Glenelg Estuary and Discovery Bay Ramsar Site Management Plan

December 2025

ACKNOWLEDGEMENT

We acknowledge Gunditjmara and Buanditj traditional owners and custodians of the land and waters of the Glenelg region. We pay our deepest respects to their Elders past and present. We acknowledge and accept the long-standing connection to Country that Traditional Owners bring to conversations and management. We value and respect the traditional knowledge that protects cultural heritage and supports future management of Gunditjmara Nyamat Mirring (Sea Country).

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Abbreviations

ANZECC	**Australia and New Zealand Environment and Conservation Council**
BD	Boundary Description
CalP Act	Catchment and Land Protection Act 1994
CAMBA	China-Australia Migratory Bird Agreement
CMA	Catchment Management Authority
BCMS	Bonn Convention on Migratory Species
CPS	components, processes and benefits/services
DCEEW	Department of the Climate Change, Energy, the Environment and Water (Australian Government)
DEECA	Department of Energy, Environment and Climate Action
DELWP	Department of Environment, Land, Water and Planning
DoEE	Department of Energy and Environment (Australian Government)
EAAF	East Asian-Australasian Flyway
ECD	Ecological Character Description
EEMSS	Estuary Entrance Management Support System
EES	Environmental Effects Statement
EPA	Environment Protection Authority
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
FSL	Full Supply Level
GEDB RCC	General Environmental Duty
GEDB RCC	Glenelg Estuary and Discovery Bay Ramsar Coordinating Committee
GPS	Global Positioning System
GSC	Glenelg Shire Council
HPAI	High Pathogenicity Avian Influenza
IEC	Index of Estuary Condition
IPA	Indigenous Protected Areas
JAMBA	Japan-Australia Migratory Bird Agreement
LAC	Limits of Acceptable Change
MERI	Monitoring, Evaluation, Reporting and Improvement

Abbreviations (continued)

NRM	Natural Resource Management
MNES	Matters of National Environmental Significance
PFAS	per- and poly-fluoroalkyl substances
RCT	Resource Condition Target
RIS	Ramsar Information Sheet
RKOAMBA	Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA)
SRW	Southern Rural Water
TOAC	Traditional Owners Aboriginal Corporation
VBA	Victorian Biodiversity Atlas
VCAT	Victorian Civil and Administrative Tribunal
VFA	Victorian Fisheries Authority
VWMS	Victorian Waterway Management Strategy

EXECUTIVE SUMMARY

The Glenelg Estuary and Discovery Bay Ramsar Site Management Plan aims to protect and enhance the site's ecological values through coordinated agency efforts. This plan builds on the previous management plan, incorporating an updated risk assessment aligned with Australian government guidelines.

Key principles guiding the development of this plan include:

- Stakeholder Involvement: Extensive consultation with Traditional Owners, management agencies, technical experts, Non-Government Organisations (NGOs), and the community.
- Evidence-Based Approach: Utilisation of the best available knowledge for risk assessment and prioritisation of values and threats.
- Precautionary Principle: Proactive measures to prevent environmental degradation despite scientific uncertainties.
- Building on Existing Activities: Leveraging ongoing regional, catchment, and site activities to enhance ecosystem services without duplicating efforts.
- Adaptive Management: A seven-year plan with a mid-term review after four years, incorporating a monitoring program based on the principles of monitoring, evaluating, reporting, and improving.

This comprehensive approach ensures the sustainable management and conservation of the Glenelg Estuary and Discovery Bay Ramsar Site (GEBD), promoting the Ramsar concept of wise use of wetlands.

The plan comprises:

- A summary of the ecological character of the site (Section 2) including, the Ramsar criteria that the site meets (Section 2.3) and the current status of ecological character against Limits of Acceptable Change (Section 2.5);
- Identification of management priorities (Section 3), through a risk assessment process (Section 3.1 and Appendix B) that determined high priority threats (Section 3.2) and critical knowledge gaps (Section 3.3);
- A review of the achievements of the previous (2017) Ramsar Site Management Plan (Section 2.6 and Appendix A);
- Refinement of resource condition targets for evaluating the success of management actions at the site (Section 4.2);
- Management strategies to be implemented over the next seven years (Section 4.3)
- A description of monitoring requirements (Section 5);
- Governance arrangements (Section 6).

1 Introduction

The Glenelg Estuary and Discovery Bay Ramsar Site Management Plan (DELWP 2017) established the framework for the maintenance of ecological character of the site through conservation and wise use. The plan is now over seven years old, and there has been significant progress in both our understanding of the ecological character of the site and strategic direction in management of the site and Ramsar wetlands in Australia. A consultative and collaborative process was undertaken to review and update the Ramsar Site Management Plan.

The Glenelg Estuary and Discovery Bay Ramsar Site Management Plan (this document), sits within a framework for the management of aquatic ecosystems within Australia and the State of Victoria, but also considers a global context (Text Box 1). At the national level, the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* establishes the basis for managing Ramsar sites. This management plan for the Glenelg Estuary and Discovery Bay Ramsar Site supplements and complements the Glenelg-Hopkins Waterway Strategy (Glenelg-Hopkins CMA 2014).

1.1 Purpose of the management plan

1.1.1 Ecological character

The “Ramsar Convention on Wetlands, especially as waterfowl habitat” was ratified in Ramsar, Iran in 1971. As of September 2025, there are 172 Contracting Parties, including Australia. Under the terms of the Convention, contracting parties nominate wetlands to be designated as Wetlands of International Importance, with nominated sites required to meet at least one of nine listing criteria. The act of designating a wetland as a Ramsar site carries with it certain obligations, including managing the site to maintain its ‘ecological character’ and to have procedures in place to detect if any threatening processes are likely to, or have altered the ‘ecological character’. The Ramsar Convention has defined “ecological character” and “change in ecological character” as (Ramsar Convention 2005):

“*Ecological character is the combination of the ecosystem components, processes and benefits/services [CPS] that characterise the wetlands at a given point in time*” and

“…*change in ecological character is the human induced adverse alteration of any ecosystem component, process and or ecosystem benefit/service*.”

Ramsar: A network of sites

There is a network of over 2000 Ramsar wetlands across the globe that is dedicated to sustaining biodiversity and wise use. One of the important functions, and a primary purpose for the establishment of the Convention, is to protect sites in different countries that are important for migratory birds.

The migratory birds that visit Australia are part of the East Asian-Australasian Flyway (EAAF) and most of them migrate from breeding grounds in North-east Asia and Alaska to non-breeding grounds in Australia and New Zealand, covering the journey of 10,000 km twice in a single year.

The lifecycle of most international migratory shorebirds involves (Bamford et al. 2008):

- breeding in May to August (northern hemisphere);
- southward migration to the southern hemisphere (August to November);
- feeding and foraging in the southern hemisphere (August to April); and
- northward migration to breeding grounds (March to May).

During both northward and southward migration, birds may stop at areas on route to rest and feed. These stopovers are referred to as “staging” areas and are important for the birds’ survival. In addition, birds on their first southward migration that have not yet reached breeding maturity and may remain in Australia over the southern winter period.

The Glenelg Estuary and Discovery Bay Ramsar Site regularly supports more than 1% of the flyway population of sanderling (*Calidris alba*) a migratory species listed under migratory agreements with China, Japan and the Republic of Korea. Important habitats within the site include intertidal mudflats and saltmarsh where migratory waders feed. High tide roosting sites, where waders can rest are also important.

Migratory waders in Australia need to build up their energy reserves for the homeward journey. This means that they not only require abundant food sources, but they need to minimise their activity. Disturbance of waders when roosting or feeding may result in a significant loss of energy. This may even compromise their ability to build up enough reserves to complete the return journey to breeding grounds. Disturbance of migratory shorebirds may occur as a result of recreational fishing (in some instances), four-wheel driving on beaches or in saltmarsh and intertidal areas, unleashed dogs, boating and jet skiing and any activity in the intertidal zone that causes significant noise or light. Migratory waders are also susceptible to predation by foxes and cats.

Populations of many migratory wader species are in decline, primarily through loss of habitat in breeding and staging areas outside Australia. This makes them more vulnerable while in Australia and increases the importance of maintaining habitat and conditions at overwintering sites. Residents and visitors to Glenelg Estuary and Discovery Bay need to work together to help protect and conserve these important species.

Text Box 1. A network of Ramsar Sites and the East Asian-Australasian Flyway (EAAF).

Under Article 3.2 of the Ramsar Convention, a notification of change is required if the ecological character of a site has changed, is changing, or *is likely* to change as the result of human activities. The Australian Government has established a number of principles to guide notifications in Australia (Department of the Environment, Water Heritage and the Arts 2009):

- Assessment of change will be undertaken with respect to *critical* components, processes, and benefits/services of the ecological character of the site;
- An assessment of change to support a notification must be based on best available science;
- The fact that a site was undergoing human-induced ecological character change at the time of listing does not preclude the need for an assessment, and possible notification of change, if there is evidence of significant ongoing adverse ecological change;
- Where the natural variability of a site cannot reasonably be established for the critical component process, benefit, or service against which change is being assessed, a notification, if made, will only be on the basis of *'is likely to'* change;
- A notification will not be made where the apparent character change has been identified as arising from the use of inadequate data sets at the time of listing;
- A notification will not be made where climate change is the principal cause of identified ecological character change.

Ramsar site management to maintain ecological character is reliant on a number of key documents and processes as illustrated in Figure 1. The four key documents are:

Ramsar Information Sheet (RIS) - compiled for each site and documents the essential information related to the site and its management. The Administrative Authority of each Contracting Party submits the RIS to the Ramsar Secretariat. In the case of Australia, this is the Australian Government Department of the Climate Change, Energy, the Environment and Water (DCCEEW). RIS information is updated every six years, or on the occasion of any significant change in a site's ecological character. The RIS for the Glenelg Estuary and Discovery Bay Ramsar Site can be obtained from the DCCEEW website: (https://www.environment.gov.au/water/topics/wetlands/database/pubs/67-ris.pdf).

Boundary Description (BD) – it is a requirement of the Ramsar Convention that a suitable map or maps are provided for each listed wetland. The Australian Government requires that both the written description and the spatial data of the Ramsar site boundaries are accurate. This information is used to gazette the boundary of the declared Ramsar wetland in accordance with Section 327 of the EPBC Act). The BD for the Glenelg Estuary and Discovery Bay Ramsar Site can be obtained from the Department of Energy, Environment and Climate Action (DEECA) website: (https://www.water.vic.gov.au/__data/assets/pdf_file/0028/672814/Glenelg-Ramsar-Boundary-Description_Final.pdf).

Ecological Character Description (ECD) – provides a more detailed and quantitative description of ecological character for a Ramsar site. The ECD establishes a benchmark, at the time of listing, which in the case of the Glenelg Estuary and Discovery Bay is 2017. The ECD identifies the critical components, processes and services of the site (critical CPS) and sets limits of acceptable change (LAC). The Australia Government has developed a standard method for describing ecological character (Department of the Environment, Water, Heritage and the Arts 2008). The ECD for the Glenelg Estuary and Discovery Bay Ramsar

Site was completed in 2017 and can be accessed from the DEECA website: (https://www.water.vic.gov.au/__data/assets/pdf_file/0030/672816/Glenelg_ECD_Final.pdf).

Management plan – documents the management strategies required to protect and improve the ecological character of a Ramsar site. In Australia, the EPBC Act establishes the framework for management of Australian Ramsar sites, and Schedule 6 of the EPBC Act Regulations outlines the principles relevant to the preparation of Ramsar Site Management Plans (Text Box 2).

Ramsar Site Management Plans must adhere to these principles. Of note is that the primary purpose of the management plan must be in accordance with the Ramsar Convention:

- to describe and maintain the ecological character of the wetland;
- to formulate and implement planning that promotes:
    - conservation of the wetland;
    - wise and sustainable use of the wetland for the benefit of humanity in a way that is compatible with maintenance of the natural properties of the ecosystem.

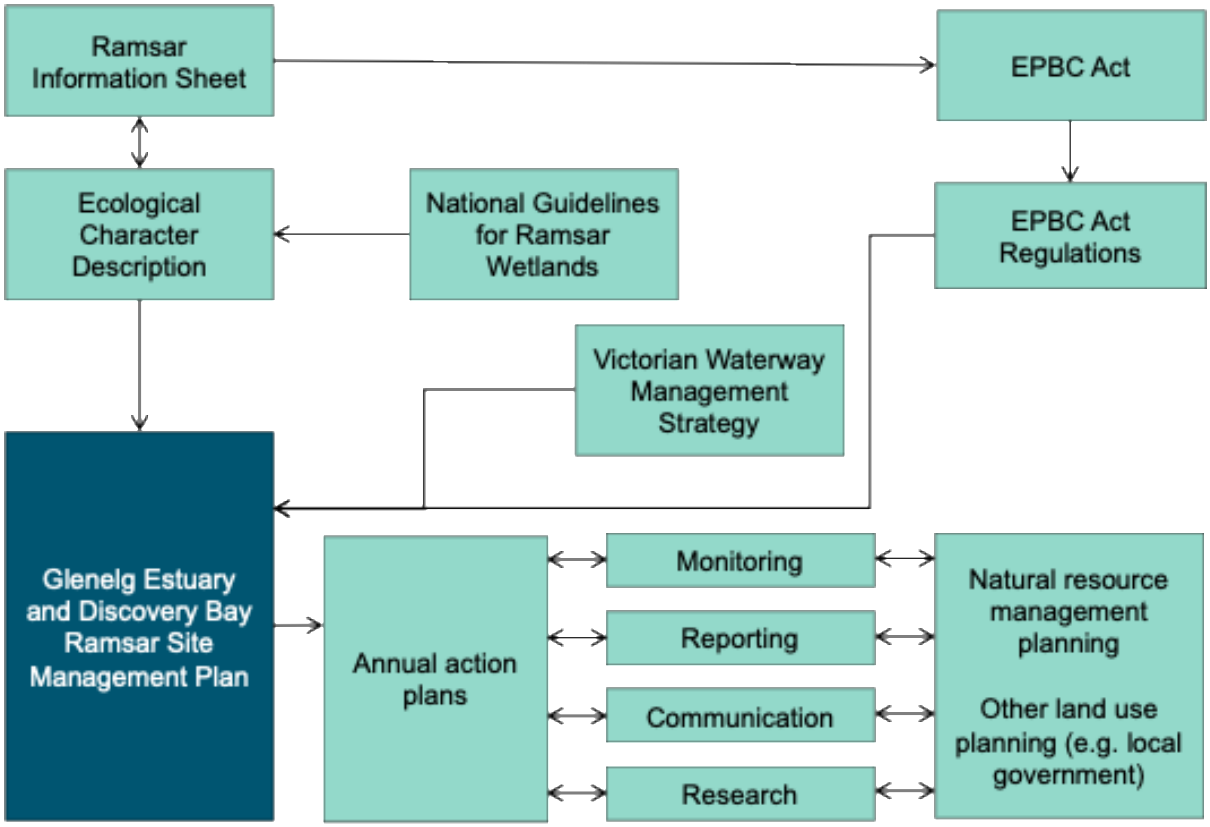


Figure 1. The Glenelg Estuary and Discovery Bay Ramsar Site Management Plan in context of other requirements for the management of Ramsar sites (adapted from the Department of the Environment, Water, Heritage and the Arts 2008).

1.2 Objectives of the management plan

The primary purpose of the Glenelg Estuary and Discovery Bay Ramsar Site Management Plan is to maintain ecological character and promote wise use of the site. Wise use is defined by the Convention as (Ramsar Convention 2005):

"*the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development*".

The Glenelg Estuary and Discovery Bay Ramsar Site supports a number of socio-economic and cultural values that result from maintaining the condition of the Ramsar site. This plan has adopted the principle that by maintaining (or improving) ecological character, the socio-economic and cultural values associated with the Ramsar site will also be conserved, within the concept of wise use. Therefore, the primary objective of the Glenelg Estuary and Discovery Bay Ramsar Site Management Plan is:

"***To maintain, and where necessary improve, the ecological character of the Glenelg Estuary and Discovery Bay Ramsar Site and promote wise and sustainable use***".

1 General principles

1.01 The primary purpose of management of a declared Ramsar wetland must be, in accordance with the Ramsar Convention:

(a) to describe and maintain the ecological character of the wetland; and

(b) to formulate and implement planning that promotes:

(i) conservation of the wetland; and

(ii) wise and sustainable use of the wetland for the benefit of humanity in a way that is compatible with maintenance of the natural properties of the ecosystem.

1.02 Wetland management should provide for public consultation on decisions and actions that may have a significant impact on the wetland.

1.03 Wetland management should make special provision, if appropriate, for the involvement of people who:

(a) have a particular interest in the wetland; and

(b) may be affected by the management of the wetland.

1.04 Wetland management should provide for continuing community and technical input.

2 Management planning

2.01 At least one management plan should be prepared for each declared Ramsar wetland.

2.02 A management plan for a declared Ramsar wetland should:

(a) describe its ecological character; and

(b) state the characteristics that make it a wetland of international importance under the Ramsar Convention; and

(c) state what must be done to maintain its ecological character; and

(d) promote its conservation and sustainable use for the benefit of humanity in a way that is compatible with maintenance of the natural properties of the ecosystem; and

(e) state mechanisms to deal with the impacts of actions that individually or cumulatively endanger its ecological character, including risks arising from:

(i) physical loss, modification or encroachment on the wetland; or

(ii) loss of biodiversity; or

(iii) pollution and nutrient input; or

(iv) changes to water regimes; or

(v) utilisation of resources; or

(vi) introduction of invasive species; and

(f) state whether the wetland needs restoration or rehabilitation; and

(g) if restoration or rehabilitation is needed--explain how the plan provides for restoration or rehabilitation;

(h) provide for continuing monitoring and reporting on the state of its ecological character; and

(i) be based on an integrated catchment management approach; and

(j) include adequate processes for public consultation on the elements of the plan; and

(k) be reviewed at intervals of not more than 7 years.

3 Environmental impact assessment and approval

3.01 This principle applies to the assessment of an action that is likely to have a significant impact on the ecological character of a Ramsar wetland (whether the action is to occur inside the wetland or not).

3.02 Before the action is taken, the likely environmental impact of the action on the wetland's ecological character should be assessed under a statutory environmental impact assessment and approval process.

3.03 The assessment process should:

(a) identify any part of the ecological character of the wetland that is likely to be affected by the action;

(b) examine how the ecological character of the wetland might be affected; and

(c) provide adequate opportunity for public consultation.

3.04 An action should not be approved if it would be inconsistent with:

(a) maintaining the ecological character of the wetland; or

(b) providing for the conservation and sustainable use of the wetland.

3.05 Approval of the action should be subject to conditions, if necessary, to ensure that the ecological character of the wetland is maintained.

3.06 The action should be monitored by the authority responsible for giving the approval (or another appropriate authority) and, if necessary, enforcement action should be taken to ensure compliance with the conditions.

Text Box 2. Australian Ramsar Management Principles

1.3 Relevant policy and legislation

1.3.1 International

Ramsar Convention

The Convention on Wetlands of International Importance, otherwise known as the Ramsar Convention, was signed in Ramsar Iran in 1971 and came into force in 1975. It provides the framework for local, regional and national actions, and international cooperation, for the conservation and wise use of wetlands. Wetlands of International Importance are selected on the basis of their international significance in terms of ecology, botany, zoology, limnology and/or hydrology.

Migratory bird bilateral agreements and conventions

Australia is party to a number of bilateral agreements, initiatives and conventions for the conservation of migratory birds, which are relevant to the Glenelg Estuary and Discovery Bay Ramsar Site. The bilateral agreements are:

- *Japan-Australia Migratory Bird Agreement (JAMBA)* – The agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and their Environment, 1974;
- *China-Australia Migratory Bird Agreement (CAMBA)* - The Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment, 1986;
- *Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA)* - The Agreement between the Government of Australia and the Republic of Korea for the Protection of Migratory Birds and their Environment, 2006; and
- *The Bonn Convention on Migratory Species (CMS)* - The Bonn Convention adopts a framework in which countries with jurisdiction over any part of the range of a particular species co-operate to prevent migratory species becoming endangered. For Australian purposes, many of the species are migratory birds.

1.3.2 National

Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

The EPBC Act regulates actions that will have or are likely to have a significant impact on any matter of national environmental significance, which includes the ecological character of a Ramsar wetland (EPBC Act 1999 s16(1)). An action that will have or is likely to have a significant impact on a Ramsar wetland will require an environmental assessment and approval under the EPBC Act. An 'action' includes a project, a development, an undertaking or an activity or series of activities (http://www.environment.gov.au/epbc/index.html).

The EPBC Act establishes a framework for managing Ramsar wetlands, through the Australian Ramsar Management Principles (EPBC Act 1999 s335), which are set out in Schedule 6 of the *Environment Protection and Biodiversity Conservation Regulations 2000*. These principles are intended to promote national standards of management, planning, environmental impact assessment, community involvement, and monitoring, for all of Australia's Ramsar wetlands in a way that is consistent with Australia's obligations under the Ramsar Convention. The Regulations also cover matters relevant to the preparation of management plans, environmental assessment of actions that may affect the site, and the community consultation process (Text Box 3).

Native Title Act 1993

This Act provides for the recognition and protection of native title. It establishes ways in which future dealing affecting native title may proceed and sets standards for such dealing. It establishes a mechanism for determining claims to native title. It provides for, or permits, the validation of past acts, and intermediate period acts, invalidated because of the existence of native title.

1.3.3 Victorian state policy and legislation

Crown Land (Reserves) Act 1978

This Act provides the framework for the administration and management of Crown land reserves including nature conservation reserves. The Act also deals with the making of regulations, committees of management and leasing and licensing.

Environmental Effects Act 1978

This Act requires the assessment of the potential significant environmental impacts of a proposed development through the preparation of an Environmental Effects Statement (EES).

The Environment Protection Act 2017

This Act establishes the Environment Protection Authority (EPA) and makes provision for the Authority's powers, duties and functions. It includes environmental obligations and protections that apply to all Victorian's and includes a general environmental duty (GED). The EPA's objective is to protect human health and the environment by reducing the harmful effects of pollution and waste. The GED falls under the Environment Protection Act 2017 and breaching the GED can lead to criminal or civil penalties

Fisheries Act 1995

The Act provides a framework for the regulation, management and conservation of Victorian fisheries. It deals with commercial and recreational licences, fish culture, noxious aquatic species, research and development, the declaration and management of fisheries reserves; and the preparation of management plans for individual fisheries, declared noxious aquatic species and fisheries reserves.

Flora and Fauna Guarantee Act 1988

The Act provides a legislative and administrative framework for the conservation of biodiversity in Victoria. The Act provides for the listing of threatened taxa, communities and potentially threatening processes. It requires the preparation of action statements for listed species, communities and potentially threatening processes, and sets out the process for implementing interim conservation orders to protect critical habitats. The Act also seeks to provide programs for community education in the conservation of flora and fauna and to encourage co-operative management of flora and fauna.

Groundwater (Border Agreement) Act 1985

The Act provides a framework for the joint management of groundwater resources within a 40 km wide strip along the length of the South Australian and Victorian Border. The Border Review Committee, comprising members of the relevant water management authorities in both South Australia and Victoria, administers the Act. A Technical Working Group, reporting to and directed by the Review Committee, conducts investigations of the groundwater resources within the area covered by the Act.

Heritage Rivers Act 1992

The main purpose of this Act is to prohibit the construction in heritage river areas of new impoundments, barriers and structures that impede the passage of water and fauna. Heritage rivers are designated because of their very high nature conservation, recreational, social or cultural value or because of a combination of these values.

Marine and Coastal Act 2018

This Act provides an integrated and coordinated approach to planning and managing the marine and coastal environment. It enables protection of the coastline, supports responses to long-term challenges such as climate change, population growth, and ageing coastal structures. The Act also calls on partners work together to achieve the best outcomes for Victoria's marine and coastal environment.

National Parks Act 1975

The Act makes provision for the preservation and protection of the natural environment including wilderness areas and remote and natural areas. This includes the protection and preservation of indigenous flora and fauna and of features of scenic or archaeological, ecological, geological, historic or other scientific interest in those parks. It allows for the study of ecology, geology, botany, zoology and other sciences relating to the conservation of the natural environment in those parks, and for the responsible management of the land in those parks.

Parks Victoria Act 2018

The Act governs Parks Victoria, a statutory authority responsible for managing Victoria's parks and reserves. This Act updates the previous Parks Victoria Act 1998, and outlines the responsibilities and powers of Parks Victoria in managing over 18% of Victoria's landmass and 70% of its coastline.

Parks Victoria works in partnership with Traditional Owners to manage these areas in a culturally sensitive and ecologically appropriate way. The Act ensures that parks are maintained for the benefit of current and future generations, promoting environmental and cultural values.

Water Act 1989

The Act establishes rights and obligations in relation to water resources and provides mechanisms for the allocation of water resources. This includes the consideration of environmental water needs of rivers and wetlands, as well as for human uses such as urban water supply and irrigation.

Wildlife Act 1975

The Act ensures procedures are in place to protect and conserve Victoria's wildlife and prevent any taxa of wildlife from becoming extinct. The Act also provides for the establishment of State Game Reserves. Regulations under the Act ensure that the consumptive use or other interactions with flora and fauna in Victoria does not threaten the sustainability of wild populations, while facilitating cultural and recreational pursuits in a humane, safe, ethical and sustainable manner.

Catchment and Land Protection Act 1994 (CaLP Act)

The Act sets up a framework for the integrated management and protection of catchments. It establishes processes to encourage and support community participation in the management of land and water resources, and provides for a system of controls on noxious weeds and pest animals.

Aboriginal Heritage Act 2006

The Act provides for the protection and management of Victoria's Aboriginal heritage. It establishes the Victorian Aboriginal Heritage Council to advise the Minister in the management of cultural heritage and registered Aboriginal parties. The Act also deals with cultural heritage management plans, cultural heritage permits and agreements. The Act also includes enforcement provisions and processes for handling dispute resolution. This includes the review of certain decisions through the Victorian Civil and Administrative Tribunal (VCAT).

Victorian Waterway Management Strategy

The Victorian Waterway Management Strategy (VWMS) provides the framework for government in partnership with the community, to maintain or improve the condition of rivers, estuaries and wetlands so that they can continue to provide environmental, social, cultural and economic values for all Victorians. The framework is based on regional planning processes and decision-making, within the broader system of integrated catchment management in Victoria. The existing Victorian Waterway Management Strategy was released in 2013 and has reached the end of its lifespan. A new VWMS is currently in development and is due to be released in 2026.

Water is Life Traditional Owner Access to Water Roadmap

The foundational document provides a pathway to outcomes of integrity for Traditional Owners, recognising the importance of Country, people and water. The roadmap outlines how Caring for Country and water will deliver strong cultural economies and benefits for all Victorians, now and into the future. Further information can be found on the DEECA website:

https://www.water.vic.gov.au/our-programs/aboriginal-water-program/water-is-life-roadmap

1.3.4 Regional plans and policy

There are a very large number of regional and local plans that are relevant to the management of the Glenelg Estuary and Discovery Bay Ramsar Site. A few of the most significant of these are outlined on the Glenelg Hopkins CMA's website here: https://www.ghcma.vic.gov.au/about-us/strategies-plans-and-reports/.

Glenelg Hopkins Regional Catchment Strategy (RCS)

RCSs are statutory documents under the CaLP Act that provide the overarching framework for land, water and biodiversity management and conservation in each of the 10 catchment management regions of Victoria.

The RCS is the primary planning document for the Glenelg Hopkins region. It identifies priorities for natural resource management for water and biodiversity and provides a framework for integrated management of catchments. The RCS for the Glenelg Hopkins region can be found here: https://glenelghopkins.rcs.vic.gov.au/.

Glenelg Hopkins Waterway Strategy

Regional waterway strategies have been developed for each of the 10 catchment management regions in Victoria. These sit under the VWMS and RCS frameworks and outline the detailed planning and management for rivers, estuaries and wetlands across the State. The Glenelg Hopkins Waterway Strategy (Glenelg Hopkins CMA 2014) was guided by the direction and principles outlined in the VWMS. The 2014 regional waterway strategies are being updated and will be released in 2026.

Ngootyoong Gunditj Ngootyoong Mara South West Management Plan

The Ngootyoong Gunditj Ngootyoong Mara South West Management Plan (Parks Victoria 2015) has been developed to provide a strategic guide for managing and protecting the parks, reserves and Aboriginal community owned properties (referred to as Indigenous Protected Areas - IPAs) of south-western Victoria. The plan reflects a new approach by setting goals and priorities across National, State, Coastal, Forest and Regional parks and reserves and IPAs, including the cooperative management of Budj Bim National Park. This approach recognises Gunditjmara Countries (River Forest Country, Stone Country, Forest Country and Sea Country) and natural ecosystems in developing strategies for management. The strategies take a practical approach that recognises both the purpose of the parks and reserves and the Gunditjmara Traditional Owners' role in managing these special areas.

Gunditjmara Nyamat Mirring Plan

The Nyamat Mirring Plan outlines for Gunditjmara, and for others who use or have an interest in Gunditjmara Country, what Gunditjmara are concerned about and what changes need to be made to enable Gunditjmara to fulfil their responsibilities to Country.

Through this Plan, Gunditjmara assert their responsibilities to Nyamat Mirring through their cultural obligation to Mirring, to Ceremony, to Learnings/Lore, to Wurrung (language) and Relationships. The Plan also identifies the ongoing harms that impact Nyamat Mirring, and barriers that limit the Gunditjmara's opportunities for enacting self-determination through power over decision-making, management, and economic interests. The Plan provides a framework that describes the goals for Nyamat Mirring and identifies priority actions to achieve those goals.

Glenelg Hopkins Biodiversity and Agricultural Natural Capital Emergency Preparedness and Response Plan

This plan aims to enhance preparedness and response to emergency events that could severely impact biodiversity and agricultural natural capital in the Glenelg Hopkins Natural Resource Management (NRM) region. It focuses on increasing resilience by recognising risks from natural disasters and implementing mitigation and recovery actions. The scope is limited to climate-driven disaster events, particularly those affecting priority species and ecological communities listed under relevant conservation acts, and agricultural resources like soil and water. The plan considers the feasibility of actions and future viability, addressing threats from drought, heatwaves, fires, floods, and storm surges.

Glenelg Estuary and Discovery Bay Ramsar Site Coordinating Committee

The primary purpose of the Glenelg Estuary and Discovery Bay Ramsar Coordinating Committee (GEDB RCC) is to oversee and coordinate the implementation of the Glenelg Estuary and Discovery Bay Ramsar Site Management Plan (Management Plan).

The key responsibilities of the GEDB RCC are to:

- Oversee implementation of the Management Plan by undertaking the following actions:
    - Prioritise annual Management Plan activities that ensure the best possible use of available resources;
    - Develop an annual Action Plan that determines and assigns agreed responsibility for actions and develop annual investment proposals;

    - Review the Management Plan progress, tracking activities and outputs twice per year.
- Ensure up-to-date information is provided for input to the Ramsar Management System;
- Evaluate investment proposals to undertake activities to implement the Management Plan;
- Oversee the development and implementation of the Glenelg Estuary and Discovery Bay Ramsar Site Monitoring, Evaluation, Reporting and Improvement (MERI) plan, to assess the status of ecological character and management effectiveness.

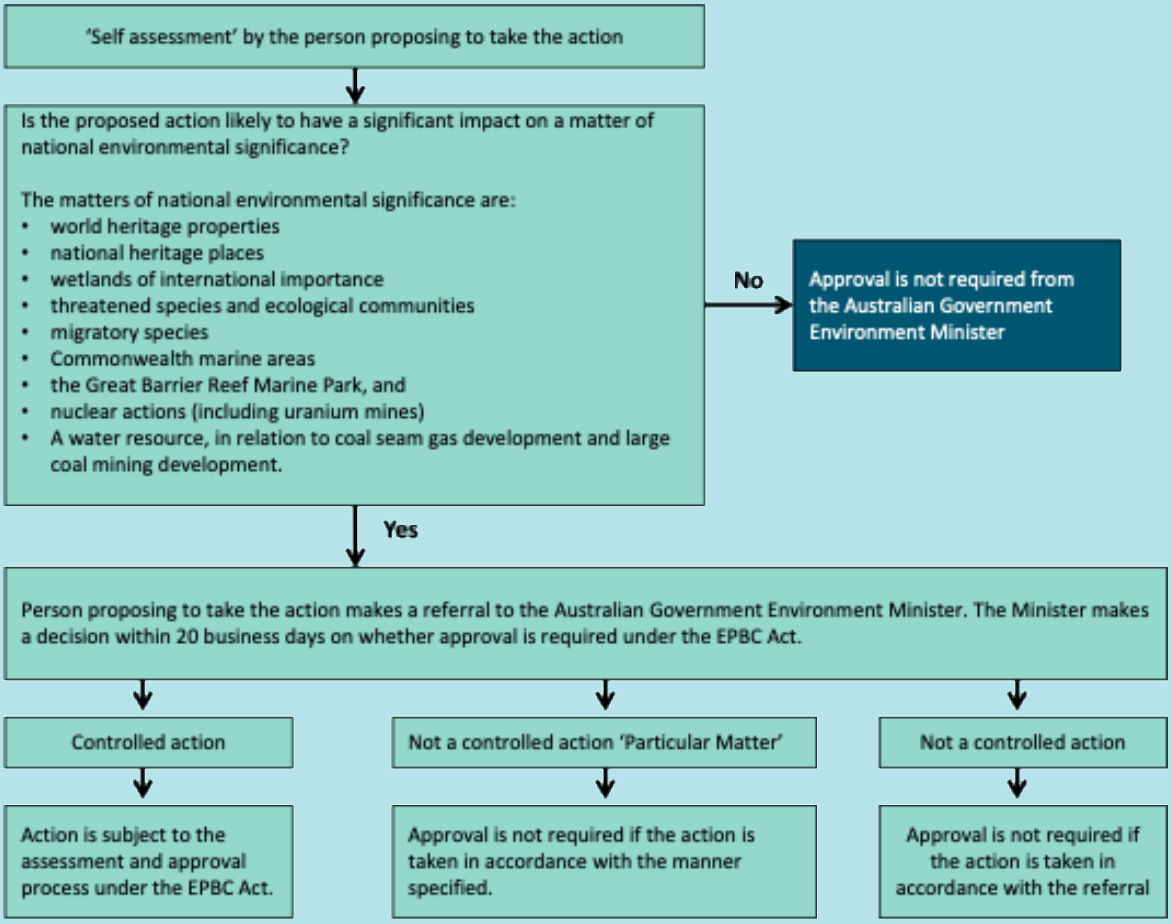
The GEDB RCC was established in 2018 and contains representatives from by the following agencies:

- Glenelg Hopkins CMA;
- Parks Victoria;
- Gunditj Mirring Traditional Owners Aboriginal Corporation (Gunditj Mirring TOAC);
- DEECA Barwon South West Region;
- Glenelg Shire Council (GSC);
- Southern Rural Water (SRW);
- Victorian Fisheries Authority (VFA).

Representatives from DCCEEW and DEECA Waterway Policy and Programs Branch participate in the GEDB RCC as observers as these agencies undertake state-wide and Australia-wide coordination and governance roles.

Assessing the impact of major projects on Ramsar sites

Under the EPBC Act, a person must not take an action that has, will have or is likely to have a significant impact on any of the matters of environmental significance without approval from the Australian Government Minister for the Environment. In this context, an 'action' is a project, a development, an undertaking, an activity or a series of activities, or an alteration of any of these things. The EPBC Act referral process comprises several steps:



Although the EPBC referral process begins with "self assessment", there are strict penalties for not referring an action. A person who takes an action that is likely to have a significant impact on a matter of national environmental significance, without first obtaining approval, can be liable for a civil penalty of up to $900,000 for an individual and $9 million for a body corporate, or for a criminal penalty of seven years imprisonment.

DEECA administers the statutory environmental impact assessment system for major projects in Victoria with potentially significant environmental effects. This includes referrals to the Minister for Planning for Environmental Effects Statements (EES) under the *Environment Effects Act 1978* as well as assessment and approvals for major transport projects under the *Major Transport Projects Facilitation Act 2009*. In addition, Victoria has a bilateral agreement with the Commonwealth for environmental impact assessments that avoids duplication of assessment processes. It essentially allows the Commonwealth to use the assessments made by Victoria to inform decisions about impacts to matters of national environmental significance (which includes Ramsar sites) under the EPBC Act.

This is a very simplified summary of the process, for more information, refer to the DEECA website: https://www.planning.vic.gov.au/environmental-assessments/environmental-assessment-guides/environment-effects-statements-in-victoria and the Australian Government Department of Climate Change, Energy, the Environment and Water website https://www.dcceew.gov.au/environment/epbc/approvals

Text Box 3. Assessing the impact of major projects on Ramsar Sites in Victoria.

1.4 About this management plan

The Glenelg Hopkins CMA facilitated the renewal the 2017 Glenelg Estuary and Discovery Bay Ramsar Site Management Plan. The project was based on a robust and transparent method to analyse and prioritise values and threats within the Ramsar site, with the aim of maintaining and where possible, restoring the ecological character of the site, within a coordinated and collaborative framework for management. Further detail on the methods used is provided in the sections below:

- Risk assessment – Section 3.1;
- Identification of priority threats – Section 3.2;
- Management strategies – Section 4.

1.4.1 Principles of the planning process

Throughout the development of the Glenelg Estuary and Discovery Bay Ramsar Site Management Plan, a number of principles were adopted and underpinned the planning process, consistent with the Australian Ramsar Site Management Principles (Text Box 2) and the Victorian Waterway Management Strategy (DEECA in prep.).

- Stakeholder involvement – this plan has been developed with the input of a broad range of stakeholders through every phase. This consultation included Traditional Owners, agencies with a role in management of the site, technical experts, non-government organisations and the general community (see below);
- Evidence-based approach – best available knowledge has been used to underpin the development of this plan including the risk assessment and prioritisation of values and threats;
- Precautionary principle – lack of full scientific certainty was not seen as a reason for postponing cost-effective measures to prevent environmental degradation;
- Building on existing activities – there are a large number of activities already being implemented within the region, catchment and site to maintain and improve condition and ecosystem services. This plan seeks to build on these existing activities rather than duplicate effort;
- Adaptive management – the plan life is for seven years, with a mid-term review after four years. A monitoring program has been included and the principles of monitor, evaluate, report and improve have been adopted.

1.4.2 Stakeholder involvement

The importance of stakeholder engagement in the development of management plans for Ramsar sites is recognised by the Convention and in the Australian Ramsar Management Principles (Text Box 2). In terms of the development of this Ramsar Site Management Plan, stakeholders were involved in every step of the process (Table 1).

The major groups involved in the development of this project were:

Project Steering Committee (PSG): Representatives of agencies primarily responsible for the management of the Ramsar site (Glenelg Hopkins CMA, DEECA, Parks Victoria, Gunditj Mirring TOAC).

Glenelg Estuary and Discovery Bay Ramsar Coordinating Committee (GEDB RCC): Members comprise representative of the following organisations: Glenelg Hopkins CMA, DEECA (Barwon South West region), Parks Victoria, Gunditj Mirring TOAC, GSC, VFA and SRW. Representatives from DCCEEW and DEECA (Waterway Policy & Programs Branch)

participate as an observer as their substantive role reports directly to the Ramsar Secretariat based on information received from Victoria's Ramsar Coordinator lead, DEECA.

Technical Experts:

1. Technical experts in their respective fields were contacted individually for advice / input and included individual and organisations with extensive knowledge of the site and the biota they support. This included:
    - Parks Victoria;
    - Glenelg Hopkins CMA;
    - BirdLife Australia;
    - Nature Glenelg Trust;
    - Australis Biological;
    - Karl Just (ecological consultant);
    - Arthur Rylah Institute;
    - Deakin University.

Community: Broader community and stakeholder engagement through local workshops at Nelson and Portland and a public consultation process through the Engage Victoria platform (https://engage.vic.gov.au/).

1.4.3 Working with Traditional Owners

Glenelg Hopkins CMA work with the Gunditj Mirring TOAC under a memorandum of understanding on all projects and are represented on the GEDB RCC. The Gunditjmara are one of the primary guardians, keepers and knowledge holders of Aboriginal cultural heritage for the area. Gunditjmara representatives were directly consulted in June 2015 and again in 2025 to discuss how traditional knowledge might be introduced to the management of the Site.

The goals and management strategies of the plan were presented through workshop and meeting processes. Gunditj Mirring staff worked with the team to collaboratively build the Ramsar Site Management Plan. The outcome of this process was a statement illustrating importance of Country and support for the nomination and continued involvement for managing this important area (Text Box 4).

In addition, a working relationship exists with South East Aboriginal Focus Group and Burrandies Aboriginal Corporation, who together provide representation of the Traditional Owner family clan groups of the Buanditj people. Like the shared boundary with Gunditjmara along Bochara and Koonang Gunditj, Buanditj people support the shared role of protecting and restoring these ecosystems for future generations.

Consistent with Victorian Government policy, Traditional Owner groups are invited on a preferential basis to delivery activities to manage the Ramsar site.

Table 1. Summary of stakeholder participation in the renewal of the Glenelg Estuary and Discovery Bay Ramsar Site Management Plan

Task	Stakeholder involvement	Outputs
Defining the scope and focus of the 2025 Ramsar Site Management Plan	Online workshop with the GEDB RCC, plus representatives from Nature Glenelg Trust.	Agreed approach, identification of additional knowledge and data relevant to the status of ecological character and threats to the site.
Review of the 2017 Ramsar site management plan	Online workshop with the GEDB RCC, plus representatives from Nature Glenelg Trust. Out of session commentary from agencies with a role in site management.	Summary of achievements, cross referencing of management activities against management strategies.
Risk assessment	Online workshop with the GEDB RCC, plus representatives from Nature Glenelg Trust, BirdLife Australia, Australis Biological, Arthur Rylah Institute. Additional input from technical experts (Deakin University, Karl Just).	Updated risk assessment. Priority threats and values for management in the life of the Ramsar Site Management Plan.
Resource Condition Targets	Online workshop with the GEDB RCC. Two additional online meetings based on themes (vegetation and fauna) with technical experts (Parks Victoria, Nature Glenelg Trust, Karl Just, Australis Biological).	Refined Resource Condition Targets.
Management strategies	Online workshop with the GEDB RCC. Out of session commentary from site managers.	Agreed management strategies
Reporting	Draft reports circulated to the GEDB RCC members.	Final draft reports for public consultation.
Public consultation	Public information session at Nelson. Public consultation process through the Engage Vic portal.	Feedback from stakeholders that was taken to the GEDB RCC for review and updates made to the final Glenelg Estuary and Discover Bay Ramsar Site Management Plan.

The authors of this report acknowledge the Gunditj Mirring TOAC as one of the primary guardians, keepers and knowledge holders of Aboriginal cultural heritage for the area being nominated for Ramsar listing as a Wetland of International Importance. As such, guidance and collaboration was sought to strengthen the case for nominating the site through recognition of Country. The Gunditj Mirring TOAC provided the following statement in support of the nomination of part of Country as a Ramsar site.

Creation	• At the start of the Yakinitj, Prenheal sent bolitabolita Creation Beings muyuban tungatt, woorrowarook, bocara and koonang.
Continuing Connection	• For Gunditjmara, 'Country' includes all living things–none better than the other but equal in its importance in forming this diverse natural landscape that is Gunditjmara Country. • Country means people, plants and animals alike. It embraces the seasons, stories and spirits of the creation. • This flowing, connected cultural landscape possesses its own sacred places, languages, ceremonies, totems, art, clan groupings and law. • These features are seen as inseparable and make up what is known as Country. • Our Country is a place of belonging and pride that comes with this belonging.
Impact	• Gunditjmara, other people and climate change have impacted on the profile and ecology of the Bocara Estuary and Koonang Gunditj. • The original sequence of river flow, pools and wetlands are now severely affected and the habitat and refuge provided for birds and their ecology being reduced along the Bocara Estuary and Koonang Gunditj.
Understanding Ramsar	• To help protect and conserve wetlands that provide important habitats, Gunditjmara understand the Convention on Wetlands, called the Ramsar Convention, as an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.
Supporting Ramsar	• Gunditjmara welcome a Ramsar listing for the areas identified in the Bocara Estuary and Koonang Gunditj to exist alongside our continued connection to Gunditj identified by the Ramsar nomination and our rights and interests recognised in 1997 and 2007 by Commonwealth and Victorian legislation.
Continuing Connection	• We all have a right and responsibility to care for Country, working together with respectful conversations to achieve our aspirations for Country. • We recognise the connections between people and Country; between communities and Country – past, present and future. Forever. • We will work together to restore and improve ecosystems so that they are intact and resilient.

Text Box 4.Gunditj Mirring Traditional Owners Statement of Continuing Connection and Commitment.

2 Glenelg Estuary and Discovery Bay Ramsar Site

A complete description of the ecological character of the Glenelg Estuary and Discovery Bay Ramsar Site is contained in the ECD (DELWP 2017). A summary of this information relevant to the management plan for the site is provided below.

2.1 Location

The Glenelg Estuary and Discovery Bay Ramsar Site is located adjacent to the South Australian border approximately 430 km west of Melbourne in the State of Victoria in south-east Australia. The Ramsar site covers approximately 22,280 ha and comprises the western part of Lower Glenelg National Park from the South Australian border to Nelson - Winnap Road, most of the Discovery Bay Coastal Park and the Nelson Streamside Reserve. The boundary excludes the portions of the Glenelg Estuary that lie within South Australia as well as 600 metres of the estuary channel adjacent to the town of Nelson (Figure 2).

The Ramsar site has three main systems (management units) represented by wetlands within freshwater, estuarine and beach environments:

1. **Freshwater wetlands** - Long Swamp wetlands, Bridgewater Lakes and other freshwater systems along approximately 50 km of the Discovery Bay Coastal Park.
2. **Estuary** - Glenelg River Estuary and associated Oxbow Lake and streamside reserve at the township of Nelson (excluding the Crown Land Reserve in the immediate vicinity of Nelson), along with the western part of the Lower Glenelg National Park from the South Australian border to Nelson - Winnap Road and excludes the Moleside Creek portion of the national park.
3. **Beach and dune field** - dune fields and beach down to the low water mark along the Discovery Bay Coastal Park, extending from the South Australian border to Discovery Bay Road.

2.2 Land use and tenure

Major land uses adjacent to the site include forestry (primarily pine plantations) and grazing of improved and natural pastures. Land tenure within the Ramsar site is summarised in (Table 2). Both the National Park and Coastal Park are managed by Parks Victoria in partnership with local stakeholders (Parks Victoria 2015).

Table 2. Land tenure within Glenelg Estuary and Discovery Bay Ramsar Site.

Description	Area (hectares)
Crown land – National Park managed by Parks Victoria in partnership with local stakeholders	13,272
Crown land – Crown reserve	36
Crown land – Coastal Park managed by Parks Victoria in partnership with local stakeholders	8,974
Total area	22,282

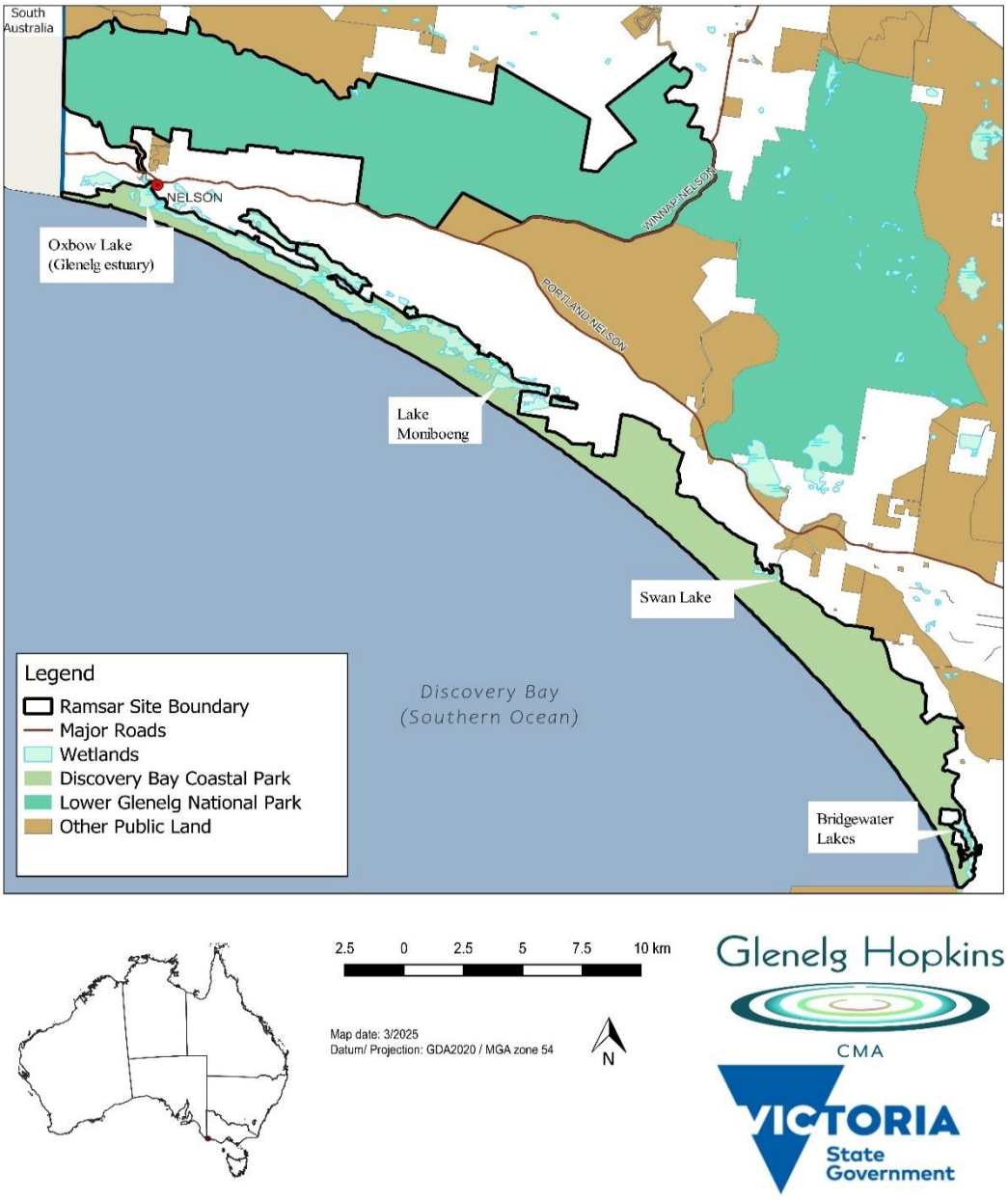


Figure 2. Location of the Glenelg Estuary and Discovery Bay Ramsar Site.

2.3 Criteria met

For a site to be designated under the Ramsar Convention, it must meet at least one of nine criteria for identifying wetlands of international importance. Glenelg Estuary and Discovery Bay meets six of the nine criteria. It does not meet criteria 3, 5 or 7. Table 3 sets out the Ramsar criteria that are met by Glenelg Estuary and Discovery Bay.

Table 3: Current criteria for Identifying Wetlands of International Importance, those that Glenelg Estuary and Discovery Bay meets are 1, 2, 4, 6, 8 and 9 as indicated by highlights

Criteria
1. A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.
2. A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.
3. A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.
4. A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.
5. A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds.
6. A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.
7. A wetland should be considered internationally important if it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity.
8. A wetland should be considered internationally important if it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.
9. A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of wetland-dependent non-avian animal species.

Justification for Glenelg Estuary and Discover Bay meeting Ramsar criteria 1,2,4,6,8 and 9 is provided below.

Criterion 1: A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.

The application of this criterion must be considered in the context of the bioregion within which the site is located. The Southeast Coast (Victoria) Drainage Division extends from the New South Wales – Victorian border along the coast to the Millicent basin in South Australia. The Ramsar guidance for this criterion indicates that the justification should be based on wetland type and hydrology. The Glenelg Estuary and Discover Bay Ramsar Site meets this criterion with respect to rare wetland types in the bioregion (and globally) peat wetlands and dune slack wetlands; and the Glenelg Estuary, which is considered a good near-natural representative of wetland type E (palustrine) in the bioregion.

The peatlands of the Ramsar site are fen wetlands (i.e. groundwater dependent) and largely have an intact hydrology. These are a rare wetland type globally, with nearby Piccaninnie Ponds Karst Wetlands Ramsar Site perhaps representing the only other significant fen wetland in the bioregion.

The site is geomorphically significant as it includes a humid dune slack system, which is rare in Australia. The dune slack system supports peatlands, wet grassland habitats and temporary pools, which are identified by the Ramsar Convention as globally significant (Ramsar Convention 2003).

The geomorphology and hydrology of the estuary section of the Ramsar site is unusual within the bioregion and can be considered a good representative of wetland type E. It is characterised by:

- being the longest estuary in Victoria (75 km);
- having a groundwater dominated hydrology;
- significant areas of limestone gorge for most of its length upstream of Nelson.

This site clearly meets criterion 1, through its unique combination of geomorphological features and wetland types, including groundwater dependent ecosystems which include several of the most globally threatened wetland types: fens, wet grasslands and temporary pools.

Criterion 2: A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.

This criterion is only applied to wetland dependent flora, fauna and ecological communities listed nationally or internationally as vulnerable, endangered or critically endangered. The Glenelg Estuary and Discovery Bay Ramsar Site regularly supports two ecological communities, six fauna and two flora species listed under the EPBC Act and / or International Union for Conservation of Nature (IUCN) Red List:

- Coastal saltmarsh – vulnerable ecological community;
- Open coast salt-wedge estuaries – endangered ecological community;
- Australasian bittern (*Botaurus poiciloptilus*) – Endangered (EPBC), vulnerable (IUCN);
- Australian fairy tern (*Sternula nereis nereis*) – Vulnerable (EPBC and IUCN);
- Bar-tailed godwit (*Limosa lapponica baueri*) – Endangered (EPBC);
- Hooded plover (*Thinornis rubricollis rubricollis*) – Vulnerable (EPBC and IUCN);
- Maroon leek-orchid (*Prasophyllum frenchii*) – Endangered (EPBC);
- Swamp greenhood (*Pterostylis tenuissima*) – Vulnerable (EPBC);
- Little galaxias (*Galaxiella toourtkoourt*) – Vulnerable (IUCN);
- Yarra pygmy perch (*Nannoperca obscura*) – Vulnerable (EPBC) Endangered (IUCN).

There are two species that were identified in the ECD (DELWP 2017) that no longer contribute to the site meeting this criterion. The ancient greenling (*Hemiphlebia mirabilis*) was formerly listed as endangered under the EPBC Act and IUCN Red list, but in 2019 was reassessed as being “least concern”. The most recent IUCN assessment concludes:

“*Hemiphlebia mirabilis was once believed to be close to extinction, but it is now known from many sites over a wide area in Victoria, South Australia and Tasmania, with evidence that it is abundant where it occurs. ….. Assessment in a high threat category is no longer warranted, and because it is not close to meeting the criteria even for Vulnerable status, it is assessed as Least Concern*”.

The growling grass frog (*Litoria raniformis*) was recorded in the site in 2013 (Bachmann et al. 2013), prior to the site being listed as a Ramsar site. Despite intensive search efforts it has not been recorded since (Farrington and Brown 2020). There is insufficient evidence to suggest that the site is important for supporting this species and is considered to have been erroneously included in the ECD. This should be re-evaluated if the species is detected again in the future.

Criterion 4: A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their lifecycles, or provides refuge during adverse conditions.

The basic description of this criterion implies a number of common functions/roles that wetlands provide including supporting fauna during migration, providing drought refuge, supporting breeding and moulting in waterfowl. There are 24 species of Palaearctic migratory shorebirds that have been recorded in the site, five of which are regularly supported (in two thirds of seasons) by the Glenelg Estuary and Discovery Bay Ramsar Site. Beach nesting birds such as hooded plover (*Thinornis rubricollis*) and red-capped plover (*Charadrius ruficapillus*) are regularly recorded nesting on the dunes of the Discovery Bay Coastal Park, albeit in low numbers (BirdLife Australia 2024). The site also supports 14 species of native fish which are diadromous, migrating between freshwater and saline habitats for part of their lifecycle. In addition, the permanent wetlands of the Long Swamp complex and Bridgewater Lakes provide habitat for obligate aquatic species when the surrounding landscape is dry and during drought conditions.

Criterion 6: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.

Assessment of this criterion is made using the most recent official population estimates (Mundkur and Langendoen 2022). Recent data indicate that the site supports > 1% of sanderling (*Calidris alba*), with an average of 1680 birds recorded in the site in the five-year period 2019-20 to 2023-24 (BirdLife Australia 2024). This represents over 5% of the EAAF population, which is estimated at around 30,000 (Mundkur and Langendoen 2022).

Criterion 8: A wetland should be considered internationally important if it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.

The Glenelg Estuary provides nursery habitat for several species of recreationally important fish including black bream (*Acanthopagrus butcheri*) and estuary perch (*Macquaria colonorum*). In particular, the seasonal opening and closing of the estuary is considered important in providing conditions for spawning of black bream (Conron and Moore 2018).

In addition, the site supports at least 14 species of fish that migrate between habitats for parts of their lifecycle including: short-finned eel (*Anguilla australis*) (Text Box 5), tupong (*Pseudaphritis urvillii*), estuary perch and common galaxias (*Galaxias maculatus*).

KOOYANG STORY

Kooyang are culturally significant for Gunditjmara and have been a valuable resource for thousands of years. Studies undertaken by Arthur Rylah Institute (ARI) and Deakin University in partnership with GMTOAC are building on traditional knowledge and helping inform future management of the kooyang and its habitat.

The ARI study focuses on monitoring movement of eels using acoustic tagging and satellite tagging, to investigate eel migration, including their initial movement downstream in freshwater toward the sea and offshore oceanic movement towards spawning areas.

While the adult eels die after spawning, the newly hatched larvae commence their journey towards the coast, before eventually entering rivers. The transmitters attached to adult eels are programmed to pop to the surface after 4-5 months and transmit data to the satellite network. Using that data, the eels journey can be reconstructed.

Another study, developed by Deakin University in partnership with GMTOAC and ARI, is using genetic tools to better understand how eels utilise different habitats within the Budj Bim cultural landscape. The study will also explore eel's dietary patterns, investigate connectivity among populations and determine factors that influence eel recruitment. Outcomes from the project will determine the resilience of kooyang to environmental changes and fishing pressures to ensure future management supports the species longevity.

'Managing the eels' habitat will also protect other species. It's about the whole country and caring for country as equal.'

Ben Church

'There are many pressures on eels, from climate change to drainage of wetlands and commercial fishing'.

'We're getting some better information about their life cycle, hopefully this assists in the protection and the continuing supply of young eels'.

Denis Rose

Two eels were tracked from the west coast of Victoria for about 3,000 kilometres up to warm tropical waters around New Caledonia, an area around the Coral Sea. This is the first time the oceanic migrations of Australian eels have been tracked and documented.

The route taken and speed varied with some eels moving south around Tasmania. These differences suggest that not all eels spawn at the same time or in the same area.

Source Arthur Rylah Institute

Text Box 5. The Kooyang story for Gunditjmara (Gunditj Mirring TOAC 2023).

Criterion 9: A wetland should be considered internationally important if it regularly supports one percent of the individuals in a population of one species or subspecies of wetland-dependent non-avian animal species.

There is evidence to suggest that the Glenelg Estuary and Discovery Bay Ramsar Site supports at least 1% of the global population of ancient greenling. The species first recorded at Long Swamp in 2008, and a detailed mark and recapture program completed in 2013 indicates that the site has supported very large numbers of the species (100,000 to 1,200,000 individuals) (Cordero-Rivera 2016).

To date, 24 sites have records for the species across Victoria (19), South Australia (3) and Tasmania (2) (Crowther 2011, DELWP 2021), however four of the Victorian sites lack recent sightings. The species is a poor flier and it is suggested that each of the known populations may be isolated and represent distinct sub-populations (Cordero-Rivera 2016, DELWP 2021).

The sub-population at Long Swamp likely represents more than 1% of the total global population for this species, possibly as much as 5%, as Long Swamp represents the largest known area of habitat with the species present (D. Crowther unpublished data, Crowther 2011, Cordero-Rivera 2016).

2.4 Critical components, processes and services

The Australian Government has developed and implemented a framework for describing the ecological character of Ramsar sites (DEWHA 2008). This framework requires the identification and description of critical components, processes and services. These are defined as characteristics of the Ramsar site:

- that are important determinants of the sites unique character;
- that are important for supporting the Ramsar criteria under which the site was listed;
- for which change is reasonably likely to occur over short to medium time scales (less than 100 years); and/or
- that will cause significant negative consequences if change occurs.

The Glenelg Estuary and Discovery Bay Ramsar Site ECD (DELWP 2017) identifies components, process and services that are critical to the ecological character of the Ramsar site. These are described briefly below; more detail on each can be found in the ECD.

Hydrology

The hydrology of the Ramsar site results from a complex interaction of surface and groundwater expression as well as local rainfall-runoff. Recent studies have helped to conceptualise the important hydrological features of three areas of the Ramsar site:

- The Glenelg Estuary and Oxbow Lake (Figure 3);
- Semi – permanent wetlands (e.g. Ewings Swamp; Figure 4);
- Permanent wetlands (e.g. Bridgewater Lakes; Figure 5).

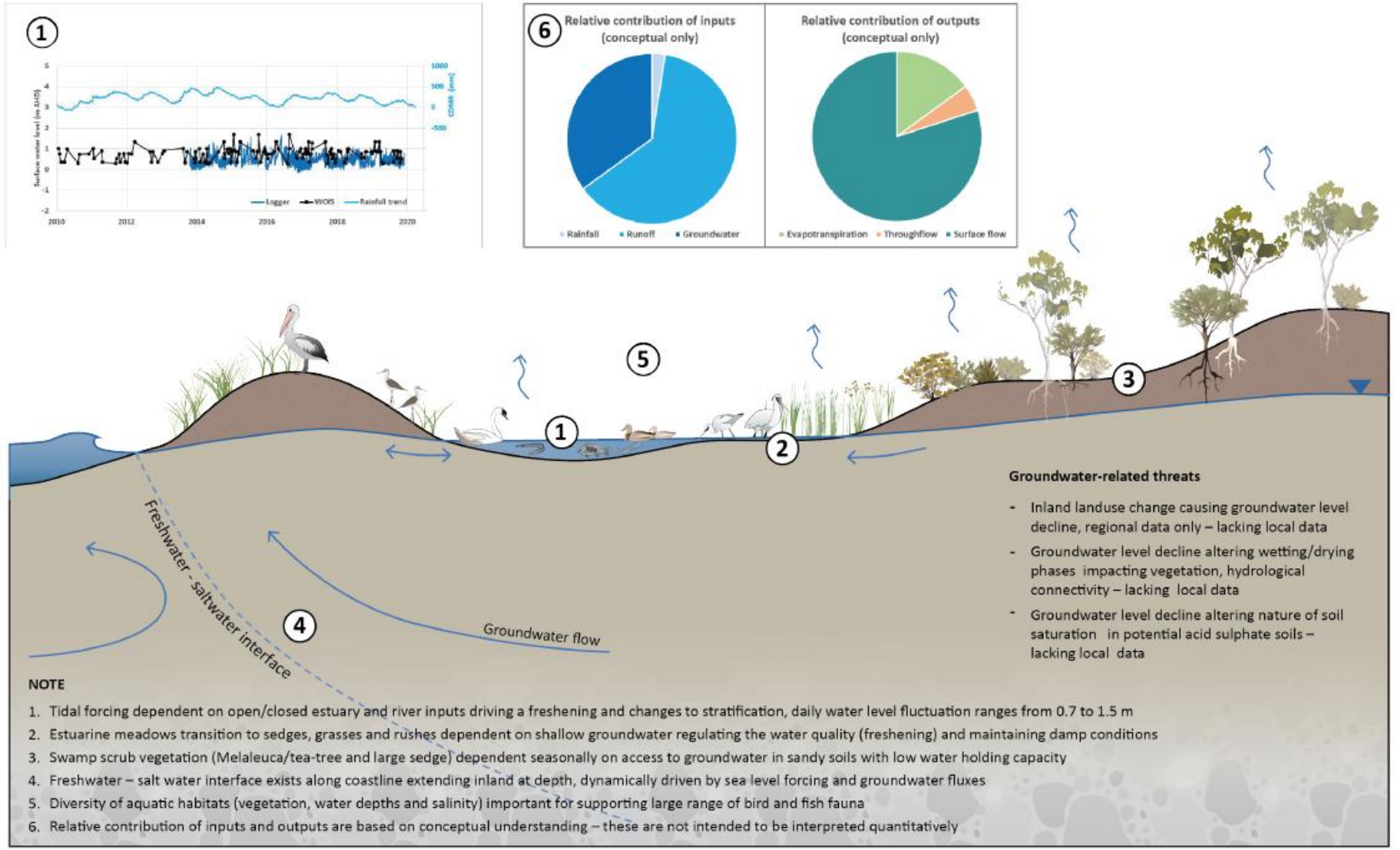


Figure 3. Conceptual model of key hydrological processes in the Glenelg Estuary and Oxbow Lake (Cranswick 2020).

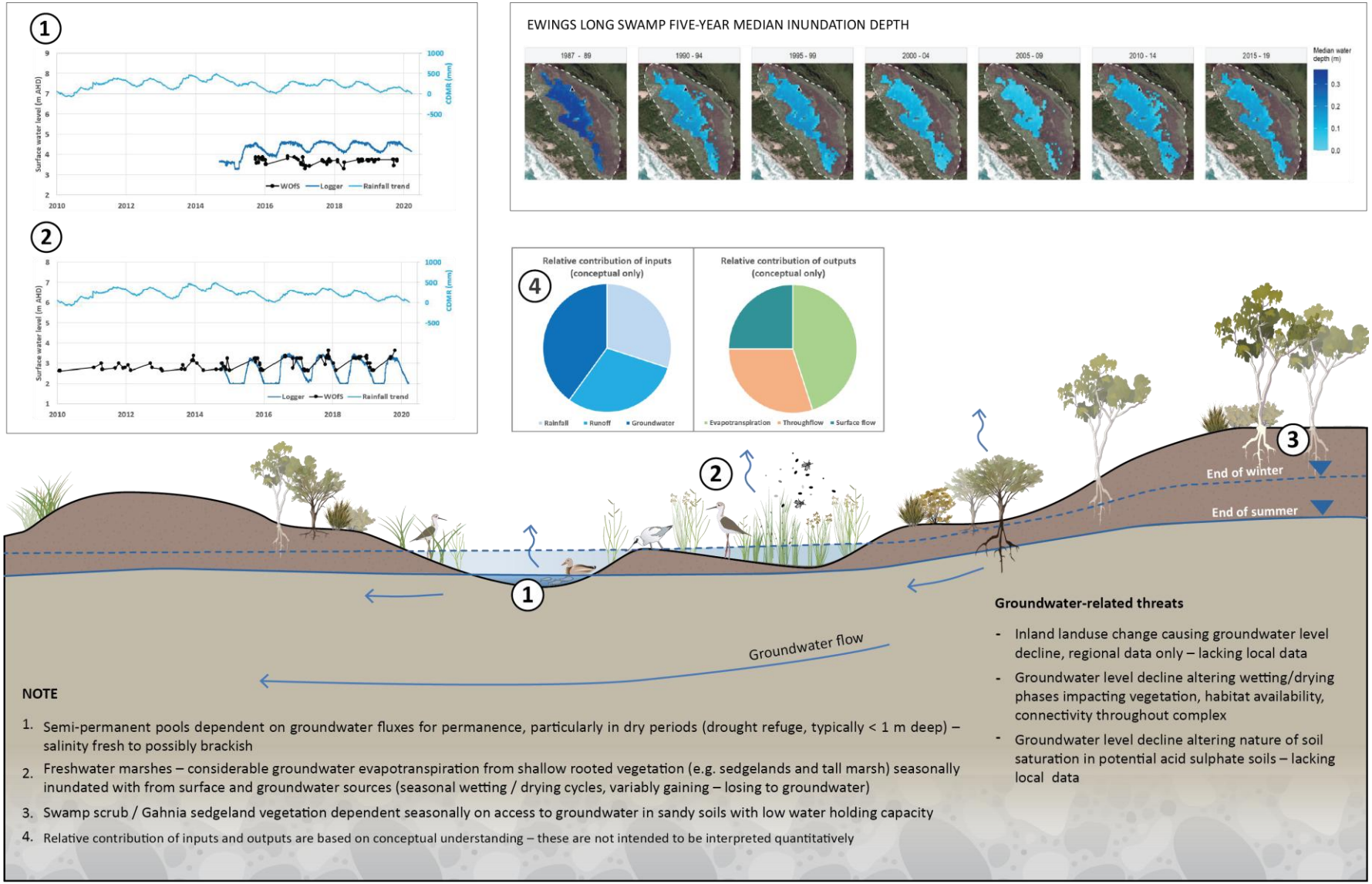


Figure 4. Conceptual model of key hydrological processes in the semi-permanent wetlands in the Ramsar site (Cranswick 2020).

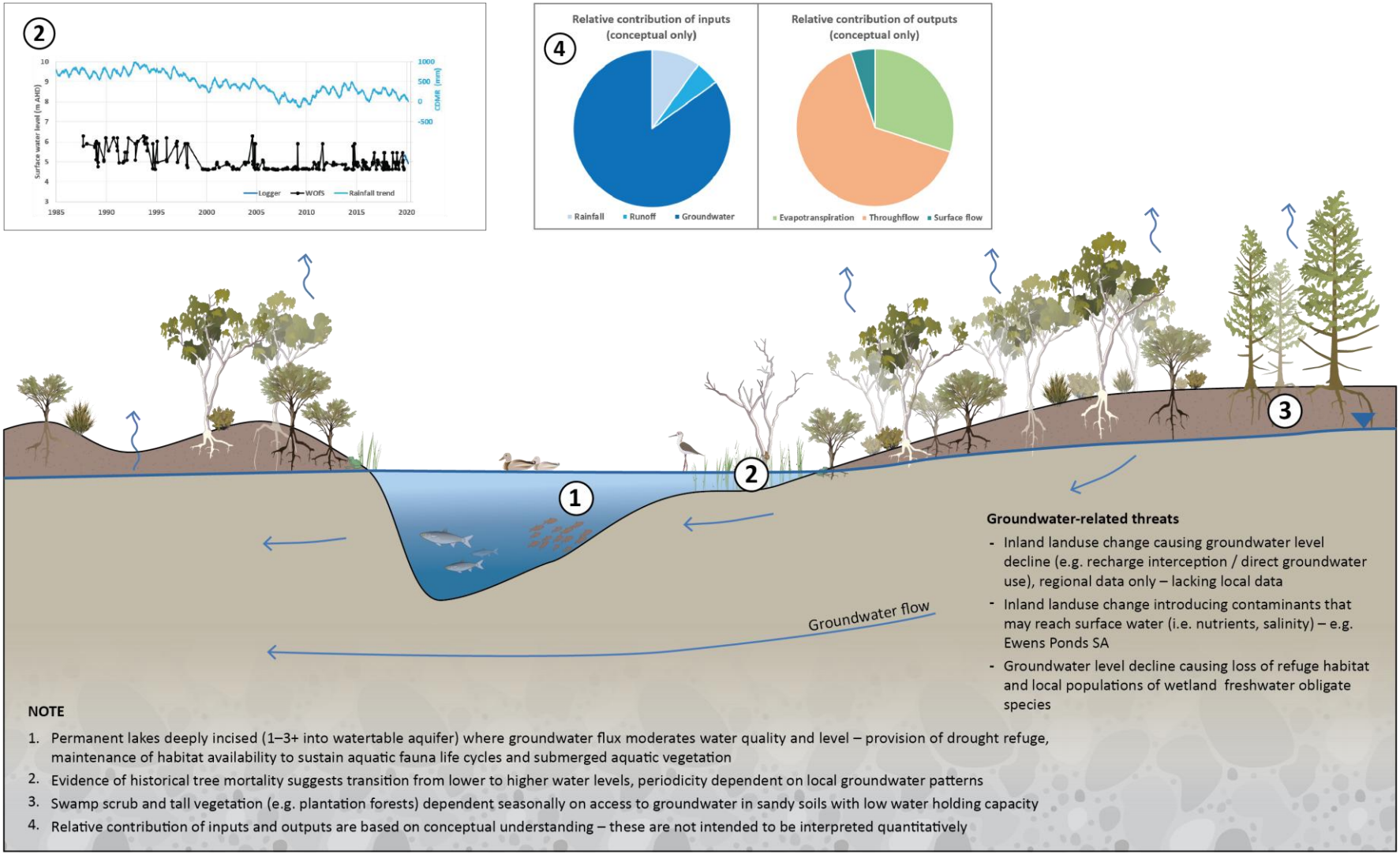


Figure 5. Conceptual model of key hydrological processes in the permanent wetlands of the Ramsar site (Cranswick 2020).

Vegetation type and extent

The Glenelg Estuary and Discovery Bay Ramsar Site supports a wide range of inundation dependent vegetation communities. The Glenelg Estuary is fringed by saline vegetation communities including several types of coastal saltmarsh, an EPBC listed vulnerable ecological community. There is a total of 20 ha of saltmarsh in the site comprising intertidal Wet Saltmarsh Herbland, most often dominated by beaded glasswort (*Sarcocornia quinqueflora*) and Coastal Tussock Saltmarsh dominated by chaffy saw-sedge (*Ghania filum*). There are a further 20 ha of the sea rush (*Juncus kraussi*) dominated Estuarine Wetland, and 20 ha of common reed (*Phragmites australis*) dominated estuarine reedbed (Australis Biological and RapidMap 2024), the latter in areas of lower salinity.

The permanently inundated areas of the estuary support macroalgal and seagrass beds. Mapping in 2009 suggested sparse beds of the seagrass *Zostera muelleri* and larger areas of drift algae and macroalgal wrack (Ball and Blake 2009). This is consistent with the recent assessment of Victorian estuaries, which also found smaller areas of seagrass and larger extents of macroalgae in the estuary and Oxbow Lake (DELWP 2022).

The freshwater wetlands of the Ramsar site support significant areas of emergent macrophytes including Gahnia sedgelands, Baumea sedgelands and tall marsh. There are smaller areas of aquatic herbland, particularly at Swan Lake and the Bridgewater Lakes (Australis Biological and RapidMap 2024).

The deeper and permanent lakes support significant submerged and floating aquatic vegetation communities. Freshwater charophyte communities are a major feature of many of the wetlands within the Ramsar site including the Bridgewater Lakes and Lake Malseed (Lervesi et al. 2019). Species recorded include *Chara* sp. and *Nitella* sp. (Barson 1984). There are also extensive beds of vascular submerged plants such as lake water-milfoil (*Myriophyllum salsugineum*), water-ribbons (*Cycnogeton procerum* - floating form), floating bog-sedge (*Schoenus fluitans*) and eel grass (*Vallisneria australis*).

Fish diversity and abundance

Over 50 native fish species from 26 families have been recorded from the estuary and wetlands within the Ramsar site. This includes several diadromous species that migrate through different habitats during their life cycles. The most common species (in terms of abundance) vary according to wetland type, with the estuarine species small-mouthed hardy-head (*Atherinosoma microstoma*) and black bream common in Oxbow Lake, and the freshwater species southern pygmy perch (*Nannoperca australis*) and Yarra pygmy perch characteristic of the fish community in Long Swamp (Veale 2014).

Spawning and recruitment of most fish species within the site remains a knowledge gap. There is, however, good evidence that the common galaxias and the two pygmy perch species have self-sustaining breeding population within the site. There is a good understanding of the spawning and recruitment of black bream in the Glenelg Estuary, with stratification and freshwater inflows important for success.

Waterbird diversity and abundance

A total of 95 waterbird species have been recorded within the Ramsar site, noting that this list excludes vagrants and species for which the site does not provide core habitat (e.g. pelagic seabirds and penguins). 24 species are listed under international migratory agreements, although only 20 species are true international migrants with the remaining species resident within their Australian range. Five international migratory shorebirds are regularly supported by the site including sanderling, sharp-tailed sandpiper (*Calidris*

acuminata), red-necked stint (*Calidris ruficollis*), double-banded plover (*Charadrius bicinctus*) and bar-tailed godwit (*Limosa lapponica baueri*).

The beaches of the Discovery Bay Coastal Park support breeding of beach-nesting birds including hooded plover, red-capped plover and Australian pied oystercatcher (*Haematopus longirostris*). Waterbird breeding within the freshwater areas of the Ramsar site is a knowledge gap with respect to species numbers and important locations and habitats.

Stratification

The lower Glenelg Estuary can be described as a seasonally closed salt-wedge estuary (Glenelg Hopkins CMA 2014). The interaction of fresh river flow and saline marine tides creates a salt wedge within the estuary. The position and behaviour of this salt wedge is affected by river flow volume and tidal cycles. For example, under an ebb tide when the estuary is open, river water extends further downstream in a thick layer over the denser seawater wedge, whilst in a flood tide the salt wedge is pushed further up the estuary. When the estuary is closed and tidal exchange ceases, the stratification (distinct layers of fresh and saline water) becomes more stable and a distinct halocline form. This prevents the mixing of bottom water layers with the surface water, lowers oxygen exchange from the atmosphere and results in a decline in dissolved oxygen in bottom waters. The seasonal nature of freshwater inflows and opening of the estuary creates a cycle of salinity and dissolved oxygen in the estuary.

Critical services

Supporting ecosystem services are those which are considered essential for the production of all other ecosystem services such as water cycling, nutrient cycling and habitat for biota. These services will generally have an indirect benefit to humans or a direct benefit over a long period of time. The critical ecological services provided by the Glenelg Estuary and Discovery Bay Ramsar Site are briefly described in Table 4.

Table 4. Summary of critical supporting services (DELWP 2017).

Critical ecosystem service	Description
Diversity of wetland types	The site comprises a network of interconnected wetland types including freshwater permanent wetlands, intermittently inundated marshes, estuarine waters and intertidal sandy beaches.
Special geomorphic features	The site is significant for a number of geological and geomorphic features; in particular the dune slack system is rare, if not unique within the bioregion.
Provides physical habitat (for waterbirds)	The site provides a network of habitats for waterbird feeding, roosting and breeding. Species that are supported by the site represent a wide range of functional groups (e.g. fishers, waders, ducks) each with different habitat requirements.
Threatened wetland species and ecosystems	Two nationally listed ecological communities and eight nationally or internationally listed species of conservation significance are supported by the site.
Ecological connectivity	The wetlands in the site are hydrologically and ecologically connected. The connection between the marine, estuarine and freshwater components is particularly important for fish migration and reproduction.

2.5 Status of ecological character

The mechanism against which change in ecological character is assessed is via comparison with Limits of Acceptable Change (LAC). LAC are defined by Phillips (2006) as:

"…the variation that is considered acceptable in a particular measure or feature of the ecological character of the wetland. This may include population measures, hectares covered by a particular wetland type, the range of certain water quality parameter, etc. The inference is that if the particular measure or parameter moves outside the 'limits of acceptable change' this may indicate a change in ecological character that could lead to a reduction or loss of the values for which the site was Ramsar listed. In most cases, change is considered in a negative context, leading to a reduction in the values for which a site was listed".

The following should be considered when developing and assessing LAC:

- LAC are a tool by which ecological change can be measured. However, LAC do not constitute a management regime for the Ramsar site;
- Exceeding or not meeting LAC does not necessarily indicate that there has been a change in ecological character within the meaning of the Ramsar Convention. However, exceeding or not meeting LAC may require investigation to determine whether there has been a change in ecological character;
- While the best available information was used to prepare the ECD and define LAC for the site, a comprehensive understanding of site character may not be possible as in many cases only limited information and data is available for these purposes. The LAC may not accurately represent the variability of the critical components, processes, benefits or services under the management regime and natural conditions that prevailed at the time the site was listed as a Ramsar wetland;
- LAC can be updated as new information becomes available to ensure they more accurately reflect the natural variability (or normal range for artificial sites) of critical components, processes, benefits or services of the Ramsar wetland.

The LAC for the Glenelg Estuary and Discovery Bay Ramsar Site were established in the ECD for critical components, processes and services (DELWP 2017). These are described briefly below together with the most current information related to the condition of the Ramsar site. There is no evidence from the information below of an exceedance of a LAC in the Glenelg Estuary and Discovery Bay Ramsar Site (Table 5).

Table 5. Summary of assessment against LAC for the Glenelg Estuary and Discovery Bay Ramsar Site.[1]

Critical CPS	Limit of Acceptable Change	Assessment
Hydrology	Bridgewater Lakes, Lake Moniboeng, Swan Lake, Malseed Lake and Cain Flat Swamp will not dry.	Geoscience Australia's Wetland Insight Tool (WIT; Geoscience Australia unpublished) indicates that the Bridgewater Lakes as well as Lakes Moniboeng and Malseed and Cain Flat Swamp have remained permanently inundated over the past decade. It is possible that Swan Lake partially dried in mid-2019, but this is represented by a single Landsat image, with inundation clear in the months before and after. **LAC is met.**

[1] Note that the LAC for growling grass frog has not been included as there is insufficient evidence to suggest that the site is important for supporting this species.

Critical CPS	Limit of Acceptable Change	Assessment
Hydrology (stratification, ecological connectivity)	The Glenelg Estuary will not remain closed for 3 consecutive years or open for greater than 5 years.	In the last decade, the longest period of estuary opening was 3.5 years (May 2020 to March 2024) and has not remained closed for more than 3 months (EEMSS Database Glenelg Hopkins CMA Accessed 2025). **LAC is met.**
Vegetation type and extent	Vegetation extent will not fall below the following: • Coastal saltmarsh - 13 ha • Freshwater sedges and tall marsh - 470 ha, with at least 270 ha of *Baumea* sedgelands.	Assessment against this LAC follows the vegetation classification described in DELWP (2017), which included several EVCs in the coastal saltmarsh category (including *Juncus kraussii*) and Ghania Sedgeland / Swamp Scrub Complex in the freshwater sedges category). Vegetation mapping in 2022 indicates (Australis Biological and RapidMap 2024): • Coastal saltmarsh – 52 ha • Freshwater sedges and tall marsh – 1123 ha • Baumea sedgelands – 291 ha **LAC is met.**
Ancient greenling	See LAC for vegetation type and extent (*Baumea* sedgelands)	See assessment for Vegetation type and extent (*Baumea* sedgelands)
Fish diversity and abundance (ecological connectivity)	Native fish within the Ramsar site will represent each of the following life history strategies: estuarine dependent, estuarine opportunists, marine migrants, diadromous and obligate freshwater species.	The recent Index of Estuary Condition (IEC) Assessment assessed records for the Glenelg Estuary over the period 2010 to 2019, this together with monitoring in the lakes and wetlands of the Ramsar site indicates that all life histories of fish remain present (DELWP 2022, Farrington 2024). **LAC is met.**
Waterbird diversity and abundance	Absence of the following waterbird guilds in any 3 out of 5 years: • Ducks, swans and grebes • Fishers • Large wading birds • Australian waders • International waders • Gulls and terns.	Waterbird monitoring (2019-20 to 2023-24) indicates that all functional groups are represented, with 36 species recorded in at least 3 of the past 5 years (Birdlife Australia 2024). **LAC is met.**
	Sanderling abundance falls below 0.7% of the global population in 3 out of 5 years.	The number of sanderlings has been > 1% of the population in all of the past 5 years (2019-20 to 2023-24), with a maximum of 4000 individuals (> 13% of the population) in 2022-23 (BirdLife Australia 2024). **LAC is met.**
Threatened species: plants	Absence of maroon leek-orchid (*Prasophyllum frenchii*) and or swamp greenhood (*Pterostylis tenuissima*) in 3 consecutive targeted surveys.	Both species of threatened plant have been recorded annually since 2018. **LAC is met.**
Threatened species: fish	Absence of Yarra pygmy perch (*Nannoperca obscura*) in any 3 out of 5 targeted surveys.	Monitoring has detected Yarra pygmy perch in annual surveys since 2015 (Farrington 2024). **LAC is met.**

Critical CPS	Limit of Acceptable Change	Assessment
Threatened species: birds	Absence of hooded plover (*Thinornis rubricollis*) in 3 out of 5 years.	Hooded plover has been recorded every year for the past 5 years (Birdlife Australia 2024). **LAC is met.**

2.6 Achievements from the 2017 plan

A large amount of on-ground work and research has been undertaken within the Glenelg Estuary and Discovery Bay Ramsar Site since the release of the 2017 Ramsar Site Management Plan. A summary of this work, highlighting significant achievements related to maintaining ecological character is provided here for each management agency. Implementation of the 2017 plan is provided in Appendix A.

Glenelg Hopkins Catchment Management Authority

The Glenelg Hopkins CMA are the Ramsar site coordinator and coordinate the Glenelg Estuary and Discovery Bay Ramsar Site Management Plan implementation. This role continues to work with other agencies to address key issues in the management of the Ramsar Site. In the term of the 2017 Ramsar Site Management Plan, the Glenelg Hopkins CMA has implemented the priority management directions from the Glenelg Hopkins Regional Catchment Strategy and Glenelg Hopkins Waterway Strategy.

The Glenelg Hopkins CMA has coordinated a range of monitoring activities (hydrology, water quality, small-bodied native fish, threatened species, wetland vegetation extent and condition), coordination of research projects to address knowledge gaps, maintaining environmental flows and estuary entrance management and implemented a range of on-ground projects in or adjacent to the site to manage the site's values. Further up the Glenelg River catchment, the Glenelg Hopkins CMA is actively investing in stock exclusion, fish passage improvements, rehabilitating wetlands, pest plant and aquatic pest animal control and improving riparian and shoreline frontages.

Notable works project activities include:

- Beach Road elevation upgrade (Text Box 6);
- Simson's Landing floating jetty;
- Sapling Creek floating jetty;
- Eel Creek fish-friendly culvert replacement;
- Annual fox baiting at Discovery Bay 2017-24;
- Sanderling tracking and habitat utilisation Honours and PhD research projects (Text Box 7);
- Feral pig treatments near Lower Glenelg National Park;
- Carp removal from Glenelg Estuary;
- Woody and non-woody weed treatments;
- Maintain the estuary entrance management support system (EEMSS) and Artificial River Mouth Openings;
- Coast Beach Daisy trial program;
- Vehicle access controls at key locations.

Parks Victoria

Parks Victoria has continued on ground actions specifically addressing threats to flora and fauna in parks and reserves in the Ramsar site. They are an active member of the GEDB

RCC and have participated in meetings and activities to implement the actions of the 2017 Ramar Site Management Plan. Over the past seven years, Parks Victoria have:

- Worked with partner agencies and NGOs to implement over 400 ha of pest animal control (fox and carp) and 3,800 ha of woody and non-woody weed control;
- Contributed in-kind technical and logistical support provided to implementing monitoring of critical CPS and assessing the status of ecological character including beach nesting bird surveys, threatened orchid and ancient greenling surveys and wetland fish monitoring;
- Continued to undertake compliance activities, especially with respect to unauthorised beach access and off-road vehicles within the Ramsar site;
- Installed and maintained access controls aimed at reducing access points to deter unauthorised beach access;
- Supported volunteer groups in beach and estuary clean-up activities.

Victorian Government Department of Energy, Environment and Climate Action

DEECA has continued to undertake a statewide coordination and oversight role for Ramsar sites in Victoria including Glenelg Estuary and Discovery Bay. DEECA oversees the implementation of Ramsar convention obligations, with a Ramsar statewide coordinator working closely with the Ramsar site coordinator to deliver requirements under the Ramsar Convention. DEECA continue to play a referral role in major projects in vicinity of the Glenelg Estuary Discovery Bay Ramsar Site. DEECA provide input to both Technical Reference Groups and review of Environmental Effect Statements for major projects and as part of this process give consideration to impacts to any values associated with the Ramsar site.

DEECA also maintain the Victorian Biodiversity Atlas (VBA) which is a web-based information system designed to manage information about native and naturalised species occurring in Victoria. Species records associated with ecological restoration monitoring projects at Glenelg Estuary Discovery Bay are recorded through the VBA.

Victorian Fisheries Authority

Over the last eight years, VFA has spent considerable time in and around the Ramsar site, with a focus on ensuring sustainable fishing practices in the Glenelg River and on Discovery Bay Beach. Specific activities include:

- Regular vessel based and land-based patrols in the Glenelg River Estuary ensuring adherence to the Fisheries Act 1995, with good compliance rates experienced;
- Compliance and education tasks include checking size and catch limits, licence inspections, vessel safety and general fisheries education for recreational fishers, with the main target species being black bream, estuary perch and mulloway (*Argyrosomus japonicus*);
- Regular patrols on Discovery Bay Beach to manage the commercial and recreational pipi fishing which has increased in the area over the last 10 years. As part of this activity, a small number of compliance operations have been successfully run targeting illegal pipi fishers;
- VFA regularly conducts research on target fish populations to ensure sustainable harvesting. There are current investigations into the status of the pipi population;

- The VFA has sponsored and assisted successful beach cleanups of Discovery Bay Beach run by Beach Patrol 3280.

Infrastructure improvements protecting ecological values

The Glenelg Estuary and Discovery Bay Ramsar Site, located in western Victoria, Australia, is a vital ecological area and internationally recognised for its diverse habitats and species. This case study explores the benefits of three key infrastructure improvements: raising infrastructure, installing fish passage-friendly culverts on Eel Creek, and replacing fixed timber jetties at Simson's Landing and Sapling Creek with floating structures.

Raising infrastructure in flood-prone areas of the Ramsar site can significantly reduce the risk of flooding, thereby protecting both natural habitats and human activities. Elevated infrastructure ensures that human values of the area remain accessible during high water events. In addition, this approach maintains the ecological character and connectivity of wetland and the estuary habitats by allowing inundation of the wetland margins. In turn this creates opportunities supporting the resilience of the ecosystem and suppressing pest plant incursions. This process is an important aspect of helping the area become resilient to climate change impacts such as sea level rise, increased flooding duration and/ intensity.

Fish passage-friendly culverts are designed to allow aquatic species to move freely through waterways, which is essential for their life cycles. Installing these culverts on Eel Creek can have several benefits:

- Improved fish migration: These culverts facilitate the movement of fish and other aquatic organisms, ensuring they can reach spawning and feeding grounds;
- Enhanced biodiversity: By allowing species to migrate, the culverts support the overall biodiversity of the estuary, contributing to a healthier ecosystem;
- Reduced habitat fragmentation: Properly designed culverts minimise the disruption of natural water flow, reducing habitat fragmentation and promoting ecological connectivity;
- Replacing fixed timber jetties with floating structures.

Replacing fixed timber jetties with floating structures at Simson's Landing and Sapling Creek offers several ecological and practical benefits:

- Adaptability to water levels: Floating jetties can adjust to changing water levels, reducing the risk of damage during floods and ensuring continuous access;
- Reduced environmental impact: Floating structures cause less disturbance to the riverbed and surrounding habitats compared to fixed jetties, which can lead to erosion and habitat loss;
- Longevity and maintenance: Floating jetties typically require less maintenance and have a longer lifespan than timber structures, which are prone to rot, decay and continual maintenance and cleaning.

Implementing these infrastructure improvements at the Glenelg Estuary and Discovery Bay Ramsar Site has enhanced the ecological integrity and resilience of this important wetland area. By raising infrastructure, installing fish passage-friendly culverts, and replacing fixed timber jetties with floating structures, we support the diverse habitats and life-cycles of species that call this Ramsar site home and continue the Ramsar concept of ‘wise use of wetlands’.

Simson’s Landing (left) and Sapling Creek boat ramp upgrades (Glenelg Estuary) supporting improved access and ecological outcomes for the Glenelg Estuary and Discovery Bay Ramsar Site. Credit: G Prentice.

Beach Road, Nelson (Glenelg Estuary) was raised in elevation in 2024 to maintain visitor access during increasingly frequent estuary inundation due to estuary mouth closure. Credit: G Prentice.

Text Box 6. Infrastructure improvements protecting ecological values.

3 Management Priorities

Priority threats and values for management in the next seven years were identified through a process that was based on a risk assessment.

3.1 Risk assessment method

The risk assessment process adopted for this project is consistent with the Australian Standard: Risk Management (AS ISO 31000:2018) and the Standards Australia Handbook: Managing environment-related risk (HB 203-2012). It builds on the risk assessment process undertaken in the 2017 management planning process, updating risks with new information where available. Consistent with an approach focussed on critical CPS, other values that are not identified as critical to the ecological character of the Glenelg Estuary and Discovery Bay Ramsar Site (e.g. visual amenity, recreational fishing) have been omitted from the 2025 risk assessment. The risk assessment approach follows a structured and iterative process, with the following steps:

1. Establish the context – existing values and environmental conditions;
2. Identify risks – threats and associated potential impacts;
3. Analyse risks – assign likelihoods and consequences to determine level of risk.

3.1.1 Establishing the context

A review of existing published and unpublished information relevant to the Glenelg Estuary and Discovery Bay Ramsar Site was undertaken to summarise the current status of ecological character and potential threats to ecological character. The spatial scale of the risk assessment was established as the three management units, with separate risk assessments completed for each unit (estuary, freshwater wetlands, and beach and dune fields).

The purpose of the risk assessment was to identify priority values and threats as the basis for identifying strategic actions in the Glenelg Estuary and Discovery Bay Ramsar Site Management Plan. The risk assessment was underpinned by both local knowledge and expert opinion. The process of prioritising values and threats and how the risk assessment contributed to this is illustrated in Figure 6.

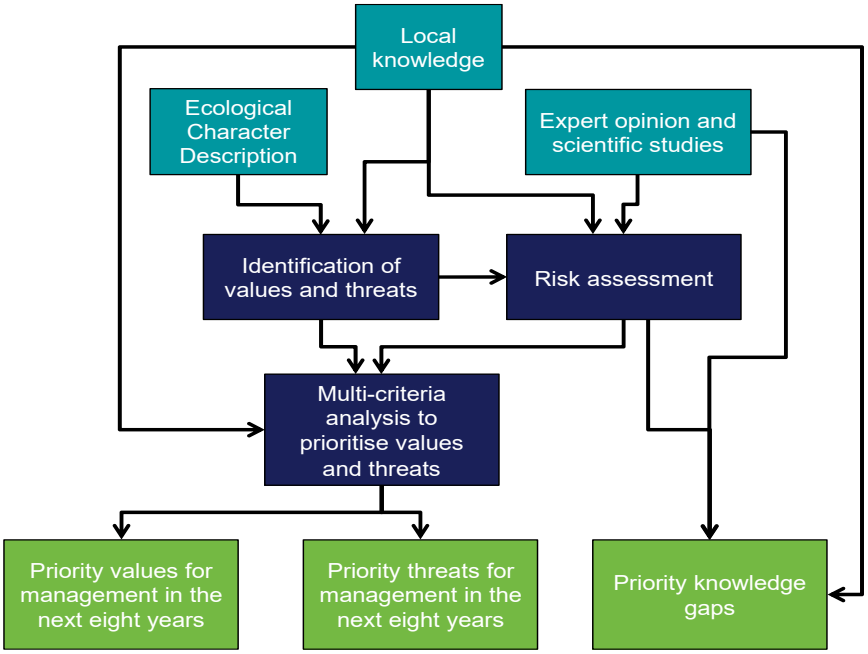


Figure 6. Process of prioritising values and threats and the role of the risk assessment.

3.1.2 Identifying risks

An impact pathway approach was adopted for identifying and analysing risks. This uses a hierarchical process to identify potential risks as follows:

- Threats (threatening activities) – actions in the Ramsar site or catchment that could affect ecological character;
- Stressors – the physical or chemical changes that could arise as a result of an activity;
- Effects – the potential responses caused by the stressors.

This allows for clear identification of the underlying causes of risks and threats to ecological character of the Ramsar site, separating the threat from the impact. An example of an impact pathway is provided below.

Activities	Stressors	Impact pathway
Invasive species	Predators (foxes and cats)	Impacts waterbird breeding

3.1.3 Analyse risks

The impact pathways formed the basis of a formal risk analysis process. Likelihood and consequence were assigned to each impact pathway in its entirety, integrating each of the levels in the hierarchy. Questions were put to stakeholder and agency technical staff to estimate the likelihood and consequence, for example: what is the likelihood that agricultural practices in the catchment will result in increased nutrients, increased algal growth and that this will result in a decline in seagrass health? What are the consequences of this with respect to the ecological character of the Ramsar site?

The risk assessment was based on a few key principles:

- Risk assessment is limited to ecological character as defined by critical components, processes and services;
- Assessment of likely impacts in the next seven years (within this management cycle);
- Assessment based on the current management regime continuing;
- Evidence based approach using scientific expertise coupled with local knowledge.

Likelihood and consequence were guided by Table 6 and Table 7, with the risk matrix (Table 8) determining the overall risk.

Table 6. Likelihood

Almost certain	Likely	Possible	Unlikely	Rare
Is expected to occur in most circumstances	Will probably occur in most circumstances	Could occur	Could occur but not expected	Occurs only in exceptional circumstances

Table 7. Consequence

Negligible	Minor	Moderate	Major	Extreme
Alteration or disturbance to ecosystem function, populations or habitat within natural variability. LAC will not be exceeded and no evidence of a declining trend in critical CPS.	Localised measurable changes to critical CPS without a major change in function (no loss of components or introduction of new species that affects ecosystem function). No sustained declining trend in ecological character and LAC will continue to be met.	Widespread measurable changes to critical CPS, up to 20% of habitat likely to be affected. Decline in ecological character. LAC may be exceeded in the next 10 years but recover to within LAC within 2 years.	Widespread measurable changes to critical CPS, up to 80% of habitat affected. Significant, sustained, negative trend in ecological character. LAC is predicted to be exceeded in the next 5 years with recovery within 10 years.	Long term and possibly irreversible damage to 1 or more critical CPS. Sustained negative trend, LAC is predicted to be exceeded continually for at least 10 years.

Table 8. Risk matrix (adapted from AS/NZS 2006).

Consequence						
		Negligible	**Minor**	**Moderate**	**Major**	**Extreme**
	Almost certain	Negligible	Medium	High	Extreme	Extreme
	Likely	Negligible	Medium	Medium	High	Extreme
	Possible	Negligible	Low	Medium	High	High
	Unlikely	Negligible	Low	Low	Medium	Medium
	Rare	Negligible	Negligible	Negligible	Low	Medium

3.1.4 Stakeholder involvement

The 2017 risk assessment for each of the three management units was updated using additional data, knowledge and ecological understanding made available in the past seven years. This draft risk assessment was provided to the project steering committee and relevant technical experts for review. An online workshop was held in November 2024. Workshop participants were asked to review the impact pathways, likelihood and consequence ratings for each impact pathway in their area of interest or expertise. In the workshop, the risk assessment was systematically worked through with discussion on the rankings and identified pathways until agreement was reached. Critical knowledge gaps were identified and documented for inclusion in the management plan. A number of risk rankings were deferred at the workshop for consultation with relevant scientific experts.

A few additional potential impact pathways were raised by stakeholders in the risk assessment workshop. These pathways were associated with proposed large-scale development projects in the region, such as onshore and offshore wind energy projects. While developments may have implications for the ecological character of the Ramsar site, their potential impacts will be thoroughly assessed through a dedicated and rigorous process at both State (Environmental Effects Act) and Federal (EPBC Act) levels (Refer Text Box 3). This Ramsar Site Management Plan acknowledges and supports that comprehensive approach and is deferring to that process to ensure alignment and avoid duplication.

The revised risk assessment is provided in Appendix B.

3.2 High priority threats

The outputs of the risk assessment were used to identify the highest priority threats for management in the next seven years using two approaches. Firstly, all identified individual risk pathways that were assessed as high or extreme were considered a priority for management in the life of the plan. Secondly, risks were assessed cumulatively looking at the pressures and stressors across all risk pathways and identifying risks that may individually be medium but combined have a significant cumulative impact. Priority threats in each section of the Ramsar site are provided in Table 9 and described briefly below. The relationship between values and threats is illustrated in Figure 7.

Table 9. Highest threats for management over the life of the management plan. Threats listed by number as per Appendix B.

Priorities for management	Freshwater wetlands	Estuary	Beach
Pollution: agricultural run-off increases nutrients and leads to low dissolved oxygen and impacts native fish	F4		
Pollution: agricultural run-off - toxicants that could impact threatened fish populations (as well as other biota)	F8		
Agriculture: wood and pulp plantations decrease groundwater affecting biota reliant on freshwater wetland habitat	F1		
Water resource use leads to decreased freshwater inflows affecting estuary mouth opening		E3	
Invasive species: foxes, pigs and cats predating on waterbirds; weeds impacting wetland and fringing vegetation and waterbird habitats	F10	E9	B4
Invasive species: weeds impacting wetland and fringing vegetation and waterbird habitats	F9		B3
Invasive species: ravens impacting beach nesting birds			B5
Invasive species: non-native grazing animals (pigs) impacting vegetation, threatened plant species and habitat for waterbirds including Australasian bittern	F11		
Recreation: physical damage and beach users disturbing waterbird feeding, breeding and roosting			B6
Climate change: decreased freshwater inflows impacting estuary opening, wetland habitat, and threatened species in freshwater wetlands	F17	E16	
Climate change: sea-level rise impacting threatened plant species	F18		
Climate change: sea level rise impacts estuary opening		E17	
Climate change: sea level rise reduces foraging habitat for shorebirds and nesting habitat for beach-nesting birds			B7
Climate change: increased storm water events lead to loss of beach profile impacting waterbird foraging and nesting habitat			B8
Avian diseases impacting on waterbirds	F19	E18	B9

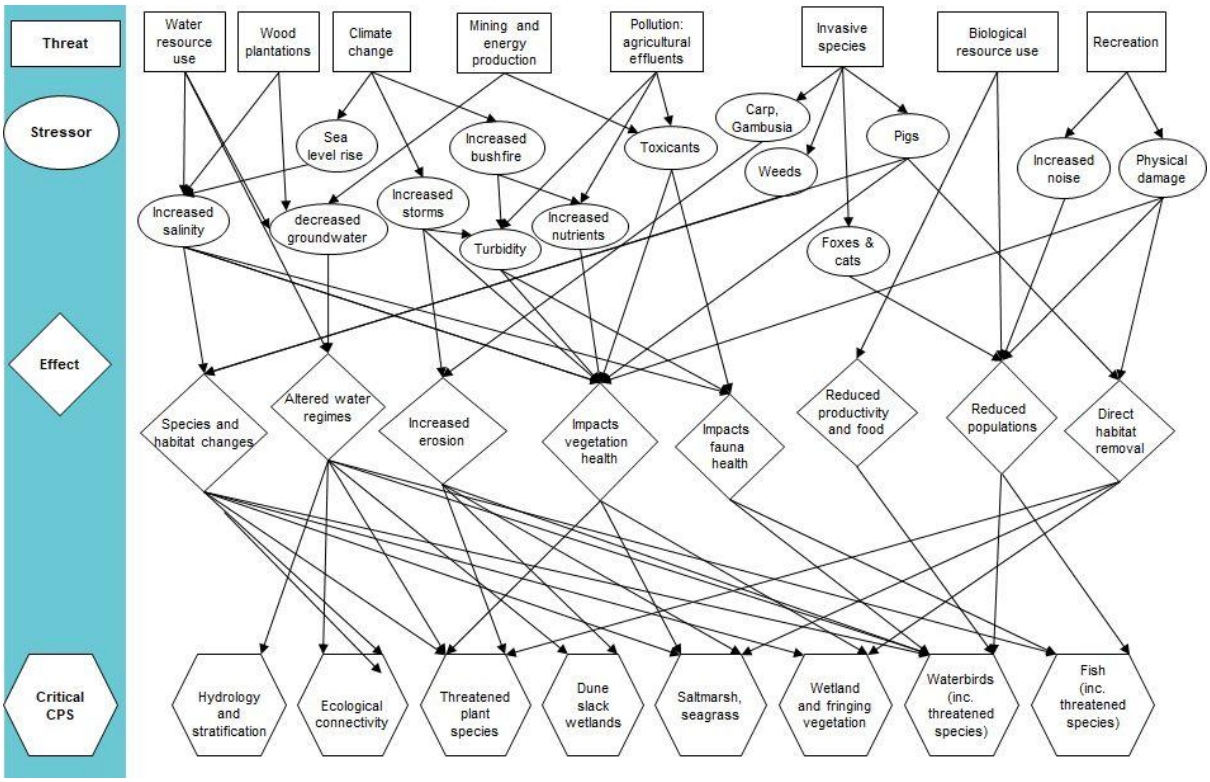


Figure 7. Stressor model illustrating the major linkages between threats (pressures and stressors) and values.

Wood plantations

Wood plantations are a significant feature in the catchments of the Ramsar site. The Victorian Land Cover Time Series (White et al. 2020) indicates that while the area of pine plantation has remained stable over the past 30 years at around 70,000 ha, the area of hardwood plantation (mostly blue gum) has increased, peaking in 2015 at around 140,000 ha. Plantation forests have been shown to both reduce groundwater recharge (via recharge interception) and directly use groundwater when the water table is accessed by their root systems, and this commonly results in declining groundwater levels (Cranswick 2020). Cranswick et al. (2020) indicated that the majority of wetlands in the Ramsar site are highly reliant on groundwater and could be significantly impacted by regional groundwater changes.

Over periods of low river flows, the hydrodynamics of the estuary are primarily controlled by non-river inflows such as groundwater, as well as tidal exchange when the entrance is open. When the entrance is closed, additional groundwater inflows in the order of 25 ML/d to 90 ML/d can cause a significant rise in water levels across the estuary (Water Technology 2016). This dependence on groundwater makes the estuary also vulnerable to regional aquifer impacts.

Climate change

The climate of the region has already changed and is continuing to change. Temperatures have increased by around 1.2 C (1910 to 2020) with the majority of that warming occurring in the last 20 years. Annual rainfall is highly variable, but a 5% decline has already occurred. Sea levels have risen on average 3.7mm / year between 2006 and 2018 (Figure 8).

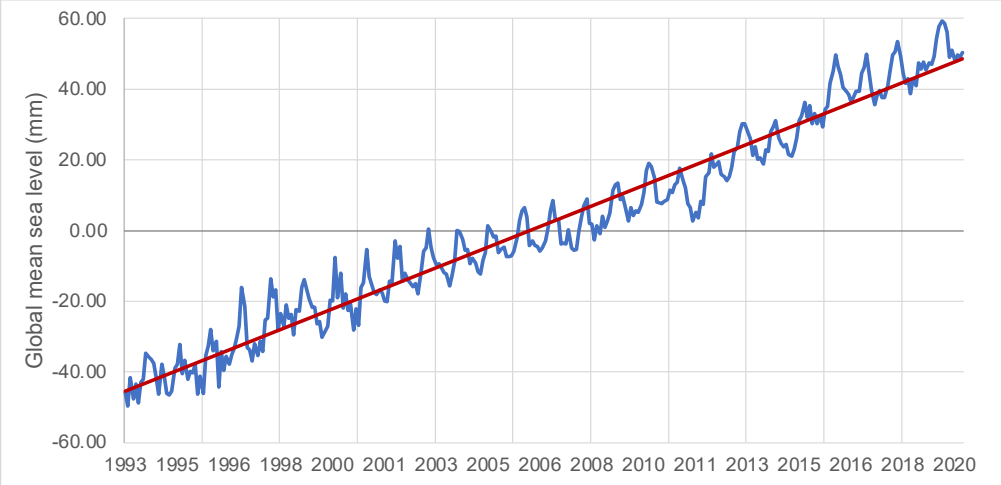


Figure 8. Mean global sea level since 1992 with seasonal signal (blue) and trend line (red). (https://www.cmar.csiro.au/sealevel/sl_hist_last_decades.html).

The most recent regional climate change models for the Great South Coast region projected the following conditions, relative to a 1986–2005 baseline (CSIRO and DEECA 2024):

- Very high confidence of further increases in temperature (0.9 C to 1.3 C) by 2050;
- Very high confidence of a significant increase in the number and duration of extreme temperature periods;
- Medium to high confidence that cool-season rainfall will decrease, but the magnitude of this change is uncertain;
- High confidence that there will be an increase in the frequency of heavy rainfall events;
- Very high confidence in a 10−30% increase in mean evaporation;
- Very high confidence in a continued increase in mean sea level and the frequency of extreme coastal sea levels (i.e. storm surges). Mean sea level is likely to increase by 2050 by 12 to 27 cm over 1995-2014 levels.

Changes in temperature and rainfall will exacerbate impacts that arise from decreased water levels (surface and groundwater) potentially altering wetland water regimes and habitats for vegetation communities and fauna. Sea level rise has the potential to impact ecological character in several ways. Recent modelling of sea level rise by DEECA has indicated that a predicted 45 cm rise by 2070, would start to move saline water into the western end of Long Swamp and inundate areas where threatened plant species have previously been recorded (Figure 9). It will also result in a significant decrease in open sand habitat for beach nesting birds.

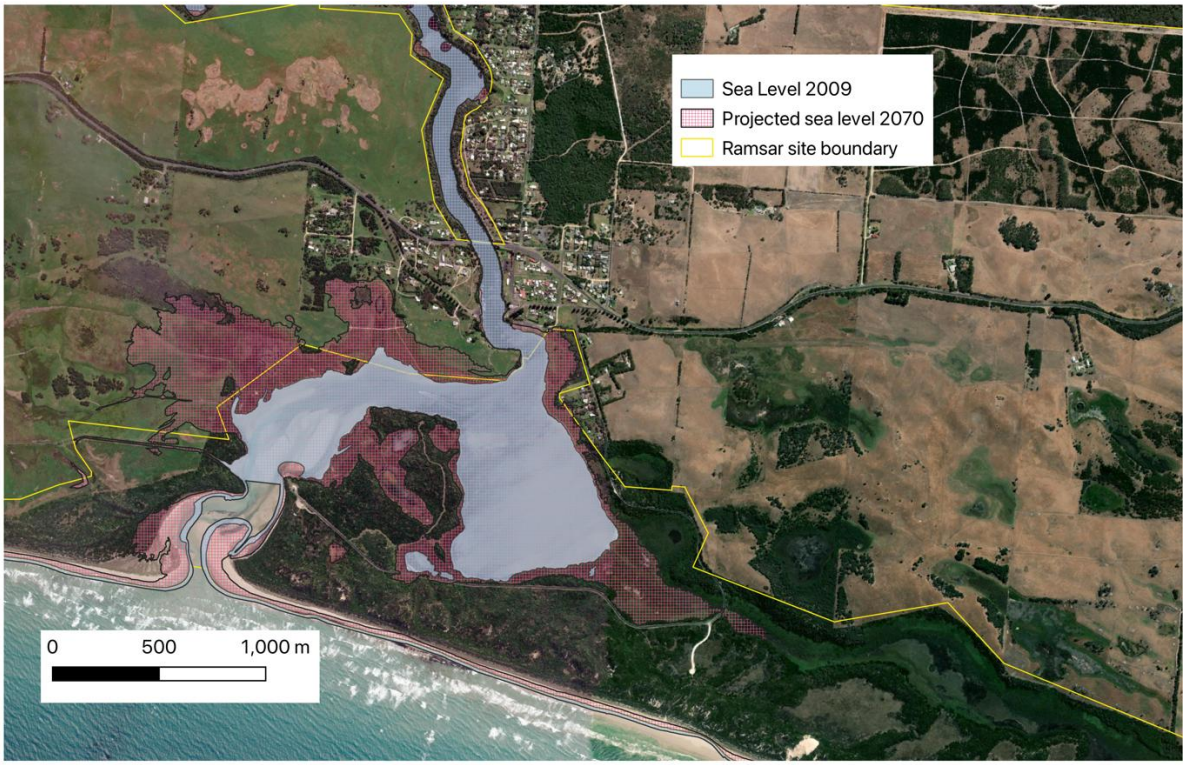


Figure 9. Projected sea level rise by 2070 at the Glenelg Estuary and along parts of the coast (VCID, www.data.vic.gov.au).

Agricultural run-off

Land use in the Glenelg catchment is dominated by dryland grazing, with small (but increasing) amounts of cropping and irrigation. Run-off from these land uses can bring nutrients, sediments and toxicants. Although information directly from the estuary is sparse, nutrient and sediment concentrations in the river upstream at Dartmoor are high during both low and high flows, suggesting loads to the estuary are also high (Lauchlan-Arrowsmith and Graham 2016).

Preliminary groundwater monitoring near freshwater wetlands also indicates high levels of nitrates suggesting that nutrient enrichment may be a problem for some wetlands, however further sampling is required. The results are consistent with data collected at bores elsewhere in the catchment, which indicate elevated levels of nitrogen (Cervantes-Servin et al. 2025).

In addition, results from groundwater monitoring near the estuary entrance and adjacent to several freshwater wetlands indicate that arsenic, chromium, copper, lead and zinc are all above the Australian and New Zealand Environment and Conservation Council (ANZECC) thresholds for protection of high value ecosystems. The levels present in the estuary and /or wetlands after dilution remains unknown. Other chemicals including herbicides, pesticides, pharmaceuticals and per- and poly-fluoroalkyl substances (PFAS) represent a knowledge gap; however, upstream land uses could be potential sources.

Water resource use

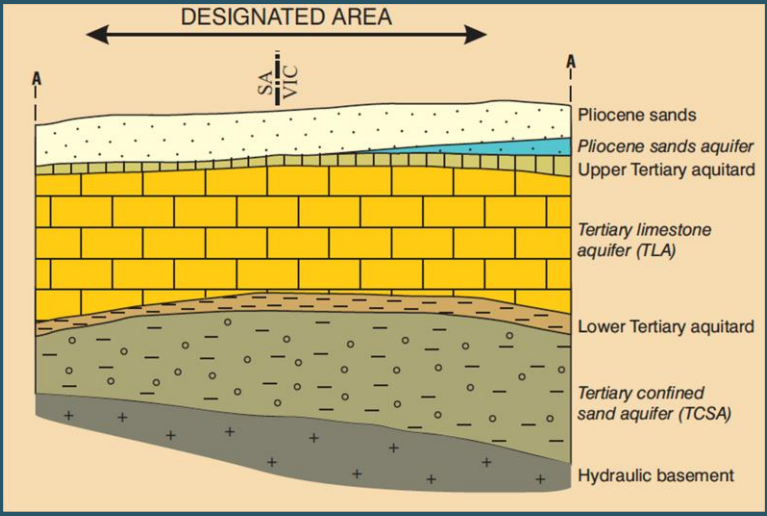
Two major storages, Moora Moora Reservoir and Rocklands Reservoir, together with a large number of small farm dams have had a significant impact on system hydrology. Rocklands Reservoir, in particular, can store 348,000 ML at the Full Supply Level (FSL); three times the average annual inflow of the Glenelg River, and diverts water from the upper Glenelg catchment to be delivered to the Wimmera system. Effectively, there has been a 60%

decrease in mean annual flow to the estuary and a decrease in the frequency of flushing flows (Streamology 2024). The IEC rated the Glenelg Estuary as "poor" for hydrology, suggesting significant impacts to the estuary from altered hydrology (DELWP 2022). While the IEC did not account for environmental flow contributions in their assessments of hydrological impacts, Lauchlan-Arrowsmith and Graham (2016) suggested that environmental water deliveries were insufficient for estuary flushing. While the site was listed with these pressures, the ongoing water use development across the groundwater management area of South Australian and Victoria has the potential for significant impacts to ecological character.

Managing groundwater resources across the South Australia – Victoria Border

In most areas close to the South Australian-Victorian State border, groundwater is the only reliable source of water. It is used for irrigation and for industrial, stock and domestic supplies. Many towns close to the border also rely on groundwater for their public water supply. Large groundwater withdrawals on one side of the border could affect users on the other side, possibly interfering with their long-term supplies. In addition, groundwater salinity increase can occur due to excessive use of groundwater. To prevent this, the Governments of South Australia and Victoria entered into an agreement for the management of the groundwater resource within a 40 km-wide strip across the two state borders (Designated Area).

Within the Designated Area there are two main regional aquifer systems - an upper aquifer referred to as the Tertiary Limestone Aquifer and a deeper confined (or pressure) aquifer termed the Tertiary Confined Sand Aquifer. These aquifers are separated wholly or in part by aquitards (or confining beds).



The Groundwater (Border Agreement) Act 1985 came into effect in January 1986 to cooperatively manage the groundwater resources along the state border of South Australia and Victoria. The Act established a Review Committee which is comprised of members from each state and is the body responsible for the joint management of sustainable groundwater resource use. Key features of the agreement are:

- Permissible annual volumes – the maximum amount each state can extract;
- Permissible rate of groundwater lowering – the rate of drawdown that cannot be exceeded;
- Permissible distance from the border – the area over which the agreement is in force;
- Permissible level of salinity – a level of salinity can be specified to protect groundwater quality;
- Bore construction – sets conditions governing the construction of new bores;
- Five-yearly management review – the agreement mandates a review of the groundwater resource at least every five years. This includes provisions to review the permissible rate of groundwater lowering and salinity levels.

Text Box 7. The Groundwater Border Agreement.

Invasive species

There are a broad range of pest plants and animals that are likely impacting the habitats and fauna of the Glenelg Estuary and Discovery Bay Ramsar Site. Introduced predators such as foxes and cats have a direct impact on waterbirds, including shorebirds and beach nesting species such as the threatened hooded plover. There is also evidence of impacts to nesting birds from native predators such as ravens (BirdLife Australia 2024).

Threatened plant species monitoring has recorded evidence of damage to vegetation by pigs in Long Swamp (Just 2020, 2021, 2022, 2023). Anecdotal evidence from site managers confirmed that pigs represented a high risk to wetland values. There is also evidence of pig damage to vegetation communities around the estuary. Other species such as deer and goats are present, but are likely having less impact than pigs.

Pest plant species are a threat to ecological character at a number of locations around the lakes. For example, introduced coastal plants such as *Arctotheca populifolia* and to a certain extent, Marram grass is displacing the sandy habitat that shore nesting birds such as hooded plover require for nesting. These birds build a nest in a scrape in the sand and a lack of sandy habitat can reduce breeding success (Mead et al. 2012).

Recent assessments of vegetation indicated that the majority of wetlands were in good to excellent condition with a small number of exceptions. Bridal creeper and ferny asparagus were found in Swamp Scrub, and tall marsh at the western end of the wetlands on the fringes of Nelson and along the road verges of Beach Road. These incursions are recent (less than 10 years) and present a considerable threat to the future integrity of sections of the Ramsar site (Australis Biological and RapidMap 2024). In addition, Lervasi et al. (2019) indicated the presence of spiny rush (*Juncus acutus*) in the Bridgewater Lakes.

Recreation

While the majority of the wetlands in the Ramsar site, with the exception of the Bridgewater Lakes, are relatively inaccessible and subject to low visitation, the estuary and the beach are both popular recreationally. Site managers have indicated that there has been increasing recreational pressure, particularly in the beach areas of the site. This is confirmed by waterbird monitoring, which records impacts to birds from recreational activities (BirdLife Australia 2024).

Increased noise from shore based or nearshore activities (including vehicles on beaches) and the presence of domestic dogs on beaches have all been identified as high risks to waterbirds both in the Ramsar site and elsewhere. There is growing evidence that disturbance of waterbirds by human activities (walking, boating, hunting, vehicles) can have significant negative impacts on both feeding behaviour and habitat use (Glover et al. 2015, Livezey et al. 2016). The consequences for individuals and populations can be significant, with decreased time spent feeding, increased energy spent in flying away from disturbances, nest abandonment and ultimately population declines all cited as potential effects (Glover et al. 2011, Martín et al. 2015, BirdLife Australia 2024).

Avian diseases

High pathogenicity avian influenza has the potential to severely affect wild bird populations including waterfowl and shorebirds. Since 2020, a variant of these viruses belonging to the H5 clade 2.3. 4.4b has led to an unprecedented number of deaths in wild birds and poultry in many countries in Africa, Asia and Europe. In 2021, the virus spread to North America, and in 2022, to Central and South America. Oceania (Australia and New Zealand) is the only region to remain free of this virus to date. There is no effective way to prevent new strains of

bird flu entering Australia, and it is possible that the virus could impact on wild bird populations in the region and in the Ramsar site in the future.

3.3 Knowledge gaps

Throughout the risk assessment and process for identifying priority values and threats for management, a number of key knowledge gaps were identified:

K1. Potential risks from bushfires on wetlands in the Ramsar site;
K2. Toxicants (heavy metals, PFAS, herbicides and pesticides) in groundwater, freshwater wetlands and the estuary;
K3. Effect of groundwater decreases on connectivity and ecological character;
K4. Impact of nutrients on the estuary and seagrass;
K5. Impacts of boat activity and wave action on wetland / estuary habitat;
K6. Implications of the expansion of tall marsh;
K7. Sea level rise impacts on groundwater / salinity levels of freshwater wetlands;
K8. Current condition and extent of seagrass.

Several of these knowledge gaps have management strategies (Table 11) or monitoring (Table 12) aimed at improving our knowledge of the site. In addition, these knowledge gaps are revisited in annual action planning when opportunities for new projects addressing priority knowledge gaps arise.

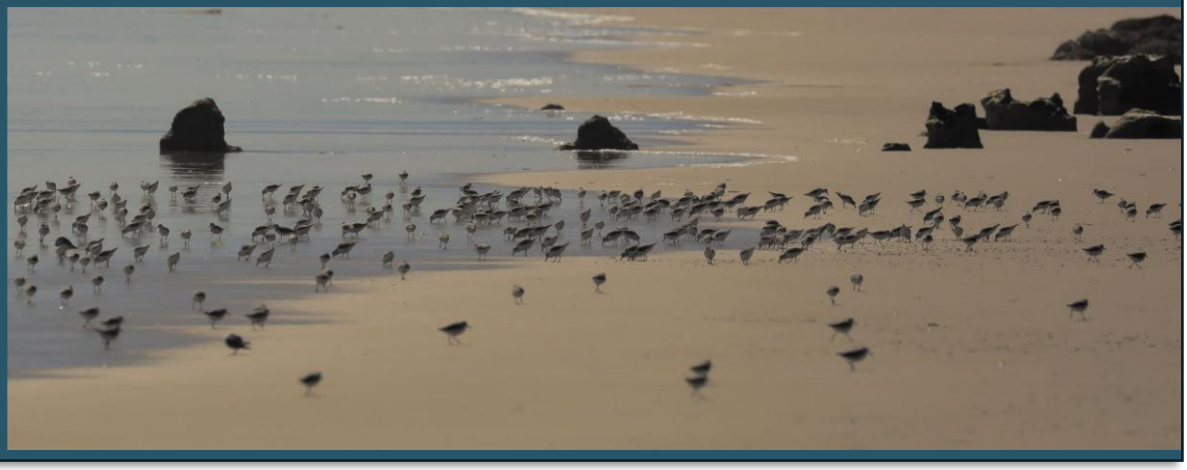
Filling Knowledge Gaps – Sanderling Tracking Project

Sanderling (*Calidris alba*) are small migratory shorebirds that breed high in the Artic. During their non-breeding season, sanderling migrate to both tropical and temperate coastal habitats around the world including Australia. One of the most important areas in Australia for sanderling is the Discovery Bay Coastal Park, within the Glenelg Estuary and Discovery Bay Ramsar Site. The sanderling tracking project was initiated to gain a better understanding of how sanderling utilise different coastal habitats within the region, thus providing essential knowledge that will aid in conserving critical habitat.

To ascertain the movements of sanderling, solar-powered global positioning system (GPS) tracking devices were deployed on sanderling in Port Fairy (Victoria) and Port MacDonnell (South Australia) in March 2023. Each device was equipped with Bluetooth technology, allowing movement data to be downloaded via a mobile phone app. Members of the public were encouraged to get out and look for sanderling with trackers to assist in gathering data.

Data revealed that sanderling are highly mobile throughout the non-breeding season, travelling on average between 34-67 km/day. In some cases, sanderling were found to travel over 100 km/day as they moved between Port Fairy and Port MacDonnell. Behavioural data showed that sanderling foraging activity was correlated with the phases of the moon, with the birds showing a preference for nighttime foraging during the full moon. Given some of the invertebrate species that sanderling feed on are more active at night and during the full moon, we believe this may explain the switch to nighttime foraging.

Additionally, data showed that sanderling location preference was influenced by time of day. During the day, sanderling that frequented the more publicly accessible beaches near Port MacDonnell moved to the remote coastline of Discovery Bay during the night. The reason for this is still currently being investigated, however, food availability is the most likely cause.



Text Box 8. Sanderling tracking project

4 Site management strategies

4.1 Approach

There are two types of indicators that are relevant to the management of the Ramsar site:

1. **Limits of Acceptable Change (LAC)** are set in the Ecological Character Description (ECD) and are based on the conditions at the time of listing. LAC are the thresholds at which ecological character may be compromised.
2. **Resource Condition Targets (RCTs)** are established in the Ramsar Site Management Plan and are the aspirational condition for each of the identified priority values (i.e. where do we want / expect the condition of each priority value to be at the end of this management plan?). These will help to assess the effectiveness of the management plan in maintaining (or improving) ecological character.

How each of these three levels of indicators fit into the planning and development process is illustrated in Figure 10.

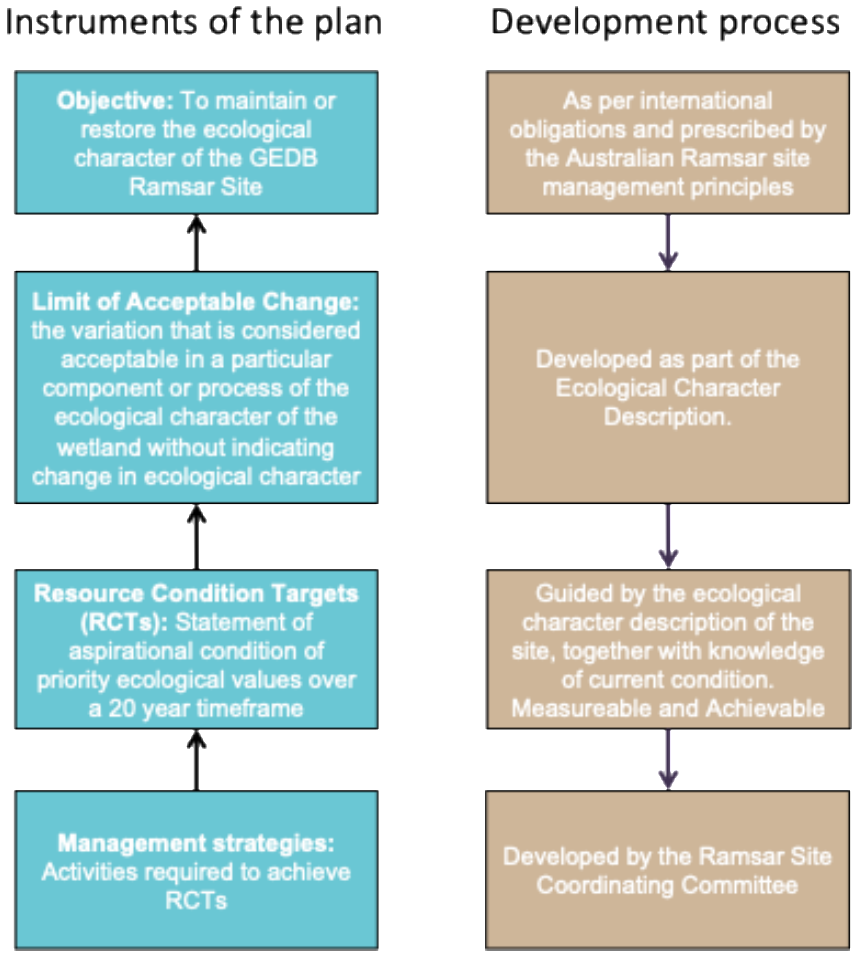


Figure 10. Relationships between the different instruments of the plan and their development process.

4.2 Resource condition targets

RCTs were developed with existing data and expert input have been defined for the Glenelg Estuary and Discovery Bay Ramsar Site (Table 10). These have helped to guide the identification of management strategies and provide a goal for monitoring the ecological character of the site (Appendix C).

Table 10. Resource Condition Targets for the Glenelg Estuary and Discovery Bay Ramsar Site.

Critical CPS	Resource Condition Target
Hydrology	Maintain wetland water regimes (as indicated by water level) at each of the following key locations: • White sands: > 3.4 m in winter / spring and < 2.2 m in autumn. • Noble Rocks: > 4.2 m in winter / spring and < 3.7 m in autumn.
Stratification	Maintain seasonal stratification in the Glenelg Estuary.
Vegetation type and extent	Condition of wetland EVCs in the Ramsar site to be considered excellent (as indicated by a score of > 90 / 100) at 98% of representative sites.
Fish diversity and abundance (ecological connectivity)	Estuary specialist fish (black bream, and estuary perch) recorded annually in the Glenelg Estuary. Presence of the following diadromous fish annually: • Estuary – tupong, short-finned eel. • Wetlands and connecting creeks – small-mouthed hardyhead.
	Annual detection of juvenile (< 30 mm) and adult (> 40 mm) southern pygmy perch annually. Native fish to represent > 70% of the total fish abundance in Long Swamp.
Waterbird diversity and abundance	Waterbird species richness to be > 32 species annually. The site supports > 5% of the flyway population of sanderling (based on a 5-year average).
Threatened species: plants	Maintain the following sub-populations of maroon leek-orchid and swamp greenhood: • east of Nobles Rock tracks; (> 20 maroon-leek orchid; > 100 swamp greenhood) • west of Nobles Rock tracks, (>5 maroon-leek orchid; presence of swamp greenhood) • 2 km west of Nobles; (>25 maroon-leek orchid) • south of Millhouse Road (> 130 maroon-leek orchid; > 90 swamp greenhood).
Threatened species: fish	Annual detection of juvenile (< 30 mm) and adult (> 40 mm) Yarra pygmy perch annually. Detection of little galaxias in at least 2 years in every 3-year period.
Threatened species: birds	To improve the nesting success of hooded plover in the site with an average fledging success of 0.3 (5-year average).
Ancient greenling	Maintain population of ancient greenling.

4.3 Management strategies

Management strategies to address priority threats and progress towards RCTs were developed with the GEDB RCC, key experts and local knowledge (Table 11). Management strategies are intended as high-level strategic actions, with detailed operational management activities prioritised and available resources identified during annual action planning with the GEDB RCC (see Section 6).

Table 11. Management strategies (Note: lead agency identified in bold font. Not all partners that will be involved in the delivery of this activity are listed. Other partners will include landholders, traditional owners, not-for profits, NGOs and others).

	Management Strategies	Lead agency and partners	Linkages to existing programs / activities	Management Units
RMP 1.	Consider the requirements to maintain ecological character in updating the Glenelg Hopkins Waterway Strategy and implement actions aimed at managing pest plants and animals within the Glenelg Estuary and Freshwater wetlands.	**Glenelg Hopkins CMA** Parks Victoria DEECA	Glenelg Hopkins Waterway Strategy Glenelg Ark	Estuary, Freshwater wetlands
RMP 2.	Continue to implement the actions in the *Ngootyoong Gunditj Ngootyoong Mara South West Management Plan* aimed at managing pest plants and animals within the Glenelg Estuary, Freshwater wetlands and beach and dune fields.	**Parks Victoria** Gunditj Mirring TOAC Glenelg Hopkins CMA DEECA	Ngootyoong Gunditj Ngootyoong Mara South West Management Plan Glenelg Ark Threatened species recovery plans	All
RMP 3.	Continue to implement estuary opening protocols at the Glenelg Estuary in accordance with the Estuary Entrance Management Support System.	**Glenelg Hopkins CMA** Parks Victoria DEECA	Glenelg Hopkins Waterway Strategy Victorian Waterway Management Strategy	Estuary
RMP 4.	Continue to develop and implement environmental watering in the Glenelg River with respect to maintaining the ecological character and values associated with the intermittently-closed salt-wedge estuary – Glenelg.	**Glenelg Hopkins CMA** VEWH DEECA	Glenelg Seasonal Watering Proposals	Freshwater wetlands, Estuary

	Management Strategies	Lead agency and partners	Linkages to existing programs / activities	Management Units
RMP 5.	Consider impacts to the ecological character of the site when implementing the Regional Groundwater Plan and Border Groundwater Agreement.	**Southern Rural Water** Glenelg Hopkins CMA (referral) DEECA	Groundwater (Border Agreement) – South Australia-Victoria Glenelg Water Supply Protection Area Local Management Plan South West Limestone Aquifer Local Management Plan Review of sustainable yields groundwater management units DEECA	Estuary, Freshwater wetlands
RMP 6.	Manage visitor activities in the Lower Glenelg National Park and the Discovery Bay Coastal Park to minimise disturbance of shorebirds and beach nesting birds. Indicative activities may include: • Signage in priority locations informing the community of the importance of shorebird feeding and the consequences of disturbance. • Community engagement events. • Continued enforcement of regulations with respect to recreational access in priority locations.	**Parks Victoria** VFA	Ngootyoong Gunditj Ngootyoong Mara South West Management Plan	Estuary, beach and dune fields
RMP 7.	Investigate options to mitigate the impacts of climate change (sea level rise) on coastal habitats and improve resilience.	**Glenelg Hopkins CMA** DEECA	Coastal & Estuarine Risk Mitigation Project Victoria's Resilient Coast	Estuary, beach and dune fields

	Management Strategies	Lead agency and partners	Linkages to existing programs / activities	Management Units
RMP 8.	Develop and implement measures to control carp within the Glenelg Estuary and prevent movement into the Long Swamp Complex.	**Glenelg Hopkins CMA** Parks Victoria		Estuary, Freshwater wetlands
RMP 9.	Continue to implement recovery plans for the threatened plant species at the site: maroon leek-orchid (*Prasophyllum frenchii*) and swamp greenhood (*Pterostylis tenuissima*)	**Parks Victoria** Glenelg Hopkins CMA DEECA	Maroon Leek Orchid Recovery Plan Recovery Plan for Three Orchid Species in South Australia and Victoria	Freshwater wetlands
RMP 10.	Continue to implement the recovery plan for the Yarra pygmy perch (*Nannoperca obscura*).	**Parks Victoria** **Glenelg Hopkins CMA** DEECA	Yarra Pygmy Perch Recovery Plan	Freshwater wetlands
RMP 11.	Protect seagrass meadows of the Glenelg estuary through impact assessment and controls consistent with wise use of wetlands principles.	**Parks Victoria** Glenelg Hopkins CMA	Seagrass meadows of Victoria southwest estuaries project	Estuary
RMP 12.	Investigate the risks associated with nutrients and toxicants in groundwater inflows to waterways of the Ramsar site.	**Glenelg Hopkins CMA** DEECA	Quarterly site groundwater monitoring	Estuary, Freshwater wetlands
RMP 13.	Investigate the impacts of boating on water quality, shorelines and littoral vegetation communities in the Glenelg Estuary and Bridgewater Lakes.	**Parks Victoria** DEECA		Estuary, Freshwater wetlands
RMP 14.	Continue to implement the Glenelg Estuary and Discovery Bay Ramsar Site wetland information and	**Glenelg Hopkins CMA** Parks Victoria DEECA Glenelg Shire Council		All

	Management Strategies	Lead agency and partners	Linkages to existing programs / activities	Management Units
	interpretation.program. Indicative activities may include: • Education and engagement of landholders • Public awareness of the impacts of recreational activities on sensitive habitats and species such as shorebirds and beach nesting birds • Mechanisms to engage recreational fishers in wise and sustainable use • The status of ecological character of the Ramsar site.			
RMP 15.	Work with Traditional Owners to improve understanding of Aboriginal values associated with the Ramsar site and develop opportunities for Aboriginal involvement in Ramsar site management and leadership.	**Glenelg Hopkins CMA** Gunditj Mirring TOAC DEECA Parks Victoria	Nyamat Mirring Plan (Sea Country) Ngootyoong Gunditj Ngootyoong Mara South West Management Plan Glenelg Hopkins Regional Catchment Strategy	All
RMP 16.	Build capacity and collaboration with community and industry groups by supporting citizen science and on-ground community action in Ramsar site management. Activities to include: • Field days in wetlands and community volunteering in pest plant and animal control.	**Glenelg Hopkins CMA** Parks Victoria	Beach Patrol 3280, Atlas of Living Australia	All

	Management Strategies	Lead agency and partners	Linkages to existing programs / activities	Management Units
	• Support of citizen science initiatives such as Water Watch and local bird observing groups.			
RMP 17.	Continue to convene a Ramsar Coordinating Committee for the Ramsar site.	**Glenelg Hopkins CMA**		All
RMP 18.	Ramsar Coordinating Committee to develop and implement annual action plan.	**Glenelg Hopkins CMA** DEECA Parks Victoria Local councils Traditional Owners	Glenelg Hopkins Waterway Strategy Implementation Plans Investment	All
RMP 19.	Apply the appropriate State and Commonwealth environmental impact assessment processes for activities that have the potential to impact on the Ramsar site and Matters of National Environmental Significance (MNES).	**DEECA** DCCEEW		All
RMP 20.	Undertake a regular review of the status of the ecological character of the Ramsar site.	**DEECA** Glenelg Hopkins CMA	Ramsar Management System (annual)	All

5 Monitoring, evaluation, reporting and improvement

5.1 Framework

Consistent with the *Victorian Waterway Management Strategy* (VWMS), the Ramsar Convention and the Australian Ramsar Management Principles, this Glenelg Estuary and Discovery Bay Ramsar Site Management Plan adopts an adaptive management approach. The Glenelg Estuary and Discovery Bay Ramsar Site Management Plan will be renewed every seven years, and is underpinned by a monitoring program that reports on the condition of the system with respect to change in ecological character and progress towards meeting resource condition targets through a four- and seven-year review.

In 2018, Victoria developed a Ramsar monitoring evaluation reporting and improvement (MERI) Framework to improve confidence in the effectiveness of management of Victoria's Ramsar sites, and to assist Victoria in meeting national reporting obligations under the Ramsar Convention (Figure 11). Under the framework each Victorian Ramsar site has developed a MERI plan, a living document that describes two types of monitoring:

1. MERI to assess the status of ecological character and meet Ramsar reporting obligations
2. MERI to evaluate the effectiveness of management at the site:
    a. General assessment of the implementation of management actions and progress towards achieving RCTs for all critical CPS
    b. Detailed evaluation testing assumptions associated with management of at least one critical CPS, with the results used to update the evidentiary basis for and to improve the effectiveness of management.

A summary of monitoring within the Glenelg Estuary and Discovery Bay Ramsar Site MERI Plan is provided in Table 12.

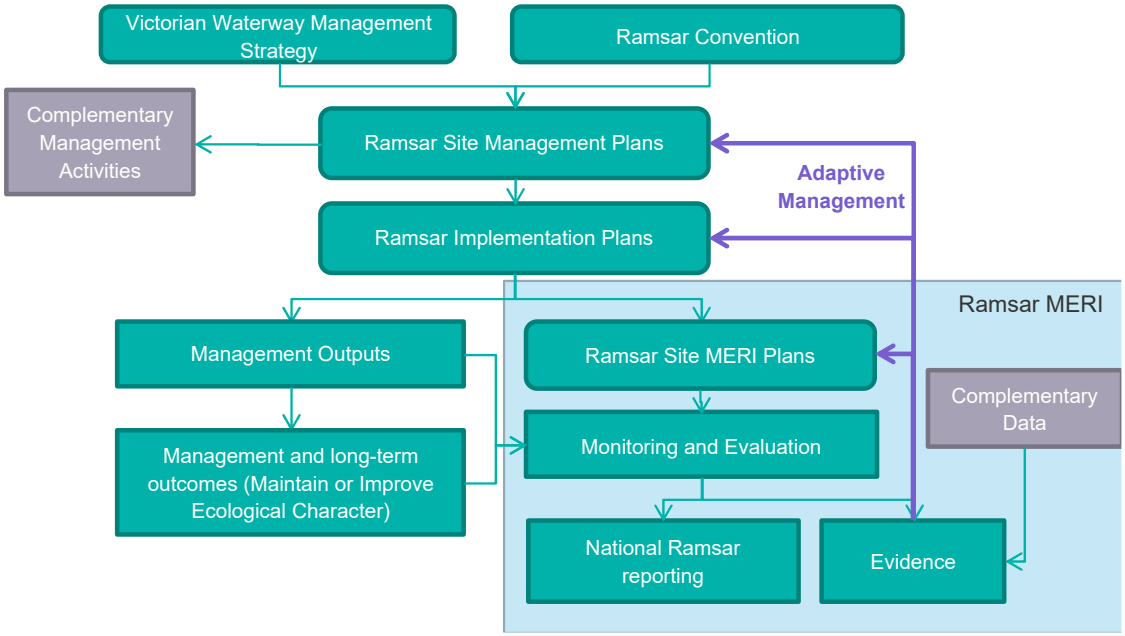


Figure 11. Monitoring, evaluation, reporting and improvement framework (DEECA unpublished).

Table 12. Recommended monitoring for the Glenelg Estuary and Discovery Bay Ramsar Site. (Note: lead agency identified in bold font)

Program	Indicators and method	Frequency	Lead agency and partners	Linkages to existing programs / activities	Locations
Hydrology	Surface and groundwater levels at key locations in the Freshwater Wetlands Management Unit, and surrounding landscape	Continuous	**Glenelg Hopkins CMA** Gunditj Mirring TOAC	Existing loggers in several wetlands, Geoscience Australia Digital Earth Australia Waterbodies and Wetlands Insight Tool	Freshwater Wetlands
Hydrology	Estuary opening / closing	Event based	**Glenelg Hopkins CMA**	Estuary telemetry; EEMS	Estuary
Vegetation: saltmarsh, freshwater emergent, submerged	Extent mapping and IWC condition assessments	Every 4 years	**Glenelg Hopkins CMA** Parks Victoria DEECA	Completed in 2022	Freshwater Wetlands, Estuary
Threatened plant species: Maroon leek-orchid, swamp greenhood	Annual surveys (as per recovery plans) Water level monitoring in key locations Soil moisture monitoring in key locations	Annual – surveys, continuous, water level	Glenelg Hopkins CMA Parks Victoria DEECA		Freshwater Wetlands
Fish diversity and abundance (including threatened Yarra pygmy perch and little galaxias)	Electro-fishing and netting as per current Nature Glenelg Trust Program	Annual	**Glenelg Hopkins CMA** VFA	Nature Glenelg Trust Program	Freshwater Wetlands, Estuary
Waterbird abundance	Bi-annual counts; BirdLife Australia standard methods	Twice yearly Seasonal program	**Glenelg Hopkins CMA** DEECA	Beach nesting birds Migratory shorebirds - Sanderling BirdLife Australia	Key locations in freshwater wetlands, Glenelg Estuary and Discovery Bay beach
Waterbird breeding	Annual surveys nest counts, breeding success (i.e. fledgling)	Annual	**Glenelg Hopkins CMA** Parks Victoria	Beach nesting Birds BirdLife Australia	Discovery Bay beach
Threatened bird species: Australasian bittern	BirdLife Australia standard methods	Annual	**Glenelg Hopkins CMA** Parks Victoria	BirdLife Australia	Freshwater wetlands

6 Governance and Implementation

6.1 Governance

The roles and responsibilities for managing Ramsar sites in Victoria can be summarised follows:

Ramsar state-wide coordinator

DEECA will undertake a state-wide coordination and oversight role:

- Facilitate a coordinated and consistent approach to MERI and adaptive management;
- Undertake preliminary and formal assessment in response to potential change in ecological character;
- Develop a management response in partnership with the site coordinator and site manager/s where change in ecological character has been confirmed;
- Address issues that are not able to be managed at a site level;
- Lead RIS updates undertaken in consultation with the Ramsar site coordinator;
- Oversee renewal of management plans and ensure that they meet the Australian Ramsar Management Principles, follow an adaptive management approach and address issues of management effectiveness identified through the MERI framework.

Ramsar site coordinator

Glenelg Hopkins CMA is the site coordinator and has the following responsibilities:

- Convene and chair a site coordination committee;
- Ensure coordination committee is engaged;
- In consultation with the coordination committee oversee the implementation of Ramsar Site Management Plan priorities, according to available resources, by:
    - engaging with Traditional Owner groups to lead and/ or deliver monitoring or on-ground activities consistent with the Ramsar Site Management Plan;
    - developing an annual action plan that determines and assigns agreed responsibility for actions, and development of annual investment proposals;
    - developing and overseeing the implementation of an annual monitoring plan, as guided by the MERI framework;
    - maintaining up-to-date information in the MERI database.
- Maintain communications with the state-wide coordinator, including:
    - annual investment and implementation reporting;
    - tracking ecological character status via the MERI database;
    - annual reporting on ecological character status (more frequent if limits of acceptable change have been exceeded).
- Maintain communications with agencies that manage areas within the Ramsar site, in line with responsibilities set out in site management plans;

- Ensuring that monitoring data is appropriately curated for future reference;
- Provide input to state-wide projects (undertaken by state-wide coordinator) relating to Ramsar sites, including any updates to RIS and ECD;
- Oversee strengthening of Ramsar Site Management Plan for sites where this is required;
- Lead the renewal of the Ramsar Site Management Plan.

Ramsar site manager/s

The Ramsar site manager/s for the Glenelg Estuary and Discovery Bay Ramsar Site include Parks Victoria and Gunditj Mirring TOAC, who have the following responsibilities:

- Participate in the site coordinating committee activities;
- Implement their agreed and resourced responsibilities outlined in Ramsar site annual action plans, in collaboration with regional partners;
- Notify the coordinator of any indication of exceeding limits of acceptable change for the critical components, processes and services as set out in the ecological character description for the site;
- Align the management strategies of the Ramsar Site Management Plan with relevant priority outcomes from Ngootyoong Gunditj Ngootyoong Mara South West Management Plan and Gunditjmara Nyamat Mirring Plan 2023 - 2033.

6.2 Implementation

The Glenelg Hopkins CMA as the Ramsar Site Coordinator, oversees implementation of this Glenelg Estuary and Discovery Bay Ramsar Site Management Plan, on behalf of regional agency partners.

The GEDB RCC are primarily responsible for the management of the Ramsar site (Glenelg Hopkins CMA, Gunditj Mirring TOAC, Parks Victoria, DEECA).

Implementation planning

Delivery partners (Glenelg Hopkins CMA, DEECA, Parks Victoria), will collaborate to develop implementation plans for the actions for which they are identified as responsible in the Glenelg Estuary and Discovery Bay Ramsar Site Management Plan. Each agency will work within their established legislative, regulatory and administrative arrangements.

Glenelg Hopkins CMA will coordinate this process and develop a single Annual Action Plan for the Glenelg Estuary and Discovery Bay Ramsar Site Management Plan by August each year. The plan will ensure that the responsibilities for individual management actions are clearly established, priorities and sequencing is logical, implementation is focused and coordinated, and funding opportunities are identified and sourced.

Glenelg Estuary and Discovery Bay Ramsar Coordinating Committee (GEDB RCC)

The GEDB RCC is convened and co-ordinated by Glenelg Hopkins CMA.

This integration approach builds on previous and current collaboration practice in the region, evident most recently in the strong participation of delivery partners in the development of the Glenelg Estuary and Discovery Bay Ramsar Site Management Plan.

The GEDB RCC will be responsible for coordinating specific aspects of implementation within the themes of the Glenelg Estuary and Discovery Bay Ramsar Site Management Plan. These responsibilities will include developing:

- implementation targets;
- action planning, updated annually;
- targeted investment proposals;
- integrated delivery arrangements;
- coordinated monitoring and evaluation of implementation, including integrated reporting against targets;
- reviewing Ramsar Site Management Plan progress bi-annually.

Resourcing implementation

Investment proposals to support actions of the Glenelg Estuary and Discovery Bay Ramsar Site Management Plan will be developed as investment opportunities arise. Project investment proposals will be prepared through the GEDB RCC, in conjunction with delivery partners and will be structured to reflect the themes within the Glenelg Estuary and Discovery Bay Ramsar Site Management Plan, and the regional programs of partner managing agencies.

Implementation of the Glenelg Estuary and Discovery Bay Ramsar Site Management Plan will be influenced by available funding and resources. The implementation approach that will be applied will coordinate the prioritisation of management actions so that maximum benefit is achieved with the resources that are available. The annual priorities are captured in annual action plans, which detail the required resources and responsible partners for implementation. These plans also provide a mechanism to track and evaluate the implementation of the Ramsar Site Management Plan.

With assistance of the Ramsar Site Coordinator, partners will seek funding for implementation of this plan through the:

- Victorian Waterway Programs Investment Framework;
- Relevant initiatives of the State and Federal Governments;
- Existing agency budgets; and
- Contributions of industries and communities.

6.3 Communication

The Glenelg Hopkins CMA will co-ordinate communications and engagement for the Ramsar site as part of its role in co-ordinating implementation of the Glenelg Estuary and Discovery Bay Ramsar Site Management Plan. A communication plan and engagement strategy developed by the GEDB RCC will guide stakeholder interactions. In particular, the communication plan will aim to include the local community (e.g. farmers, fishers, tourists, townspeople) in understanding the international values and importance of the site and how to maintain its values.

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8 Appendices

Appendix A Implementation of the 2017 plan

A review of the management strategies within the 2017 Glenelg Estuary and Discovery Bay Ramsar Site Management Plan was conducted and is summarised in Table 13.

Table 13. Review of 2017 management strategies

Management strategy	Responsibility	Activities	Status
Continue to implement the actions in the Glenelg-Hopkins Waterway Strategy aimed at managing pest plants and animals within the Glenelg Estuary (Management activities 38-201.8 and 38-201.9) and Freshwater wetlands (Management activities 20501.5, 20502.3, 20614.4, 20614.5, 20562.1 and 20562.2)	Parks Victoria Glenelg Hopkins CMA DELWP[2]	Victorian Deer strategy, deer control across Lower Glenelg National Park (north) Feral pig control program Protection Biodiversity project - woody weed control program, feral pig control Weed control (various) including African boxthorn, bridal creeper, English broom, cape wattle, Italian buckthorn, radiata pine, sallow wattle, coast beach daisy, polygala, willow, cotoneaster, spiny rush	Ongoing
Continue to implement the actions in the Ngootyoong Gunditj Ngootyoong Mara South West Management Plan aimed at managing pest plants and animals within the Glenelg Estuary, Freshwater wetlands and Beach and dune fields	Parks Victoria, Glenelg Hopkins CMA DELWP Gunditj Mirring TOAC	Weed control including African boxthorn, bridal creeper, English broom, cape wattle, Italian buckthorn, radiata pine, sallow wattle, coast beach daisy, polygala, willow, cotoneaster, spiny rush Fox control and feral pig control program	Ongoing
Continue to implement estuary opening protocols at the Glenelg Estuary in accordance with the Estuary Entrance Management Support System	Glenelg Hopkins CMA	Glenelg Estuary Entrance Management Support System - Glenelg estuary entrance program continues to be maintained by the Estuary Officer using the EEMSS decision support system a routine water quality profiling	Ongoing
Continue to develop and implement environmental watering in the Glenelg River and consider needs of Freshwater wetlands in Seasonal Watering Proposals	Glenelg Hopkins CMA, VEWH	Glenelg River seasonal watering plans – development and implementation Update to the Glenelg FLOWS study	Ongoing Complete
Consider impacts to the ecological character of the site when implementing the Regional Groundwater Plan and Border Groundwater Agreement	SRW Glenelg Hopkins CMA	Water levels at 9 locations across Discovery Bay, plus the estuary at Nelson continue to be monitored Hydrogeological processes and conceptualisation of the Glenelg River estuary and Discovery Bay Ramsar sites 2023-24 – Designed and commenced a Groundwater monitoring plan, with broad range of water quality parameters	Ongoing Complete

[2] Department of Environment, Land, Water and Planning (DELWP), now known as DEECA.

Management strategy	Responsibility	Activities	Status
Manage visitor activities in the Lower Glenelg National Park and the Discovery Bay Coastal Park to minimise disturbance of shorebirds and beach nesting birds	Parks Victoria	Regular patrols mid-week and weekends, Targeted patrols for off-road vehicles using the Site without permit (unlicensed), User group education, user groups focusing on compliance issues, compliance actions and prosecutions	Ongoing
Investigate options to mitigate the impacts of climate change (sea level rise) on coastal habitats and improve resilience	DELWP Glenelg Hopkins CMA	Beach Daisy and Marram grass treatment trial – *can foreshore weed treatments influence the beach / dune profile*? Beach Road elevation project Eel Creek Culvert replacement	Complete
Protect high priority locations from extensive shoreline erosion	Parks Victoria	No actions	Ongoing
Develop and implement measures to control carp within the Glenelg Estuary and prevent movement into the Long Swamp Complex	Glenelg Hopkins CMA Parks Victoria	Carp control (removal) from the Glenelg River and estuary	Ongoing
Continue to implement recovery plans for the threatened plant species at the site: maroon leek-orchid (Prasophyllum frenchii) and swamp greenhood (Pterostylis tenuissima)	DELWP Parks Victoria	Threatened plant species Maroon leek-orchid, swamp greenhood-Annual surveys	Ongoing
Continue to implement the recovery plan for the Yarra pygmy perch (Nannoperca obscura)	DELWP Parks Victoria	Fish diversity and abundance (including threatened Yarra pygmy perch) monitoring	Ongoing
Implement the management strategies in the Ngootyoong Gunditj Ngootyoong Mara South West Management Plan aimed at reducing the impacts of bushfires and fire management on wetland and coastal habitats	Parks Victoria, DELWP	Planned Burn Operation schedules (affecting Lower Glenelg National Park)	Ongoing
Continue to monitor the effects of the Long Swamp Restoration Trial and adaptively manage the program of works to maintain or improve ecological character	Glenelg Hopkins CMA DELWP NGOs	Bi-annual monitoring of fish and frogs Sand re-nourishment and revegetation of weir structure Hydrology (water level) monitoring 4-yearly assessments of vegetation extent and condition	Ongoing

Management strategy	Responsibility	Activities	Status
Develop and implement a Glenelg Estuary and Discovery Bay Ramsar Site wetland information and interpretation program	Parks Victoria DELWP Glenelg Hopkins CMA Local councils	Stakeholder engagement strategy developed in 2018/19. A range of engagement activities have occurred including presentations to 3 Traditional Owner groups on Ramsar site management, Portland Field Naturalists and South-west Environment Alliance. In addition, Gunditj Mirring TOAC are working on advice for updating the interpretive signage associated with the Ramsar site, with a link to site values. Annual program of events including presentations, workshops and field days in collaboration with partners. Street Survey results	Ongoing
Work with Aboriginal groups to improve understanding of Aboriginal values associated with the Ramsar site and develop opportunities for Aboriginal involvement in Ramsar site management	Glenelg Hopkins CMA DELWP Parks Victoria	Participation in RCC Invitations to conduct shared work activities – weed control, pig treatments, water quality testing, ecological survey. Burrundies Works Crew engaged to conduct weed control actions	Ongoing
Build capacity and collaboration with community and industry groups by supporting citizen science and on-ground community action in Ramsar site management	Glenelg Hopkins CMA , DELWP Parks Victoria NGOs	Support for Livingstone Island weed control (African Boxthorn, Italian Buckthorn and Bridal Creeper) Annual community forum held to engage the local community on management actions and seek feedback on progress, guest speakers Sanderling leg-flag competition	Ongoing
Convene a Ramsar Coordinating Committee for the Ramsar site	Glenelg Hopkins CMA DELWP Parks Victoria Local councils Traditional Owners Community representatives	Coordinating Committee convened in 2018. Meet twice per year.	Complete
Ramsar Coordinating Committee to develop and implement annual action plan	Glenelg Hopkins CMA DELWP Parks Victoria Local councils Traditional Owners	Annual action plans are developed with the Coordinating Committee	Ongoing

Management strategy	Responsibility	Activities	Status
Apply the appropriate State and Commonwealth environmental impact assessment processes for activities that have the potential to impact on the Ramsar site and Matters of National Environmental Significance (MNES)	DELWP DoEE[3]	Part of Business as usual, current EES referral processes, including the Kentbruck Energy project	Ongoing
Undertake a regular review of the status of the ecological character of the Ramsar site. This review should include new and emerging issues as well as the current listed values and threats	DELWP	Assessment against Lac input to the Ramsar Management System Reporting to the Conference of the Contracting Parties	Ongoing

[3] Department of Energy and Environment (DoEE) now known as Department of the Climate Change, Energy, the Environment and Water (DCCEEW)

Appendix B Risk Assessment

Table 14. Risk assessment for the Freshwater Wetlands Management Unit.

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
F1. Agriculture: Wood and pulp plantations	**Decreased groundwater**					**The Victorian Land Cover Time Series (White et al. 2020) indicates that while the area of pine plantation has remained stable over the past 30 years at around 70,000 ha, the area of hardwood plantation (mostly blue gum) has increased, peaking in 2015 at around 140,000 ha. Plantation forests have been shown to both reduce groundwater recharge (via recharge interception) and directly use groundwater when the water table is accessed by their root systems – this commonly results in declining groundwater levels (Cranswick 2020). This same study indicated that the majority of wetlands in the Ramsar site are highly reliant on groundwater. The University of Melbourne Altered water regimes projects indicates low amounts of altered water regimes within the majority of freshwater wetlands in the Ramsar site (John et al. 2023).**
F1.1 Agriculture: Wood and pulp plantations	Decreased groundwater	Impacts diversity of wetland types	Unlikely	Major	Medium	There is no evidence to suggest that wetland types have been lost or altered in the Ramsar site since listing, or in the decade preceding listing. As the permanent wetlands in the site are highly reliant on groundwater, a significant decrease in groundwater would have significant and possibly irreparable consequences.
F1.2 Agriculture: Wood and pulp plantations	Decreased groundwater	Impacts lakebed and freshwater sedge / tall marsh vegetation	Unlikely	Moderate	Low	Surveys have indicated that many of the wetlands, including the Bridgewater lakes have maintained submerged vegetation diversity and extent (Iervasi et al. 2020). There has been a loss of sedgelands, but this has been attributed to increased inundation, not decreased magnitude, extent or frequency of inundation (Sinclair 2019; Australis Biological and RapidMap 2024).
F1.3 Agriculture: Wood and pulp plantations	Decreased groundwater	Reduced habitat for native fish	Unlikely	Major	Medium	There is no indication of a loss in fish diversity or abundance in the wetlands of the site (Iervasi et al. 2020; Farrington 2024), but most would be reliant on permanent water. Small-bodied native fish highly dependent on permanent wetlands, for which groundwater is the dominant water source.

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
F1.4 Agriculture: Wood and pulp plantations	Decreased groundwater	Reduced habitat for waterbird foraging and breeding	Unlikely	Moderate	Low	There is no evidence of a loss of diversity of waterbirds using the wetlands of the site. Waterbirds in Australia are highly adapted to wet and dry cycles (Kingsford and Norman 2002).
F1.5 Agriculture: Wood and pulp plantations	Decreased groundwater	Affects threatened species: maroon leek orchid and swamp greenhood	Unlikely	Major	Medium	There is some evidence of a decline in the abundance of these threatened plant species, but this has been attributed to increased inundation in parts of Long Swamp (Just 2021), not decreased inundation. Consequence reflects the threatened status of the species.
F1.6 Agriculture: Wood and pulp plantations	Decreased groundwater	Affects threatened species: Australasian bittern	Unlikely	Major	Medium	Australasian bittern are reliant on tall marsh and sedgeland, which has reduced in part of the site. The species is still recorded in the site using suitable habitat. Consequence reflects the threatened status of the species.
F1.7 Agriculture: Wood and pulp plantations	Decreased groundwater	Affects threatened species: Yara pygmy perch	Unlikely	Major	Medium	Populations of this freshwater fish species have been maintained across many of the wetlands in the site (Iervasi et al. 2020; Farrington 2024). Consequence reflects the threatened status of the species.
F1.8 Agriculture: Wood and pulp plantations	Decreased groundwater	Affects Ancient greenling	Unlikely	Major	Medium	Risk assessment based on the impact to sedgeland habitat. Consequence reflects the threatened status of the species.
F1.9 Agriculture: Wood and pulp plantations	Decreased groundwater	Affects threatened species: Growling grass frog	Unlikely	Moderate	Low	Growling grass frog have not been recorded in the site since 2012. Other frog populations have been maintained (Farrington and Brown 2020) and there is no suggestion that altered hydrology is a factor in the non-detections of the threatened species.
F1.10 Agriculture: Wood and pulp plantations	Decreased groundwater	Loss of ecological connectivity (fish migration between freshwater units and estuary)	Unlikely	Moderate	Low	John et al (2023) indicate that there have only been small changes to the extent, duration and frequency of inundation at the wetlands in the Ramsar site since the 1980s. This suggests that connectivity may be largely unaffected.

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
F2. Energy production and mining: Oil and gas drilling	**Decreased groundwater**					**Conventional onshore oil and gas resources in the south-east of the region were extensively developed through the 1990s. The Petroleum Legislation Amendment Act 2020 has allowed the resumption of onshore conventional gas from July 2021. Conventional oil and gas exploration and extraction rely on drilling, often through aquifers, to access the resources for extraction. This can lead to reductions in groundwater for aquatic ecosystems. Cranswick (2020) indicated that the majority of wetlands in the Ramsar site are highly reliant on groundwater. The University of Melbourne Altered water regimes projects indicates low amounts of altered water regimes within the majority of freshwater wetlands in the Ramsar site (John et al. 2023). The Victorian Government assessed the risks of onshore gas operations in the Otway Basin and indicated that risks of lower groundwater supply to aquatic ecosystems were all low (Jacobs 2015). The 2018 risk assessment suggested that the likelihood of impacts from oil and gas was low, but if it were to eventuate it would constitute a greater impact than that resulting from wood plantations. All risks were assigned "rare" and "major". It was agreed to keep the 2018 risk ratings in the workshop December 2024.**
F2.1 Energy production and mining: Oil and gas drilling	Decreased groundwater	Impacts diversity of wetland types	Rare	Major	Low	Risk based on decreased likelihood, but similar consequences to wood and pulp plantations.
F2.2 Energy production and mining: Oil and gas drilling	Decreased groundwater	Impacts lakebed and freshwater sedge / tall marsh vegetation	Rare	Moderate	Negligible	Risk based on decreased likelihood, but similar consequences to wood and pulp plantations.
F2.3 Energy production and mining: Oil and gas drilling	Decreased groundwater	Reduced habitat for native fish	Rare	Major	Low	Risk based on decreased likelihood, but similar consequences to wood and pulp plantations.
F2.4 Energy production and mining: Oil and gas drilling	Decreased groundwater	Reduced habitat for waterbird foraging and breeding	Rare	Moderate	Negligible	Risk based on decreased likelihood, but similar consequences to wood and pulp plantations.

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
F2.5 Energy production and mining: Oil and gas drilling	Decreased groundwater	Affects threatened species: maroon leek orchid and swamp greenhood	Rare	Major	Low	Risk based on decreased likelihood, but similar consequences to wood and pulp plantations.
F2.6 Energy production and mining: Oil and gas drilling	Decreased groundwater	Affects threatened species: Australasian bittern	Rare	Major	Low	Risk based on decreased likelihood, but similar consequences to wood and pulp plantations.
F2.7 Energy production and mining: Oil and gas drilling	Decreased groundwater	Affects threatened species: Yara pygmy perch	Rare	Major	Low	Risk based on decreased likelihood, but similar consequences to wood and pulp plantations.
F2.8 Energy production and mining: Oil and gas drilling	Decreased groundwater	Affects Ancient greenling	Rare	Major	Low	Risk based on decreased likelihood, but similar consequences to wood and pulp plantations.
F2.9 Energy production and mining: Oil and gas drilling	Decreased groundwater	Affects threatened species: Growling grass frog	Rare	Moderate	Negligible	Risk based on decreased likelihood, but similar consequences to wood and pulp plantations.
F2.10 Energy production and mining: Oil and gas drilling	Decreased groundwater	Loss of ecological connectivity (fish migration between freshwater units and estuary)	Rare	Moderate	Negligible	Risk based on decreased likelihood, but similar consequences to wood and pulp plantations.

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
F3. Water resource use	**Decreased groundwater**					**This is a new impact pathway - water resource use was not considered to be a plausible pathway for freshwater wetlands in 2018. Cranswick (2020) however, suggested that localised groundwater extraction for consumptive purposes could impact wetland hydrology. Cranswick (2020) indicated that the majority of wetlands in the Ramsar site are highly reliant on groundwater. The University of Melbourne Altered water regimes projects indicates low amounts of altered water regimes within the majority of freshwater wetlands in the Ramsar site (John et al. 2023). Cranswick (2020) indicated that local groundwater extraction is only expected to impact wetlands that are close to extraction points (within a few kilometres). The Glenelg Shire and Southern Rural Water have indicated that to date there has not been an increase in development or water demand in areas close to wetlands in the Ramsar site. This is a lower risk than that represented by wood plantations. Likelihood and consequences have been reduced to reflect this lower risk.**
F3.1 Water resource use	Decreased groundwater	Impacts diversity of wetland types	Rare	Minor	Negligible	
F3.2 Water resource use	Decreased groundwater	Impacts lakebed and freshwater sedge / tall marsh vegetation	Unlikely	Minor	Low	
F3.3 Water resource use	Decreased groundwater	Reduced habitat for native fish	Unlikely	Minor	Low	
F3.4 Water resource use	Decreased groundwater	Reduced habitat for waterbird foraging and breeding	Unlikely	Minor	Low	
F3.5 Water resource use	Decreased groundwater	Affects threatened species: maroon leek orchid and swamp greenhood	Unlikely	Moderate	Low	
F3.6 Water resource use	Decreased groundwater	Affects threatened species: Australasian bittern	Unlikely	Moderate	Low	

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
F3.7 Water resource use	Decreased groundwater	Affects threatened species: Yara pygmy perch	Unlikely	Moderate	Low	
F3.8 Water resource use	Decreased groundwater	Affects Ancient greenling	Unlikely	Moderate	Low	
F3.9 Water resource use	Decreased groundwater	Affects threatened species: Growling grass frog	Unlikely	Moderate	Low	
F3.10 Water resource use	Decreased groundwater	Loss of ecological connectivity (fish migration between freshwater units and estuary)	Unlikely	Minor	Low	
F4. Pollution: agricultural run-off	**Increased nutrients and sediments**					**Land use in the Glenelg catchment is dominated by dryland grazing, with small (but increasing) amounts of cropping and irrigation. Preliminary groundwater monitoring within the site indicates high levels of nitrates suggesting that nutrient enrichment may be a problem for some wetlands, however further sampling is required. The results are consistent with data collected at bores elsewhere in the catchment, which indicate elevated levels of nitrogen (Cervantes-Servin et al. 2025). There is little evidence of the effects of nutrient enrichment at wetlands that are monitored within the Ramsar site, but there may be issues at less visited sites (e.g. Sheep Wash Wetland). The current risks are based on a small number of samples and so should be treated with caution. Identified as a knowledge gap.**
F4.1 Pollution: agricultural run-off	Increased nutrients and sediments	Reduced light availability and increased algal growth adversely affects lake bed vegetation	Possible	Moderate	Medium	Submerged aquatic herbland assessed at 15 locations within the Ramsar site was all in excellent condition, with no evidence of nutrient enrichment effects (Australis Biological and RapidMap 2024).
F4.2 Pollution: agricultural run-off	Increased nutrients and sediments	Reduced light availability and increased algal growth adversely affects freshwater sedge tall marsh	Rare	Minor	Negligible	Sedgeland and Tall marsh at many locations around the Ramsar site was assessed as being in good to excellent condition, with no evidence of nutrient enrichment effects (Australis Biological and RapidMap). Increased nutrients are likely to promote the growth of Tall Marsh, not inhibit it.

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
F4.3 Pollution: agricultural run-off	Increased nutrients and sediments	Decreased dissolved oxygen and impacts to fish diversity and abundance	Possible	Moderate	Medium	There was no evidence or stratification or low dissolved oxygen in the 2020 surveys of several wetlands (Iervasi et al. 2020).
F4.4 Pollution: agricultural run-off	Increased nutrients and sediments	Adversely affects aquatic vegetation used in fish reproduction	Possible	Moderate	Medium	Based on the risks to vegetation, which are low.
F4.5 Pollution: agricultural run-off	Increased nutrients and sediments	Impact physical habitat reducing opportunities for waterbird feeding	Rare	Minor	Negligible	In general, higher nutrients usually means higher productivity and this is considered to be beneficial for waterbirds (Aymerich et al. 2008; Rogers et al. 2013; Mott et al. 2023).
F4.6 Pollution: agricultural run-off	Increased nutrients and sediments	Increased algal growth, decreased dissolved oxygen and impacts to threatened fish species	Possible	Major	High	There was no evidence or stratification or low dissolved oxygen in the 2020 surveys of several wetlands (Iervasi et al. 2020).
F5. Natural systems modification: wildfire	**Increased nutrients and sediments**					**Information on fire risk from the Glenelg catchment is limited. Like all places in Australia, there is an increased risk of fire under a changed climate. The catchments of most of the wetlands in the Ramsar site are small, and the risk of significant nutrients and sediments from wildfire is low. Wildfire is episodic and the effects are also short lived, with recovery expected within a few years.**
F5.1 Natural systems modification: wildfire	Increased nutrients and sediments	Reduced light availability and increased algal growth adversely affects lake bed vegetation	Rare	Moderate	Negligible	Based on risks from agricultural run-off - similar consequence, but less likely to occur.
F5.2 Natural systems modification: wildfire	Increased nutrients and sediments	Reduced light availability and increased algal growth adversely affects freshwater sedge tall marsh	Rare	Minor	Negligible	Based on risks from agricultural run-off - similar consequence, but less likely to occur.

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
F5.3 Natural systems modification: wildfire	Increased nutrients and sediments	Increased algal growth, decreased dissolved oxygen and impacts to fish diversity and abundance	Rare	Moderate	Negligible	Based on risks from agricultural run-off - similar consequence, but less likely to occur.
F5.4 Natural systems modification: wildfire	Increased nutrients and sediments	Adversely affects aquatic vegetation used in fish reproduction	Rare	Moderate	Negligible	Based on risks from agricultural run-off - similar consequence, but less likely to occur.
F5.5 Natural systems modification: wildfire	Increased nutrients and sediments	Impacts physical habitat reducing opportunities for waterbird feeding	Rare	Minor	Negligible	Based on risks from agricultural run-off - similar consequence, but less likely to occur.
F5.6 Natural systems modification: wildfire	Increased nutrients and sediments	Increased algal growth, decreased dissolved oxygen and impacts to threatened fish species	Rare	Major	Low	Based on risks from agricultural run-off - similar consequence, but less likely to occur.
F7. Natural systems modification: wildfire	**Direct impacts (burning of wetlands)**					**Temporal wetlands are vulnerable to burning during the dry phase, although fires that burn wetlands are not common (Zhang and Lim 2019). The majority of the wetlands in the Ramsar site are permanently inundated and the likelihood of direct burning of the wetland is low. Workshop participants in December 2024 agreed to leave the risk ratings as per 2017 assessment.**
F7.1 Natural systems modification: wildfire	Direct impacts (burning of wetlands)	Loss of habitat for Australasian Bittern	Rare	Major	Low	
F7.2 Natural systems modification: wildfire	Direct impacts (burning of wetlands)	Loss of habitat for Ancient greenling	Rare	Minor	Negligible	

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
F7.3 Natural systems modification: wildfire	Direct impacts (burning of wetlands)	Increased mortality through direct burning of Growling grass frog	Rare	Major	Low	
F7.4 Natural systems modification: wildfire	Direct impacts (burning of wetlands)	Increased mortality through direct burning of threatened plant species	Rare	Major	Low	
F8. Pollution: agricultural run-off	**Toxicants (includes metals as well as chemicals of emerging concern such as agricultural pharmaceuticals and pesticides / herbicides)**					**New impact pathway in 2024: Results from groundwater monitoring around several wetlands in the site indicate that arsenic, chromium, copper, lead and zinc are all above the ANZECC thresholds for protection of high value ecosystems. Although what levels are within the actual wetlands once diluted are unknown. Other chemicals including herbicides, pesticides, pharmaceuticals and PFAS remain a knowledge gap, but there are few plausible point sources close to wetlands in the Ramsar site. The current risks are based on a small number of samples and so should be treated with caution. Identified as a knowledge gap.**
F8.1 Pollution: agricultural run-off	Toxicants	Impacts lakebed and freshwater sedge / tall marsh vegetation	Unlikely	Minor	Low	Risk to aquatic plants from toxicants will be predominantly via the effects of herbicides.
F8.2 Pollution: agricultural run-off	Toxicants	Impacts native fish diversity and abundance	Possible	Moderate	Medium	The early life stages of fish (eggs, larvae and young juveniles) are the most susceptible to the effects of contaminants, although other effects can occur, such as a deleterious effect of DDT accumulation on reproductive development (Jenkins and McKinnon 2006).
F8.3 Pollution: agricultural run-off	Toxicants	Impacts waterbird diversity and abundance	Unlikely	Minor	Low	There is the potential for impacts through the food chain for heavy metals and PFAS.
F8.4 Pollution: agricultural run-off	Toxicants	Affects threatened species: maroon leek orchid and swamp greenhood	Rare	Moderate	Negligible	

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
F8.5 Pollution: agricultural run-off	Toxicants	Affects threatened species: Australasian bittern	Unlikely	Moderate	Low	Impacts greater due to threatened species.
F8.6 Pollution: agricultural run-off	Toxicants	Affects threatened species: Yara pygmy perch	Possible	Major	High	Impacts greater due to threatened species.
F8.7 Pollution: agricultural run-off	Toxicants	Affects Ancient greenling	Unlikely	Minor	Low	Through loss of habitat?
F8.8 Pollution: agricultural run-off	Toxicants	Affects threatened species: Growling grass frog	Possible	Moderate	Medium	
F9. Invasive species	**Non-native woody weeds (e.g. boxthorn, mirror bush)**					**Assessments of vegetation indicated that the majority of wetlands were in good to excellent condition, with a small number of exceptions. Italian buckthorn, mirror bush and sweet pittosporum were found in Swamp Scrub and Tall Marsh at the western end of the wetlands on the fringes of Nelson and along the road verges of Beach Road. These incursions are recent (less than 10 years) and present a considerable threat to the future integrity of sections of the Ramsar site (Australis Biological and RapidMap 2024). Woody weeds are impacting the fringes / littoral zone of wetlands, and the effect is a small scale - risk ratings adjusted to reflect this.**
F9.1 Invasive species	Non-native woody weeds (e.g. boxthorn, mirror bush)	Increased competition displaces native freshwater sedge/tall marsh	Possible	Minor	Low	Evidence of only a small number of sites having significant weed invasions, most sites assessed were in good to excellent condition (Australis Biological and RapidMap 2024).
F9.2 Invasive species	Non-native woody weeds (e.g. boxthorn, mirror bush)	Increased competition displaces threatened plant species	Possible	Moderate	Medium	No evidence of weeds causing impacts to threatened plant species and no high threat weeds were found near threatened species populations (Just 2021).
F9.3 Invasive species	Non-native woody weeds (e.g. boxthorn, mirror bush)	Loss of suitable habitat affects waterbirds including Australasian bittern	Unlikely	Moderate	Low	

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
Invasive species	**Non-native non-woody weeds (e.g. Arum lily, buffalo grass, Phalaris)**					**Assessments of vegetation indicated that the majority of wetlands were in good to excellent condition, with a small number of exceptions. Bridal creeper and ferny asparagus were found in Swamp Scrub and Tall Marsh at the western end of the wetlands on the fringes of Nelson and along the road verges of Beach Road. These incursions are recent (less than 10 years) and present a considerable threat to the future integrity of sections of the Ramsar site (Australis Biological and RapidMap 2024). Iervasi et al. (2020) indicated the presence of spiny rush (*Juncus acutus*) in the Bridgewater Lakes.**
F9.4 Invasive species	Non-native non-woody weeds (e.g. Arum lily, buffalo grass, Phalaris)	Increased competition displaces native freshwater sedge/tall marsh	Likely	Moderate	Medium	Evidence of only a small number of sites having significant weed invasions, most sites assessed were in good to excellent condition (Australis Biological and RapidMap 2024).
F9.5 Invasive species	Non-native non-woody weeds (e.g. Arum lily, buffalo grass, Phalaris)	Increased competition displaces threatened plant species	Possible	Moderate	Medium	No evidence of weeds causing impacts to threatened plant species and no high threat weeds were found near threatened species populations (Just 2021).
F9.6 Invasive species	Non-native non-woody weeds (e.g. Arum lily, buffalo grass, Phalaris)	Loss of suitable habitat affects waterbirds including Australasian bittern	Unlikely	Moderate	Low	
F10. Invasive species	**Predators (foxes)**					**Foxes are known to be present in the Ramsar site, and monitoring from the Glenelg Ark program north of the wetlands indicates that there is a large difference in fox populations and target prey items in areas that have active control programs. PV and partners have an active fox control program in place.**
F10.1 Invasive species	Predators (foxes and cats)	Affects waterbird breeding	Almost certain	Moderate	High	

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
F11. Invasive species	**Grazing animals (pigs)**					**Threatened plant species monitoring has recorded evidence of damage to vegetation by pigs in Long Swamp (Just 2021). Anecdotal evidence from site managers confirmed that pigs represented a high risk to wetland values.**
F11.1 Invasive species	Grazing animals (pigs)	Adversely affects freshwater sedges and tall marsh	Almost certain	Moderate	High	
F11.2 Invasive species	Grazing animals (pigs)	Adversely affects threatened plant species	Almost certain	Moderate	High	
F11.3 Invasive species	Grazing animals (pigs)	Loss of suitable habitat affects waterbirds including Australasian bittern	Almost certain	Moderate	High	
F12. Invasive species	**Grazing animals (goats, deer)**					**Damage from deer and goats is limited in the wetlands in the system and a lesser issue than that caused by pigs.**
F12.1 Invasive species	Grazing animals (goats, deer)	Adversely affects freshwater sedges and tall marsh	Possible	Minor	Low	
F12.2 Invasive species	Grazing animals (goats, deer)	Adversely affects threatened plant species	Possible	Minor	Low	
F12.3 Invasive species	Grazing animals (goats, deer)	Loss of suitable habitat affects waterbirds including Australasian bittern	Possible	Minor	Low	
F13. Invasive species	**Gambusia**					**Gambusia is present in many of the freshwater lakes of the system (Iervasi et al. 2020) and in some seasons and locations they represent the most numerous fish species (Brown and Farrington 2021).**
F13.1 Invasive species	Gambusia	Affects native fish diversity and abundance	Possible	Minor	Low	Despite the periodic high abundance of Gambusia, populations of small-bodied native fish are maintained in the wetlands of the site (Farrington 2024).

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
F13.2 Invasive species	Gambusia	Competition affects abundance of threatened fish species	Possible	Moderate	Medium	Despite the periodic high abundance of Gambusia, populations of threatened fish are maintained in the wetlands of the site (Farrington 2024).
F14. Human intrusion and disturbance: recreational activities						**The majority of wetlands in the Ramsar site are inaccessible by vehicle and impacts to values are low. There is anecdotal evidence of increased boat (and larger boat) use in the Bridgewater lakes - the effect of this on shorelines and littoral vegetation is a knowledge gap.**
F14.1 Recreational activities	Increased human presence	Increased presence initiates abandonment of waterbird breeding	Unlikely	Minor	Low	
F14.2 Recreational activities	Increased noise	Increased noise disrupts waterbird breeding	Unlikely	Minor	Low	
F14.3 Recreational activities	Increased noise	Increased noise disturbs Australasian bittern	Unlikely	Minor	Low	
F14.4 Recreational activities	Physical damage (vegetation)	Increased damage and degradation of lake bed vegetation	Rare	Moderate	Negligible	
F14.5 Recreational activities	Physical damage (vegetation)	Increased damage and degradation of fringing vegetation	Unlikely	Moderate	Low	
F14.6 Recreational activities	Physical damage (vegetation)	Increased damage destroys threatened plant species	Possible	Moderate	Medium	
F15. Biological resource use	**Recreational fishing**					
F15.1 Biological resource use	Recreational fishing	Increased catch reduces target fish abundance	Unlikely	Minor	Low	

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
F15.2 Biological resource use	Recreational fishing	Increased catch reduces waterbird feeding opportunities	Unlikely	Minor	Low	
F15.3 Biological resource use	Duck hunting	Decreased abundance and diversity of target species (ducks)	Almost certain	Minor	Low	The area in the Ramsar site where hunting is permitted is very small (5 ha or < 0.02% of the Ramsar site). Recent research suggests that duck hunting direct impacts on target species have remained stable for over a decade (Moloney et al. 2022).
F15.3 Biological resource use	Duck hunting	Decreased abundance and diversity of non-target species	Unlikely	Moderate	Low	The effects of duck hunting on disturbance of non-target bird species has recently been reviewed, with effects on Australian bittern and species of egret considered to be high (Menkhorst and Thompson 2022). The small area in the GEDB Ramsar site is open to hunting, however does not provide significant habitat to species that would be at high risk.
Climate change						**Regional climate projections have recently been released by CSIRO for sub-cluster regions in Australia. The relevant region for GEDB is Great South Coast (CSIRO and DEECA 2024). Relevant details of those projections are described below.**
F 16. Climate change	**Increased temperature**					**There is very high confidence in continued substantial increases in projected mean, maximum and minimum temperatures projected in line with our understanding of the effect of further increases in greenhouse gas concentrations. For the near future (2030), the annually averaged warming across all emission scenarios is projected to be around 0.4 to 1.1 °C above the climate of 1986–2005. Water quality monitoring in the freshwater wetlands shows a seasonal pattern for temperature, but no sustained trend.**
F16.1 Climate change	Increased temperature	Adversely affects submerged aquatic vegetation	Unlikely	Minor	Low	
F16.2 Climate change	Increased temperature	Adversely affects sedges and tall marsh	Unlikely	Minor	Low	
F16.3 Climate change	Increased temperature	Impacts threatened plant species	Unlikely	Minor	Low	
F16.4 Climate change	Increased temperature	Impacts native fish diversity and abundance	Unlikely	Minor	Low	

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
F16.5 Climate change	Increased temperature	Impacts threatened fish species	Unlikely	Minor	Low	
F16.6 Climate change	Increased temperature	Impacts waterbirds through habitat and food chain impacts	Unlikely	Minor	Low	
F16.7 Climate change	Increased temperature	Impacts habitat for Australasian bittern	Unlikely	Minor	Low	
F17. Climate change	**Decreased rainfall and freshwater inflows**					**In the near future (2030) natural variability is projected to predominate over trends due to greenhouse gas emissions. Understanding of physical rainfall processes (southward shift of winter storm systems), supported by climate model results, indicate rainfall decreases for winter and spring (high confidence). It was agreed in the workshop held in December 2024 that decreased inundation due to climate change was a major threat to wetlands in the system.**
F17.1 Climate change	Decreased rainfall and freshwater inflows	Impacts diversity of wetland types	Likely	Major	High	
F17.2 Climate change	Decreased rainfall and freshwater inflows	Impacts lakebed and freshwater sedge / tall marsh vegetation	Likely	Moderate	Medium	
F17.3 Climate change	Decreased rainfall and freshwater inflows	Reduced habitat for native fish	Possible	Moderate	Medium	
F17.4 Climate change	Decreased rainfall and freshwater inflows	Reduced habitat for waterbird foraging and breeding	Possible	Moderate	Medium	
F17.5 Climate change	Decreased rainfall and freshwater inflows	Affects threatened species: maroon leek orchid and swamp greenhood	Possible	Minor	Low	

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
F17.6 Climate change	Decreased rainfall and freshwater inflows	Affects threatened species: Australasian bittern	Possible	Moderate	Medium	
F17.7 Climate change	Decreased rainfall and freshwater inflows	Affects threatened species: Yara pygmy perch	Likely	Moderate	Medium	
F17.8 Climate change	Decreased rainfall and freshwater inflows	Affects Ancient greenling	Likely	Major	High	
F17.9 Climate change	Decreased rainfall and freshwater inflows	Affects threatened species: Growling grass frog	Possible	Major	High	
F17.10 Climate change	Decreased rainfall and freshwater inflows	Loss of ecological connectivity (fish migration between freshwater units and estuary)	Likely	Minor	Medium	
F18. Climate change	**Increased sea level**					**For 1966 to 2009, the average rate of relative sea-level rise for Australia, from observations along the coast, was 1.4 mm/year. There is very high confidence in future sea-level rise. By 2030 the projected range of sea-level rise for the cluster coastline is 0.08 to 0.18 m above the 1986–2005 level, with only minor differences between emission scenarios. Modelling by DEECA's Arthur Rylah Institute indicates that there will be intrusion of sea water into the western end of Long Swamp as early as 2040, with further influences by 2065. The prediction is that by 2090, most of the freshwater wetlands in the site will be inundated with sea water (VCID, www.data.vic.gov.au).**
F18.1 Climate change	Increased sea level - salinity	Impacts diversity of wetland types	Possible	Moderate	Medium	Modelling suggests that within the timeframe of this risk assessment (2040), only a small proportion of wetlands will be impacted.
F18.2 Climate change	Increased sea level - salinity	Impacts lakebed and freshwater sedge / tall marsh vegetation	Possible	Minor	Low	

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
F18.3 Climate change	Increased sea level - salinity	Reduced habitat for native fish	Unlikely	Minor	Low	
F18.4 Climate change	Increased sea level - salinity	Reduced habitat for waterbird foraging and breeding	Unlikely	Minor	Low	
F18.5 Climate change	Increased sea level - salinity	Affects threatened species: maroon leek orchid and swamp greenhood	Possible	Major	High	
F18.6 Climate change	Increased sea level - salinity	Affects threatened species: Australasian bittern	Unlikely	Moderate	Low	
F18.7 Climate change	Increased sea level - salinity	Affects threatened species: Yara pygmy perch	Possible	Moderate	Medium	
F18.8 Climate change	Increased sea level - salinity	Affects Ancient greenling	Possible	Minor	Low	
F18.9 Climate change	Increased sea level - salinity	Affects threatened species: Growling grass frog	Possible	Minor	Low	
F18.10 Climate change	Increased sea level - salinity	Loss of ecological connectivity (fish migration between freshwater units and estuary)	Rare	Minor	Negligible	Connectivity will be increased.
F19. Invasive & Other Problematic Species, Genes & Diseases	**High pathogenicity avian influenza (HPAI)**					**Since 2021, there have been many detections overseas of HPAI viruses in wild birds, wild mammals, and poultry. HPAI H5N1 clade 2.3.4.4b has been the predominant strain since 2022. Both individual and mass mortalities have been observed. Detections of HPAI are rare in Australia. All previous Australian outbreaks have been in poultry, but this does not preclude an outbreak in the wild bird population. Some species such as black swan have been identified as at greatest risk.**

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
F19.1 Invasive & Other Problematic Species, Genes & Diseases	High pathogenicity avian influenza (HPAI)	Adversely affects waterbirds	Almost certain	Moderate	High	

Table 15. Risk assessment for the Estuary Management Unit

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
E1. Agriculture: Wood and pulp plantations	**Decreased groundwater**					**The Victorian Land Cover Time Series (White et al. 2020) indicates that while the area of pine plantation has remained stable over the past 30 years at around 70,000 ha, the area of hardwood plantation (mostly blue gum) has increased, peaking in 2015 at around 140,000 ha. Plantation forests have been shown to both reduce groundwater recharge (via recharge interception) and directly use groundwater when the water table is accessed by their root systems, which commonly results in declining groundwater levels (Cranswick 2020). Over periods of low river flows, the hydrodynamics of the estuary are primarily controlled by non-river inflows such as groundwater, as well as tidal exchange when the entrance is open. When the entrance is closed, additional groundwater inflows in the order of 25ML/d to 90 ML/d can cause a significant rise in water levels across the estuary (Water Technology 2016).**

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
E1.1 Agriculture: Wood and pulp plantations	Decreased groundwater	Reduced freshwater inputs affects salinity regime and stratification	Unlikely	Moderate	Low	Groundwater inflows are thought to play a major role in moderating temperature and freshening the Estuary and Oxbow Lake. If groundwater levels decline, this would reduce the groundwater discharge to the river and estuary and reduce the connectivity and water quality regulation provided by groundwater inflows (Cranswick 2020). Groundwater is only a significant contributor when entrance conditions are closed.
E1.2Agriculture: Wood and pulp plantations	Decreased groundwater	Impacts to hydrology, salinity and temperature regimes affect seagrass extent and density	Unlikely	Moderate	Low	Temperature and salinity are important determinants of seagrass extent and condition (York et al. 2013; Carruthers et al. 2007). Impact would only occur under closed entrance conditions and so persist for a relatively short period of time.
E1.3 Agriculture: Wood and pulp plantations	Decreased groundwater	Impacts to hydrology, salinity and temperature regimes affect saltmarsh extent and community composition	Unlikely	Moderate	Low	Several saltmarsh communities fringe the Glenelg Estuary including Coastal Dry Saltmarsh, Estuarine Reedbed and Estuarine Wetland (Sinclair 2019). Inundation and salinity are determinants of saltmarsh community composition and extent (Boon et al. 2011). Cranswick (2020) suggested that altered groundwater inflow could affect both the water regime and salinity of the fringing vegetation. Impact only occurs under entrance closed conditions.
E1.4 Agriculture: Wood and pulp plantations	Decreased groundwater	Impacts to habitat, salinity and temperature affect diversity and abundance of native fish	Unlikely	Moderate	Low	While most estuarine fish are adapted to varying salinity regimes, there are several species that are dependent on specific temperature and salinity regimes for successful breeding (e.g. black bream, Nicholson et al. 2008). Disruptions to stratification and altered temperature regimes could negatively impact these species.
E1.5 Agriculture: Wood and pulp plantations	Decreased groundwater	Reduced fish causes impacts to waterbirds through the food chain	Unlikely	Moderate	Low	Impact would be to fish eating species only.

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
E2. Energy production and mining: Oil and gas drilling	**Decreased groundwater**					**Conventional onshore oil and gas resources in the south-east of the region were extensively developed through the 1990s. The Petroleum Legislation Amendment Act 2020 has allowed the resumption of onshore conventional gas from July 2021. Conventional oil and gas exploration and extraction rely on drilling, often through aquifers, to access the resources for extraction. This can lead to reductions in groundwater for aquatic ecosystems. Over periods of low river flows, the hydrodynamics of the estuary are primarily controlled by non-river inflows such as groundwater, as well as tidal exchange when the entrance is open. When the entrance is closed, additional groundwater inflows in the order of 25ML/d to 90 ML/d can cause a significant rise in water levels across the estuary (Water Technology 2016). All risks were assigned "rare" and "major". It was agreed to keep the 2018 risk ratings in the workshop December 2024.**
E2.1 Energy production and mining: Oil and gas drilling	Decreased groundwater	Reduced freshwater inputs affects salinity regime and stratification	Rare	Moderate	Negligible	Risk based on decreased likelihood, but similar consequences to wood and pulp plantations.
E2.2 Energy production and mining: Oil and gas drilling	Decreased groundwater	Impacts to hydrology, salinity and temperature regimes affect seagrass extent and density	Rare	Moderate	Negligible	Risk based on decreased likelihood, but similar consequences to wood and pulp plantations.
E2.3 Energy production and mining: Oil and gas drilling	Decreased groundwater	Impacts to hydrology, salinity and temperature regimes affect saltmarsh extent and community composition	Rare	Moderate	Negligible	Risk based on decreased likelihood, but similar consequences to wood and pulp plantations.
E2.4 Energy production and mining: Oil and gas drilling	Decreased groundwater	Impacts to habitat, salinity and temperature affect diversity and abundance of native fish	Rare	Moderate	Negligible	Risk based on decreased likelihood, but similar consequences to wood and pulp plantations.

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
E2.5 Energy production and mining: Oil and gas drilling	Decreased groundwater	Reduced fish causes impacts to waterbirds through the food chain	Rare	Moderate	Negligible	Risk based on decreased likelihood, but similar consequences to wood and pulp plantations.
E3. Water resource use	**Decreased surface water**					**Two major storages, Moora Moora Reservoir and Rocklands Reservoir together with a large number of small farm dams have had a significant impact on system hydrology. Rocklands Reservoir, in particular, can storage 348,000 ML; 3 times the average annual inflow, and diverts water from the upper Glenelg catchment to be delivered to the Wimmera system. Effectively, there has been a 60% decrease in mean annual flow to the estuary and a decrease in the frequency of flushing flows (Streamology 2024). The IEC rated the Glenelg Estuary as "poor" for hydrology. The IEC did not account for environmental flow contributions, however, Water Technology (2016) suggested that environmental water deliveries were insufficient for estuary flushing. While the site was listed with these pressures, the ongoing water use development has the potential for significant impacts to ecological character.**
E3.1 Water resource use	Decreased surface water	Decreased inflows alters surface water regime and the frequency of opening and closing of the estuary mouth	Possible	Major	High	It is certain that water resource use has altered the condition of the estuary and resulted in reduced frequency of estuary opening. This must be considered in the context of the estuary opening strategy, which reduces the time that the estuary remains closed.
E3.2 Water resource use	Decreased surface water	Reduced freshwater inputs affects salinity regime and stratification	Likely	Moderate	Medium	Altered salinity and stratification are associated with reduced flushing flows (Streamology 2024, Water Technology 2016).
E3.3 Water resource use	Decreased surface water	Impacts to hydrology, salinity and temperature regimes affect seagrass extent and density	Likely	Moderate	Medium	Temperature and salinity are important determinants of seagrass extent and condition (York et al. 2013). Impact is of a higher magnitude and occurs more often than for decreased groundwater, likelihood and consequence have been increased.
E3.4 Water resource use	Decreased surface water	Impacts to hydrology, salinity and temperature regimes affect	Likely	Moderate	Medium	Several saltmarsh communities fringe the Glenelg Estuary including Coastal Dry Saltmarsh, Estuarine Reedbed and Estuarine Wetland (Sinclair 2019). Inundation and salinity are determinants of saltmarsh community composition and extent (Boon et al. 2011). Cranswick

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
		saltmarsh extent and community composition				(2020) suggested that altered groundwater inflow could affect both the water regime and salinity of the fringing vegetation. Impact only occurs under entrance closed conditions.
E3.5 Water resource use	Decreased surface water	Impacts to habitat, salinity and temperature affect diversity and abundance of native fish	Likely	Moderate	Medium	While most estuarine fish are adapted to varying salinity regimes, there are several species that are dependent on specific temperature and salinity regimes for successful breeding (e.g. black bream, Nicholson et al. 2008). Disruptions to stratification and altered temperature regimes could negatively impact these species.
E3.6 Water resource use	Decreased surface water	Reduced fish causes impacts to waterbirds through the food chain	Possible	Minor	Low	Impact would be to fish eating species only.
E3.7 Water resource use	Decreased surface water	Decreased inflows reduces ecological connectivity for fish migration	Likely	Moderate	Medium	The estuary supports several diadromous fish species that could be impacted if closed estuary conditions persist. This must be considered in the context of the estuary opening strategy, which reduces the time that the estuary remains closed.
E3.8 Water resource use	Decreased surface water	Decreased inflows alters surface water regime and the frequency of opening and closing of the estuary mouth	Possible	Major	High	It is certain that water resource use has altered the condition of the estuary and resulted in reduced frequency of estuary opening. This must be considered in the context of the estuary opening strategy, which reduces the time that the estuary remains closed.
E4. Pollution: agricultural run-off	**Increased nutrients and sediments**					**Land use in the Glenelg catchment is dominated by dryland grazing, with small (but increasing) amounts of cropping and irrigation. Although information directly from the estuary is sparse, nutrient and sediment concentrations in the river upstream at Dartmoor are high during both low and high flows, suggesting loads to the estuary are also high (Water Technology 2016).**
E4.1 Pollution: agricultural run-off	Increased nutrients and sediments	Increased nutrients from the catchment result in increased epiphytic algal growth, impacting on seagrass	Likely	Moderate	Medium	The IEC noted that much of the seagrass in the Glenelg Estuary was either covered in macroalgae or replaced by macroalgae (DELWP 2021). This suggests that the effect of nutrients may be marked. The status of seagrass on the system is a knowledge gap.

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
E4.2 Pollution: agricultural run-off	Increased nutrients and sediments	Impacts to seagrass affect fish	Possible	Moderate	Medium	There are several fish species that are reliant on seagrass habitat, but several of these could use macroalgae as structural habitat as well. The IEC rated the fish community of the Glenelg Estuary as "good".
E4.3 Pollution: agricultural run-off	Increased nutrients and sediments	Increased sediment and nutrients from the catchment result in increased algal growth, decreased dissolved oxygen and impacts to fish diversity and abundance	Possible	Minor	Low	Low dissolved oxygen, during periods of stratification, is a feature of the estuary, but the role of nutrients in this remains a knowledge gap (Water Technology 2016).
E4.4 Pollution: agricultural run-off	Increased nutrients and sediments	Reduced fish causes impacts to waterbirds through the food chain	Possible	Minor	Low	Impact would be to fish eating species only.
E5. Natural systems modification: wildfire	**Increased nutrients and sediments**					**Information on fire risk from the Glenelg catchment is limited. Like all places in Australia, there is an increased risk of fire under climate change. Evidence from elsewhere (e.g. Gippsland Lakes, Far East Gippsland) indicates that bushfires followed by large floods result in very high loads of sediments and nutrients entering a system (Kirono et al. 2022). However, flood residence time when mouth of estuary is open to the ocean is likely to be short during high river flows. Impacts from fire are short lived.**
E5.1 Natural systems modification: wildfire	Increased nutrients and sediments	Increased nutrients from the catchment result in increased epiphytic algal growth, impacting on seagrass	Possible	Moderate	Medium	The IEC noted that much of the seagrass in the Glenelg Estuary was either covered in macroalgae or replaced by macroalgae (DELWP 2021). This suggests that the effect of nutrients may be marked. The time that nutrients and sediments would be elevated would be low.
E5.2 Natural systems modification: wildfire	Increased nutrients and sediments	Impacts to seagrass affect fish	Possible	Moderate	Medium	There are several fish species that are reliant on seagrass habitat, but several of these could use macroalgae as structural habitat as well. The IEC rated the fish community of the Glenelg Estuary as "good".

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
E5.3 Natural systems modification: wildfire	Increased nutrients and sediments	Increased sediment and nutrients from the catchment result in increased algal growth, decreased dissolved oxygen and impacts to fish diversity and abundance	Possible	Minor	Low	Low dissolved oxygen during periods of stratification is a feature of the estuary, but the role of nutrients in this remains a knowledge gap (Water Technology 2016).
E5.4 Natural systems modification: wildfire	Increased nutrients and sediments	Reduced fish causes impacts to waterbirds through the food chain	Possible	Minor	Low	Impact would be to fish eating species only.
E6. Pollution: agricultural run-off	**Toxicants (includes metals as well as chemicals of emerging concern such as agricultural pharmaceuticals and pesticides / herbicides)**					**Results from groundwater monitoring near the estuary entrance indicate that arsenic, chromium, copper, lead and zinc are all above the ANZECC thresholds for protection of high value ecosystems, although what levels are within the estuary once diluted are unknown. Other chemicals including herbicides, pesticides, pharmaceuticals and PFAS remain a knowledge gap, but the upstream land uses could be sources.**
E6.1 Pollution: agricultural run-off	Toxicants	Impacts seagrass	Unlikely	Moderate	Low	Risk to aquatic plants from toxicants will be predominantly via the effects of herbicides.
E6.2 Pollution: agricultural run-off	Toxicants	Impacts saltmarsh	Unlikely	Moderate	Low	Risk to aquatic plants from toxicants will be predominantly via the effects of herbicides.
E6.3 Pollution: agricultural run-off	Toxicants	Impacts native fish	Possible	Moderate	Medium	The early life stages of fish (eggs, larvae and young juveniles) are the most susceptible to the effects of contaminants, although other effects can occur, such as a deleterious effect of DDT accumulation on reproductive development (Jenkins and McKinnon 2006).

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
E6.4 Pollution: agricultural run-off	Toxicants	Impacts waterbird diversity and abundance	Possible	Minor	Low	There is the potential for impacts through the food chain. Studies from elsewhere have indicated that waterbirds can accumulate PFAS (EPA Victoria 2019).
E7. Invasive species	**Non-native woody weeds Italian buckthorn, boxthorn, polygala, pine wildlings)**					**The most recent vegetation assessment (Australis Biological and RapidMap 2024) and the IEC vegetation assessment in 2019 found that saltmarsh and fringing vegetation communities of the estuary were largely weed free and in excellent condition.**
E7.1 Invasive species	Non-native woody weeds Italian buckthorn, boxthorn, polygala, pine wildlings)	Increased competition displaces native species and communities in saltmarsh	Unlikely	Minor	Low	
E8. Invasive species	**Non-native non-woody weeds (e.g. Sicilian sea lavender)**					**The most recent vegetation assessment (Australis Biological and RapidMap 2024) and the IEC vegetation assessment in 2019 found that saltmarsh and fringing vegetation communities of the estuary were largely weed free and in excellent condition.**
E8.1 Invasive species	Non-native non-woody weeds (e.g. Sicilian sea lavender)	Increased competition displaces native species and communities in saltmarsh	Unlikely	Minor	Low	
E9. Invasive species	**Predators (foxes)**					**Foxes are known to be present in the Glenelg Estuary portion of the Ramsar site, and monitoring from the Glenelg Ark program upstream indicates that there is a large difference in fox populations and target prey items in areas that have active control programs. Parks Victoria and partners have an active fox control program in place.**
E9.1 Invasive species	Predators (foxes and cats)	Affects waterbird abundance and diversity	Almost certain	Moderate	High	

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
E10. Invasive species	**Grazing animals (pigs)**					**Anecdotal evidence from site managers confirmed that pigs represented a high risk in the upper estuary.**
E10.1 Invasive species	Grazing animals (pigs)	Adversely affects saltmarsh	Likely	Moderate	Medium	Saltmarsh in the estuary was assessed as being in excellent condition (Australis Biological and RapidMap 2024). No evidence of impacts from grazing animals were noted.
E10.2 Invasive species	Grazing animals (pigs)	Impacts to saltmarsh impact waterbird habitat	Possible	Minor	Low	
E11. Invasive species	**Grazing animals (goats, deer)**					**Damage from deer and goats is limited in estuary, and a lesser issue than that caused by pigs.**
E11.1 Invasive species	Grazing animals (goats, deer)	Adversely affects saltmarsh	Possible	Minor	Low	Saltmarsh in the estuary was assessed as being in excellent condition (Australis Biological and RapidMap 2024). No evidence of impacts from grazing animals were noted.
E11.2 Invasive species	Grazing animals (goats, deer)	Impacts to saltmarsh impact waterbird habitat	Possible	Minor	Low	
E12. Invasive species	**Gambusia, carp**					**Gambusia is present in many of the freshwater lakes of the system (Iervasi et al. 2020), and in some seasons and locations they represent the most numerous fish species (Brown and Farrington 2021).**
E12.1 Invasive species	Gambusia, carp	Altered habitat reducing fish diversity and abundance	Possible	Moderate	Medium	
E12.2 Invasive species	Gambusia, carp	Increased competition reducing fish abundance and diversity	Rare	Minor	Negligible	
E13. Human intrusion and disturbance: recreational activities						

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
E13.1 Recreational activities	Increased human presence	Increased presence disturbs feeding waterbirds	Possible	Minor	Low	
E13.2 Recreational activities	Increased noise	Increased noise disrupts waterbird breeding	Likely	Moderate	Medium	
E13.3 Recreational activities	Increased noise	Increased damage of saltmarsh	Possible	Moderate	Medium	Saltmarsh in the estuary was assessed as being in excellent condition (Australis Biological and RapidMap 2024). No evidence of impacts from vehicles was noted.
E13.4 Recreational activities	Physical damage (vegetation)	Increased damage reduces habitat availability and quality for waterbird breeding	Rare	Minor	Negligible	
E13.5 Recreational activities	Physical damage (vegetation)	Affects waterbird abundance	Possible	Minor	Low	
E14. Biological resource use	**Recreational fishing**					
E14.1 Biological resource use	Recreational fishing	Increased catch reduces target fish abundance	Rare	Moderate	Negligible	
E14.1 Biological resource use	Recreational fishing	Increased catch reduces waterbird feeding opportunities	Rare	Minor	Negligible	
Climate change						**Regional climate projections have recently been released by CSIRO for sub-cluster regions in Australia. The relevant region for GEDB is Great South Coast (CSIRO and DEECA 2024). Relevant details of those projections are described below.**

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
E15. Climate change	**Increased temperature**					**There is very high confidence that mean, maximum, and minimum temperatures will continue to rise, in line with projections based on increasing greenhouse gas concentrations. For the near future (2030), the annually averaged warming across all emission scenarios is projected to be around 0.4 to 1.1 °C above the climate of 1986–2005.**
E15.1 Climate change	Increased temperature	Adversely affects seagrass	Possible	Moderate	Medium	Assessment of impacts of climate change related temperature increases on seagrass and soft sediment habitats in Victoria indicated low vulnerability, but high uncertainty (Morris 2013). The risk would be higher to intertidal seagrass, than subtidal due to increased exposure.
E15.2 Climate change	Increased temperature	Adversely affects saltmarsh	Possible	Moderate	Medium	Several invasive species for saltmarsh such as Spartina are C4 plants that are likely to be competitively advantaged by higher temperatures (and CO2) concentrations, increasing the risk to saltmarsh communities from these invasive species.
E15.3 Climate change	Increased temperature	Adversely affects fish abundance and diversity	Possible	Minor	Low	An assessment of climate change related increased temperature impacts to marine fish indicated high vulnerability and low adaptive capacity of larval stages (Hirst and Hamer 2013). However, the greatest risks are for longer term projections and the likelihood and magnitude of change in the next 2 decades is lower.
E15.4 Climate change	Increased temperature	Adversely affects waterbirds	Possible	Moderate	Medium	Temperature effects the timing of migration in many shorebirds, which may influence recruitment and survival (Robinson et al. 2009).
E16. Climate change	**Decreased rainfall and freshwater inflows**					**In the near future (2030), natural variability is projected to predominate over trends due to greenhouse gas emissions. Understanding of physical rainfall processes (southward shift of winter storm systems), supported by climate model results, indicate rainfall decreases for winter and spring (high confidence).**
E16.1 Climate change	Decreased rainfall and freshwater inflows	Decreased inflows alters surface water regime and the frequency of opening and closing of the estuary mouth	Possible	Major	High	It is certain that water resource use has altered the condition of the estuary and resulted in reduced frequency of estuary opening, and that climate change will exacerbate this situation. This must be considered in the context of the estuary opening strategy, which reduces the time that the estuary remains closed.
E16.2 Climate change	Decreased rainfall and freshwater inflows	Reduced freshwater inputs affects salinity regime and stratification	Likely	Moderate	Medium	Altered salinity and stratification are associated with reduced flushing flows (Streamology 2024, Water Technology 2016).

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
E16.3 Climate change	Decreased rainfall and freshwater inflows	Impacts to hydrology, salinity and temperature regimes affect seagrass extent and density	Likely	Moderate	Medium	Temperature and salinity are important determinants of seagrass extent and condition (York et al. 2013). Impact is of a higher magnitude and occurs more often than for decreased groundwater, likelihood and consequence have been increased.
E16.4 Climate change	Decreased rainfall and freshwater inflows	Impacts to hydrology, salinity and temperature regimes affect saltmarsh extent and community composition	Likely	Moderate	Medium	Several saltmarsh communities fringe the Glenelg Estuary including Coastal Dry Saltmarsh, Estuarine Reedbed and Estuarine Wetland (Sinclair 2019). Inundation and salinity are determinants of saltmarsh community composition and extent (Boon et al. 2011). Cranswick (2020) suggested that altered groundwater inflow could affect both the water regime and salinity of the fringing vegetation. Impact only occurs under entrance closed conditions.
E16.5 Climate change	Decreased rainfall and freshwater inflows	Impacts to habitat, salinity and temperature affect diversity and abundance of native fish	Likely	Moderate	Medium	While most estuarine fish are adapted to varying salinity regimes, there are several species that are dependent on specific temperature and salinity regimes for successful breeding (e.g. black bream, Nicholson et al. 2008). Disruptions to stratification and altered temperature regimes could negatively impact these species.
E16.6 Climate change	Decreased rainfall and freshwater inflows	Reduced fish causes impacts to waterbirds through the food chain	Possible	Minor	Low	Impact would be to fish eating species only.
E16.7 Climate change	Decreased rainfall and freshwater inflows	Decreased inflows reduces ecological connectivity for fish migration	Likely	Moderate	Medium	The estuary supports several diadromous fish species that could be impacted if closed estuary conditions persist. This must be considered in the context of the estuary opening strategy, which reduces the time that the estuary remains closed.
E17. Climate change	**Increased sea level**					**For 1966 to 2009, the average rate of relative sea-level rise for Australia, from observations along the coast, was 1.4 mm/year. There is very high confidence in future sea-level rise. By 2030 the projected range of sea-level rise for the cluster coastline is 0.08 to 0.18 m above the 1986–2005 level, with only minor differences between emission scenarios.**
E17.1 Climate change	Increased sea level - salinity	Increased sea level affects surface water regime and changes character from an intermittently	Possible	Major	High	Without sufficient hydraulic gradient, i.e. the differential between the water level in the estuary and the sea level, the entrance of the estuary can fail to open successfully, as the erosion and the size of the channel is insufficient to maintain the outflow, and wave action pushes sand back into the excavated channel (Water Technology 2016). It is possible that sea level rise will further exacerbate the situation and

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
		opening and closing estuary				make opening the entrance more difficult and the period of opening will reduce.
E17.2 Climate change	Increased sea level - salinity	Increased marine water inputs alters coastal saltmarsh extent	Possible	Moderate	Medium	Several saltmarsh communities fringe the Glenelg Estuary including Coastal Dry Saltmarsh, Estuarine Reedbed and Estuarine Wetland (Sinclair 2019). Inundation and salinity are determinants of saltmarsh community composition and extent (Boon et al. 2011). There is little room for landward migration of coastal saltmarsh communities.
E17.3 Climate change	Increased sea level - salinity	Impacts to habitat, salinity and temperature affect diversity and abundance of native fish	Possible	Moderate	Medium	While most estuarine fish are adapted to varying salinity regimes, there are several species that are dependent on specific temperature and salinity regimes for successful breeding (e.g. black bream, Nicholson et al. 2008). Disruptions to stratification and altered temperature regimes could negatively impact these species.
E17.4 Climate change	Increased sea level - salinity	Reduced fish causes impacts to waterbirds through the food chain	Possible	Minor	Low	Impact would be to fish eating species only.
E17.5 Climate change	Increased sea level - salinity	Increased sea level reduces ecological connectivity for fish migration	Possible	Moderate	Medium	The estuary supports several diadromous fish species that could be impacted if closed estuary conditions persist. This must be considered in the context of the estuary opening strategy, which reduces the time that the estuary remains closed. In the future it may be more difficult to maintain open conditions.
E18. Invasive & Other Problematic Species, Genes & Diseases	**High pathogenicity avian influenza (HPAI)**					**Since 2021, there have been many detections overseas of HPAI viruses in wild birds, wild mammals, and poultry. HPAI H5N1 clade 2.3.4.4b has been the predominant strain since 2022. Both individual and mass mortalities have been observed. Detections of HPAI are rare in Australia. All previous Australian outbreaks have been in poultry, but this does not preclude an outbreak in the wild bird population. Some species such as black swan have been identified as at greatest risk.**
E18.1 Invasive & Other Problematic Species, Genes & Diseases	High pathogenicity avian influenza (HPAI)	Adversely affects waterbirds	Almost certain	Moderate	High	

Table 16. Risk assessment for the Beach and dune fields Management Unit

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
B1. Agriculture: Wood and pulp plantations	**Decreased groundwater**					**The Victorian Land Cover Time Series (White et al. 2020) indicates that while the area of pine plantation has remained stable over the past 30 years at around 70,000 ha, the area of hardwood plantation (mostly blue gum) has increased, peaking in 2015 at around 140,000 ha. Plantation forests have been shown to both reduce groundwater recharge (via recharge interception) and directly use groundwater when the water table is accessed by their root systems – this commonly results in declining groundwater levels (Cranswick 2020).**
B1.1 Agriculture: Wood and pulp plantations	Decreased groundwater	Altered groundwater interactions affecting hydrological processes which support dune slack wetlands	Unlikely	Major	Medium	Unknown - likely a knowledge gap.
B2. Natural systems modification: wildfire	**Direct impacts (burning)**					**Information on fire risk from the Glenelg catchment is limited. Like all places in Australia, there is an increased risk of fire under a changed climate.**
B2.1 Natural systems modification: wildfire	Direct impacts (burning)	Decreased vegetation cover reduces dune stability, affecting the area and distribution of dune slack wetlands	Unlikely	Severe	Medium	
B3. Invasive species	**Non-native non-woody weeds (e.g. Sicilian sea lavender)**					**Elsewhere there have been reports of beach nesting birds, including terns avoiding nest locations with vegetation cover (Sullivan 2020).**
B3.1 Invasive species	Non-native non-woody weeds (e.g. Marram grass, Sicilian sea lavender)	Colonisation of sandy habitat reduces nesting sites for beach nesting birds	Possible	Major	High	
B4. Invasive species	**Predators (foxes)**					**Fox prints are seen in beach nesting and migratory bird surveys with no sign of a decrease in the number of prints detected since**

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
						monitoring began in 2019-2020 (BirdLife Australia 2024). Parks Victoria and partners have an active fox control program in place.
B4.1 Invasive species	Predators (foxes and cats)	Increased predation affects beach nesting birds	Almost certain	Moderate	High	
B4.2 Invasive species	Predators (foxes and cats)	Increased predation affects migratory birds	Almost certain	Moderate	High	
B5. Invasive species	**Native animals (ravens)**					**An increasing number of ravens have been seen in beach nesting and migratory bird surveys since monitoring began in 2019-2020 (BirdLife Australia 2024).**
B5.1 Invasive species	Native animals (ravens)	Increased predation affects beach nesting birds	Almost certain	Moderate	High	
B5.2 Invasive species	Native animals (ravens)	Increased disturbance of migratory birds	Likely	Moderate	Medium	
B6. Human intrusion and disturbance: recreational activities						**The beach is a popular recreational destination and site managers agree that there is increased pressure on values due to higher recreational use.**
B6.1 Recreational activities	Increased human presence	Increased presence disturbs migratory birds	Likely	Moderate	Medium	Includes recreational use as well as pipi harvesting.
B6.2 Recreational activities	Increased noise	Increased noise disrupts beach nesting bird breeding	Likely	Moderate	Medium	
B6.3 Recreational activities	Physical damage (vegetation)	Increased damage reduces habitat availability and quality for waterbird breeding	Almost certain	Moderate	High	Identified as a significant risk in BirdLife Australia reports, with recent increases in vehicle tracks reported (BirdLife Australia 2024).
B6.4 Recreational activities	Litter	Affects waterbird habitat values	Likely	Minor	Medium	There is anecdotal evidence of large amounts of marine debris on the beach, which can impact waterbirds though entanglements and consumption of plastics.
Climate change						**Regional climate projections have recently been released by CSIRO for sub-cluster regions in Australia. The relevant region for GEDB is Great South Coast (CSIRO and DEECA 2024). Relevant details of those projections are described below.**

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
B7. Climate change	**Increased sea level**					**For 1966 to 2009, the average rate of relative sea-level rise for Australia, from observations along the coast, was 1.4 mm/year. There is very high confidence in future sea-level rise. By 2030 the projected range of sea-level rise for the cluster coastline is 0.08 to 0.18 m above the 1986–2005 level, with only minor differences between emission scenarios.**
B7.1 Climate change	Sea level rise	Increased sea level leads to loss of beach profile and reduced area for waterbird breeding	Possible	Major	High	Nesting habitat for terns, oyster catchers and hooded plover occurs in a narrow band of sand between high tide and the dune vegetation. This area is prone to inundation under sea level rise
B7.2 Climate change	Sea level rise	Loss of beach profile reduces habitat available for migratory birds	Possible	Major	High	Migratory shorebirds feed in a narrow range of shallow water depths and sea level rise could reduce this habitat.
B8. Climate change	**Increased extreme storm events**					**Increased intensity of extreme rainfall events is projected, with high confidence.**
B8.1 Climate change	Increased extreme storm events	Increased in large storm frequency and erosion leads to loss of beach profile and reduced area for waterbird breeding	Possible	Major	High	Nesting habitat for terns, oyster catchers and hooded plover occurs in a narrow band of sand between high tide and the dune vegetation. This area is prone to erosion under storm events.
B8.2 Climate change	Increased extreme storm events	Loss of beach profile leads to reduced waterbird feeding habitat	Possible	Major	High	Migratory shorebirds feed in a narrow range of shallow water depths and alterations to the beach profile could reduce this habitat.
B9. Invasive & Other Problematic Species, Genes & Diseases	**High pathogenicity avian influenza (HPAI)**					**Since 2021, there have been many detections overseas of HPAI viruses in wild birds, wild mammals, and poultry. HPAI H5N1 clade 2.3.4.4b has been the predominant strain since 2022. Both individual and mass mortalities have been observed. Detections of HPAI are rare in Australia. All previous Australian outbreaks have been in poultry, but this does not preclude an outbreak in the wild bird population. Some species such as black swan have been identified as at greatest risk.**
B9.1 Invasive & Other Problematic Species,	High pathogenicity avian influenza (HPAI)	Adversely affects waterbirds	Almost certain	Moderate	High	

Threats	Stressors	Impact	Likelihood	Consequence	2024 Risk	Evidence / comments
Genes & Diseases						

Appendix C Derivation of Resource Condition Targets

Critical CPS	Limit of Acceptable Change	Current condition / rationale for RCT	Resource Condition Target
Hydrology	Bridgewater Lakes, Lake Moniboeng, Swan Lake, Malseed Lake and Cain Flat Swamp will not dry. The Glenelg Estuary will not remain closed for 3 consecutive years or open for greater than 5 years.	There are water level meters in several locations in the Long Swamp complex (and several other wetlands in the Ramsar site). In a meeting on February 25, 2025, with vegetation and fish ecologists and site managers several key points were agreed: • The current water regime in Long Swamp is supporting ecological character of vegetation, native fish and threatened species and the aim should be to maintain this. • Seasonal variability in water levels is important for the threatened orchids (low water levels during flowering) and native fish (productivity boosts on rewetting of littorals zones and beds). • Understanding water levels and other habitat characteristics (e.g. salinity) is important for maintaining sub-populations of the threatened orchid species and this will be picked up in the monitoring recommendations. • RCT have been established based on maintaining 80th percentiles in winter/spring and 20th percentiles in autumn.	Maintain wetland water regimes (as indicated by water level) at each of the following key locations: • White sands: > 3.4 m in winter / spring and < 2.2 m in autumn. • Noble Rocks: > 4.2 m in winter / spring and < 3.7 m in autumn.
Stratification	See LAC for hydrology (Glenelg Estuary)	The Glenelg River estuary is a seasonally closed salt-wedge estuary with 3 distinct layers that vary under different tidal and freshwater inflow conditions. Maintaining this variability in salinity and dissolved oxygen regimes is important for many biological and chemical functions and processes. The variability is maintained by the opening and closing of the estuary mouth. *No change from 2017 RCT.*	Maintain seasonal stratification in the Glenelg Estuary.

Critical CPS	Limit of Acceptable Change	Current condition / rationale for RCT	Resource Condition Target
Vegetation type and extent	Vegetation extent will not fall below the following: • Coastal saltmarsh - 13 ha • Freshwater sedges and tall marsh - 470 ha, with at least 270 ha of *Baumea* sedgelands.	In 2018 and 2022 extensive vegetation condition assessments (IWC) were completed across most of the wetland EVCs in the Ramsar site. From the over 700 assessments of condition, just 13 (2%) scored less than 90 / 100 and were considered to be in less than excellent condition. Vegetation experts and land managers agreed on a target based on maintaining this excellent condition	Condition of wetland EVCs in the Ramsar site to be considered excellent (as indicated by a score of > 90 / 100) at 98% of representative sites.
Fish diversity and abundance	Native fish within the Ramsar site will represent each of the following life history strategies: • estuarine dependent • estuarine opportunists • marine migrants • diadromous • obligate freshwater species.	Monitoring of fish in the estuary is sporadic, but it was a target based on target estuarine specialist fish and diadromous fish based was agreed in meetings of fish experts and land managers in February 2025.	Estuary specialist fish (black bream, and estuary perch) recorded annually in the Glenelg Estuary. Presence of the following diadromous fish annually: • Estuary – tupong, short-finned eel. • Wetlands and connecting creeks – small-mouthed hardyhead.
		There is good data for small-bodied native fish in wetlands and a target based on maintaining juvenile (+1) and adult southern pygmy perch was identified as appropriate. In addition, currently, the wetlands are generally dominated by native species, with occasional increases in eastern gambusia (exotic species composed between 2% and 40% of the total catch, 2019 – 2023).	Annual detection of juvenile (< 30 mm) and adult (> 40 mm) southern pygmy perch annually. Native fish to represent > 70% of the total fish abundance in Long Swamp.
Waterbird diversity and abundance	Absence of the following waterbird guilds in any 3 out of 5 years: • Ducks, swans and grebes • Fishers • Large wading birds • Australian waders • International waders • Gulls and terns	BirdLife monitoring recorded between 25 and 51 waterbird species annually (2019-2024) but this is just the estuary and beach. If you add in citizen science records that include some of the freshwater lakes, then the numbers are 35 to 65. Birdlife monitoring indicates between 500 and 4000 sanderlings annually (5-year average = 1670 = 5.6% of the population).	Waterbird species richness to be > 32 species annually. The site supports > 5% of the flyway population of sanderling (based on a 5-year average).

Critical CPS	Limit of Acceptable Change	Current condition / rationale for RCT	Resource Condition Target
	Sanderling abundance falls below 0.7% of the global population in 3 out of 5 years.		
Threatened species: plants	Absence of maroon leek-orchid (*Prasophyllum frenchii*) and or swamp greenhood (*Pterostylis tenuissima*) in 3 consecutive targeted surveys.	Abundance of both species is highly variable year to year making a quantitative target difficult to establish. A meeting on February 25, 2025, of vegetation ecologists and site managers identified maintaining sub-populations of each of the orchid species as important. Habitat characteristics such as water level and salinity were identified as critical for the monitoring recommendations. The importance of the McFarlane site for the threatened orchids should be explored in future monitoring.	Maintain the following sub-populations of maroon leek-orchid (*Prasophyllum frenchii*) and swamp greenhood (*Pterostylis tenuissima*): • east of Nobles Rock tracks; (> 20 maroon-leek orchid; > 100 swamp greenhood) • west of Nobles Rock tracks, (>5 maroon-leek orchid; presence of swamp greenhood) • 2 km west of Nobles; (>25 maroon-leek orchid) • south of Millhouse Road (> 130 maroon-leek orchid; > 90 swamp greenhood).
Threatened species: fish	Absence of Yarra pygmy perch (*Nannoperca obscura*) in any 3 out of 5 targeted surveys	Similar to southern pygmy perch, Yarra pygmy perch are a short-lived species, reaching maturity in a year. Maintaining evidence of recruitment and good population structure is the aim for management of this species. The little galaxias has been recently listed as vulnerable under the IUCN red list The species is detected in the system in most surveys, but in low numbers.	Annual detection of juvenile (< 30 mm) and adult (> 40 mm) Yarra pygmy perch annually. Detection of little galaxias in at least 2 years in every 3 year period.
Threatened species: birds	Absence of hooded plover (*Thinornis rubricollis*) in 3 out of 5 years.	Average of 37.8 hooded plover (2019 – 2024). Nesting success is low (compared to other Victorian beaches) with a fledging rate of 0 to 0.27 over the past 5 years and an average of 0.11 (2019-2024). Bird Life's target for hooded plover fledging is 0.4 to 0.5 Fairy tern only recorded in 2019-20 (12 individuals). Australasian bittern only from citizen science records (but no dedicated surveys). It was agreed in the workshop on January 31, that a target for hooded plover should be based on nesting success. The other 2 species identified as a knowledge gap and deferred to monitoring.	To improve the nesting success of hooded plover in the site with an average fledging success of 0.3 (5-year average).

Critical CPS	Limit of Acceptable Change	Current condition / rationale for RCT	Resource Condition Target
Threatened species: growling grass frog	Absence of growling grass frog (*Litoria raniformis*) in any 3 out of 5 targeted surveys at 50% of known (recent) locations within the Ramsar site (see Bachmann et al. 2013).	Not recorded in the site since 2012. ALA records indicate that the species has not been recorded elsewhere in the Ramsar site.	No target set, the importance of the site in supporting growling grass frog to be reviewed in the next updated of the Ramsar Information Sheet.
Ancient greenling	See LAC for Vegetation type and extent.	The species is observed when the threatened plant species surveys are completed, but the numbers are highly variable (200+ in 2017, 6 in 2020). To be included in the recommendations for monitoring – full surveys every 4 or 5 years.	Maintain population of ancient greenling.
Ecological connectivity	See LAC for hydrology (Glenelg Estuary) and fish (continued presence of diadromous fish).	Covered by diadromous fish and hydrology – knowledge gap of understanding how and when wetlands are connected to be addressed with monitoring.	