

Victorian
Environmental
Assessment
Council

Assessment of Victoria's Coastal Reserves Draft Report

For Public Comment

October 2019



Victorian Environmental Assessment Council

The Victorian Environmental Assessment Council (VEAC) was established in 2001 under the *Victorian Environmental Assessment Council Act 2001*. It provides the State Government of Victoria with independent advice on protection and management of the environment and natural resources of public land.

The five Council members are:

Ms Janine Haddow (Chairperson)

Ms Joanne Duncan

Ms Anna Kilborn

Dr Charles Meredith

Dr Geoffrey Wescott

Acknowledgement of Aboriginal Victorians

The Victorian Environmental Assessment Council pays its respects to Victoria's Aboriginal peoples, Native Title Holders and Traditional Owners and acknowledges their rich cultural and intrinsic connections to Country. Council recognises that the land and sea is of spiritual, cultural, environmental and economic importance to Aboriginal people and values their contribution and interest in the management of land and sea.

Written submissions are invited on this draft report.

The closing date for submissions is

Monday 11 November 2019.

You may make an online submission via VEAC's website at www.veac.vic.gov.au or send your written submission by post or by email (see contact details).

There is no required format for submissions, except that you must provide your name, address and your contact details, including an email address if you have one. All submissions will be treated as public documents and will be published on VEAC's website. Please contact VEAC if you do not wish your submission to be published. The name of each submitter will be identified as part of each published submission, but personal contact details will be removed before publishing.

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Overview

BACKGROUND

- At the request of the Minister for Energy, Environment and Climate Change, the Hon Lily D'Ambrosio, VEAC has assessed Victoria's coastal reserves, including their legal status, significant values and values that are at risk from the impacts of climate change.
- The focus of the assessment is on collation and analysis of information to assist the Victorian government's future planning and decision making for the coast. It does not recommend changes to the current uses of coastal reserves.
- Most of Victoria's coastal land is in public ownership. The majority of coastal public land is reserved for conservation. Of the remainder, most are coastal reserves of various types, with some others designated for specific uses such as ports.
- Coastal reserves – the subject of this report – are usually narrow strips of Crown land along the shore often intensively used by the community for recreation and leisure activities. They may be known locally as foreshore reserves, parklands or campgrounds. Coastal reserves often retain natural values and may contain buildings, facilities or coastal infrastructure.
- For VEAC's recent Assessment of the Values of Victoria's Marine Environment Traditional Owners advised VEAC that the nature of Aboriginal culture and knowledge means that there is not a well-documented inventory of information relating to sections of the Victorian coast available to decision makers.
- In accordance with the Victorian government's draft marine and coastal policies, VEAC does not attempt to speak on behalf of Traditional Owners. VEAC supports a broader self-determination approach that emphasises the need to listen to and respect Traditional Owners' voices and knowledge throughout planning, management and decision making in the marine and coastal environment.
- VEAC welcomes comments on this draft report and the associated maps and inventory. Comments, corrections and additional information will be considered and incorporated in the final report.

INTERIM RESULTS

- Some 1400 Crown parcels (63,140 hectares) have been identified as coastal reserves along the open coast, on the foreshores of bays and inlets, and at the Gippsland Lakes. On the open coast, coastal reserves border 800 kilometres of the coastline. The shallow water bodies of the Gippsland Lakes that are included here as coastal reserves, together with the adjacent onshore areas, make up approximately 65 per cent of the total area (40,570 hectares).

- The inventory contains some 230 coastal reserve land units (approximating individual coastal reserves), including 36 in the Gippsland Lakes.
- Coastal reserves are typically reserved for either 'public purposes' (70 per cent) or 'protection of the coastline' (20 per cent). More than 1700 hectares of coastal reserve is unreserved Crown land.
- The information presented in this assessment on coastal reserve reservation and status highlights a fragmented land tenure and regulatory regime that is unprepared for future demands including the uncertain effects of climate change on cadastral (land tenure) boundaries.
- Coastal reserves are variously managed by DELWP, Parks Victoria, local government or public committees of management.
- The assessment has identified significant values in most coastal reserve land units. Biodiversity and recreation and tourism values are those most often recorded, reflecting the relative ease with which these values can be mapped and measured. More than 95 per cent of coastal reserves scored in at least one of the ten indicators of high biodiversity value and over 65 per cent of coastal reserves scored for at least one of the four indicators of important recreation and tourism values.
- Modelling prepared for the Victorian Coastal Monitoring Program indicates that coastal reserves will be heavily affected under relatively conservative sea level rise scenarios of 20 centimetres by 2040 and 82 centimetres by 2100. More than 75 per cent or 181 coastal reserve land units will be impacted by the predicted 2040 sea level rise. By 2100 a further 13 coastal reserves will be affected (194 reserves in total). Thirteen of these 194 reserves will be impacted across more than 85 per cent of their area.
- When the modelling includes storm surges, 196 coastal reserve land units (some 85 per cent) are predicted to be at risk of inundation by 2040. By 2100, storm surges will affect a further eight reserves, with 204 in total at risk of inundation.
- Coastal acid sulphate soils are currently present in 161 coastal reserves, 37 of which have these soils present in over 99 per cent of their area.
- At a statewide scale climate change, population growth and ageing coastal infrastructure are broadly agreed to be the most significant pressures on marine and coastal environments.

Comments invited

VEAC welcomes comments on any aspect of this draft report and the associated maps and inventory. Comments, corrections and additional information will be considered in the preparation of the final report.

Comments are also invited on the following questions related to information presented in the report:

Chapter 2

Do the purposes and objectives for coastal reserves appropriately reflect current and future values and uses?

Do you have any suggested changes to or comments on VEAC's technical definition of coastal reserves?

Do you have any suggested changes to or comments on VEAC's maps of coastal reserves?

How can we best prepare for changes to land tenure boundaries of coastal Crown land resulting from the effects of climate change?

What is the best way to provide clarity and certainty for land owners and managers along the coastline?

Chapter 3

Should all coastal reserves be reserved for specific purposes?

Chapter 4

Are there any additional uses or values of coastal reserves that should be reported or included in the inventory?

Are there other ways to present the information that would assist land managers with planning and decision making?

Chapter 5

Are there other important trends or emerging uses of coastal reserves?

Chapter 7

Are there other climate change datasets that should be considered when assessing coastal reserve values at risk from the impacts of climate change?



More than 95 per cent of Victoria's coastline has been retained as Crown land. Around 70 per cent is set aside as protected areas (national parks, coastal parks or conservation reserves) and the remainder managed for a variety of purposes. Public ownership means that Victorians enjoy open access to coastal and marine areas.

Coastal reserves usually form a narrow strip of public land along the coast set aside primarily for public recreation, education and conservation of natural environments. Many coastal reserves are in townships and may be known locally as foreshore reserves, parklands or campgrounds depending upon levels of naturalness or the types of facilities and infrastructure.

Australia is a complex and diverse society with multiple social and cultural identities. The coast and the beach are strongly associated with many of these identities as places for daily, weekend and holiday leisure activities. Victoria's coastal reserves are important to the community and contribute to local and regional economies, supporting tourism, education and a variety of associated businesses.

While VEAC's assessment focuses on the coastal reserves only, adjoining land use along the coast is important when identifying the range of values and uses, and managing threats such as climate change.

Traditional Owners rights, interests and knowledge

Traditional Owners do not separate coastal from associated catchment or marine values. For VEAC's recent Assessment of the Values of Victoria's Marine Environment, Traditional Owners advised that the nature of Aboriginal culture and knowledge means that there is not a well-documented inventory of information relating to sections of the Victorian coast available to decision-makers. This was considered to represent a very significant gap under the terms of reference for that assessment.

Chapter 7 of the report for the Assessment of the Values of Victoria's Marine Environment provided an outline of the Aboriginal cultural values for Sea Country in Victoria, based on a report prepared for VEAC by the Federation of Victorian Traditional Owner Corporations. A strategic framework prepared by the Federation was also included articulating Victorian Traditional Owners' long-term goals and objectives for developing and applying Indigenous knowledge and practice for Sea Country in a contemporary Victorian context.

The *Draft Marine and Coastal Policy* (2019) acknowledges that institutional barriers have limited the opportunities for many Traditional Owners to manage and use land and Sea Country, and to have their voices heard in planning and decision-making processes. Recognising this history, the draft marine and coastal policies do not attempt to speak on behalf of Traditional Owners. They support a broader self-determination approach that emphasises the need to listen to and respect Traditional Owners' voices and knowledge throughout planning, management and decision making in the marine and coastal environment.

1.1 Terms of reference

On 3 June 2018 the Minister for Energy, Environment and Climate Change requested the Victorian Environmental Assessment Council (VEAC) to conduct an assessment of Victoria's coastal reserves. See box 1.1 for the terms of reference.

Box 1.1 Terms of reference

Pursuant to section 26B of the *Victorian Environmental Assessment Council Act 2001*, the Minister for Energy, Environment and Climate Change hereby requests the Victorian Environmental Assessment Council (the Council) to carry out an assessment of Victoria's coastal reserves¹.

The purpose of the assessment is to:

- a) review the number and types (reservation status) of coastal reserves in Victoria;
- b) identify reserves with high environmental, cultural heritage, social and economic values and identify values at risk from the impacts of climate change;
- c) identify current and emerging uses of the coastal reserves; and
- d) compile an inventory, including spatial distribution, of values and uses of the coastal reserves.

As a first step, the Council is required to publish a definition of coastal reserves to be used in the assessment, including a diagrammatic representation and map of Victoria's coastal reserves.

The assessment and associated inventory will assist the Victorian Government's future planning and decision-making for Victoria's coasts.

The Council must take into account relevant agreements under the *Traditional Owner Settlement Act 2010*.

As part of the assessment, the Council must produce a draft report and seek public comment on it.

The Council must report on the completed assessment by 6 December 2019.

¹ For the purposes of this assessment, Victoria's coastal reserves include any Crown land along Victoria's coast (including the coast of any bay, inlet and estuary and the Gippsland Lakes) that is:

- a) reserved under section 4(1)(ze) of the *Crown Land (Reserves) Act 1978* for the protection of the coastline or is otherwise reserved under that Act and is landward of low water mark; or
- b) unreserved Crown land under the *Land Act 1958* that is landward of low water mark.

For clarity, Victoria's coastal reserves do not include any Crown land described as a park or marine sanctuary in Schedule 2, 2B, 3, 4, 7 or 8 to the *National Parks Act 1975* or any unreserved Crown land from low water mark to the outer limit of Victoria's coastal waters (mostly 3 nautical miles).

1.2 About VEAC

VEAC provides the Victorian government with independent and strategic advice on matters related to the protection and management of the environment and natural resources of public land. It was established under the *Victorian Environmental Assessment Council Act 2001*.

VEAC carries out its investigations or assessments and provides advice at the request of the Minister for Energy, Environment and Climate Change. Together the Act and terms of reference provided by the Minister describe how an investigation or assessment must be conducted, including the number of reports to be prepared, matters to be taken into account, timeframes and public consultation.

The VEAC Act was amended in 2016 to allow the Minister to request the Council to conduct an assessment or to provide advice in relation to a matter that, in the opinion of the Minister, does not require an investigation, having regard to the matter's limited scale or scope or its technical nature. Assessments do not require formal public consultation unless specified by the Minister in the terms of reference.

This assessment of Victoria's coastal reserves is requested pursuant to the new section 26B of the Act.

The current five members appointed to VEAC are Ms Janine Haddow (Chairperson), Ms Joanne Duncan, Ms Anna Kilborn, Dr Charles Meredith and Dr Geoffrey Wescott. A brief biography of each of the Council members can be found on VEAC's website at <http://www.veac.vic.gov.au>. The Council is supported by a small research and policy team and an administrative secretariat.

1.3 Aims of the assessment

The assessment has been requested to assist the Victorian government's future planning and decision-making for Victoria's coasts and support the government's marine and coastal reforms. The assessment will provide information on the extent of coastal reserves, existing uses and values.

The scope of the assessment does not include making recommendations for changes to either public land use classifications or existing access to coastal reserves.

The purpose of the assessment is to:

- a) review the number and types (reservation status) of coastal reserves in Victoria
- b) identify reserves with high environmental, cultural heritage, social and economic values and identify values at risk from the impacts of climate change
- c) identify current and emerging uses of the coastal reserves, and
- d) compile an inventory, including spatial distribution, of values and uses of the coastal reserves.

The Victorian government accepted recommendation R22(a) in VEAC's *Statewide Assessment of Public Land Final Report* (2017) to provide information on the number and types of coastal reserves and an inventory of values and uses to assist future planning, decision-making and enhance management effectiveness. The *Marine and Coastal Reforms Final Transition Plan* (2018) also includes this VEAC assessment as action 1.2. The information gathered by VEAC both for this assessment and the completed Assessment of the Values of Victoria's Marine Environment supports the State of the Marine and Coastal Environment Report to be delivered by the Commissioner for Environmental Sustainability in 2020.

Addressing the assessment purposes

Reporting on part (a) of the terms of reference to *review the number and types of coastal reserves in Victoria* is achieved by including this information in an online mapping tool and summarising the data within this draft report.

Reporting on part (b) of the terms of reference purpose to *identify coastal reserves with high values and those at risk from the impacts of climate change* is achieved through summaries in this draft

report and provision of a tabulated dataset using land units to approximate reserves. Currently the coastal reserves dataset contains some 230 coastal reserve land units including 36 units in the Gippsland Lakes. Each of these has been scored (largely based on analysis of available GIS datasets) for significant values and the potential effects of climate change. This information also addresses part (d) of the terms of reference to *compile an inventory, including spatial distribution, of values and uses of the coastal reserves*.

A dataset with a climate change erosion vulnerability score, predicted inundation and modelled impacts was prepared in 2017 for DELWP by Spatial Vision.¹ These data provide climate change threat measures for each coastal reserve land unit.

Reporting on part (c) of the terms of reference purpose to *identify current and emerging uses of coastal reserves* has been included in this draft report.

1.4 Consultation and information gathering

Stakeholder consultation is a key part of VEAC's work program, tailored to the nature and specific requirements of each investigation or assessment. For this assessment, the consultation process includes provision of information to interested organisations and individuals, targeted stakeholder consultation on technical information and one formal submission period on this draft report.

The Council is required to publish a definition of coastal reserves to be used in the assessment and produce a draft report and seek public comments on it.

A technical definition of coastal reserves was developed with the assistance of practitioners and key stakeholders and informally circulated for comment in July 2019 (see section 2.2).

Commissioned work

The Public Land Consultancy was commissioned to prepare a brief review of the implications of the changing coastline for coastal Crown land boundaries (the cadastre) including the predicted impacts of climate change. This report is summarised in section 2.5 of this draft report and the full report is available on VEAC's website at <http://www.veac.vic.gov.au/investigation/assessment-coastal-reserves/resources>.

1.5 Overview of coastal land use

More than 95 per cent of Victoria's onshore coastline has been retained as Crown land. Along the coast there are a range of public land uses including national parks, coastal parks, nature reserves and wildlife and state game reserves. Protected areas (13 national or state parks, 5 coastal (conservation) parks and several conservation reserves) make up around 70 per cent of the coastline. The land use category 'coastal reserve' has a specific meaning in the classification system of public land use and excludes Victoria's offshore waters; these are classified as coastal waters reserve. However, some coastal reserves include adjacent offshore areas, and these are included in this assessment (e.g. Gippsland lake beds are part of larger reserves including significant onshore areas).

The criteria for identifying coastal reserves provided in chapter 2 outlines the approach in this assessment for the Gippsland Lakes and Gippsland Lake Reserve and community use reserves such as foreshore caravan parks, parklands and lighthouses.

There are a number of technical challenges when describing both coastal land boundaries and management arrangements. The Crown land dataset established for this assessment has almost 7000 records. Chapters 2 and 3 highlight technical or information issues and provide an opportunity to consider coastal reserves within the broader statewide context of coastal Crown land use.

1.6 Past studies

For more than 45 years the role of the Victorian Environmental Assessment Council (VEAC) and its predecessors, the Land Conservation Council (LCC) and Environment Conservation Council (ECC), has been to draw together scientific and other research, consult with the community, and make recommendations to the government on the protection and management of Victoria's public land.

Coastal Crown land has been a part of many studies, reviews and investigations (see figure 1.1). The first two studies completed by the LCC — South Western District 1 Final Recommendations (1973) and South Gippsland District 1 Final Recommendations (1973) — introduced public land use classifications of 'Parks - Coastal Reserve' and 'Other Recreation and Conservation - Coast Frontage.' The distribution of public land uses along the coast has changed significantly since that time, together with most other public land uses across Victoria. Today, coastal public land is largely divided into various park categories under the *National Parks Act 1975* and reserve categories — including coastal reserves — under the *Crown Land Reserves Act 1978*. This assessment specifically excludes areas scheduled under the National Parks Act.

Previous investigations of relevance to the coast highlighted in figure 1.2 have been reviewed as background to the current assessment.

Figure 1.1 Past public land use investigations along the coast by the LCC/ECC/VEAC

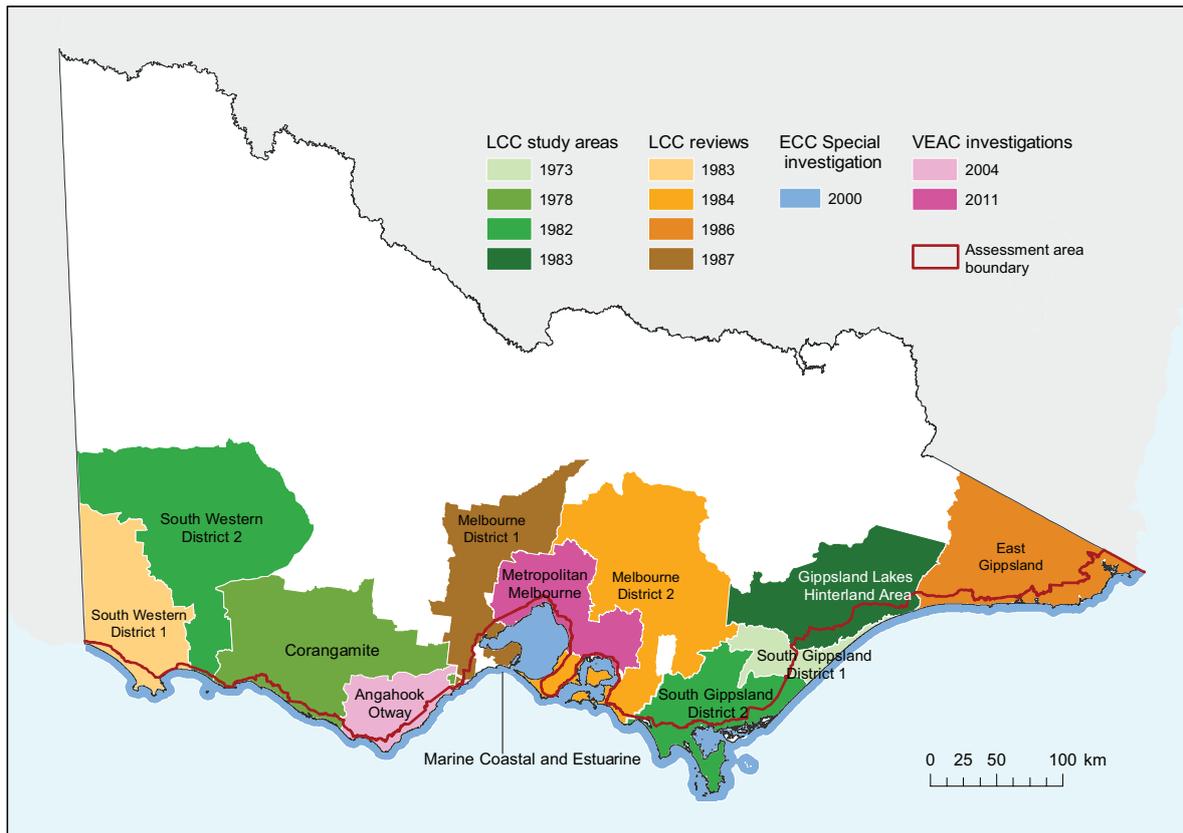
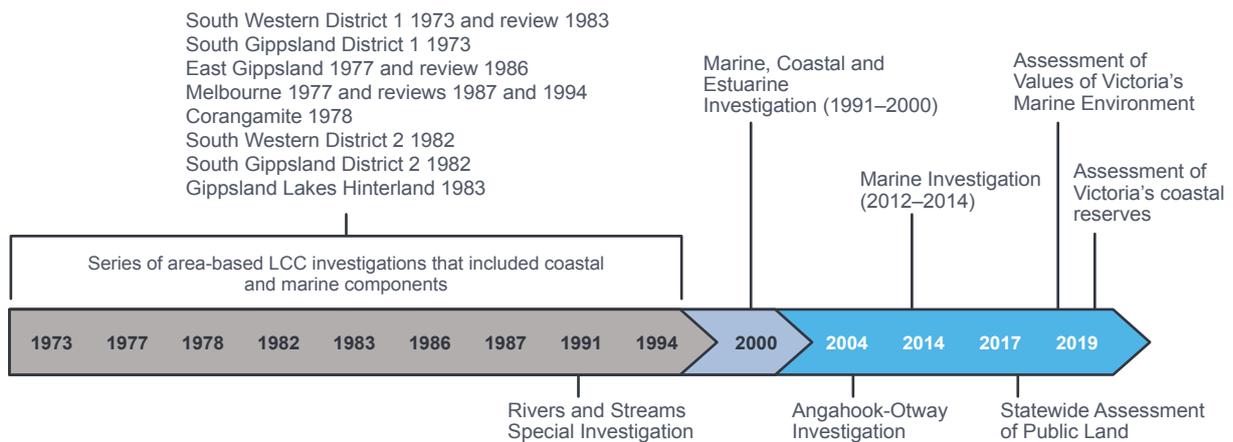


Figure 1.2 VEAC, ECC and LCC investigations of relevance to the marine and coastal environment

Purposes and objectives of coastal reserves

The purposes or objectives that are recommended to apply to most coastal reserves, as updated in VEAC's Statewide Assessment of Public Land Final Report (2017), are described below. There may be exceptions for some specific reserves and in special circumstances. These broad purposes may be modified or expressed differently in new land legislation. Note that 'coastal Crown land' as defined in the *Marine and Coastal Act 2018* includes but is not the same as coastal reserves for the purposes of this assessment. The purposes are:

- to provide opportunities for informal recreation associated with enjoyment of the coastal environment
- to protect natural coastal landscapes, ecosystems and cultural features
- to protect the rights and interests of Traditional Owners, native title holders and Aboriginal Victorians, and their cultural values
- to provide for facilities consistent with the conservation of natural and cultural values.

In the past, public land use recommendations for this category may also have listed suitable uses and inappropriate uses or included policies that explained or interpreted the basic purposes, and any principles and/or guidelines for detailed management planning or site-specific uses.

1.7 Legislative and policy context

A range of legislative reforms have recently taken place or are in development affecting areas of coastal Crown land. These include significant changes to Crown land legislation and introduction of a new *Marine and Coastal Act 2018* including requirements for a new marine and coastal policy (currently at draft stage) and a subsequent strategy to be prepared in 2020. A range of site-specific or regional programs are also underway with many opportunities for community involvement.

A summary is provided below of those reforms and the existing policies most relevant to coastal Crown land and their status at the time of writing.

Land legislation

Four primary land Acts govern Crown land use in Victoria: the *Land Act 1958*, *Forests Act 1958*, *Crown Land (Reserves) Act 1978* and *National Parks Act 1975*.

The Land Act focuses on sale, leasing and licencing of Crown land and preventing unauthorised occupations. Its provisions date back to the original *Sale of Crown Lands Act 1860*. Over time many of

the provisions of the early Land Acts were dispersed to more specific Acts including those for national and other parks moved to the National Parks Act and those for reserving and managing Crown land moved to the Crown Land (Reserves) Act.

The Crown Land (Reserves) Act provides for the reservation, use and management of Crown land, either temporarily or permanently, for purposes including conservation, recreation, services and utilities. The Act lists 33 purposes for which reserves may be established, singly or in combination. The Act also provides for the appointment of committees of management to manage Crown land reserves.

For unreserved Crown land the provisions of the Land Act apply.

Acquired Crown land, either surrendered from freehold ownership or purchased, is deemed to be temporarily reserved for a public purpose under the Crown Land (Reserves) Act upon transfer. Detailed records of these transactions are not generally centralised and therefore any associated reservation purpose may be unclear. Where unclear, 'public purposes' reservation purpose was adopted.

The government accepted VEAC's recommendations in the Statewide Assessment of Public Land (2017) for reform of land legislation, which includes aligning reservation purpose and use with government-accepted public land use classifications and onground management.

Leasing and licensing policy

Public land can be leased or licensed for a variety of purposes that align with the management goals of the land. A lease provides a tenant with the exclusive right to occupy land for a specific time periods (generally applies to a building or structure). A licence gives non-exclusive use for a permitted activity. Permits may be issued by the land manager for short-term or one-off events such as weddings, festivals and sporting events.

In July 2018 DELWP provided an update to the 2010 *Leasing policy for Victorian Crown land* and formalised three Crown land leasing principles:

- to provide benefits to the public through leasing
- to ensure consistency and transparency in leasing
- to manage leased Crown land in an ecologically sustainable manner.

These principles guide land managers and tenants and inform decision making around leasing of Crown land, including ensuring robust and sound procurement processes are applied. The policy applies to Crown land under the Crown Land (Reserves) Act, the Forests Act and the Land Act.

Coastal camping and caravan park policy

In July 2011, the Department of Sustainability and Environment (now DELWP) released its *Improving Equity of Access to Crown Land Caravan Parks* policy. This policy and associated 2012 *Best Practice Management Guidelines* were developed to improve equity of access to Crown land caravan and camping parks in Victoria. The policy does not apply to caravan and camping parks in national parks, on private land, or on council-owned freehold land. Section 4.6 of this draft report provides additional information on recreation and tourism including the estimated 60 caravan parks located on coastal reserves.

The policy and guidelines enable public land managers to better respond to increasing demand for sites and facilities, particularly during peak holiday periods, and to ensure affordable and equitable access to Crown land caravan and camping parks. The policy outlines a suite of actions to be implemented by caravan park managers, such as providing clear communication around Crown land permit conditions and limitations, ensuring the accommodation mix and price structures cover costs for park and reserve management, and a process for managing on-site sales.

Marine and Coastal Act

The *Marine and Coastal Act 2018* is the guiding legislation in Victoria for integrated planning and management of the marine and coastal environment. The Act enables protection of the coastline and mechanisms to address the long-term challenges of climate change, population growth and ageing coastal structures.

The Marine and Coastal Act, which replaced the *Coastal Management Act 1995*, came into operation in August 2018. The Act is supported by the *Victoria's Marine and Coastal Reforms – Final Transition Plan*, which outlines a series of actions needed to establish an integrated and co-ordinated whole-of-government approach to protect and manage Victoria's marine and coastal environment. This assessment of coastal reserves by VEAC is listed as Action 1.2 in the transition plan.

The Act requires the development of a marine and coastal policy, which includes a marine spatial planning framework, and a marine and coastal strategy. The Act also provides a consents process to use, develop or undertake works on marine and coastal Crown land.

A draft Marine and Coastal Policy including a marine spatial planning framework, was published for public comment in August. A final policy is required by the end of 2019.

Climate Change Act

The *Climate Change Act 2017* provides Victoria with a legislative foundation to manage climate change risks, maximise the opportunities that arise from decisive action, and drive transition to a climate resilient community and economy with net zero emissions by 2050. The Act sits alongside other key Victorian government energy and climate change initiatives including *Victoria's Climate Change Framework*, *Victoria's Climate Change Adaptation Plan 2017-2020* and *Victoria's Renewable Energy Action Plan*.

Of relevance to the coast is that the Act requires the government to develop a Climate Change Strategy setting out how Victoria will meet its targets and adapt to the impacts of climate change (from 2020). It also requires preparation of adaptation action plans for key systems (including plans for natural environment systems, which includes coastal environments) and a process for use of Crown land for carbon sequestration.

Interests of Aboriginal peoples

Formal recognition of the interests of Aboriginal peoples in Victoria's coastal environment can derive from native title determinations under the Commonwealth *Native Title Act 1993* as well as through agreements made pursuant to Victoria's *Traditional Owner Settlement Act 2010*. Indigenous rights to land and resources may be implemented through joint management plans in the case of certain types of protected areas, through indigenous land use agreements made pursuant to native title determinations or through agreements pursuant to the Traditional Owner Settlement Act.

The Traditional Owner Settlement Act offers an alternative to court-determined native title determinations. It enables the Victorian government to make agreements with Traditional Owners to recognise their relationship to land and provide for certain rights on Crown land and other benefits. In entering into a settlement, Traditional Owners must agree to withdraw any native title claim they have and agree not to make a claim into the future.

The first settlement under the Traditional Owner Settlement Act was the Gunaikurnai agreement. The settlement area, which extends from west Gippsland east to the Snowy River, includes the area up to 200 metres seawards of the territorial sea baseline. A land use activity agreement has been developed and will result in recognition of certain natural resource rights held by the Traditional Owners. The agreement also provides for joint management of some parks and reserves. These include, on the coast, The Lakes National Park, Gippsland Lakes Coastal Park, parts of Raymond Island and the

Corringle Foreshore Reserve at Marlo. The Gunaikurnai, under separate orders, also have native title recognised under the Native Title Act.

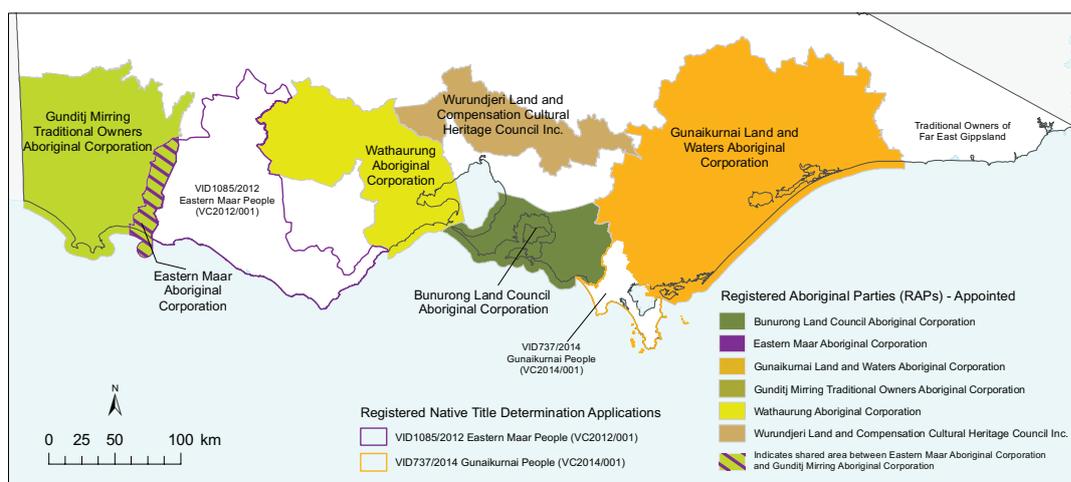
The *Victorian Aboriginal Heritage Act 2006* recognises Aboriginal people as the primary guardians, keepers and knowledge holders of Aboriginal cultural heritage. An 'Aboriginal place' under the Act may be in the coastal waters of Victoria. This is relevant to land and sea managers who must manage lands in accordance with the provisions of the Act. Those responsibilities include, for example, reporting discovery of Aboriginal places and objects.

The Victorian Aboriginal Heritage Council (VAHC) was created under the Aboriginal Heritage Act to ensure the preservation and protection of Victoria's Aboriginal cultural heritage. The VAHC, which is made up of Traditional Owners appointed by the Minister for Aboriginal Affairs, plays an important role in the implementation of the Act including making decisions on Registered Aboriginal Party (RAP) applications.

Under the Act, RAPs play a key role in ensuring the preservation and protection of Victoria's rich Aboriginal cultural heritage. RAPs have a number of rights and responsibilities in relation to Aboriginal cultural heritage sites and objects located on public land.

RAPs are involved in preparation, evaluation and implementation of cultural heritage management plans. These plans set out measures and actions to be taken before, during and after a proposed activity in order to manage and protect Aboriginal cultural heritage in the activity area. RAPs are one of the approval bodies for cultural heritage permits under the Aboriginal Heritage Act.

Figure 1.3 Registered Aboriginal Parties with interests in the Victorian coast and native title determination applications



Biodiversity legislation

The *Flora and Fauna Guarantee Act 1988* enables and promotes the conservation of Victoria's native flora and fauna and provides a range of procedures that can be used for the conservation, management or control of flora and fauna and the management of potentially threatening processes. Mechanisms include listing of threatened species and communities and threatening processes, the preparation of a strategies and action statements, identification of critical habitat and controls over protected flora and fauna. Reforms to the Act passed the Victorian Parliament in August 2019. Amendments include recognition of the rights and interests of Traditional Owners, a requirement for all public authorities in Victoria to give proper consideration to the Act's principles and plans developed under the Act, and an up-to-date threatened species list.

The *Wildlife Act 1975* was established to promote the protection and conservation of wildlife, promote prevention of taxa of wildlife from becoming extinct, promote sustainable use of and access to wildlife, and

prohibit and regulate the conduct of persons engaged in activities concerning or related to wildlife. For the purposes of the Act, wildlife is defined broadly as any animal of a vertebrate taxon other than mankind that is indigenous to Australia although it also includes exceptions such as deer and some other taxa.

The long-term strategy for the management of biodiversity, which includes the marine environment, is outlined in Victoria's biodiversity plan *Protecting Victoria's Environment – Biodiversity 2037*.

Non-Aboriginal cultural heritage

The *Heritage Act 2017* provides for the protection and conservation of places and objects of cultural heritage significance and the registration of such places and objects including shipwrecks, shipwreck artefacts and sunken aircraft in Victorian state waters.

The Act establishes the Heritage Council, the Victorian Heritage Register, the Heritage Inventory and a Heritage Fund.

The Commonwealth *Underwater Cultural Heritage Act 2018* provides complementary protections in Commonwealth waters to the edge of the continental shelf.

Planning

The *Planning and Environment Act 1987* establishes a framework for planning the use, development and protection of land in Victoria in the present and long-term interests of all Victorians. The focus of the Act is on land, including land covered with water. The Act provides for establishment of planning schemes and the *Victoria Planning Provisions*.

The Planning and Environment Act allows for some flexibility in how boundaries of planning schemes may be drawn; however, they generally extend 600 metres seaward from the municipal boundary, which coincides with the low water mark.

The planning system is directly relevant to the consent process for developments along the coast. A responsible authority under the Planning and Environment Act must not decide to grant a permit to use or develop coastal Crown land within the meaning of the Marine and Coastal Act unless the minister has consented to the use or development.

Recent amendments to the Planning and Environment Act provide for the declaration by the minister of distinctive areas and landscapes, and subsequent preparation and implementation of a Statement of Planning Policy which provides state-level protection against inappropriate development in declared distinctive areas and landscapes. Declarations are currently being considered for the Bass Coast, Bellarine Peninsula and Surf Coast to protect seaside townships and coastal landscapes from urban development pressure.

State of the environment reporting

The *Victorian State of the Environment 2018* Report evaluated the condition of the state's natural environment and reported on the monitoring and management systems. The report is the first known attempt in Australia to apply the United Nations Sustainable Development Goal framework to environmental reporting at a sub-national level. The report assesses 170 scientific indicators. It is a comprehensive, scientific baseline on the health of Victoria's environment, and identifies gaps in research and monitoring programs. Information is reported across 13 themes including an assessment of 24 indicators in the marine and coastal environments theme.

The findings state that a business-as-usual approach and ad hoc investment in monitoring, science and reporting are unlikely to meet our requirements for effective, adaptive management practices into the future. There are 20 recommendations to target those interventions that will improve multiple outcomes for Victoria. Recommendation 10 is for the marine knowledge framework to be expanded to

include all marine and coastal environments, and for this information to be available for inclusion in the forthcoming *State of the Marine and Coastal Environment 2021 Report*.

Better investment and use of spatial data, data analytics and scientific research are addressed in Recommendation 14: 'That DELWP develop its spatial information capability and database, and ensure it is regularly and routinely updated, to inform decision-making across the environment portfolio.' The existing information systems are unreliable and present a number of risks and sources of misinformation. The report states that marine and coastal datasets are limited in a number of ways, particularly outside conservation parks and reserves, and that most monitoring is undertaken by non-government bodies, community groups and through citizen science.

Waterways management

Under the *Water Act 1989*, the Victorian government retains the overall right to the use, flow and control of all surface water and groundwater on behalf of all Victorians. The Act also defines the Environmental Water Reserve as the amount of water set aside to meet environmental needs.

Catchment management authorities are established under the *Catchment and Land Protection Act 1994* and, amongst other duties, must prepare regional catchment strategies and coordinate and monitor their implementation. These strategies consider the cumulative impact of catchment processes on coastal waters and promote management actions to mitigate these impacts.

The *Victorian Waterway Management Strategy (2013)* provides the framework for government, in partnership with the community, to manage rivers, wetlands and estuaries so it can support environmental, social, cultural and economic values now and into the future. The catchment management authorities – Glenelg Hopkins, Corangamite, West Gippsland and East Gippsland – and Melbourne Water are required to develop management strategies for estuaries within their areas of operation.

Victorian Auditor-General (VAGO) audits

VAGO has recently conducted two audits relevant to coastal reserves. The 2014 audit *Oversight and accountability of committees of management (CoMs)* found that significant improvement was required and that the then Department of Environment and Primary Industries was not targeting its support to reserves with higher risk profiles and consequently had not taken sufficient steps to ensure that community-based CoMs are managing Crown land reserves appropriately. The *Follow up of oversight and accountability of committees of management* in 2018 reported that the 11 recommendations had not been fully addressed and some actions had heightened the risks identified in the original audit. VAGO commented that the absence of a robust risk assessment approach, poor governance and fragmented oversight is compounded by poor information about Crown land reserves.

VAGO reported in 2018 on *Protecting Victoria's coastal assets*. The report highlighted that managing and safeguarding coastal protection structures is as important as managing the assets they shield both now and into the future. The report states that a sea level rise of 0.8 metres by 2100 would put 48,000 residential buildings and more than 650 kilometres of roads and railways at risk of inundation. The replacement cost for these assets was estimated at more than \$10 billion.

The report states that coastal assets, both natural and built, are not being adequately protected and management approaches are not systematic, consistent or risk based. VAGO found that no one agency or system collects asset condition information across the entire Victorian coast.

Asset management

Public assets support the delivery of government services to the community, including preserving cultural and heritage assets with unique historical, cultural or environmental values. The Department of

Treasury and Finance's 2016 *Asset Management Accountability Framework* (AMAF) outlines how effective asset management is achieved, details mandatory requirements including developing strategies, governance frameworks, performance standards and processes to regularly monitor and improve asset management.

The AMAF applies to non-current assets (physical and intangible) but not financial assets. Land, buildings, infrastructure, plant and equipment comprise the bulk of Victoria's non-current assets. Implementation guidance notes outline how assets should be managed across their whole lifecycle. The AMAF aims to improve transparency and accountability through the attestation process with reporting on, and ensuring, efficient and effective asset management.

Current coastal initiatives

As indicated above, marine and coastal policy, programs and reforms is a very active environment. Some of the key coastal initiatives currently being undertaken across the state include:

- Marine and Coastal Policy (due December 2019)
- Marine and Coastal Strategy (due 2020)
- Great Ocean Road Management Reform
- Bass Coast Marine and Coastal Park (Bass Coast coastal Crown land reforms)
- Statewide Coastal Asset Management Database
- Coastal Assets and Values Project
- Protecting Victoria's coastal assets (2018)
- Protection of priority Victorian beaches and foreshores
- Victorian Coastal Monitoring Program (VCMP) projects in Western Port and Corner Inlet and Open Coast and Port Phillip Bay; four pilot local coastal hazard assessments (LCHA) at Port Fairy, Western Port, Bellarine Peninsula/ Corio Bay, and Gippsland Lakes/90 Mile Beach
- Committees of Management (CoM) Reform Program
- Future Foreshores Project
- Planning scheme amendments to establish three new Distinctive Area Landscapes – Bass Coast, Bellarine Peninsula, Surf Coast
- Inverloch erosion multi-agency working group
- Boating Coastal Action Plan (BCAPs) review and central coastal region's Recreational Boating Facilities Framework (RBFF).

1.8 Management arrangements

DELWP has overall responsibility for the management of Victoria's Crown land, including coastal reserves, often in partnership or by arrangement with other organisations, government agencies, local government or committees of management.

DELWP administers the delegation of management through legislation and other formal appointment processes. There are several state government departments, public authorities or agencies, boards or committees of management that provide on-ground public land management, and land is also used or managed through tenures such as leases, licences or permits. Public authorities include water authorities; various public bodies relating to transport (VicRoads, VicTrack, port authorities), education (schools), health (hospitals, community facilities), justice (police stations, courts) and emergency services. They use a mix of Crown land held under vested or other delegated arrangements or under licence or lease and may include freehold title land. Much of this land is operational, with purpose-built infrastructure or buildings.

More than three quarters of all public land is managed by either DELWP directly or by Parks Victoria. Parks Victoria manages some four million hectares of Crown land across the state comprising a range of parks and reserves including national and state parks, coastal (conservation) parks and a significant amount of Victoria's coastline including coastal reserves. Many high-profile public land areas across the state are managed by specialist entities such as Phillip Island Nature Parks and Zoos Victoria.

Government road reserves also make up a significant area of public land and are managed by VicRoads or local government but may be closed and licensed by DELWP for other purposes such as grazing.

Committees of management (CoMs)

Crown land reserves may also be managed by members of the public through formal appointment as a Committee of Management (CoMs). The role of such a committee is to manage, improve and maintain the reserve on behalf of the Minister for Energy, Environment and Climate Change. DELWP oversees more than 1500 Crown land reserves managed by around 1200 local committees of management across the state. Some of these are very small areas of Crown land, while others with significant assets require greater levels of governance and financial reporting. DELWP's 2019-2020 categorisation framework has four categories based on financial and non-financial criteria (e.g. category 1 CoMs have either cash or annual revenue exceeding \$1 million, or is Crown land of statewide significance or political interest).²

There are seven category 1 CoMs statewide. Four of these CoMs are responsible for coastal reserves located on the Bellarine Peninsula and parts of the Otway coastline. There are several other coastal reserve committees that are close to meeting financial thresholds for category 1, particularly those with camping and recreation facilities on the Mornington Peninsula. All CoMs managing coastal Crown land are included in category 2 (if not already in category 1) and make up 25 of 36 listed in that classification.²

There are a number of programs currently looking at the roles and responsibilities of CoMs, including those that manage coastal reserves in the Great Ocean Road Action Plan Reform and Future Foreshores in Western Port. DELWP's CoM Reform Program — established in response to VAGO's 2014 audit and 2018 follow up of the oversight and accountability of CoMs (see section 1.7) — focuses on strengthening governance by CoMs and increasing DELWP's support to CoMs.

Coastal CoMs were required to prepare a management plan under the former Coastal Management Act and similar provisions were carried into the new Marine and Coastal Act.

Local councils

Municipal councils also manage over 2800 Crown land reserves across the state as committees of management including many areas of coastal and foreshore reserves. Some local parks and reserves may also include freehold land owned by the local council. VEAC's assessment includes Crown land only.



2.1 Introduction

The land use category 'coastal reserve' has a specific meaning in the classification of public land use developed for Victoria. In VEAC's *Statewide Assessment of Public Land Investigation Final Report (2017)*, which reviewed public land classification, the coastal reserve category was recommended to be retained. Along the coast a range of other public land use categories are also utilised including national parks, coastal or conservation parks, nature reserves, and wildlife and state game reserves. Victoria's offshore waters are classified as coastal waters reserve. The extent of coastal reserve was estimated in VEAC's *Statewide Assessment of Public Land Investigation Discussion Paper (2016)* as some 21,390 hectares.

There are several key differences in approach in this assessment of coastal reserves, notably inclusion of Gippsland Lakes and Gippsland Lake Reserve and some community use reserves such as foreshore caravan parks, parklands and lighthouses. In addition, VEAC's 2016 estimate excludes any offshore portions of coastal reserves while, as a general principle in this assessment, coastal reserves are not split along the coastline or high water mark.

The terms of reference (box 1.1) note that a first step for the assessment is publication of a definition of coastal reserve including a diagrammatic representation and map of coastal reserves. This requirement is because the terms of reference provide only a general description of Crown land to be included or excluded from the definition.

Establishing a definition and map base of coastal reserves is a precursor to preparation of an inventory of values and uses and other technical analyses required for this assessment. VEAC has sought feedback and discussion with experts and key stakeholders including coastal reserve managers on some technical elements of the definition and welcomes any additional comments in response to this draft report.

Investigation reveals that the definition is a complex interplay of two main criteria: Crown land tenure or reservation purpose and government-accepted public land use recommendations. Geographic parameters are also of assistance where there is uncertainty in reservation or recommendations. However, for most locations the decision making is clear for at least one of the two main criteria.

This chapter outlines the decision-making process used to establish a definition of coastal reserves and has the following aims:

- to define coastal reserves using a combination of existing information including government-accepted recommendations of the Land Conservation Council (LCC), Environment Conservation Council (ECC) and VEAC, Crown land tenure or reservation purpose, and geographic location
- to seek feedback on a definition provided as both maps and written descriptions, and
- to clearly describe areas of public land not included, such as *National Parks Act 1975* parks or reserves, and those with other specified purposes such as wildlife and game reserves (state game reserves), historic reserves, nature reserves, commercial ports etc.

2.2 Coastal reserve public land use category

For more than 45 years the role of VEAC and its predecessors, the LCC and ECC, has been to draw together scientific and other research, consult with the community and make recommendations to the government on the protection and management of Victoria's public land. As described in section 1.6, coastal Crown land has been a part of many studies, reviews and investigations.

Uses of coastal reserves have changed over time, notably both the types and intensity of recreation activities, and are likely to continue to do so. The public land use category of coastal reserves today describes generally linear areas of public land (foreshores) adjacent to the open coast and the coastlines of bays, coastal lakes, inlets and estuaries. In townships coastal reserves often provide facilities for intensive visitor use and provide access to the sea.

The most recent purposes and objectives that are recommended to apply to most coastal reserves are described below. There may be exceptions for some specific reserves and in special circumstances. These broad purposes may be modified or expressed differently in new land legislation. Note that 'coastal Crown land' as defined in the *Marine and Coastal Act 2018* includes but is not the same as coastal reserve for the purposes of this assessment (see section 2.3).

Purposes and objectives of coastal reserves

- To provide opportunities for informal recreation associated with enjoyment of the coastal environment
- To protect natural coastal landscapes, ecosystems and cultural features
- To protect the rights and interests of Traditional Owners, native title holders and Aboriginal Victorians, and their cultural values
- To provide for facilities consistent with the conservation of natural and cultural values.

In the past, public land use recommendations for this category may also have listed suitable uses, inappropriate uses, included policies that explained or interpreted the basic purposes, and any principles and/or guidelines for detailed management planning or site-specific uses.

The ECC's *Marine, Coastal and Estuarine Investigation Final Report* (2000) broadly classified coastal reserves into coastal recreation and coastal protection zones, with the zoning recommended to be incorporated in the Victorian Coastal Strategy in accordance with government policy at the time. This work was not carried out as the Victorian Coastal Strategy subsequently focused at a more strategic role. The recommended zoning is not included in this assessment and has not been established as a management tool.

COMMENTS INVITED

Do the purposes and objectives for coastal reserves appropriately reflect current and future values and uses?

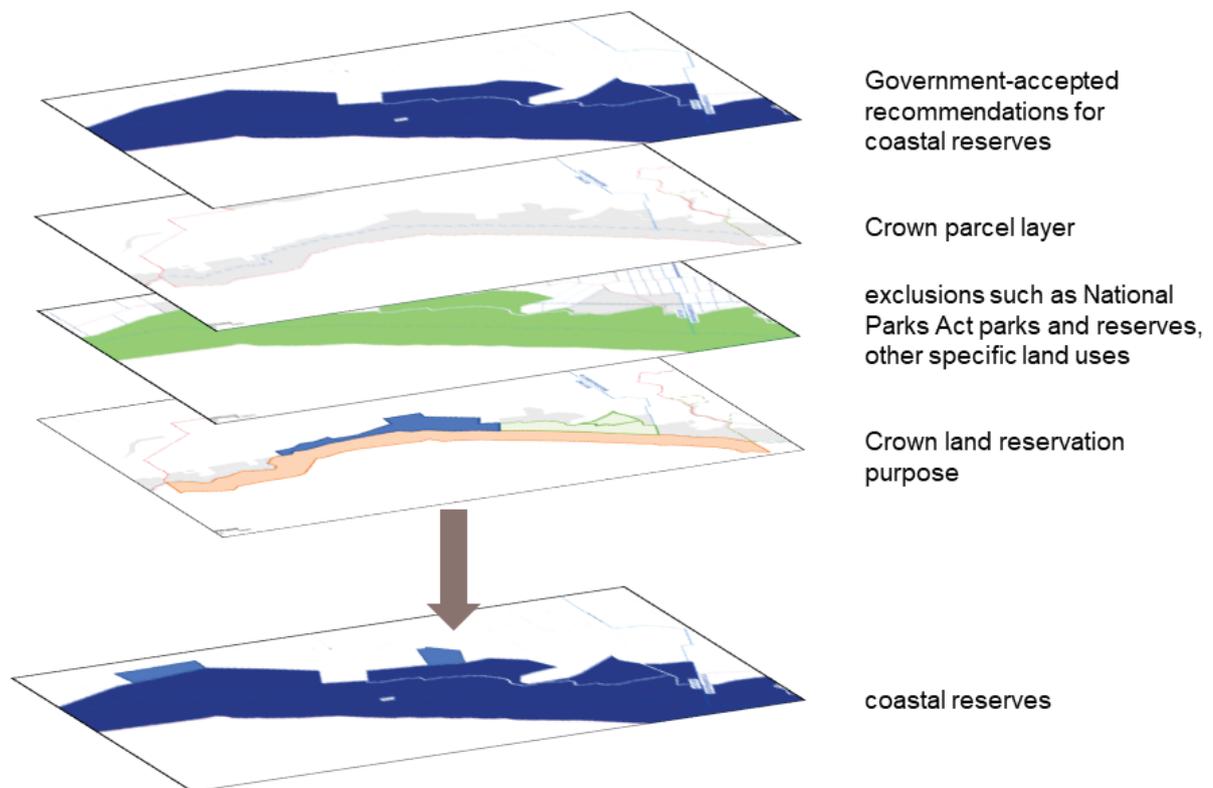
2.3 Approach and decision-making criteria

For most Crown land along the coast decision making as to whether an area is coastal reserve or not is clear and supported by multiple criteria. For other areas there are complex relationships between the criteria and, in some instances, a lack of detail to support decision making. The information provided below outlines VEAC's considerations. A visual representation of the criteria is shown in figure 2.1.

The three main criteria used to develop a technical description of coastal reserves are:

- a. current government-accepted public land use recommendations of the LCC, ECC and VEAC
- b. Crown land reservation purpose
- c. geographic location and proximity to the coastline (where a. and b. do not apply).

Figure 2.1 Information sources used to define Victoria's coastal reserves



Public land use recommendations

Government-accepted LCC/ECC/VEAC recommendations provide the framework for public land use in Victoria including coastal reserves. More than 12 public land use studies from 1973 to 2011 include recommendations for coastal reserves (see figure 1.1). Unless government makes a subsequent formal decision to change or vary the use of public land, the most recent government-accepted public land use recommendation remains the accepted definition of use and purpose. In many instances, a government-accepted LCC/ECC/VEAC coastal reserve recommendation overlays a pre-existing Crown land reservation purpose. In many cases, the recommendation more narrowly specifies a pre-existing broad reservation purpose, notably that for 'public purposes'.

For several older LCC studies, particularly those in the 1970s and early 1980s, detailed mapping of public land use was not published. This is the case for several LCC studies along the coastline (e.g. Corangamite, South Gippsland, East Gippsland, South West District 1 and 2) and some interpretation has been required to apply these recommendations to current Crown land parcels. Additionally, the LCC did not systematically identify small areas of public land, such as recreation areas or services and utilities areas. Recent reporting has included more detailed parcel-based mapping of public land use. This information is available for the coastal areas of VEAC's Metropolitan Melbourne Investigation (2011) and Angahook-Otway Investigation (2004) (see figure 2.2) and has been utilised in this assessment.

Across the state there are some relatively small areas with no government-accepted recommendations. Examples include public land in designated cities, towns or boroughs excluded from LCC studies (i.e. Portland, Port Fairy, Warrnambool, Queenscliffe). This is also the case for Crown land acquired (or identified as Crown land) after the most recent study or investigation was completed. An example relevant to the coast is the ten lighthouse reserves transferred from the Commonwealth to Victoria in 1995. Two of these areas at Cape Otway and Split Point (Aireys Inlet) are subject to government-accepted recommendations from the Angahook-Otway Investigation (2004) for national park and coastal reserve respectively. The remaining eight lighthouse areas have no public land use recommendation. When transferred to the state these areas were deemed reserved for 'tourism and public purposes'. A discussion related to Crown land reservation purpose is provided below. VEAC has included those remaining lighthouse reserves within the definition of coastal reserve.

Figure 2.2 Extract of VEAC's Angahook-Otway Investigation (2005) recommendations for the Wye River area showing coastal reserve (F1) in dark blue and national park in green



The LCC's *Gippsland Lakes Hinterland Final Recommendations* (1983) established the Gippsland Lakes Reserve as a public land use category in addition to coastal reserve retained on the open ocean coastline. At the time the lake beds and water were excluded from the LCC's study. The LCC's approach focused on integrated management of public land with proposed zoning directing location-specific management objectives. Although these recommendations were accepted by government, subsequent reservation of Crown land in some places across parts of Gippsland Lakes Reserve has imposed more specific land uses. Noting the exception of areas specifically allocated to other uses such as wildlife and game reserves (state game reserve), VEAC considers the remaining parts of Gippsland Lakes Reserve (largely reserved for 'public purposes') to be a foreshore reserve equivalent to coastal reserve.

Much of the Gippsland Lakes is shallow and large areas are intertidal or seasonally inundated. For the purposes of this assessment Gippsland Lakes Reserve and contiguous reserved lake beds are classified together as coastal reserve. The Gippsland Lakes water bodies and lake beds comprise approximately 35,245 hectares: Lake Wellington (14,085 hectares), Lake King (13,015 hectares) and Lake Victoria (8145 hectares). The proposed approach is to include all reserved parts of the Gippsland Lakes, retaining both onshore parts previously recommended as Gippsland Lakes Reserve (with exceptions outlined above) and lake bed as a whole reserve. This follows the general principle applied here to retain the entire Crown reserve when there are portions both onshore and offshore.

In eastern parts of the state the beds of several large inlets are reserved together with the onshore parks (e.g. Sydenham Inlet is within Cape Conran Coastal Park, Tamboon Inlet and Wingan Inlet are within Croajingolong National Park). The exceptions are the beds of Mallacoota Inlet and Lake Tyers that are generally reserved separately to the onshore Crown land. Most Crown land onshore at Mallacoota Inlet is national park, including most of the intertidal zone and islands, and reserved onshore of low water mark. At Lake Tyers State Park the alignment of Crown parcels with the shoreline is less precise but reservation is intended to be inland from high water mark. The inlets and water bodies are here defined as coastal waters reserve and not coastal reserve. The approach is summarised here for major coastal inlets and water bodies (and underlying land):

- Port Phillip Bay and Western Port are coastal waters reserve (with some relatively minor exceptions)
- Shallow Inlet, Corner Inlet and Nooramunga marine and coastal parks areas – although not all formally reserved – are considered as equivalent to conservation parks under the National Parks Act
- Sydenham Inlet is within Cape Conran Coastal Park (under the National Parks Act)
- Tamboon (590 hectares) and Wingan Inlets (150 hectares) are within Croajingolong National Park
- Mallacoota Inlet (2740 hectares) and Lake Tyers (1160 hectares) are coastal waters reserve.

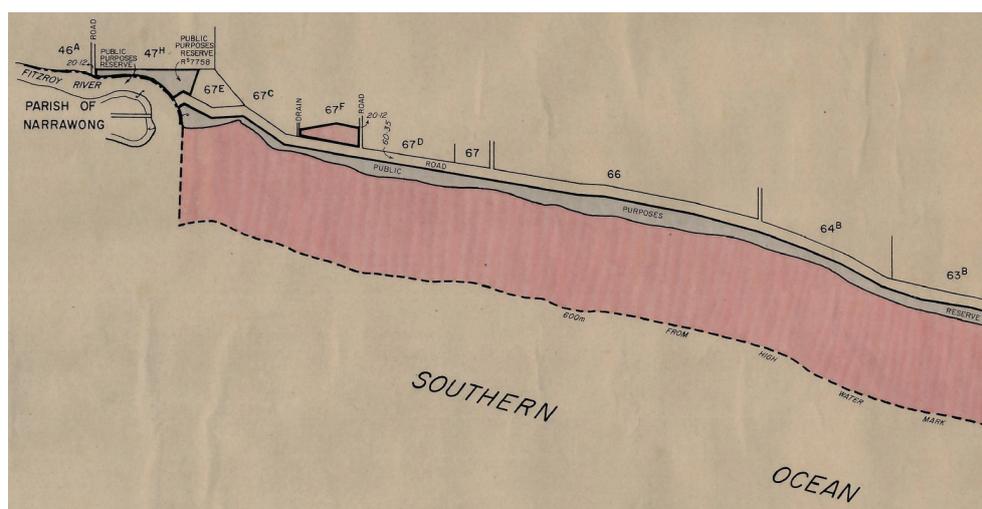
Crown reservation purpose

This assessment provides a listing of current reservation purposes for all Crown land defined as coastal reserve and highlights areas of unreserved Crown land (see chapter 3). Reservation purpose can also be used to identify areas of coastal reserve, particularly where no public land use recommendation applies or there is ambiguity.

The terms of reference specify reservation purposes not included in coastal reserves as 'any Crown land described as a park or marine sanctuary in Schedule 2, 2B, 3, 4, 7 or 8 to the National Parks Act'. These parks and reserves abut a substantial proportion of Victoria's coastline (estimated at 70 per cent). The relevant individual parks and reserves in the coastal environment are listed in appendix 1 and include national parks, state parks, other parks (including some coastal parks and conservation parks), marine national parks and marine sanctuaries, marine reserve or marine parks, and marine and coastal parks.

The terms of reference specifically include areas reserved under section 4(1)(ze) of the Crown Land (Reserves) Act for 'the protection of the coastline' referring to a series of permanent Crown land reserves established in the 1980s. In several instances these permanent reserves extend offshore 600 metres from high water mark (see figure 2.3), while others such as those at Port Fairy and Griffith Island, Western Port and Torquay extend to low water mark. These reserves are identified in chapter 3 and listed at appendix 4. Some areas originally reserved were subsequently included in National Parks Act parks or reserves and are therefore not included as coastal reserve.

Figure 2.3 Extract of coastal protection reserve Central Plan Office map CPR 25 accompanying the permanent reservation of an area for the protection of the coastline (areas shaded pink and blue) published in the Government Gazette 20 March 1984 page 961



Specific reservation purpose may also be used as a criterion to exclude areas from consideration as coastal reserves. For example, state game reserves are typically reserved for 'the protection or management of wildlife' under the Crown Land (Reserves) Act and scheduled for hunting under the *Wildlife Act 1975*. There are 19 wildlife and game reserves in the coastal environment outlined for this assessment, mostly in Gippsland (see appendix 1). These areas are excluded from the definition of coastal reserve by the specific reservation purpose and in most cases also the criterion of earlier government-accepted public land use recommendations as wildlife and game reserves.

In addition, there are a range of other specific reservation purposes (and often a corresponding government-accepted public land use recommendation) that can be utilised to exclude areas from the definition of coastal reserve. Some of these are nature reserve, historic reserve, state forest, bushland reserve, regional park and water production reserve and are listed in appendix 1.

For locations with more generalised reservation purposes (e.g. public purposes) other criteria are required to determine if coastal reserve is the appropriate classification.

Geographic parameters

The terms of reference state that coastal reserves comprise Crown land adjoining and landward of low water mark (onshore), including contiguous bays, estuaries and inlets and the Gippsland Lakes. Based on this definition unreserved Crown land from low water mark to the outer limit of Victoria's coastal waters (mostly 3 nautical miles), often described as the seabed or offshore, is excluded from the definition. The waters of Mallacoota Inlet and Lake Tyers are considered to be seabed.

The inland extent of coastal reserves is not defined in the terms of reference creating some initial ambiguity. As outlined above VEAC's approach for this assessment is to provide clarity through publication of the technical written description of coastal reserves provided here and online maps.

In developing a series of criteria for the assessment, other government definitions of coastal land were examined. The *Marine and Coastal Act 2018* provides a geographic definition of both 'marine and coastal Crown land' and the 'marine and coastal environment' for the purposes of the Act as follows:

- the marine and coastal environment extends 5 kilometres inland from the coastline
- marine and coastal Crown land is defined as between the outer limit of Victorian coastal waters and 200 metres inland of the high-water mark of the sea, and to a depth of 200 metres.

Exemptions to these criteria may be gazetted under the Marine and Coastal Act. VEAC's mapping shows that coastal reserves do not extend more than 5 kilometres inland from the coastline (including coastlines of the Gippsland Lakes and inlets and estuaries) but there are many instances where contiguous Crown land extends more than approximately 200 metres inland. As these geographic definitions do not add meaningfully to the criteria outlined above and largely apply to planning and coastal consent processes they have not been adopted in this assessment.

In estuaries, individual Crown reserves or parcels may extend contiguously some distance upstream and beyond the environmental influence of the sea. In some locations, stream bed (and lake bed) reserves may include intertidal or onshore areas. The geographic complexity of these areas necessitates decisions on a case-by-case basis, and these are reflected on the mapping accompanying this draft report. If required, a restriction of no more than 5 kilometres inland from the sea has been applied in coastal rivers and estuaries.

Summary of coastal reserve geographic parameters

Using the information outlined above, coastal reserves can be broadly defined within the following geographic parameters:

- (a) onshore coastal Crown land including the foreshore of bays, inlets and estuaries (e.g. Gippsland Lakes, Western Port, Port Phillip Bay)
- (b) coastal Crown land that is part of a single Crown land reserve (includes reserves consisting of both onshore and offshore parts)
- (c) excludes offshore unreserved Crown land below low water mark.

Note: a general guideline of no more than 5 kilometres from the coastline will be applied where contiguous Crown land extends significantly inland. Maps prepared by VEAC for this assessment will provide the definitive answer where there is some ambiguity.

Other issues

A number of Crown land coastal or foreshore community use areas are included in the definition. These individual cases (e.g. many lighthouse reserves) were examined in detail. Examples of included uses are:

- coastal camping and caravan parks
- parklands and gardens, passive recreation open space areas
- some tourism or active recreation areas, museums, lighthouses, kiosks
- publicly accessible coastal infrastructure such as piers and jetties, boat ramps.

Coastal reserve definition

Given the technical nature of the definition and the range of stakeholder interest, a descriptive definition is provided here in box 2.1 for discussion. VEAC's maps of coastal Crown land are also available online showing coastal reserves, and an interactive map is available to allow detailed examination of reserves in townships and estuaries (see www.veac.vic.gov.au).

There are three main criteria used to define coastal reserve for the purposes of this assessment:

- a. government-accepted public land use recommendations for coastal reserve or equivalent category
- b. appropriate Crown land reservation purposes, and
- c. geographic location and proximity to the coastline, where a) and b) do not apply.

COMMENTS INVITED

Do you have any suggested changes to or comments on VEAC's technical definition of coastal reserves?

Do you have any suggested changes to or comments on VEAC's maps of coastal reserves?

Box 2.1 Technical definition of coastal reserve

Coastal reserve is Crown land along Victoria's coast (including bays, inlets and estuaries, and the Gippsland Lakes), comprising:

- areas subject to government-accepted LCC/ECC/VEAC coastal reserve recommendations
- areas reserved for protection of the coastline
- areas reserved more generally for public or similar purposes, contiguous with the coastline (exclusions specified below)
- coastal Crown land that is contiguous with the coastline (and coastal lakes) and is part of a single Crown land reserve. This includes the Crown land in both onshore and offshore parts of the reserve (exclusions specified below)
- onshore unreserved Crown land contiguous with and within 5 kilometres of the coastline
- some reserves for community use located on the foreshore, such as coastal camping and caravan parks, open space, parklands and gardens, and some public buildings
- publicly accessible coastal infrastructure such as lighthouses, pier and jetties, and
- in estuaries, Crown land contiguous with and within 5 kilometres of the coastline.

For clarity, coastal reserve does not include:

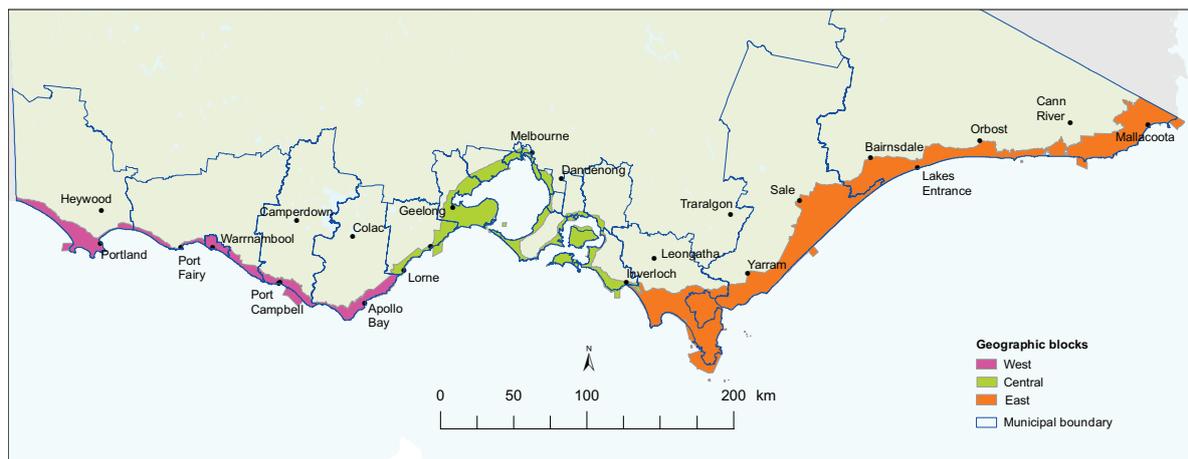
- freehold land owned by local government, public authorities or private owners
- Commonwealth land
- Aboriginal title land under the *Traditional Owner Settlement Act 2010*
- the seabed or a lake bed (i.e. Mallacoota Inlet, Port Phillip Bay, Western Port) except where a single reserve includes significant onshore areas (i.e. Gippsland Lakes, various protection of the coastline reserves)
- a park, reserve or marine sanctuary under the *National Parks Act 1975*
- land reserved under the *Crown Land (Reserves) Act 1978*, or subject to government-accepted LCC/ECC/VEAC recommendations, for certain other specific purposes including:
 - state game reserve or wildlife reserve (hunting permitted), lake reserve
 - nature reserve, nature conservation reserve or flora and fauna reserve
 - state forest or softwood plantations
 - historic reserve
 - water production reserve
 - public land water frontage, stream beds or banks
 - bushland reserve, streamside reserve, natural or scenic features reserves
 - regional park, metropolitan park, forest park
 - utilities or government services, earth resources, commercial ports and coastal infrastructure (with restricted access), roads and railways.

2.4 Mapping and documentation approach

The terms of reference for this assessment did not include a map of the assessment area boundary but instead provided descriptive guidance of areas for inclusion and exclusion. In order to translate this description into a map of coastal reserves, as a starting point, Crown land in a broad zone of the coastal environment was selected based on boundaries on the inland or onshore side aligning with major features such as main highways and roads or Crown land reserve boundaries, and, on the seaward side, low water mark of the coastline (with some exceptions). The boundary shown has no formal status but provides an envelope containing the onshore extent of coastal reserves. This approach allows analysis of coastal reserves within a broader dataset of all Crown land along the coast. The area includes parks and reserves that extend offshore, and major islands. As a principle Crown reserves have generally not been split by the assessment area boundary (large national parks and conservation reserves that extend inland excepted).

Mapping is depicted in three geographic blocks (i.e. West, Central and East) separated along Local Government Area (LGA) boundaries. The LGAs for each block and approximate outline of the assessment area boundary are shown in figure 2.4.

Figure 2.4 Diagrammatic representation of the three geographic blocks utilised for mapping coastal reserves and the inland limit of the assessment area



Offshore and near shore islands are within scope of the geographic extent of coastal reserves. With the exception of French and Phillip Island, most islands are small and uninhabited. Major navigational features, some staffed, are located on several islands (e.g. Gabo Island, Griffith Island). In Victorian waters most islands are protected in national parks or conservation reserves and therefore do not meet the criteria for coastal reserves. A list of major islands and island groups along Victoria's coast is provided at appendix 3 together with their public land use classification.

2.5 The coast and the cadastre

This section summarises a brief review of the implications of the changing coastline for coastal Crown land boundaries (the cadastre) including the predicted impacts of climate change prepared by The Public Land Consultancy. The full report is available on VEAC's website at <http://www.veac.vic.gov.au/investigation/assessment-coastal-reserves/resources>.

The description of any parcel of land requires, at some point, a definition of its boundaries regardless of whether it is Crown or freehold land. In Victoria the *Surveying Act 2004* specifies that administration of land boundary definitions (the cadastre) is performed by cadastral surveyors under the authority of the Surveyor-General.

For freehold land, parcel boundaries define the spatial limits of interests held by private landowners, tenants, mortgagees etc. For Crown land (including Crown reserves, national parks, and reserved forest) boundaries may define the spatial extent of the relevant governance regime – for instance, the extent of the jurisdiction of a committee of management or the applicability of regulations made under the Crown Land (Reserves) Act.

Most cadastral boundaries are geometrically well-defined. They may be fixed in position and described in terms of lengths and bearings. Other boundaries may be defined by reference to topographic features, such as high water mark (HWM), low water mark (LWM) of the sea or the edge of a waterway. These topographic boundaries may move and are described as 'ambulatory' literally meaning 'capable of walking'. Although such topographic features are used in various Acts and regulations, they do not have statutory definitions.

As topographic features move, ambulatory boundaries may correspondingly move in response under the common law 'doctrine of accretion and diluvion'. A doctrine is a body of common law built through successive judgements of the courts. In general, the common law cannot nullify or contradict statutory laws such as those established by Acts of parliament.

Accretion is where land size has increased due to an accumulation of sediment, while diluvion is more often referred to as erosion and reflects the case where land is lost to the sea (or water more generally). The doctrine is well established internationally but has resulted in very little Australian case law. As a result, the Surveyor-Generals' rulings are generally accepted as being *de facto* expressions of the common law (see also CNR 1993).¹

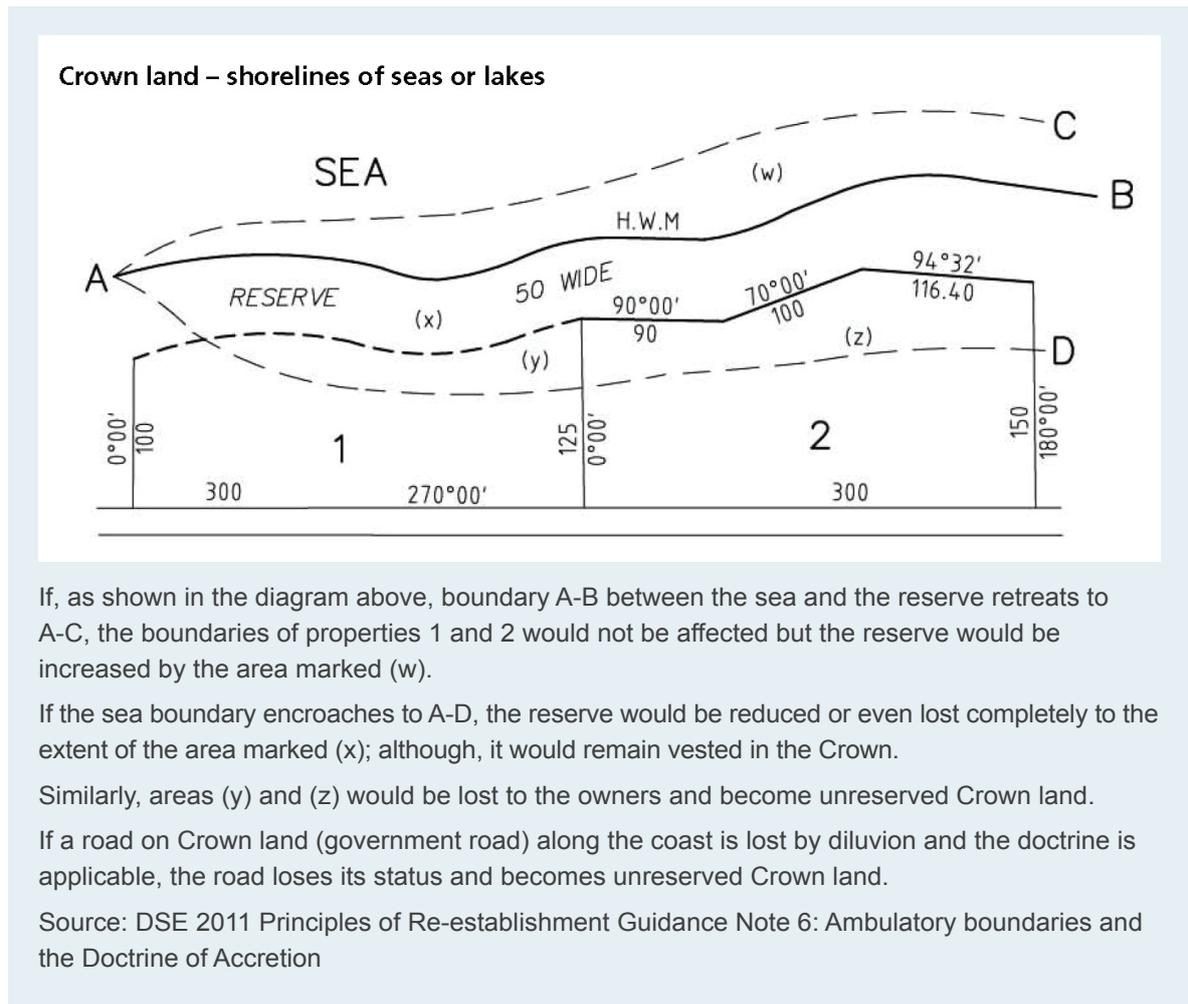
The spatial extent of most coastal reserves in Victoria are defined, in part at least, by topographic ambulatory cadastral boundaries – most commonly mean HWM, wherever it may be from time to time. Other ambulatory boundaries may be designated as LWM, or some given distance from HWM, or by some geographic description such as 'Shore of Port Phillip Bay' or 'on the shore of Bass Strait and the Southern Ocean'.

Effects of ambulatory boundaries on Crown land reserves

Movement of coastal topographic features may be in either direction: landward as a result of erosion or seaward from accretion. Change may be 'gradual and imperceptible' or rapid, even catastrophic. It may be caused by natural forces or by human intervention. The doctrine as it has evolved responds to these parameters in different ways: in some circumstances the relevant ambulatory boundary is deemed to have moved, in others it is deemed to remain unchanged.

The impact of the doctrine can be dramatic and may result in effects unanticipated by the legislators and policy makers who originally defined the reserve. In some cases, the width of a reserve may be increased; in others it may be narrowed – and, in the extreme, it may be lost completely. Box 2.2 reproduces a diagram summarising how the doctrine applies to shorelines provided by the Surveyor-General in a guidance note for surveyors.²

Box 2.2 The Doctrine of Accretion applied to shorelines. Source: DSE 2011²



There are exceptions and subtleties that lead to significantly different outcomes for reserves of similar on-ground nature. For example, it is held that some permanent reserve boundaries change in concert with the relational ambulatory boundary. However, if the landward boundary of a permanent reserve is defined as being a fixed distance from a topographic boundary – say 200 metres from HWM – that landward boundary is fixed at the time of reservation and does not move in response to changes in the seaward ambulatory boundary.

There are further subtleties: the Surveyor-General may deem that a 'metes and bounds' boundary was originally intended to be, and therefore is, an ambulatory boundary. A band of unreserved Crown land between a landward ambulatory boundary and nearby freehold boundary may be deemed to be within the permanent reserve.

Insofar as ambulatory boundaries are an ongoing source of much confusion, responses have been few, ad hoc and reactive. To the best of our knowledge, no relevant case has come before the Victorian courts. The Surveyor-General has made rulings in several cases, notably the relatively recent Point King case of 2009, where the freehold land is defined by the ambulatory boundary shown on the original 1871 Crown Grant as 'the margin of Port Phillip'. These rulings have been untested in the courts. In the past, Parliament resolved one set of problems regarding coastal accretion by enacting the *Chelsea Land Act 1981*. This Act provided clarity that movement of the shoreline creating additions of land served to only widen the Crown land reserve. The freehold land abutting the reserve was

unchanged in this case the freehold land does not directly abut the ambulatory boundary (HWM). There has been no attempt at State-wide statutory response – akin to the 1881 decision to reserve the State's riparian Crown lands, or the 1905 decision to rescind centre-of-the-waterway freehold boundaries. In 1995 the *Local Government Act 1989* was amended to cause the boundaries of coastal municipalities to move seaward from HWM to LWM, but no parallel change was made to coastal Crown reserves.

Box 2.3 Principles of shoreline law

The term 'shoreline law' has been adopted to encapsulate those elements of the doctrine which deal with boundaries formed by tidal waters, especially the sea. Nine key principles of property law relevant to lands bounded by tidal waters have been proposed by John Corkill in the 2012 paper *Principles and Problems of Shoreline Law*:³

1. The legal boundary between tidal waters and adjacent land is the High Water Mark (except where the sea boundary is otherwise defined).
2. Where land is bounded by water, the legal boundary of the land changes to reflect changes in the position of the water's edge, but only if certain conditions are met.
3. To be recognised in law, changes in a water boundary must be 'gradual' and 'natural'.
4. The doctrine of accretion, includes gradual changes brought about by erosion, and by the advance or retreat of water.
5. New land formed by accretion belongs to the adjoining owner (whether Crown or freehold).
6. Land below high water mark (or other sea boundary) belongs to the Crown.
7. Land 'lost' to the sea, below high water mark (or other sea boundary) by gradual erosion or diluvion, cease to be real property and reverts to the Crown.
8. Ambulatory boundaries supplant and rescind surveyed boundaries.
9. No compensation is payable for either gradual loss or gain of land.

A related issue is the mechanism by which boundaries of Crown reserves are set and by which they may be altered. In general, the Crown Land (Reserves) Act provides for a 'temporary' reserve to be altered by administrative action whereas a 'permanent' reserve may be altered only by a new, purpose specific Act of Parliament (many coastal reserves are 'permanent'). Although a permanent reserve can be abolished only by Parliament, its gazetted purpose may be narrowed (not broadened) by administrative action. Therefore, Crown land permanently reserved for public purposes – encompassing large areas of coastal reserves – may by formal administrative action be declared to be for a specific purposes such as a road reserve or a nature reserve.

Ambulatory cadastral boundaries (whether associated with coastlines or with rivers and lakes) will become increasingly problematic. It has been predicted that climate change will result in sea level rises of 0.8 metres by 2100, with an increased likelihood of storm surges and movements of coastal sediments. Problems would arise even without climate change: population increase, usage patterns, and capital investment will all intensify. More engineering interventions can be expected such as beach renourishments and coastal infrastructure such as jetties and breakwaters.

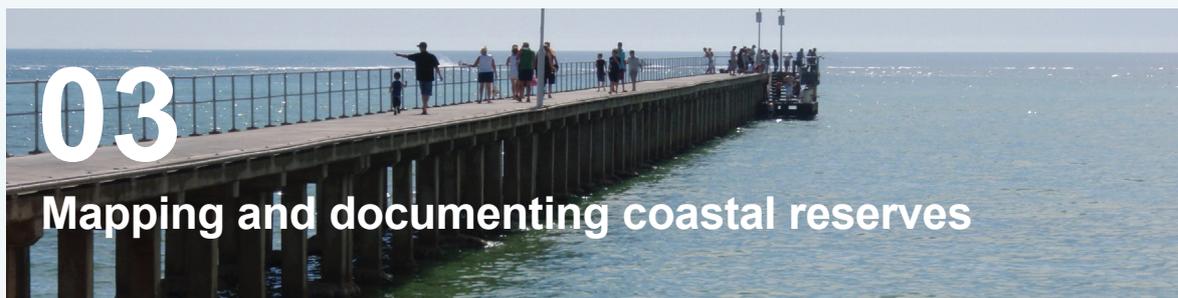
Loss of public land is undesirable, but loss of private freehold land is more likely to trigger legal action. This environment of uncertainty may well foment disputes and challenge accepted views of ambulatory

boundaries and established interpretations of the doctrine of accretion. Policy matters, which should be the prerogative of parliaments, may be tested and settled in the courts. Simultaneously, society's view of the coast is certain to evolve. Independently of climate change, coastal usage will intensify putting increasing pressure on cadastral boundaries. On the inland side of Crown reserves the Crown-freehold boundary will welcome or resist permeability on a case-by-case basis leading to confusion and ambiguity. On the seaward side the boundary between reserved and unreserved Crown land will become increasingly meaningless – as has already been acknowledged by the seaward extension of many planning schemes.

COMMENTS INVITED

How can we best prepare for changes to the cadastral boundaries of coastal Crown land resulting from the effects of climate change?

What is the best way to provide clarity and certainty for land owners and managers along the coastline?



3.1 Introduction

The decision-making criteria for identification of coastal reserves for the purposes of this assessment are described in chapter 2. This chapter addresses that part of the terms of reference that requires VEAC to review the numbers and types (reservation status) of coastal reserves in Victoria. Coastal reserves are considered in the context of the broader coastline and the technical challenges associated with Crown land information are discussed. A broad-scale analysis of management arrangements for coastal reserves is also provided.

In summary, some 63,140 hectares of coastal reserve have been identified including 22,570 hectares along the open coast and major bays and inlets, and 40,570 hectares within the Gippsland Lakes (largely known as the Gippsland Lakes Reserve) (see figure 3.1). More than 70 per cent of this area is reserved broadly for ‘public purposes’.

Results are summarised here for local government areas (LGAs) and available online in VEAC’s inventory and interactive maps at www.veac.vic.gov.au. The online information includes detailed Crown parcel-based information including reservation type and reservation purpose together with coastal reserve name (or land unit), area (hectares) and appointed Crown land manager. Information is also available on VEAC’s website in summary form as fact sheets and coastal reserve maps for each LGA. Current information on management arrangements for coastal reserves is complex and incomplete for many locations across the state. Several areas are currently under consideration for changes in land use or management arrangements (e.g. Great Ocean Road management reform, Bass Coast coastal Crown land reforms, Future Coasts program).

Figure 3.1 Victoria’s coastal reserves



3.2 Extent of coastal reserves

Around 230 coastal reserve land units have been identified for the purposes of this assessment using the criteria described in chapter 2. Land units consist of areas of Crown land grouped because of similar reservation purpose, on-ground land use or geographic location. In some instances, coastal infrastructure or specific uses such as piers and jetties are reported as a separate land unit to the adjoining coastal reserve. In other cases, a wide range of uses occur across a broad land unit. For example, the Anglesea Coastal Reserve contains a river estuary, surf lifesaving club, caravan park, parklands including a sculpture garden and playground, memorials, car parking and visitor facilities such as a visitor centre, walking paths, picnic facilities and toilet blocks. The variability in delineating land units is largely inherited from the diverse range of underlying Crown land reservations, types of uses, Crown parcel boundaries, and various leases and licences (tenures).

Areas of 160 hectares at Marlo (Corringale Coastal Reserve) and 250 hectares at Raymond Island are coastal reserves comprising Aboriginal Title land.

Mapping of public land use in this assessment is depicted in three geographic blocks (west, central and east) separated along LGA boundaries. The LGAs for each block and outline of the assessment area boundary are shown at figure 2.4.

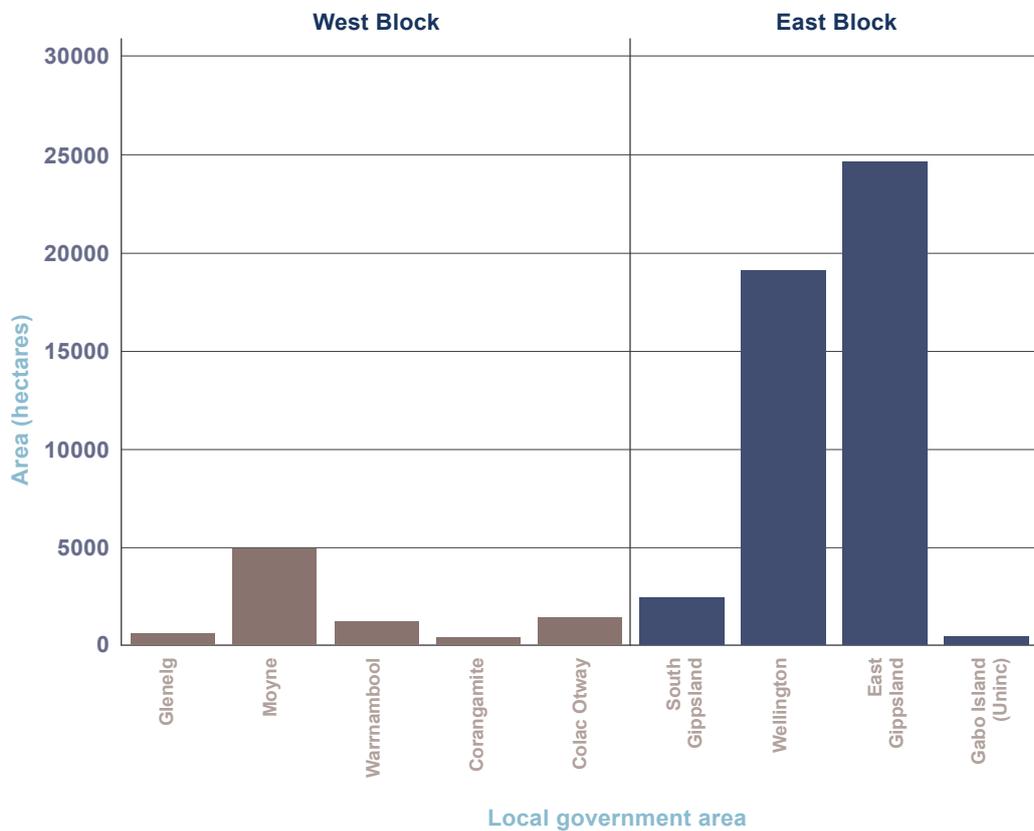
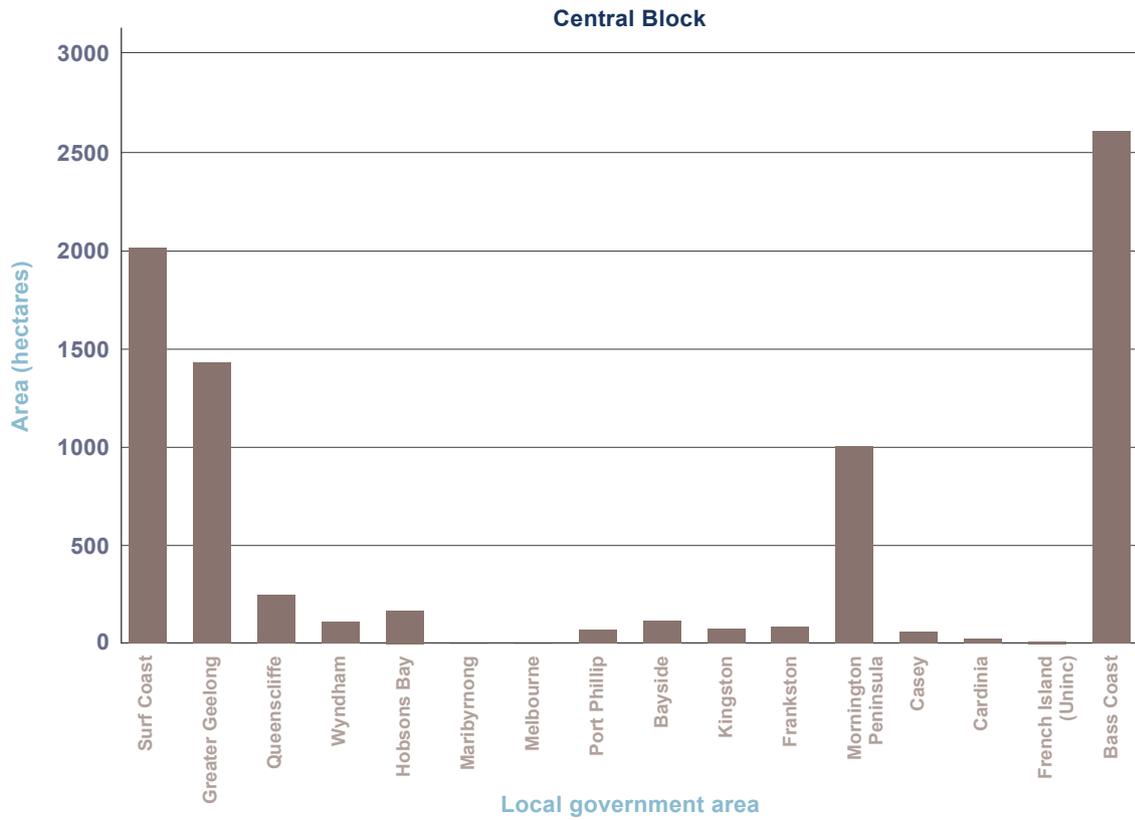
In delineating the boundary of the geographic blocks, accessibility of Melbourne's population was a key consideration given the influx of seasonal visitors to the coast from the city. The central block is a proxy for areas within about a two-hour drive from Melbourne, with a minor modification to align with the nearest LGA boundary.

The area of coastal reserve within these blocks is similar for areas outside the Gippsland Lakes. The central block has some 8025 hectares, and the west block 8465 hectares. In the east block some 40,565 hectares is Gippsland Lakes Reserve with the remaining 8280 hectares largely on the open coast. The largest number of land units occurs in the central block (125 land units). Fragmentation occurs less in the west block with 26 land units. The 71 land units in the east block are on average much larger than elsewhere across the state due to the inclusion of the lake beds for Lake Wellington, Lake King and Lake Victoria.

The extent of coastal reserve and coastal Crown land in LGAs varies considerably across the state (figure 3.2). Of note is the 10-fold difference in scale between the central and the combined east and west areas in figure 3.2. Unsurprisingly larger LGAs and those outside the metropolitan area have more extensive areas of coastal reserve, but proportionately some smaller municipalities have more coastal reserve along the shoreline than other areas. This variation is also related to the extent of national and conservation parks along the coastline, most of which are outside the metropolitan area.

At a broad level, coastal reserves are concentrated around population centres and townships and, although not as extensive in the central block compared to the east and west blocks, generally comprise a larger percentage of frontage to the coastline in highly populated areas (see table 3.1).

Figure 3.2 Coastal reserve area (hectares) for coastal municipalities



Defining the length of the coastline

The contribution of coastal reserves to Victoria's coastline, in percentage terms, was investigated for this assessment. In theory this is a simple calculation of the intersection of Crown land parcels defined as coastal reserve with 'the coastline'. In practice this is significantly more complex, mostly due to the difficulties in obtaining a rigorous definition of what constitutes the boundary between land and sea — the coastline — and also the imprecision of Crown land mapping along the coast. For example, high and low water marks and many features are dynamic and subject to seasonal movements and longer-term erosion or accretion (see section 2.5). In addition, the seabed adjoining the coast is not typically mapped as Crown parcels — although in most cases this is unreserved Crown land — adding to the potential for inaccuracies in calculations particularly using GIS mapping approaches.

The scale at which detail is captured also significantly alters the calculation of the length of the coastline. For example, detailed measurements that follow each shore platform, sand bar, coastal embayment and island will be longer than those drawn with less precise detail (e.g. with rounded or smoothed lines).

A measurement of the length of the coastline undertaken in the 1970s, prepared using 1-kilometre intercepts on 1:250 000 scale mapsheets, estimated the length to be about 1700 kilometres comprising over 1000 kilometres of open ocean coastline, 262 kilometres for Port Phillip Bay, 263 kilometres for Western Port and 150 kilometres for Corner Inlet.¹ Geoscience Australia reports the length of the Victorian coast calculated at 1:100 000 scale as 2515 kilometres including some 645 kilometres of the coastline of islands (GEODATA_Coast_100k_2004).

For this assessment the spatial dataset Vic_Coastline_2008 has been used as the approximation of the coastline. This dataset is based primarily on a zero metre (0 metre) contour dataset from the Vicmap Elevation Coastal Digital Elevation Map (DEM) and Contours product, derived using LIDAR remote sensing technology and reviewing this dataset against the most recent and highest resolution aerial photography available. Where LIDAR contours were absent or of poor quality, the coastline was digitised from recent aerial photography imagery.

This dataset has formed the basis for several recent mapping products for coastal values. Work undertaken by DELWP to edit the data — primarily to identify sand movement — has been adapted by VEAC to create a polyline representation of the nominal, persistent coastline at 0 metre and 0.5 metre Australian Height Datum (AHD) referenced contours and consistent with Vic_Coastline_2008.

Modifications were required to produce an integrated and continuous coastline. Manual editing was required where offshore islands were missing from the dataset and where smaller rocks stacks were joined as mainland peninsulas. In the west of the state the zero contour was largely incomplete, and 0.5 metre contour was used. These contour intervals are referenced to the AHD maintained by Geoscience Australia. Where no LIDAR and photography was available, linework at alternative scales was used (including for internal state boundaries).

For completeness, this assessment also requires the inclusion of a coastline (or shoreline) for the Gippsland Lakes which are not included in the Vic_Coastline_2008 data. The coastline within the Gippsland Lakes was prepared by adapting information provided by Gippsland Ports. The data provided by Gippsland Ports were prepared using various high-resolution aerial imagery datasets and manually digitised to approximate mean water mark. This information has been integrated with the ocean shoreline mapping to create a single dataset (figure 3.3).

Calculations of the length of the coastline presented here in table 3.1 are based on the dataset developed by VEAC based on the two resources described above. Some key calculations are as follows:

- length of the open (ocean) coastline (including major bays and inlets): 2565 kilometres
- length of the coastline within Gippsland Lakes: 490 kilometres
- length of the coastline for offshore islands: 715 kilometres

Aerial photos along the coast show that in some places the Crown land boundary is now located inland and sand accretion has formed new onshore areas. The extent of this 'unparcellised' Crown land (formerly seabed) onshore will be examined for the final report as time permits. The implications for coastal reserves and land tenure boundaries of the movement of the coastline through accretion and erosion is discussed in section 2.5.

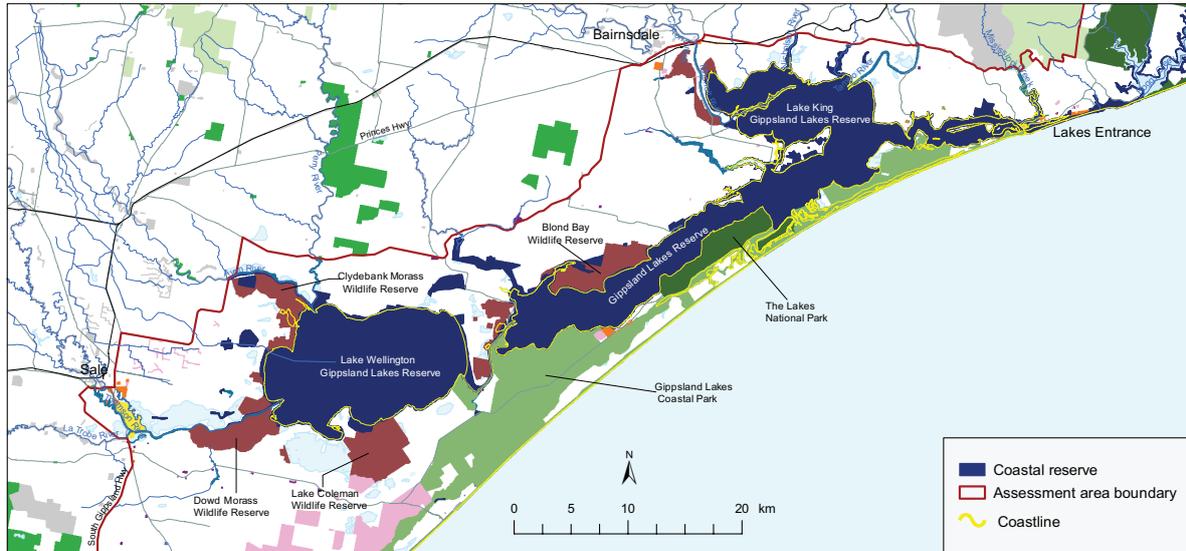
Table 3.1 Key statistics for coastal reserves in each local government area (including adjoining unincorporated areas)

Local government area (LGA)	Coastal reserve area (hectares) ¹	Length of coastline (kilometres) ²	Length of coastal reserve frontage to coastline (kilometres) and percentage (%) ²
Glenelg	575	166	42 [25]
Moyne	4912	127	90 [71]
Warrnambool	1198	26	25 [97]
Corangamite	371	80	10 [13]
Colac Otway	1409	128	55 [43]
Surf Coast	2017	73	55 [76]
Greater Geelong	1431	163	89 [55]
Queenscliffe	246	18	11 [61]
Wyndham	111	26	16 [61]
Hobsons Bay	168	29	19 [67]
Maribrynong	-	-	-
Melbourne	-	33	-
Port Phillip	70	14	11 [79]
Bayside	115	19	16 [87]
Kingston	76	14	13 [89]
Frankston	85	9.6	9.5 [100]
Mornington Peninsula	1004	239	85 [35]
Casey	58	62	2.2 [4]
Cardinia	23	21	0.7 [3]
French Island	10	89	1.3 [2]
Bass Coast	2612	264	104 [39]
South Gippsland	2410	256	56 [11]
Wellington	19,062	251	38 [15]
East Gippsland ¹	24,596	402	39 [10]
Gabo Island	158	8.6	8.6 [100]
TOTAL	62,726	2790	800 [29]

¹ excluding coastal reserves in Aboriginal title comprising 410 hectares in East Gippsland LGA

² coastline includes major islands such as Phillip and French islands and Gabo Island and excludes Gippsland Lakes shoreline

Figure 3.3 Extract of coastal reserves dataset showing the coastline in the Gippsland Lakes



3.3 Review of Crown land reservation status and types

The terms of reference for this assessment ask VEAC to review the number and extent of coastal reserves as well as their Crown land reserve types (reservation status). Reservation status is interpreted as reserve type – permanent, temporary, unreserved – and reserve purpose such as public purposes, protection of the coastline, public recreation and so on.

Reservation information was compiled using data provided by Land Use Victoria (January 2019) and correlated with DELWP's online titles for Crown land (VOTS), other Crown land records and government gazettes.

The results of the review show that the majority of coastal reserves are set aside ('reserved') from sale either temporarily or permanently for public purposes, but that areas of unreserved Crown land also occur along the coastline (table 3.2). Results are summarised below and provided for each local government area along the coast in a series of fact sheets available at www.veac.vic.gov.au.

The two main reservations for public purposes that apply were in the late nineteenth century. The first is a series of temporary reserves from sale by orders dated 11 August 1879 published in the government gazette 1879 p. 2045 – for Bass Strait and the Southern Ocean - Foreshore - lands depicted on a series of plans (A-J); identified as Rs 2362 on parish plans be reserved for public purposes. The second is a widespread permanent reserve from sale by orders 23 May 1881 for public purposes and published in the government gazette on 27 May 1881 p. 1389 for land generally described along rivers, lakes and inlets beds and inland to 150 links from the highwater mark (including islands). The beds of the Gippsland Lakes were permanently reserved for public purposes in 1881. An extract of these gazettes and a related Crown land plan are shown at figure 3.4.

The main exception to the broad use of 'public purposes' are reserves permanently set aside for 'protection of the coastline' in a series of orders in the 1980s and detailed in accompanying plans. An overview of the approximately 13,500 hectares of coastal protection reserve is provided at figure 3.5 with details in appendix 4. In many instances these reserves include both onshore and offshore areas; both parts are included in this assessment as coastal reserve following the principle established in chapter 2 to include parts of single reserves extending below low water mark or offshore. In some locations protection of the coastline reserves were subsequently incorporated into new national parks or conservation reserves (e.g. Port Campbell National Park, Great Otway National Park).

Coastal reserves are reserved for a range of purposes, a small number of which are obsolete or inconsistent with the current land use (i.e. watering and camping purposes, affording access to water, drainage, supply of gravel). A list of all reservation purposes is provided at appendix 2. An important finding is that there are also significant areas of unreserved Crown land along the coastline (table 3.2).

VEAC's *Statewide Assessment of Public Land Final Report* (2017) noted that the distinction between temporary and permanent Crown land reserves in Victorian legislation is not made in any other Australian jurisdiction and contributes to the inconsistencies and complexity of reserving and managing Crown land. The provisions that require amending legislation to revoke permanent reserves, but not temporary reserves, lead to arbitrary outcomes unrelated to significance of the values or the potential risks. Government accepted VEAC's recommendation that the distinction be removed with a parliamentary role retained but linked to specific public land use categories or individual reserves of high significance, including coastal reserves.

The review of reservation status and types reveals that, although marine and coastal environments have a high value to the community, the underlying legislative basis for use, management and development for public purposes is poorly defined or ambiguous. Public land reservation information is difficult to obtain and interrogate.

A range of land stewardship and management issues arise from the underlying legal inconsistencies. Application of regulations in particular are hindered by coastal Crown land being subject to different reserve purposes or, in some instances, remaining unreserved.

COMMENTS INVITED

Should all coastal reserves be reserved for specific purposes?

Figure 3.4 Historic public purposes reserves along Victoria's coastline

49. *Gippsland Lakes : Lake Wellington—and Maclennan's Straits.*—The bed of Lake Wellington and of Maclennan's Straits, and all lands, the property of the State, within a distance of one hundred and fifty links from the contour line of the winter level of the water in the said lake and straits.

49A. *Lake Victoria—Lake Bunga—Lake Reeve—Lake King—and Reeves River.*—The bed of Lake Victoria, of Lake Bunga, of Lake Reeve, of Lake King, and of Reeves River, and all lands, the property of the State, within a distance of one hundred and fifty links from high-water mark at spring tides on the shore of the said lakes and river, and of all islands within the circuit of the said lakes and river to its mouth on the Ninety-mile Beach.

55. *Genoa River and Mallagoota Inlet.*—The bed of the Genoa River from the point where it is intersected by the boundary-line between New South Wales and Victoria to the point where it enters Mallagoota Inlet, the bed of Mallagoota Inlet, and all lands, the property of the State, within a distance of one hundred links from either bank of the said river from the said boundary-line to the extreme point reached by the tidal water; thence all lands, the property of the State, within a distance of one hundred and fifty links from high-water mark at spring tides on either bank of the said river, around the shores of the said outlet and its several arms, and around all islands within the circuit of the said inlet to its mouth on Bass' Strait.



Figure 3.5 Existing permanent reserves for protection of the coastline

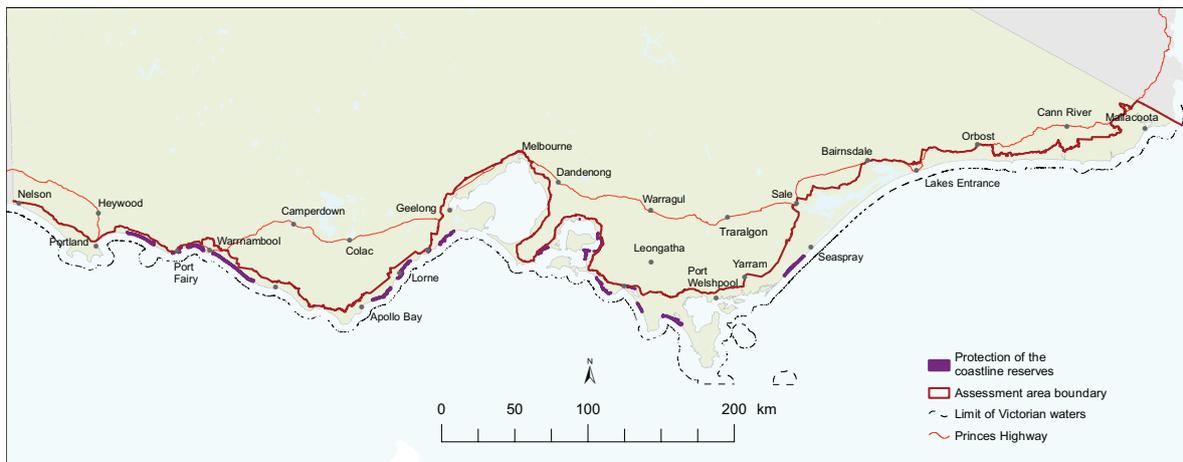


Table 3.2 Summary of coastal reserve area, reservation type and public purpose (including any near shore unincorporated parts of coastal reserves)

Local government area (LGA)	Total area coastal reserve (hectares)	Area of reservation types (hectares)					Area of main reservation purposes (hectares)	
		permanent	temporary	deemed reserved	unreserved	Other/ error*	Public purposes	Protection of the coastline
Glenelg	575	11	390	29	145	-	303	8.1
Moyne	4912	4619	165	54	74	0.3	222	4416
Warrnambool	1198	1040	100	4.5	54	-	201	826
Corangamite	371	347	0.5	-	23	-	346	-
Colac-Otway	1409	1133	251	-	25	-	263	1110
Surf Coast	2017	1887	129	-	1.3	0.01	108	1847
Greater Geelong	1431	1227	127	-	68	9.3	1238	-
Queenscliffe	246	80	158	1.0	4.6	3.0	231	-
Wyndham	111	101	9.5	-	-	-	111	-
Hobsons Bay	168	19	148	-	1.2	-	120	-
Maribyrnong	-							
Melbourne	-							
Port Phillip	70	20	49	-	1.0	-	26	-
Bayside	115	96	14	-	4.8	0.2	13	-
Kingston	76	75	0.7	-		-	33	-
Frankston	85	83	2.4	-	0.1	-	28	-
Mornington Peninsula	1004	613	223	-	109	59	471	275
Casey	58	2.7	43	-	12.1	-	36	2.7
Cardinia	22	22	0.2	-	-	-	7.1	16
French Island	10	-	7.5	-	2.5	0.1	7.5	-
Bass Coast	2612	2018	575	-	19	-	545	1960
South Gippsland	2419	1741	382	-	270	26	378	1555
Wellington	19,063	17,015	1794	0	174	80	17,035	1463
East Gippsland	25,007	22,968	1774	3.7	242	19	23,837	-
Aboriginal title coastal reserves	410	247	160	-	2.2	-	294	-
Gabo Island	158	-	-	158	-	-	-	-
TOTALS	63,136	55,117	6343	250	1229	197	45,559	13,479

*Error in Victorian Online Titles System (VOTS) reporting of Crown land and parcels information. No coastal reserves were identified for Maribyrnong and Melbourne LGAs.

3.4 Management of coastal reserves

The management arrangements for coastal reserves are described in general terms in section 1.8. Currently there are a range of initiatives examining management arrangements, such as those arising from the 2014 VAGO audit *Oversight and Accountability of Committees of Management* and the *Great Ocean Road Action Plan* (2018). DELWP has also established the Modernising Crown Land Management Project and Crown Land Information Project (CLIP) implementing reforms to information management and governance that will support delegated managers including local government and community-based committees of management.

DELWP is responsible for Crown land. There are several mechanisms by which DELWP delegates management responsibilities to other government agencies, organisations and community groups. Reservation is a necessary precursor to establish a formal delegated management arrangement and therefore for unreserved Crown land (and places where delegation arrangements are not evident) DELWP is listed as the land manager. In general information on Crown land reservation and management is difficult to obtain and interrogate. Centralised information held by DELWP for cadastral definitions of Crown land, reservation purposes and assignment of land managers is imperfect and reflects the complexity of information sources and processes. Information quality is generally only good in areas with high public profile or arising from projects where budgeting permits completion of administrative and survey requirements.

Additional complexity arises because cadastral boundaries do not always align with management responsibilities. In many instances along the coast there are multiple managers appointed for a single Crown land parcel. Documenting these arrangements is complicated and leads to fragmentation of land information for systems already affected by interaction with coastal processes and definitions using ambulatory boundaries such as high or low water mark. Public land use classification can also cut across Crown parcel boundaries, notably in areas where government-approved land use recommendations have not yet been implemented by appropriate formal reservation.

Documentation of land management arrangements for coastal reserves is therefore only an indicative representation at a statewide level. Reforms underway will also lead to significant changes for areas of coastal reserve in the Great Ocean Road and Surf Coast regions, the Bass Coast region and for the shorelines of Western Port. In these locations there is potential for areas to be allocated to other public land uses as well as changes in the appointed manager for areas retained as coastal reserve.

As a starting point to establish an inventory of management arrangements for coastal reserves, DELWP is listed as the default manager. Coastal reserves are also listed as managed by local government, Parks Victoria and local committees of management where this can be determined. VEAC's inventory and online maps provide information on management arrangements but cannot readily depict the complexities of this information. Table 3.3 shows the coastal reserve area managed by different agencies or bodies.

Table 3.3 Summary of coastal reserve area managed by different agencies or bodies

Coastal reserve land manager(s)	Area (hectares)
DELWP/ Parks Victoria*	39,401
local government	3829
Gunaikurnai Joint Management (including transitional arrangements with other land managers)	409
water authority/ Melbourne Water	141
Other government departments or agencies (Department of Treasury and Finance, Victrack, Gippsland Ports, Port of Melbourne)	72
part DELWP/ part local govt	1401
part Parks Victoria/ part local govt	224
Committees of Management (COMs) – Category 1	
Barwon Coast	236
Bellarine Bayside	126
Great Ocean Road Coast	125
Otway Coast	225
Part DELWP/ part COM CAT 1	2151
Part Other government bodies/ part COM CAT 1	566
Committees of Management (COMs) – Category 2	
local COM CAT 2 (20 COMs)	697
Part DELWP/ part COM CAT 2	104
Other bodies and part COM CAT 2	1401
Other shared management arrangements	
Various shared arrangements	12,029

* delegation arrangements between DELWP and Parks Victoria are not accurately recorded in Crown parcel-based information.



This chapter addresses part of part (b) of the terms of reference: the requirement to identify coastal reserves with high environmental, cultural heritage, social and economic values. This information and maps provided online (including the online interactive maps) also meet the requirements of part (d) of the terms of reference: the request to compile an inventory, including spatial distribution, of values and uses of the coastal reserves. The results are reported here and presented in summary form as part of the online inventory.

The coastal reserves dataset contains some 230 coastal reserve land units including 36 in the Gippsland Lakes. There are instances where reserves do not match VEAC's land units, particularly for long areas of single reserves and around piers and jetties or coastal infrastructure. Land units are Crown land parcels grouped because of similar purposes, use or management but have inherited underlying variability in cadastral and reserve boundaries.

4.1 Introduction and approach

The boundary between land and sea is a complex and sometimes hostile environment. Victoria's coast is exposed to strong south westerly forces of the Southern Ocean moderated in part by the presence of Tasmania and the relatively shallow Bass Basin. Along our high energy ocean coastline are more sheltered embayments including Port Phillip Bay, Western Port and Corner Inlet, often protected by rocky headlands such as Bellarine and Mornington peninsulas, and Wilsons Promontory. The action of the sea upon a diverse assortment of substrates has produced a wide variety of coastal landforms, specialised habitats and environments.

The Gippsland Lakes is one of the largest coastal lake systems in southern Australia. Together with some 115 river estuaries these areas reflect a complex relationship with past and present sea levels forming intermittent barriers to the ocean. This environment has sustained Aboriginal people for tens of thousands of years.

Sheltered waters encourage a range of recreational activities, while wild and rugged coastal landscapes such as the Great Ocean Road and the Twelve Apostles and the penguin parade at Phillip Island attract large numbers of domestic and international visitors.

Many outstanding natural coastal areas have been reserved for current and future generations in national and other parks. The values and uses described in this chapter are for coastal reserves only comprising some 62,670 hectares along the open coast, foreshores of bays and inlets and the Gippsland Lakes. Many of these coastal reserves are located within easy reach of major population centres and include much loved holiday destinations. The continuing desire to live near the coast is reflected in increases in both resident and visitor numbers to coastal towns and brings a range of management challenges for coastal reserves.

Identifying high values and uses

In selecting high or significant values and uses of coastal reserves VEAC has applied various criteria depending upon the nature of the available information. The information sources are recorded in the supporting documentation for the inventory. The criteria are explained in the supporting documentation and summarised in the relevant sections of this chapter. An example of the inventory entry for one coastal reserve land unit is provided in figure 4.1.

The list of high or significant values was informed by discussion with key stakeholders and feedback received at the 2019 Marine and Coastal Forum Workshop organised by DELWP.

Consultation on significant values and uses

In June 2019 VEAC facilitated a workshop on *Coastal Reserves - Understanding Values and Uses* at the DELWP Victorian Marine and Coastal Forum. Participants were asked to contribute to VEAC's coastal reserves assessment by helping to identify values and uses of coastal reserves and to consider how these might change over the next 20 years, and specifically with respect to climate change.

Workshop participants included representatives of committees of management, local government, DELWP, consultants and conservation groups and drew on a wide range of knowledge. Participants recognised that many uses could be classified under multiple categories of value – environmental, cultural, social and economic. Examples of these types of values included camping and boating that were considered as both social and economic values; and visual landscapes that have cultural, social and economic value. Values and uses of coastal reserves that were most frequently mentioned were:

- biodiversity and habitat
- Aboriginal and non-Aboriginal cultural heritage
- recreation and tourism.

Groups were asked to choose two significant or important values and to list potential changes to these values over the next 20 years and what factors will drive those changes. The significant coastal reserve values considered by the groups were varied and included: ecosystem services, biolinks and habitat, facilities (e.g. boats ramps, playgrounds, toilets), sport and recreation, tourism and education.

Themes approach

Information presented here and in the associated inventory of coastal reserves utilises the themes approach used recently by VEAC for the Assessment of the Values of Victoria's Marine Environment (2019). The thematic approach reflects the complexity and intersectionality of more traditional categories of environmental, social, cultural and economic values and uses. It also allows for the variability of information available and acknowledges a bias favoring data collection for biophysical values compared to cultural values for example. The earlier report provided information on and discussed issues relating to values, threats and emerging uses across nine themes.

There are some minor ways that the information for this assessment differs, related to the narrow definition of coastal reserves compared to the area covered by marine values assessment. Unlike the marine environment that is entirely Crown land, this current assessment is restricted to areas identified specifically as coastal reserves. The ports and shipping and fisheries (commercial) themes are therefore not included here as these are not uses of coastal reserve (commercial ports and fisheries reserves are excluded from the definition of coastal reserves). Coastal reserves are, however, used extensively for recreational fishing and public access to the marine environment together with a range of other values and uses. These values and uses are reported under the recreation and tourism theme. The climate and oceanography theme of the marine values assessment is modified and encompassed in chapters 6 and 7 of this report on climate change

risks for coastal reserves with high values. The marine values assessment theme of energy and earth resources is reported within a broader resources theme in section 4.8 of this assessment of coastal reserves.

Figure 4.1 Example of presentation of information in the inventory for each coastal reserve land unit

Land Unit	Aireys Inlet Coastal Reserve		Assessment Block	Central	ID#	10107	
	Coastal Reserve	Land Unit Area (hectares)	39.1			77	
Natural values							
Bioregion(s) <input type="text" value="Otway Plain"/>							
Conservation-listed species		Plant <input type="checkbox"/>	<input type="text" value=""/>	Count	UNESCO Biosphere Reserve <input type="checkbox"/>		
<small>Species recorded on an international treaty, EPBC, FFG, or DELWP advisory list</small>		Animal <input checked="" type="checkbox"/>	4	Count	Ramsar wetland <input type="checkbox"/>		
EVC (BCS) <input checked="" type="checkbox"/> <small>Endangered, vulnerable, depleted, rare</small>		Important marine biotope <input checked="" type="checkbox"/> <small>Restricted extent, important ecological function, vulnerable community</small>		Important coastal bird site <input type="checkbox"/>			
Site of high blue carbon <input type="checkbox"/>		DELWP marine asset <input checked="" type="checkbox"/>		BirdLife International Key Biodiversity Area (KBA) <input type="checkbox"/>			
Geological site of significance <input checked="" type="checkbox"/>							
Recreation and tourism values							
Marine access infrastructure <input type="checkbox"/> <small>includes jetties and piers</small>		Built community facilities <input checked="" type="checkbox"/>		<input type="text" value="Lighthouse, Tourist lookout"/>			
Caravan or camping area <input type="checkbox"/>		Active sports facilities <input type="checkbox"/>		<input type="text" value=""/>			
Cultural values							
National Heritage List <input type="checkbox"/>		Victorian Heritage Register <input checked="" type="checkbox"/>		Traditional Owners			
Landscape significance <input checked="" type="checkbox"/>		Historic shipwreck <input type="checkbox"/>		<input type="text" value="Wathaurung"/>			
				Country Plan <input type="checkbox"/>			
Infrastructure and tenures							
Utilities/ infrastructure <input type="checkbox"/>		Coastal protection structures <input type="checkbox"/>		Crown land tenure			
				CL licence <input checked="" type="checkbox"/> CL lease <input type="checkbox"/>			
Climate change risks							
Sea level rise 2040 <input checked="" type="checkbox"/>		% of land unit <input type="text" value="14.9"/>		2100 <input checked="" type="checkbox"/>		% of land unit <input type="text" value="18.5"/>	
				Erosion vulnerability <input type="checkbox"/>			
Storm surge 2040 <input checked="" type="checkbox"/>		% of land unit <input type="text" value="20.7"/>		2100 <input checked="" type="checkbox"/>		% of land unit <input type="text" value="21.6"/>	
				Acid sulphate soils <input checked="" type="checkbox"/>		% of land unit <input type="text" value="2.3"/>	
Crown parcels included in land unit							
Parcel Numb	Area (ha)	LGA	Land manager	Reserve type	Reserve purpose	SPI	CR/
P394837	11.5	Surf Coast	DELWP	Temporary	Public Purposes	2033\PP2015	
P376837	23.7	Surf Coast	part local govt/ part	Temporary	Public Purposes (foreshore)	2019\PP2015	
P110082	3.7	Surf Coast	GORC COM CAT 1	Temporary	Public and tourism purposes (lighth	15F\PP2015	
P110083	0.2	Surf Coast	local govt	Temporary	Public and tourism purposes (lighth	15G\PP2015	
P109765	0.0	Surf Coast	local govt	Temporary	Public and tourism purposes (lighth	15D\PP2015	
P109837	0.0	Surf Coast	local govt	Temporary	Public and tourism purposes (lighth	15E\PP2015	

COMMENTS INVITED

Are there any additional uses or values of coastal reserves that should be reported or included in the inventory?

Are there other ways to present the information that would assist land managers with planning and decision making?

4.2 Geophysical environment

Victoria's many coastlines are inherited from underlying rock structures established when Australia and Antarctica were separated. These underlying large geological structures have had a significant influence on coastal landforms by creating alternating fault-bound blocks with elevated or uplifted areas providing cliffed coastal margins and low-lying blocks forming depressions or embayments. Victoria's coastal geology is a broad representation of the rest of the state, hosting rocks from Cambrian (580 million years ago) to the younger Quaternary dune systems and sedimentary lagoons (10,000 years to 1 million years ago). The Victorian coastline has been considerably influenced by tectonic activity (faulting, uplift and subsidence) as well as sea level changes.

Some of the most spectacular landscapes along the coastline are the cliffed margins, including 60 metre limestone cliffs, rock stacks and caves along the Port Campbell coastline, and mountainous granite outcrops at Wilsons Promontory sheltering the waters of Corner Inlet. Cape Liptrap forms a steep cliffed promontory cutting into some of the oldest rocks exposed along the Victorian coastline (near Walkerville). An isolated area of Cambrian rocks also occurs at Phillip Island. The Otway Ranges, Mornington Peninsula and Gippsland Ranges are elevated landscapes associated with tectonic uplift of fault-bound blocks. In the far east of the state the coastal cliffs are formed in folded and faulted basement rocks of the Tasman Orogen.

The Otways coast exposes Cretaceous sedimentary rocks flanked by Cenozoic sedimentary rocks. The Great Ocean Road hugs the coastline here and is listed on the National Heritage List for its scenic and cultural values. To the west the Otway Ranges dip beneath younger Cenozoic volcanics flows and extensive areas of limestone including the well-known Port Campbell Limestone, seen in the Twelve Apostles and other features along the southwest coast. In the east the surf coast section of the Otways exposes the sedimentary rocks in a series of cliffs and is one of the best places in the world to study sedimentary deposition processes.

Much of western Victoria was flooded by flows of basalt, forming the volcanic plains derived from the Newer Volcanics Province that commenced in the Late Miocene and continued through to the present. As well as lava flows, the province has numerous scoria cones, lava domes, maars and maar complexes (e.g. Tower Hill).

The Gippsland Lakes lie within a former marine embayment in a structural trough that extends eastward from the La Trobe Valley and into Bass Strait. During the Quaternary the lakes were subject to repeated episodes of marine transgression and regression. The lakes are fed by several rivers and are separated from the sea by a succession of sandy barriers extending along Ninety Mile Beach. Rivers draining into the lakes include the Thompson, Latrobe, Avon, Mitchell, Tambo and Nicholson rivers and are fed by catchments in the eastern highlands. Except for the Nicholson these rivers have conspicuous deltas into the lakes. The shoreline of the lakes complex measures some 230 kilometres with many ephemeral wetlands and morass areas.

Victoria's coastlines can be characterised in terms of high or low energy environments and three main landform types:

- cliffs
- sand barriers with dunes and sandy beaches
- sheltered marshes, tidal banks and mangrove swamps.

Most of the cliffed coastal margins are protected in national, state or coastal parks. Wilsons Promontory was one of the first national parks declared in Victoria (1898) and the Port Campbell National Park was established in 1964.

In the state's far west, high-energy conditions driven by a consistent southwest swell break upon the gently curving sandy beach of Discovery Bay backed by extensive dunes. The rocky headland of

Bridgewater Promontory marks the end of an unbroken 60-kilometre sandy coastline. The vertical cliffs of this promontory consist of volcanic rocks capped by calcite-rich sands and dunes. The Portland Peninsula and at Port Fairy Newer Volcanics basalts form erosion-resistant coastal headlands shielding natural harbors from the prevailing southwest swells. Outcrops of Older Volcanic basalts also occur along the southern coastline of Phillip Island and Cape Schanck forming steep shorelines, rocky island and near shore rock stacks.

Sand barrier coasts are characterised by broad accumulations of sand. Dunes form parallel to the shoreline and may shield lagoons or swales from the influence of ocean waves. Most of the coast between Corner Inlet and the New South Wales border is this type. The Ninety Mile Beach, Venus Bay ocean beach, and Discovery Bay are all this type of coastline.

Sheltered coasts are protected from the direct impacts of the ocean by headlands, islands or sand barriers. The most extensive marshlands are in Western Port, Corner Inlet and parts of the western shores of Port Phillip. These low energy environments have fine sediment substrates such as mudflats, mangroves and sea grass and, above high tide zones, salt marshes. Mangroves hold together muddy areas creating swamps high in organic matter.

Estuaries are zones of variability with fluctuations in water flow and salinity, and consequently many changes in the numbers and diversity of fauna. The Gippsland Lakes are a large estuarine system, now more marine in character because of interventions to ensure the entrance to the sea is retained open. The Glenelg River forms the longest estuary in Victoria at Nelson.

Sites of geological and geomorphological significance

Many of the spectacular coastal features are also sites of scientific importance. Some of the most important geological sites are exposed in coastal cliffs or shore platforms while other areas provide outstanding examples of both contemporary and past coastal geomorphological processes. Examples include nationally significant features such as the Twelve Apostles and Nooramunga barrier islands. Many of the most significant features are cherished scenic landscapes protected within Victoria's national parks and conservation reserves, although geological values are largely unrelated to aesthetics.

Coastal cliffs provide excellent natural rock exposures important for the study of local geology (figure 4.2). The cliffs between Lorne and Anglesea expose a sequence of Cenozoic age sedimentary rocks that illustrate sedimentary process known as sequence stratigraphy. Several important fossil locations and are protected at least in part in national parks and conservation reserves (e.g. Dinosaur Cove, Otway Ranges, Beaumaris Cliffs, Mornington Cliffs, near Inverloch to Cape Paterson).

In 1993 coastal sites of geological significance were researched for the entire state to inform the LCCs Marine, Coastal and Estuarine Investigation.¹ Many regional studies have also been completed by members of the GSA (Victoria Division) Heritage subcommittee including detailed documentation of site values and assessments of significance.²⁻⁷ In 2003 a list of sites of national and international significance was published in chapter 27 of *The Geology of Victoria*.⁸ Based on this and more recent investigations⁹ a list of coastal geological and geomorphological sites of international and national significance along the coastline is provided at table 4.1. Additional investigation and assessments of significance are underway for some sites of high significance along the coast and a provisional listing of these is included in table 4.1 based on communications with GSA (Victoria Division) Heritage subcommittee.

Of the 12 sites of international and 20 national geological or geomorphological significance identified along Victoria's coastline, eight include areas of coastal reserve. In some locations the site encompasses areas both onshore and offshore areas and therefore in some cases there are multiple land use classifications. These sites are included in the inventory of coastal reserves with high values.

Figure 4.2 Sites of high geological significance located in coastal reserves: Beaumaris Cliffs
(Photo: M Mitchell)



Table 4.1 Sites of international or national geological and geomorphological significance located along Victoria’s coastline (sites that include areas of coastal reserve are shaded blue)

GSA site code	Site name	Public land use
International		
CL 020.28	Dinosaur Cove Cretaceous fossil site, Johanna	Great Otway National Park
QN 048	Torquay to Aireys Inlet coastal cliffs, Tertiary stratigraphic sequence, Anglesea	Great Otway National Park and part coastal reserve
ML310	Beaumaris Miocene–Pliocene fossil site, Beaumaris (Keepers)	Beaumaris Nature Reserve and adjoining coastal waters reserve
ML311	Beaumaris Miocene–Pliocene fossil site, Beaumaris (Yacht Squadron)	Coastal reserve and adjoining coastal waters reserve
QN 030	Yallerong Creek Reserve zeolite sites, Flinders	Mornington Peninsula National Park
WL 096	Westernport Bay tidal watershed [North-eastern Westernport Bay between Palmer Point (French Island) and the Lang Lang River mouth.]	Coastal waters reserve and French Island Marine National Park
WL 039	Eagles Nest and Flat Rocks Cretaceous fossil site, east of Cape Paterson	Bunurong Marine Park offshore (HWM), coastal reserve onshore
WL 210	Inverloch fossil site	Bunurong Marine Park
WL 210.01	Inverloch sea caves (includes a subsite)	Bunurong Marine Park offshore (HWM), coastal reserve onshore
WL 30	Clonmel Island south of Port Albert	Nooramunga Marine and Coastal Park
BR 035	Mitchell River silt jetties, Bairnsdale	Coastal reserve (Gippsland Lakes Reserve)

GSA site code	Site name	Public land use
BR 068	Cunninghame Arm, Lakes Entrance	Coastal reserve (Gippsland Lakes Reserve)
National		
PR 004	Lady Julia Percy Island, Port Fairy	Lady Julia Percy Island Nature Reserve
CL 020	Port Campbell National Park, Port Campbell (includes a number of subsites and extends into Great Otway National Park and The Twelve Apostles Marine National Park)	Port Campbell National Park, The Arches Marine Sanctuary & The Twelve Apostles Marine National Park
CL 020.12	The Twelve Apostles	The Twelve Apostles Marine National Park
CL 020.17	Pebble Point	Great Otway National Park
CL 086	Point Lewis dinosaur locality, Apollo Bay	Great Otway National Park
CL 124	Cape Patton (Ramsden Cave), Kennett River	Great Otway National Park
QN 152	Yallock Creek swamp sediments, Koo Wee Rup	Western Port Nature Reserve and Yallock Creek water frontage
WL 101	Pioneer Bay, Quaternary stratigraphy near Jam Jerrup	Coastal reserve
QN 002	Bass River delta, floodplain and terraces, South Gippsland	Reef Island and Bass River Nature Reserve
WL 001	Waratah Bay and Cape Liptrap, Walkerville	Cape Liptrap Coastal Park, and coastal reserve
WL 012	Wilson's Promontory National Park Tidal River	Wilson's Promontory National Park
WL 047	Wilson's Promontory sand dunes, Darby River, Yanakie Dunes)	Wilson's Promontory National Park and Shallow Inlet Marine and Coastal Park
WL 046	Corner Inlet Barrier Island and mainland fringe, Port Albert (includes a number of subsites)	Nooramunga Marine and Coastal Park
WL 046.01	Port Albert Entrance	Nooramunga Marine and Coastal Park
WL 046.02	Kate Kearney Entrance	Nooramunga Marine and Coastal Park
WL 046.03	Shallow Inlet (near Port Albert)	Nooramunga Marine and Coastal Park
WL 046.04	New Entrance, Port Albert	Nooramunga Marine and Coastal Park
WL 023	Snake Island	Nooramunga Marine and Coastal Park
WL 030	Clonmel Island, Port Albert	Nooramunga Marine and Coastal Park
MC 051	Telegraph Point sandy foreland, east of Mallacoota	Croajingolong National Park
Assessment pending - Interim National significance		
BR 064	Sperm Whale Head (includes a number of subsites)	The Lakes National Park and Gippsland Lakes Coastal Park
WL 211	Arch Rock and Morgan's Beach	Cape Liptrap Coastal Park
BR 150	Gippsland Lakes, coastal lake and barrier system	The Lakes National Park and Gippsland Lakes Coastal Park

4.3 Biodiversity values

Within modified landscapes such as the coastal strip, habitat loss and fragmentation have resulted in populations of flora and fauna occurring in discrete patches, where previously they were substantially connected. Landscape features that maintain or enhance connectivity, such as coastal reserves, are more likely to support populations of the various species that once occupied the original landscape. Where ecosystems are degraded, protecting and restoring native vegetation improves ecosystem function and contributes to ecological resilience. More resilient ecosystems are more likely to be able to adapt to the additional stressors of climate change. Coastal reserves, while generally narrow and linear in shape, therefore play an important role in maintaining ecological connectivity and promoting ecosystem resilience.

Biodiversity values are often quantified by the presence of native vegetation, records of conservation-listed species and sites of significance such as Ramsar wetlands. With some caveats (explained below), this type of information is relatively easily represented in a spatial format and suitable for scoring the presence of high biodiversity values using an inventory approach.

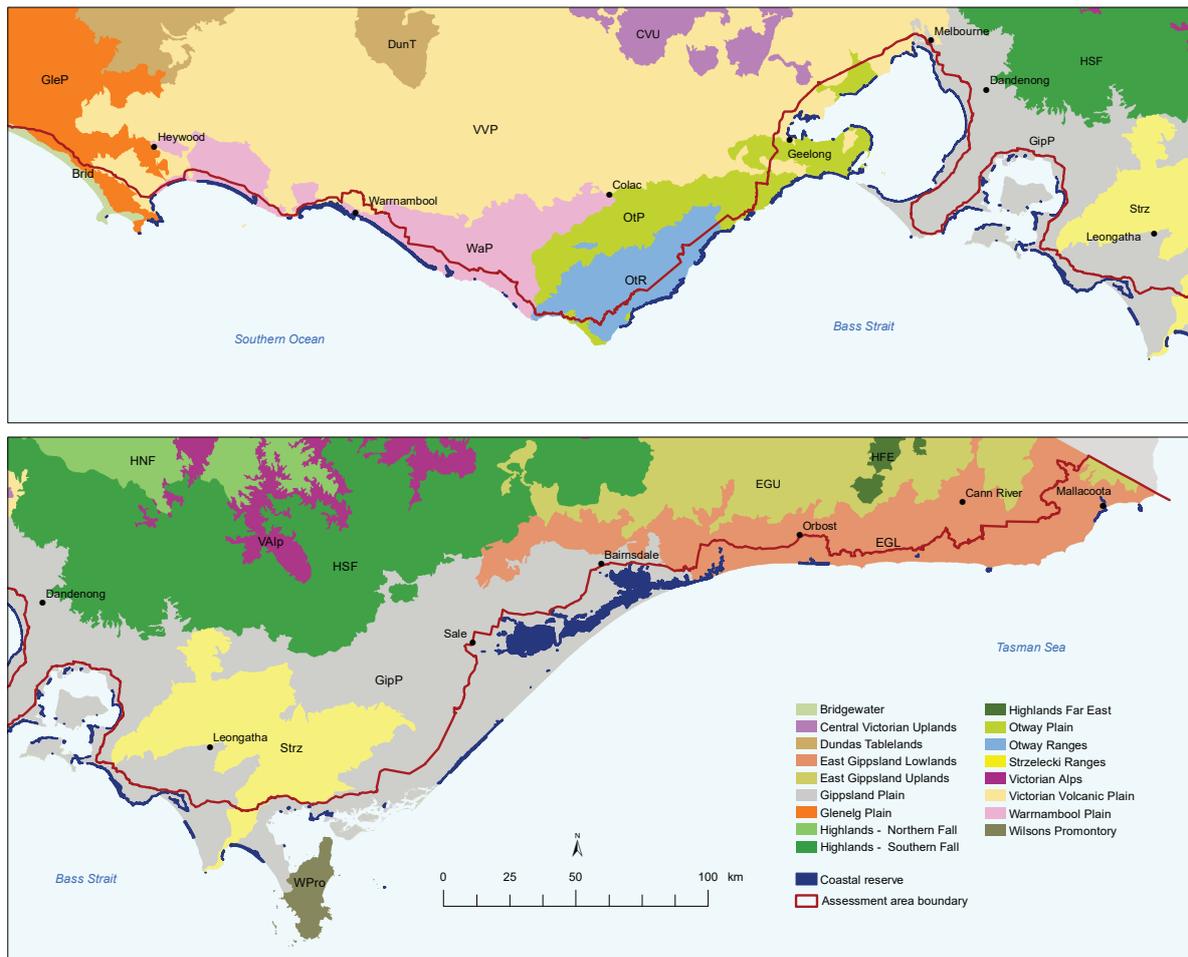
Emerging ways to express biodiversity values focus on multiple attributes. One example is the recent strategic biodiversity values analyses conducted by the Arthur Rylah Institute for Environmental Research for VEAC's Central West Investigation.¹⁰ These analyses combine information on areas important for threatened flora and fauna, and vegetation types and condition to provide a view of relative biodiversity importance of parts of the Victorian landscape. This type of analysis has not been completed for this draft report but may be incorporated in the final report.

Recognition is also increasing for the important services that healthy, functioning ecosystems provide, termed ecosystem services. Simply put, ecosystem services are the benefits that humans derive from nature.¹¹ Coastal reserves provide a multitude of ecosystem services including provisioning services (e.g. food), regulating services (e.g. carbon storage), cultural services (e.g. recreation) and supporting services (e.g. habitat provision). Carbon sequestration (termed blue carbon in the marine environment) has been used as an example of how some ecosystem services may be quantified.

Bioregions

Bioregions are a landscape-scale classification of the environment using a range of features including climate, geology, landform, native vegetation and species information. Of the 89 bioregions identified in the Interim Biogeographic Regionalisation for Australia (IBRA), 11 occur in Victoria. The broad scale that is appropriate for national purposes does not provide adequate discrimination at a statewide level and so Victoria has been further divided into 28 bioregions (which are equivalent to the IBRA subregions). Victoria's coastal bioregions are: Bridgewater, Glenelg Plain, Victorian Volcanic Plain, Warrnambool Plain, Otway Plain, Otway Ranges, Gippsland Plain, Strzelecki Ranges, Wilsons Promontory and East Gippsland Lowlands (see figure 4.3). The East Gippsland Upland bioregion occurs in the inland catchment area of Mallacoota Inlet.

Figure 4.3 Victoria's coastal bioregions and coastal reserves



The Bridgewater bioregion is one of Victoria's smallest and is almost entirely within the coastal reserves assessment area. The only coastal reserves in the bioregion are small areas at Cape Bridgewater. The bioregion is characterised by gently sloping sand ridges and dunes with an inland lagoonal system. The southern parts of the Glenelg Plain occur inland of the Bridgewater bioregion from Nelson to Portland. Coastal reserves in this region include the Cape Nelson Lighthouse Reserve and areas from the Narrawong Coastal Reserve to Portland Harbour. East of Portland, the coast is within either the Victorian Volcanic Plains or Warrnambool Plain bioregions.

At Moonlight Head the Otway Ranges bioregion commences and the terrain becomes more rugged and steep. The Otway Ranges are interrupted by the more subtle landscapes of the Otway Plain bioregion in the Aire River wetlands and estuary from Johanna to east of Cape Otway, and again at around Apollo Bay. East of Fairhaven, the landscape is again within the Otway Plain and Victorian Volcanic Plain bioregions. Here gently undulating plains extend along the coast to Williamstown.

East of the Yarra River mouth, the coastal landscape is dominated by the extensive Gippsland Plain bioregion all the way to Lakes Entrance. Corner Inlet, Ninety Mile Beach and the Gippsland Lakes are included in the Gippsland Plains bioregion. A small part of the rocky landscapes of the Strzelecki Ranges bioregion are exposed at Cape Liptrap. The granitic peninsula of Wilson's Promontory bioregion occurs in the far south. From Lakes Entrance to the NSW border, the East Gippsland Lowlands bioregion dominates the coastal landscape. North east of Mallacoota, areas of the East Gippsland Uplands bioregion border the upper sections of the inlet along Coleman Inlet and the Wallagarough River but do not intersect with coastal reserves.

Ecological vegetation classes

Native vegetation in Victoria is often considered in terms of the bioregion in which it occurs. Ecological vegetation classes (EVCs) are the standard unit for describing native vegetation types in Victoria and have been used as surrogates for ecological communities for many years. EVCs are defined by a combination of floristics (occurrence of plant species), lifeforms, position in the landscape, and an inferred preference for and fidelity to specific environments. Each EVC includes a collection of plant communities that may differ in species but have similar habitat and ecological processes operating. Many EVCs occur across multiple bioregions. Within every bioregion, each EVC is assigned a bioregional conservation status (BCS) (see table 4.2). The BCS is a function of the current extent and condition for each EVC compared to its extent and condition prior to European settlement (expressed as pre-1750 extent). As different bioregions have differing amounts of vegetation remaining, an EVC may have a different conservation status across bioregions. The BCS was last updated for each EVC by DELWP in 2005.

Most coastal reserves are long linear strips typically less than 100 metres wide. However, they are important for maintaining ecological connectivity between larger habitat patches (e.g. adjacent national parks). The occurrence of EVCs in coastal reserves varies across bioregions. This is due to a combination of the limited coverage of certain bioregions within the assessment area (e.g. Strzelecki Ranges), the minimal area of coastal reserves in some bioregions (e.g. much of Wilsons Promontory bioregion is within a national park) and the extent of clearing and other pressures on existing coastal vegetation in other bioregions (e.g. Gippsland Plain).

The coastal reserves inventory reports the occurrence of rare, depleted, vulnerable or endangered EVCs as high biodiversity values (see appendix 5). More than 170 coastal reserves contained patches of greater than or equal to 0.1 hectare of bioregionally important EVCs (e.g. see figure 4.4). In total, 117 high value EVCs were recorded (see table 4.3). The most restricted EVC (0.16 hectares) was the endangered damp sands herb-rich woodland/damp heathland/damp heathy woodland mosaic which only occurred in the Fitzroy River-Eumeralla River coastal reserve near Yambuck. The most widespread EVC was swamp scrub (1867 hectares) which was endangered across two bioregions (Gippsland and Warrnambool Plains) and occurred in 47 coastal reserves. Some 55 coastal reserves had only one EVC with an important BCS. Areas of the Gippsland Lakes record up to 18 different bioregionally important EVCs.

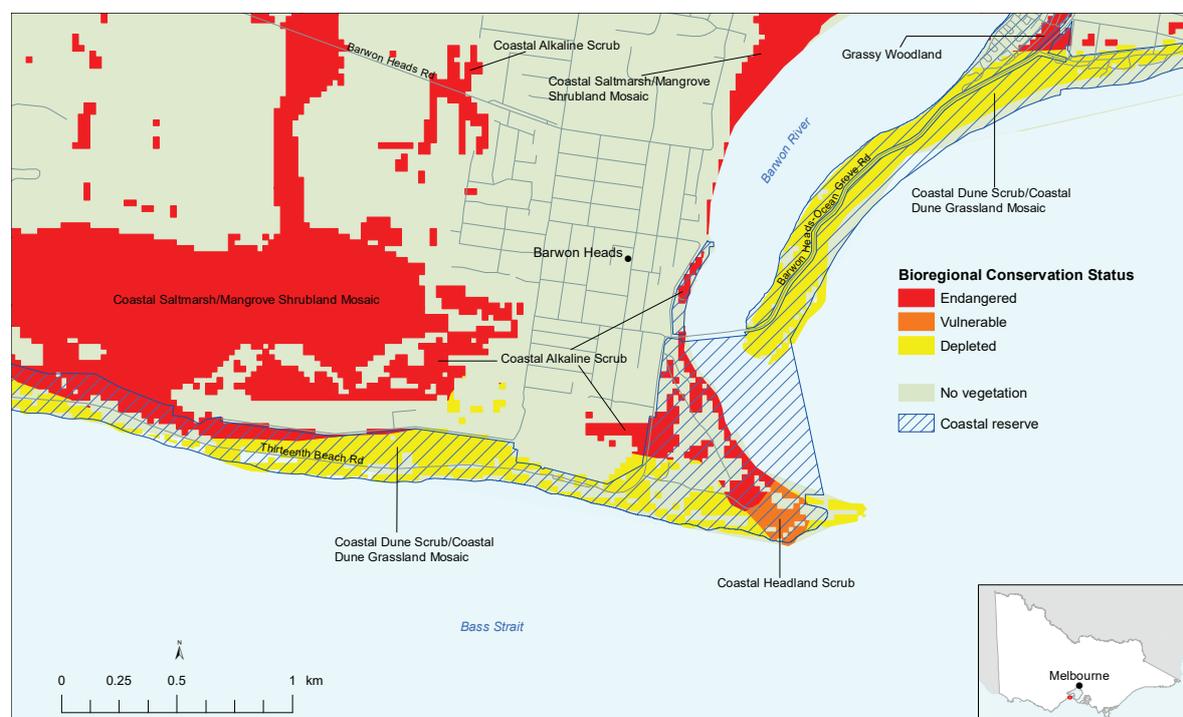
Table 4.2 Ecological vegetation classes (EVCs) bioregional conservation status

Status	Description
Endangered	<ul style="list-style-type: none"> - Contracted to less than 10% of former range; OR - Less than 10% pre-European extent remains; OR - Combination of depletion, degradation, current threats and rarity is comparable overall to the above: 10 to 30% pre-European extent remains and severely degraded over most this area; OR naturally restricted EVC reduced to 30% or less of former range and moderately degraded over most this area; OR rare EVC cleared and/or moderately degraded over most of former area.
Vulnerable	<ul style="list-style-type: none"> - 10 to 30% pre-European extent remains; OR - Combination of depletion, degradation, current threats and rarity is comparable overall to the above: greater than 30% and up to 50% pre-European extent remains and moderately degraded over most of this area; OR greater than 50% pre-European extent remains and severely degraded over most of this area; OR naturally restricted EVC where greater than 30% pre-European extent remains and moderately degraded over most of this area; OR rare EVC cleared and/or moderately degraded over a minority of former area.
Depleted	<ul style="list-style-type: none"> - Greater than 30% and up to 50% pre-European extent remains; OR - Combination of depletion, degradation and current threats is comparable overall to the above: greater than 50% pre-European extent remains and moderately degraded over most of this area.
Rare	<ul style="list-style-type: none"> - Rare EVC (as defined by geographic occurrence) but neither depleted, degraded nor currently threatened to an extent that would qualify as Endangered, Vulnerable or Depleted.
Least concern	<ul style="list-style-type: none"> - Greater than 50% pre-European extent remains and subject to little to no degradation over a majority of this area.

Table 4.3 Number of EVCs with rare, depleted, vulnerable or endangered status in Victoria's ten coastal bioregions that occur in coastal reserves

Bioregion	Rare	Depleted	Vulnerable	Endangered
Bridgewater	0	0	1	0
Glenelg Plain	1	1	1	3
Victorian Volcanic Plain	0	1	7	7
Warrnambool Plain	0	2	6	4
Otway Plain	1	2	3	7
Otway Ranges	0	4	2	1
Gippsland Plain	2	8	19	22
Strzelecki Ranges	0	0	2	1
Wilson's Promontory	0	0	1	0
East Gippsland Lowlands	1	2	4	1

Figure 4.4 Bioregionally important EVCs in Barwon Heads Coastal Reserve



Marine habitat mapping

DELWP has recently undertaken a statewide collation of marine habitat mapping and classification project using the Combined Biotope Classification Scheme (CBiCS). This is a relatively new schema which draws on components from European (EUNIS) and US (CMECS) schemas. The CBiCS provides a unified way to classify all marine habitats and biotopes and is analogous to Victoria's terrestrial system of EVCs for describing vegetation. This system incorporates data from the littoral (intertidal) zone to the deep sea.

The CBiCS uses seven components to classify habitat, each containing between three and six nested hierarchical levels. These components are: biotic, biogeographic setting, aquatic setting, water column, geoform, substrate and morphospecies (species described by morphology rather than taxonomy). The biotic component is the core classification component, and centres around the idea

of a biotope – a community of species in a defined abiotic (non-living) habitat. This system has brought about significant changes in the classification and mapping of Victorian marine environments and will aid in aligning methods with international best practice to meet the requirements of modern natural resource management.¹²

More than 100 biotope complexes have been identified across Victoria. These are accessible through DELWP’s Coast Kit online mapping tool at <http://dev-coastkit.cbics.org/>. An example of a biotope complex map for Hastings Coastal Reserve is shown in figure 4.5. For more detailed analysis of habitat and biotope complexes along Victoria’s coast, see the VEAC’s recently completed Assessment of the Values of Victoria’s Marine Environment Atlas.¹³

Important marine biotope complexes were assessed based on expert opinion as those that are rare, vulnerable to disturbance or play a key known ecological role (e.g. nursery habitat). Important biotope complexes that occurred within 87 coastal reserves included mangroves (*Avicennia marina*), brackish herbland, seasonally inundated sub-saline herbland, seagrass communities (*Amphibolis antarctica*, *Halophila australis*, *Posidonia australis*, *Ruppia* spp. and *Zostera* spp.), macroalgae (*Ecklonia radiata* and *Durvillaea potatorum*), one sessile invertebrate community and the southern tidal sands in Port Phillip Bay Heads (see figure 4.6).

Figure 4.5 Biotope complex map for Hastings Coastal Reserve

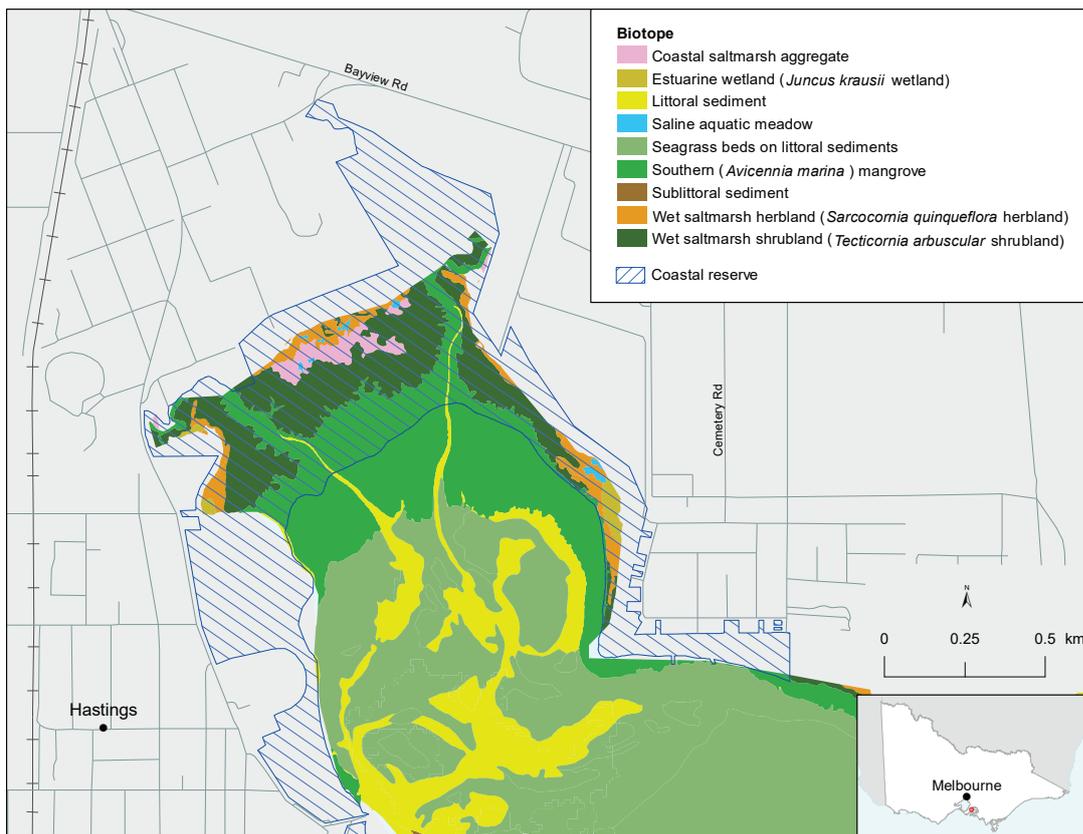


Figure 4.6 Important marine biotope species: Leather kelp *Ecklonia radiata* (left), White mangrove *Avicennia marina* subsp. *australasica* (right) (Photos: B Boyle (L), M Mitchell (R))



However, the marine habitat mapping coverage varies across the state with some areas (nearshore, closer to population centres, marine protected areas) better assessed than others (remote offshore islands, deep sea), so this is likely to be an underestimate of the important areas of marine and intertidal habitat within coastal reserves. For example, while marine habitat mapping covered 179 coastal reserves, in 45 of them the mapping was not yet detailed enough to identify any biotope complexes, let alone ones that are rare, vulnerable or play key ecological roles. As the level of detail in Victoria's marine and intertidal habitat mapping coverage increases, more important biotopes are likely to be identified.

DELWP marine assets

To help inform natural resource management, DELWP developed a system for identification of marine assets. Marine assets are defined in this context as tangible biophysical elements that are valuable for their ecosystem services.¹⁴ As many coastal reserves include a marine component, this asset layer can help identify high biodiversity values. Furthermore, many of the assets include a significant coastal component such as hooded plover habitat.

Criteria considered in identifying marine assets included:

- state or bioregional importance of the asset for its biodiversity, endemism, ecological role or function
- support and contribution of the asset to the fitness of a species that is of international, state or bioregional importance for biodiversity
- performs a key ecological role or function
- representativeness of the asset in terms of marine habitats, and the naturalness and resilience of the asset.

Statewide, approximately 140 marine assets were identified, many of which were nested within larger assets. A description of the largest and most significant assets, as assessed by scientific experts, can be found in appendix 2 of the VEAC's Assessment of the Values of Victoria's Marine Environment.¹³ Each of the marine assets and threats to them are included on the relevant pages of the accompanying assessment atlas.¹⁵

Some 55 coastal reserves included 46 DELWP marine assets. Fifteen assets were significant at the state level, 12 at the bioregion level, 18 at the local level and one at the estuary level. Larger land units were more likely to overlap multiple assets, and larger assets were more likely to overlap multiple reserves.

While most reserves (44) only overlapped one asset, Yangery coastal reserve overlapped five assets. Over half of the identified assets (29) occurred in only one coastal reserve, while the North east Port Phillip Bay reef complex and Port Phillip Heads asset group are each found in five coastal reserves.

Ramsar wetlands

The 1971 Convention on Wetlands of International Importance especially as waterfowl habitat was signed in Ramsar, Iran. Known as the 'Ramsar Convention', this agreement aims to halt the worldwide loss of wetlands and conserve those that remain through wise use and management. There are 12 Ramsar sites in Victoria, five of which are coastal: Gippsland Lakes, Corner Inlet, Western Port, Port Phillip Bay (Western Shoreline) and Bellarine Peninsula, and Glenelg Estuary and Discovery Bay (see figure 4.7). All but the Glenelg Estuary and Discovery Bay sites overlap some coastal reserves. In total, 84 coastal reserves are within these four Ramsar sites.

Figure 4.7 Victoria's five coastal Ramsar sites



Biosphere reserves

Biosphere reserve is an international designation made by the United Nations Educational, Scientific and Cultural Organisation (UNESCO) based on nominations submitted by countries participating in the Man and the Biosphere Program. Victoria has two biosphere reserves – Croajingolong National Park (designated in 1977) and Mornington Peninsula and Western Port (2002).

The biosphere reserve concept promotes both conservation and sustainable use of natural resources. The program was launched in 1971 to stimulate a greater understanding and provision of knowledge and skills to support sustainable relationships between people and their environment. Biosphere reserves provide a global network of sites for cooperative research and to demonstrate the sustainable use goals of the World Conservation Strategy.

Only the Mornington Peninsula and Western Port biosphere reserve includes areas of coastal reserve. A total of 58 coastal reserve land units form part of this biosphere reserve.

Key Biodiversity Areas

Birdlife International has identified 20 sites along the Victorian coast that are globally significant for migratory shorebirds (see figure 4.8). Formerly known as Important Bird and Biodiversity Areas (IBAs), these sites were reassessed and named Key Biodiversity Areas (KBAs). Each KBA needs to either have more than half of one per cent of an endangered species population, or at least one per cent of the total population of a species at a critical stage of their life cycle e.g. migration stopover. Examples of some of Victoria's threatened shorebirds are provided in figure 4.9.

Shorebird roosting sites

The Oil Spill Response Atlas is a national database maintained by the Australian Maritime Safety Authority. Some of the spatial information this database contains are details of sites of biological and environmental significance that could be impacted by a marine oil or chemical spill. Data on shorebird and seabird roosting, feeding and nesting sites were extracted from this database. While many of these important sites overlap terrestrial protected areas or Ramsar wetlands, a number do not. Of the 22 coastal reserves hosting these sites, nearly half (10 reserves) are not part of Ramsar wetlands.

Figure 4.8 Key biodiversity areas along Victoria's coast as identified by Birdlife International

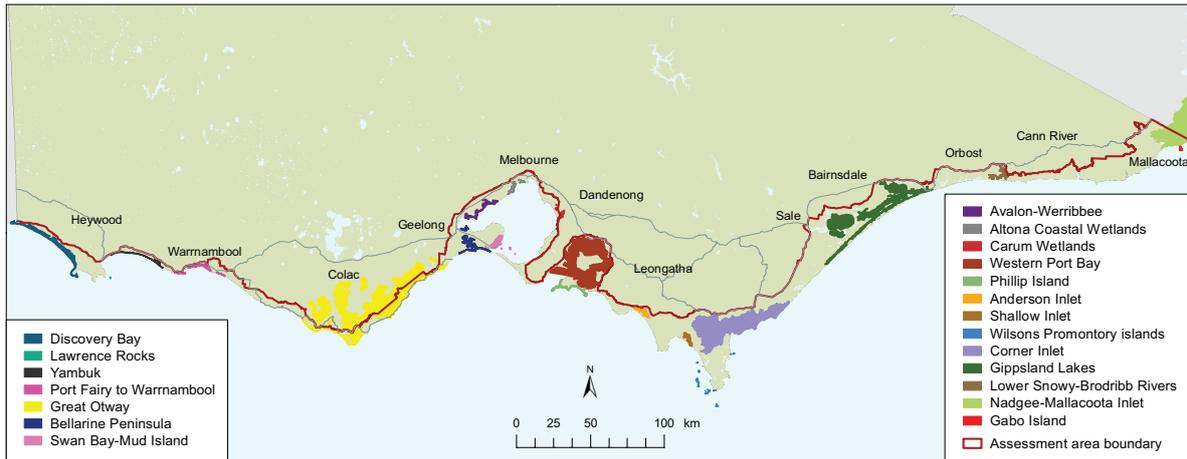


Figure 4.9 Photos of some of Victoria's threatened shorebirds: resident Hooded Plover (left) and migratory Bar-tailed Godwit (right) (Photos: M Mitchell)



Blue carbon

Coastal saltmarsh, mangroves and seagrass (collectively known as blue carbon ecosystems) have a key role in carbon sequestration, a key ecosystem service (see figure 4.10). Burial rates of organic carbon in these ecosystems are exceptionally high¹⁶ and can be 30-50 times higher than rates in the soils of terrestrial forests.¹⁷ This is in part because blue carbon ecosystems can trap particles and suspend sediments out of the water column. Undisturbed, these sediments accrete over time.¹⁸ This allows blue carbon ecosystems to continually capture carbon, unlike terrestrial ecosystems in which carbon capture may eventually plateau.¹⁹

In Victoria, more than 2.91 million megagrams (Mg) of organic carbon is stored in the top 30 centimetres of sediment in blue carbon ecosystems. Coastal saltmarshes are responsible for almost 53 per cent of Victoria's blue carbon stock, although they represent only 30 per cent of the blue carbon

ecosystem area. Every year, Victoria's blue carbon ecosystems sequester around 22,700 Mg of additional organic carbon.¹⁶

Figure 4.10 Coastal ecosystems play an important role in storing carbon (blue carbon) and include marine and intertidal species such as *Posidonia australis* shown in (left) and saltbush and mangrove communities (right) found in Corner inlet Parks Victoria (L), R Molloy (R))



Blue carbon ecosystems were mapped across Victoria as part of The Nature Conservancy's Mapping Ocean Wealth project. This work was also supported by an Australian Research Council Linkage Grant led by Deakin University with The Nature Conservancy, University of Queensland, Parks Victoria, and DELWP as partners. The maximum recorded value for tonnes of carbon was used to assess coastal reserves with high soil carbon. Researchers advised that values above 350 tonnes of carbon are assessed as 'high.' Some 25 reserves had high values for soil carbon, ranging from 548 tonnes (Gippsland Lakes Reserve) to 360 (Hollands Landing- Gippsland Lakes Reserve). Reserves with high soil carbon ranged in size from 2,577 hectares to two hectares. A further 65 reserves had moderately high values for soil carbon (between 150 and 349 tonnes).

Conservation-listed species

Across Victoria, DELWP maintains non-statutory threatened species advisory lists for vertebrates²⁰, invertebrates²¹ and rare or threatened plants²² (see figure 4.11 for examples). Fauna species may be listed as critically endangered (extremely high risk of extinction in the wild), endangered (facing a very high risk of extinction in the wild), vulnerable (high risk of extinction in the wild), near threatened (close to qualifying for, or likely to qualify for a threatened category in the near future) or data deficient (more information is required and future research may show that threatened classification is appropriate). Flora species may be listed as endangered (at risk of disappearing from the wild state if present land use and other causal factors continue to operate), vulnerable (not presently endangered but likely to become so soon due to continued depletion), rare (not considered threatened but there are relatively few known populations or the taxon is restricted to a relatively small area) or poorly known (suspected to belong to one of the threatened categories, at present accurate distribution information is inadequate). Species and communities may also be listed on the *Flora and Fauna Guarantee Act 1988* (FFG Act) Threatened List. This list includes only those species or communities that have been nominated, assessed by the Scientific Advisory Committee and approved for listing by the Minister for Energy, Environment and Climate Change and the Minister for Agriculture and Food Security.

Federally, species may be listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as threatened. Species may be listed as critically endangered (CR: extremely high risk of extinction in the wild in the immediate future), endangered (EN: very high risk of extinction in the wild in the

near future), vulnerable (VU: high risk of extinction in the wild in the medium-term future) or conservation dependent (CD: a species is the focus of a specific conservation program, the cessation of which would result in the taxon becoming vulnerable, endangered or critically endangered within five years).

Four international treaties apply to migratory species which are native to Australia. These are the Bonn Convention, Japan-Australia Migratory Bird Agreement (JAMBA), China-Australia Migratory Bird Agreement (CAMBA), and Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).

To assess the presence of conservation-listed flora and fauna in coastal reserves, the Victorian Biodiversity Atlas was searched for records of species on the DELWP advisory lists, Flora and Fauna Guarantee Act, Environment Protection and Biodiversity Conservation Act, or international treaties (Bonn, JAMBA, CAMBA or ROKAMBA). A conservative approach was taken; fauna that were listed as data deficient or near threatened and flora that were listed as poorly known or rare on DELWP's advisory lists were included. To ensure data currency, only records of species since 1980 were included.

As vertebrates and vascular plants are relatively well studied, the listings for these taxa are more likely to be relatively good representations of their conservation status. Given the vast numbers of invertebrates (100 times more than vertebrates) and fungi (10 times more than vascular plants) and our relatively low level of knowledge about these species, the listings for these taxonomic groups should be viewed as underestimates. Across taxonomic groups, most marine species are less well known than terrestrial species, so listings for these species are also likely underestimates.

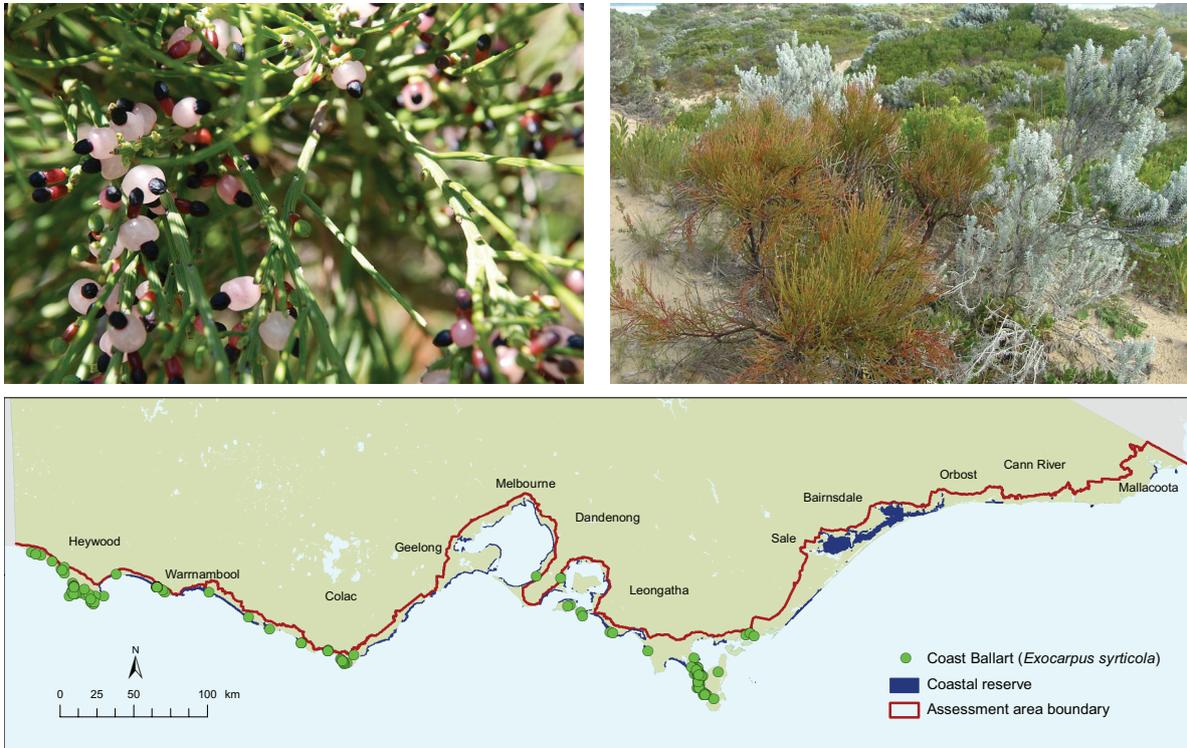
Fauna

Some 132 species of conservation-listed fauna were identified in 126 coastal reserves (appendix 5). DELWP advisory lists included 100 species (eight critically endangered, 19 endangered, 43 vulnerable, 28 near threatened and two data deficient), the FFG Act listed 57 species, the federal EPBC Act listed 42 species (five critically endangered, 14 endangered and 23 vulnerable), and 62 species were listed on international treaties (47 Bonn, 36 CAMBA, 35 JAMBA, 29 ROKAMBA) (appendix 5).

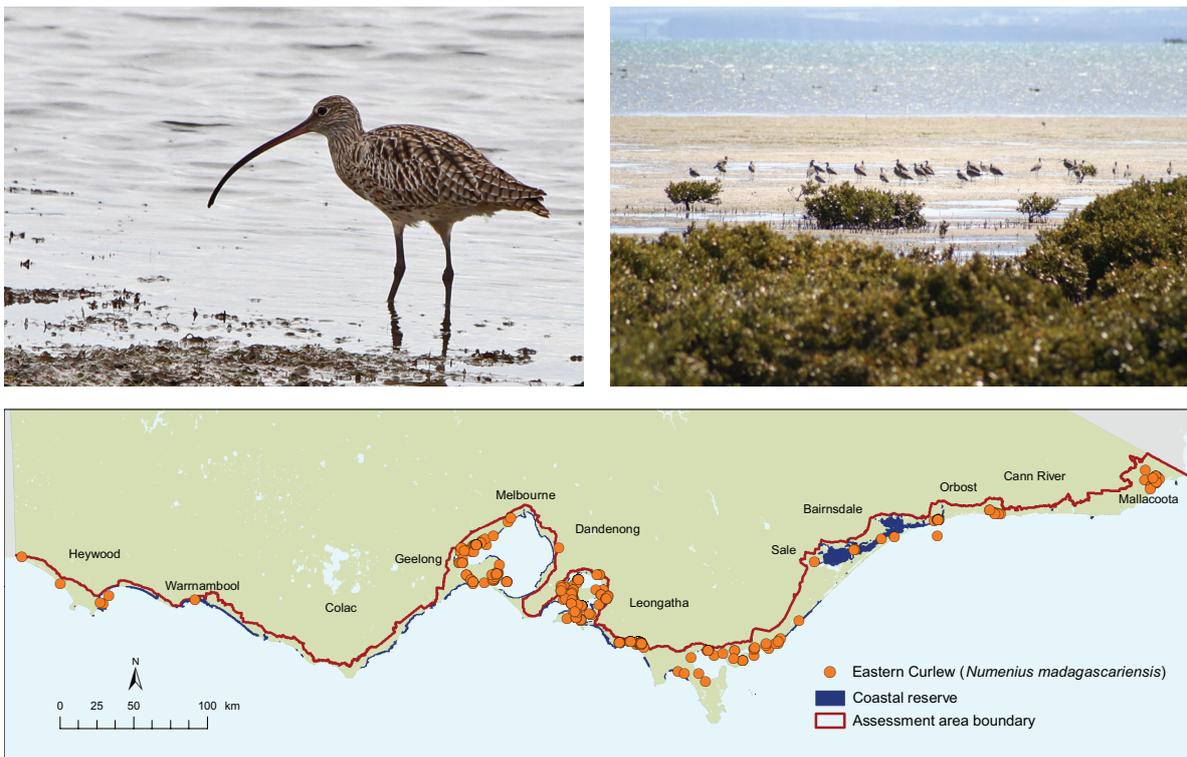
Across all listings, seven invertebrates, three fish, three amphibians, seven reptiles, 92 birds and 20 mammals were included. Approximately one quarter of species (36) were only recorded in a single coastal reserve land unit. The most widely recorded species were the pied cormorant and Pacific gull which were recorded in 50 and 72 reserves respectively. Single records of species were sometimes due to the restricted nature of species distributions (e.g. Sherbrooke amphipod *Austrogammarus haasei*) but not always; the blue whale *Balaenoptera musculus* was also recorded in only one coastal reserve. This pattern also partly reflects survey effort. The Gippsland Lakes Reserve had 47 records of conservation-listed species, while 27 reserves had only one species recorded.

Figure 4.11 Examples of conservation-listed coastal species (records 1980- current)

Coast Ballart *Exocarpus syrticola* is a species of coastal shrub listed as rare in Victoria. Restricted to southern coastal dunes and cliffs, this species occurs from near Wilsons Promontory west to Port Lincoln, South Australia (Photos: B Doyle (L), S Sinclair (R))



Eastern Curlew *Numenius madagascariensis* is Australia's largest migratory shorebird and is listed as critically endangered on the national EPBC Act and the international treaties Bonn, CAMBA, JAMBA, ROKAMBA. In Victoria this species is listed as vulnerable. (Photos: M Mitchell)



Flora

Some 75 species of conservation-listed fauna were identified in 47 coastal reserves (see appendix 5). DELWP advisory lists included 75 species (11 endangered, 21 vulnerable, 36 rare and six poorly known), the FFG Act listed 20 species, and the federal EPBC Act listed nine species (four endangered and five vulnerable).

Across all listings, two epiphytes, one fern, four vines, 20 herbs, 13 orchids, 11 grasses, 18 shrubs, and six trees were included. Many reserves (22) had only one conservation-listed species recorded. The Gippsland Lakes Reserve and Narrawong Coastal Reserve each had eight species recorded. While most plants (53) were recorded in only one reserve, the most widely-recorded conservation-listed species (marsh saltbush *Atriplex paludosa subsp. paludosa* and thick-lip spider orchid *Caladenia tessellata*) were each recorded in five coastal reserves.

4.4 Aboriginal values and interests

As noted in chapter 1, Traditional Owners do not separate marine from coastal or associated catchment values. For the recent Assessment of the Values of Victoria's Marine Environment, Traditional Owners advised VEAC that the nature of Aboriginal culture and knowledge means that there is not a well-documented inventory of information relating to sections of the Victorian coast available to decision-makers. This was considered to represent a very significant gap under the terms of reference for the assessment.

VEAC's Assessment of the Values of Victoria's Marine Environment provided an outline of the Aboriginal cultural values for Sea Country in Victoria, based on a report prepared for VEAC by the Federation of Victorian Traditional Owner Corporations. A strategic framework prepared by the Federation was also included articulating Victorian Traditional Owners' long-term goals and objectives for developing and applying Indigenous knowledge and practice for Sea Country in a contemporary Victorian context.

Marine and Coastal Policy and Marine and Coastal Strategy

There are a number of provisions in the new *Marine and Coastal Act 2018* that support Traditional Owner rights and interests, including:

- to acknowledge Traditional Owner groups' knowledge, rights and aspirations for land and sea Country
- to engage with specified Aboriginal parties ... in marine and coastal planning, management and protection.

The Marine and Coastal Act Transition Plan notes desired outcomes that include stronger links to cultural values in the planning and management of the marine and coastal environment. The *Draft Marine and Coastal Policy (2019)* acknowledges that institutional barriers have limited the opportunities for many Traditional Owners to manage and use land and Sea Country, and to have their voices heard in planning and decision-making processes.

Development of the Marine and Coastal Policy and Marine and Coastal Strategy offers opportunities to incorporate cultural values and the aspirations, rights and interests of Traditional Owner communities.

Sea Country plans

The foundational, consistent planning document for Victorian Traditional Owner groups, that sets out their aspirations and goals with respect to managing Country, is the Country Plan. A Country Plan is a document that is prepared and approved by Traditional Owner Corporation groups, under self-determination principles.

Where appropriate, Country Plans may include Sea Country plans that form a suitable basis to guide group directions and priorities for Sea Country (as advised by Elders and other knowledge holders for that Country) and further informed by the values and strategic directions expressed by Traditional Owners.

The status of Country Plans and Sea Country Plans for the Victorian marine and coastal environment is summarised in table 4.4 below.

Table 4.4 Status of Country Plans and Sea Country Plans for Victorian Traditional Owner groups

Traditional Owner group	Prescribed Body Corporate, Traditional Owner group entity or RAP	Country Plan status	Sea Country plan status
Gunditjmara	Gunditj Mirring Traditional Owner Aboriginal Corporation	No ²³	Koonang Mirring (Sea Country) plan to be developed in 2019 ²⁴
Eastern Maar	Eastern Maar Aboriginal Corporation	Yes ²⁵	Sea Country Plan to be developed in 2019
Wathaurung/ Wadawurrung	Wathaurung Aboriginal Corporation	No	Country Plan that incorporates Sea Country interests will be produced in 2019
Bunurong/ Boon Wurrung	Bunurong Land Council Aboriginal Corporation	No	Country Plan that incorporates Sea Country interests will be produced in 2019
Wurundjeri	Wurundjeri Land and Compensation Cultural Heritage Council Aboriginal Corporation	Yes	Country Plan currently under review and not publicly available
Gunaikurnai	Gunaikurnai Land and Waters Aboriginal Corporation	Yes ²⁶	Country Plan addition outlining the importance of sea birds will be produced in 2019

4.5 Non-Aboriginal cultural heritage

The sea and coast have played a central role in the early economic, social and physical development of Victoria by non-Aboriginal settlers. Physical evidence of past dependence on the sea and coast remains in numerous historic places and objects along the coastline and offshore.

The early history and settlement of the coastline is documented in several publications²⁷ and summarised in chapter 8 of VEAC's *Assessment of the Values of Victoria's Marine Environment Report 2019*. Many historic sites along the coast record this varied history including industries such as sealing and whaling, transportation ports and infrastructure including maritime safety such as lighthouses, defence and quarantine, as well as recreation and visitor facilities for public bathing.

This section reports on historic and non-Aboriginal cultural heritage, including historic places or sites, historic landscapes or areas, historic buildings or groups of buildings, historic objects, post-contact Aboriginal Cultural Heritage places, sites or objects. Unlike VEAC's recent Historic Places Investigation (2016), this assessment focuses only on *high* historic values on coastal reserves i.e. those sites of state significance and above located or partly located on coastal reserves.

Historic themes

In 2000 the Australian Heritage Commission developed a national framework – the Australian Historic Themes Framework. In 2010 the Heritage Council of Victoria and Heritage Victoria built on this national work and published a framework specifically for Victoria comprising nine historical themes. The framework recognises that all places in Victoria have associations for Aboriginal people.

The nine historical themes demonstrate the many complex layers of Victoria's history and provide a framework for understanding and interpreting heritage values. Structures, objects, human experiences and the environment can be understood through several themes simultaneously providing linkages and a wider historical context. For example, structures built during the formation of Victoria, such as Point Nepean and the Point Gellibrand Battery site at Williamstown, can be interpreted through the themes covering 'Governing Victoria', 'Peopling Victoria's places and landscapes' and 'Building Victoria's industries and workforce'. The historic theme 'Shaping Victoria's environment' looks at living with natural processes such as the coast and includes places and objects like shipwreck relics and lighthouses. The many historic jetties, piers, and ports along Victoria's coast encompass themes of 'Peopling Victoria's places and landscapes' and 'Connecting Victorians by transport and communications'. Together these themes link the story of immigration with the development of maritime trade.

Themes are also useful for understanding the cultural role of coastal areas in community life as seen through 'Shaping cultural and creative life' which helps to explore the history of the coast in sports, arts, popular culture and entertainment. Climatic and topographic changes too are explored as part of coastal heritage through 'Shaping Victoria's environment' focusing on the climatic and topographic changes which are often most observable along the coastline.

Legislative protection and recognition

Historically significant places and objects in Victorian waters and on land are protected under the *Heritage Act 2017*. The Act includes provisions for all shipwrecks and relics in Victorian state waters including bays, harbours and rivers such as Port Phillip Bay and Gippsland Lakes. Shipwrecks and other underwater cultural heritage are also protected under complementary Commonwealth legislation.

Those places and objects of state significance are recorded on the Victorian Heritage Register (VHR) and archaeological sites listed on the Victorian Heritage Inventory. Shipwrecks are documented separately.

Places or objects of natural historic or Indigenous value to all Australians are registered on the National Heritage List under the provisions of the Commonwealth EPBC Act.

Figure 4.12 The Great Ocean Road is the only place of national heritage significance found on Victoria's coastal reserves. This place also includes areas of road reserve and national park (Photo: M Mitchell)



Coastal reserve sites of high cultural heritage value

National Heritage List places in Victoria's coastal environment are Point Nepean defence and quarantine precinct, Point Cook RAAF Air base (Commonwealth land), Great Ocean Road (Torquay to Allansford), HMVS Cerberus (near shore on the seabed). Of these, only the Great Ocean Road is partly located on coastal reserves (see figure 4.12).

There are 42 Victorian Heritage Register places at least partly located or objects housed on coastal reserves (see table 4.5). Most of these are in the central areas of the state with Hobsons Bay and Mornington Peninsula municipalities having the most sites.

Historic themes have been included in table 4.5 for each VHR site located on a coastal reserve. These themes categorise places and objects using 'Historic Group' as defined by Heritage Victoria. There are many cases where historic places represent multiple historic groups; in these cases the predominant historic group is used.

Shipwrecks

Shipwrecks, shipwreck artefacts and sunken aircraft in Victorian waters that are 75 years old or more are protected in Victoria under the Heritage Act. Protected Zones have been placed around particularly fragile or important wrecks where it is an offence to enter, anchor, fish, trawl or dive on without a permit. There are currently no protection zones applying to wrecks on coastal reserves. All underwater cultural heritage including shipwrecks, shipwreck artefacts and sunken aircraft in Victorian waters are also protected under the Commonwealth *Underwater Cultural Heritage Act 2018*.

Shipwrecks are some of the most readily recognisable sites of maritime archaeology but fewer than half of the 780 shipwrecks along the Victorian coast have been located. There are 29 known shipwreck sites on coastal reserves, around half of these are located along southwest Victoria's 'Shipwreck coast' - some 130 kilometres of coastline extending from Port Fairy to Cape Otway.

Table 4.5 Historic places and objects of national or state significance (VHR) on coastal reserves

Local Government Area (LGA)	VHR ID#	Site name	Historic group
National Heritage List			
Colac Otway/Corangamite/Moyne/Surf Coast	H2261	Great Ocean Road	Transport
Victorian Heritage Register			
WEST BLOCK			
Glenelg	H1773	Cape Nelson Lightstation	Maritime Industry
Moyne	H2213	Moyne River Training Walls	Maritime Industry
Moyne	H1659	Griffith Island Lighthouse, Port Fairy	Maritime Industry
Moyne	H1431	Lifeboat Station Port Fairy	Maritime Industry
Warrnambool	H2124	Warrnambool Breakwater	Maritime Industry
CENTRAL BLOCK			
Bayside	H2206	Former Old Melbourne Gaol Burial Markers	Law Enforcement
Greater Geelong	H1288	Lime Kiln Complex	Manufacturing and Processing
Greater Geelong	H0929	Eastern Beach Bathing Complex & Reserve	Recreation and Entertainment
Greater Geelong	H1848	Barwon Heads Bridge	Transport
Hobsons Bay	H1733	Wilkinson Memorial Fountain	Monuments and Memorials

Local Government Area (LGA)	VHR ID#	Site name	Historic group
Hobsons Bay	H1088	Gellibrand & Breakwater Piers	Maritime Industry
Hobsons Bay	H1512	Former Morgue Ann St, Williamstown	Government and Administration
Hobsons Bay	H1513	Tide Gauge House, Williamstown	Maritime Industry
Hobsons Bay	H1649	Time Ball Tower, Williamstown	Maritime Industry
Hobsons Bay	H1790	Melbourne Harbour Trust Stores & Workshops	Manufacturing and Processing
Hobsons Bay	H1811	Fort Gellibrand, Williamstown	Military
Hobsons Bay	H1885	Blunts Boatyard & Slipway, Williamstown	Maritime Industry
Hobsons Bay	H0927	Dressing Pavilion, Williamstown (part)	Recreation and Entertainment
Hobsons Bay	H1599	Williamstown Railway Station Complex	Transport
Mornington Peninsula	H0759	Coolart (Southern boundary along stream)	Agriculture - Farming and Grazing
Mornington Peninsula	H1050	Collins Settlement Site, Sorrento	Exploration, Survey and Historical Events
Mornington Peninsula	H1090	Former Fort Franklin (Portsea Camp)	Military
Mornington Peninsula	H0906	Former Jetty Cargo Shed, Flinders	Maritime Industry
Mornington Peninsula	H1996	The Pines Foreshore Reserve, Shoreham	Recreation and Entertainment
Mornington Peninsula	H2299	Rosebud Sound Shell	Recreation and Entertainment
Mornington Peninsula	H1516	Lighthouse, McCrea	Maritime Industry
Mornington Peninsula	H1748	Cape Schank Lightstation	Maritime Industry
Port Phillip	H1805	Catani Gardens, St Kilda (part)	Parks, Gardens and Trees
Port Phillip	H0982	Leading Lights, Port Melbourne	Maritime Industry
Port Phillip	H1534	Kerferd Road Pier, Albert Park	Maritime Industry
Port Phillip	H0984	Station Pier Northern Section, Port Melbourne	Maritime Industry
Port Phillip	H0981	Princes Pier, Port Melbourne	Maritime Industry
Queenscliffe	H1517	Point Lonsdale Lighthouse	Maritime Industry
Queenscliffe	H1515	Steamer Pier & Lifeboat Shed, Queenscliff	Maritime Industry
Surf Coast	H2032	Bells Beach Surfing Recreation Reserve	Recreation and Entertainment
Surf Coast	H2270	Split Point Lightstation, Aireys Inlet	Maritime Industry
EAST BLOCK			
East Gippsland	H1983	Point Hicks Lightstation	Maritime Industry
East Gippsland	H1648	Slip & Winch Shed, Paynesville	Maritime Industry
East Gippsland	H1532	New Works Historic Complex, Lakes Entrance	Maritime Industry
South Gippsland	H2043	Walkerville Lime Kilns	Manufacturing and Processing
Gabo Island	H1843	Gabo Island Lightstation (part)	Maritime Industry

4.6 Tourism and recreation

Tourism on Victoria's coast

Tourism involves people travelling to, and staying in, places for short periods of time typically for leisure or business.²⁸ Tourism contributes to regional economies through money spent on transportation, accommodation, food and beverages, entertainment, equipment, sightseeing, souvenirs and various other services or products.

Marine and coastal tourism are distinct but closely related forms of tourism. While marine tourism is connected to, and dependent on, the sea and the marine environment, coastal tourism is generally associated with land-based activities that are linked to a coastal location. Victoria's most popular marine and coastal visitor destinations are the Twelve Apostles on the Great Ocean Road and the Penguin Parade on Phillip Island. Neither of these include areas of coastal reserve.

Coastal tourism in Victoria includes visits to maritime museums and lighthouses, scenic lookouts and driving, activities such as birdwatching and whale-watching (from land) and coastal walks. Many of these activities take place in Victoria's coastal reserves or the associated buildings and facilities (such as the museums and lighthouses) located on coastal reserves. For example, Victoria has more than 20 lighthouses, 11 of which are located on coastal reserves. Ten of the lighthouses are open to the public (including Point Lonsdale and Split Point lighthouses that are both located on coastal reserves).

Popular coastal walks or multi-use trails offer visitors unique views of Victoria's coastline in areas that are not always accessible otherwise. Examples of Victorian coastal walks that pass through coastal reserve include the Surf Coast Walk (a multi-use trail in the Great Ocean Road region running between Torquay and Aireys Inlet) and the George Bass Coastal Walk (a cliff-top trail stretching between San Remo and Kilcunda).

Coastal reserves often provide an entry point to the marine environment. While marine tourism activities take place in the sea, the supporting facilities and infrastructure are often found on coastal reserves. For example, boat-based tourism is a growing industry and includes dive boats, fishing charters, scenic cruising boats and yachts. Associated marine access infrastructure (such as boat ramps, launches, slipways, jetties and piers) is found on coastal reserves. Information prepared by DELWP on marine access indicates that 97 coastal reserves offer marine access (70 launches, 61 ramps, 11 slipways, 27 jetties, 12 piers). These data includes marine access infrastructure in the Gippsland Lakes – a popular area for boating and an important tourism destination.

Coastal caravan and camping parks are a popular choice of accommodation in coastal areas. There are more than 60 caravan parks on 50 coastal reserves in Victoria – around 20 per cent of Victoria's coastal reserves host a coastal caravan and camping park.

Economic importance of coastal tourism in Victoria

Victoria has twelve tourism regions, of which six include coastal areas: Great Ocean Road, Geelong and the Bellarine, Melbourne, Mornington Peninsula, Phillip Island and Gippsland. The coastal tourism regions (excluding Melbourne), which contribute about 15 per cent of the gross state product,²⁹ have a strong dependence on the natural values of the marine and coastal environment for attracting visitors and tourism investment. However, at a regional scale it is difficult to identify how much of this tourism is related to Victoria's coast, thus making it difficult to determine the importance of the coast and more specifically, coastal reserves, to tourism and Victoria's economy.

Licensed tour operators, ecotourism and emerging tourism

People or businesses who conduct an organised tour or recreational activity in Victoria for profit on public land (including the marine environment) are required to have a tour operator licence. There are more than 80 licensed tour operator licences currently issued over approximately 30 coastal reserves by Parks Victoria.

Ecotourism is ecologically sustainable tourism with a focus on increasing environmental and cultural awareness. Compared with more traditional tourism, ecotourism has a lesser environmental impact. Popular activities include swimming with and viewing marine mammals, surfing and paddling – sometimes taking place from or relying on facilities on coastal reserves, or entering the marine environment through a coastal reserve.

Growing or emerging tourism sectors include Aboriginal cultural experiences, nature-based and adventure tourism.

Recreation on Victoria's coast

Recreation is defined as the activities people pursue in their free time. One of the main objectives of the coastal reserve public land use category is to provide for informal recreation associated with enjoyment of the coastal environment (figure 4.13). More formal or developed recreation, sports and visitor facilities are also found in many coastal reserves. For example, in some places, coastal reserves include bowls clubs, golf courses and public buildings.

Figure 4.13 A broad range of recreational and tourism activities are popular on Victoria's coastal reserves (Photo: L Lewis)



Research commissioned by DELWP identified that coastal areas are an important part of the lives of most Victorians.²² Of those surveyed, 77 per cent had made at least one day trip to the coast in the past year, with the average number of day trips being 16. Of those who visited the coast, the most commonly reported activities were walking/hiking, swimming, nature appreciation, sunbathing/relaxing on the beach and fishing. Nineteen per cent of the respondents said they just enjoyed being on the coast.

A survey conducted by DELWP in collaboration with BehaviourWorks reported in *Victorians Value Nature Survey Results 2019* found that beaches were ranked in the top three places that Victorians felt most connected to nature. These results reflect the sense of peace and relaxation that many people describe when they visit coastal areas, whether it be escaping a busy urban life through outdoor recreational pursuits, the feeling of awe when visiting sites of scenic beauty, or simply the aesthetic value of the natural environment and the solace this may provide. For many, there is an inherent appreciation of the natural world, the value of open space and the benefits to both physical and mental health of slowing down and taking time to connect with nature. Sometimes it is simply the knowledge that natural places exist, whether they are experienced directly or not. It is important to many people that they are able, if they choose, to access natural areas themselves, but also to know that future generations will be afforded the same opportunity.

Contribution of coastal reserves to recreation

Coastal reserves often provide access and entry to the marine environment. Many recreational activities that take place on or in the water are supported by facilities and infrastructure that are located onshore on coastal reserves. These associated facilities and infrastructure have been principally established for community use and they continue to support the recreational uses and any associated tourism in these areas. Examples include surf lifesaving club rooms, sailing and yacht clubs, bowls clubs, golf courses, community halls and ovals (sometimes including sports club rooms), swimming pools, tennis courts, rotundas, picnic and barbeque areas, skate parks and marine access infrastructure such as boat ramps and jetties. Around ten per cent of Victoria's coastal reserves include areas of active sports facilities such as bowls clubs, golf courses, skate parks, swimming pools and tennis courts. Examples include the Inverloch Bowling Club, the Rosebud Bowls Club and the Port Fairy Golf Club, each located on coastal reserve.

The occurrence of facilities and infrastructure on coastal reserves (compared to other land tenures) is variable. For instance, more than 90 per cent of Victoria's surf lifesaving clubs are located on coastal reserves (54 clubs on 36 coastal reserves). Similarly, of the 87 sailing or yacht clubs in Victoria (listed by Australian Sailing), more than 65 per cent are located on coastal reserves (58 clubs on 39 coastal reserves).

Coastal reserves provide for a broad range of recreational uses including defined areas specifically for popular activities, such as the Lorne 'dog beach' and a dog-friendly beach in San Remo.

Recreation and tourism in the future

Facilities and infrastructure supporting recreational uses and tourism are found on various land tenures including coastal reserve, land owned by local councils and private freehold land. Land tenure is not often known or understood by the public, and it can be complicated with different tenures existing side-by-side or even within an area of a single building or facility. Rather than tenure, it is the continuation of access to coastal areas, public facilities or infrastructure, and to the marine environment, that is important to most people. Maintaining access to coastal areas (and the facilities and infrastructure) and retaining coastal land in the public land estate are most important.

As Victoria continues to experience population growth and urban densification, the pressure on Victoria's coastal areas to provide opportunities for tourism and recreation is likely to increase. Urban population growth interacting with climate change generates a complex mix of threats to tourism and recreation. These include overcrowding and conflict between users, climate change impacts to natural (e.g. beaches) and built (e.g. boat ramps) assets and decreased water quality. This makes it increasingly important that we maintain the opportunities that are currently offered and look for new opportunities where practical given climate change impacts.

Information provided by land managers indicates that many coastal reserves are at or over capacity much of the summer period but there is limited knowledge on current visitor numbers at a fine scale. Areas within approximately two hours from Melbourne appear to be experiencing the most overcrowding. In addition, the number of applications for access or to construct jetties and boat moorings is significantly increasing and onshore facilities are often overcrowded with impacts encroaching into adjoining areas.

The online inventory supporting this draft report provides a record of built community facilities, marine access infrastructure, caravan or camping areas and active sport facilities as indicators of the types of significant recreation and tourism values present on coastal reserves.

4.7 Coastal development

Coastal development is influenced by broader settlement patterns and population trends. More recently, coastal development has been driven by increasing population, lifestyle choices (sea change) and recreation, and facilitated by improved roads and reduced travel times.

VEAC's Assessment of Values or the Marine Environment 2019 provides a summary of coastal development. This section restates the key points relevant to coastal reserves and summarises demographic data to contextualise the changing nature of coastal land use and the demands of a growing population on the environment.

Pressures from population growth and the effects of climate change, including sea level rise, storm surges and altered weather patterns, will drive new patterns of coastal development into the future.

Key points relevant to coastal reserves are:

- Demographic data provide context for assessing impacts of people on the marine and coastal environment and for planning future needs. Limiting development within township boundaries protects some natural and social values but puts increased pressure on others.
- Demand for coastal access will increase with population growth. Crowding at boat ramps, conflict between users (e.g. boats and swimmers), noise and chemical pollution are all emerging concerns.
- Victoria has more than 400 boat launching sites, yacht clubs and marinas. These facilities provide access to the marine environment but create localised impacts.
- There are more than 1000 coastal protection structures (e.g. sea walls) in Victoria with a replacement cost of about \$700 million. Ageing and inadequately maintained structures are increasingly subject to climate change impacts and increased use by growing populations.
- While coastal protection structures protect approximately \$10 billion dollars of built assets, they can alter the physical and ecological dynamics of coastal areas, alter settlement patterns for plants and animals and facilitate colonisation by marine pests.
- Beach renourishment protects and stabilises sandy beaches with lower environmental impacts than hard structures. However, it is costly and temporary.

Coastal demography

VEAC's recent Assessment of Values or the Marine Environment provides a summary of coastal population and settlement patterns based on Australian Bureau of Statistics and other government data sources prepared by the Land Use and Population Research group within DELWP.³¹ The analysis shows coastal settlement patterns are related to the proximity to urban centres, particularly Melbourne, the radial nature of settlement along the coast and transport corridors, and the lasting influence of historic coastal trading ports.

Trend information shows that the number of people living along the coast is increasing in areas that are within two hours' drive of Melbourne. For example, populations in coastal towns such as Torquay and Ocean Grove west of Melbourne, and Dromana on the Mornington Peninsula are growing at a faster rate than towns further away from Melbourne. Coastal towns in the far east and far west of the state recorded declining populations in 2016-17.

The limitations to growth of coastal populations in Victoria is partly attributed to the significant area of national parks and reserves along the coast, and planning controls that keep residential development within township boundaries. Consequently, where populations are higher and access to the coastline is available, pressures on the environment and resources are increasing.

Age profiles in coastal towns are influenced by migration and natural population increase. People at different stages in their lives have specific needs and interests in the marine and coastal environment which has implications for marine and coastal management. For example, people with young children

may want access to safer swimming beaches, while people with mobility difficulties such as the elderly may require ramps rather than stairs to access beaches. Younger retirees are more likely to make greater use of coastal assets, such as boating facilities. More couples and young families have been attracted to centres like Torquay, which has resulted in population growth through natural increase as well as net in-migration.³¹ Bass Coast and Far East Gippsland show the highest proportion of population being in the 60 to 69 years age category.

A key characteristic of most coastal settlements is the relatively high proportion of holiday homes, with non-residents and changes in levels of habitation between week days and weekends, and during summer time or school holidays. A total of 36,800 unoccupied dwellings were counted in Victorian coastal towns and cities (excluding Melbourne and Geelong) by the 2016 census representing an average winter vacancy rate of around 37 per cent.

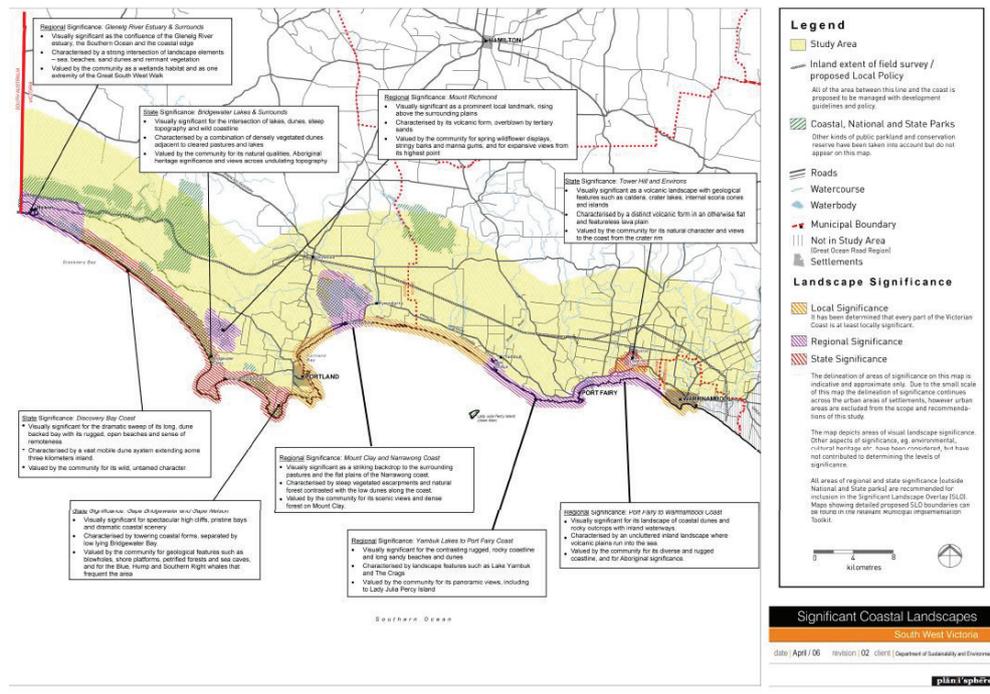
Some areas experience very high population peaks for festivals or sporting events. The annual Pier to Pub swim at Lorne can attract an additional 20,000 visitors. This represents a 20-fold increase over the resident population.

Coastal landscapes

The importance of recognising and protecting coastal landscapes from inappropriate development has been acknowledged in the various versions of coastal strategies or regional coastal plans and identified as management overlays in several past LCC/ECC/VEAC studies.

The *Planning and Environment Act 1987* provides most legislative controls for landscapes including the new Distinctive Areas and Landscape provisions introduced in 2018. Planning schemes and overlays together with restrictions for settlement boundaries (urban growth) signal the need to protect significant coastal landscapes from development impacts. The former Victorian Coastal Council and DSE's commissioned *Coastal Spaces Landscape Assessment Study* (2006) also provides a framework for managing impacts on significant landscapes (figure 4.14). DELWP is currently reviewing the implementation and effectiveness of these planning instruments in parallel with the Great Ocean Road Action Plan and establishing the Distinctive Areas and Landscapes for the Bass Coast, Bellarine Peninsula and Surf Coast.

Figure 4.14 Sample of map from *Coastal Spaces Landscape Assessment Study* (2006) identifying significant coastal landscapes



The *Draft Marine and Coastal Policy 2019* also acknowledges the importance of natural features and landscapes (including seascapes) with two associated policy statements to protect and enhance these values.

The coastal reserves inventory includes identification of significant landscapes as reported in the 2006 study. A summary of the sections of coastline identified as coastal landscapes of state significance and the approximate area of coastal reserves is provided in table 4.6.

Table 4.6 Sections of coastal reserves identified as state landscape significance in the 2006 Coastal Spaces Landscape Assessment Study report to VCC and DSE

Sites of coastal landscape significance	Area of coastal reserves (hectares)
Cape Bridgewater and Cape Nelson	30
Coastline from west of Princetown to Warrnambool	2900
Coastline from west of Cape Otway to west of Princeton	21
Coastline from east of Skenes Creek to west of Marengo	1400
Coastline from Lorne to west of Kennett River	900
Coastline and Otway Ranges from Breamlea to Lorne	800
Bells Beach Coastal Landscape	400
The Heads at Point Lonsdale	200
Phillip Island Western and Southern Coast	140
Cape Liptrap to Waratah Bay	1600
Nooramunga Coast and Islands	300
Ninety Mile Beach	1700
Gippsland Lakes	40,200
Cape Conran Coast	450
Croajingolong Coast	140
Mallacoota Inlet and Surrounds	200

4.8 Resource uses and licensed occupations

Across Victoria, public land is an important source of natural resources particularly timber, stock grazing, apiculture, earth resources and water. Coastal reserves, because of their small size and position in the landscape, provide for relatively few extractive resource uses. Much of the economic value of coastal reserves is derived from visitors to the coast for recreation and tourism (described in section 4.6).

Licence and lease (tenures) data provided by DELWP for areas identified as coastal reserves shows that there are some 138 tenures directly issued by the department as summarised in table 4.7. Delegated managers of Crown land (mainly local government and committees of management) may also issue certain types of tenures. A total of 81 tenures issued by committees of management are recorded mostly consisting of buildings or infrastructure such as caravan parks, tourist or recreation-related facilities. Committees of management also issue tenures for bathing boxes and boat sheds, most of which are located on coastal reserves. This information is not centralised and therefore an estimate of the numbers of these assets is not readily available. There are believed to be some 2000 coastal boatsheds and bathing boxes in Victoria, mostly in Port Phillip Bay, Western Port and Gippsland Lakes.

Table 4.7 Summary of Crown land licence types for coastal reserves (source DELWP, 2019)

Licence/tenure type	Number of tenures
Direct tenures	138
Grazing licence	14
Unused road licence (grazing)	3
Water frontage licence (grazing)	54
Riparian management licence	6
Surf lifesaving club lease	12
Other licence	22
Other lease	23
Apiculture	4
Committee of Management tenures	81
Lease	51
Licence	30

Jetties

Information held by DELWP on licences issued for jetties and mooring is not spatially defined and cannot be readily assessed to determine the underlying Crown land status or reservation. Many jetties exist over unreserved Crown land forming the seabed and therefore cannot be attributed to a Crown land parcel. Around 625 jetty licences have been issued for coastal municipalities. VEAC is unable to determine how many of these are located at least partly within coastal reserves (including the Gippsland Lakes); however, around 340 licences are from East Gippsland and Wellington LGAs.

Agricultural resources

Stock grazing

Domestic stock grazing is undertaken on public land under licence or permit. Grazing may also be undertaken as a land management tool; in particular, short term or intermittent grazing at low stocking rates has been demonstrated to maintain grassland habitats and to control weeds by reducing overall biomass. Grazing licences do not confer exclusive use of public land to the licence holder. Certain types of recreation are permitted on the licensed area such as walking, fishing and nature appreciation. However, members of the public are not permitted to camp or light fires on the licensed land.

There are some 71 Crown land licences that include grazing across Victoria's coastal reserves (table 4.7), although not all of this area is necessarily grazed. Most areas are licensed to adjoining land owners and may not be readily distinguished from the abutting freehold land.

Apiculture

Apiculture (beekeeping) utilises public land for both production of honey and to rest bees before undertaking pollination of private agricultural crops. There are four apiculture permits or licences held over areas of coastal reserve and four designated sites in the east of the state. These sites are utilised in rotation depending upon local flowering conditions.

Earth resources

Victoria's coastal environment has not been historically heavily used for production of earth resources. Coastal land is becoming used more for renewable energy, particularly wind farms.

The availability of good quality building and construction materials has played an important role in the development of a prosperous city. In the past materials such as basalt (bluestone and blue metal), sand, gravel and clay minerals have been readily obtained from coastal Crown land nearby to the population centres.

Mineral and extractive resources

Known mineral occurrences along the coast are not economic to extract and the potential for new resources is low. However building and agricultural materials have been extracted from coastal Crown land in the past. Some of these are limestone, sea salt, crushed rock, and building stone and they were mostly used in nearby areas.

Quarries produce predominantly hard rock, clay, sand and gravel, which are mostly used for constructing houses, public infrastructure and private sector developments. The total number of quarries has remained relatively stable over the last decade. As at 30 June 2018, there were 881 current work authorities for quarries across Victoria; only two include areas of coastal reserves.

Historically coal was mined from sea cliffs and shore platforms at Cape Patterson and Kilcunda. In some places brown coal seams are known to extend offshore and at Eastern View near Anglesea where seams outcrop along the beach. Mining for coal does not currently occur in coastal reserves.

Petroleum – oil and gas resources

Oil and gas were first discovered in Victoria in 1924 at Lake Bunya near Lakes Entrance. Exploration commenced in the Otway Basin in 1941. The first offshore production well (Barracoota-1) drilled in the Gippsland Basin in 1964. Today petroleum production occurs largely in Commonwealth waters of the offshore Gippsland, Otway and Bass basins, located along Victoria's southern coastline.

There is currently no onshore natural gas production in Victoria. The *Petroleum Act 1998* was amended in 2017 to impose a moratorium on any petroleum exploration and petroleum production in the onshore areas of Victoria until 30 June 2020. The amendments also ban hydraulic fracturing and prevent the exploration for, and mining of, coal seam gas.

Exploration and production for offshore gas continues, including drilling from onshore to offshore which substantially reduces both the visual impacts and infrastructure footprint of drilling projects. Near Port Campbell the Iona and Otway gas plants process natural gas from the near shore Halladale-Speculant and nearby gas fields of the Otway Basin via a 33-kilometre pipeline.³² Onshore processing occurs at Longford for the offshore Gippsland Basin gas fields located in Commonwealth waters.

Renewable energy

Coasts have the potential to provide renewable energy sources from wind, waves and tides. While potential for wave and tidal energy generation has been identified in Victoria, the costs are prohibitive without significant government investment. In recent years a pilot wave energy project near Port Fairy was abandoned due to ongoing technical problems and costly time delays.

Wind farms operate on coastal land in several locations in Victoria. Most sites are located on private freehold land (e.g. see figure 4.15). Four sites at Portland operate 98 turbines (Yambuk, Cape Nelson south, Cape Sir William Grant, Cape Bridgewater), nearby to Victoria's first wind farm opened in 2001 at Codrington. Coastal reserve south of Portland hosts the Cape Sir William Grant wind farm. In the east of the state wind farms are located on private land at Wonthaggi, Bald Hills, and Toora.

Figure 4.15 Windfarms located on private land adjoining Cape Bridgewater (Photo: M Mitchell)



Geothermal energy

As at 30 June 2018, there were five current geothermal energy exploration permits in Victoria. No geothermal energy retention leases or production licences were granted in 2017-18. Geothermal energy activities in Victoria currently remain limited to exploration.

Coastal infrastructure

Utilities and government services reserve is a broad public land category that encompasses uses such as transport (roads and railways), commercial ports, cemeteries, hospitals, government buildings, water or sewage treatment facilities, justice services and easements for water, electricity or gas. Public land allocated to this category has utilities as the primary purpose but may also provide for other compatible secondary uses. One of the largest of these areas is Melbourne Water's Western Treatment Plant comprising some 6685 hectares on the western shoreline of Port Phillip Bay fringed by a narrow strip of mostly intertidal coastal reserve.

The public land use category of coastal reserve is for land set aside primarily for public recreation, education and conservation of natural environments but also provides for a range of compatible services and utilities. In particular utilities supporting coastal activities and navigation such as lighthouses, and markers or beacons are more likely to be located in coastal reserves than on other coastal public land. Buildings and other publicly-accessible infrastructure supporting coastal activities are also typically located on coastal reserves such as yacht or sailing clubs, surf lifesaving clubs, caravan and camping sites, boat ramps and jetties or piers. In some locations active sports facilities may be located on coastal reserves (golf course, sports ovals, lawn bowls club).

There are over 120 coastal reserve land units with coastal protection structures including sea walls, groynes, or levees.

Coastal facilities and infrastructure are documented in the online inventory of coastal reserves supporting this draft report.



This chapter addresses part (c) of the terms of reference which asks VEAC to identify current and emerging uses of coastal reserves. Documenting trends and emerging uses specifically for coastal reserves is difficult as there is little information collected for this public land use category alone compared to the broader range of coastal land uses. Most information collected relates to trends and uses of the broader marine and coastal environment regardless of land classification. The available information is considered here for coastal reserves where possible and applicable.

At a statewide scale climate change, population growth and ageing coastal infrastructure are considered to be the three most important drivers of change operating on marine and coastal environments.^{1,2} These pressures exacerbate existing threats and bring new challenges. Climate change intersects with and intensifies other drivers of change. The impacts of climate change on coastal reserves is addressed in chapters 6 and 7 of this report. Population growth and ageing coastal infrastructure are discussed here together with other often associated or interrelated trends or changes for coastal environments.

5.1 Population growth

Victoria experienced 2.1 per cent population growth in the year ended 31 March 2019.³ This is higher than the national growth of 1.6 per cent and is the fastest of all states and territories. The challenges this trend presents to coastal environments has been documented elsewhere and is summarised in section 4.7. The effect of this trend on coastal environments is explored in more detail below.

Coastal regions within about two hours' drive of Melbourne, including the Surf Coast, the Bellarine Peninsula, Greater Geelong, Mornington Peninsula, and the Bass Coast have experienced strong growth in resident numbers and this pattern is predicted to continue. While there are some variations in coastal population growth over recent years, behavioural research conducted in 2018 indicated that significantly more people are considering a move to the coast in the next five years compared to a previous survey in 2011.⁴ Coastal areas which have recently shown strong population growth include Torquay, Ocean Grove - Barwon Heads, Werribee South, Point Cook East, Koo Wee Rup, and Dromana.⁵

So far coastal settlements have avoided sprawling linear development, which has allowed distinct coastal settlements to retain their character. It is expected that coastal development will continue to occur in designated areas consistent with maintaining settlement character and protection of coastal values. However, as coastal settlements become more developed there may be increased pressure to move township boundaries and increase availability of visitor facilities which may have effects on coastal landscapes and scenic values. There are significant planning challenges. Balancing the pressures of population growth with the local social and environmental values that make coastal settlements attractive is a challenging task for state and local government.

Coastal settlements often have a relatively high proportion of vacant houses during much of the year, inhabited mainly during summer and school holidays. Coastal towns experience a large difference between the size of their resident population and the size of the population at particular times of the day, week or year. Where there is a large difference between resident and peak populations, stress can

be placed on local services and facilities, many of which are funded by local authorities or staffed by volunteers. The largest differences between resident and peak populations is during festival or sporting events which have generally experienced significant growth in popularity (see box 5.1).

Increased population may affect the health of the marine and coastal environment. Direct environmental impacts include habitat loss and degradation, introduction of invasive and pest species, and higher levels of pollutants (e.g. litter, stormwater runoff, wastewater discharges) discussed in section 5.4. These impacts are generally greatest in the most popular areas and locations within easy access from Melbourne.

Increased visitation also puts pressure on local infrastructure and services, as well as visitor facilities such as walking tracks, boat ramps and marinas, lifesaving clubs and recreational infrastructure. Growth in demand for access can lead to calls for alterations to the beach, foreshore, wetlands and natural processes through groynes, sea walls and dredging to support future and expanding uses. If not properly managed, conflicts can develop between users and the carrying capacity of popular sites will be exceeded.²

5.2 Tourism and recreation

Tourist destinations

Victoria's tourism industry has experienced strong growth with visitor expenditure growing by 6.7 per cent annually since 2010, reaching \$26.7 billion in 2017/18. Much of this growth has come from international overnight expenditure. Tourism is particularly important for employment in regional and rural Victoria, as more than half of Victoria's tourism employment is located regionally.^{6,7}

In the 12 months to March 2019, the Great Ocean Road, Mornington Peninsula and the Geelong/Bellarine coastal regions showed growth in tourism expenditure for daytrips, and domestic and international overnight stays.⁸ Phillip Island recorded a modest decline in expenditure, which was attributed to declining daytrips and domestic overnight visitors. However, during the same period, international overnight visitor numbers and expenditure grew.⁹

Proposed developments to support tourism growth include a potential Stony Point to Cowes car ferry¹⁰ and projects within the Shipwreck Coast masterplan.¹¹

Ecotourism

The number of tour operator licences issued by Parks Victoria across the state has increased by about 7 per cent annually for the past ten years. Most licences are issued for activities such as bush walking, bus tours and bird watching. Employment in the outdoor adventure sector across Australia has shown very strong growth in the last ten years from 900 jobs in 2005 to 2600 jobs in 2015 with 2800 jobs predicted by 2022.

Marine access

There are almost 100 coastal reserves with marine access infrastructure including jetties, piers, boat ramps, launches and slipways. This infrastructure provides access for recreational craft and commercial tours. Better Boating Victoria is a dedicated boating infrastructure authority which was created as part of the state government's plan for recreational fishing, Target One Million, in March 2019. The authority is overseeing a program of reforms supporting recreational boating, which include maintaining and improving boating ramps, jetties and berths.

Popular tours include fishing charters, sightseeing, marine mammal observation, scuba diving and snorkelling. The fishing charter industry is likely to continue to grow in line with population growth and in response to initiatives that encourage recreational fishing. Recent data indicate that

expenditure associated with marine sightseeing tours has been growing by three to four per cent annually.¹² The Wildlife (Marine Mammals) Regulations 2009 are currently being revised. The new regulations are likely to support more effective monitoring of visitor numbers and potential impacts on marine mammals. Future management of the industry under these regulations provides increased flexibility to respond to dynamic populations of marine mammals. There is likely to be increased interest in the creation of artificial reefs for diving following the success of the sinking of the ex-HMAS Canberra. Artificial reefs can also promote and build recreational fish stocks.¹³

Continued growth in recreational boat ownership is likely to drive demand to upgrade existing facilities and construct new ramps to address overcrowding.^{4,14} Boat registrations in Victoria increased on average at two per cent per annum between 2005 and 2016. Based on this trend, it is forecast that there would be almost 125,000 additional boat registrations in Victoria by 2051 resulting in an estimated 315,200 registered boats.

There will be a corresponding need to increase the number of associated car parks, launching and retrieval piers, and dredged areas for boats waiting to access facilities. Some of the forecast new boat registrations will also require a marina berth for storage, indicating that demand for new berths will also continue to increase.⁴

Coastal recreation

Tourism visitor numbers⁶ and beach attendance during summer on patrolled beaches¹⁶ indicate annual growth in beach use (figure 5.1). However, behavioural research conducted in 2018 showed that 77 per cent of respondents had made a day trip to the coast in the last 12 months, down from 84 per cent of respondents in 2011.⁷

Figure 5.1 Point Leo beach on Boxing Day (Photo: A Kilborn)



Surfing is expected to grow in line with population growth. At Bells Beach there is pressure from local groups to create a 'surf sanctuary' to protect the area from the impacts of increased visitation rates, tourism, commercial development and housing; and to respect, protect and cultivate the environmental values, Aboriginal heritage and recreational surfing experience of Bells Beach now and for future generations.¹⁷

The number of Australian households with dogs grew by three per cent between 2013 and 2016.¹⁸ Given the increased popularity of dog ownership, there are likely to be more requests to local councils for access to foreshores for exercising dogs (figure 5.2). For example, Bass Coast Shire is currently considering extending times and opening more beaches for off-lead exercise. Councils are also likely to increase enforcement of dog ownership by-laws to offset the negative impacts of the increased use of beaches. Dogs, particularly when off lead, disturb beach-nesting birds such as hooded plovers leading to egg and chick abandonment, nest predation, and ultimately breeding failure.¹⁹

Figure 5.2 People access and use coastal reserves differently depending on their life stage (Photos: S Garnick)



Camping and caravanning on coastal Crown land provide affordable opportunities for many people to visit and access the coast. DELWP reports that approximately 175 caravan and camping parks are located on Crown land and there are more than 60 located in coastal reserves. Camping is growing in popularity²⁰ and demand for sites at peak holiday times greatly exceeds the capacity of most sites. It can therefore be a challenge for site managers to ensure fair and equitable access. DELWP's policy on improving equity of access to Crown land caravan and camping parks²¹ helps to provide opportunities for new users to gain access to popular locations by ensuring these sites are not managed for exclusive long-term occupancy. Caravan and camping parks can help generate important revenue for marine and coastal managers to spend on maintaining and improving facilities as well as for environmental, emergency and waste water management.²

During the summer school holidays Coastcare in partnership with Parks Victoria co-ordinates an annual program of events and activities along the coast known as Summer by the Sea. The program has been run for more than 20 years and has become increasingly popular with more than 300 free activities on offer in 2019. Coastcare groups also provide a range of volunteer opportunities.

Citizen science

Citizen science is the involvement of community members in scientific projects through the collection of data and/or involvement in project design. It provides an opportunity for participants to learn from each other and work closely with researchers. Participation in citizen science is growing, facilitated by improved digital platforms for entering, accessing and sharing data.²⁷ Between 2010 and 2015 there was a 224 per cent increase in the number of scientific publications using data collected by citizen scientists.²⁸

A survey conducted by DELWP in collaboration with BehaviourWorks found that acting to protect the natural environment (while in nature) provided a stronger feeling or connection to nature. The survey also aimed to better understand barriers to Victorians enacting pro-environmental behaviours and made some recommendations to facilitate greater involvement. One recommendation addressed barriers through better information sharing of pro-environmental behaviours Victorians can undertake while in nature (i.e. informing Victorians of the citizen science actions they could take while visiting the beach).²⁹

The Victorian Biodiversity Atlas, managed by DELWP, allows volunteer naturalists to record their observations of plants and animals. DELWP manages the data in conjunction with key partners, including reviewing and verifying new records and error checking. Bird watching is a growing pastime and information collected, either as part of specific programs or more casually, can assist research. The rise of citizen science has seen more people involved in targeted monitoring and collecting data on Australia's birds, particularly through programs focused on threatened species including coastal species like hooded plovers or migratory shorebirds.³⁰

Parks Victoria runs several citizen science projects including Sea Search and Reef Life surveys. Marine citizen science projects have been implemented for intertidal reefs, seagrass and subtidal reefs. The 2018

Box 5.1 Case study: Growth of recreational events

Victoria has a number of organised events such as ocean swims and triathlons that attract thousands of people to coastal areas. These events can flood local towns with visitors, benefitting local businesses such as cafes and restaurants, shops and accommodation providers. Participants and spectators at these events choose to stay in nearby towns and family and friends of participants may join them, frequently staying for the weekend and enjoying tourist attractions such as lighthouse tours, museums visits and nature-based activities.

Event facilities are often located in coastal reserves. Coastal reserves can be sensitive environments and require careful management by land managers. Events can put extra strain on relatively compact areas of Victoria's coastline (i.e. thousands of people occupying a small coastal area). This is challenging for land managers and the challenge is expected to continue with increasing event popularity. In some cases the benefits to the local economy do not flow through to coastal reserve managers who, together with services and utilities providers, experience the greatest impacts from high visitor numbers.

Two ocean recreational events that utilise Victoria's coastal reserves are described below. These provide examples of the types of population pressures that are becoming more common in coastal areas of Victoria.

Lorne 'Pier to Pub'

The Lorne Pier to Pub event ran for the first time in 1981 with only a small number of swimmers taking part. It now attracts some 5000 swimmers each year and is the largest ocean swim in the world. The swim is 1.2 kilometres in length starting at the Lorne Pier and finishing on the foreshore in front of the Lorne Surf Lifesaving Club house.²² The event takes place in the Lorne Coastal Reserve that includes offshore areas reserved for 'protection of the coastline'.

**Bells Beach Rip Curl Pro**

The Rip Curl Pro at Bells Beach is the world's longest running international surfing event.²³ The first formal competition at Bells Beach was held in 1962 and the event turning professional in 1973.²⁴ Held over the Easter long weekend this event is currently the second tournament on the World Surf League calendar. In recent years the event has been attended by between 30,000 to 40,000 spectators.^{25,26} The beach is congested during peak periods and to improve access the event is now also live-streamed in Torquay and at various nearby towns such as Jan Juc, Anglesea, Aireys Inlet, Lorne and Winchelsea.

The onshore part of the event occurs on Crown land managed by the Surf Coast Shire Council as well as on adjoining municipal freehold land. The area is listed on Victoria's Heritage Register because of the historical and social association with surfing and is included within the National Heritage Place listing of the Great Ocean Road.²³

State of the Environment Report reflects that most marine and coastal data outside conservation parks and reserves is collected by non-government bodies, community groups and through citizen science.

The Victorian National Parks Association coordinates a number of coastal and marine projects. Under the Reef Watch program, underwater photographers are being asked to upload their photographs of weedy seadragons. The sighting information is being used to get a better understanding of the abundance and distribution of this important species in Port Phillip Bay and Western Port.

5.3 Ageing coastal infrastructure and protection structures

Over the past 100 years, coastal assets have been constructed to provide access to the coast (e.g. piers, jetties, boat ramps) or to protect the coastal environment from erosion (e.g. sea walls, groynes, levees). Victoria has more than 1000 coastal assets located mostly in embayments (Port Phillip, Western Port, Gippsland Lakes and Corner Inlet) and estuaries. There are more than 120 coastal reserves that host coastal protection structures.

With increasing population pressures and demand for access to the coastline, coastal protection structures will become even more important but are under significant threat from predicted climate change effects – particularly erosion and inundation. Managing and, where necessary, safeguarding protective structures is as important as managing the public and private coastal assets they shield.³¹

The Department of Treasury and Finance's *Asset Management Accountability Framework* (2016) recognises that effective management of public assets supports delivery of government services to the community. The asset management framework encourages departments to prioritise asset management needs within their resource budget, determine the adequacy of existing funds and apply for additional funds when existing funds are not adequate. The reporting framework improves transparency and accountability for the whole lifecycle of assets.

While it is understood that coastal erosion and inundation under climate change are likely to threaten many coastal assets, there are still current gaps in knowledge of coastal hazard at a localised scale. The 2018 VAGO report on coastal assets commented that information is generally poor and that, across the state, it is estimated that between 20 and 30 per cent of coastal assets are in poor condition, and between 30 and 50 per cent are estimated to have less than 10 years' useful life remaining.

Protecting coastal assets includes designing, constructing, operating, maintaining, repairing and replacing assets and is costly. The capacity of coastal Crown land managers to generate revenue or obtain funding impacts their ability to maintain or repair aging coastal assets (figure 5.3). It is also challenging for agencies and managers to work out how to best allocate limited funds for asset protection given the variable quality of information available and general lack of consistent or risk-based approaches. Fragmented management arrangements as highlighted in section 3.4 are also an impediment to planning and identification of priorities. Over time, funding shortfalls have created a deferred asset works liability, which compromises both service delivery and public safety. In summary, VAGO reported good management of coastal assets was hindered by funding limitations, prioritisation of current or immediate hazards, and uncertainty about the impacts of climate change.³¹

Figure 5.3 Significant storm damage to the Black Rock historic bluestone masonry seawall and promenade constructed in the 1930s is costly for land managers to repair. (Photo: M Mitchell)



5.4 Declining natural values

Trends in natural values are related to the effects of climate change and degradation from the impacts of increasing population and visitor numbers. Urban runoff and pollutants are also identified as emerging issues by both community and government. The impacts of climate change on values is discussed in more detail in chapter 7.

Pest plants and animals

The spread of marine and coastal pest plants and animals is predicted to increase as climate change alters distributional patterns. Pest plants and animals negatively impact marine and coastal habitats and ecological processes. For example, in marine environments the strengthening of the East Australian Current has led to a range extension from New South Wales to Victoria of the black sea urchin (*Centrostephanus rodgersii*) which causes denudation of rocky reefs forming urchin barrens.³² Another example is cordgrass (*Spartina anglica* and *S. x townsendii*) which colonises the intertidal zone. Dense infestations promote sediment accretion and channelisation that alter hydrology, negatively impacting native macroinvertebrates, fish and shorebirds.^{33,34,35}

Increases in global shipping traffic are also high-risk vectors for the transfer and establishment of non-native marine species through hull fouling and ballast water Hewitt and Campbell 2010.³⁶ Currently, Australian waters receive on average one new non-native marine species annually. This is predicted to increase to between five and ten new species annually by 2050.³⁷

Litter and pollutants

The prediction for more intense rainfall events over summer as a result of climate change will increase the risk of more storm event-related flows to coastal waters. These flows will bring increased loads of nutrients, sediments and other pollutants at times of the year when more people use the coast. While nutrients, sediments and litter have been well characterised, at least for Port Phillip Bay, there are numerous contaminants of emerging concern which have not been monitored in a systematic way. These include endocrine-disrupting compounds, pharmaceuticals, flame retardants, pesticides (other than organochlorines) and microplastics as shown in figure 5.4.³⁸

Figure 5.4 Microplastics including plastic rein pellets known as 'nurdles' collected in a surface trawl of Port Phillip Bay. (Photo: A Kilborn)



As urban populations grow, the flow of litter to the marine and coastal environment is also likely to increase. In 2017/18, the National Litter Index showed a 22 per cent increase in the number of litter items on Victorian beaches compared to the previous year (KAB 2018).⁴⁰ Community concern for litter and debris on beaches is driving a strong response with the formation of clean up volunteer groups such as Beach Patrol which has 30 groups and 3500 people involved, mostly around Port Phillip Bay.

Similarly, other groups such as the Dolphin Research Institute, Marine Mammal Foundation, Port Phillip EcoCentre and the Bellarine Catchment Network continue to work with schools and local communities to improve stewardship values for the environment.

5.5 Ports and industry

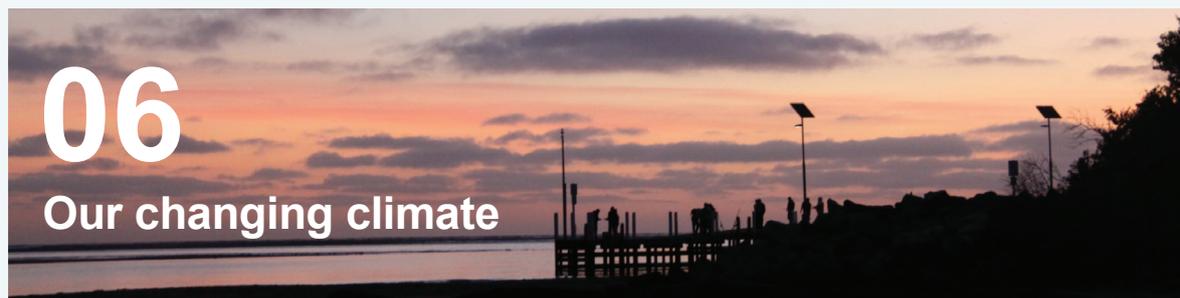
In addition to the economic values associated with recreation and tourism identified above, coasts are important sites for utilities and services, and, in particular, facilitate marine transport.

However, the dependence of manufacturing businesses on proximity to sea ports is less relevant than it once was. Together with the decline in heavy industries such as steel works and oil refineries in Victoria, this has reduced the need for expansion of industrial areas along Victoria's coast. Although commercial ports are excluded from the definition of coastal reserves (see section 2.3), there remains the potential for expansion of port activities into adjacent coastal reserves to meet increasing demands.

There is a current trend for coastal land used for industrial and sea port businesses close to city centres to transition to residential use. Past examples include Docklands and Point Cook. Recent projects include the former Moolap Saltworks at Point Henry (Geelong), and former parts of Webb Dock in Port Melbourne.

COMMENTS INVITED

Are there other important trends or emerging uses of coastal reserves?



The Intergovernmental Panel on Climate Change's recently released Special Report on the Ocean and Cryosphere in a Changing Climate states that global warming has already reached 1.0°C above pre-industrial levels and highlights the effects of global warming on oceans and ice sheets (cryosphere).¹ Unprecedented and enduring changes are observed in the ocean which is now warmer, more acidic and less productive. Sea level rise has accelerated and is currently rising at 3.6 millimetres per year. Extreme coastal events are becoming more severe and more frequent. The report also recognises a need to improve community knowledge and education about climate change in order to access more innovative solutions, to better manage risks, take effective action, and build resilience and capacity.

Victoria's climate is changing. Changes that have already been observed in the marine and coastal climate include warming air and sea surface temperatures, longer and more intense fire seasons, reduced rainfall and streamflow, and more extreme weather events.² During this century the Victorian coast will be further impacted by sea level rise, increased storm surge, changing sea temperatures, altered rainfall and ocean acidification. The interaction of these dynamic elements increases the complexity of managing the coast. There will be implications for coastal biodiversity, how coastal environments are used, the viability of coastal infrastructure and facilities, and risks to which Victorians are exposed.³

6.1 Introduction

This chapter provides the context to address some of part (b) of the terms of reference: the requirement to identify values at risk from the impacts of climate change. Information on the magnitude and extent of observed and predicted climate change is readily available. The data and figures presented in this chapter are largely drawn from published reports by the CSIRO and Bureau of Meteorology based on sophisticated national and international global climate models. This information is included to set the scene for the ways in which coastal reserves with high environmental, cultural heritage, social, and economic values will be impacted by climate change. The detailed impacts of climate change on high values in coastal reserves is described in more detail in the next chapter.

Future greenhouse gas emissions are linked to a range of activities including population growth energy consumption, economic changes and technology development. To accommodate this, climate models use different emissions scenarios to model future climate parameters, known as representative concentration pathways. Under a high emissions scenario (known as RCP8.5), there will be little curbing of emissions and carbon dioxide concentration will reach 940 parts per million by 2100. Under a low emissions scenario (RCP2.6), emissions will peak around 2020 then rapidly decline to 420 parts per million by 2100. It is likely that later in the century active removal of carbon dioxide from the atmosphere would be required for this scenario to be achieved.²

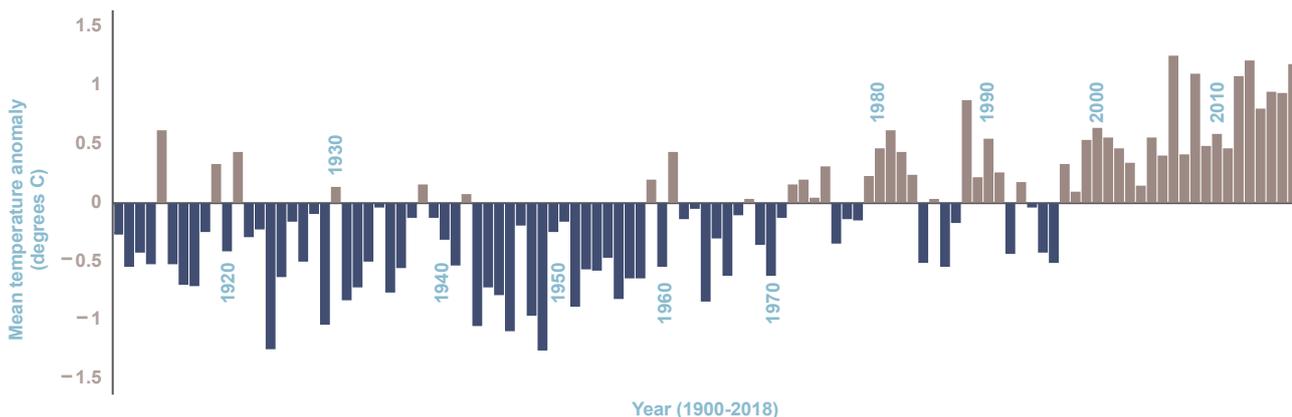
6.2 Climate variables

Increasing surface air temperatures and altered rainfall patterns will have the greatest impacts on the values of coastal reserves in Victoria. The observed and predicted magnitudes of change in these parameters are described and some of the main predicted impacts are explained below. More detail on impacts of these changes to high value coastal reserves can be found in chapter 7.

Surface air temperature

Australian surface air temperatures have warmed by an average of 0.9°C since 1910. More warming has occurred in night time minimum temperature than daytime maximum temperature.⁴ Differences in the magnitude of warming have been recorded across Victoria. Between 1910 and 2013, daily maximum temperatures increased by 1.0-1.1°C in the west and 0.8-0.9°C in the east. During the same period, daily minimum temperatures increased by 0.6-0.7°C in the west and 1.0°C in the east. Based on the annual mean temperature deviation from the average between 1961 and 1990 (annual mean temperature anomaly) Victoria's warmest year was 2007 (figure 6.1).²

Figure 6.1 Annual mean temperature anomaly between 1910 and 2018. Brown bars indicate years that were warmer than the average, while blue bars indicate years that were cooler than the average. Source: <http://www.bom.gov.au/climate/change>



Victorian air temperatures are projected to continue to warm throughout the 21st century. The extent of warming depends strongly on the increase in global greenhouse gas concentrations. For 2030, there are only minor differences between emissions scenarios, and the annual warming will be between 0.4-1.1°C. However, by 2090, annual warming will be 1.1-4.0°C. This is a large change compared to natural variability in Victoria; under high emissions scenarios, cold years will become warmer than warm years in the current climate by 2050.²

Increasing surface air temperatures will impact on the frequency of frosts (below 2°C) and extreme heat days (above 35°C). Melbourne currently experiences 0.9 days of frost per year. By 2090, this will decrease to 0-0.3 days. The current 11 extreme heat days in Melbourne will increase to 15-32 days by 2090.²

A hotter (and drier) climate will lead to the drying of intertidal areas and coastal vegetation (e.g. coastal saltmarsh). Burrow-nesting birds like little penguins (*Eudyptula minor*) are susceptible to overheating when temperatures remain above 35°C for too long.⁵ More people head to the beach to cool off when the weather warms; this can lead to overcrowding and trampling and disturbance effects on biota.

A combination of decreases in relative humidity and increases in drought and air temperature have contributed to the observed increase in extreme fire weather and in the length of the fire season across large parts of Australia since the 1950s.^{4,6} This increase has been particularly strong in spring in

southeastern Australia. In the future, fire seasons will start earlier, end later and be more intense throughout their duration. This effect will be most pronounced by 2050 but will be apparent by 2020 (table 6.1).⁷ Bushfires impact negatively on built coastal assets (e.g. surf lifesaving clubs, camp grounds) as well as biodiversity values (e.g. beach-nesting birds, coastal vegetation). Fires also destabilise dunes (by altering vegetation) which may expose or degrade culturally significant sites.

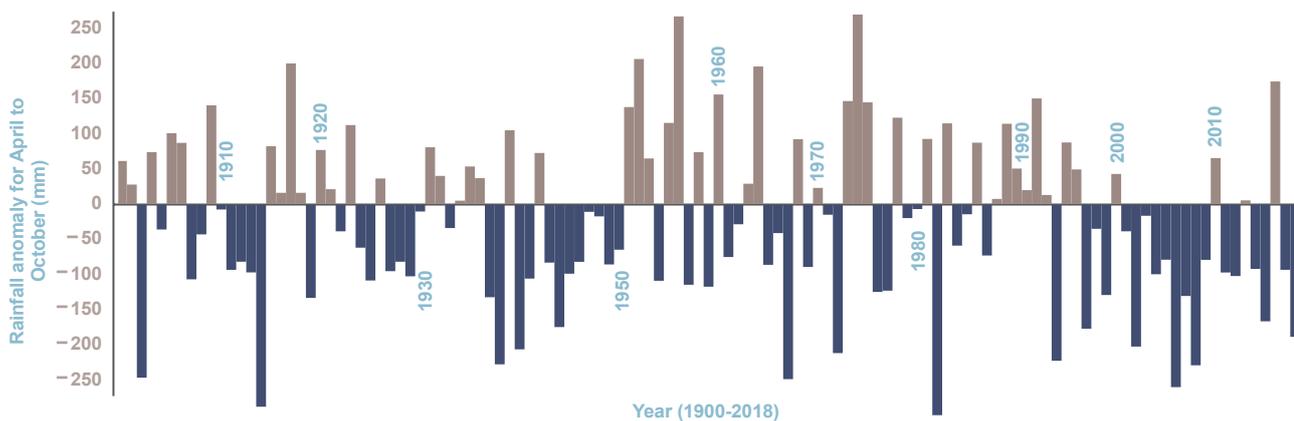
Rainfall

The drying in recent decades across southern Australia is the most sustained large-scale change in rainfall since national records began in 1900 (figure 6.2). The decrease has been most pronounced in the roughly seven month 'rainy period' from April to October. Since 1999 southern Australia experienced below-average rainfall in 17 of the last 20 rainy periods. Average April to October rainfall between 1999-2018 has decreased by around 11 per cent compared to the average for 1900-1998 period. Recent years with above-average rainfall were generally associated with drivers of higher than usual rainfall across Australia, such as La Niña in 2010 and a strong negative Indian Ocean Dipole in 2016.⁸

Table 6.1 Average number of very high (FFDI = 25) or greater fire danger days in Victoria.
Source: Lucas et al. 2007⁷

Location	Average 1973-2007	Predicted 2020	Predicted 2050
Bendigo	13.9	16.1-18.4	17.1-28.6
Laverton	11.8	12.3-13.6	12.8-19.2
Melbourne Airport	14.8	15.9-17.6	16.5-23.6
Mildura	56.6	60.3-66.9	63.7-90.5

Figure 6.2 Rainfall anomaly (deviation from the average between 1961 and 1990) for the Victorian rainy period (April to October). Source: <http://www.bom.gov.au/climate/change>



The drying trend is linked with a trend towards higher mean sea level pressure (a documented response to global warming) and a decrease in the incidence and intensity of weather systems known as cut-off lows. These low-pressure systems bring the majority of rainfall and the most intense rainfalls in eastern Victoria.⁴

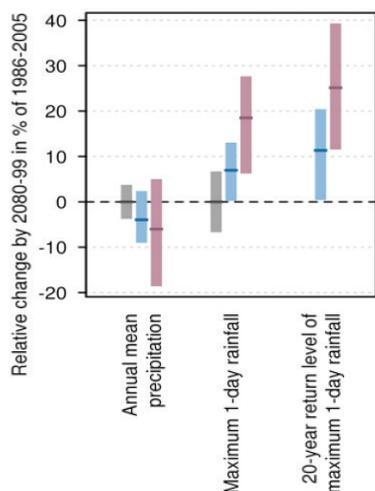
Streamflow typically reduces by two to three times the percentage reduction in rainfall. Over the past 20 years, catchments across Victoria experienced declines in streamflow between 25-75 per cent compared to the average for 1975-1997. Most of this reduction occurred in the period between April to October.

North western Victoria experienced the highest decline of 68 per cent, whereas south eastern Victoria experienced a decline of only 27 per cent.⁸ Reduced freshwater flows impact negatively on estuaries, which are culturally and recreationally important coastal areas. Reduced flushing of estuaries leads to altered salinity, nutrient and sediment flows, which can ultimately change the ecology of these systems. For example, Australian bass (*Macquaria novemaculeata*) require high river flows for successful spawning in estuaries.⁹

While mean annual rainfall is projected to decrease, there will be seasonal differences, with the strongest declines in Victoria in spring and winter. By 2090, winter rainfall will decline by 15-30 per cent. The strongest decline is predicted for western Victoria in spring, where rainfall will decrease by 25-45 per cent. It is unclear whether summer rainfall will increase or decrease, and autumn rainfall is predicted to remain about the same. The extent of the decline is depended upon which emission scenario occurs (figure 6.3).²

While overall rainfall will decline, more rainfall is predicted to fall in shorter, intense periods. For heavy rain days, total rainfall is expected to increase by around 7 per cent per degree of warming.⁴ Further decreases in runoff (and therefore streamflow) are also predicted. Under a high emissions scenario, runoff will decrease by 5-15 per cent over most of Victoria by 2040 and 10-30 per cent by 2065. Larger reductions are predicted for south-west Victoria.⁸

Figure 6.3 Predicted change to Victorian and Tasmanian rainfall by 2090 under two emissions scenarios. Maximum 1-day rainfall is the highest amount of rain that falls in one day throughout the year. The 20-year return level of maximum 1-day rainfall represents a maximum 1-day rainfall level that has a 5 per cent chance of occurrence in any given year. Grey bars indicate natural variability based on 1986-2005 data. Blue bars indicate moderate (RCP4.5) and purple bars indicate high (RCP8.5) emissions scenarios. Data source: Grose et al. (2015)²



Extreme weather events such as flash floods and storms pose risks of erosion, damage and loss of infrastructure or property, and flooding or inundation. There are significant risks for tourism and recreation as well as economic costs associated with asset maintenance and repair – for example, flooding of drainage systems or erosion of coastal roads. Impacts to biodiversity of increased storm frequency include erosion of beach, foreshore and cliff habitats as well as increased sedimentation in bays and estuaries that smothers filter feeders and seagrass. Increased water movement and sandblasting that occur during storms may damage submerged cultural heritage sites.

Large freshwater pulses associated with heavy downfall events wash significant amounts of pollutants (e.g. plastics, nutrients, sediments, chemicals) into the marine and coastal environment with stormwater. Nutrient inputs can lead to algal blooms that force beach closures.

6.3 Oceanographic variables

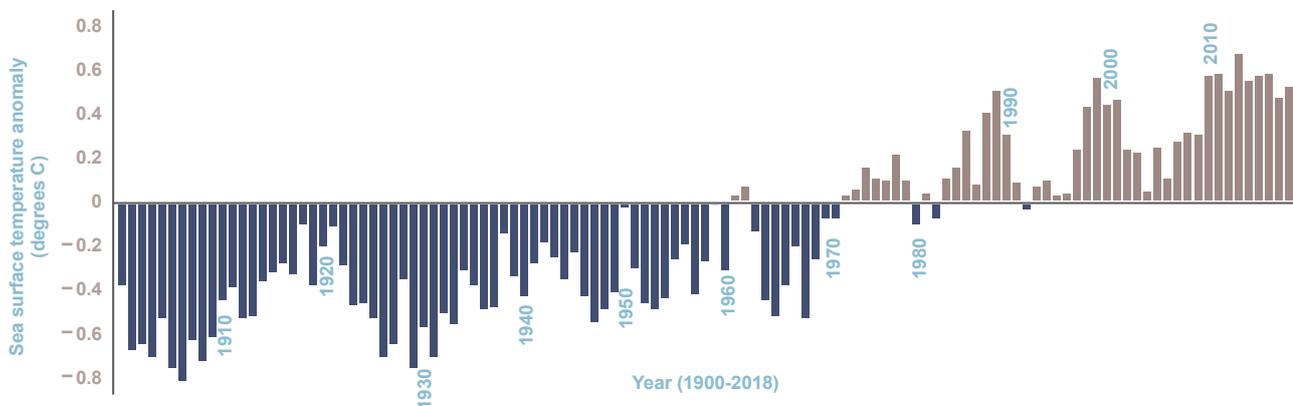
The main oceanographic variables which will impact on coastal reserves under climate change are sea level rise and increased wave height. The observed and predicted magnitudes of change in these parameters are described and some of the main predicted impacts are explained below. More detail on modelled risks of these changes to high value coastal reserves can be found in chapter 7.

Other variables will have smaller direct or indirect impacts on coastal reserves. Southern Australian oceans are acidifying faster than those to the north. The pH of southern seawater has already decreased by 0.1 units and may change by up to a further 0.3 units by 2090.^{2,10} Ocean acidification will impact the ecology of intertidal ecosystems and has the potential to impact tourism and coastal protection.¹¹

Over the last 50 years seawater has become more saline in southern and south-eastern Australia. These changes are associated with changes in precipitation and evaporation and the strengthening of the East Australian Current.¹² It is likely that sea surface salinity will continue to increase, particularly under high emissions scenarios. These changes will impact ocean circulation and mixing around Australia.¹⁰

Between 1950 and 2017, Southern Australian sea surface temperatures warmed by about 0.16 degrees per decade (figure 6.4). Part of the East Australian Current now extends further south, creating an area of more rapid warming. Compared to the average for 1986-2005, Victorian sea surface temperatures will rise by up to 3.8°C by 2090.² Warming of the ocean has already altered ocean currents, impacting on the dispersal of native (e.g. King George whiting *Sillaginodes punctatus*) and invasive (e.g. black sea urchin *Centrostephanus rodgersii*) species.^{13,14}

Figure 6.4 Annual sea surface temperature (down to 20 centimetres) anomaly based on 30-year average between 1961-1990 for southern Australia between 1900-2018. Brown bars indicate years that were warmer than the average, while blue bars indicate years that were cooler than the average. Source: <http://www.bom.gov.au/climate/change>



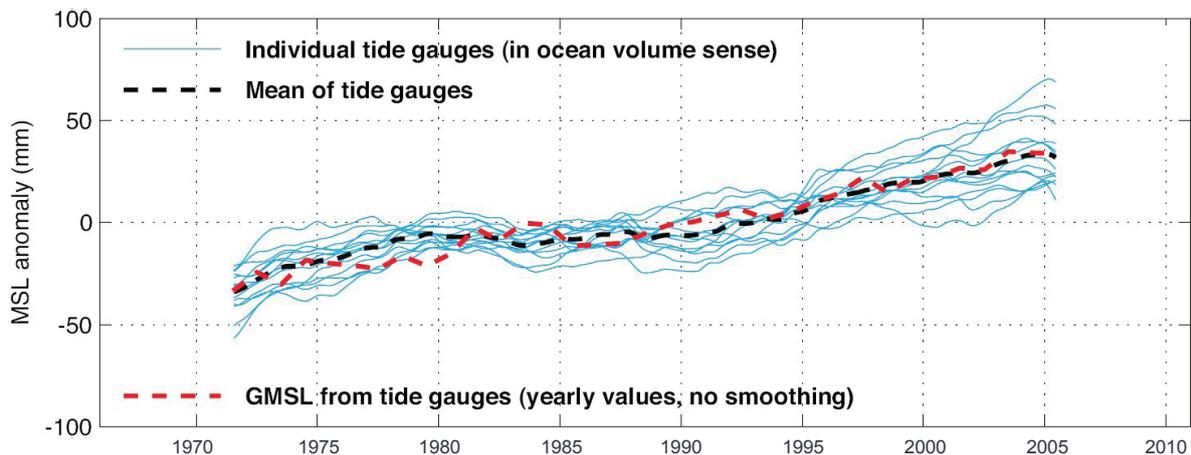
Sea level rise

Sea level varies greatly from year to year. This is in part due to global climate influences (the Southern Oscillation Index) and the uplift or rising of land (in response to historic higher sea levels). Once these influences have been removed from the data, tide gauges indicate that sea levels across Australia increased by about 3.1 millimetres a year between 1993 and 2009 (figure 6.5). This amount of sea level rise has been confirmed by analysis of satellite altimetry data and is similar to data for global sea level rise.¹⁰ The recently released IPCC special report states that global sea level rise is accelerating and is now at 3.6 millimetres per year.¹

As the ocean warms it expands. Such expansion has contributed about a third of the observed global sea level rise of over 20 centimetres since the 1880s. Loss of ice from glaciers and polar ice sheets and changes in the amount of water stored on the land are responsible for the remainder of the change in global sea level.⁴

Compared to the mean for the period 1986-2005, Victorian sea levels are predicted to rise by 7-18 centimetres by 2030. By 2090, under a low emissions pathway, sea levels will rise by 22-55 centimetres; under a high emissions pathway sea levels will rise between 38-84 centimetres. If the marine based sectors of the Antarctic ice sheet collapse, these projections could be higher by several tenths of a metre by 2090.¹⁰

Figure 6.5 Adjusted tide gauge data from 16 sites across Australia from 1966 to 2010 smoothed with a ten-year average (blue lines). Black line indicates the mean of tide gauges across Australia. Red line indicates unsmoothed, yearly global mean sea level. Source: McInnes et al (2015)¹⁰



Extreme sea levels

Extreme sea levels occur due to a complex combination of factors including regular tidal patterns (astronomical tide), storm surges and wind waves. Storm surges can arise from the passage of weather systems with strong winds and falling atmospheric pressure. Falling atmospheric pressure and onshore wind increase coastal sea levels, whereas offshore winds reduce coastal sea levels. Along the south coast of Australia, most storm surges occur in response to westerly to south-westerly winds that accompany strong cold fronts.¹⁵ Generally, storm surges are higher in coastal regions with relatively wide and shallow continental shelves, like the Bass Strait. Storm tides occur due to the combination of storm surge and astronomical tides. Wave breaking in the surf zone can further increase coastal sea levels through wave setup (temporary elevation in sea levels due to waves breaking) and wave runup (the maximum elevation up the shore reached by an individual wave). Ocean currents and climate variability also contribute to variations in coastal sea levels. For example, warm and cool eddies from the East Australian Current contribute to local sea level changes of about 20 centimetres.¹⁰

Under future climate conditions, extreme sea levels will change due to increases in regional sea level and changes in climate and meteorological events. The minimum height that coastal structures will need to be raised in the future so that the expected number of breaches of that height will remain the same as those expected under present sea level conditions is known as the extreme sea level allowance.¹⁶ For south-eastern Australia, the extreme sea level allowance is between 21 to 30 centimetres by 2050 and 43 to 84 centimetres by 2090, depending on the emissions scenario.¹⁰

Sea level rise and extreme sea levels will have many and diverse negative effects on coastal environments. Impacts to natural values include more frequent inundation of low-lying areas (including saltmarsh), loss of coastal habitat (e.g. roosting and nesting sites for sea and shorebirds), cliff, beach and foreshore erosion, altered intertidal, saltmarsh and mangrove habitats, declines in seagrass abundance and extent and increased tidal ranges in areas like estuaries and embayments where there is a constricted opening. Impacts on built and cultural values include damage to infrastructure (seawalls, jetties, roads, walking tracks, beach access, dune fencing, navigation aids, drainage systems), loss or damage to private property and loss of heritage sites. There will also be a loss of coastal Crown land for tourism and recreation and a likely increase in demand for coastal protection structures (e.g. seawalls). Changed wave patterns will lead to the realignment of shorelines and altered beach profile and orientation.¹⁷



07

Climate change impacts on significant values

This chapter focuses on the measurable impacts of climate change (where known) on coastal reserves with high environmental, cultural, social and economic values. It addresses part of part (b) of the terms of reference: the requirement to identify values at risk from the impacts of climate change.

To date, only a subset of climate change impacts has been modelled at a scale which is appropriate for use in assessing coastal reserves across the state. The data on climate change impacts reported here are derived from DELWP corporate spatial layers – presence of coastal acid sulphate soils and inland flooding – and a project conducted by Spatial Vision for DELWP as part of the Victorian Coastal Monitoring Program on statewide vulnerability to erosion and inundation along the Victorian coastline in 50 metre blocks. These two key hazards of erosion and inundation were assessed for likely impacts to assets along the Victorian coast. The modelling conservatively assumes a sea level rise of 20 centimetres by 2040 and 82 centimetres by 2100 based on the projections provided by CSIRO and BOM in March 2014 (CIMP5).^{1,2} Inundation was assessed using a combination of inland flooding (from 1 in 100 year flood events) and storm surge modelling (sea level rise plus additional wind forcing).¹

Many finer-scale assessments of climate change vulnerability have been conducted along Victoria's coast.³ While these are valuable for local planning and adaptation, they are difficult to integrate into datasets at different resolutions and not able to be used in a statewide assessment. Other datasets such as the impacts of bushfires and heatwaves have been excluded due to the unavailability of fine-scale data.

Even using a restricted subset of potential climate change impacts, it is clear that coastal reserves will be extensively impacted by climate change. Only 7 per cent of the coastal reserves assessed for climate change impacts were unaffected by any of the measured values. This number is likely to underestimate affected reserves, as some of the reserves that were considered unaffected are more likely to have been excluded from the modelling (e.g. offshore areas).

A detailed discussion of the effects of coastal erosion and inundation is provided below followed by a review of the intersection of these threats with significant values described in chapter 4 and documented in the inventory of coastal reserve land units.

7.1 Coastal erosion and inundation

While erosion and inundation are natural processes in the coastal zone, they will be exacerbated under current and future climate change. Multiple aspects of climate change interact to produce erosion and inundation hazards. Some of the major factors are indicated in figure 7.1.

Figure 7.1 Coastal hazards and the drivers or cause. Source: CoastAdapt 2017



Coastal erosion

The vulnerability of a segment of the coast to erosion depends on several factors, including the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity to change, and its adaptive capacity.

Exposure of the Victorian coast to erosion was assessed for the Victorian Coastal Monitoring Program,¹ using six attributes that directly or indirectly influence the level to which a section of coast will be exposed to anticipated climate change, particularly severe storm events (figure 7.2). These attributes were coastal type (open or embayment), orientation, wave height, wave energy, fetch (perpendicular distance to open water), and bathymetric profile (distance from the coast to 20 metres depth). Sensitivity to climate change was assessed using erodibility (based on geomorphology) and the likely level of sediment movement in relation to sea level rise and anticipated storm surge. Exposure and sensitivity were combined to generate an impact score. Areas most likely to be impacted had both a high level of likely exposure and sensitivity.¹

The potential impacts of climate change can be buffered by adaptive capacity or resilience of coastal land. Adaptive capacity was assessed using the presence of engineered structures (e.g. groyne), natural structures (proximity to reef strata) or natural vegetative cover (intertidal and land-based vegetation). The final coastal erosion vulnerability rating was the product of impact and adaptive capacity ratings. Areas that were assessed to be most highly impacted can be assessed as less vulnerable where elements were present that increased adaptive capacity (e.g. engineered structures and native vegetation cover).

Figure 7.2 Erosion vulnerability for the Victorian coastline. Source: Spatial Vision 2017¹



While nearly two thirds of the Victorian coastline received a moderate or low vulnerability rating, some 23 coastal reserves have very high vulnerability to coastal erosion and a further 47 have high vulnerability. Highly vulnerable areas along the eastern coastline include Venus and Waratah bays, Wilsons Promontory, Snowy and Cann river estuaries, and Mallacoota Inlet. To the west Discovery Bay is also highly vulnerable. Generally, embayments and sheltered coastlines are less vulnerable. Urbanised or sheltered coastal strips, such as Port Phillip Bay, tend to have lower vulnerability as they typically have engineered structures to protect urban assets or greater cover of intertidal vegetation in sheltered inlets.

Recent findings by the Victorian Auditor-General indicate that a third of DELWP's coastal protection assets have less than ten years of useful life remaining.⁴ This outcome has the potential to seriously decrease the utility of engineered structures and increase vulnerability to coastal erosion.

While engineered structures including breakwaters, seawalls, revetments and groynes can fix the shoreline in place, stabilise the underlying strata and prevent coastal processes and exposures that may be viewed as detrimental to the coast, they also alter the physical and ecological dynamics of coastal areas. Engineered structures act as barriers to the natural movement of marine organisms and materials, alter settlement patterns for plants and animals, and provide additional substrate for colonisation by non-native species.^{5,6}

Natural habitats including shellfish reefs, seagrass beds, mangroves and coastal saltmarsh provide important coastal protection services.⁷ Climate change, habitat loss and pollution put these valuable ecosystem services at risk. Rehabilitating these habitats is of emerging interest for local communities.⁸ There is also an increasing recognition that the design, construction methods and materials used for coastal protection structures can mitigate ecological impacts associated with traditional structures.⁹ 'Living shorelines' is a concept that has been popularised by environmental groups and regulatory agencies in the United States as an attempt to incorporate natural habitats into coastal protection structures.⁵

Coastal inundation

As climate change continues, the combination of increasing frequency of heavy rainfall events and rising sea levels means that coastal and estuarine environments may have an increased flood risk from multiple causes. Extreme coastal sea levels occur due to a combination of astronomical tides, storm surges and wind waves. Along the south coast of Australia, most storm surges occur in response to westerly to south-westerly winds that accompany strong cold fronts.¹⁰ Storm surges tend to be higher in coastal regions with relatively wide and shallow continental shelves, such as Bass Strait. Storm tides occur due to the combination of storm surge and astronomical tides. Wave breaking in the surf zone can further increase coastal sea levels through wave setup (temporary elevation in sea levels due to

the cumulative effect of wave breaking) and wave runup (the maximum elevation up the shore reached by an individual wave breaking).²

The potential impact of coastal inundation has been assessed for the Victorian Coastal Monitoring Program using predicted sea level rise and storm surge data for three periods (2040, 2070 and 2100), the extent of 1:100-year inland flood events, and the presence of coastal acid sulphate soils (see figure 7.3).¹ The modelling uses a conservative sea level rise of 20 centimetres by 2040 and 82 centimetres by 2100. The effects of storm surges were modelled using sea level rise plus added wind forcing of six per cent on 20 centimetres in 2040 and 19 per cent on 82 centimetres in 2100.¹ As sea level rise encroaches coastal land, the extent of inland flooding will decrease. The area of land impacted by inland flooding was therefore reduced for each of the timeframes due to increases in sea level and storm surge.

Using the modelled inundation data with a predicted sea level rise by 2040 of 20 centimetres¹ 181 coastal reserve land units (more than 75 per cent) will be impacted by this predicted sea level rise. Three reserves will be impacted across more than 85 per cent of their area: Anderson Inlet Coastal Reserve - East Block (88 per cent), Swan Bay Coastal Reserve (88 per cent) and Peterborough Coastal Reserve (87 per cent). By 2100 with an 82 centimetre predicted sea level rise, a further 13 coastal reserves will be affected (194 reserves in total). Thirteen of these 194 reserves will be impacted across more than 85 per cent of their area. The worst affected will be the Corner Inlet Boat Club Reserve (completely inundated) and Tucker Swamp - Gippsland Lakes Reserve (97 per cent inundated).

In combination with a 20 centimetre sea level rise, in 2040 storm surges are predicted to affect 196 coastal reserve land units (some 85 per cent). Of these, 20 reserves will be impacted over 85 per cent of their area. Four small reserves will be impacted over their entire area: Corner Inlet Boat Club Reserve, Hastings Yacht Club, Loch Sport Safety and Water Sports Centre, and Port Welshpool Bowling Club Reserve.

By 2100, using modelling with an 82 centimetre sea level rise,¹ storm surges will affect a further eight reserves, with 204 in total being impacted. A total of 33 coastal reserves are predicted to be inundated during storm surges. In addition to the four reserves that are predicted to be totally inundated during storm surges by 2040, Fisher Reserve (Foster Beach) Port Franklin and Queenscliff Fish Co-operative will also be impacted over their entire area by 2100.

Around 100 coastal reserves are currently susceptible to 1 in 100-year inland flooding events. Many of the worst-affected reserves (over 99 per cent inundation) occur within the Gippsland Lakes area, but also include other low-lying regions such as the Werribee South Jetty and the Queenscliff Fish Co-operative. As altered rainfall patterns under climate change increase flood risk, more coastal reserves are likely to be impacted by inland flooding.

Coastal acid sulphate soils produce sulphuric acid during wetting and drying events, such as occurs during flood or storm surge events. This can be detrimental to the areas in which they are found as it can lead to acidification of water sources and soil profiles, breakdown of rocks, sediments and concrete, and corrosion of metals. Coastal acid sulphate soils are currently present in 161 coastal reserves; 37 of which have these soils present in over 99 per cent of their area (figure 7.4). Many of these reserves are vulnerable to sea level rise or storm surge inundation by 2040 (e.g. The Dardenelles - Gippsland Lakes Reserve, Lake Pertobe Foreshore Reserve and Port Welshpool Ferry Terminal Reserve).

Figure 7.3 Extract of inundation vulnerability for a section of the Victorian coastline.
 Source: Spatial Vision 2017¹

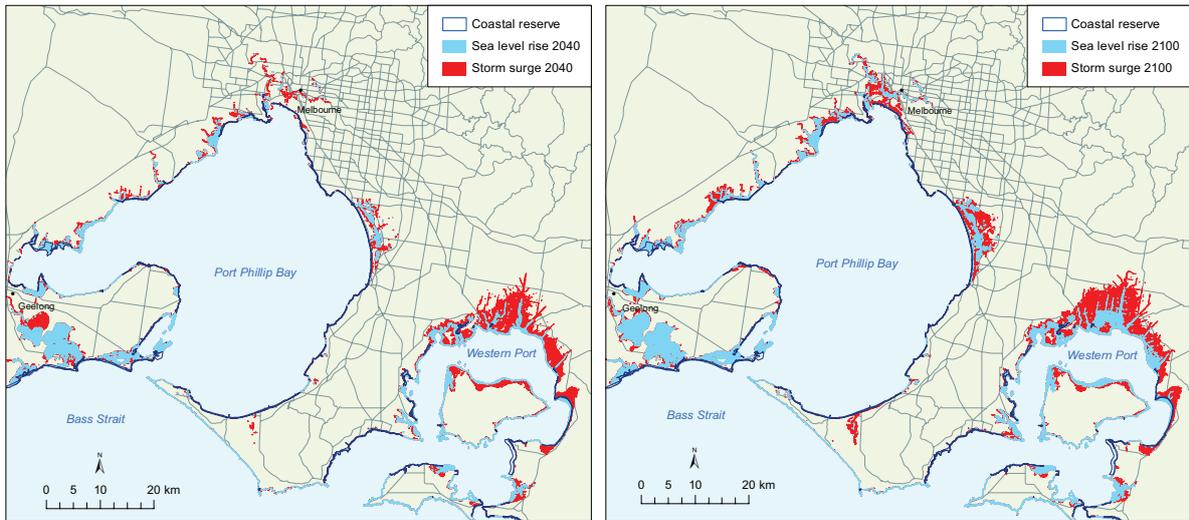
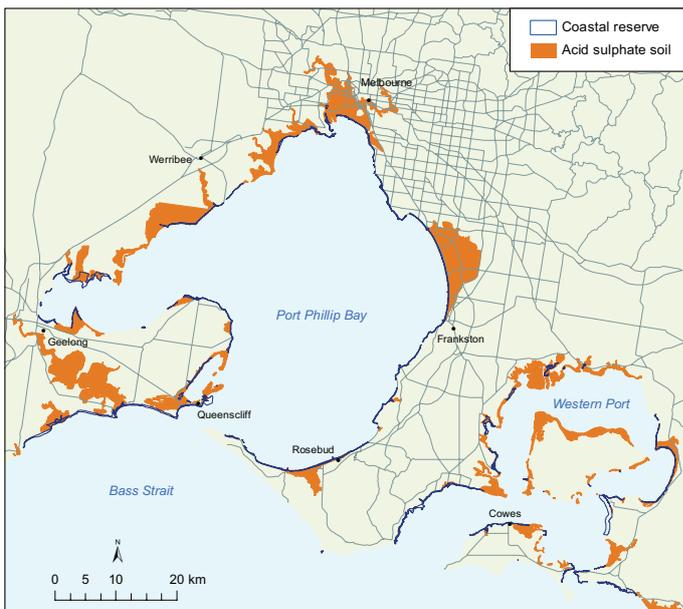


Figure 7.4 Extract of coastal acid sulphate soils at risk of 1 in 100 flood event for a section of the Victorian coastline. Source: Spatial Vision 2017¹



COMMENTS INVITED

Are there other climate change datasets that should be should be assessed when considering the impacts of climate change on the values of coastal reserves?

7.2 Assessment of coastal reserves with high values at risk of climate change

The unique position in the landscape of coastal reserves and the proximity of most to major population centres, means that these areas are significant across multiple values. Consequently this assessment has identified significant values in the majority of coastal reserve land units. Biodiversity and recreation and tourism values were those most often recorded in coastal reserves. This is likely to be due both to the relative ease with which these values types can be spatially quantified, and to the sorts of uses that occur on coastal reserves. For example, over 95 per cent of coastal reserves scored high values in at least one of the ten indicators of biodiversity value and over 65 per cent of coastal reserves scored high values in at least one of the four indicators of recreation and tourism values.

Geological, cultural and resource values were recorded less frequently. Some six per cent of coastal reserves scored highly for significant geological value. Cultural values are not always easily spatially defined. It is therefore unsurprising that only around 12 per cent of coastal reserves scored highly in the four indicators of significant non-Aboriginal cultural values. Because coastal reserves are not frequently used for their natural resource value, high resource values were only recorded in a small percentage of coastal reserves against three indicators.

Aboriginal cultural heritage values

As discussed in the introduction to this draft report, in relation to VEAC's recently completed Assessment of the Values of Victoria's Marine Environment, Traditional Owners advised VEAC that the nature of Aboriginal culture and knowledge means that there is not a well-documented inventory of information relating to sections of the Victorian coast available to decision-makers.

For the purposes of this assessment, it is likely that all coastal reserves have high Aboriginal cultural heritage values at risk from the impacts of climate change.

The Victorian Aboriginal Heritage Register holds all the information about known Aboriginal cultural heritage places and objects within Victoria, with their location and a detailed description. The register is not a publicly accessible register, as it contains culturally sensitive information. This register can only be accessed by people or organisations who need detailed information on cultural heritage places and objects to protect and manage them.

Biodiversity values

Over 95 per cent of coastal reserves scored highly for biodiversity values in at least one of the ten indicators. Given that several of the indicators are broad landscape-scale values, this is unsurprising (e.g. Ramsar wetlands, important coastal bird sites, Key Biodiversity Areas). Reserves which had no recorded biodiversity values tended to be small (generally less than 0.5 hectares), developed for a recreational purpose (e.g. caravan park, boat club, surf lifesaving club) and predominantly cleared of native vegetation.

Almost all the coastal reserves with high biodiversity values (94 per cent) are predicted to be impacted by coastal erosion, inundation, or disturbance of coastal acid sulphate soils. These hazards are likely to be already occurring; there were only four reserves which were vulnerable to sea level rise or storm surge in 2100 that were not predicted to show impacts by 2040.

The statewide scale of this assessment did not allow the identification of individual impacts to each biodiversity value in each affected coastal reserve. Land managers are likely to be aware of these issues and hazards at a local level. To assist with future management of the impacts of climate change, monitoring of impacts at a local level could include:

- changed salinity and character of wetlands and estuaries
- inundation of critical habitats (e.g. seagrass meadows, shorebird foraging sites)

- loss of sensitive species (e.g. salt-intolerant plants) and habitats
- reduced provision of ecosystem services (e.g. blue carbon storage capacity)
- altered species distributions (including non-native species).

Geophysical values

Relatively few of the Victoria's most significant geological sites found along the coast are located in coastal reserves (see table 4.1). The eight sites of national or international significance intersect with only 15 of the approximately 230 coastal reserve land units, although greater investigation of areas in the east of the state may reveal important sites along the coast and Gippsland Lakes. Most significant sites are located within national parks or coastal parks.

For some geomorphological features of significance, climate change has the potential to change tidal dynamics, sediment movements and erosion or accretion processes. Engineering structures or other activities that interrupt the tidal, wave, and sediment movement patterns may also cause damage to these sites. The coast adjacent to Western Port tidal watershed site of international significance is particularly susceptible to engineering interventions, as well as sea level rise and alteration to weather patterns that affect the form, dynamics, and sedimentation of the tidal divide area.

For many geologically significant sites along the coast tourism and recreation pose the greatest threats. This is particularly the case for scenic landscapes along the Great Ocean Road and areas of the Gippsland Lakes used intensively for recreation. Appropriate management is needed to ensure that the vulnerable parts of these landscapes are not over developed and that adequate facilities for tourism are provided in more robust areas. Public access to fossil sites along the coast is also a significant management issue.

Non-Aboriginal cultural heritage values

There are 35 heritage sites listed on the Victorian Heritage Register (VHR) that occur in coastal reserves (see table 4.5). Of these, 27 are at risk from threats that include degradation by natural forces some of which (e.g. storm surges) are predicted to worsen with climate change, including four sections of the extensive Great Ocean Road site which is also recorded on the Australian National Heritage list.

The heritage-listed Great Ocean Road site occurs in five coastal reserve land units: sites at Apollo Bay, Lorne, Peterborough, Boonah and Fairhaven coastal reserves. Sections of the road at these locations are at risk of high to very high coastal erosion. These areas are already impacted with damage to surrounding car parks and amenities (see box 7.1).

The Bells Beach Surfing Recreation Reserve has been listed on the VHR for its social and historic significance as an international icon of Australian surfing culture. The beach is at risk of being reduced due to rising sea levels and increasing erosion from more frequent and severe storm surges.

Piers and jetties are particularly vulnerable to rising sea levels and severe storms. All three piers listed on the VHR are located on coastal reserves and at risk from these threats, including the northern section of Station Pier in Port Melbourne. Surrounding the piers there are also several VHR-listed features including life boat sheds, boat yards and cargo sheds that may also be damaged or lost in predicted storm surges.

Some heritage sites comprise complexes of several buildings and other infrastructure. Early settlement sites at Blairgowrie and Sorrento which include monuments and historic graves may be affected by rising sea levels. The former Fort Franklin site (now Portsea Camp), Fort Gellibrand and the New Works historic complex at Lakes Entrance contain cottages, barracks, bunkers, observation posts, the remains of engineering equipment and gun emplacements. All these sites face hazards from rising sea levels with houses, cottages and barracks being particularly vulnerable to increased storm surges. Storm surges may also result in artefacts being uncovered from increased disturbance.

Other VHR-listed sites located on coastal reserves at risk include:

- lighthouses at Aireys inlet, Cape Schanck, Gabo Island, Point Hicks and Point Lonsdale

- bathing boxes located in Geelong Coastal Reserve
- lime kilns and other kiln complexes
- training walls in Belfast Coastal Reserve
- railway stations and associated infrastructure at Port Melbourne and Point Gellibrand (Williamstown) coastal reserves.

Recreation and tourism values

Recreation and tourism values are identified in the coastal reserves inventory using four categories: community facilities (and buildings), caravan and camping parks, active sports or recreation facilities, and marine access infrastructure including boat ramps, piers and jetties. Over 65 per cent of coastal reserve land units scored highly for recreation and tourism values in at least one of the four indicators. Coastal reserves which had no recreation or tourism values tended to be those located away from townships or population centres or smaller areas.

Almost all the coastal reserves with high recreation and tourism values (96 per cent) are predicted to be impacted by coastal erosion, inundation or disturbance of coastal acid sulphate soils by 2100. All the coastal reserves with active sports facilities (e.g. pools, tennis courts, bowls clubs) are at risk of from the impacts of climate change by 2040. Almost 95 per cent of the coastal reserves with caravan or camping facilities are predicted to be impacted by climate change by 2040. Of the coastal reserves with built community facilities (e.g. club houses, surf lifesaving facilities, tourist sites), some 88 per cent may be impacted by 2040 and 95 per cent by 2100. Due to the low-lying nature of marine access infrastructure, it is unsurprising that nearly all coastal reserves offering marine access are at risk from the impacts of climate change by 2100.

The statewide scale of this assessment doesn't identify the localised impacts to the recreation and tourism values in each affected coastal reserve. The specific location and nature of the recreation and tourism value determines the extent to which climate change impacts affect each asset. The inventory provides an indication of where further detailed local studies would be of value. The types of climate change impacts that can be monitored at a local level include:

- loss of coastal public land (e.g. inundation of coastal caravan and camping areas)
- reduced access to the marine environment (e.g. loss of jetties and beach access, damage to roads)
- changes to patterns of use affecting local businesses and Victoria's tourism industry more broadly
- opportunities for recreation affected by varied weather conditions and extreme weather events (e.g. damage to coastal walking trails)
- nature-based tourism activities affected by changes to biodiversity values (e.g. species diversity, distribution and abundance)
- increasing risk of accidents or emergencies relating to boating/yachting/cruise ships in extreme weather events
- impacts on tourism from loss of significant heritage and visitor sites.

Demography and landscape values

While population growth along the Victorian coast is generally not as strong as in some other states, it is relatively high in locations close to Melbourne. Areas within two hours drive of metropolitan Melbourne (i.e. Geelong, Bellarine Peninsula, Surf Coast and Bass Coast) have all experienced growth. Of concern is the increasing population density in coastal suburbs of Melbourne as this may result in larger numbers of people at risk from the coastal impacts of climate change. The types of local level impacts may include:

- loss of coastal public land leading to increasing pressure and demand (overcrowding) on

remaining areas of public land, especially in areas expected to experience strong growth in residents and/or visitors, making it increasingly difficult to ensure equitable access

- damage to, or loss of, Victoria's unique coastal settlements (e.g. changes to the attributes or features that give them their distinctive character)
- increased community safety issues as a result of changes to weather conditions or extreme weather events (e.g. flooding following increased rainfall or bushfires near coastal areas)
- some residents and visitors to coastal areas may be more vulnerable to environmental hazards (e.g. those that are elderly, unwell, infants/young children and international visitors who are unfamiliar with the area).

Box 7.1 Case study: sand management on mobile coastlines

Coastlines with soft substrates composed of sandy or unconsolidated sediments are vulnerable to erosion and where there is also a restricted supply of sediment (for example, due to limited catchment sources or seafloor and headland configuration) loss of beach area can occur. In addition, seasonal sandy sediment movements along much of the Victorian coastline are affected by sea walls, groynes and breakwaters which have modified natural processes resulting in beach reductions in some locations and accumulations in others. These changes affect public amenity of the coastline, threaten infrastructure and often lead to calls for artificial beach restoration or renourishment.

Deficits in beach sands are also exacerbated by climate change and rising sea levels resulting in stronger wave and swash action at high tide, or increased frequency and intensity of storms with increased wind speed and wave height. Two case studies presented here demonstrate different ways land managers are seeking to resolve beach sediment deficits in coastal reserves.

Beach renourishment at Mounts Bay, Marengo

At Mounts Bay, Marengo near Apollo Bay the sandy beach is backed by fine, unconsolidated sandy dunes with low resistance to wind and wave erosion. Between 2007 and 2016, the dune line retreated by approximately 10 metres. A winter storm in 2012 resulted in substantial dune recession which reduced beach amenity and presented a hazard for the utilities, infrastructure and the foundations of a section of the Great Ocean Road.

In 2017, emergency beach renourishment was carried out with addition of 15,940 cubic metres of sand as a short-term measure. However, less than five months after the works were completed, substantial sand loss had already occurred despite no extreme or unusual weather or oceanographic conditions. Within nine months between 70 to 90 per cent of the replaced sand was lost. At Mounts Bay beach renourishment provided short-term, emergency relief from coastal hazards but, as expected, did not deliver a long-term solution to sand loss. Engineered interventions are now being considered including construction of offshore reefs, rock revetments and finger groynes that may provide longer-term coastal defence for up to 50 years. Dune stabilisation works are also underway.

Sand management at Mounts Bay beach in 2017. (Photo: DELWP)



Wet sand fence, Inverloch surf beach

Since 2013, Inverloch surf beach has retreated more than 40 metres through erosion of vegetated dunes, particularly from an extreme erosion event in winter 2018. The average loss is six metres per year, which represents one of the most rapid changes along a sandy Victorian coastline. Over the same period, the beach level has also lowered by more than 1.5 metres, and the area of beach at low tides is now significantly reduced. These shoreline changes threaten coastal infrastructure and the amenity, ecological, Aboriginal cultural heritage and economic values of the popular surf beach.

Left: Erosion undermining the Inverloch patrol tower in 2018 has continued. Right: Wet sand fence after completion in early 2019. (Photos: A Kilborn)



As a trial measure, two 50-60 metre sections of wet-sand fencing were installed in March 2019 to protect threatened infrastructure including the Inverloch Surf Life Saving Club and Cape Paterson Road. The fences are designed to decrease the energy of incoming waves and allow sand to accumulate behind the fence. The foredune was also renourished in June 2019 with 3000 cubic metres of sand, and revegetation is planned for spring/summer 2019/20 to further stabilise the dunes.

Storms between April and July 2019 damaged the fences, necessitating repair works, and removed some of the renourished dune. However, early indications are that the fences provide some protection to the dune face. The effectiveness of the trial will be evaluated in March 2020. If successful, the fence may be extended to protect the full length of vegetated dunes. The cost of installing the full fence has been estimated as less than the annual cost to the local economy of losing the dunes; a highly valued feature of the beach. Co-contributions from a partnership between local and state government agencies totalled some \$160,000 for the initial trial project. Additional longer-term mitigation actions will be necessary here, pending the findings of a detailed local coastal hazard assessment.

References

1 Introduction

1. Spatial Vision (2017) *Victorian coastal hazard assessment 2017: A second-pass statewide assessment of erosion and inundation hazards resulting from future climate change scenarios to inform the Victorian coastal monitoring program*. Report to Department of Environment, Land, Water and Planning. Spatial Vision, Melbourne. Available at: https://www.marineandcoasts.vic.gov.au/__data/assets/pdf_file/0021/122709/VCHA2017_R1_Victorian_Coastal_Hazard_Assessment_2017_Final_R1.compressed.pdf
2. Department of Environment, Land, Water and Planning (2018) *Committees of Management Categorisation Framework (2019-2020)*. State of Victoria, Melbourne. Available at: <https://www2.delwp.vic.gov.au/boards-and-governance/committees-of-management>

2 Defining coastal reserves

1. Department of Conservation and Natural Resources (1993) *The doctrine of accretion*. Department of Conservation and Natural Resources guideline NO: 02-20:0734-1, issued 06/ 1993. State of Victoria, Melbourne. Available at: https://www.propertyandlandtitles.vic.gov.au/__data/assets/pdf_file/0028/55558/The_Doctrine_of_Accretion.pdf
2. Department of Sustainability and Environment (2011) *Principles of re-establishment Guidance Note 6: Ambulatory boundaries and the doctrine of accretion*. State of Victoria, Melbourne. Available at: https://www.propertyandlandtitles.vic.gov.au/__data/assets/pdf_file/0018/55620/guidancenote6march11.pdf
3. Corkill, J. (2012) *Principles and problems of shoreline law*. National Climate Change Adaptation Research Facility, Gold Coast, Queensland. Available at: https://www.nccarf.edu.au/settlements-infrastructure/sites/www.nccarf.edu.au/settlements-infrastructure/files/DPG_ACCARNSI_Node_1_Principles&ProblemsOfShorelineLaw_FINAL.pdf

3 Mapping and documenting coastal reserves

1. Bird E.C.F. (1993) *The Coast of Victoria*. Melbourne University Press, Melbourne.

4 Values and uses of coastal reserves

1. Buckley, R.W. (1993) *Sites of geological and geomorphological significance along the Victorian Coast*. Geological Survey of Victoria unpublished report 1993/4.
2. McRae-Williams, M.S., Rosengren, N.J. and Kraemers S.M. (1981) *Sites of geological and geomorphological significance in East Gippsland, Victoria*. Environmental Studies Series 341. State of Victoria, Ministry for Conservation, Melbourne.
3. Rosengren, N.J. (1984) *Sites of geological and geomorphological significance in the Shire of Otway Bay*. Environmental Studies Publication 399. State of Victoria, Ministry for Conservation, Forests and Lands, Melbourne.
4. Rosengren, N.J. (1984) *Sites of geological and geomorphological significance in the catchment of Westernport Bay*. Environmental Studies Publication 401. State of Victoria, Ministry for Conservation, Forests and Lands, Melbourne.
5. Rosengren, N.J. (1988) *Making the most of the bay: Sites of geological and geomorphological significance on the coast of Port Phillip Bay*. Technical report series, Ministry for Planning and Environment. State of Victoria, Melbourne.
6. Rosengren, N.J., McRae-Williams, M.S. and Kraemers, S.M. (1981) *Sites of geological and geomorphological significance in central Gippsland*. Report to the Environmental Studies Division, Ministry for Conservation, Victoria. Department of Geography, University of Melbourne, Victoria.
7. Mitchell, M., King R.L. and Cochrane R.M. (2000) *Sites of geological significance in the Melbourne 1:250 000 mapsheet area*. Geological Survey of Victoria unpublished report 2000/1. Geological Survey of Australia (Victoria Division).
8. White, S., King, R.L., Mitchell, M.M., Joyce, E.B., Cochrane, R.M., Rosengren, N.J. and Grimes, K.G. (2003) Conservation and heritage: Registering sites of significance. In: *Geology of Victoria*. Birch, W.D. (ed.) Geological Society of Australia Special Publication 23, Geological Society of Australia (Victoria Division), Melbourne. Pages 703-711.
9. Wakelin-King, G. and White, S. (2013) *Sites of geological and geomorphological significance in the VEAC Marine Investigation area*. Report to the Victorian Environmental Assessment Council. Available at: <http://www.veac.vic.gov.au/investigation/marine-investigation/resources>
10. Victorian Environmental Assessment Council (2018) *Central West Investigation Draft proposals paper*. State of Victoria, Melbourne. Available at: <http://www.veac.vic.gov.au/investigation/central-west-investigation/reports>
11. Millennium Ecosystem Assessment (2005) *Ecosystems and human well-being: General synthesis*. Island Press, Washington DC. Available at: <http://www.millenniumassessment.org/en/Synthesis.html>
12. Edmunds, M. and Flynn, A. (2018) *CBiCS classification of Victorian biotopes*. Report to Department of Environment, Land, Water and Planning. Australian Marine Ecology report #560, Melbourne.
13. Victorian Environmental Assessment Council (2019) *Assessment of the Values of Victoria's Marine Environment Report*. State of Victoria, Melbourne. Available at: <http://www.veac.vic.gov.au/investigation/assessment-of-the-values-of-victorias-marine-environment>
14. Kent, J. and Jenkins, G.P. (2012) *Ecological descriptions of the significant marine environmental assets of Victoria: Interim report*. Fisheries Victoria Technical Report No. 177. State of Victoria, Department of Primary Industries, Queensland.
15. Victorian Environmental Assessment Council (2019) *Assessment of the Values of Victoria's Marine Environment Atlas*. State of Victoria, Melbourne. Available at: <http://www.veac.vic.gov.au/investigation/assessment-of-the-values-of-victorias-marine-environment>
16. Ewers Lewis, C.J., Carnell, P.E., Sanderman, J., Baldock, J.A. and Macreadie, P.I. (2018) Variability and vulnerability of coastal 'blue carbon' stocks: A case study from Southeast Australia. *Ecosystems* 21: 263-279.
17. McLeod, E., Chmura, G.L., Bouillon, S., Salm, R., Bjork, M., Duarte, C.M., Lovelock, C.E., Schlesinger, W.H. and Silliman, B.R. (2011) A blueprint for blue carbon: Toward an improved understanding of the role of vegetated coastal habitats in sequestering CO₂. *Frontiers in Ecology and the Environment* 9: 552-60.
18. Duarte, C.M., Losada, I.J., Hendriks, I.E., Mazarrasa, I. and Marba, N. (2013) The role of coastal plant communities for climate change

mitigation and adaptation. *Nature Climate Change* 3: 961–8.

19. Schlesinger, W.H. and Lichter, J. (2001) Limited carbon storage in soil and litter of experimental forest plots under increased atmospheric CO₂. *Nature* 411: 466–9.

20. Department of Sustainability and Environment (2013) *Advisory list of threatened vertebrate fauna in Victoria*. State of Victoria, Melbourne. Available at: <https://www.environment.vic.gov.au/conserving-threatened-species/threatened-species-advisory-lists>

21. Department of Sustainability and Environment (2009) *Advisory list of threatened invertebrate fauna in Victoria*. State of Victoria, Melbourne. Available at: <https://www.environment.vic.gov.au/conserving-threatened-species/threatened-species-advisory-lists>

22. Department of Environment and Primary Industries (2014) *Advisory list of rare or threatened plants in Victoria*. State of Victoria, Melbourne. Available at: <https://www.environment.vic.gov.au/conserving-threatened-species/threatened-species-advisory-lists>

23. Parks Victoria, Department of Environment, Land, Water and Planning, and Gunditj Mirring Traditional Owners Aboriginal Corporation (2015) *Ngootyoong Gunditj Ngootyoong Mara South West Management Plan*. State of Victoria, Melbourne. Available at: https://parkweb.vic.gov.au/__data/assets/pdf_file/0003/662763/NGNM-South-West-Management-Plan.pdf

24. Framlingham Aboriginal Trust and Winda Mara Aboriginal Corporation (2004) *Kooyang Sea Country Plan*. Report prepared by Smyth and Bahrtdt Consultants on behalf of the Framlingham Aboriginal Trust and Winda Mara Aboriginal Corporation. Available at: <https://www.environment.gov.au/system/files/resources/4fc3aad8-47f4-4d90-b58e-bbadbd9e369d/files/kooyang-plan05.pdf>

25. Eastern Maar Aboriginal Corporation (2015) *Meerreengeeye ngakeepoorryeeyt*. Eastern Maar Aboriginal Corporation, North Melbourne. Available at: http://easternmaar.com.au/wp-content/uploads/2012/10/EM_CountryPlan_FINAL.pdf

26. Gunaikurnai Land and Waters Aboriginal Corporation (2015) *Gunaikurnai Whole-Of-Country Plan*. Gunaikurnai Land and Waters Aboriginal Corporation, Bairnsdale. Available at: https://www.gunaikurnai.org/wp-content/uploads/gk_whole-of-country%20plan%20LR%20FINAL%20270815.pdf

27. Barnard, J. (2008) *Jetties and piers: A background history of maritime infrastructure in Victoria*. Heritage Council of Victoria, Melbourne. Available at: <http://livinghistories.net.au/our-work/commissioned-histories/>

28. Victorian Competition and Efficiency Commission (2011) *Unlocking Victorian tourism: An inquiry into Victoria's tourism industry*. Summary report. State of Victoria, Melbourne. Available at: <https://www.dtf.vic.gov.au/sites/default/files/2018-02/unlocking-victorian-tourism-summary-report-pdf.pdf>

29. Department of Jobs, Precincts and Regions (2019) *Value of Tourism to Victoria*. Fact sheet produced by Tourism, Events and Visitor Economy Research Unit, August 2019. State of Victoria, Melbourne. <https://www.business.vic.gov.au/tourism-industry-resources/research/teve-research>

30. Ipsos (2019) *Wave 5 – Marine and coastal community attitudes and behaviours research 2018*. Report to Department of Environment, Land, Water and Planning. Ipsos-Eureka Social Research Institute, Melbourne.

31. McKenzie, F. (2018) *Coastal demographics in Victoria*. Background research paper prepared by Land Use and Population Research Branch, Department of Environment, Land, Water and Planning. Melbourne.

32. Constantine, A., Morgan, G., O'Leary, R. and Smith, S. (2018) The Halladale–Speculant fields: The first nearshore gas fields to be developed from mainland Australia. *The APPEA Journal* 58: 255–281.

5 Current trends and emerging uses of coastal reserves

1. Department of Environment, Land, Water and Planning (2018) *Victoria's marine and coastal reforms final transition plan*. State of Victoria, Melbourne. Available at: <https://www.marineandcoasts.vic.gov.au/marine-and-coastal-act>

2. Department of Environment, Land, Water and Planning (2019) *Draft marine and coastal policy*. State of Victoria, Melbourne. Available at: <https://www.marineandcoasts.vic.gov.au/marine-and-coastal-act>

3. Department of Environment, Land, Water and Planning (2019) *Victoria in future 2019. Population projections 2016 to 2056*. State of Victoria, Melbourne. Available at: <https://www.planning.vic.gov.au/land-use-and-population-research/victoria-in-future>

4. Ipsos (2019) *Wave 5 – Marine and coastal community attitudes and behaviours research 2018*. Report to the Department of Environment, Land, Water and Planning. Ipsos-Eureka Social Research Institute, Melbourne.

5. McKenzie, F. (2018) *Coastal demographics in Victoria*. Background research paper prepared by Land Use and Population Research Branch, Department of Environment, Land, Water and Planning. Melbourne.

6. Department of Economic Development, Jobs, Transport and Resources (DEDJTR) (2016) *Victorian Visitor economy strategy*. State of Victoria, Melbourne. Available at: <https://www.business.vic.gov.au/tourism-industry-resources/tourism-industry/the-branch>

7. Department of Jobs, Precincts and Regions (2019) *Value of tourism to Victoria*. Fact sheet produced by Tourism, Events and Visitor Economy Research Unit, August 2019. State of Victoria, Melbourne. <https://www.business.vic.gov.au/tourism-industry-resources/research/teve-research>

8. Department of Jobs, Precincts and Regions (2019) *Victorian tourism performance overview- Year ending March 2019*. Fact sheet produced by Tourism, Events and Visitor Economy Research Unit, July 2019. State of Victoria, Melbourne. <https://www.business.vic.gov.au/tourism-industry-resources/research/teve-research>

9. Department of Jobs, Precincts and Regions (2019a) *Phillip Island regional summary- Year ending March 2019*. Fact sheet produced by Tourism, Events and Visitor Economy Research Unit, July 2019. State of Victoria, Melbourne. <https://www.business.vic.gov.au/tourism-industry-resources/research/teve-research>

10. AECOM Australia Pty Ltd (2018) *Cowes to Stony Point car ferry – full business case*. Report to Bass Coast Shire Council and Mornington Peninsula Shire Council. AECOM Australia, Melbourne. Available at: <https://www.basscoast.vic.gov.au/services/business/cowes-to-stony-point-car-ferry>

11. McGregor Coxall (2016) *Shipwreck coast master plan*. Report to Parks Victoria. McGregor Coxall, Melbourne. Available at: https://parkweb.vic.gov.au/__data/assets/pdf_file/0003/685200/Shipwreck-Coast-Master-Plan-Part-1.pdf

12. IBISWorld (2018) *Marine sightseeing tours - Australia market research report*. IBISWorld. Available at: <https://www.ibisworld.com.au/industry-trends/specialised-market-research-reports/consumer-goods-services/marine-sightseeing-tours.html>

13. Brickhill, M.J., Lee, S.Y. and Connolly, R.M. (2005) Fishes associated with artificial reefs: Attributing changes to attraction or production using novel approaches. *Journal of Fish Biology* 67: 53–71.

14. Ipsos (2015) *Boating behaviour 2014*. Report to maritime Safety Victoria. Ipsos-Eureka Social Research Institute, Melbourne. Available at: <https://transportsafety.vic.gov.au/maritime-safety/newsroom/victorian-boating-behaviour-report>
15. Essential Economics Pty Ltd (2018) *St Kilda Marina: marina market research and viability assessment*. Report to City of Port Phillip. Available at: <http://www.portphillip.vic.gov.au/default/Final%20St%20Kilda%20Marina%20Market%20Reserach%20and%20Viability%20Assessment%20Feb%202018.pdf>
16. Life Saving Victoria (2018) *Life Saving Victoria annual report 2017/18*. Life Saving Victoria, Port Melbourne. Available at: <https://lsv.com.au/about/publications/>
17. AEC Group (2014) *Economic value of the surf industry to Surf Coast Shire*. Prepared for Surf Coast Shire Council. Available at: <https://www.surfcoast.vic.gov.au/Community/Businesses/Economic-and-population-profiles>
18. Animal Medicines Australia (2016) *Pet ownership in Australia 2016*. Report to Animal Medicines Australia. Newgate Research, Sydney. Available at: https://animalmedicinesaustralia.org.au/wp-content/uploads/2016/11/AMA_Pet-Ownership-in-Australia-2016-Report_sml.pdf
19. Weston, M.A. and Elgar, M.A. (2005) Disturbance to brood-rearing hooded plover *Thinornis rubicollis: responses and consequences*. *Bird Conservation International* 15: 193-209.
20. Australian Camps Association (2018) *Australian Camps Association annual report 2017-2018*. Preston, Victoria. Available at: <https://auscamps.asn.au/about/annual-report>
21. Department of Sustainability and Environment (2012) *Policy statement: Improving equity of access to Crown land caravan and camping parks 2011*. State of Victoria, Melbourne. <https://www.forestsandreserves.vic.gov.au/land-management/managing-crown-land/crown-land-caravan-and-camping-parks>
22. Lorne Surf Lifesaving Club (2017) Website. Available at: <http://www.lornesurfclub.com.au/pier-to-pub-events/pier-to-pub/pier-to-pub-home/>
23. Surf Coast Shire Council (2015) *Bells Beach Surfing Recreation Reserve coastal management plan 2015-25*. Surf Coast Shire Council, Torquay. Available at: <https://www.surfcoast.vic.gov.au>
24. Rip Curl (no date) Website. Available at: <https://www.ripcurl.com.au/company/history/rip-curl-pro.html>
25. State Government of Victoria (2017) *Rip Curl Pro to ride the waves at Bells Beach until 2022*. Media Release. Friday, 8 September 2017. Available at: <https://www.premier.vic.gov.au/rip-curl-pro-to-ride-the-waves-at-bells-beach-until-2022/>
26. Bells Beach Committee (2016) *Minutes for the Bells Beach Committee meeting 2*. 18 April 2016. Available at: <https://www.surfcoast.vic.gov.au>
27. Martin, V.Y., Christidis, L. and Pecl, G.T. (2016) Public interest in marine citizen science: Is there potential for growth? *BioScience* 66: 683-692.
28. Kullenberg, C. and Kasperowski, D. (2016) What is citizen science? A scientometric meta-analysis. *PLOS One* 11: e0147152.
29. Meis-Harris, J., Saeri, A., Boulet, M., Borg, K., Faulkner, N. and Jorgensen, B. (2019) *Victorians value nature – Survey results*. BehaviourWorks Australia, Monash University, Melbourne.
30. Menkhorst, P., Rogers, D., Clarke, R., Davies, J., Marsack, P. and Franklin, K. (2017) *The Australian bird guide*. CSIRO Publishing, Melbourne.
31. Victorian Auditor-General's Office (2018) *Protecting Victoria's coastal assets*. State of Victoria, Melbourne. Available at: <https://www.audit.vic.gov.au/report/protecting-victorias-coastal-assets?section=>
32. Carnell, P.E. and Longmore, A.R. (2014) *Resilience of Victorian reefs to climate change: An investigation utilising the sub-tidal reef monitoring program*. Report to Victorian Environmental Assessment Council Marine Investigation. Centre for Aquatic Pollution Identification and Management Technical report 42. University of Melbourne, Melbourne. Available at: <http://www.veac.vic.gov.au/investigation/marine-investigation/resources>
33. Goss-Custard, J.P. and Moser, M.E. (1988) Rates of change in the numbers of dunlin, *Calidris alpina*, wintering in British estuaries in relation to the spread of *Spartina anglica*. *Journal of Applied Ecology* 25: 95-109.
34. Hedge, P. and Kriwoken, L.K. (2000) Evidence for effects of *Spartina anglica* invasion on benthic macrofauna in Little Swanport estuary, Tasmania. *Austral Ecology* 25: 150-159.
35. Weiss, J. and Dugdale, T. (2017) *Impacts of priority wetland weeds. Knowledge document of the impact of priority wetland weeds Part 2*. Report to Department of Environment, Land, Water and Planning (DELWP) Water and Catchments Group. Agriculture Victoria, Attwood. Available at: https://www.ari.vic.gov.au/__data/assets/pdf_file/0027/69912/Knowledge-document-of-the-impact-of-priority-wetland-weeds-Part-2-16-June-2017.pdf
36. Hewitt, C.L. and Campbell, M.L. (2010) *The relative contribution of vectors to the introduction and translocation of invasive marine species*. Report to Department of Agriculture, Fisheries and Forestry, Canberra. National Centre for Marine Conservation and Resource Sustainability, Australian Maritime College, Launceston. Available at: <https://www.marinepests.gov.au/what-we-do/research/vectors-introduction-translocation>
37. Sardain, A., Sardain, E. and Leung, B. (2019) Global forecasts of shipping traffic and biological invasions to 2050. *Nature Sustainability* 2: 274-282.
38. Barbee, N., Longmore, A., Townsend, K. Pettigrove, V. and Swearer, S. (2016) *Science knowledge synthesis of nutrient cycling, marine pests and pollutants: Informing the development of the new Port Phillip Bay environmental management plan*. Centre for Aquatic Pollution Identification and Management Technical Report No. 60, University of Melbourne, Melbourne.
39. Keep Australia Beautiful National Association (2018) *National Report 2017 – 2018 National Litter Index*. Keep Australia Beautiful National Association, Newtown. Available at: <http://kab.org.au/litter-research/national-litter-index/>

6 Our changing climate

1. Intergovernmental Panel on Climate Change (2019) Summary for Policymakers. In: *IPCC special report on the ocean and cryosphere in a Changing Climate* (H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, M. Nicolai, A. Okem, J. Petzold, B. Rama, N. Weyer (eds.)). In press.
2. Grose, M., Abbs, D., Bhend, J., Chiew, F., Church, J., Ekstrom, M., Kirono, D., Lenton, A., Lucas, C., McInnes, K., Moise, A., Monselesan, D., Mpelasoka, F., Webb, L. and Whetton, P. (2015) Southern slopes cluster report. In: *Climate change in Australia's natural resource management regions: Cluster reports*. Ekstrom, M., Whetton, P., Gerbing, C., Grose, M., Webb, L. and Risbey, J. (eds.). CSIRO and Bureau of Meteorology, Commonwealth of Australia, Canberra. Available at: <https://www.climatechangeinaustralia.gov.au/en/impacts-and-adaptation/southern-slopes/>

3. Victorian Coastal Council (2014) *Victorian coastal strategy 2014*. State of Victoria, Melbourne. <https://www.marineandcoasts.vic.gov.au/coastal-management/victorian-coastal-strategy>
4. Bureau of Meteorology and CSIRO (2018). *State of the climate 2018*. Commonwealth of Australia, Canberra. Available at: <http://www.bom.gov.au/state-of-the-climate/>
5. Stahel, C.D. and Nicol, S.C. (1982) Temperature regulation in the little penguin, *Eudyptula minor*, in air and water. *Journal of Comparative Physiology B* 148: 93-100
6. Clarke, H., Lucas, C. and Smith, P. (2013) Changes in Australian fire weather between 1973 and 2010. *International Journal of Climatology* 33: 931-944.
7. Lucas, C., Hennessy, K., Mills, G. and Bathols, J. (2007) *Bushfire weather in southeast Australia: Recent trends and projected climate change impacts*. Report for The Climate Institute of Australia. Prepared by Bushfire CRC, Australian Bureau of Meteorology and CSIRO Marine and Atmospheric Research, Melbourne. Available at: http://www.climateinstitute.org.au/verve/_resources/fullreportbushfire.pdf
8. Hope, P., Timbal, B., Hendon, H., Ekström, M. Potter, N. (2017) *A synthesis of findings from the Victorian Climate Initiative (VICCI)*. Bureau of Meteorology, Commonwealth of Australia, Canberra. Available at: <https://www.water.vic.gov.au/climate-change/climate-and-water-resources-research/victorian-climate-initiative>
9. Stoessel, D.J., Morrongiello, J.R., Raadik, T.A., Lyon, J. and Fairbrother, P. (2018) Is climate change driving recruitment failure in Australian bass *Macquaria novemaculeata* in southern latitudes of the species range? *Marine and Freshwater Research* 69: 24-36.
10. McInnes, K., Monselesan, D., Church, J., Lenton, A. and O'Grady J. (2015) Projections (and recent trends): Marine and coasts. In: *Climate change in Australia. Information for Australia's natural resource management regions: Technical report*. CSIRO and Bureau of Meteorology, Commonwealth of Australia, Canberra. Available at: <https://www.climatechangeinaustralia.gov.au/en/publications-library/technical-report/>
11. Cooley, S.R., Kite-Powell, H.L. and Doney, S.C. (2009) Ocean acidification's potential to alter global marine ecosystem services. *Oceanography* 22: 172-181.
12. Durack, P.J. and Wijffels, S.E. (2010) Fifty-year trends in global ocean salinities and their relationship to broadscale warming. *Journal of Climate* 23: 4342-4362.
13. Carnell, P.E. and Longmore, A.R. (2014) *Resilience of Victorian reefs to climate change: An investigation utilising the sub-tidal reef monitoring program*. Report to Victorian Environmental Assessment Council Marine Investigation. Centre for Aquatic Pollution Identification and Management Technical report 42. University of Melbourne, Melbourne. Available at: <http://www.veac.vic.gov.au/investigation/marine-investigation/resources>
14. Longmore, A. (2014) *Spatial and temporal scales of key ecological processes in marine protected areas*. Report to Victorian Environmental Assessment Council Marine Investigation. Fisheries Victoria, Science report series # 4. Available at: <http://www.veac.vic.gov.au/investigation/marine-investigation/resources>
15. McInnes, K. and Hubbert, G. (2003) A numerical modelling study of storm surges in Bass Strait. *Australian Meteorological Magazine* 52: 143-156.
16. Hunter, J. (2012) A simple technique for estimating an allowance for uncertain sea-level rise. *Climatic Change* 113: 239-252.
17. Holper, P., Torok, S. and Pearce, K. (2018) *Victoria's coast and marine environments under projected climate change: Impacts, research gaps and priorities*. Victorian Coastal Council, East Melbourne. <https://www.coastsandmarine.vic.gov.au/home/victorian-coastal-council/publications-and-resources>

7 Climate change impacts on significant values

1. Spatial Vision (2017) *Victorian coastal hazard assessment 2017: A second-pass statewide assessment of erosion and inundation hazards resulting from future climate change scenarios to inform the Victorian coastal monitoring program*. Report to Department of Environment, Land, Water and Planning. Spatial Vision, Melbourne. Available at: https://www.marineandcoasts.vic.gov.au/__data/assets/pdf_file/0021/122709/VCHA2017_R1_Victorian_Coastal_Hazard_Assessment_2017_Final_R1.compressed.pdf
2. McInnes, K., Monselesan, D., Church, J., Lenton, A. and O'Grady J. (2015) Projections (and recent trends): Marine and coasts. In: *Climate change in Australia. Information for Australia's natural resource management regions: Technical report*. CSIRO and Bureau of Meteorology, Commonwealth of Australia, Canberra. Available at: <https://www.climatechangeinaustralia.gov.au/en/publications-library/technical-report/>
3. Cardno (2015) *Bellarine Peninsula - Corio Bay local coastal hazard assessment*. Report prepared to City of Greater Geelong, the Department of Sustainability and Environment, the Corangamite Catchment Management Authority, the Department of Planning and Community Development and the Borough of Queenscliffe. Cardno, Melbourne. Available at: http://www.ourcoast.org.au/inundation_report/
4. Victorian Auditor-General's Office (2018) *Protecting Victoria's coastal assets*. State of Victoria, Melbourne. Available at: <https://www.audit.vic.gov.au/report/protecting-victorias-coastal-assets?section=>
5. Nordstrom, K.F. (2014) Living with shore protection structures: A review. *Estuarine, Coastal and Shelf Science* 150: 11-23
6. Bishop, M.J., Mayer-Pinto, M., Airoidi, L., Firth, L.B., Morris, R.L., Loke, L.H.L., Hawkins, S.J., Naylor, L.A., Coleman, R.A., Chee, S.Y. and Dafforn, K.A. (2017) Effects of ocean sprawl on ecological connectivity: Impacts and solutions. *Experimental Marine Biology and Ecology* 492: 7-30.
7. Duarte, C.M., Losada, I.J., Hendriks, I.E., Mazarrasa, I. and Marba, N. (2013) The role of coastal plant communities for climate change mitigation and adaptation. *Nature Climate Change* 3: 961-8.
8. Morris, R.L., Konlechner, T.M., Ghisalberti, M., and Swearer, S.E. (2018) From grey to green: Efficacy of eco-engineering solutions for nature-based coastal defence. *Global Change Biology* 24: 1827-1842.
9. Strain, E.M.A., Morris, R.L., Bishop, M.J., Tanner, E., Steinberg, P., Swearer, S.E., MacLeod, C. and Alexander, K.A. (2019) Building blue infrastructure: Assessing the key environmental issues and priority areas for ecological engineering initiatives in Australia's metropolitan embayments. *Journal of Environmental Management* 230: 488-496.
10. McInnes, K. and Hubbert, G. (2003) A numerical modelling study of storm surges in Bass Strait. *Australian Meteorological Magazine* 52: 143-156.

Appendix 1

Classes of Crown land parks and reserves excluded from the definition of coastal reserve for this assessment and located in the coastal environment

Excluded *National Parks Act 1975* parks and reserves along the coastline

The terms of reference lists schedules of the National Parks Act that comprise areas excluded from the definition of coastal reserves. The schedules relate to the following land use classifications, and are itemised below for reserves along the coastline (west to east):

- Schedule 2 national parks
- Schedule 2B State parks
- Schedule 3 other parks (including coastal parks and reserves)
- Schedule 4 marine reserve or marine parks, marine and coastal parks, nature conservation reserves
- Schedule 7 marine national parks (shaded blue in list below)
- Schedule 8 marine sanctuaries (shaded blue in list below)

Discovery Bay Coastal Park
[Discovery Bay Marine National Park](#)
 Cape Nelson State Park
 Mount Richmond National Park
 Budj Bim National Park (Mount Eccles)
[Merri Marine Sanctuary](#)
 Bay of Islands Coastal Park
 Port Campbell National Park
[The Arches Marine Sanctuary](#)
[Twelve Apostles Marine National Park](#)
 Great Otway National Park
[Marengo Reefs Marine Sanctuary](#)
[Eagle Rock Marine Sanctuary](#)
[Point Addis Marine National Park](#)
[Point Danger Marine Sanctuary](#)
[Barwon Bluff Marine Sanctuary](#)
[Port Phillip Heads Marine National Park](#)
[Point Cooke Marine Sanctuary](#)
[Jawbone Marine Sanctuary](#)
[Ricketts Point Marine Sanctuary](#)
 Arthurs Seat State Park
 Point Nepean National Park
 Mornington Peninsula National Park
[Mushroom Reef Marine Sanctuary](#)
[Yaringa Marine National Park](#)
 French Island National Park
[French Island Marine National Park](#)
[Churchill Island Marine National Park](#)

Bunurong Marine Park
[Bunurong Marine National Park](#)
 Cape Liptrap Coastal Park
 Shallow Inlet Marine and Coastal Park
 Wilsons Promontory National Park
 Wilsons Promontory Marine Park
 Wilsons Promontory Marine Reserve
[Wilsons Promontory Marine National Park](#)
 Corner Inlet Marine and Coastal Park
[Corner Inlet Marine National Park](#)
 Nooramunga Marine and Coastal Park
[Ninety Mile Beach Marine National Park](#)
 The Lakes National Park
 Gippsland Lakes Coastal Park
 Lake Tyres State Park
[Beware Reef Marine Sanctuary](#)
[Point Hicks Marine National Park](#)
 Cape Conran Coastal Park
 Croajingolong National Park
[Cape Howe Marine National Park](#)

Excluded LCC-ECC-VEAC public land use categories

- state game reserve or wildlife reserve (hunting permitted)
- lake reserve
- nature reserve, nature conservation reserve or flora and fauna reserve
- state forest
- softwood plantations
- historic reserve
- water production reserve
- public land water frontage, stream beds or banks
- bushland reserve, streamside reserve, natural or scenic features reserves
- regional park, metropolitan park, forest park
- utilities or government services, earth resources, roads and railways
- commercial ports and coastal infrastructure (with restricted access).

Examples of excluded *Crown Land (Reserves) Act 1978* areas along the coastline

Bald Hill Water Reserve [Portland]	<i>Wildlife and Game Reserves</i>
Portland Old General Cemetery Reserve	<i>(State game reserves)</i>
Walook Swamp (Lake) Reserve [Portland]	Goose Lagoon Wildlife Reserve
Convincing Ground Historic Reserve	Tower Hill Wildlife Reserve
Tyrendarra Flora Reserve	Lake Gilllear Wildlife Reserve
Yambuk Wetlands Nature Reserve	Princetown (Serpentine Creek) Wildlife Reserve
Peterborough Recreation Reserve	Aire River Wildlife Reserve
Port Campbell Rifle Range Reserve	(includes Lakes Hordern, Craven and Costin)
Princetown Recreation Reserve	Lake Connewarre Wildlife Reserve
Johanna River Public Hall & Tennis Courts	(includes Reedy Lake and Hospital Swamp)
Marengo Nature Reserve	Fresh-water Swamp (Ballong) Wildlife Reserve
Queens Park Reserve (Lorne)	Jack Smith Lake Wildlife Reserve
Eumeralla Education Area	Lake Denison Wildlife Reserve
Breamlea Flora and Fauna Reserve	Ewing Morass Wildlife Reserve
Swan Bay – Edwards Point Wildlife Reserve	Lake Corringale Wildlife Reserve
Salt Lagoon St Leonards Nature Reserve	Lake Curlip Wildlife Reserve
(wildlife area-no hunting)	<i>Gippsland Lakes</i>
Portarlington Flora & Fauna Reserve	Dowd Morass Wildlife Reserve
Bittern Coastal Wetlands Reserve	Heart Morass Wildlife Reserve
(bushland reserve)	Clydebank Morass Wildlife Reserve
Phillip Island Nature Park	Lake Coleman Wildlife Reserve
Reef Island and Bass River Mouth	Blond Bay Wildlife Reserve
Nature Reserve	MacLeod Morass Wildlife Reserve
	Jones Bay Wildlife Reserve

Appendix 2

Reservation purposes for areas identified as coastal reserve

Affording access to water
Camping and affording access to water
Camping and recreation; Camping and public recreation
Crown Land Reserves Act Sec 4(1) (M) and public recreation
Conservation of an area of natural interest
Conservation of an area of natural interest and preservation of wildlife habitat
Conservation of an area of natural interest and public recreation
Conservation of an area of natural interest; Conservation of an area of natural interest or beauty
Conservation of water
Drainage
Fisheries and Wildlife Dept Purposes
Government road; Public way; Road and public purposes
Jetty and other public purposes
Lighthouse purposes
Park; Public park
Park and recreation; Recreation
Place of public resort or recreation
Preservation of an area of ecological significance
Preservation of an area of geological significance
Prevention of the irruption of sand
Protection of flora and fauna and as a site of natural interest
Protection of the coastline
Public and tourism purposes (lighthouses)
Public gardens; Public park and gardens
Public hall
Public park and public recreation, Public park and recreation
Public purposes
Public purposes (aerodrome)
Public purposes (amusement and recreation)
Public purposes (conservation, education and recreation)
Public purposes (conservation of an area of natural interest)
Public purposes (foreshore)
Public purposes (marina and tourism purposes)
Public purposes (marine science facilities)
Public purposes (protection of the coast)
Public purposes (public open space)
Public purposes (public park and recreation)
Public purposes (rail trail)
Public purposes (road and preservation of natural vegetation)
Public purposes (tourists camping); Tourist camping
Public purposes (trigonometrical station)
Public purposes (conservation and management of stream environs)
Public recreation
Public recreation and drainage
Public recreation and public park

Public recreation and public purposes
Public recreation, drainage and conservation of an area of natural interest
Recreation and camping
Recreation and convenience of the people
Recreation convenience and amusement of the people, Recreation convenience or amusement of the people
Site for lighthouse
Supply of gravel
Tourism and public purposes
Water supply, public recreation and public purposes (trigonometrical survey station)
Watering and camping
Watering purposes
Wharfage purposes

Appendix 3

Land status of islands and island groups

Name and location	Area (hectares)	Length (km)	Land use classification
West Block			
Lawrence Island	5.1	1.7	Lawrence Rocks Nature Reserve
Lawrence Rocks (Portland)	1.3	0.5	Lawrence Rocks Nature Reserve
Deen Maar (Lady Julia Percy) Island	147	5.9	Lady Julia Percy Island Nature Reserve
Griffiths Island (Port Fairy)	40	4	Port Fairy Coastal Reserve
Green Island (Port Fairy)	1.4	0.9	Coastal waters reserve
Middle Island	1.5	0.7	Merri and Middle Islands Coastal Reserve
Merri Island (Warrnambool)	0.4	0.4	Merri and Middle Islands Coastal Reserve
London Bridge	0.8	0.4	Port Campbell National Park
Mutton Bird Island	2.4	1.1	Port Campbell National Park
Bridge Island	0.7	0.6	Port Campbell National Park
The Razorback (Mepunga to Gellibrand River)	0.2	0.2	Port Campbell National Park
Central Block			
Swan Bay Queenscliff			
Swan Island	395.0	15.2	Port Phillip Heads Marine National Park
Duck Island(s)	14.0	1.8	Swan Bay – Edwards Point Nature Reserve
Tip Island	0.9	0.4	Swan Bay Coastal Reserve
The Spit (Point Wilson)	8.5	3.3	The Spit Nature Reserve
Mud islands (Port Phillip Bay)	36.1, 30.0	4.1, 5.6	Port Phillip Heads Marine National Park
Pulpit Rock (Cape Schanck)	1.1	0.5	Coastal waters reserve
Phillip Island			
Churchill Island	66.3	5.8	Phillip Island Nature Park
Jessie Island	0.2	0.2	Coastal waters reserve
Pyramid rock	0.9	0.6	Phillip Island Nature Park
The Nobbies (Round Island)	7.4	2.0	Phillip Island Nature Park
small islands (2)	0.4, 0.1	0.3, 0.2	
Seal Rocks (main)	4.5	1.7	Phillip Island Nature Park
small islands (3)	0.1, 0.1, 0.1	0.1, 0.1, 0.2	
Black Rock	1.5	0.7	Phillip Island Nature Park
French Island			
Sandstone Island	24.8	2.4	Private freehold
Charing Cross Island (1km north of French Island)	0.6	0.3	Coastal waters reserve
Barrilliar Island	0.3	0.2	French Island National Park
Elizabeth Island	20.3	2.3	Private freehold
Pelican Island	1.2	0.5	French Island National Park
Reef Island (Bass)	27	3.5	Reef Island and Bass River Mouth Nature Reserve
Long Island (Hastings)	10	1.5	Coastal waters reserve

Name and location	Area (hectares)	Length (km)	Land use classification
Eagles Nest (Cape Paterson)	0.7		Bunurong Coastal Reserve
East Block			
Arch Rock (Liptrap)	1.4	0.9	Cape Liptrap Coastal Park
Bird Rocks and Dog Rocks	0.2, 0.1, 0.1	0.2, 0.2, 0.1	Cape Liptrap Coastal Park
Digger Island (Walkerville)	0.3	0.2	Cape Liptrap Coastal Park
Wilsons Promontory islands			Wilsons Promontory National Park
Ungrouped islands			
Shellback Island	37	2.7	
Norman Island	51	4.8	
Wattle Island	24	2.5	
Rabbit Island	28	2.4	
Rabbit Rock(s)	1.4	0.5	
Glennie Group			all Wilsons Promontory National Park
Great Glennie Island	143	8.6	
Dannevig Island	20	2.7	
Citadel Island	19	1.9	
McHugh Island	9.3	1.2	
Anser Group			all Wilsons Promontory National Park
Anser Island	82	5.0	
Kanowna Island	33	2.9	
Cleft Island (Skull Rock)	7.3	1.1	
Anderson Islets (3)	0.7, 0.7, 0.6	0.3, 0.3, 0.4	
Corner Inlet islands			
Benison Island	6.8	1.1	Wilsons Promontory National Park
Granite Island	1.5	0.5	Wilsons Promontory National Park
Corner Island	34	3.3	Wilsons Promontory National Park
Long Island	98	5.8	Wilsons Promontory National Park
Doughboy Island	3.4	0.8	Wilsons Promontory National Park
Mangrove Island	26	2.8	Corner Inlet Marine and Coastal Park
Hogan Group			
Boundary Islet (part Victoria)	2	~1	85 m onshore boundary with Tasmania
Rondondo Island	106	4.3	Part of Tasmania (Nature Reserve)
West Moncoeur Island	9.2	2.0	Part of Tasmania (Nature Reserve)
associated islands (2)	0.7, 1.3	0.4, 0.5	
East Moncoeur Island	14	1.8	Part of Tasmania
Nooramunga islands			most Nooramunga Marine and Coastal Park (exceptions listed below)
Mangrove Island (Barry Beach)	26	2.8	
Little Snake Island	842	27	
Snake Island (Sand Island)	5727	87	
Snaggy Island	20	2.3	

Name and location	Area (hectares)	Length (km)	Land use classification
One Tree Island (west)	21	2.3	
Bullock Island	13	2.1	Private land (mostly)
Sunday Island	2061	46	Private land (mostly)
Pelican Island	47	4.1	
Mop Island	6.4	1.3	
Sheep Island	45	4.1	
Scrubby Island	165	7.7	
Horn Island	28	3.0	
Shag Island	8.6	2.0	
Clonmel Island	697	31	
Dog Island (near Port Albert)	542	21	
Calf Island	40	4.5	
One Tree Island (east)	18	1.9	
Cyril Island	34	3.2	
East Scrubby Island	450	19	
St Margaret Island	2030	28	
outer barrier (west)	435	15	
outer barrier (east)	525	15	
Seal Islands (east off Wilsons Promontory)			
Notch Island	10	1.9	Seal Islands Nature Reserve
Seal Island	19	2.2	Seal Islands Nature Reserve
Rag Island(s)	5.0, 0.8, 0.5	1.1, 0.3 & 0.4	Seal Islands Nature Reserve
Cliffy Island	6.7	1.0	Cliffy Island Lighthouse Reserve
Gippsland Lakes islands			
Raymond Island	756	15	Parts freehold, parts coastal reserve (GLR), parts Aboriginal title coastal reserve
Mitchell River Silt jetties	1.8, 0.2, 69	0.7, 0.3, 13	Mitchell River Silt Jetties - Gippsland Lakes Reserve
Pelican Island	3.8	1.3	Lake King - Gippsland Lakes Reserve
Flannagan's Island	85	7.2	Private land
Fraser Island (McAuliffs)	34	2.3	Private land
Rigbys Island	131	7.8	Rigby Island - Gippsland Lakes Reserve
Bullock Island	11	1.3	Gippsland Ports, part freehold
Baxter Island	4.5	1.2	Gippsland Lakes Reserve
Wallaby Island	3.1	0.8	Gippsland Lakes Coastal Park
Unnamed Islands	17, 6.6, 1.8	2.1, 1.2, 0.7	Gippsland Lakes Coastal Park
Waddy Island	12	2.1	Gippsland Lakes Coastal Park
Crescent Island(s)	0.3, 6.5, 0.6	0.6, 1.9, 0.5	Gippsland Lakes Coastal Park
Barton Island	33	2.7	Gippsland Lakes Coastal Park
Rotten Island	19	2.0	Gippsland Lakes Coastal Park
Rotamah Island	267	9.7	The Lakes National Park
Mud Islands (several small sandy islands)	15, 9.0, 1.8, 2.8, 0.6	1.7, 1.1, 0.6, 0.7, 0.3	Lake Tyers State Park

Name and location	Area (hectares)	Length (km)	Land use classification
Snowy River estuary islands			
Honeymoon Island	5.1	1.0	Lake Corringale Wildlife Reserve
First and Second Islands	20, 5.8	2.1, 1.1	First and Second Islands Nature Reserve
Mallacoota Inlet islands			
Goodwin Sands	41	4.2	Croajingolong National Park
Rabbit Island	4.8	0.9	Croajingolong National Park
Horse Island	12	1.6	Croajingolong National Park
Goat Island	12.0	2.3	Croajingolong National Park
six smaller islands	4.7		Mallacoota Coastal Reserve
The Skerries (Wingan Inlet)	2.1, 1.6, 1.2	0.6, 0.6, 0.5	Croajingolong National Park
Gabo Island	159	8.7	Gabo Island Coastal Reserve
Tullaberga Island (Mallacoota)	4.5	1.6	Croajingolong National Park

Notes:

Total areas and coastlines of Phillip Island and French Island are included here only as there are multiple land uses.

Rocky platforms and nearshore reefs, sandy shallow islands, small rock stacks and rocky outcrops attached to shoreline are not included here. These include the Bay of Islands and Port Campbell coastal islands and rock stacks as well as others such as The Craggs (Yambuk), Pulpit Rock, Elephant Rock, (Cape Schanck), Marengo Reef (Apollo Bay), Eagle Rock (Aireys Inlet), Quail and Chinaman islands (Warneet), Boags rocks (Gunnamatta).

Man-made structures such as South Channel Fort and HMVS Cerberus are not included.

Appendix 4

Permanent *protection of the coastline reserves* established under the provisions of *Crown Land (Reserves) Act 1978* section 4(1) ze

Parish (P) or Township (T)	CPR#	Coastal reserve name(s)	Area (ha)	Approx area offshore (ha)	Local Government Area (LGA)
WEST BLOCK					
Nirrandra	07	Bay of Islands Coastal Protection Reserve	815	815	Moyne
Mepunga	10	Bay of Islands Coastal Protection Reserve	1402	1354	Warrnambool/Moyne
Wongarra	20	Apollo Bay Coastal Reserve	1110	1055	Colac-Otway
Belfast (P) and Port Fairy (T)	22	Belfast (Port Fairy) Coastal Protection Reserve	199	0*	Moyne
Eumeralla	23	Tyrendarra-Eumeralla Coastal Protection Reserve	845	685	Moyne
Tyrendarra	25	Tyrendarra-Eumeralla Coastal Protection Reserve	534	473	Moyne and Glenelg
Yangary	30	Yangary Coastal Protection Reserve	1454	820	Warrnambool
CENTRAL BLOCK					
Lang Lang (P) and Jam Jerrup (T)	01	Western Port Coastal Reserve	71	0#	Cardinia and Bass Coast
Puebla	03	Torquay – Breamlea Coastal Protection Reserve	180	24*	Surf Coast
Balnarring	04	Balnarring Coastal Protection Reserve	187	0*	Mornington Peninsula
Flinders and Shoreham	05	Flinders and Shoreham Coastal Protection Reserve	90	0*	Mornington Peninsula
Jan Juc (P) and Anglesea (T)	08	Jan Juc Beach Surf Lifesaving Club	575	415	Surf Coast
Wonthaggi	09	Wonthaggi-Cape Paterson Coastal Protection Reserve	1273	512	Bass Coast
Drumledara (P) and Inverloch (T)	11	Anderson Inlet Coastal Protection Reserve	58	20	Bass Coast
Koo-Wee-Rup	12	Tooradin Foreshore Reserve	3	0#	Cardinia
Boonah	13	Boonah (Eastern View) Coastal Protection Reserve	187	187	Surf Coast
Corinella (P) and Grantville (T)	16	Corinella Coastal Protection reserve	573	0*	Bass Coast
Lorne	24	Lorne Coastal Reserve	904	862	Surf Coast
EAST BLOCK					
Waratah North	02	Sandy Point Foreshore Reserve	1163	837	South Gippsland
Tarwin South	06	Tarwin South Coast Protection Reserve	392	392	South Gippsland
Woodside	17	McLoughlins Beach - Seaspray Coastal Reserve	840	800	Wellington
Darriman	21	McLoughlins Beach - Seaspray Coastal Reserve	624	600	Wellington

Plans were prepared for the following parishes but the associated reserves were not gazetted. Waratah North -Shallow Inlet (2A), Waratah (CPR 19), Angahook (CPR 26), Giffard (P) and Seaspray (T) (CPR 29)

* Reserve boundary defined as low water mark

Reserve boundary defined as high water mark

Appendix 5 Biodiversity data

Table 5.1 Area of conservation listed ecological vegetation classes (EVCs) in coastal reserves

Bioregion	BCS	EVC name	Area (ha)
Bridgewater	V	Coastal Headland Scrub	0.4
Glenelg Plain	E	Coastal Headland Scrub	158.2
Glenelg Plain	E	Coastal Mallee Scrub	3.3
Glenelg Plain	E	Spray-zone Coastal Shrubland	2.4
Glenelg Plain	V	Heathy Woodland/Damp Heathy Woodland/Damp Heathland Mosaic	40.8
Glenelg Plain	D	Damp Heathland/Sand Heathland Mosaic	48.4
Glenelg Plain	R	Coastal Sand Heathland	32.7
Victorian Volcanic Plain	E	Coastal Alkaline Scrub	2.0
Victorian Volcanic Plain	E	Coastal Saltmarsh/Coastal Dune Grassland/Coastal Dune Scrub/Coastal Headland Scrub Mosaic	2.3
Victorian Volcanic Plain	E	Coastal Saltmarsh/Mangrove Shrubland Mosaic	104.0
Victorian Volcanic Plain	E	Grassy Woodland	9.5
Victorian Volcanic Plain	E	Plains Grassland	11.3
Victorian Volcanic Plain	E	Plains Grassland/Plains Grassy Woodland Mosaic	4.0
Victorian Volcanic Plain	E	Plains Grassy Woodland	0.3
Victorian Volcanic Plain	V	Coast Banksia Woodland/Coastal Dune Scrub Mosaic	2.7
Victorian Volcanic Plain	V	Coastal Headland Scrub	4.6
Victorian Volcanic Plain	V	Coastal Saltmarsh	24.1
Victorian Volcanic Plain	V	Coastal Tussock Grassland	15.1
Victorian Volcanic Plain	V	Damp Sands Herb-rich Woodland	1.7
Victorian Volcanic Plain	V	Herb-rich Foothill Forest	2.7
Victorian Volcanic Plain	V	Mangrove Shrubland	2.7
Victorian Volcanic Plain	D	Coastal Dune Scrub/Coastal Dune Grassland Mosaic	4.3
Warrnambool Plain	E	Damp Sands Herb-rich Woodland	46.0
Warrnambool Plain	E	Damp Sands Herb-rich Woodland/Damp Heathland/Damp Heathy Woodland Mosaic	0.2
Warrnambool Plain	E	Swamp Scrub	6.7
Warrnambool Plain	E	Swamp Scrub/Aquatic Herbland Mosaic	304.1
Warrnambool Plain	V	Coastal Dune Scrub/Coastal Dune Grassland Mosaic	3.6
Warrnambool Plain	V	Coastal Headland Scrub	20.8
Warrnambool Plain	V	Coastal Headland Scrub/Coastal Tussock Grassland Mosaic	26.7
Warrnambool Plain	V	Coastal Tussock Grassland	1.3
Warrnambool Plain	V	Damp Heath Scrub	6.5
Warrnambool Plain	V	Herb-rich Foothill Forest	0.7
Warrnambool Plain	D	Coastal Dune Scrub	1050.7
Warrnambool Plain	D	Estuarine Wetland	76.1
Otway Plain	E	Coastal Alkaline Scrub	118.1
Otway Plain	E	Coastal Saltmarsh	10.3
Otway Plain	E	Coastal Saltmarsh/Mangrove Shrubland Mosaic	125.1
Otway Plain	E	Estuarine Wetland	1.9
Otway Plain	E	Grassy Woodland	11.0
Otway Plain	E	Plains Grassland	0.9
Otway Plain	E	Plains Grassy Woodland	17.3
Otway Plain	V	Coastal Headland Scrub	106.6
Otway Plain	V	Coastal Tussock Grassland	16.4

Bioregion	BCS	EVC name	Area (ha)
Otway Plain	V	Damp Sands Herb-rich Woodland	19.7
Otway Plain	D	Coastal Dune Scrub/Coastal Dune Grassland Mosaic	452.1
Otway Plain	D	Lowland Forest	0.3
Otway Plain	R	Sand Heathland	8.1
Otway Ranges	E	Estuarine Wetland	1.8
Otway Ranges	V	Coastal Tussock Grassland	1.5
Otway Ranges	V	Damp Sands Herb-rich Woodland	1.4
Otway Ranges	D	Coastal Dune Scrub/Coastal Dune Grassland Mosaic	22.4
Otway Ranges	D	Coastal Headland Scrub	117.8
Otway Ranges	D	Grassy Dry Forest	0.3
Otway Ranges	D	Herb-rich Foothill Forest	3.1
Gippsland Plain	E	Berm Grassy Shrubland	58.4
Gippsland Plain	E	Coast Banksia Woodland/Warm Temperate Rainforest Mosaic	13.4
Gippsland Plain	E	Damp Sands Herb-rich Woodland/Swamp Scrub Mosaic	1.4
Gippsland Plain	E	Dry Rainforest	3.7
Gippsland Plain	E	Dry Valley Forest/Swamp Scrub/Warm Temperate Rainforest Mosaic	62.2
Gippsland Plain	E	Estuarine Flats Grassland	1.5
Gippsland Plain	E	Floodplain Reedbed	38.0
Gippsland Plain	E	Floodplain Riparian Woodland	24.3
Gippsland Plain	E	Grassy Woodland	51.3
Gippsland Plain	E	Gully Woodland	9.4
Gippsland Plain	E	Limestone Pomaderris Shrubland	2.7
Gippsland Plain	E	Plains Grassland	31.4
Gippsland Plain	E	Plains Grassy Wetland	1.1
Gippsland Plain	E	Plains Grassy Woodland	235.0
Gippsland Plain	E	Plains Grassy Woodland/Gilgai Wetland Mosaic	5.3
Gippsland Plain	E	Swamp Scrub	1860.2
Gippsland Plain	E	Swamp Scrub/Wet Heathland Mosaic	1.4
Gippsland Plain	E	Swampy Riparian Woodland	23.5
Gippsland Plain	E	Swampy Woodland	0.3
Gippsland Plain	E	Valley Grassy Forest/Swamp Scrub Mosaic	1.5
Gippsland Plain	E	Warm Temperate Rainforest	41.8
Gippsland Plain	E	Wetland Formation	10.4
Gippsland Plain	V	Aquatic Hermland/Plains Sedgy Wetland Mosaic	161.2
Gippsland Plain	V	Coast Banksia Woodland	308.1
Gippsland Plain	V	Coast Banksia Woodland/Coastal Dune Scrub Mosaic	547.2
Gippsland Plain	V	Coast Banksia Woodland/Swamp Scrub Mosaic	2.0
Gippsland Plain	V	Coastal Alkaline Scrub	54.4
Gippsland Plain	V	Coastal Headland Scrub/Coast Banksia Woodland Mosaic	52.4
Gippsland Plain	V	Coastal Saltmarsh/Coastal Dune Grassland/Coastal Dune Scrub/Coastal Headland Scrub Mosaic	13.9
Gippsland Plain	V	Coastal Saltmarsh/Mangrove Shrubland Mosaic	8.4
Gippsland Plain	V	Coastal Tussock Grassland	0.4
Gippsland Plain	V	Damp Heathy Woodland	0.4
Gippsland Plain	V	Damp Heathy Woodland/Lowland Forest Mosaic	7.0
Gippsland Plain	V	Damp Sands Herb-rich Woodland	332.2
Gippsland Plain	V	Deep Freshwater Marsh	644.2

Bioregion	BCS	EVC name	Area (ha)
Gippsland Plain	V	Herb-rich Foothill Forest	0.7
Gippsland Plain	V	Limestone Box Forest	135.3
Gippsland Plain	V	Lowland Forest	1.7
Gippsland Plain	V	Lowland Forest/Damp Sands Herb-rich Woodland Mosaic	148.5
Gippsland Plain	V	Plains Grassy Forest	180.0
Gippsland Plain	V	Valley Grassy Forest	3.0
Gippsland Plain	D	Coastal Dune Scrub	7.2
Gippsland Plain	D	Coastal Dune Scrub/Coastal Dune Grassland Mosaic	667.4
Gippsland Plain	D	Coastal Headland Scrub	141.2
Gippsland Plain	D	Coastal Headland Scrub/Coastal Tussock Grassland Mosaic	57.2
Gippsland Plain	D	Estuarine Wetland/Estuarine Swamp Scrub Mosaic	34.8
Gippsland Plain	D	Lowland Herb-rich Forest	7.5
Gippsland Plain	D	Sand Heathland/Wet Heathland Mosaic	29.5
Gippsland Plain	D	Wet Heathland	30.3
Gippsland Plain	R	Bird Colony Succulent Herbland/Coastal Tussock Grassland Mosaic	3.3
Gippsland Plain	R	Sand Heathland	21.4
Strzelecki Ranges	E	Damp Forest	13.1
Strzelecki Ranges	V	Coastal Headland Scrub	0.1
Strzelecki Ranges	V	Damp Heathy Woodland/Lowland Forest Mosaic	22.2
Wilson's Promontory	V	Coastal Headland Scrub	0.3
East Gippsland Lowlands	E	Dry Rainforest	0.7
East Gippsland Lowlands	V	Clay Heathland	69.2
East Gippsland Lowlands	V	Damp Sands Herb-rich Woodland	11.5
East Gippsland Lowlands	V	Estuarine Wetland	23.1
East Gippsland Lowlands	V	Limestone Box Forest	80.5
East Gippsland Lowlands	D	Coastal Saltmarsh	84.5
East Gippsland Lowlands	D	Riparian Forest	4.2
East Gippsland Lowlands	R	Warm Temperate Rainforest	7.5

Areas of bioregionally important EVCs greater than 0.1 hectare within coastal reserves are included.

Data source: DELWP corporate spatial data layer 'FLORAFUNA1.NV2005_EVCBCS' also available on NatureKit (<http://maps.biodiversity.vic.gov.au/viewer/?viewer=NatureKit>)

For descriptions of EVC BCS, see chapter 4.3.

Table 5.2 Conservation-listed fauna recorded in coastal reserves

Common name	Scientific name	EPBC Act	FFG Act	DELWP advisory list	Bonn	CAMBA / JAMBA / ROKAMBA
Invertebrate						
Ghost shrimp	<i>Pseudocalliax tooradin</i>		L	vu		
Hairy Burrowing Crayfish	<i>Engaeus sericatus</i>			vu		
Mallacoota Burrowing Crayfish	<i>Engaeus mallacoota</i>		L	vu		
Otway Black Snail	<i>Victaphanta compacta</i>		L	en		
Portland Burrowing Crayfish	<i>Engaeus strictifrons</i>			vu		
Sea Cucumber (species 5258)	<i>Pentocnus bursatus</i>		L	vu		
Sherbrooke Amphipod	<i>Austrogammarus haasei</i>		L	vu		
Amphibian						
Green and Golden Bell Frog	<i>Litoria aurea</i>	VU		vu		
Growing Grass Frog	<i>Litoria raniformis</i>	VU	L	en		
Tyler's Toadlet	<i>Uperoleia tyleri</i>			dd		
Fish						
Australian Grayling	<i>Prototroctes maraena</i>	VU	L	vu		
Australian Mudfish	<i>Neochanna cleaveri</i>		L	cr		
Flinders Pygmy Perch	<i>Nannoperca</i> sp. 1			vu		
Reptile						
Eastern Snake-necked Turtle	<i>Chelodina longicollis</i>			dd		
Glossy Grass Skink	<i>Pseudemoia rawlinsoni</i>			vu		
Green Turtle	<i>Chelonia mydas</i>	VU			L	
Hawksbill Turtle	<i>Eretmochelys imbricata</i>	VU			L	
Loggerhead Turtle	<i>Caretta caretta</i>	EN			L	
Pacific (Olive) Ridley	<i>Lepidochelys olivacea</i>	EN			L	
Swamp Skink	<i>Lissolepis coventryi</i>		L	vu		
Bird						
Arctic Jaeger	<i>Stercorarius parasiticus</i>					J, R
Australasian Bittern	<i>Botaurus poiciloptilus</i>	EN	L	en		
Australasian Shoveler	<i>Anas rhynchos</i>			vu		
Australian Painted Snipe	<i>Rostratula australis</i>	EN	L	cr		C
Azure Kingfisher	<i>Alcedo azurea</i>			nt		
Baillon's Crake	<i>Porzana pusilla palustris</i>		L	vu		
Bar-tailed Godwit	<i>Limosa lapponica</i>	VU			L	C, J, R
Black Falcon	<i>Falco subniger</i>			vu		
Black-browed Albatross	<i>Thalassarche melanophris melanophris</i>	VU		vu	L	
Black-faced Cormorant	<i>Phalacrocorax fuscescens</i>			nt		
Black-faced Monarch	<i>Monarcha melanopsis</i>				L	
Blue-billed Duck	<i>Oxyura australis</i>		L	en		
Brolga	<i>Grus rubicunda</i>		L	vu		
Buller's Albatross	<i>Thalassarche bulleri</i>	VU	L		L	
Caspian Tern	<i>Hydroprogne caspia</i>		L	nt		C, J
Cattle Egret	<i>Ardea ibis</i>					C, J
Clamorous Reed Warbler	<i>Acrocephalus stentoreus</i>				L	
Common Diving-Petrel	<i>Pelecanoides urinatrix</i>			nt		

Common name	Scientific name	EPBC Act	FFG Act	DELWP advisory list	Bonn	CAMBA / JAMBA / ROKAMBA
Common Greenshank	<i>Tringa nebularia</i>			vu	L	C, J, R
Common Sandpiper	<i>Actitis hypoleucos</i>			vu	L	C, J, R
Common Tern	<i>Sterna hirundo</i>					C, J, R
Curllew Sandpiper	<i>Calidris ferruginea</i>	CR		en	L	C, J, R
Diamond Firetail	<i>Stagonopleura guttata</i>		L	nt		
Double-banded Plover	<i>Charadrius bicinctus</i>				L	
Eastern Bristlebird	<i>Dasyornis brachypterus brachypterus</i>	EN	L	en		
Eastern Curlew	<i>Numenius madagascariensis</i>	CR		vu	L	C, J, R
Eastern Great Egret	<i>Ardea modesta</i>		L	vu		C, J
Eastern Reef Egret	<i>Egretta sacra</i>					C
Emu	<i>Dromaius novaehollandiae</i>			nt		
Fairy Prion	<i>Pachyptila turtur</i>	VU		vu		
Fairy Tern	<i>Sternula nereis nereis</i>	VU	L	en		
Fork-tailed Swift	<i>Apus pacificus</i>					C, J, R
Freckled Duck	<i>Stictonetta naevosa</i>		L	en		
Glossy Black-Cockatoo	<i>Calyptorhynchus lathami lathami</i>		L	vu		
Glossy Ibis	<i>Plegadis falcinellus</i>			nt	L	C
Great Knot	<i>Calidris tenuirostris</i>	CR	L	en	L	C, J, R
Greater Sand Plover	<i>Charadrius leschenaultii</i>	VU		cr	L	C, J, R
Grey Goshawk	<i>Accipiter novaehollandiae novaehollandiae</i>		L	vu		
Grey Phalarope	<i>Phalaropus fulicaria</i>					C, J
Grey Plover	<i>Pluvialis squatarola</i>			en	L	C, J, R
Grey-tailed Tattler	<i>Tringa brevipes</i>		L	cr	L	C, J, R
Gull-billed Tern	<i>Gelochelidon nilotica macrotarsa</i>		L	en		
Hardhead	<i>Aythya australis</i>			vu		
Hooded Plover	<i>Thinornis rubricollis rubricollis</i>	VU	L	vu		
Indian Yellow-nosed Albatross	<i>Thalassarche carteri</i>	VU	L	vu	L	
Intermediate Egret	<i>Ardea intermedia</i>		L	en		
Latham's Snipe	<i>Gallinago hardwickii</i>			nt	L	C, J, R
Lesser Sand Plover	<i>Charadrius mongolus</i>	EN		cr	L	C, J, R
Lewin's Rail	<i>Lewinia pectoralis pectoralis</i>		L	vu		
Little Egret	<i>Egretta garzetta nigripes</i>		L	en		
Little Tern	<i>Sternula albifrons sinensis</i>		L	vu	L	C, J, R
Long-toed Stint	<i>Calidris subminuta</i>			nt	L	C, J, R
Magpie Goose	<i>Anseranas semipalmata</i>		L	nt		
Marsh Sandpiper	<i>Tringa stagnatilis</i>			vu	L	C, J, R
Musk Duck	<i>Biziura lobata</i>			vu		
Nankeen Night Heron	<i>Nycticorax caledonicus hillii</i>			nt		
Northern Giant-Petrel	<i>Macronectes halli</i>	VU	L	nt	L	
Orange-bellied Parrot	<i>Neophema chrysogaster</i>	CR	L	cr		
Osprey	<i>Pandion cristatus</i>				L	
Pacific Golden Plover	<i>Pluvialis fulva</i>			vu	L	C, J, R

Common name	Scientific name	EPBC Act	FFG Act	DELWP advisory list	Bonn	CAMBA / JAMBA / ROKAMBA
Pacific Gull	<i>Larus pacificus pacificus</i>			nt		
Pied Cormorant	<i>Phalacrocorax varius</i>			nt		
Powerful Owl	<i>Ninox strenua</i>		L	vu		
Rainbow Bee-eater	<i>Merops ornatus</i>					J
Red Knot	<i>Calidris canutus</i>	EN		en	L	C, J, R
Red-necked Stint	<i>Calidris ruficollis</i>				L	C, J, R
Royal Spoonbill	<i>Platalea regia</i>			nt		
Ruddy Turnstone	<i>Arenaria interpres</i>			vu	L	C, J, R
Ruff	<i>Philomachus pugnax</i>				L	C, J, R
Rufous Bristlebird	<i>Dasyornis broadbenti sp.</i>		L	nt		
Rufous Fantail	<i>Rhipidura rufifrons</i>				L	
Sanderling	<i>Calidris alba</i>			nt	L	C, J, R
Satin Flycatcher	<i>Myiagra cyanoleuca</i>				L	
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>				L	C, J, R
Short-tailed Shearwater	<i>Puffinus tenuirostris</i>					J, R
Shy Albatross	<i>Thalassarche cauta</i>	VU	L	vu		
Sooty Albatross	<i>Phoebastria fusca</i>	VU	L		L	
Sooty Oystercatcher	<i>Haematopus fuliginosus</i>			nt		
Southern Giant-Petrel	<i>Macronectes giganteus</i>	EN	L	vu	L	
Spotted Quail-thrush	<i>Cinclosoma punctatum</i>			nt		
Square-tailed Kite	<i>Lophoictinia isura</i>		L	vu		
Swift Parrot	<i>Lathamus discolor</i>	CR	L	en		
Terek Sandpiper	<i>Xenus cinereus</i>		L	en	L	C, J, R
Wandering Albatross	<i>Diomedea exulans</i>	VU	L	en	L	J
Whimbrel	<i>Numenius phaeopus</i>			vu	L	C, J, R
Whiskered Tern	<i>Chlidonias hybridus javanicus</i>			nt		
White Wagtail	<i>Motacilla alba</i>					C
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>		L	vu		C
White-faced Storm-Petrel	<i>Pelagodroma marina</i>			vu		
White-fronted Tern	<i>Sterna striata</i>			nt		
White-throated Needletail	<i>Hirundapus caudacutus</i>			vu		C, J, R
White-winged Black Tern	<i>Chlidonias leucopterus</i>			nt		C, J, R
Mammal						
Australian Sea Lion	<i>Neophoca cinerea</i>	VU				
Blue Whale	<i>Balaenoptera musculus</i>	EN	L	cr	L	
Burrnan Dolphin	<i>Tursiops australis</i>		L	en		
Common Bent-wing Bat	<i>Miniopterus schreibersii</i> GROUP		L			
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	VU	L	vu		
Heath Mouse	<i>Pseudomys shortridgei</i>	EN	L	nt		
Humpback Whale	<i>Megaptera novaeangliae</i>	VU	L	vu	L	
Killer Whale	<i>Orcinus orca</i>				L	
Long-nosed Fur Seal	<i>Arctocephalus forsteri</i>			vu		
Long-nosed Potoroo	<i>Potorous tridactylus</i> <i>tridactylus</i>	VU	L	nt		

Common name	Scientific name	EPBC Act	FFG Act	DELWP advisory list	Bonn	CAMBA / JAMBA / ROKAMBA
Pygmy Right Whale	<i>Caperea marginata</i>				L	
Southern Brown Bandicoot	<i>Isoodon obesulus obesulus</i>	EN	L	nt		
Southern Elephant Seal	<i>Mirounga leonina</i>	VU				
Southern Myotis	<i>Myotis macropus</i>			nt		
Southern Right Whale	<i>Eubalaena australis</i>	EN	L	cr	L	
Sperm Whale	<i>Physeter macrocephalus</i>				L	
Spot-tailed Quoll	<i>Dasyurus maculatus maculatus</i>	EN	L	en		
Subantarctic Fur Seal	<i>Arctocephalus tropicalis</i>	EN				
Swamp Antechinus	<i>Antechinus minimus maritimus</i>	VU	L	nt		
White-footed Dunnart	<i>Sminthopsis leucopus</i>		L	nt		

Data source: Victorian Biodiversity Atlas. Also available on NatureKit (<http://maps.biodiversity.vic.gov.au/viewer/?viewer=NatureKit>)
 For descriptions of listing status abbreviations, see chapter 4.3.

Table 5.3 Conservation-listed flora recorded in coastal reserves

Common name	Scientific name	EPBC Act	FFG Act	DELWP advisory list
Vascular plants				
Angahook Pink-fingers	<i>Caladenia maritima</i>		L	e
Annual Fireweed	<i>Senecio glomeratus</i> subsp. <i>longifructus</i>			r
Austral Trefoil	<i>Lotus australis</i> var. <i>australis</i>			k
Basalt Peppercross	<i>Lepidium hyssopifolium</i> s.s.	EN	L	e
Beaded Glasswort	<i>Sarcocornia quinqueflora</i> subsp. <i>tasmanica</i>		L	k
Bellarine Yellow-gum	<i>Eucalyptus leucoxydon</i> subsp. <i>bellarinensis</i>		L	e
Blotched Sun-orchid	<i>Thelymitra benthamiana</i>			v
Bluish Pigface	<i>Carpobrotus glaucescens</i>			r
Branching Grass-flag	<i>Libertia paniculata</i>			r
Broad-leaf Prickly Moses	<i>Acacia verticillata</i> subsp. <i>ruscifolia</i>			r
Coast Ballart	<i>Exocarpos syrticola</i>			r
Coast Bitter-bush	<i>Adriana quadripartita</i>			v
Coast Cassinia	<i>Cassinia maritima</i>			r
Coast Fescue	<i>Poa billardiieri</i>			r
Coast Mistletoe	<i>Muellerina celastroides</i>			r
Coast Saltwort	<i>Salsola tragus</i> subsp. <i>pontica</i>			r
Coast Twin-leaf	<i>Zygophyllum billardiieri</i>			r
Coast Wirilda	<i>Acacia uncifolia</i>			r
Coastal Greenhood	<i>Pterostylis alveata</i>			v
Coastal Lignum	<i>Muehlenbeckia gunnii</i>			v
Creeping Rush	<i>Juncus revolutus</i>			r
Crimson Berry	<i>Leptecophylla juniperina</i> subsp. <i>oxycedrus</i>			v
Curly Sedge	<i>Carex tasmanica</i>		L	v
Dune Fan-flower	<i>Scaevola calendulacea</i>			v
Dune Poa	<i>Poa poiformis</i> var. <i>ramifer</i>			r
Dune Wood-sorrel	<i>Oxalis rubens</i>			r
Dwarf Coast Poa	<i>Poa halmaturina</i>			v
Dwarf Kerrawang	<i>Commersonia prostrata</i>	EN	L	e
Floodplain Fireweed	<i>Senecio campylocarpus</i>			r
Green Leek-orchid	<i>Prasophyllum lindleyanum</i>			v
Grey Mangrove	<i>Avicennia marina</i> subsp. <i>australasica</i>			r
Jointed Mistletoe	<i>Korthalsella rubra</i> subsp. <i>rubra</i>			v
Large-flower Crane's-bill	<i>Geranium</i> sp. 1		L	e
Leafless Tongue-orchid	<i>Cryptostylis hunteriana</i>	VU	L	e
Leafy Greenhood	<i>Pterostylis cucullata</i> subsp. <i>cucullata</i>		L	e
Limestone Pomaderris	<i>Pomaderris oraria</i> subsp. <i>calcicola</i>			r
Marsh Saltbush	<i>Atriplex paludosa</i> subsp. <i>paludosa</i>			r
Mellblom's Spider-orchid	<i>Caladenia hastata</i>	EN	L	e
Metallic Sun-orchid	<i>Thelymitra epipactoides</i>	EN	L	e
Otway Bush-pea	<i>Pultenaea prolifera</i>			r
Otway Grey-gum	<i>Eucalyptus litoralis</i>			v
Oval Sea-wrack	<i>Halophila australis</i>			k
Oval-leaf Logania	<i>Logania ovata</i>			r
Pale Guinea-flower	<i>Hibbertia pallidiflora</i>			r

Common name	Scientific name	EPBC Act	FFG Act	DELWP advisory list
Vascular plants				
Paper Flower	<i>Thomasia petalocalyx</i>			r
Prickly Arrowgrass	<i>Triglochin mucronata</i>			r
Purple Diuris	<i>Diuris punctata</i>		L	v
Red Bloodwood	<i>Corymbia gummifera</i>			r
River Swamp Wallaby-grass	<i>Amphibromus fluitans</i>	VU		
Robust Spider-orchid	<i>Caladenia valida</i>		L	e
Salt Lawrenzia	<i>Lawrenzia spicata</i>			r
Sandfly Zieria	<i>Zieria smithii</i> subsp. <i>smithii</i>			r
Sea Nymph	<i>Amphibolis antarctica</i>			k
Sea Water-mat	<i>Althenia marina</i>		L	v
Shore Spleenwort	<i>Asplenium obtusatum</i> subsp. <i>northlandicum</i>			v
Silky Kidney-weed	<i>Dichondra</i> sp. 1			r
Spiral Sun-orchid	<i>Thelymitra matthewsii</i>	VU	L	v
Star Cucumber	<i>Sicyos australis</i>			v
Swamp Diuris	<i>Diuris palustris</i>		L	v
Swamp Everlasting	<i>Xerochrysum palustre</i>	VU	L	v
Tasman Grass-wrack	<i>Heterozostera tasmanica</i>			r
Thick-lip Spider-orchid	<i>Caladenia tessellata</i>	VU		v
Tiny Arrowgrass	<i>Triglochin minutissima</i>			r
Tiny Logania	<i>Logania pusilla</i>			r
Tiny Spyridium	<i>Spyridium cinereum</i>			v
Tufted Grass-tree	<i>Xanthorrhoea caespitosa</i>			r
Viscid Daisy-bush	<i>Olearia viscosa</i>		L	v
Wallaby-bush	<i>Beyeria lasiocarpa</i>			r
Water Parsnip	<i>Berula erecta</i>			k
Western Peppermint	<i>Eucalyptus falciformis</i>			r
Western Sheoak	<i>Allocasuarina mackliniana</i> subsp. <i>mackliniana</i>			k
Winter Sun-orchid	<i>Thelymitra hiemalis</i>		L	e
Yellow Milk-vine	<i>Marsdenia flavescens</i>			r
Yellow Sea-lavender	<i>Limonium australe</i> var. <i>australe</i>			r
Yellow-wood	<i>Acronychia oblongifolia</i>		L	r

Data source: Victorian Biodiversity Atlas. Also available on NatureKit (<http://maps.biodiversity.vic.gov.au/viewer/?viewer=NatureKit>)

For descriptions of listing status abbreviations, see chapter 4.3.

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