MAY 2019

Assessment of the Values of Victoria's Marine Environment

Summary

VICTORIA

VEAC
Victorian Environmental Assessment Council

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.

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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.

Contents

Foreword

Victoria has a distinctive marine environment, rich in biodiversity and steeped in history. Our marine waters are positioned on Australia's unique southern coastline, and support a diverse assemblage of environments, habitats and species.

The Aboriginal peoples of south-eastern Australia have long inhabited coastal and marine environments. The cultural, social and spiritual meaning of Sea Country to Aboriginal Victorians is demonstrated in historical and contemporary accounts of Aboriginal dreaming stories.

Today, our inshore marine areas are well known and loved by millions of Victorians and visitors. Both inshore and offshore marine areas also host the activities of important sectors such as fisheries, ports and shipping, and energy.

VEAC was requested to undertake the Assessment of the Values of Victoria's Marine Environment in March 2018 to inform and support the development of Victoria's marine and coastal policy and strategy including the proposed marine spatial planning framework.

This summary draws on the comprehensive assessment report and atlas.

On behalf of the council I want to thank all those individuals and organisations who have so generously supported the preparation of this assessment. We believe that it brings together the key issues and sources of information needed to inform development of marine and coastal policy and the strategies and plans to implement that policy.

Janine Haddow, Chairperson

Eagles Nest, Bunurong Marine National Park

1 Introduction

Victoria's marine environment is positioned on Australia's unique southern coast. Isolated for some 65 million years, the high species richness and diversity of Australia's southern coast is influenced by the resulting endemic element as well as temperate, tropical and cold-water elements.

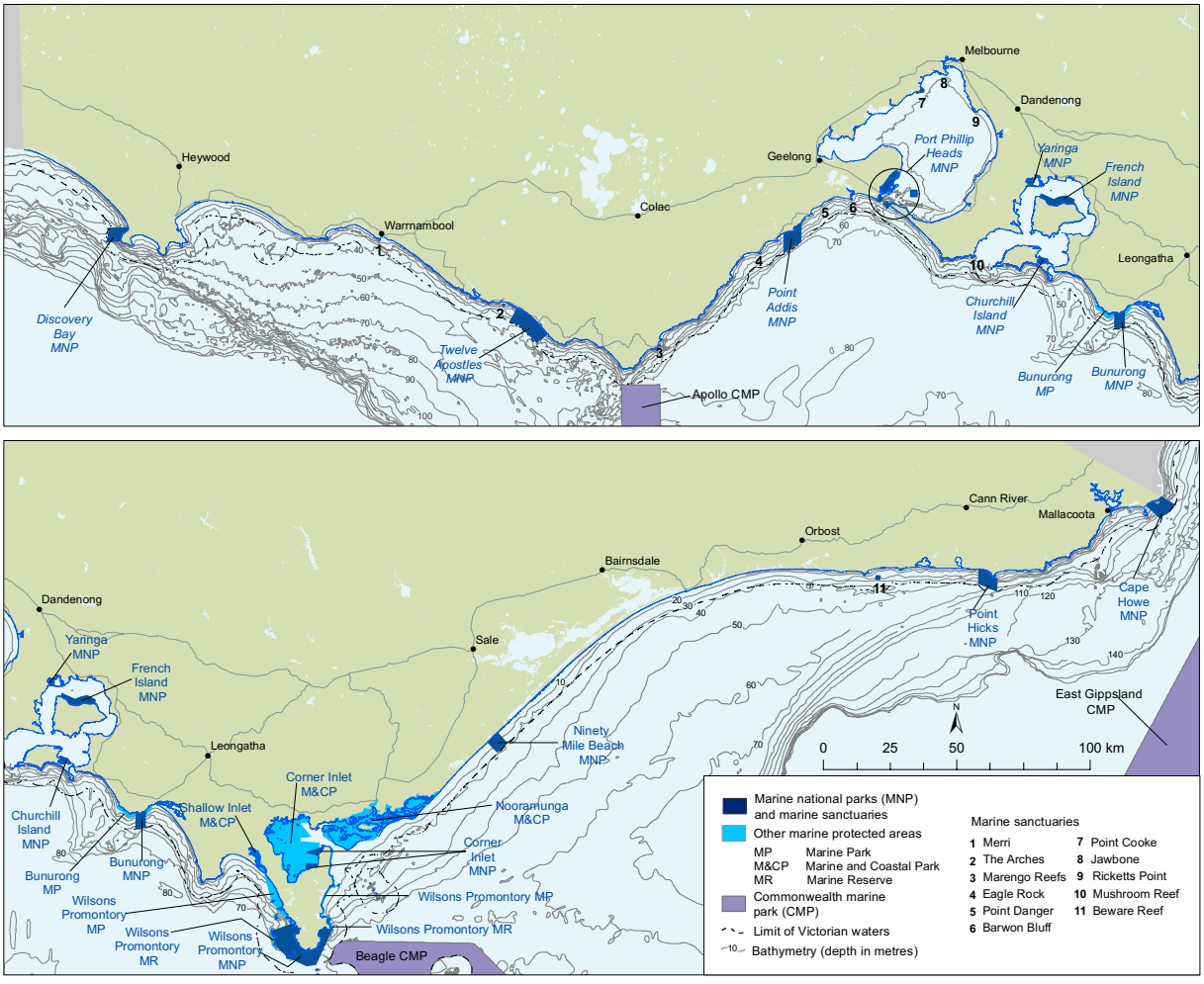
Victoria's marine environment is important for its diverse range of environmental, economic, social and cultural values. Understanding this special environment is a key step towards ensuring appropriate management for current and future generations.

Victoria's marine environment encompasses the seabed and overlying waters between the outer limit of Victorian coastal waters and the high-water mark of the sea.

Victoria has jurisdiction over coastal waters extending 3 nautical miles, (5.56 kilometres) seaward from the low tide line and, on the landward side, the intertidal area, bays, inlets and estuaries. In total, these waters cover approximately 10,014 square kilometres (excludes area of Gippsland Lakes and estuaries).

Waters beyond and abutting Victoria's coastal waters are under the jurisdiction of the Commonwealth.

Figure 1 Victoria's marine waters



Scope of the assessment

In March 2018 the Victorian government asked VEAC to assess the values of Victoria's marine environment. The assessment is to inform a statewide marine and coastal policy, marine and coastal strategy and development of a marine spatial planning framework all of which are requirements of the *Marine and Coastal Act 2018*. The assessment encompasses all State coastal waters, including the Gippsland Lakes.

The purpose of the assessment is to:

- identify current environmental, economic, social and cultural values of Victoria's marine environment, including their spatial distribution where relevant
- identify current and likely future threats to these values
- provide independent advice on future patterns, trends and direction related to existing and emerging uses
- determine a process to systematically classify data and an approach to describe social and economic values and uses of Victoria's marine waters
- provide an inventory of available knowledge and data on existing values, uses and threats and advise on any significant gaps.

The assessment involved consultation with technical and sector experts including government departments and public authorities, researchers and data custodians, Traditional Owners, industry associations, marine conservation groups and marine user groups.

The assessment outputs include a technical report and atlas.

Assessment report

Working within a broad framework of values, threats and emerging uses, the assessment report provides an authoritative account of current information and issues across nine themes: climate and oceanography, biodiversity, Aboriginal cultural values, non-Aboriginal heritage, coastal development, tourism and recreation, fisheries, ports and shipping, and energy and earth resources.

The first part of the report (chapters 1 to 4) establishes the context and background for the assessment: objectives, values framework, legislative arrangements and boundary definitions.

The second part addresses the first three purposes in the terms of reference. It includes chapters for each theme (chapters 5 to 13) describing values, threats and emerging uses.

The third part (chapters 14 and 15) addresses the fourth and fifth purposes in the terms of reference. It discusses processes for classifying data for social and economic values, and provides an inventory of available data and advice on significant knowledge gaps.

Atlas

The atlas brings together information for the 26 marine bioregional units (biounits) along Victoria's coast. These biounits were defined through the Department of Environment, Land, Water and Planning (DELWP) marine habitat mapping program.

The atlas provides a local view of values, uses and threats and gives context to information presented in the assessment report. It draws on DELWP's marine asset work and biotope mapping, marine national park and marine sanctuary management plans, and catchment and stream condition assessments.

Summary

This summary document highlights the key values, threats to those values and emerging uses. See the fully referenced assessment report for more detail.

Mangroves in French Island Marine National Park

Assessment process

Values

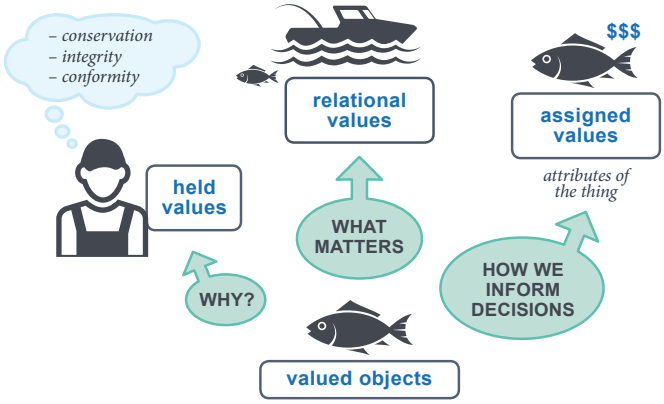
The term 'values' is understood in different ways depending on the context. In contemporary land and resource management, environmental values are mostly conceptualised as biophysical attributes of the environment, such as landscape features, ecological processes, biodiversity and endangered species. More broadly, values may also refer to the values held by people about the environment, or the value of extracted natural resources to the Victorian economy.

Behind any valuation are things in the world that are valued by people, referred to as 'valued objects'. To understand the diversity of values in the marine environment, VEAC has used a held/relational/assigned values framework (figure 2).

Held values inform people's judgements and preferences about the world. The interaction of a person and a valued object gives rise to relational values. Assigned values are the stories, measures and indicators used to describe or quantify valued objects and relational values i.e. attributes.

Marine values can and do incorporate an attitude of stewardship towards nature (held values), endangered species (valued objects), the importance of places for cultural practices (relational values) and the market price of a fish (assigned values).

Figure 2 Illustration of the three core concepts of value and their relationships to the valued object



Threats

Threats are the activities or processes that have impacted, are impacting or may impact the status of the value being assessed. There is typically a chain of contributing factors behind any given threat.

To provide consistency, VEAC has adopted definitions for threats used by the International Union for Conservation of Nature (IUCN) for ecosystem assessment (figure 3).

A direct threat for one value or valued object can be an indirect threat for another or pose no threat to other values. For example, unsustainable fishing will directly threaten target and bycatch species and may also have indirect effects (negative or positive) on species that prey upon, compete with or are preyed upon by targeted species. This complexity of effects requires careful consideration when planning actions to eliminate or mitigate threats.

Figure 3 General model for assessment of threats – actions can be applied to contributing factors and threats to reduce stresses on values

Trends

To assess emerging uses and trends, there is a need to assess changes that have occurred over a past time period and use available information and outlooks to forecast what might occur in the future.

As a general guide, VEAC has used a 30-year outlook for emerging uses and the past 30 years for assessing trends in conditions. However, the accuracy of any predictions or assessment of patterns of change is dependent on the data available and conceptual understanding of the drivers of change.

In some instances, it can be more realistic to consider a time that coincides with a change in physical conditions. For example, a 0.5-metre sea level rise is expected, but when this will occur is dependent on a complex interplay of processes.

Another way to predict emerging uses is to consider the life cycle of an industry. There are many examples where past uses have changed to meet the demands of current communities. For example, there have been regulatory changes imposed on commercial fishing in Port Phillip Bay that are expected to increase fish stocks, which will subsequently support increased recreational fishing.

2 Climate and oceanography

Victoria's coastal waters are influenced by three main oceanographic systems (figure 4): from the west by the Leeuwin Current, from the south by swell waves generated in the Southern Ocean, and from the east by the East Australian Current that brings warmer water from the northeast along the coast and into Bass Strait.

The position of Tasmania and the relative shallowness of Bass Strait combined with the influence of tidal currents result in a net east to west movement of water through Bass Strait.

This larger scale movement of water combined with local weather systems and the physical shape of the coast influences the strength and direction of waves and currents nearer to shore. This in turn influences the biological communities that exist along Victoria's coast and in its bays and inlets.

The ability to model these physical drivers and processes and project changes as a result of climate change at a regional scale is critical to decision making in the marine environment.

Climate change is affecting average weather conditions in southern Victoria. Winter and spring rainfalls are declining but the intensity of rainfall events is increasing. Warmer air temperatures, more hot days and warm spells, and increased wind speeds are also occurring.

Climate change will alter oceanographic conditions. Sea level is predicted to rise between 0.4 to 1.0 metres by 2100. Frequency and intensity of storms and magnitude of storm surges will increase. Sea surface temperatures and salinity will increase, and wave directions and currents will change.

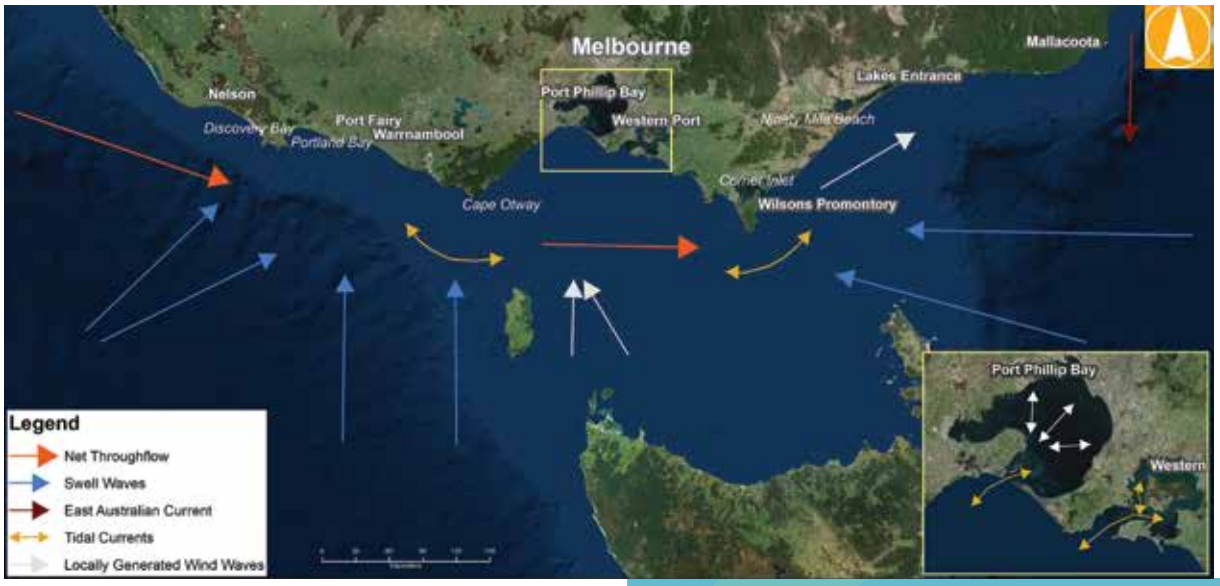
Sea surface temperatures have already increased by 0.1 to 0.2°C per decade since 1970 and are predicted to increase a further 1.9 to 3.8°C by 2090.

The acidity of oceans will increase as more atmospheric carbon dioxide is absorbed by seawater. Decreases in pH of 0.07 to 0.3 are expected by 2090.

Increasing sea levels and storm intensities will intensify coastal hazards such as coastal flooding, storm erosion and long-term shoreline recession. Sea level rise will lead to more frequent inundation of low-lying areas, loss of coastal habitat, and cliff, beach and foreshore erosion.

The most extensive area vulnerable to erosion by 2040 is the Gippsland coast. Other coasts at risk include west of Portland, beaches in Port Phillip Bay between Mordialloc and Frankston, and the coast between Cape Paterson and Cape Liptrap in South Gippsland (figure 5).

Figure 4 Indicative wave and current characteristics



Coastal areas most vulnerable to inundation by 2040 with a 20-centimetre sea level rise include areas around Portland, Port Fairy and Barwon Heads in the west; Queenscliff, Point Wilson, Point Cook to St Kilda and Mordialloc to Seaford around Port Phillip Bay; Tooradin and Lang Lang in Western Port; and Seaspray on Ninety Mile Beach, Gippsland.

In response to the threat from coastal erosion and inundation, DELWP are coordinating the Victorian Coastal Monitoring Program. The program aims to provide communities with information on coastal condition, change, hazards, and the expected longer-term impacts associated with climate change that will support decision making and adaptation planning.

3 Biodiversity

Australia's southern coast is the only major south-facing coastline in the southern hemisphere. It has been isolated for some 65 million years and as a result many of the species in this region are found nowhere else (endemic). It also has high species richness and diversity resulting from the endemic component and a combination of temperate, tropical and cold-water elements.

Knowledge of the major habitat types in the marine environment and types of species and communities they support, together with key ecological processes and potential threats to these, is critical for policy makers and planners. Understanding what biodiversity values are subject to such threatening processes provides a strong basis for decision making.

Broad-scale variables such as tidal level, substrate type, exposure and dominant flora shape the major habitat types in Victorian coastal waters. These broad-scale habitat types are: beaches, intertidal reefs, subtidal reefs, coastal saltmarsh and mangroves, seagrasses, sheltered intertidal flats, subtidal soft substrates, open waters, coastal islands and artificial habitats.

There has been less investment in relation to rare and threatened taxa in the marine environment compared to the terrestrial species, and the number of conservation-listed marine species and communities is considered to be an underestimate of threatened species. Nevertheless, 172 species and four communities that occur in Victorian marine waters have been given conservation listing.

Any loss or deterioration in the condition of biodiversity can compromise all the values that are dependent on biodiversity. Some of the key threats identified at a broad scale include climate change, habitat loss and degradation, pollution, pests, weeds and disease.

Marine species and communities are susceptible to a range of threats, from the very local scale to widespread or global processes.

Figure 5 Predicted coastal erosion impact along Victoria's coastline

Common seadragon

Coastal saltmarsh, Churchill Island

Exploring the unique environment of the Twelve Apostles Marine National Park

Species or communities with very restricted habitat requirements, small home ranges and limited mobility are likely to be most severely affected by localised disturbances. For example, communities of invertebrates in soft sediments on the sea floor, and the important ecological services they provide, can be threatened by changes to wave patterns that alter rates of sediment deposition.

Seagrass beds, estuarine mudflats and mangroves are amongst the most vulnerable habitat types in Victoria as they require sheltered environments that are at increased risk from nutrients and pollutants transported by stormwater. These specialised habitats are critical for all or some life cycle stages of many marine species.

Some marine species are threatened by land-based processes including loss of habitat, predation and disturbance (e.g. the impacts of humans, dogs and horses on beach-nesting birds).

Coastal saltmarsh along with mangroves and seagrass (collectively known as blue carbon ecosystems) play a key role in carbon sequestration. Burial rates of organic carbon in blue carbon ecosystems are exceptionally high and can be 30-50 times higher than rates in the soils of terrestrial forests. 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. This allows blue carbon ecosystems to continually capture carbon, unlike terrestrial ecosystems in which carbon capture may eventually plateau.

Many of the threatening processes affecting marine biodiversity values will be compounded by climate change. For example, changes to ocean currents, sea level, pH, water temperature and frequency of storms are likely to affect a wide range of ecological processes with resulting reductions in the availability of some species, areas of suitable habitat and breeding/roosting sites.

DELWP's marine biotope mapping and classification project is based on the Combined Biotope Classification Scheme (CBiCS). 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 Victoria's marine environment, and will aid in aligning methods with international best practice to meet the requirements of modern natural resource management.

4 Aboriginal cultural values

Traditional Owners feel a deep sense of connection and responsibility to Country and it is increasingly a practice of public land managers to involve Aboriginal people in land and water management, including policy, strategy and project activities.

An important part of this connection and recognition is authority to speak for and make decisions about the management of Country, including a shared understanding of cultural values and the application of Indigenous knowledge and practice.

VEAC's discussion of Aboriginal cultural values is based on a report prepared for VEAC by the Federation of Victorian Traditional Owner Corporations.

Aboriginal peoples of the coastal and marine areas of Victoria identify today as Monero/Ngarigo, Bidwell, Yuin, Gunaikurnai, Boon Wurrung, Bunurong, Wurundjeri, Wathaurung/ Wadawurrung, Eastern Maar and Gunditjmara.

The long-term goals and objectives of Victorian Traditional Owners are to develop and apply Indigenous knowledge and practice for Sea Country in a contemporary Victorian context.

Cultural, social and spiritual meaning of Sea Country to Aboriginal Victorians is demonstrated in historical and contemporary accounts of Aboriginal dreaming stories. These stories date back many thousands of years and are firmly situated in the ecological and social contexts of southeastern Australia.

For example, stories of inundation by rising sea levels that created Bass Strait and severed land links to Tasmania corroborate the postglacial sea level rise that occurred some 6000 years ago.

These dreaming stories are integral to informing understanding of the importance of Sea Country and how to develop frameworks that facilitate the cultural application of Sea Country management in the contemporary Victorian landscape.

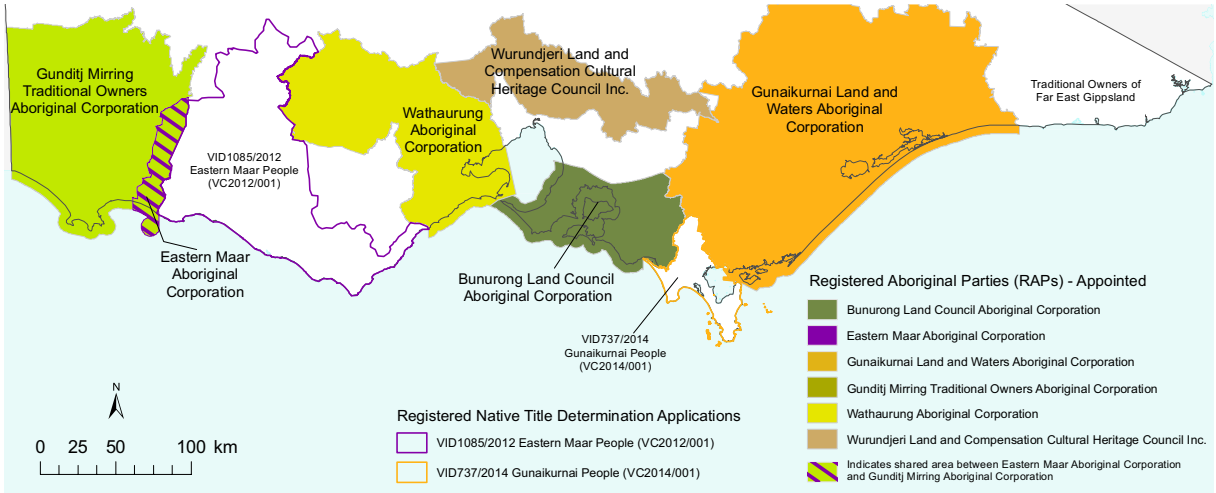
Aboriginal Victorians continue to utilise and harvest the resources of their Country. They and their extended families maintain regular camping sites along the coast in which they pass knowledge of the coastal and marine environment from generation to generation. This interaction with the coast has always been a crucial source of physical and spiritual sustenance and vital to Traditional Owners' identity as coastal people.

The coast contains many sacred and valuable sites for Victorian Aboriginal peoples, many of which are described on the Victorian Aboriginal Heritage Register.

Of concern is that there are examples where Aboriginal cultural values and environmental values more broadly are threatened. These examples often highlight poor decision making when Aboriginal people do not have a real voice in policy, planning and implementation processes.

There is an important opportunity for Aboriginal values to be incorporated in the development of a statewide marine and coastal policy and strategy and in the marine spatial planning framework.

Figure 6 Registered Aboriginal Parties with interests in Victorian marine waters and estuaries



However, the nature of Aboriginal culture and knowledge means that there is not a well-documented inventory of information relating to the Victorian coast available to decision makers.

Included in chapter 7 of the assessment report is a strategic framework that articulates the measures that Traditional Owners advise are needed to fill knowledge gaps and avoid threats to natural and cultural values. The actions outlined in the strategic framework can also complement and support broader processes of reconciliation.

5 Non-Aboriginal heritage

Maritime archaeology focuses on the tangible evidence of seafaring history, including vessels, structures such as ports and lighthouses, and subsistence activities including fishing and whaling.

These physical remnants of the past have historical, social, archaeological, technical, interpretive and scientific significance, which provide an important sense of connection to community and landscape, to the past and to lived experiences.

The sea had a central role in the early economic, social and physical development of Victoria by Europeans. Physical evidence of past dependence on the sea for transport of people, goods and information remains in numerous historic places and objects.

Many sites in Victoria that are rich in non-Aboriginal heritage are also of significance to Aboriginal people – both pre- and post-contact with Europeans – but these values are not as well documented. The Shared Heritage Project in Victoria is identifying places with both Aboriginal and other heritage values.

The permanent European settlement of Victoria from the 1830s led to the establishment of maritime infrastructure, as sea transportation was much more reliable than inland travel. Investment in ports, harbours, shipping channels and navigation aids continued through the nineteenth and twentieth centuries.

Historically significant places and objects in Victorian waters and on land are protected under the *Heritage Act 2017*. Shipwrecks and other underwater cultural heritage are also protected under complementary Commonwealth legislation.

Many heritage values are not well known or documented. For example, while shipwrecks are some of the most readily recognisable sites of maritime archaeology, fewer than half of the 780 shipwrecks along the Victorian coast have been located.

Shipwrecks were often damaged by treasure hunting divers, but legislative protection and education – including through establishment of shipwreck trails – have promoted more benign forms of tourism.

General threats to maritime heritage include degradation by natural forces, some of which (e.g. storm surges) will worsen with climate change.

Increasing pressure for coastal and foreshore development is likely to lead to disturbance of undiscovered or undocumented heritage sites and objects.

Divers investigating the SS Cambridge that sunk in 1942 off Wilsons Promontory

Recreational divers have an important role in helping to identify and preserve shipwrecks

6 Coastal development

Coastal development involves altering the marine and coastal environment through the construction of commercial infrastructure (e.g. ports and commercial building), housing, recreation and tourism facilities, and structures that enable access to and protection from the marine environment (e.g. wharfs and boat ramps, seawalls and breakwaters).

To improve planning and management of coastal development there is a need to understand the physical processes that have shaped the nature of the coast, and how it might change with demands of a growing population and pressures of climate change.

Early coastal settlement was driven by access to safe harbours. More recently it has been influenced by increasing population and lifestyle factors such as the 'sea change' phenomenon.

Demographic data provides context for assessing impacts of people on the marine environment and for planning future needs. Coastal populations, within two hours of Melbourne have been increasing at a rate of between 3 and 5 per cent annually (figure 7). Continued growth at this rate could have significant impact on marine and coastal values.

Limiting development within township boundaries protects some natural and social values but puts increased pressure on others.

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.

Rehabilitating habitats such as shellfish reefs and mangroves for coastal protection is an emerging activity at a local scale.

Victoria has more than 400 boat launching sites, yacht clubs and marinas. These facilities provide access to the marine environment but have localised impacts.

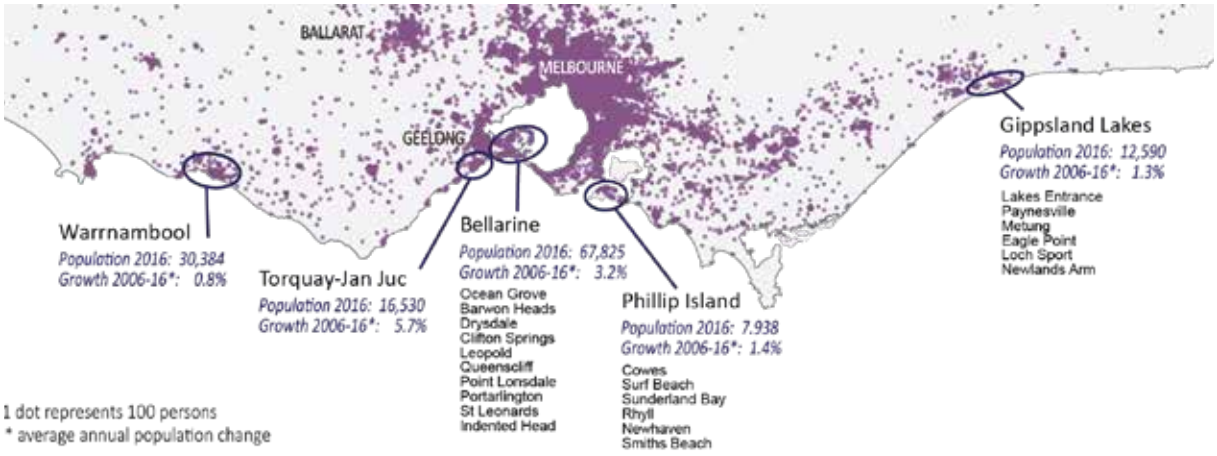
Demand for coastal access will increase with population growth. Crowding at boat ramps, conflict between users (e.g. boats and swimmers), noise and water pollution are all emerging concerns.

Seawater is used for industrial purposes including cooling during energy generation, aquaculture and desalination. Treated sewage effluent and industrial wastewater is discharged through outfalls. With population growth the volume of seawater extracted and wastewater discharged will increase, extending the area of impact.

Climate change will increase the number of intense rainfall events and volume of stormwater. Impervious surfaces associated with coastal development will increase runoff volumes. Stormwater carrying nutrients, sediments and pollutants threatens biodiversity and recreational uses of marine environments.

Stormwater pollutants of emerging concern include endocrine-disrupting compounds, flame retardants,

Figure 7 Population concentration along the Victorian coast, 2016



pesticides and microplastics. As these compounds are not systematically monitored, concentrations and the extent of impacts are unknown.

Pressures associated with a growing urban population, climate change and ageing coastal infrastructure will ultimately impact on feasibility of living in or developing some coastal locations.

7 Tourism and recreation

Tourism involves people travelling to, and staying in, places for short periods of time typically for leisure or business, while recreation is defined as the activities people pursue in their free time.

As Victoria continues to experience population growth and urban densification, the marine environment will be visited by more people, in more places, for tourism and recreation.

Marine tourism is a large and growing part of Victoria's tourism sector. It is strongly dependent on marine natural values such as popular or appealing ('charismatic') animals and pristine landscapes. Growing or emerging tourism sectors include Indigenous, nature-based and adventure tourism.

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.

Ecotourism is ecologically sustainable tourism with a focus on increasing environmental and cultural awareness. Popular activities include swimming with and viewing marine mammals, surfing and paddling. Compared with more traditional tourism, ecotourism has a lesser environmental impact.

Recreation in the marine environment includes activities beside, on and in the water, all providing significant health benefits.

Most on-water activities include boats of some sort. There are more than 400,000 licensed boat operators and over 200,000 registered boats, more than 20,000 of which are personal watercraft. Threats from boating include pollution, localised biodiversity impacts of access structures (e.g. boat ramps) and disturbance to biodiversity.

Boat-based tourism is a growing industry and includes dive boats, fishing charters, scenic cruising boats and yachts. Mostly small to medium-sized boats are involved, so impacts and risks of marine pollution are considered to be minor.

Marine mammals (whales, dolphins and seals) are the focus of a number of air, land and sea-based tourism businesses. To manage the disturbance impacts on the animals, a combination of regulations, permits and exclusion zones are in place.

Artificial reefs, including sunken ships, are growing in popularity for diving and improving recreational values.

Citizen science and community-based volunteer projects are important recreational activities that raise the awareness of environmental values and encourage marine stewardship.

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.

There is limited knowledge on current visitor numbers at a finer scale. These data are needed to inform infrastructure priorities.

Cooperation and a shared vision across the local community, tourism industry and government are necessary to sustain the appeal of tourist destinations.

Nippers program, Inverloch

Burrunan dolphins

8 Fisheries

Victoria's four marine fisheries sectors are: commercial wild catch, aquaculture, recreational and Aboriginal (the latter overlapping with the other three sectors). The available information on the specific values, threats and emerging uses varies substantially across these sectors.

Understanding the status of fish stocks and potential impacts from climate change and increased fishing pressure will be critical for ongoing management.

The commercial wild catch sector targets a diversity of species (finfish, molluscs, echinoderms, crustaceans and sharks) across various environments (bays, estuaries and open ocean).

Nearly 5000 live weight tonnes of seafood were commercially harvested in Victorian waters in 2016-17; this represents approximately half of the commercial wild catch in 1986-87.

Domestic seafood production (both wild caught and aquaculture) accounted for 27 per cent of ready-to-eat seafood consumed in Australia in 2016-17.

Assessing fish stocks and the impacts of harvesting is difficult and more data are needed for some target species and most non-target species.

Aquaculture is currently limited to a few mollusc species (abalone and mussels) but is growing in value. Aquaculture production is well-documented through returns by licensees. In 2016-17, almost 1600 tonnes of marine organisms were cultured.

Recreational fishing is a large and dispersed sector. Around 10 per cent of Victorians are estimated to fish recreationally in marine and estuarine waters, particularly Port Phillip Bay, Western Port, Corner Inlet and the Gippsland Lakes.

Current government policy aims to increase recreational fishing participation. Monitoring of recreational fishers (e.g. number of fishers, total catch) is logistically challenging and expensive, so there are large knowledge gaps for this sector.

The Victorian Aboriginal Fishing Strategy aims to incorporate the rights, interests, aspirations and culture of Aboriginal people into fisheries management. Customary use and access rights are only available to some Traditional Owners under native title or settlement agreements. Harvests of pipis and short-finned eels have received most attention, but there is little information about most aspects of this sector.

For a species or population to support fishing, it needs to be part of a healthy and functioning ecosystem. Habitat loss affects key life stages, such as larval recruitment, especially for species dependent on limited habitats such as seagrass beds. Other threats to fisheries include poor water quality, invasive species and diseases.

Certain traits render species more vulnerable to overexploitation: these include being long-lived, slow to mature, producing few young and having narrow habitat requirements. Several species have been overexploited in Victoria, most recently scallops in the 2000s.

South-eastern Australia is a climate change hotspot with well-documented recent changes in the marine environment, including warming waters, changes in the continental currents and reduced freshwater flows into bays and estuaries. The potential impacts to fish stocks from these changes need further investigation.

Commonwealth and state fisheries legislation adopts a sustainable use approach. Fishing is prohibited or restricted in certain places across the Victorian coast, such as in marine national parks and sanctuaries.

Competition between the commercial and recreational fishing sectors for limited resources has led to the exclusion of commercial fishing activities from many bays and inlets since the 2000s.

Fishing off Rye Pier

9 Ports and shipping

Victorian ports and shipping are part of complex supply chains that link road, rail and sea transport to service trade to and from Victoria.

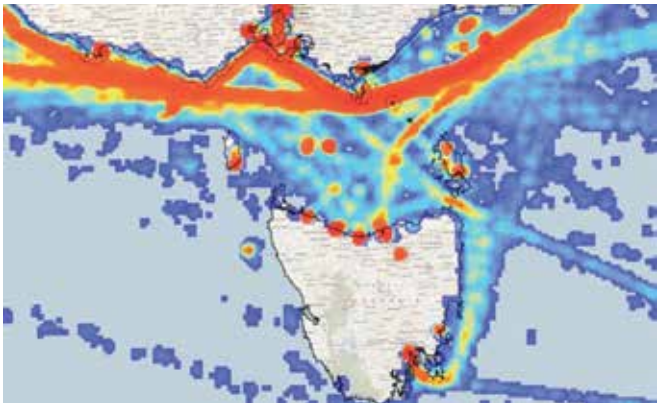
Understanding requirements for port operations and shipping, such as maintenance of channels and safe navigation, and threats posed by climate change and trade demand are critical to ongoing management.

Victoria has four commercial ports: Port of Melbourne, Port of Hastings, Port of Geelong and Port of Portland. There are also fourteen local ports managed by eight local port managers including Parks Victoria, Gippsland Ports and local councils.

The initial construction of port facilities often involved substantial impacts on sensitive environments through dredging and land reclamation. Present-day maintenance (such as dredging) and upgrading of port facilities is conducted with much more attention on mitigating these environmental impacts.

More than 4000 ships visit Victorian ports annually, with about 3200 visiting the Port of Melbourne.

Figure 8 Visualisation of ship tracking data. Source: AUSREP



The Port of Melbourne is Victoria's only container port. Over the past ten years, the volume of all trade through the port has grown by 3.2 per cent annually. This growth is projected to continue, with strongest growth predicted in container trade. While the Port of Melbourne has capacity to more than double the volume of container trade, long-term plans have been developed for a second container port, Bay West, near Werribee.

Locations at highest risk of shipping accidents and spillages are the ports of Melbourne, Geelong and Hastings as well as Port Phillip Heads. These areas are associated with the greatest levels of nearshore shipping activity and, in the case of the ports, an additional threat posed by oil transfer activities.

Once outside port waters, ships take the shortest route to the next port of call, with these routes mostly outside of Victoria's coastal waters (figure 8). Exceptions are for routes around Cape Nelson for ships visiting Portland, and Cape Otway and Wilsons Promontory for ships visiting Port Phillip Bay and Western Port.

To reduce the risk of ship collisions in Bass Strait, there are two traffic separation schemes. Eastbound and westbound shipping lanes have been established for ships to pass the islands south of Wilsons Promontory and also for ships to pass between the oil rigs in Bass Strait.

To accommodate increasing volumes of trade, ships are becoming longer and wider but not deeper. Increasing draught would impact on the ability of ships to use existing port infrastructure, including channels and berths.

Climate change impacts on port infrastructure in Victoria are predicted to be low, as many engineering solutions are already in place to accommodate rising sea levels and changing ocean chemistry.

Concerns exist about the impact of ship anchors on sensitive benthic environments, particularly within marine protected areas.

There is substantial latent capacity in Victoria's commercial ports. If capacity is reached, the ability to expand existing ports depends on surrounding land uses, environmental sensitivities and connectivity to road and rail networks.

Container ship leaving Port Phillip Bay

10 Energy and earth resources

Victoria's coastal waters and the adjacent Commonwealth waters provide significant resources for the energy sector. These include oil and gas production and emerging opportunities for renewable energy through offshore wind farms, wave energy converters and tidal stream turbines. Other energy-related uses include potential storage and sequestration of carbon dioxide (CO_2) in depleted offshore gas fields and use of deep-water ports for shipping and transfer of fuels.

Three oil and gas basins straddle Victorian and Commonwealth waters: the Otway, Bass and Gippsland basins. Production in Victorian waters occurs only within the Otway Basin.

Most of the gas Victoria consumes comes from Commonwealth waters. A shortfall in gas supply has been predicted from 2022.

Seismic surveys are an essential part of oil and gas exploration although they can have negative impacts on marine organisms. Substantial environmental controls accompany seismic survey work.

The process of hydraulic fracturing ('fracking'), used to release unconventional gas from the sedimentary rocks in which it is found, was prohibited in Victoria in 2017.

While substantial potential for wave and tidal energy generation has been identified in Victorian waters and pilot projects carried out, these sources seem unlikely to progress without significant government support.

Offshore wind farms are increasingly popular in Europe. While there is a current proposal in Commonwealth waters offshore from Gippsland, the size and visual impact of offshore wind farms may limit their development in waters closer to shore.

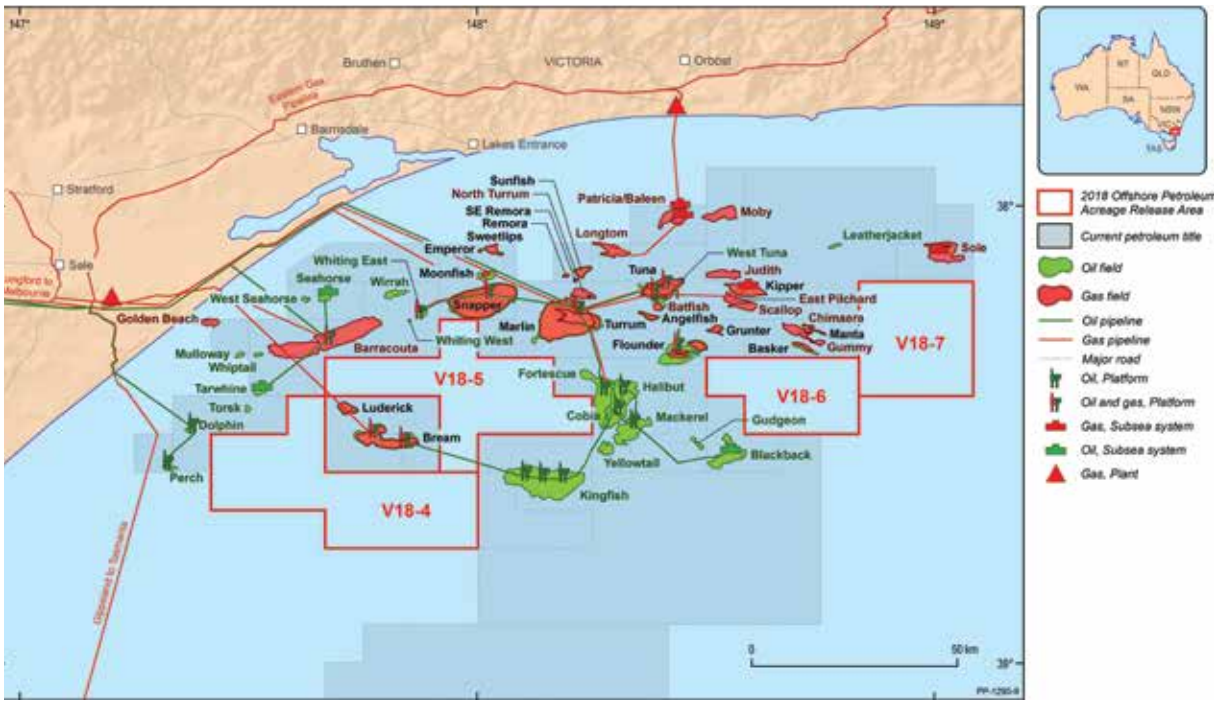
Other sources of renewable energy, including geothermal and biofuels, have low potential for development in Victoria.

No mineral resources are mined in Victorian waters. Where valuable minerals occur, it is currently not economically viable to extract them in commercial quantities. In some locations offshore sand deposits are dredged for beach renourishment, although this is not considered mining.

More research is required to assess the suitability of depleted oil and gas wells for offshore carbon dioxide sequestration. A pilot project was built onshore near Warrnambool and further investigation is occurring off the Gippsland coast.

The potential for decommissioned oil and gas infrastructure (e.g. pipelines, platforms) to remain in the marine environment and act as artificial reefs has been considered in other jurisdictions.

Figure 9 Gippsland Basin oil and gas fields and pipelines



11 Threats to marine values

VEAC assessed threats across each of the themes and against six classes of threats: climate change, physical processes, biological processes, catchment processes, pollution and community/industry demand. These threat classes align with those used by the IUCN for ecosystem assessment.

The chart below provides an indication of those threats that are present or have the potential to be present across each of the assessment themes. The degree to which the threat is present or likely to occur has not been indicated and therefore this chart is suitable for summary purposes only. The discussion that follows is based on the information reviewed for the assessment report and atlas.

Threat class	Threat pathway/ outcome	Biodiversity	Sea Country	Non-Aboriginal heritage	Coastal development	Tourism and recreation	Fisheries	Ports and shipping	Energy and earth resources
Climate change	Altered oceanography (currents, waves, wind)	•	•	•	•	•	•	•	•
	Sea level rise	•	•	•	•	•	•	•	
	Ocean warming	•	•	•		•	•	•	•
	Ocean acidification	•	•	•		•	•	•	•
	Increased storm frequency	•	•	•	•	•	•	•	•
	Increased hot, dry weather	•	•	•	•	•	•		
Physical processes	Habitat loss/degradation	•	•		•	•	•		
	Trampling	•	•	•		•	•		
	Erosion	•	•	•	•	•	•	•	•
	Site degradation/destruction (inc. dredging)	•	•	•	•	•	•	•	•
	Corrision/decompostion of built assets			•	•	•	•	•	•
	Exposure caused by waves and wind	•	•	•	•	•	•	•	•
Biological processes	Pathogens	•	•			•	•		
	Introduced species/marine pests	•	•			•	•	•	•
	Overabundant native species	•	•			•	•		
	Range-expanding species	•	•	•	•	•	•		
	Food web disruption/collapse	•	•		•	•	•		
	Harvesting/bycatch	•	•			•	•		
	Behavioural alteration	•	•			•			
	Recruitment failure	•	•			•	•		
	Altered species abundance/distribution	•	•		•	•	•		
Catchment processes	Altered hydrological regimes/freshwater flows	•	•		•	•	•	•	
	Sedimentation	•	•	•	•	•	•	•	
Pollution	Marine debris/litter	•	•		•	•	•	•	
	Chemicals/heavy metals/oil	•	•		•	•	•	•	•
	Nutrients	•	•		•	•	•	•	
	Light	•	•						
	Noise	•	•			•	•		
Community and industry demand	Expansion of industry	•	•	•	•	•	•	•	•
	Demand for tourism	•	•	•		•	•	•	
	Sector competition over resources	•	•	•	•	•	•	•	•
	Recreational access/crowding	•	•	•	•	•	•	•	
	Technology development/obsolescence	•		•		•	•	•	•
	Safety risk	•	•	•	•	•		•	•
	Access to coastal land	•	•	•		•	•	•	•
	Social licence				•	•	•	•	•
	Complex regulatory requirements/altered controls		•		•	•	•	•	•
	Commercial viability				•	•	•	•	•

• Threat present or with potential to occur

Climate change

Victoria's marine environment, its plants and animals and physical features, have been shaped by climate and oceanographic conditions and the underlying geology. Climate change is altering these conditions with cascading effects in Victoria's marine environment.

Altered oceanography

Strengthening of the East Australian Current and weakening of the Leeuwin Current will impact dispersal of fish species that rely on pelagic transport of adults and larvae, such as short-finned eel, western blue groper and King George whiting. Changes in fish stocks impact on the ability of fishers to harvest targeted species, with potential flow on impacts to businesses that cater to these fishers. Any negative impacts on biodiversity affects the health of Sea Country.

The larger infrastructure associated with shipping and energy industries (e.g. quay cranes) may become more expensive to build and replace to meet changing design standards, particularly around increased wind loading.

Altered wave patterns will affect sand movement, exposing shipwrecks and artefacts that are currently protected through being buried.

Changes in wave direction and strength will increase demand for coastal protection, such as sea walls, in vulnerable locations. These are costly to construct and maintain, and also have impacts on the physical and ecological dynamics of coastal areas.

Sea level rise

Along developed coastlines, mangroves cannot advance in response to rising sea levels. These are critical habitats for many species, including as nurseries for juvenile fish targeted by fishers (e.g. yellow-eye mullet).

Sites of cultural significance (e.g. Aboriginal middens, early maritime infrastructure) located in coastal dunes are threatened by erosion and inundation. Low-lying infrastructure such as boat ramps, jetties, yacht clubs and access roads to ports are also at risk.

Ocean warming

Warming oceans have led to the southward expansion of several species, such as the black sea urchin. This species is native to New South Wales and when abundant creates barren habitats that no longer support harvested species like abalone.

There is some evidence that the expansion in range of marine borers that damage wooden heritage structures (e.g. shipwrecks and old piers) is facilitated by ocean warming. There is a potential increasing impact on shipping and maintenance of built structures in marine waters.

Species that tourist operations depend upon (e.g. little penguins) may change where they forage or nest depending on food sources that change with warming oceans.

Ocean acidification

Under more acidic oceans, marine calcifying organisms such as some invertebrates (e.g. calcifying plankton, scallops, corals) may struggle to build shells or skeletons. This will impact on marine food webs and fisheries that harvest these species (e.g. abalone, mussels). Any negative impacts on biodiversity affect the health of Sea Country.

Metal structures in the ocean (e.g. outfall pipes, ships, oil rigs) will corrode more quickly in increasingly acidic water and may require increased protection with sacrificial cathodes. Metal shipwrecks will also be increasingly vulnerable to corrosion.

Saltmarsh and mangroves, Churchill Island

Penguin parade, Phillip Island

Increased storm frequency and storm surge

Extreme rainfall events increase sedimentation in bays and estuaries. High levels of suspended sediments increase turbidity and smother important habitats such as seagrass beds that form nurseries for harvested fish species.

Fishing, recreational and tourism vessels may have decreased opportunities to access waters, leading to additional costs and uncertainties for businesses. Infrastructure including aquaculture farms, boat ramps and vessels may be lost or damaged during storms. Cultural heritage is also at risk during extreme events, through exposure of middens because of erosion or sandblasting of underwater sites.

In response to safety risks associated with extreme weather, industry design standards may be increased, for example to allow for greater wind loading. It is also likely that coastal communities will require more and improved coastal protection works (e.g. sea walls).

Increased hot dry weather

Periods of hot dry weather threaten the survival of those species that come ashore for breeding or raising their young, such as seals, penguins and other shorebirds. On hot days, more people visit beaches, putting stress on facilities and leading to overcrowding.

Physical processes

Habitat loss and degradation

Habitat loss affects species across their lifecycle. Particularly vulnerable stages include breeding and recruitment. The replacement of native dune vegetation by weeds has impacts on beach nesting birds like hooded plovers, while the loss of seagrass affects recreationally and commercially important fish species. Any negative impacts on biodiversity affects the health of Sea Country. Loss of native coastal vegetation and the species it supports diminishes the amenity of an area, making it less attractive to local residents and tourists.

Trampling

Trampling can occur because of unauthorised access to sensitive areas such as middens or overuse of vulnerable areas such as rocky intertidal platforms. It can lead to the direct loss of species (e.g. Neptune's necklace) or damage to habitats (e.g. seagrass). Accidental damage can also occur on shipwrecks due to careless diving practices or from boat operators dropping anchors. Trampling damage impacts on the natural character of biological and cultural sites and can diminish their value as tourist destinations.

Erosion

Increases in sediment deposition threaten seafloor communities and the ecological services they provide (including denitrification). Inshore habitats like seagrass can be impacted by siltation, which has follow-on effects for the fish species that depend upon them. Inshore siltation increases the need for dredging and sand bypass infrastructure to maintain adequate depths within ports. Loss of sediment may expose cultural heritage sites and artefacts including middens and shipwrecks. Local residents and visitors expect that popular beaches will be protected and stabilised by ongoing sand replacement (beach renourishment).

Site degradation or destruction

Between 20 and 30 per cent of coastal protection assets are in poor condition and between 30 and 50 per cent have less than 10 years of useful life remaining. The degradation of these assets puts coastal communities and industries at risk. Extreme weather events are likely to damage even those built assets that are in good condition, including boating and other tourist infrastructure.

Storm surge, Mordialloc Creek

Neptune's necklace at Point Addis

Insensitive coastal development can lead to the clearing of sensitive vegetation (e.g. mangroves) and sacred and significant Aboriginal sites. Site destruction is occasionally intentional in the case of looting or vandalism to cultural heritage sites.

Decomposition or corrosion of built assets

Metal structures in the ocean (e.g. outfall pipes, ships, oil rigs, piers, shipwrecks) will corrode more quickly in increasingly acidic water and may require protection with sacrificial cathodes. The build-up of oxygen pockets within shipwrecks associated with visits by divers can also speed up corrosion in metal wrecks.

Exposure by waves and wind

Some types of cultural heritage (e.g. middens, shipwrecks) are protected by being buried in sediments. Exposure of these sites by waves and wind increases their rate of decay and risk of looting or vandalism. Shipwrecks act as artificial reefs, providing habitat for numerous fish and other species and are also popular dive sites. Decay of shipwrecks diminishes their tourist and ecological value. Changes in wave and wind patterns also leads to increased stress on other built assets.

Biological processes

Pathogens

Pathogens include all organisms (e.g. bacteria, viruses and parasites) capable of causing disease. In 2006, abalone viral ganglioneuritis caused up to 90 per cent mortality in impacted abalone farms and wild populations in Victoria. Pathogens found in stormwater can lead to beach closures for public health.

Introduced species and marine pests

Declared marine pests and other introduced species have impacts on both habitats and ecological processes. For example, introduced species may negatively affect denitrification processes by outcompeting or preying on infauna. Marine pests (e.g. Pacific sea star *Asterias amurensis*) also compete with harvested species for food. The presence of introduced species impacts on the health of Sea Country and the desirability of locations as tourist destinations. To assist in reducing the introduction and spread of marine pests via ballast water, there are obligations on high-risk vessels operating within Australian waters. The failure to manage biofouling marine pests can result in ships being refused entry to some ports.

Overabundant native species

Native species can behave like pests if they are introduced outside of their normal range or if constraints to population growth, such as predation or food availability, are eased. The Victorian species of white sea urchin (*Heliocidaris erythrogramma*) has been increasing in abundance and forming barrens, especially in the northern parts of Port Phillip Bay. Urchin barrens devoid of kelp no longer support important recreational fish species and are less attractive to divers and tourists.

Range expanding species

The black sea urchin (*Centrostephanus rodgersii*) has expanded its range from central and southern New South Wales to eastern Victoria and Tasmania in response to warming of sea surface temperatures and strengthening of the East Australian Current. This species forms barrens that are devoid of habitat-forming macroalgae such as kelp, the preferred food of abalone.

Shell middens under threat from erosion

Recording the size of northern Pacific seastars in Wilsons Promontory Marine National Park

Food web disruption or collapse

Ocean acidification will impair species at the bottom of food webs (e.g. calcifying plankton), with flow on negative impacts on species that feed on them (e.g. marine mammals). Food web disruptions may lead to reduced fish stocks and other species that attract tourists as well as reduced amenity.

Harvesting and bycatch

School shark are vulnerable to overexploitation because they are long-lived and slow to reproduce. They are considered overfished but are still taken as bycatch for gummy shark. Other harvested species that have previously been subject to overexploitation in Victoria include native flat oyster, blue mussel, barracouta and scallops.

Behavioural alteration

Certain species are particularly sensitive to disturbance through recreational activities. For example, hooded plovers are prone to abandon eggs and chicks when disturbed on beaches, particularly by dogs off lead. Unless properly managed, tourist interactions with dolphins may cause the animals to move elsewhere, interfering with future tourist opportunities.

White sea urchin barren near Mornington

Black sea urchin off Gabo Island

Recruitment failure

Reduced freshwater flows into bays and estuaries, associated with reduced rainfall and runoff, have impacted negatively on recruitment in Australian bass and sand flathead, recreationally harvested species.

Altered species abundance or distribution

Reduction in the abundance of fish stocks has impacts on commercial fisheries. Decreased numbers of fish also negatively affects recreational fishers and tourists, as well as decreasing the amenity of coastal locations.

Reductions in the abundance and distribution of saltmarsh, mangrove and seagrass decreases important carbon sequestration services.

Catchment processes

Altered hydrological regimes and reduced freshwater flows

Reduced rainfall and increasing river regulation will have negative impacts on fish species such as Australian bass (an important recreational fish) that require high river flows and cool water temperatures for successful recruitment.

Estuaries have a strong reliance on freshwater flows. Reduced flows can lead to poorer water quality and decreased amenity, limiting some recreational uses (e.g. swimming, fishing and boating).

Common dolphins, Port Phillip Bay

Sedimentation

Nutrients and sediments are the main causes of poor water quality in embayments and estuaries, which leads to decreases in aesthetic, recreational and ecological values. Filter feeders are particularly sensitive to poor water quality.

High levels of suspended sediments can smother important habitats like seagrass beds. Numbers of some important fish species (e.g. mullet and bream) have been dwindling as areas have become silted (e.g. Hopkins River, Merri River).

If bays and inlets become too shallow due to sedimentation, boats will be unable to launch unless dredging is undertaken.

Diving requires clear water, which can be degraded by excess sediment that reduces water clarity.

Underwater cultural heritage may be covered by sediments. While this may help preserve relics, sediments impair the ability of divers to access sites.

Pollution

Marine debris

Litter has negative impacts on visual amenity, reduces water quality and can kill or harm marine animals. Beaches are prominent locations for the accumulation of litter, a significant community concern. Marine animals (e.g. leathery turtles) are vulnerable to plastic ingestion, which prevents feeding, creates internal blockages and accumulates toxic chemicals. The bioaccumulation of toxins is a public health concern for harvested species. The health of Sea Country is also impacted by pollution.

Catchment-sourced litter collects in sheltered areas, often in ports and entrances to rivers and creeks, creating nuisance impacts and costs to clean up.

Chemicals and heavy metals

Species that occur in embayments are exposed to higher levels of toxins due to lower flushing times and accumulation of upstream catchment impacts (e.g. Burrunan dolphins, black bream). While current quantities and impacts are unknown, contaminants of emerging concern include endocrine-disrupting compounds, pharmaceuticals, flame retardants, pesticides and microplastics. Such chemicals and heavy metals decrease the amenity of locations to locals and tourists.

Oil and chemical spills lead to costly emergency clean-up costs, damage infrastructure and limit access. Dredge spoil containing contaminated sediments (e.g. cadmium, mercury and nickel) is more complicated and costlier to dispose of.

Nutrients

Nutrients and sediments are the main sources of poor water quality in embayments. Filter feeders (e.g. commercially-important mussels) are particularly sensitive to poor water quality. Any negative impacts on biodiversity affect the health of Sea Country. Nutrient influxes can also lead to algal blooms that decrease amenity and lead to beach closures. Excess nutrients may also foster the growth of biofouling organisms.

Light

Nocturnally-active fledglings (e.g. short-tailed shearwater) are attracted to artificial light sources, rendering them vulnerable to collision with infrastructure or predation on the ground.

Noise

Anthropogenic noise (e.g. seismic survey) impacts on cetacean (e.g. blue whale) communication and physiology as well as on survival of commercially-important species (e.g. scallops). Excess noise can also impact on the amenity of tourist destinations.

Screw Creek, Andersons Inlet

Accumulated marine debris, Docklands, Melbourne

Community and industry demand

Expansion of industry

Ports are often in sensitive ecological locations (e.g. Ramsar wetlands), which can limit the opportunities for expansion of industries in these areas. Coastal development can also lead to destruction of sensitive environmental and culturally significant sites (e.g. middens), similarly limiting opportunities for expansion. In offshore areas, the risks associated with disturbing the seabed through dredging or construction activities (laying pipelines) can limit opportunities.

Increased visitation rates at popular tourism destinations can lead to negative impacts on the destinations. However, visitor limitations may threaten the profitability of tourism businesses.

Demand for tourism

Ecotourism is intended to minimise environmental impacts. For this reason, many Traditional Owner groups are exploring cultural ecotourism. However, increasing demand risks damaging the resources it depends on and the amenity of locations.

There is concern that the promotion of wrecks through shipwreck trails could lead to increased looting and souveniring. Increasing levels of ecotourism may compete with fishers for access to infrastructure (e.g. boat launching) and fish stocks.

It is also possible that the tourism sector will oppose expansion of other industries seen as less desirable (e.g. ports and energy extraction).

Sector competition over resources

Use of the marine environment relies on a limited number of access points like boat ramps. Busy periods can lead to conflict between users. Conflicts also occur between swimmers, jet skis and speed boats.

There are conflicts between users of marine resources, and between conservation and resource use. Because of perceptions that commercial fishing is a threat to recreational fishing, the state government has implemented commercial netting bans and exclusion zones in bays and inlets.

As seismic surveys impact on marine mammals (e.g. whales), there may be conflict between marine mammal tour operators and oil and gas exploration for access to areas.

Conflicts also exist between developing a resource (e.g. access to underwater cultural heritage) and preserving it through excluding access (e.g. coastal vegetation).

Recreational access and crowding

Popular locations, especially over summer, may be subject to overcrowding, which has impacts on people's ability to participate in their favoured activities. Overcrowding can lead to reduced visitor numbers, threatening local businesses.

Lesser levels of recreational access may also impact on values. Middens are easily damaged by access tracks and recreational activities. Hooded plovers are prone to abandon eggs and chicks when disturbed on beaches. Fragile shipwrecks may inadvertently be damaged by inexperienced divers.

Short-tailed shearwater

Hooded plover warning sign

Technological development or obsolescence

Technological advances allow increased access to previously unavailable resources. For example, developments in SCUBA equipment have allowed access to more difficult to reach deeper wrecks. While this facilitates the discovery of new sites, it increases risks of looting and damage.

The oil and gas industry is anticipating a large increase in decommissioning activity as infrastructure reaches the end of its useful life. While complete removal and plugging of wells is currently the default response, in the US petroleum companies pay a fee to local governments to use their decommissioned structures as artificial reefs.

Safety risk

Safety risks can lead to the closure of sites for recreation and other uses. Damaged piers are closed and, when pathogen levels are elevated, beaches are closed to swimmers.

Increased design standards to maintain safety for heavy infrastructure (e.g. ports, energy) in the face of climate change may impose additional costs.

Access to coastal land

Coastal land will increasingly come under pressure from rising sea levels and population growth. Competing land use priorities and the preferences of residents may prevent or limit the expansion of industries such as aquaculture and ports.

Overcrowding reduces the amenity of destinations and leads to the deterioration of sites.

Social licence

Social licence refers to the public acceptance of an activity. For example, while Port Phillip Bay is technically appropriate for offshore wind energy, the community may be unlikely to support such a project due to visual impacts. Similar community opposition exists for expanding port operations in sensitive environments and expanding coastal settlements outside of township boundaries.

Illegal, unreported and unregulated fishing threatens stock sustainability, impacts market prices of fish and threatens the social acceptability of fishers who are complying with regulations.

Complex regulatory environment

A complex regulatory environment may stop or restrict development or activities such as port development or oil and gas exploration. Regulatory impacts may also occur at a finer scale, e.g. bag limits may not accommodate the practice of Aboriginal fishers providing food for extended networks of people who cannot fish themselves.

Altered input and output controls affect commercial fishers. The numbers of commercial fishing licences available are subject to environmental variability and political decision making (input controls). The total allowable catch limits vary annually (output controls). These uncertainties can have impacts on the viability of commercial businesses of licence holders.

Commercial viability

Political decisions and market forces affect the commercial viability of certain activities. Where minerals of value occur in Victorian coastal waters their extraction at a commercial scale is not currently economically viable. The allocation of bay and inlet fisheries to recreational rather than commercial fishing has impacts on the viability of commercial fishing businesses. To maintain international competitiveness, ports need to continue dredging to provide adequate depth in shipping channels.

12 Classifying social and economic values

While systems to classify environmental data are relatively well developed, social and economic values are more challenging to capture, particularly as they relate to the environment. One approach is to link these values through the concept of ecosystem services. Ecosystem services are the contribution of ecosystem components to human wellbeing. The importance of ecosystem services is recognised in the United Nations Sustainable Development Goals. However, measurement is not straightforward and to date only a limited number of ecosystem services have been assessed in the marine environment.

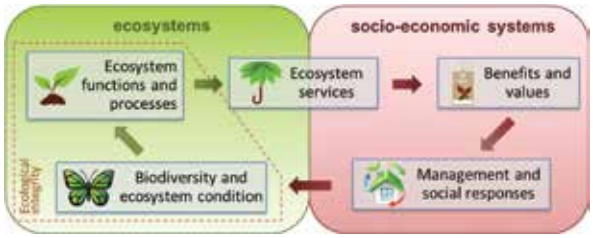
Given the ecological complexity of the marine environment, the diversity of benefits and the numerous stakeholders, a combination of processes and tools are required to bring together social and economic values for the purpose and scale of the specific task. Approaches complementary to ecosystem services include risk assessment, numerical modelling, scenario testing, expert elicitation as well as methods that incorporate community knowledge.

Adopting evaluation tools and methods that align with international standards, using bottom-up approaches for engagement of stakeholders, and collating knowledge from a diverse range of sciences provides the best approach to describing social and economic values and uses of Victoria's marine environment.

Figure 10 provides a simplified representation of the cascading framework of ecosystem services. Ecosystem functions and processes comprise all the biophysical roles that sustain the provision of a specific ecosystem service, thus indicating the natural capacity to provide that service.

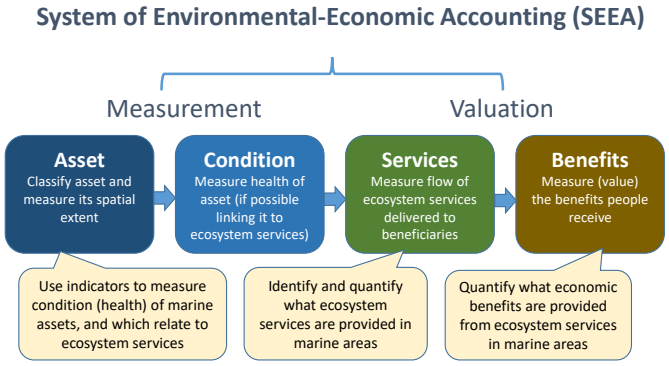
Building knowledge and understanding of these services and benefits then drives initiatives for protecting ecosystems, their ecosystem services and consequently human wellbeing.

Figure 10 Linking of natural and social systems through ecosystem services



The System of Environmental Economic Accounting (SEEA) is a framework for developing ecosystem accounts and expanding the scope of conventional accounts for economic activity. As illustrated in figure 11, it is used to integrate measurements of environmental assets and to value the benefits they provide. Ideally, as benefits from ecosystem services increase, the condition of environmental assets should not deteriorate.

Figure 11 SEEA integrates measurement of environmental assets and valuation of their benefits



Historically, management of marine environments has been approached on a sector by sector basis. The preference now is for more inclusive approaches that protect and enhance natural assets, processes and functioning, while still delivering the ecosystem services from which society can benefit.

In addition, seeking to understand community preferences through stakeholder engagement, and identifying and understanding areas of conflict, builds a strong foundation for development of marine policy.

13 Data inventory and knowledge gaps

Knowledge of the way in which marine ecosystems operate and how they respond to changing conditions is critical for informing management decisions. To improve knowledge there is a need to have in place processes for data collection, data management, data analysis and decision support systems that support planning and management.

Current systems for collecting and managing knowledge about the marine environment include DELWP's marine knowledge framework (in development) and Australia's integrated marine observing system (IMOS) that collects data on oceanic waters.

Other programs and key datasets are listed and discussed in chapter 15 of the assessment report.

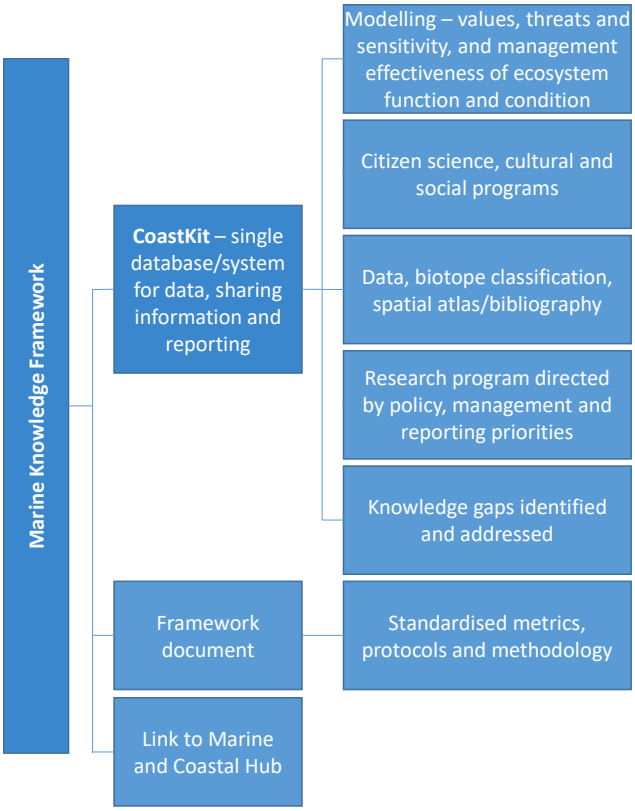
If Aboriginal cultural values and threats to those values are to be more effectively addressed in marine planning and management, Traditional Owners need to be able to mobilise their knowledge and fulfil their rights and obligations to care for Country.

Citizen science has an important role to play in building knowledge and understanding of marine values and threats to those values. Citizen scientists can assist with routine monitoring, data collation and analysis, highlighting issues that require further research and building awareness of the marine environment in the wider community. However, citizen science programs need to be supported through continued investment by research institutions and government agencies in education, data collection standards, data analysis and research projects.

The marine knowledge framework builds on DELWP's existing CoastKit Resources system and includes investigation reports, biotope mapping, scientific observations and monitoring data in a centralised relational database (known as q-Core).

When fully developed, the framework will facilitate data sharing and dashboard reporting on trends, condition and health of the marine environment, and will provide an evidence base for evaluating management interventions.

Figure 12 Features in the marine knowledge framework



Assessment

This assessment has identified current environmental, economic, social and cultural values of Victoria's marine environment, together with threats to these values and advice on future patterns, trends and direction related to existing and emerging uses.

Collectively, the information presented in this assessment can be used in the development of a marine and coastal policy, marine and coastal strategy, marine spatial planning framework and the State of the Marine and Coastal Environment report, all of which are requirements of the *Marine and Coastal Act 2018*.

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