



MARINE AND COASTAL ENVIRONMENTS (MC)
SCIENTIFIC ASSESSMENTS Part III



Commissioner
for Environmental
Sustainability
Victoria



Traditional Owners

The Commissioner for Environmental Sustainability proudly acknowledges Victoria's Aboriginal community and their rich culture and pays respect to their Elders past and present.

We acknowledge Aboriginal people as Australia's first peoples and as the Traditional Owners and custodians of the land and water on which we rely. We recognise and value the ongoing contribution of Aboriginal people and communities to Victorian life, and how this enriches us.

We embrace the spirit of reconciliation, working towards the equality of outcomes and ensuring an equal voice.

Marine and Coastal Environments

The information, data and indicators presented in this chapter focus on the marine and coastal environments of Victoria. Although some of the indicators build on the comprehensive assessment of marine science for Port Phillip Bay and Western Port that was presented in *State of the Bays 2016*, not all the science is repeated here, and the reader should refer to that earlier work for a complete presentation of the science.

In terms of the integration of this chapter with the other chapters in SoE 2018, marine water quality, estuarine health and marine biodiversity are all reported on here, but note two important exclusions:

1. Only coastal Ramsar sites and wetlands are presented in this chapter; refer to the Biodiversity chapter for inland sites.
2. Sea-level rise and associated impacts are reported on in the Climate Change Impacts chapter.

Background

Massive sand dunes bookend the Victorian coastline at its borders with South Australia and New South Wales. Connecting Discovery Bay in the west to the east's Cape Howe Wilderness Zone are 2,500 km of rock stacks, granite islands, sheer cliffs, intertidal platforms, dominant headlands, extensive mudflats, fringing saltmarsh and mangroves, sandy beaches, large bays, coastal lagoons and more than 100 estuaries.

Facing south, Victoria's coastline looks out on the cool temperate waters of the Southern Ocean, where 75% of red algae species, 85% of fish species and 95% of seagrass species are found nowhere else, giving them local, national and international significance.¹ Beneath Victoria's 10,000 km² of coastal waters are subtidal reefs, deep canyons, seagrass meadows, sponge gardens and sandy and muddy seabeds that support a rich marine life of more than 12,000 plant and animal species.²

The Victorian Government and local governments have worked to improve marine and coastal planning, protection and management through the following processes: legislation, regulation, institutional policy-setting, strategic and statutory planning, and the creation of conservation reserves. Local communities have also engaged in consultation, monitoring and habitat-restoration works. But the pressures on coastal and marine environments have continued to build, largely driven by the resource-intensive demands of population growth and climate change.

The success or otherwise of these responses has in recent years been measured by *State of the Environment* reports in 2008 and 2013, *State of Bays 2016* report, and the *Gippsland Lakes Condition Report 2018*. This chapter builds on the research and evaluation of these earlier reports while also looking towards 2021 (when the first of five-yearly *State of the Marine and Coastal Environment* reports will be released) and 2030 (the time horizon of the United Nations Sustainable Development Goals targets).

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1. Government of South Australia 2013, 'State of the Environment Report 2013', Adelaide, South Australia http://www.epa.sa.gov.au/soe_2013/main/coast-1-why-is-it-important.html Accessed 4 December 2018.
 2. PV 2018, 'Sea Search manual: A guide for community-based monitoring of Victoria's marine national parks and marine sanctuaries', Melbourne, Victoria.

Pressures on Marine and Coastal Environments

A 2012 Ipsos poll for the Victorian Coastal Council showed that the top four marine and coastal issues for Victorians were overfishing/illegal fishing, pollution, development and stormwater pollution. Compared to earlier polls, fewer respondents believed the coast was well-managed and two-thirds felt that the sea level was rising due to climate change, and this was causing erosion and flooding.³ This section reviews these and other pressures.

Population growth and urbanisation

The rate of population growth in Victoria's coastal populations varies by region. In parts of the south-west coast, populations are stable or in decline. From 2011 to 2016, the Barwon Heads – Ocean Grove population grew by more than 28%, Torquay-Jan Juc, 27%, the Surf Coast and Bellarine Peninsula, 18%, and the Bass Coast, 11%.⁴

Most population growth is occurring on the Mornington and Bellarine peninsulas, driven by the expansion of Melbourne and Geelong and the 'sea change' phenomenon. Towns within commuting distance of Melbourne and Geelong are expanding and becoming 'dormitory suburbs' or places to retire. In towns bordering the Gippsland Lakes, retirees are responsible for an annual growth rate of more than 2%. According to the 2012 Ipsos poll, growth like this will continue: 7% of respondents who lived more than 5 km from the coast said that they planned to move to the coast within five years.⁵

The Victorian Coastal Council describes the impacts of population growth:

... biodiversity and habitat loss, water degradation in coastal waters, wetlands, lakes and rivers, coastal habitat loss, damage to wetlands, the introduction of pest plants and animals, coastal erosion, destruction of coastal ecosystems, loss of cultural heritage, conversion of productive agricultural land and impacts on scenic coastal landscapes, views and vistas. Socially, it can lead to pressures on the particular values and character of coastal areas and settlements – the very reason people choose to move to or visit a place.⁶

3. Ipsos Consultants 2012, 'Coastal and marine environment community attitudes and behaviour: wave four report', prepared for Victorian Coastal Council, Ipsos Consultants, Melbourne, p.7.

4. ABS 2016, 'Quick Stats 2016', www.abs.gov.au/websitedbs/censushome.nsf/home/quickstats?opendocument&navpos=220/ Accessed 4 December 2018.
5. Ipsos Consultants 2012, 'Coastal and marine environment community attitudes and behaviour: wave four report', prepared for Victorian Coastal Council, Ipsos Consultants, Melbourne, p.4.
6. Victorian Coastal Council 2017, 'Population and growth', <http://vcc.vic.gov.au/page/victorian-coastal-strategy/population-and-growth> Accessed 4 December 2018.

Victoria's coastline attracts significant numbers of tourists. Growing numbers of domestic and international visitors will place further stress on marine and coastal environments, building pressure on authorities to increase access with new roads, car parks and other visitor management and attractions infrastructure. Visitor numbers in the four key coastal tourism regions of the Great Ocean Road – Geelong and Bellarine Peninsula, Mornington Peninsula and Phillip Island⁷ – increased substantially between 2013 and 2018. Across the regions, all annual increases were as follows: domestic daytrip visitors – between 2% and 7.2%; domestic overnight visitors – between 5.4% and 8.5%; and international overnight visitors – between 6% and 14%.⁸ The Great Ocean Road had the highest numbers of international visitors but on Phillip Island and the Mornington Peninsula their numbers increased at a faster rate.

About 96% of Victoria's coast is within public land which abutts the high-water mark, although in many places it is a very narrow strip squeezed between rising seas and coastal development. The *Victorian Coastal Strategy 2014* acknowledged the coastal squeeze and that it could lead to a loss of public open space and community access:

If the coastal resources that maintain biological diversity such as saltmarshes and mangroves are to adapt to the impacts of sea-level rise and urban encroachment, outlays to 'buy-back' land will be required. Also, in some circumstances, incorporation of private land, to replace eroded public land, may be warranted to ensure community access to parts of the beach.⁹

Habitat loss, fragmentation, degradation and disturbance

Coastal and catchment development over the past two centuries has led to significant losses of coastal ecological vegetation classes (EVCs), with some now endangered, vulnerable or depleted. Coastal alkaline scrub has been reduced to 22% of its original cover on the Victorian Volcanic Plain,¹⁰ 31% on the Otway Plain and 56% on the Gippsland Plain. The Otway Plain has just 26% of its pre-1750s cover of coastal saltmarsh – Port Phillip Bay, only 50%.¹¹

Migratory shorebirds, 35 species of which visit Australia, have been severely affected by the loss of habitats along their international flyways, particularly in the Yellow Sea. However, habitat loss has also occurred in Australia due to population growth, urbanisation and agricultural development. A 2015 Commonwealth report found that 'estuaries and permanent wetlands of the coastal lowlands have experienced the most losses, especially in the southern parts of the continent'.¹² Other threats include: disturbance from human activities; pollution; climate change; invasive species; and harvesting of intertidal prey such as fish, urchins and sea weeds.

Altered catchments can also lead to habitat degradation. The permanent opening of the entrance to the Gippsland Lakes and catchment dam construction have changed the site's ecology by leading to increased salinity, reduced bank vegetation, mobilised bank sediments and reduced light penetration, which has impacted seagrass.¹³

7. Although visitor numbers for the four selected regions include some visitation to areas away from the coast, for the other two regions with coastal boundaries, Melbourne and East Gippsland (includes mountain areas), the coast may not be the main attractor. Data for these two regions have been excluded.

8. DEDJTR (Tourism, Events and Visitor Economy Research Unit) 2018, 'Regional tourism summaries for Great Ocean Road, Geelong and the Bellarine, Mornington Peninsula and Phillip Island for the year ending March 2018', Melbourne, Victoria, <http://www.business.vic.gov.au/tourism-industry-resources/research/regional-visitation> Accessed 4 December 2018.

9. Victorian Coastal Council 2014, 'Victorian coastal strategy', Victorian Coastal Council, Melbourne, Victoria, p.24.

10. VEAC 2017, 'Statewide assessment of public land: statewide EVCs bioregional conservation status', Melbourne, Victoria.

11. Sinclair S, Boon P 2012, 'Changes in the area of coastal marsh in Victoria since the mid 19th century', *Cunninghamia* 12 (2), pp. 153–176.

12. Department of the Environment and Energy 2015, 'Wildlife conservation plan for migratory shorebirds', Canberra, Australian Capital Territory, p.14.

13. Boon P, Cook P, Woodland R 2015, 'The Gippsland Lakes: management challenges posed by long-term environmental change', *Marine and Freshwater Research* 67 (6), pp.721-737 <http://dx.doi.org/10.1071/MF14222> Accessed 4 December 2018.

Marine and coastal wildlife can also suffer the effects of human disturbance. Since 1980, Birdlife Australia volunteers have been conducting biennial counts for beach-nesting birds, including the hooded plover (*Thinornis rubricollis rubricollis*). Its Victorian population was in serious decline but the work of community volunteers and coastal managers to protect breeding sites and improve regulations, education and enforcement has seen numbers slowly increase. However, its conservation status remains 'vulnerable' and threats such as coastal development, dogs, racehorses, vehicles, foxes, cats, sea-level rise and disturbance (dune stabilisation, beach cleaning and seaweed removal) are more generally on the increase.¹⁴

Water pollution

Coastal urbanisation increases runoff, with Port Phillip Bay each year receiving 540 billion litres of stormwater from more than 300 outfalls annually.¹⁵ Stormwater can also contain hydrocarbons, pesticides, detergents, leaves, garden clippings, animal faeces and plastics, along with sewage from leaking, broken or overflowing sewers. The Yarra River, which flows through a large catchment containing urban, industrial and agricultural uses, discharges 14,000 tonnes of sediment into the bay annually, along with 650 tonnes of nutrients in fertiliser, litter, heavy metals and bacteria.¹⁶

Beyond Port Phillip Bay, agricultural uses influence water quality by causing nutrient and sediment pollution that threatens estuaries and coastal ecosystems. For example, in Corner Inlet there are strong connections across catchment nutrients and sediments, algal blooms, reduced light-penetration and seagrass decline, which in turn impacts the inlet's commercial and recreational fisheries. This was 'the first strong evidence that the activities in the catchment are contributing to habitat loss and productivity costs to the fishery'.¹⁷

Eighteen ocean outfalls are found along the open coast and are used to discharge sewage and other waste that have undergone various levels of treatment. Total annual discharges have been estimated at 323 GL, with annual total nitrogen loads of 3,811 tonnes and annual total phosphorous loads of 2,784 tonnes.¹⁸

14. Maguire G, Cullen M, Mead R 2014, 'Managing the hooded plover in Victoria: a site by site assessment of threats and prioritisation of management investment on Parks Victoria managed land, *Birdlife Australia*, Melbourne, Victoria https://parkweb.vic.gov.au/_data/assets/pdf_file/0007/679030/managing-hooded-plover-birdlife-australia.pdf Accessed 4 December 2018.

15. EPA 2018, 'Yarra and Bay', www.yarraandbay.vic.gov.au/issues/stormwater Accessed 4 December 2018.

16. Ibid

17. Ford J, Barclay K, Day R 2016, 'Using local knowledge to understand and manage ecosystem-related decline in fisheries productivity', Fisheries Research and Development Corporation Final Project Report, Melbourne, Victoria.

18. Clean Ocean Foundation 2018, 'The national outfall database community report', Australia <http://www.cleanocean.org/news/the-national-outfall-database-community-report> Accessed 4 December 2018.

Litter and marine debris

Of the litter found on Port Phillip Bay beaches, 95% washes off suburban streets and into the stormwater system.¹⁹ In 2012–13, litter control programs removed 7,850 tonnes of litter and debris from waterways around Melbourne.²⁰ It has been estimated that 820 million pieces of litter are discharged into Port Phillip Bay from the Yarra and Maribyrnong rivers each year.²¹

In 1991, an EPA Victoria tagged litter survey estimated that 4–5 million pieces of plastic were entering Melbourne waterways annually, with most washed up on beaches along Port Phillip Bay's east coast.²² For 12 months from March 2016, members of BeachPatrol Australia, a Melbourne-based community group, conducted daily collections of plastic along a 35-metre stretch of the Port Melbourne Beach.²³ By the survey's end, 126,000 pieces of plastic litter had been collected, with 60% greater than 5 mm and 15% smaller than 5 mm. A Port Phillip EcoCentre survey²⁴ found that plastic film remnants were the second-most collected items, with plastic bags and wrappers third. Nurdles (microplastics) were found on 12 of 23 Port Phillip Bay beaches, although coordinators believed this number may have been understated because volunteers were reluctant to invest time in collecting such small items.

In addition to being an eyesore on beaches and waterways, litter and marine debris impact marine life. From 1997 to 2013, researchers found 359 entangled Australian fur seals (mainly juveniles and pups) at Seal Rocks at Phillip Island, equivalent to 1% of the site's population. The researchers found that commercial fishing operations were the main source of entanglement materials that included trawl nets, fishing line and box straps. They determined that neither the decline in regional fishing intensity nor changing seal population size influenced the incidence of entanglements.²⁵

Fishing-related gear, balloons and plastic bags posed the greatest entanglement risk to marine fauna.²⁶ Between 2010 and 2013, the Zoos Victoria Seal the Loop Program collected 21.7 km of fishing line in specially designed bins dotted along the Victorian coastline.²⁷ By 2013, the bins were collecting 25 metres daily or 9 kilometres annually. Zoos Victoria and Phillip Island Nature Parks have now launched the 'When balloons fly, seabirds die' campaign to educate the community about the impact that balloons are having on marine life and to urge people to stop using balloons outdoors. A 2016 CSIRO paper noted that short-tailed shearwaters on Australia's east coast ingested 82% of all balloons recorded in a survey of marine debris, possibly due to the balloons resembling the birds' main prey, the red arrow squid.²⁸

19. CES 2016, 'State of the Bays 2016', Melbourne, Victoria.
 20. EPA 2018, 'Litter', Melbourne, Victoria <https://yarraandbay.vic.gov.au/issues/litter> Accessed 4 December 2018.
 21. Preiss B 2018, 'A tale of two beaches, where volunteers fight to keep tide of city's litter at bay', *The Age* 7 July 2018.
 22. EPA 1993, 'Backyard to bay: tagged litter report', Melbourne, Victoria.
 23. Headifen R 2017, 'A new survey method to determine plastic rubbish in Port Phillip Bay', BeachPatrol Australia.
 24. Port Phillip EcoCentre 2017, 'Turn off the tap – catchment to bay litter prevention and monitoring. Final report', Port Phillip EcoCentre, St Kilda, Victoria.
 25. McIntosh RR, Kirkwood R, Sutherland DR, Dann P 2015, 'Drivers and annual estimates of marine wildlife entanglement rates: a long-term case study with Australian fur seals', *Marine Pollution Bulletin* 101, pp. 716–723.

26. Wilcox C, Mallos NJ, Leonard GH, Rodriguez A, Hardesty BD 2016, 'Using expert elicitation to estimate the impacts of plastic pollution on marine wildlife', *Marine Policy* 65, pp. 107–114.
 27. Zoos Victoria 2013, 'Seal the Loop 2012–2013 report', Zoos Victoria, Melbourne, Victoria.
 28. Roman L, Schuyler QA, Hardesty BD, Townsend KA 2016, 'Anthropogenic debris ingestion by avifauna in eastern Australia', *PLoS One*, 11(8) pp. 1–14 <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0158343> Accessed 4 December 2018.

Climate Change

The south-eastern waters of Australia are one of 10 global hotspots for rising sea-surface temperatures – the rate is almost four times faster than the global average.²⁹ This has energised the East Australian Current. It now reaches the coast of Tasmania, 350 kilometres further south than where it was 60 years ago, transporting warm waters and subtropical species such as cobia to Victoria.

In June 2018, the Victorian Coastal Council released *Victoria's Coast and Marine Environments under Projected Climate Change: Impacts, Research Gaps and Priorities*. The report stated that:

Victoria's coastal regions are expected to have a warmer climate year-round, more hot days and warm spells, harsher fire weather and longer fire seasons, less rainfall in winter and spring, more frequent and more intense downpours, rising sea level, increased frequency and height of extreme sea-level events, increased wave height in winter, increased frequency of easterly winds, and warmer and more acidic oceans.³⁰

The report notes that since 1880, Victoria's sea level has risen 22.5 cm, while projecting rises in sea level of 8–20 cm by 2030 and 20–59 cm by 2070, and of sea-surface temperatures by 1.1–2.5°C by 2070. In the offshore areas, the report suggests that rising water temperatures may decrease oxygen levels and reduce fisheries production. Along with the economic effects of rising water temperature, the report found that declining stocks of fish will also affect the island colonies of the Australian fur seal, little penguins and short-tailed shearwaters that rely on these stocks for food. The report recommends regular monitoring and reporting on the health of these colonies, which would be an important indicator of ocean health and climate change.

Closer to shore, the report found that, if the effects of climate change are not halted, then the ecological functions of seagrasses and kelps will be reduced, as will the protection they afford the coast. Other changes that the report highlights include, the loss of intertidal flats, platforms and beaches; closed estuaries; increased salinity and flooding; and the prevalence of more tropical species.

Climate change will also impact food security and human health, culture and livelihoods. A recent ecological sensitivity assessment³¹ suggests that blacklip abalone and southern rock lobster (the two mainstays of Victorian commercial fisheries) and black bream and King George whiting (very popular targets of recreational fishers) are the most sensitive to climate change due to factors such as altered habitats, increased water temperatures, changing estuarine salinity and invasion by other species such as urchins. Southern calamari and Australian salmon will also be affected. The same research also showed that the catches of many commercial species had declined and that other stressors such as overfishing, invasive species, habitat loss, degradation of seagrass beds, and pollution in intertidal zones and juvenile nursery areas will exacerbate the impacts and reduce the ability of species to adapt to environmental change.

The loss of giant kelp forests (*Macrocystis pyrifera*), once in a strip stretching along much of the Victorian coast, may in part be due to climate change and its associated rise in sea-surface temperatures. Small patches in the Otway, Central, Flinders and Twofold Shelf marine bioregions are all that remain, with water pollution, sedimentation and storms other factors in the decline.³²

29. Hobday A, Pecl G 2013, 'Identification of global marine hotspots: sentinels for change and vanguards for adaptation action', *Reviews in Fish Biology and Fisheries*, 24(2), pp. 415–425 <https://link.springer.com/article/10.1007/s11160-013-9326-6> Accessed 4 December 2018.

30. Victorian Coastal Council 2018, 'Victoria's coast and marine environments under projected climate change: impacts, research gaps and priorities', Melbourne, Victoria.

31. Pecl GT, Ward TM, Doubleday ZA, Clarke S, Day J, Dixon C, Frusher S, Gibbs P, Hobday AJ, Hutchinson N, Jennings S, Jones K, Li X, Spooner D, Stoklosa R 2014, 'Rapid assessment of fisheries species sensitivity to climate change', *Climatic Change*, 127(3–4), pp. 505–520 <https://link.springer.com/article/10.1007/s10584-014-1284-z> Accessed 4 December 2018.

32. Department of the Environment and Energy 2009, 'Advice to the Minister for Environment Protection, Heritage and the Arts from the Threatened Species Scientific Committee (the Committee) on an Amendment to the List of Threatened Ecological Communities under the *Environment Protection and Biodiversity Conservation Act 1999*', Canberra, Australian Capital Territory.

Commercial and recreational fishing

Commercial fishers have been operating in Victorian waters since the 19th century, using nets, dredges, pots, hooks and hand collection to harvest various marine species. In September 2017, there were 627 commercial licences across all Victorian fisheries, targeting more than 40 finfish and 30 species of molluscs, crustaceans, sharks and rays.³³

Reduced fish populations, bycatch, entanglement of wildlife in discarded fishing gear, vessel impacts and changes to trophic structures are some of the impacts of fishing on marine and coastal environments. But the closure of most commercial fishing in Port Phillip Bay and Western Port, and lower catches elsewhere, has reduced the industry's pressure on stocks. However, this change will limit future data on fish stocks and require an expanded role for the monitoring of recreational fishing.

Although there are more than 100 fish species recorded in Victorian bays and inlets, recreational fishers target about a dozen species, with snapper (*Pagrus auratus*), King George whiting (*Sillaginodes punctata*) and black bream (*Acanthopagrus butcheri*) as the most prized. In 2000–01, 88% of recreation catches came from Port Phillip Bay, and those for snapper (211 tonnes) and King George whiting (93 tonnes) were higher than the respective commercial catches of 53 tonnes and 85 tonnes.³⁴

Assessing the broader impact of recreational fishing in Victoria's marine and coastal environments will require clarity on the number of recreational fishers in Victoria. Although only 271,395 Victorian recreational fishing licences were sold in 2016–17³⁵ across the five categories, three previous estimates have angler participation in the state at 549,000,³⁶ 721,000³⁷ and 830,000³⁸ (adult residents), while the Victorian Government is committed to increasing angler numbers to 1 million through its Target One Million program.³⁹

33. VFA 2018, 'Commercial fish production', Melbourne, Victoria <https://vfa.vic.gov.au/commercial-fishing/commercial-fish-production> Accessed 4 December 2018.

34. Ryan KL, Morison AK, Conron S 2009, 'Evaluating methods of obtaining total recreational catch estimates for individual Victorian bay and inlet recreational fisheries', Project No. 2003/047. A report for the Department of Primary Industries, Melbourne, Victoria, and Fisheries Research and Development Corporation, Canberra, Australian Capital Territory.

35. VFA 2017, 'Recreational fishing licence trust account 2016–17: a report to each House of Parliament on the disbursement of recreational fishing licence revenue', Melbourne, Victoria.

36. Henry G, Lyle J 2003, 'The national recreational and indigenous fishing survey', Project No. 1999/158. A report for the Australian Government Department of Agriculture, Fisheries and Forestry. Canberra, Australian Capital Territory.

37. VFA 2010, 'Economic study of recreational fishing in Victoria – headline results VRFish', Melbourne, Victoria <https://vfa.vic.gov.au/about/publications-and-resources/fisheries-reports/your-licence-fees-at-work-reports/2009-2010/economic-study-of-recreational-fishing-in-victoria-headline-results-vrfish> Accessed 4 December 2018.

38. Ernst and Young 2015, 'Economic study of recreational fishing in Victoria', a report for VFA Melbourne, Victoria.

39. VFA 2018, 'Target one million budget 2015–2019', Melbourne, Victoria www.vfa.vic.gov.au/recreational-fishing/target-one-million/budget Accessed 4 December 2018.

Ports, shipping and boating

Port operations and shipping activity can impact marine and coastal environments by causing habitat damage and loss, increased turbidity (from dredging), localised beach accretion and erosion, an increased risk of spills, air pollution and the introduction and spread of invasive marine species. Most of the invasive marine species in Port Phillip Bay arrived on the hulls or in the ballast water of visiting ships, thousands of which visit the Port of Melbourne and Geelong Port each year.

Concerns like these, along with social, economic and logistical considerations, saw the Victorian Government seek advice from Infrastructure Victoria on the best location for a second container port – the Port of Melbourne is Australia’s largest and busiest and will likely outgrow its current site. After extensive investigations, Infrastructure Victoria recommended Bay West in Port Phillip Bay, rather than an expansion of the Port of Hastings, but indicated that operation of the new port would not be required until 2055.⁴⁰ Both locations are Ramsar sites: port construction and its associated infrastructure could impact on those wetland habitats.

Recreational boating has become an increasingly popular activity in Victoria. In 1962, an aerial survey of Port Phillip Bay identified 1,208 recreational boats,⁴¹ but by 2015 there were 117,000 identified in Port Phillip Bay and Western Port.⁴² Boating infrastructure such as breakwaters and car parks can have localised impacts on coastal and marine environments. Sandringham Harbour’s breakwater has altered longshore drifting of sand and has led to significant coastal erosion. Harbour construction and expansion, along with associated road access, car parking, boat ramps and clubhouses, can reduce public open space. In the case of the proposed expansion of the Beaumaris Motor Yacht Squadron, development would further bury internationally significant land and marine fossil beds already impacted by the existing harbour infrastructure.⁴³

40. Infrastructure Victoria 2017, 'Advice on securing Victoria's port capacity', Melbourne, Victoria.

41. Lynch D 1966, 'Port Phillip survey 1957–1963: the fisheries', *Memoirs of the National Museum of Victoria* 27, pp.16.

42. Boating Industry Association of Victoria 2015, 'Boating industry snapshot: drivers of growth in Victoria', Melbourne, Victoria.

43. Smith B 2015, 'World-class fossil site in Beaumaris threatened by marina expansion plans', *The Age* 20 February 2015.

Invasive marine species

More than 160 introduced marine species are now resident in Port Phillip Bay. Few impact local marine habitats and species. Those of greatest concern are the northern Pacific seastar (*Asterias amurensis*), the European fan worm (*Sabella spallanzanii*), the European green shore crab (*Carcinus maenas*), Japanese kelp (*Undaria pinnatifida*), the New Zealand screw shell (*Maoricolpus roseus*) and the Pacific oyster (*Crassostrea gigas*). The Asian date mussel (*Musculista senhousia*), cordgrass (*Spartina anglica* and *Spartina x townsendii* sp.), dead man’s finger (*Codium fragile* ssp.) and red algae (*Grateloupia turuturu*) are also of concern. Invasive marine species prey on – or outcompete – native species for space, food and light.

The eradication of invasive marine species is only possible in very limited circumstances, and so the primary management focus is the prevention of their introduction and spread. But the growing number of vessels operating in Victorian waters could undermine these efforts. For example, Japanese kelp was initially confined to northern Port Phillip Bay, but its range has expanded to the southern bay and also Apollo Bay Harbour (where eradication has proved impossible). Japanese kelp has recently been detected in Port Welshpool.

Invasive marine species in the Gippsland Lakes include the Pacific oyster (*Crassostrea gigas*), the European green shore crab (*Carcinus maenas*), the Asian date mussel (*Musculista senhousia*) and the introduced green macroalgae, *Codium fragile* (subsp. *fragile*).⁴⁴ Also recorded were three species listed on the National Introduced Marine Pest Information System database: pleated sea squirt (*Styela plicata*), stalked ascidian (*Styela clava*) and sea vase (*Ciona intestinalis*).

44. Hirst A, Bott N 2016, 'Gippsland Lakes: existing threats and future monitoring', Centre for Environmental Sustainability and Remediation, RMIT, Melbourne, Victoria.

Overabundant native animals

Increasing numbers of native sea urchins are causing the loss of marine habitats in Port Phillip Bay, Nooramunga and Beware Reef Marine Sanctuary.

Intact kelp beds can resist invasions by exotic marine plants, provide habitat for fish targeted by recreational fishers, and be popular sites for snorkelling and diving. But along the northern shores of Port Phillip Bay, grazing by the purple sea urchin (*Heliocidaris erythrogramma*) has led to a 90% reduction in kelp in the bay's marine sanctuaries.⁴⁵ In March 2018, Parks Victoria, Deakin University and volunteer citizen scientists carried out a cull of urchins in Jawbone and Point Cooke Marine Sanctuaries,⁴⁶ with the aim of keeping urchin numbers low for at least two years to allow the kelp beds to recover. If successful, the program will be expanded to other areas in the bay. A current project by the University of Melbourne, Deakin University and Parks Victoria aims to manage urchin numbers and also trial kelp restoration techniques outside protected areas.

In eastern Victoria, the small Beware Reef Marine Sanctuary has also suffered an outbreak of the black-spined sea urchin (*Centrostephanus rodgersii*), a native of New South Wales carried south at a rate of approximately 16 km's each year by the warming East Australian Current.⁴⁷ The urchins graze on kelp and other algae, creating areas of bare rock or urchin barrens. The Friends of Beware Reef, and Parks Victoria, staff culled 2,500 urchins in early 2018,⁴⁸ and a draft native animal impact management plan has now been prepared by the agency.

Sydney's gloomy octopus (*Octopus tetricus*) has also extended its range on the East Australian Current. Scientists were first alerted to its spread when citizen scientists reported sightings to the smart app, Redmap. Further research⁴⁹ confirmed the extended range of the octopus, which is a predator of commercially targeted abalone and rock lobster.

45. Deakin University 2018, 'Sea urchin cull in Port Phillip Bay to help restore kelp forests', media release, 15 March 2018, Deakin University, Geelong.

46. Ibid

47. PV 2018, 'Centrostephanus rodgersii (black-spined sea urchin) impact management plan', Melbourne, Victoria.

48. PV 2018, 'United against the urchin front in East Gippsland', media release, Melbourne, Victoria.

49. Ramos JE, Pecl GT, Moltschanivskyj NA, Semmens JM, Souza CA, Strugnell JM 2018, 'Population genetic signatures of a climate change driven marine range extension', *Scientific Reports*, 8(9558), pp. 1-12.

Environmental weeds

Environmental weeds are a major problem for coastal habitats, especially near township gardens and farms, from where they often spread. They compete with and prevent regeneration of indigenous native plants, alter coastscapes, increase bushfire risk and reduce available habitat for wildlife. Some Australian native species, such as acacia, eucalypt, melaleuca and allocasuarina, have also become weeds, introduced through past dune stabilisation projects.⁵⁰

Oil and gas exploration and production

Oil and gas have been flowing from Bass Strait since the 1960s, and in western Victoria from the early 2000s. In May 2018 the Victorian Government⁵¹ released five new blocks for oil and gas exploration near existing gas production areas in the Otway Basin off Victoria's west coast, while new production wells in the Gippsland Basin are set to produce gas in 2019.

SoE 2013 noted that exploration and production of oil and gas can disturb seabed habitats. Seismic testing may impact on cetaceans, and there is also the risk of spills during operations.⁵²

In 2007, the CSIRO Wealth from Oceans flagship program investigated the contribution that the extraction of water and hydrocarbons from the Gippsland Basin, along with the effects of extreme wave conditions and sea-level rise, could make to land subsidence and inundation along the Ninety-mile Beach. CSIRO's modelling predicted that by 2056, under a realistic scenario, the coast could subside by 480 mm, whereas in a worst-case scenario the figure was 1,208 mm. However, the contribution of land subsidence to the predicted levels of inundation ranged between 1% and 20% – the larger figure for a small area with a low combined risk of inundation. The CSIRO study concluded that:

'the simulations conducted predict that subsidence due to fluid extraction, although small in comparison, will exacerbate the risk of inundation of the coastline due to extreme storm tide and wave conditions with larger parts of the Gippsland Coastline potentially being affected.'⁵³

50. Mark Trengove Ecological Services 2013, 'Barwon Coast vegetation management plan final draft', Geelong, Victoria prepared for Barwon Coast Committee of Management.

51. The Hon Pallas T, MP 2018, 'Offshore gas exploration to build future supply', media release, Melbourne, Victoria.

52. CES 2013, 'State of the environment report', Melbourne, Victoria.

53. Freij-Ayoub R, Underschultz J, Li F, Trefry C, Hennig A, Otto C, McInnes K 2007, 'Simulation of coastal subsidence and storm wave inundation risk in the Gippsland Basin', CSIRO Petroleum Report 07-003, Bentley, Western Australia.

The Bass Strait oil and gas rigs are ageing and will eventually have to be decommissioned. They could be viewed as waste, dismantled and removed from the marine environment. Alternatively, they could be left where they stand, continuing to act as artificial reefs should evidence show that any environmental outcomes would be equal to or better than if they were removed. But the disused rigs could also attract invasive species, alter food webs and become navigational hazards.

Droughts and Floods

During the millennium drought (1996–2010) there were significant seagrass losses in Port Phillip Bay.⁵⁴ Land-based nitrogen inputs during the millennium drought dropped by 64%; northern Pacific seastar (*A. amurensis*) arrived in the bay in 1995 and its biomass rose to 56% of resident fish biomass in 2000; and in the centre of the bay, fish biomass dropped 69%.⁵⁵ The reduced productivity during the drought caused most of the loss in fish biomass. However, *A. amurensis* was implicated in a sharp decline of three species – the eastern shovelnose stingaree (*Trygonoptera imitata*), southern eagle ray (*Myliobatis australis*) and globefish (*Diodon nicthemerus*) – due to competition for food. The improvement plan for the Western Treatment Plant also led to a reduction in nutrient discharges.⁵⁶

The end of the millennium drought was followed by major flooding across Victoria in 2010–11. Floods send large volumes of sediments and nutrients into estuaries, bays and offshore waters, significantly affecting water quality and the health of receiving waters.

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54. Jenkins G, Keogh M, Ball D, Cook P, Ferguson A, Gay J, Hirst A, Lee R, Longmore A, Macreadie P, Nayer S, Sherman C, Smith T, Ross J, York P 2015, 'Seagrass resilience in Port Phillip Bay: final report to the Seagrass and Reefs Program for Port Phillip Bay, University of Melbourne, Melbourne, Victoria http://www.pir.sa.gov.au/_data/assets/pdf_file/0004/265585/Seagrass_Resilience_in_Port_Phillip_Bay.pdf Accessed 4 December 2018.
55. Hirst A, Parry G 2016, 'Decadal decline in demersal fish biomass coincident with a prolonged drought and the introduction of an exotic starfish', *Marine Ecology Progress Series*, 544, pp.37-52.
56. Hirst AJ, Werner GF, Heislars S, White CA, Spooner D 2011, 'Port Phillip Bay Annual Trawl Sub-Program Milestone Report No. 4 (2011)', Fisheries Victoria Technical Report Series No. 139, Queenscliff, Victoria.

Marine and Coastal Policy, Management and Monitoring Challenges

Policy and management challenges

Key future challenges for the marine and coastal environment of Victoria include:

- ensuring effective community engagement in the ecologically sustainable management of coastal and nearshore environments
- implementing an effective and ecosystem-based marine spatial planning framework to ensure equitable access to resources, while ensuring the needs of the natural environment are met
- improving and simplifying coastal management governance and oversight
- adapting to climate change and the impacts of population growth
- identifying and filling gaps in the marine and coastal conservation estate
- developing dispute resolution and arbitration mechanisms that are specifically related to the unique challenges in the marine and coastal environment.

Data and monitoring challenges

Data and monitoring challenges include:

- expanding monitoring programs beyond localised areas within Port Phillip Bay, Western Port and the Gippsland Lakes
- broadening monitoring, from species to ecosystems
- publicly releasing fisheries data on the impacts of commercial and recreational fishing on bycatch, habitats, threatened species and trophic structures
- adapting monitoring programs to cover the loss of fisheries data from the closure of commercial bays and estuaries to commercial fishing
- aligning the research priorities of agencies, academic institutions and citizen scientists with the needs of marine and coastal management
- developing historical ecological baselines
- monitoring the loss of coastal foreshore reserves, and their EVCs, from erosion.

Current Victorian Government Settings: Legislation, Policy, Programs

There have been many efforts by successive Victorian governments to improve marine and coastal planning, protection and management. This section briefly reviews the most recent.

Victoria's new *Marine and Coastal Act 2018* (the Act) provides improved governance and oversight of the marine and coastal environment and aims to:

- establish an integrated and coordinated whole-of-government approach to protect and manage Victoria's marine and coastal environment
- provide for integrated and coordinated policy, planning, management, decision-making and reporting across catchment, coastal and marine areas
- establish objectives and guiding principles for ecologically sustainable planning, management and decision-making.

Recognising the need to plan for and manage the impacts of climate change is a significant addition to coastal management in Victoria – as is the acknowledgement of Traditional Owner groups' knowledge, rights and aspirations for land and sea country.

Under the Act, the number of advisory bodies has been simplified by phasing out the regional coastal boards and Victorian Coastal Council and establishing the statewide advisory Marine and Coastal Council. The council will be responsible for providing advice on the implementation of the Act by agencies including the Department of Environment, Land, Water and Planning (DELWP) and will be able to establish subcommittees – for example, a science panel.

The Act establishes statutory documents for planning and management of the marine and coastal environment at statewide, regional and local levels. This includes the preparation of a Marine and Coastal Policy, and a Marine and Coastal Strategy, every five years by DELWP. These both require agreement across relevant portfolios and are intended to help deal with key challenges such as the impacts of climate change and population growth. The policy will include a marine spatial planning framework to help achieve integrated and coordinated planning and management of the marine environment.

The new legislation requires that a State of the Marine and Coastal Environment report be prepared every five years by the Commissioner for Environmental Sustainability, with the first due in 2021. This report will monitor trends in a variety of indicators to help measure the condition of the marine and coastal environment and any changes. This information will be used to better inform ecologically sustainable policy, planning and decision-making.

The Act introduces a new partnership approach for planning for significant regional issues impacting the marine and coastal environment. Regional and strategic partnerships (RASPs) will be formed in certain areas, and they will produce tools to address regional issues. Tools may include coastal hazard assessments, adaptation plans or other regional plans. Importantly, these partnerships can formally include community and non-government members to boost public involvement.

Environmental management plans will consider a broad range of threats to the health of the marine environment and aim to identify actions to address them. Catchment management authorities (CMAs) are also now required to better plan for impacts on the marine and coastal environment through Regional Catchment Strategies, and possibly RASPs.

Local-level planning will provide opportunities for the community's voice to be heard, and the government anticipates a more streamlined process for consents to use, develop or undertake works on public land.

The new Act also aims to help address a key technical gap by enabling organisations advising on coastal flooding (namely, coastal CMAs and Melbourne Water) to be consulted on matters relating to coastal erosion.

The Victorian Environmental Assessment Council (VEAC) is currently preparing a report on the environmental, economic and social values of Victoria's marine environments which will inform the Victorian Government's preparation of the statewide marine and coastal policy and marine spatial planning framework under the *Marine and Coastal Act 2018*. VEAC is also investigating coastal reserves and will:

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

A revised *State Environment Protection Policy (Waters)* commenced on 19 October 2018.

The purpose of this new policy is to provide a framework to protect and improve the quality of Victoria's waters, while its objectives are to:

- achieve the level of environmental quality required to support the beneficial uses of waters
- ensure that pollution to waters from both diffuse and point sources is managed in an integrated way to deliver the best outcome for the community as a whole
- protect and improve environmental quality through consistent, equitable and proportionate regulatory decisions that focus on outcomes and use the best available information.

The policy also includes various environmental quality indicators, regional targets and priority areas, pollutant load reduction targets, and rules and obligations. It also identifies high conservation-value areas: high-value wetlands (including wetlands of international importance listed under Ramsar) and areas of significance for spawning, nursery, breeding, roosting and feeding of aquatic species and fauna.

The vision for the *Port Phillip Bay Environmental Management Plan 2017–2027*⁵⁷ is of a 'healthy Port Phillip Bay that is valued and cared for by all Victorians'. This 2017 plan replaced the 2001 plan and contains a broader set of priorities and actions. The seven priorities are: connect and inspire, empower action, nutrients and pollutants, litter, pathogens (human health), habitats and marine life, and marine biosecurity.

*Victoria's Climate Change Adaptation Plan 2017–2020*⁵⁸ will build a detailed understanding of the state's exposure to climate change risks and impacts, catalyse partnerships for integrated and effective responses, and tackle immediate priorities to reduce climate change risks. The plan will work to ensure up-to-date information on the coastal impacts of climate change, provide guidance to managers on coastal adaptation, ensure sea-level-rise benchmarks are based on the best science, and provide resourcing through the Climate-Ready Victorian Infrastructure – Critical Coastal Protection Assets Program (2015–2019), which includes works to repair, renew and protect cliffs, seawalls and groynes across the state. Local Coastal Hazard Assessments will also be used to provide a more detailed analysis of climate change risks and impacts.

57. DELWP 2017, 'Port Phillip Bay environmental management plan 2017-2027', Melbourne, Victoria.

58. DELWP 2017, 'Victoria's climate change adaptation plan 2017-2020', Melbourne, Victoria.

The Invasive Plants and Animals Policy Framework (IPAPF) presents the overarching Victorian Government approach to the management of existing and potential invasive species. The IPAPF incorporates a biosecurity approach to ensure that Victoria maintains a comprehensive planning framework to guide the management of invasive species. The Department of Economic Development, Jobs, Transport and Resources is developing a whole-of-government marine pest module under the IPAPF to guide the management of marine pests in the state. The scope of this module will encompass exotic invasive marine plants, marine algae, marine invertebrate animals and marine fish.

The Victorian Waterway Management Strategy addresses:

- the direct management of estuaries, for example the use of risk-based assessments (such as the Estuary Entrance Management Support System) to inform artificial estuary openings
- the management of upstream waters and their catchments and associated inputs to estuaries and coastal environments – through, for example, riparian revegetation and stock exclusion delivered through the Victorian Waterway Management Program and initiatives such as the Regional Riparian Action Plan.

The *Parks Victoria Act 1998* was reviewed and then replaced with the *Parks Victoria Act 2018*. The new Act establishes Parks Victoria as an independent statutory authority, no longer acting as a service agency to government and with management powers granted to its board rather than delegated by the secretary of DELWP. The Act aims to strengthen Parks Victoria's role of protecting, conserving and enhancing Victoria's parks and waterways.

In 2017, the Victorian Government established the Victorian Fisheries Authority to support the development of recreational and commercial fishing and aquaculture in Victoria, regulate fisheries and provide advice to government on a range of fisheries management opportunities.

The 2021 State of the Marine and Coastal Environment report will be able to evaluate the implementation of these policies, strategies and plans.

Marine and Coastal Environmental Indicators

Overview of indicator status assessment

This section of the chapter provides the status assessments for 24 indicators that cover: coastal wetlands and estuaries; intertidal and subtidal reefs; seabirds, shorebirds and waterbirds; pressures on the marine and coastal environments; and conservation in protected areas. Assessments for some of the indicators in *State of the Bays 2016* report have been reproduced here, while the summaries that accompanied them have been abridged. This is also the case for those indicators applied to the Gippsland Lakes, with the status, trends and summaries sourced from the *Gippsland Lakes Condition Report 2018*.

For the indicators added for SoE 2018, the assessment of their status and trends has been hampered by a lack of available data. In most cases the data has either been absent, out of date or gathered over an insufficient time period. Without robust data it is not possible to determine the status and trends for many of these indicators.

Marine and coastal environments that aren't part of Victoria's marine conservation estate are surveyed infrequently. Some areas have only been surveyed once, and in many instances, there is no recent data. What monitoring that does occur is largely undertaken by academic institutions, non-government organisations and volunteers, with public agencies constrained in their efforts by limited resources. The work of volunteer organisations – such as Birdlife Australia, The Nature Conservancy, the Victorian National Parks Association (ReefWatch and nature conservation reviews) and groups and individuals involved in Sea Search, EstuaryWatch, Coastcare, Reef Life Survey, Landcare and other programs – has been pivotal in maintaining a degree of monitoring. This voluntary effort requires ongoing support and should be complemented by a significant increase in government agency monitoring.

In summary, marine and coastal data is limited in the following ways:

- The focus of marine data collection has been on the 5% of coastal waters in marine national parks and sanctuaries, leaving 95% of coastal waters largely unmonitored.
- Data is very often inadequate to determine status and trends for many indicators, with the gap between monitoring periods too long (or the research has not been repeated).
- Comparisons are often between pre-1750s and current data with no recent data to establish contemporary trends.
- Data collected may not be meaningful or may be insufficient for the indicators that are being assessed.
- The analysis and public reporting on data collected are at times minimal, with data on websites sometimes requiring specific browsers and/or login security details and/or presented in file formats that are not directly useable by the community.
- Changing data collection methodologies and terminologies make comparison over time and between different databases difficult.
- The coastal environment is often included in statewide analyses without separate or specific treatment.
- Government agencies' reliance on limited data collections, while universities, other research institutions and the community have much to offer.

The development of a Marine Knowledge Framework, as recommended by the *State of the Bays 2016* report, will extend to coastal environments and begin to address these issues.

Coastal Wetlands and Estuaries

There are at least 16 coastal wetland EVCs, of which the most common and spatially extensive are: mangrove shrubland (EVC 140), coastal saltmarsh (EVC 9), estuarine wetland (EVC 10), brackish grassland (EVC 934), brackish wetland (EVC 656), seagrass meadows (EVC 845) and saline aquatic meadow (EVC 854).⁵⁹

The most recent inventory⁶⁰ of coastal wetlands estimated there were 19,212 hectares of coastal saltmarsh, 5,177 hectares of mangroves and 3,227 hectares of estuarine wetland along the Victorian coastline. Of these, 218 hectares of mangroves and 6,390 hectares of coastal saltmarsh were on private land.

Six areas of coastal wetlands in Victoria have been listed under the Ramsar Convention: Corner Inlet (including Nooramunga) (67,186 hectares), Edithvale–Seaford Wetlands (262 hectares), Gippsland Lakes (60,015 hectares), Glenelg Estuary and Discovery Bay (22,289 hectares), Port Phillip Bay (Western Shoreline) and Bellarine Peninsula (22,897 hectares), and Western Port (59,297 hectares).

There has been growing scientific interest in the monitoring and assessment of estuary condition in Victoria's more than 100 estuaries since the release of the National Land and Water Resources Audit of 2002,⁶¹ and the subsequent development of the Index of Estuarine Condition in Victoria, due for release in 2020 and based on five themes: physical form, hydrology, water quality, flora and fauna. Even so, saline coastal wetlands and estuaries remain very poorly studied habitats in south-eastern Australia.⁶²

Rises in sea level, and carbon dioxide, and air and water temperatures and increased storm intensity, along with changing rainfall patterns and wave regimes, will impact on coastal wetlands already affected by population growth and its associated coastal development, land reclamation and levee bank construction.

This section reviews indicators for mangroves, saltmarsh, seagrass, seagrass-dependent fish and estuaries.

59. DELWP 2016, 'Climate change vulnerability and adaptive capacity of coastal wetlands. Decision Support Framework – Volume Two', Melbourne, Victoria.

60. Boon PJ, Allen R, Carr G, Frood D, Harty C, McMahon A, Mathews S, Rosengren N, Sinclair S, White M, Yugovic J 2014, 'Coastal wetlands of Victoria, south-eastern Australia: providing the inventory and condition information needed for their effective management and conservation', *Aquatic Conservation Marine and Freshwater Ecosystems*, 25(4), pp. 454–479.

61. National Land and Water Resources 2002, 'Australian catchment river and estuary assessment', Canberra, Australian Capital Territory.

62. Sinclair S, Boon P 2012, 'Changes in the area of coastal marsh in Victoria since the mid 19th century', *Cunninghamia*, 12 (2), pp. 153–176.

	Status				Trend	Data quality
	UNKNOWN	POOR	FAIR	GOOD		
MC:01 Mangrove extent						 DATA QUALITY Good
			CI NMCP	WPT OMAC		

Data custodian DELWP Biodiversity

Rationale

Saltmarshes and mangroves are critical habitats for many marine and coastal species, and provide many ecosystem services for coastal communities. Measured negative changes in mangrove extent may signal the need for management responses.

Summary

Western Port

Western Port has retained 90–95% of its pre-1750s mangrove habitat, estimated at 1,320 hectares.⁶³ Losses have been caused by harvesting in the 19th century to produce barilla ash, land claim for industrial and port development, and the drainage of adjacent land.⁶⁴ In some areas, mangroves have expanded in area, including encroaching on saltmarsh, yet it is still unclear whether they are advancing seawards or landwards.⁶⁵

Corner Inlet and Nooramunga

Mangroves are at their southern-most limit in Corner Inlet and Nooramunga, where 80% of the pre-1750s cover remains. Corner Inlet/Nooramunga has the most extensive stands of mangrove along Victoria’s coast: 846 hectares in Corner Inlet and 2,241 hectares in Nooramunga (compared with 1,230 hectares in Western Port and 84 hectares in the lower Barwon region).

Other Marine and Coastal Areas

A survey of 30 coastal sectors compared pre-1750s and current mangrove (and saltmarsh) extents. Of the 30 coastal sectors analysed, only 14 had mangroves present.⁶⁶ On a statewide basis, 90% of the pre-1750’s extent of mangroves remains. Most coastal sectors have 100% remaining, except for Corner Inlet and Western Port, with 80% and 90% respectively; Shallow Inlet, where all of an estimated 250 hectares have been lost; and Anderson Inlet, where mangrove extent has increased. There are some indications that mangroves may be expanding in extent and increasing in vigour in response to climate change.⁶⁷







63. Boon PI, Allen R, Carr G, Froud D, Harty C, McMahon A, Mathews S, Rosengren N, Sinclair S, White M, Yugovic J 2011, 'Mangroves and coastal saltmarsh of Victoria: distribution, condition, threats and management', Institute for Sustainability and Innovation, Victoria University, Melbourne, Victoria.

64. Melbourne Water Corporation 2011, 'Understanding the Western Port environment', Melbourne, Victoria.

65. Ibid

66. Boon PI, Allen R, Carr G, Froud D, Harty C, McMahon A, Mathews S, Rosengren N, Sinclair S, White M, Yugovic J 2015, 'Coastal wetlands of Victoria, south-eastern Australia: providing the inventory and condition information needed for their effective management and conservation', *Aquatic Conservation: Marine and Freshwater Ecosystems*, 25(4), pp. 454-479.

67. Boon PI 2017, 'Are mangroves in Victoria (south-eastern Australia) already responding to climate change?', *Marine and Freshwater Research*, 68(12), pp. 2366-2374.

	Status				Trend	Data Quality
	UNKNOWN	POOR	FAIR	GOOD		
MC:02 Saltmarsh extent	 OMAC		 PPB	 GLA WPT	OMAC ? PPB → GLA ? WPT ↘	 DATA QUALITY Fair - PPB & WPT  Poor - GLA & OMAC
	Data Custodian DELWP Biodiversity					

Rationale

This indicator measures the spatial extent of saltmarsh, a critical habitat for many species, and will assist management responses.

Summary

Port Phillip Bay

About 50% of Port Phillip Bay’s pre-1750s saltmarsh cover of 3,710 hectares remains today.⁶⁸ The losses are the result of Melbourne’s growth, port development, conversion to evaporating ponds for saltworks, housing at Sanctuary Lakes and the creation of the Western Treatment Plant. Monitoring of four sites in Port Phillip Bay between 2008 and 2011 found no detectable change outside expected variability in saltmarsh health.⁶⁹ Parks Victoria will carry out an assessment of saltmarsh in Port Phillip Heads Marine National Park using remote-sensing data.

Western Port

In Western Port, 90–95% of saltmarsh that once covered 1,460 hectares⁷⁰ remains today. In addition to the impact of mangrove encroachment and subsequent saltmarsh displacement along tidal creeks, significant portions of saltmarsh were removed for agriculture. Saltmarsh has returned in some areas, particularly around the northern and western shores of Western Port, for example near Tooradin airport; however, concerns over declining saltmarsh extent remain, with erosion a problem on the eastern shoreline.⁷¹ Although loss of saltmarsh to mangrove habitat in Western Port is low (5–10% of saltmarsh area) compared with 30% across south-east Australia, it remains a challenge for managers.⁷²

The saltmarshes of Western Port face a number of threats (see Figure MC.1). For example, sea-level rise will increase the time that water covers saltmarsh, facilitating mangrove encroachment. This has been occurring at several sites including Rhyll, Koo Wee Rup, French Island and Quail Island.⁷³

68. Ibid
69. CES 2016, ‘State of the Bays 2016’, Melbourne, Victoria.

70. Sinclair S, Boon PI 2012, ‘Changes in the area of coastal marsh in Victoria since the mid 19th century’, *Cunninghamia*, 12(2), pp. 153–176.
71. CES 2016, ‘State of the Bays 2016’, Melbourne, Victoria.
72. Ibid
73. Ibid

Gippsland Lakes

Historical mapping⁷⁴ of lakes Reeve, Victoria and Wellington indicates that between 65% and 100% of pre-1750s saltmarsh has been retained in the Gippsland Lakes:

the Gippsland Lakes area presented particular problems for calculating depletion statistics, as there have been potentially large gains or proportionally smaller losses along this section of the Victorian coast, especially for Lake Wellington. The primary difficulty is with existing areas of coastal saltmarsh, some of which are natural occurrences, some of which seem to be expansions of saltmarsh since European colonization.⁷⁵

Saltmarsh and other areas of saline coastal wetland around the Gippsland Lakes are especially complex spatially and temporally, and this has made it impossible to resolve changes in post-European extent. Future sea-level rise and storm surges, exacerbated by ongoing dredging of the entrance, are expected to reduce saltmarsh extent,⁷⁶ although increasing salinisation caused by the 1889 opening of the artificial entrance may see areas of saltmarsh increase and areas of non-halophytic fringing vegetation, such as common reed, decline.^{77,78}

Other Marine and Coastal Areas

A survey of 30 coastal sectors that compared pre-1750s and current mangrove (and saltmarsh) extents found seven of the coastal sectors had 35–65% of saltmarsh remaining. Seven were 100% intact, one had expanded to 130% (Lang Lang), and the other fourteen ranged from 70–95%.^{79,80}

The intensity levels of 20 impacts across 30 coastal sectors where saltmarsh is present were identified (see Figure MC.1). The most intense and more common impacts were land claim (total removal of pre-existing wetland for uses including agriculture and port development), landfill and spoil dumping, vehicle access and stock grazing.

74. Sinclair S, Boon PI 2012, 'Changes in the area of coastal marsh in Victoria since the mid 19th century', *Cunninghamia*, 12(2), pp. 153–176.

75. Ibid

76. Boon PI, Cook P, Woodland R 2016, 'The challenges posed by chronic environmental change in the Gippsland Lakes Ramsar site', *Marine and Freshwater Research*, 67(6), pp. 721–737.

77. Bird E 1966, 'The impact of man on the Gippsland Lakes, Australia', In *Geography as Human Ecology. Methodology by Example*, (eds. S Eyre and G Jones), Edward Arnold, London, Great Britain, pp. 55–73.

78. Boon PI, Frood D, Oates A, Reside J, Rosengren N 2018, 'Why has *Phragmites australis* persisted in the increasingly saline Gippsland Lakes? A test of three competing hypotheses', *Marine and Freshwater Research*, <https://doi.org/10.1071/MF18145> Accessed 4 December 2018.

79. Boon PI, Allen R, Carr G, Frood D, Harty C, McMahon A, Mathews S, Rosengren N, Sinclair S, White M, Yugovic J 2015, 'Coastal wetlands of Victoria, south-eastern Australia: providing the inventory and condition information needed for their effective management and conservation', *Aquatic Conservation: Marine and Freshwater Ecosystems*, 25(4), pp. 454–479.






80. Boon PI, Allen R, Carr G, Frood D, Harty C, McMahon A, Mathews S, Rosengren N, Sinclair S, White M, Yugovic J 2011, 'Mangroves and coastal saltmarsh of Victoria: distribution, condition, threats and management', Institute for Sustainability and Innovation, Victoria University, Melbourne, Victoria.

Sector	Land-claim	Landfill and spoil	Tidal restriction	Stormwater input	Shell-grit mining	Salt production	Treatment ponds	Vehicle access	Stock grazing	Deer, goats, pigs	Weed invasion	Spartina	Inappropriate rehabilitation	Inappropriate recreation	Boat-wash	Overdevelopment	Mowing	Landward barrier (artificial)	Landward barrier (land use)	Landward barrier (topographic)
Glenelg	|	.	.	w	.	.	.	.	|	.	|	.	.	|	|	w	.	|	w	|
Fawthrop-Belfast	w	|	.	w	.	.	.	.	|	.	|	.	.	|	|	w	.	|	w	|
Western estuaries	|	.	.	?	.	.	|	|	w	.	|	.	|	|	|	w	.	.	w	|
Aire-Gellibrand	w	.	.	.	.	.	.	|	w	.	w	.	.	.	.	.	.	.	w	w
Surf-coast estuaries	|	.	.	w	.	.	|	.	|	.	|	.	|	|	.	w	.	|	w	w
Breamlea	|	|	w	|	.	.	w	|	w	.	|	.	.	|	.	w	.	w	w	w
Connewarre	|	|	w	|	|	.	.	|	|	|	|	|	|	|	|	w	|	w	w	w
Bellarine Lakes	|	.	Na	|	.	.	.	|	|	.	?	.	.	|	.	w	.	|	|	|
Salt Lagoon	.	.	Na	?	.	.	.	|	.	.	?	.	.	?	.	w	.	|	w	w
Swan Bay	|	|	|	|	|	.	.	|	|	.	|	.	.	.	|	w	|	|	w	|
Mud Island	.	.	.	.	.	.	.	.	.	.	.	.	.	.	|	.	.	.	.	|
Port Phillip	|	.	|	|	?	|	w	|	?	.	?	.	|	|	|	|	.	w	w	|
The Inlets	|	|	.	w	.	.	.	|	|	.	|	|	.	.	.	.	.	w	w	.
Western Port	|	|	.	|	.	.	.	|	|	.	|	.	.	|	|	w	.	|	w	|
French Island	.	.	.	.	.	|	.	|	|	w	|	.	.	.	|	.	.	.	|	|
Rhyll Inlet	|	|	.	w	.	.	.	|	|	.	|	.	.	|	.	w	.	|	w	.
Lang Lang coast	.	.	.	.	.	.	.	|	|	.	|	.	.	.	.	.	.	.	w	.
Bass River	|	.	.	.	.	.	.	|	|	.	|	|	.	.	.	.	.	w	w	.
Powlett-Kilcunda	w	.	.	.	.	.	.	|	w	.	|	.	.	|	.	w	.	|	w	.
Anderson Inlet	w	|	.	|	.	.	.	|	|	.	|	w	|	|	|	w	.	w	w	.
Shallow Inlet	w	.	.	|	.	.	.	.	.	.	|	.	.	.	|	.	.	w	w	.
Wilson's Promontory	.	.	.	.	.	.	.	.	.	|	?	.	.	.	|	.	.	.	.	.
Corner Inlet	w	|	|	|	.	.	.	|	|	|	|	|	.	?	|	|	.	w	w	w
Nooramunga Coast	w	|	|	?	.	.	.	|	|	|	?	|	.	|	|	|	.	.	|	.
Nooramunga Is.	.	.	|	.	.	.	.	|	|	|	?	?	.	.	?	.	.	.	.	.
Jack Smith Lake	.	.	Na	?	.	.	.	|	|	|	?	.	.	.	.	.	.	w	w	!?
Lake Reeve	|	|	|	|	.	.	.	|	|	|	|	.	.	.	.	|	.	|	w	.
Lakes Victoria & King	|	.	.	.	.	.	.	|	|	|	|	.	.	|	|	.	.	|	w	!?
Lake Wellington	|	.	|	.	.	.	.	|	|	|	|	.	.	.	|	.	.	w	w	|
East Gippsland Inlets	w	.	|	?	.	.	.	|	w	|	?	.	.	?	?	.	.	|	|	w

Figure MC.1 An assessment of saltmarsh degradation according to degrading processes throughout Victoria, assessed sector-by-sector⁸¹

Note: The intensity of impact is colour-coded where red is high, orange is medium and yellow is low. The letter 'l' and 'w' within a cell refers to whether the impact is widely or locally evident. A '?' indicates uncertainty as to impacts in that sector. 'Na' is not applicable, and the final three columns are not coded, as it is currently impossible to gauge sea-level rise impacts.

81. Boon PJ, Allen R, Carr G, Frood D, Harty C, McMahon A, Mathews S, Rosengren N, Sinclair S, White M, Yugovic J 2015, 'Coastal wetlands of Victoria, south-eastern Australia: providing the inventory and condition information needed for their effective management and conservation', *Aquatic Conservation: Marine and Freshwater Ecosystems*, 25(4), pp. 454-479.

	Status				Trend	Data Quality
	UNKNOWN	POOR	FAIR	GOOD		
MC:03 Seagrass condition					WPT ? GLA ? PPB → OMAC ? CI ↘	 DATA QUALITY Fair
	WPT OMAC		GLA CI	PPB		

Data Custodian DELWP Biodiversity

Rationale

Seagrass meadows are critical habitat for many marine species, including fish targeted by commercial and recreational fishers, provide shoreline protection and store significant amounts of carbon. Changes in their condition can have environmental, social and economic effects.

Summary

Port Phillip Bay

The health of seagrass was assessed at three sites in Port Phillip Bay from 2004–5 to 2006–7 (as well as sites in Western Port and Corner Inlet), establishing a baseline dataset for future monitoring and comparison.⁸² Along with aerial mapping to determine changes in percentage cover, the researchers monitored a large range of seagrass variables including shoot length, density and biomass, along with epiphyte cover, epifauna, water temperature and light. Aerial mapping for Port Phillip Bay showed reductions in seagrass cover at Point Richards and Blairgowrie, an increase at Kirk Point and no change at Swan Bay.

Baywide extent of seagrasses is relatively constant while there can be large changes in cover in localised areas: 'For example, in regional areas such as Blairgowrie, St Leonards and Bellarine Bank, there has been a long-term increase in seagrass cover from the 1950s to the late 1990s but then a dramatic decline in the 2000s.'⁸³ During the millennium drought (1996–2010), there was a large

reduction in seagrass extent in Port Phillip Bay, where the Bellarine Bank reduced by more than 90% from 2000 to 2011.⁸⁴ Seagrasses in sheltered areas (Corio Bay, Point Henry, Swan Bay) were relatively stable or 'persistent', whereas those in exposed areas (southern bay, Bellarine Bank) were 'ephemeral' and heavily influenced by nutrient loadings.⁸⁵

A review of aerial photos of the Bellarine Bank from 2009 to 2014, found that 'the rapid decline in seagrass since the onset of the millennium drought is consistent with a decline in nutrient loadings to the bay; however, it may also reflect changes in other pressures such as prevailing winds and bay circulation patterns'.⁸⁶

Western Port

During the 1970s and 1980s, Western Port lost 70% of its seagrass due to excessive sediment inflows and coastal bank erosion that smothered seagrass and reduced light penetration. A CSIRO study⁸⁷ for Melbourne Water estimated that 32% of the sediment was sourced from the erosion of a nine-kilometre stretch of shoreline in the bay's north-eastern corner between the mouth of the Yallock Creek and the Lang Lang caravan park.

A 2011 review of Western Port seagrass research revealed that the seagrass decline was followed by an increase from the mid-1990s to 1999. Most variability was observed in the *Zostera*-dominated beds, while *Amphibolis antarctica* beds remained relatively stable.⁸⁸ In the north of the bay, seagrass in Yaringa Marine National Park was rated in 'good' condition in 2017.⁸⁹

82. Ball D, Hirst A, Parry G, Heislors S, Blake S, Werner G, Young P, Coots A 2010, 'Victorian multi-regional seagrass health assessment 2004–07', Fisheries Victoria Technical Report No.66, Department of Primary Industries, Queenscliff, Victoria.

83. Jenkins G, Keogh M, Ball D, Cook P, Ferguson A, Gay J, Hirst A, Lee R, Longmore A, Macreadie P, Nayer S, Sherman C, Smith T, Ross J, York P 2015, 'Seagrass resilience in Port Phillip Bay: final report to the Seagrass and Reefs Program for Port Phillip Bay, University of Melbourne, Melbourne, Victoria http://www.pir.sa.gov.au/_data/assets/pdf_file/0004/265585/Seagrass_Resilience_in_Port_Phillip_Bay.pdf Accessed 4 December 2018.

84. Ibid

85. Ibid

86. Ibid

87. Wilkinson SN, Anstee JM, Joehnk KD, Karim F, Lorenz Z, Glover M, Coleman R 2016, 'Western Port sediment supply, seagrass interactions and remote sensing', Report to Melbourne Water Corporation, CSIRO, Melbourne, Australia.

88. CES 2016, 'State of the Bays 2016', Melbourne, Victoria.

Gippsland Lakes

The *Gippsland Lakes Condition Report* noted the natural variability of seagrass in temperate Australia and revealed that, between 1997 and 2016, seagrass extent had declined in the area. But this snapshot of two endpoints, with no monitoring data points in between 1997 to 2016, was insufficient to determine whether the reduction would be sustained.⁹⁰ Conversely, over the same period seagrass density had increased from 50% to 63%. The report rated seagrass extent as 'fair' and its condition as 'good'.⁹¹

Corner Inlet

There was an observed decline in seagrass cover in Corner Inlet (except for Granite Island),⁹² where seagrass extent had declined on average by 0.5 km² per year between 1965 and 2013, with algal blooms and turbidity both impacting on light penetration.⁹³

The ecological character description⁹⁴ for the Corner Inlet Ramsar site indicated a decline in *Posidonia australis* seagrass due to reduced water quality, stating that 'die-off of *P. australis* and possibly the occurrence of blooms of filamentous algae 'slub' are consistent with the effects of nutrient enrichment',⁹⁵ and that 'dense seagrass beds, mostly comprised of *P. australis*, were observed to have declined in extent, whereas there was an increase in the distribution of sparse seagrass'.⁹⁶

Other Marine and Coastal Areas

Aerial surveys of seagrass extent in Anderson, Shallow, Corner, Tamboon, Wingan and Mallacoota inlets were conducted in 1998 and 1999, but none have been repeated. Therefore, current data for these areas is not available.

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89. Carey J, Howe S, Pocklington J, Rodrigue M, Campbell A, Addison P, Bathgate R 2017, 'Report on condition of Yaringa Marine National Park 2002 to 2013', Parks Victoria Technical Series No. 112, Melbourne, Victoria.
90. East Gippsland Catchment Management Authority, 'State of the Gippsland Lakes: Technical Report', (*Publication pending*).
91. Ibid
92. Ball D, Hirst A, Parry G, Heislors S, Blake S, Werner G, Young P, Coots A 2010, 'Victorian multi-regional seagrass health assessment 2004–07', Fisheries Victoria Technical Report No.66, Department of Primary Industries, Queenscliff, Victoria.
93. Ford J, Barclay K, Day R 2016, 'Using local knowledge to understand and manage ecosystem-related decline in fisheries productivity', Fisheries Research and Development Corporation Final Project Report, Melbourne, Victoria.
94. Department of Sustainability, Environment, Water, Population and Communities 2011, 'Ecological character description of the Corner Inlet Ramsar site – final report', Canberra, Australian Capital Territory.
95. Ibid
96. Ibid

	Status				Trend	Data Quality
	UNKNOWN	POOR	FAIR	GOOD		
MC:04 Seagrass-dependent fish					?	
	PPB WPT OMAC GLA					
Data Custodian DELWP Biodiversity, PV						

Rationale

Seagrass meadows are used by many fish species for breeding, feeding and shelter. Any change in population numbers and diversity (evenness of species distribution) of seagrass-dependent fish could indicate changes in seagrass health with potential environmental, social and economic effects.

Summary

Port Phillip Bay

Fish species, biomass and diversity within Port Phillip Bay seagrass beds were monitored at three sites from 2008 to 2012.⁹⁷ The research concluded that a loss of seagrass or reduction in seagrass condition at varied depth ranges may affect individual fish species differently. The data is insufficient to determine status or trends.

Western Port

Zostera muelleri seagrass is dominant, with high species richness (the number of species). That includes the spotted pipefish (*Stigmatopora argus* and other conservation-listed syngnathids), grass whiting (*Haletta semifasciata*), little weed whiting (*Neoodax balteatus*) and leatherjackets (*Monacanthidae* spp.), as well as providing an important area for settling King George whiting larvae. *Amphibolis antarctica* seagrass dominates the entrance to Western Port and also has high fish species richness, including the sixspine leatherjacket (*Meuschenia freycineti*), little weed whiting, weedy seadragon (*Phyllopteryx taeniolatus*-conservation-listed), and is being habitat for southern calamari squid (*Sepioteuthis australis*) and King George whiting. The maintenance of fish biodiversity in Western Port relies on the persistence of significant areas of *Z. muelleri*, particularly in the intertidal, shallow sub-tidal zone.⁹⁸

In another Western Port study, night-time trawls were used to survey seagrass fish in Yaringa Marine National Park. The six trawls collected 14,073 organisms: 12,734 crustacea, 514 fish, 791 molluscs, 33 polychaetes and 1 pynogonida.⁹⁹

Again, there is insufficient data for an assessment of status and trends.

97. Hutchison N, Jenkins G, Brown A 2012, 'Variation with depth in temperate seagrass-associated fish assemblages in southern Victoria, Australia', *Estuaries and Coasts*, 37(4), pp. 801-814.

98. Jenkins G, Kenner T, Brown A 2013, 'Determining the specificity of fish-habitat relationships in Western Port', Centre for Aquatic Pollution Identification and Management, Technical Report No.26, Melbourne, Victoria.

99. Kirkman H, Stevenson I, Avery L 2016, 'The juvenile fish and macroinvertebrates of Yaringa Marine Sanctuary in Western Port', Western Port Seagrass Partnership, Western Port, Victoria.

Gippsland Lakes

Fish assemblages and seagrass condition were assessed at 30 sites in the Gippsland Lakes from September 2008 to April 2012. Seagrass extent and qualitative condition rose and then fell during the assessment period. Fish species were generally consistent with those expected in shallow Victorian estuaries and represented a range of functional guilds, including estuarine resident species, species that depend on estuarine habitats to complete their lifecycle, and species that use estuaries opportunistically. Relative abundances were highly variable among sampling rounds and variation in per cent abundances also varied.¹⁰⁰ The assessment provided a good baseline of data to monitor future changes but is insufficient to determine status and trends.

Other Marine and Coastal Areas

There is insufficient data to assess status and trends.

100. Warry F, Hindell J 2012, 'Fish assemblages and seagrass condition of the Gippsland Lakes: 2012', Unpublished client report for the Gippsland Lakes Ministerial Advisory Committee, Arthur Rylah Institute for Environmental Research, Heidelberg, Victoria.

Indicator	Status				Trend	Data Quality
	UNKNOWN	POOR	FAIR	GOOD		
MC:05 Estuarine condition Data Custodian Catchments, Waterways, Cities and Towns					?	 Poor

Rationale

Estuaries provide important ecosystem services that have environmental, economic, cultural and social benefits dependent on estuarine health.

Summary

The National Land and Water Resources Audit (2002),¹⁰¹ assessed the condition of a selection of Victorian estuaries and found the following:

- 14 were categorised as near pristine (including East Gippsland Lowlands bioregion)
- 20 were largely unmodified (including Warrnambool Plain, Otway Plain, Otway Ranges and Wilsons Promontory bioregions)
- 23 were modified (including Port Phillip Bay and on the Warrnambool, Otway and Gippsland plains bioregions)
- 4 were extremely modified (including Laverton and Kororoit creeks, the Gippsland Lakes and the Merri River).

To support the development of the Index of Estuarine Condition, a separate assessment from the above 2002 audit, 101 estuaries were analysed from 2010 to 2012.¹⁰² Most estuaries had readings of either 'good' or 'excellent' for form and hydrology, whereas for water quality and flora, most were assessed as 'moderate' or 'good'. Estuaries in the Otway Ranges, around Wilsons Promontory and in Croajingolong National Park were more likely to be assessed as 'good' to 'excellent', whereas those with developed catchments, for example Mordialloc Creek in Port Phillip Bay, recorded lower scores.

Until the completion of the Index of Estuarine Condition in 2020, there is insufficient data to assess status and trends.

101. National Land and Water Resources 2002, 'Australian Catchment River and Estuary Assessment', Canberra, Australian Capital Territory.







102. Pope A, Barton J, Quinn G 2015, 'Victorian index of estuary condition: implementation trial final report', School of Life and Environmental Sciences, Deakin University Warrnambool, Victoria.

Intertidal and Subtidal Reefs

The intertidal and subtidal reefs in Victoria's coastal waters support a diverse and colourful range of marine plants and animals. Intertidal reefs are popular with people who enjoy rock-pool rambling, while subtidal reefs are a magnet for divers and snorkellers, and also a focus for black lip abalone (*Haliotis rubra*) and greenlip abalone (*Haliotis laevis*) fishery.

On rocky shores in the intertidal zone, and for the seaweeds, molluscs, worms, sea squirts, crabs and other animals and plants living there, the environment is constantly changing due to tidal and wave action. Some species are mobile and move across the rocks, while others are sessile (stationary). On the deeper subtidal reefs, seaweeds such as bull kelp provide shelter for reef fish and rock lobsters, and the rocky surfaces are grazed by abalone and sea urchins.

This section assesses the status of invertebrates, fish and macroalgae that are found on Victoria's reefs.

Indicator	Status				Trend	Data Quality
	UNKNOWN	POOR	FAIR	GOOD		
<p>MC:06 Mobile invertebrates on intertidal reefs</p> <p>Data Custodian PV Intertidal Reef Monitoring Program, Sea Search/Museum of Victoria ad-hoc surveys</p>	 WPT OMAC PPB			 MNPS	WPT ? OMAC ? PPB ? MNPS →	 DATA QUALITY Good MNPS  DATA QUALITY Poor OMAC, PPB & WPT

Rationale

Intertidal invertebrates are important food sources for marine and coastal animals and also popular with people rambling across shore platforms. Any declines in populations or cover could indicate the effects of illegal harvesting, trampling, reduced water quality or climate change.

Other Marine and Coastal Areas

Parks Victoria draft control charts assess the condition of mobile invertebrates in marine national parks beyond Port Phillip Bay as 'good'.

Summary

Port Phillip Bay

Data for mobile invertebrates from Parks Victoria’s Intertidal Reef Monitoring Program indicate that in the bay’s marine national park and sanctuaries they have remained in 'good' condition since 2003.







Western Port

Western Port has few reefs but there are three notable ones:

1. Crawfish Rock
2. a small San Remo reef significant for opisthobranchs (soft-bodied marine snails), listed in the *Flora and Fauna Guarantee Act 1988*,
3. intertidal reefs along the south-west coast, particularly Honeysuckle Reef.

A loss of diversity is evident at Crawfish Rock, most likely a result of high turbidity in the North Arm.¹⁰³

103. Melbourne Water Corporation 2011, 'Understanding the Western Port environment: a summary of current knowledge and priorities for future research', Melbourne, Victoria.







Indicator	Status				Trend	Data Quality
	UNKNOWN	POOR	FAIR	GOOD		
MC:07 Sessile invertebrates on intertidal reefs Data Custodian PV Intertidal Reef Monitoring Program, Sea Search/Museum of Victoria ad-hoc surveys	 UNKNOWN OMAC	 POOR	 FAIR	 GOOD MNPS	OMAC ? MNPS →	 DATA QUALITY Good MNPS  DATA QUALITY Poor OMAC

Rationale

Sessile invertebrates are important food sources for marine and coastal animals. Declining populations or cover could indicate impacts from illegal harvesting, trampling, reduced water quality, invasive species or climate change.

Summary

Parks Victoria has prepared draft control charts for several marine national parks and sanctuaries to track changes in indicators of key natural values and impacts of threats. Sessile invertebrates are a key ecological attribute on intertidal reefs in 12 parks, with their condition assessed as 'good' in nine parks and 'fair' in three. However, there is no data for reefs outside the boundaries of protected areas.

Indicator	Status				Trend	Data Quality
	UNKNOWN	POOR	FAIR	GOOD		
MC:08 Mobile megafaunal invertebrates on subtidal reefs	 OMAC	 NPPB		 MNPS SPPB	OMAC ? MNPS ? NPPB ↘ SPPB →	 DATA QUALITY Good MNPS, NPPB, SPPB  DATA QUALITY Poor OMAC
Data Custodian Parks Victoria; Reef life survey						

Rationale

Some mobile megafaunal invertebrates, such as abalone and rock lobster, are key species in marine national parks and sanctuaries. Outside the park boundaries they are targeted by commercial and recreational fishers. Monitoring can assist Parks Victoria’s compliance program, and provide data on trends in catches and stocks to support fisheries management.

Summary

Port Phillip Bay

The subtidal reef biota (macroalgae, invertebrates and fish) for a number of marine national parks and sanctuaries (and reference sites outside) were surveyed between 2011 and 2013, with the results compared with earlier surveys and published in Park’s Victoria’s Technical Report Series.¹⁰⁴

For the three marine sanctuaries¹⁰⁵ in the north of Port Phillip Bay – Point Cooke, Jawbone and Ricketts Point – blacklip abalone at Point Cooke had been replaced by purple sea urchins, which had also become dominant at Jawbone and were heavily grazing Ricketts Point. However, invertebrate species richness and diversity were stable at Ricketts Point, and the total abundance of species increased significantly at Jawbone, driven by increased urchin numbers.

The Reef Ecosystem Evaluation Framework (REEF) evaluation survey determined that species’ community assemblages and the ecosystem health of reefs vary regionally within Port Phillip Bay (generally, northern and western reefs are considered to have diminished quality).¹⁰⁶ Megafaunal invertebrates are diverse in the north of the bay, in part due to the additional nutrients from the Western Treatment Plant, Yarra River and Kororoit Creek inflows.¹⁰⁷

The last survey of native seastars at Port Phillip Heads revealed some seastar communities were diseased with necrosis (across Victoria, native seastar numbers have fallen over the past decade, with very low numbers recorded for the past seven years; the cause of this decline is unknown).¹⁰⁸ Greenlip abalone are recovering in terms of abundance and size – both in marine protected areas and at reference sites outside these areas.¹⁰⁹

Parks Victoria control charts rated the health of megafaunal invertebrates as ‘good’ in the Port Phillip Heads Marine National Park in the south of the bay, while in the north the ratings were ‘unknown’ in Point Cooke and Jawbone and ‘fair’ in Ricketts Point.

104. The survey reports can be found at <https://parkweb.vic.gov.au/park-management/environment/research-and-scientific-management/technical-series2> Accessed 4 December 2018.

105. Survey reports for the subtidal reef biota in the three sanctuaries can be found at <https://parkweb.vic.gov.au/park-management/environment/research-and-scientific-management/technical-series2> Accessed 4 December 2018.

106. Johnson CR, Swearer SE, Ling SD, Reeves S, Kriegisch N, Trembl EA, Ford JR, Fobert E, Black KP, Weston K, Sherman CDH 2015, ‘The reef ecosystem evaluation framework (REEF): managing resilience in temperate environments’, Melbourne, Victoria, pp. 1-39.

107. CES 2016, ‘State of the Bays 2016’, Melbourne, Victoria.

108. Ibid

109. Edmunds M, Stewart K and Pritchard K 2010, ‘Victorian Subtidal Reef Monitoring Program: the reef biota at Port Phillip Heads Marine National Park’, Volume 4, Parks Victoria Technical Series No. 63, Melbourne, Victoria.

Other Marine and Coastal Areas

At Cape Howe Marine National Park, the 2011–2013 survey and review of earlier research found that the abundances of the long-spined sea urchin and blacklip abalone were high, abalone abundance having increased since the park's establishment in 2002, while urchin numbers had remained stable.¹¹⁰ The density of purple and long-spined sea urchins had increased at Beware Reef Marine Sanctuary towards the end of the survey period, having earlier been in decline. The total number of invertebrates had also declined.¹¹¹

The densities of blacklip abalone and purple sea urchin, along with the total numbers of invertebrates (half of baseline levels), had declined at Wilsons Promontory Marine National Park. Invertebrate abundances, again including blacklip abalone and purple sea urchin, also declined at Bunurong Marine National Park.¹¹²

Invertebrate densities increased in the Point Addis Marine National Park,¹¹³ while at Eagle Rock Marine Sanctuary,¹¹⁴ species richness and diversity were in slight decline, and blacklip abalone abundance in sharp decline after 2009. Marengo Reefs Marine Sanctuary experienced fluctuating species richness and diversity, but there was a declining trend for blacklip abalone abundance and total invertebrate abundance was at its lowest at the end of the survey period.¹¹⁵ Inside the Merri Marine Sanctuary, southern rock lobster (*Jasus edwardsii*) abundance was double that outside the boundaries, while biomass was three to five times greater. Invertebrate abundance was low and stable and blacklip abalone densities were low.¹¹⁶

Parks Victoria draft control charts assessed mobile megafaunal invertebrates as 'good' in 12 of the parks, 'fair' in 1 and 'unknown' in 1. There is no data on trends.

Abalone abundance more generally has been impacted by 'abalone viral ganglioneuritis (AVG); previous distributions of fishing pressure and overharvesting; illegal, unreported and unregulated fishing; possible growth in recreational fishing; and competition from other benthic organisms, particularly sea urchins'.¹¹⁷

110. Edmunds M, Woods B 2017, 'Victorian Subtidal Reef Monitoring Program: The reef biota at Cape Howe Marine National Park, December 2014', Parks Victoria Technical Series No. 99. Parks Victoria, Melbourne, Victoria.

111. Edmunds M, Hallein E, Flynn A 2014, 'Victorian subtidal reef monitoring program: the reef biota at Beware Reef Marine Sanctuary', Parks Victoria Technical Series No. 88, Melbourne, Victoria.

112. Davis S, Pritchard K, Edmunds M 2011, 'Victorian subtidal reef monitoring program: the reef biota at Bunurong Marine National Park, May 2011', Parks Victoria Technical Series No. 84. Melbourne, Victoria.








113. Woods B, Edmunds M, Brown H 2014, 'Victorian subtidal reef monitoring program: the reef biota at Point Addis Marine National Park', Parks Victoria Technical Series No. 94, Melbourne, Victoria.

114. Edmunds M, Brown H, Woods B 2014, 'Victorian subtidal reef monitoring program: the reef biota at Eagle Rock Marine Sanctuary', Parks Victoria Technical Series No. 89, Melbourne, Victoria.

115. McArthur M, Smith A, Davis, S, Edmunds M, Pritchard K 2011, 'Victorian subtidal reef monitoring program: the reef biota at Marengo Reefs Marine Sanctuary, Parks Victoria Technical Series No. 85, Melbourne, Victoria.

116. Woods B, Edmunds M 2013, 'Victorian subtidal reef monitoring program: the reef biota at Merri Marine Sanctuary', Parks Victoria Technical Series No. 87, Melbourne, Victoria.

117. Department of Primary Industries 2012, 'Abalone Recovery Review Workshop', Fisheries Victoria Management Report Series No. 83, Melbourne, Victoria.

Indicator	Status				Trend	Data Quality
	UNKNOWN	POOR	FAIR	GOOD		
MC:09 Subtidal reef fish	 OMAC		 NPPB	 MNPS SPPB	OMAC ? NPPB ? MNPS ? SPPB ↗	 DATA QUALITY Good SPPB & MNPS  DATA QUALITY Fair NPPB  DATA QUALITY Poor OMAC
Data Custodian DELWP Biodiversity, PV						

Rationale

Reef fish are highly visible and colourful elements of subtidal reefs. They are key species in marine national parks and sanctuaries and are popular with divers and snorkellers. Monitored changes in their populations could indicate excessive harvesting, water pollution or climate change, and could alert agencies to the need for management action.

Summary

Port Phillip Bay

A 17-year assessment comprised of three separate studies, spanning from 1992 to 2009, of fish assemblages on shallow rocky reefs in Port Phillip Bay found significant increases in diversity and changes in faunal composition between 17 (+38%) and 7 (+151%) years, providing evidence of long-term changes in faunal composition and diversity within the bay.¹¹⁸ Lower diversity in 2003–04 compared to 1992 could be explained by a slow recovery following the cessation of scallop dredging or from the effects of drought. The highest fish diversity was found on the bay’s east coast reefs with significant changes within fish assemblages, including increased abundance of the southern hulafish (*Trachinops caudimaculatus*), zebra fish (*Girella zebra*) and scalyfin (*Parma victoriae*), was possibly due to improved environmental conditions.

Data from Parks Victoria’s long-term Subtidal Reef Monitoring Program, two rounds of Reef Life Survey monitoring data at The Heads and several years of surveys in the three marine sanctuaries in the bay’s north have been integrated with Parks Victoria’s control charts and provide a good dataset for the bay’s reef fish.

The sanctuaries generally had a low number of fish species and abundance with no consistent trends, with the southern hulafish (*T. caudimaculatus*) dominating the fish assemblages.¹¹⁹ In southern Port Phillip Bay, the health of reef fish communities was rated as ‘good’. Reflecting the improving health of the ecosystem there, western blue groper numbers, which used to be abundant, were increasing at Nepean Bay and Point Lonsdale,¹²⁰ and were reported at nearby South Channel Fort, as well as Barwon Bluff and Beware Reef marine sanctuaries along the open coast. In the bay’s northern sanctuaries, the health of reef fish communities was rated as ‘unknown’ in Jawbone and ‘fair’ in Point Cooke and Ricketts Point.

118. Jung C, Swearer S, Jenkins G 2010, ‘Changes in diversity in the fish assemblage of a southern Australian embayment: consistent spatial structuring at decadal scales’, *Marine and Freshwater Research*, 61, pp. 1425–143.

119. The surveys for the three Marine Sanctuaries are from the Parks Victoria Technical Series, <https://parkweb.vic.gov.au/park-management/environment/research-and-scientific-management/technical-series2> Accessed 4 December 2018.
 120. CES 2016, State of the Bays report 2016’, Melbourne, Victoria.
 121. Edmunds M, Woods B 2017, ‘Victorian subtidal reef monitoring program: the reef biota at Cape Howe Marine National Park’, Parks Victoria Technical Series No. 99, Melbourne, Victoria.

Other Marine and Coastal Areas

At Cape Howe Marine National Park, a 2011–13 Parks Victoria long-term Subtidal Reef Monitoring Program survey, and review of earlier research, found that the biomass of fished species had increased, but there was an observed change in their size, with smaller individuals more abundant.¹²¹ Fish species richness and diversity had also increased over the survey period. Beware Reef Marine Sanctuary was characterised by high abundance of butterfly perch, while purple wrasse and blue throat wrasse had decreased in density. The abundance of banded morwong had declined between 2004 and 2011 (but increased in 2013).¹²²

Purple wrasse had declined in abundance at Wilsons Promontory Marine National Park, while butterfly perch (*Caesioperca iepidoptera*) and barber perch (*Caesioperca rascor*) had increased. However, there had been a substantial decline in fish abundance, biomass and diversity (evenness of species distribution), but not in species richness (the number of species). A decline in the abundance of fish over 200 mm in length was observed at Bunurong Marine National Park, along with low fish density, but total fish abundance fluctuated.¹²³

Marine sanctuaries along the west coast – Eagle Rock, Marengo Reefs and Merri – varied in their recorded data. Blue throat wrasse (*Notolabrus tetricus*) abundance had increased at Eagle Rock, along with total fish abundance, species richness and diversity in the latter half of the survey period.¹²⁴ However, at Merri, the three indices had experienced slight declines,¹²⁵ while at Marengo Reefs there were no trends in species richness and

diversity but a decline in the abundance of larger fish across the species.¹²⁶ There were no changes in fish abundance, richness and diversity at Point Addis Marine National Park.¹²⁷







In a comment that reflects the data more generally in Victoria’s coastal waters, the authors of the report on Marengo Reefs Marine Sanctuary noted that:

The results in this report present a snapshot in time for community structures and species population trends, which operate over long time scales. As monitoring continues and longer-term datasets are accumulated (over multiple years to decades) the programme will be able to more adequately reflect the average trends and ecological patterns occurring in the system.¹²⁸

Parks Victoria’s integrated dataset and control charts show that the condition of large mobile fish (including sharks and rays) on subtidal reefs in marine national parks and sanctuaries beyond Port Phillip Bay was assessed as ‘good’ in 14 parks, ‘fair’ in 1 and ‘unknown’ in 1.

122. Edmunds M, Hallein E, Flynn A 2014, ‘Victorian subtidal reef monitoring program: the reef biota at Beware Reef Marine Sanctuary’, Parks Victoria Technical Series No. 88, Melbourne, Victoria.
 123. Davis S, Pritchard K, Edmunds M 2011, ‘Victorian subtidal reef monitoring program: the reef biota at Bunurong Marine National Park’, Parks Victoria Technical Series No. 84, Melbourne, Victoria.
 124. Edmunds M, Brown H, Woods B 2014, ‘Victorian subtidal reef monitoring program: the reef biota at Eagle Rock Marine Sanctuary’, Parks Victoria Technical Series No. 89, Melbourne, Victoria.
 125. Woods B, Edmunds M 2013, ‘Victorian subtidal reef monitoring program: the reef biota at Merri Marine Sanctuary’, Parks Victoria Technical Series No. 87, Melbourne, Victoria.

126. McArthur M, Smith A, Davis, S, Edmunds M, Pritchard K 2011, ‘Victorian subtidal reef monitoring program: the reef biota at Marengo Reefs Marine Sanctuary’, Parks Victoria Technical Series No. 85, Melbourne, Victoria.
 127. Woods B, Edmunds M and Brown H 2014, ‘Victorian Subtidal Reef Monitoring Program: The reef biota at Point Addis Marine National Park, June 2013’, Parks Victoria Technical Series No. 94, Melbourne, Victoria.
 128. McArthur M, Smith A, Davis, S, Edmunds M, Pritchard K 2011, ‘Victorian subtidal reef monitoring program: the reef biota at Marengo Reefs Marine Sanctuary’, Parks Victoria Technical Series No. 85, Melbourne, Victoria.

Indicator	Status				Trend	Data quality
	UNKNOWN	POOR	FAIR	GOOD		
MC:10 Macroalgae-dominated subtidal reefs	 OMAC		 NPPB	 SPPB MNPS	OMAC ? NPPB ? MNPS ? SPPB ↘	 DATA QUALITY Good - SPPB & MNPS  DATA QUALITY Poor - NPPB & OMAC

Data Custodian PV Reef Life Survey

Rationale

Macroalgal communities on subtidal reefs provide shelter, nursery and feeding areas for reef fish and other marine species. Broken stems washed ashore form beach wrack that is used as food for invertebrates living on beaches and mudflats, which in turn become food for migratory and resident shorebirds. Changes in the condition of macroalgal beds can have broad implications for marine and coastal species.

cover has declined. Along the bay’s east coast, species richness and diversity have fluctuated at Ricketts Point Marine Sanctuary, but algal cover has declined.

Most reefs in the north are low-wave energy and have been permanently changed by purple sea urchins (*H. erythrogramma*) and the highly-invasive Japanese kelp (*Undaria pinnatifida*), which exploits the disturbance caused by the urchins.¹³¹ Their ecological status is highly variable and trends are currently unknown.

Summary

Port Phillip Bay

Parks Victoria’s Subtidal Reef Monitoring Program has demonstrated that reefs in the Port Phillip Heads Marine National Park are healthy – with the exception of decreasing numbers of seastars. Anecdotally, *Undaria* and kelp dieback disease is an increasing risk in the south – and potentially other pests and diseases are too.¹²⁹

At Point Cooke Marine Sanctuary,¹³⁰ a macroalgal cover of common kelp (*Macrocystis pyrifera*) has been replaced by purple sea urchin (*Heliocidaris erythrogramma*) barrens, coralline algae and filamentous brown algae, possibly due to changes in water quality and catchment inputs that have led to reduced nutrients and restrictions on kelp growth. However, at Jawbone Marine Sanctuary, there are no trends in species abundance richness and diversity although common kelp (*M. pyrifera*)

Other Marine and Coastal Areas

The subtidal reef biota (macroalgae, invertebrates and fish) for a number of marine national parks and sanctuaries (and reference sites outside) were surveyed between 2011 and 2013, with the results compared with earlier surveys and published in Park’s Victoria’s Technical Report Series.¹³²

Although the cover of crayweed (*Phyllospora comosa*) had declined in Cape Howe Marine National Park, algal species richness and diversity had increased with greater abundance of smaller understory species.¹³³ Algal species richness fluctuated at Beware Reef, while algal assemblages were little changed. However, common kelp (*M. pyrifera*) abundance declined, while bull kelp (*Durvillaea potatorum*) cover increased.¹³⁴







129. CES 2016, ‘State of the Bays 2016’, Melbourne, Victoria.
 130. Woods B, Donnelly, Edmunds M 2013, ‘Victorian subtidal reef monitoring program: the reef biota at Point Cooke Marine Sanctuary’, Parks Victoria Technical Series No. 99, Melbourne, Victoria.

131. CES 2016, ‘State of the Bays 2016’, Melbourne, Victoria.
 132. The survey reports can be found at <https://parkweb.vic.gov.au/park-management/environment/research-and-scientific-management/technical-series2> Accessed 4 December 2018.
 133. Edmunds M, Woods B 2014, ‘Victorian subtidal reef monitoring program: the reef biota at Cape Howe Marine National Park’, Parks Victoria Technical Series No. 99, Melbourne, Victoria.
 134. Edmunds M, Hallein E, Flynn A 2014, ‘Victorian subtidal reef monitoring program: the reef biota at Beware Reef Marine Sanctuary’, Parks Victoria Technical Series No. 88, Melbourne, Victoria.

Macroalgae abundance remained high in Wilsons Promontory¹³⁵ and Bunurong¹³⁶ marine national parks, while species richness and diversity were high at Point Addis Marine National Park,¹³⁷ although there was a substantial loss of common kelp (*M. pyrifera*) by the end of the survey period. The abundance, richness and diversity of macroalgal species was stable throughout the survey period in Eagle Rock Marine Sanctuary,¹³⁸ while there were no clear trends in Marengo Reefs¹³⁹ and Merri¹⁴⁰ marine sanctuaries.

The condition of brown algae communities on subtidal reefs has been assessed in Parks Victoria draft control charts for marine national parks and sanctuaries. On subtidal reefs the assessment revealed them to be in 'good' condition in 14 parks and 'fair' in 30.

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135. Woods B, Donnelly D, Edmunds M 2014, 'Victorian subtidal reef monitoring program: the reef biota at Point Cooke Marine Sanctuary', Parks Victoria Technical Paper Series No. 93, Melbourne, Victoria.
 136. Davis S, Pritchard K, Edmunds M 2011, 'Victorian subtidal reef monitoring program: the reef biota at Bunurong Marine National Park', Parks Victoria Technical Series No. 84, Melbourne, Victoria.
 137. Woods B, Edmunds M, Brown H 2014, 'Victorian subtidal reef monitoring program: the reef biota at Point Addis Marine National Park', Parks Victoria Technical Series No. 94, Melbourne, Victoria.
 138. Edmunds M, Brown H, Woods B 2014, 'Victorian subtidal reef monitoring program: the reef biota at Eagle Rock Marine Sanctuary', Parks Victoria Technical Series No. 89, Melbourne, Victoria.
 139. McArthur M, Smith A, Davis, S, Edmunds M, Pritchard K 2011, 'Victorian subtidal reef monitoring program: the reef biota at Marengo Reefs Marine Sanctuary', Parks Victoria Technical Series No. 85, Melbourne, Victoria.
 140. Woods B, Edmunds M 2013, 'Victorian subtidal reef monitoring program: the reef biota at Merri Marine Sanctuary', Parks Victoria Technical Series No. 87, Melbourne, Victoria.

Indicator	Status				Trend	Data Quality
	UNKNOWN	POOR	FAIR	GOOD		
MC:11 Macroalgae on intertidal reefs	 OMAC			 PPB MNPS	OMAC ? PPB → MNPS →	 DATA QUALITY Good - PPB & MNPS  DATA QUALITY Poor - OMAC
<p>Data Custodian PV Intertidal Reef Monitoring Program; Sea Search/Museum of Victoria ad-hoc surveys</p>						

Rationale

Macroalgae are an important source of food and shelter for many marine species, and provide shoreline protection. Changes in this intertidal community may be a sign of other changes occurring in the marine environment that require management action.

Other Marine and Coastal Areas

The condition of brown algae communities on intertidal reefs has been assessed in Parks Victoria draft control charts for marine national parks and sanctuaries. The communities were assessed as being in 'good' condition in five parks, 'fair' in six parks and 'poor' in one park.

Summary

Port Phillip Bay

Neptune's necklace (*Hormosira banksii*) is an intertidal algae that forms large beds and habitats for macroinvertebrate grazers, predators, scavengers and microfauna. Data for macroalgae, sessile and mobile invertebrate indicators from the Intertidal Reef Monitoring Program indicate these reef communities have remained in 'good' condition since 2003, with *H. banksii* cover increasing steadily since 2009.¹⁴¹ However, water quality is an issue for intertidal habitats near Point Cooke Marine Sanctuary and Boags Rocks, close to the Eastern and Western treatment plants, in Hobsons Bay (affecting Jawbone Marine Sanctuary), along the bay's north-eastern shoreline (affecting Ricketts Point Marine Sanctuary) and stormwater inflows.

141. CES 2016, 'State of the Bays 2016', Melbourne, Victoria.






Seabirds, Shorebirds and Waterbirds

Seabirds, shorebirds and waterbirds are the most visible elements of marine and coastal animal life. Albatrosses, pelicans, penguins, spoonbills, sandpipers, hooded plovers and other birds rely on healthy marine and coastal environments, some for feeding and others for breeding. Trends in their numbers and distribution can provide important data for agencies responsible for habitat management and species conservation.

Reduced bird numbers may indicate a change in the availability of prey species, perhaps due to fishing pressure, climate change or catchment-based water pollution. Declining populations may also suggest the loss or degradation of their habitat in Victoria or elsewhere. Conserving their habitat in Victoria can provide refuges for bird species suffering habitat loss in other parts of their range.

To support the conservation of threatened international migratory species that visit each year, Australia has signed a number of international agreements that it must uphold, while resident threatened birds are listed under various statutes that require species conservation measures.

This section reviews indicators for migratory shorebirds, penguins, fish-eating birds and waterbirds.

Indicator	Status				Trend	Data Quality
	UNKNOWN	POOR	FAIR	GOOD		
MC:12 Migratory shorebirds Data Custodian DELWP Biodiversity; Birdlife Australia; Victorian Wader Studies Group					OMAC ↓ PBB ↓ CI ↓	 DATA QUALITY Fair - PPB & C I & OMAC

Rationale

Measuring trends in the distribution and abundance of migratory shorebirds can assist federal and state agencies and community organisations to protect habitats and minimise threats.

Summary

Port Phillip Bay

Since 1981, red-necked stint (*Calidris ruficollis*), curlew sandpipers (*Calidris ferruginea*) and sharp-tailed sandpipers (*Calidris acuminata*) have been counted during high tide twice a year at eight coastal sites in Port Phillip Bay. Their numbers are declining in-line with populations throughout the world over the past 20 years, largely due to the development and reclamation of intertidal flats in Asia, especially the Yellow Sea. However, periods of drought and high rainfall can cause variations in wetland coverage and affect shorebird distribution in Australia (for example, there were fewer sharp-tailed sandpipers (*C. acuminata*) on the intertidal areas of Port Phillip Bay, reflecting their movement to inland areas after drought).¹⁴²

Corner Inlet

A review of 30 years of data (1981–2011) for migratory shorebird numbers in Corner Inlet and Nooramunga revealed a decline of 23% in the combined numbers of all species, down from 35,000–40,000 to 25,000–30,000.¹⁴³ Ten species

declined, one increased and five showed no significant change. Although there was uncertainty on the causes, the authors suggested that habitat loss along the birds' flyway could be the main factor.







Other Marine and Coastal Areas

Birdlife Australia data¹⁴⁴ on numbers of the red-necked stint (*C. ruficollis*), curlew sandpipers (*C. ferruginea*) and sharp-tailed sandpipers (*C. acuminata*) along coastal areas (counts also include inland areas) show considerable fluctuations from year to year since the 1980s and 1990s but also quite low numbers. Red-necked stint (*C. ruficollis*) numbers in East Gippsland peaked in 1999 but have since declined, while on the Bass Coast the peak occurred in 2013 before a decline. The Bellarine Peninsula has the highest numbers. For the eastern curlew (*Numenius madagascariensis*), counts are higher along the east coast than the west, with increased sightings in East Gippsland and the Bass Coast. Short-tailed shearwater (*Ardenna tenuirostris*) counts have increased on the Bellarine Peninsula and Bass Coast, with fluctuating counts elsewhere. However, the most recent data indicates that each species has experienced reductions in sightings in the past few years.

Rising sea levels and reduced intertidal areas, as well as incremental losses from coastal development, could reduce the available habitat for shorebirds and lead to reductions in their numbers in Victoria.

142. Loyn RH, Rogers DI, Swindley RJ, Stamation K, Macak P, Menkhorst P 2014, 'Waterbird monitoring at the Western Treatment Plant, 2000–12: the effects of climate and sewage treatment processes on waterbird populations', Arthur Rylah Institute for Environmental Research Technical Report Series No. 256, Heidelberg, Victoria.
 143. Minton C, Dann P, Ewing A, Taylor S, Jessop R, Anton P, Clemens R 2012, 'Trends of shorebirds in Corner Inlet, Victoria, 1982–2011', *Stilt*, 61, pp. 3–18.

144. Birdlife Australia, <https://birddata.birdlife.org.au> Accessed 4 December 2018.

Indicator	Status				Trend	Data Quality
	UNKNOWN	POOR	FAIR	GOOD		
MC:13 Little penguins					OMAC ? STK → PI →	 <p>DATA QUALITY Good STK & PI</p>  <p>DATA QUALITY Poor OMAC</p>
<p>Data Custodian Phillip Island Nature Park/ Earthcare St Kilda</p>						

Rationale

The health of little penguin (*E. minor*) colonies in terms of numbers, breeding success and body weight can indicate trends in the general health of the marine environment. Little penguin colonies at Phillip Island and St Kilda have also become major tourist assets, with any decline in their health having potential economic impacts.

Summary

Phillip Island

The numbers of little penguins (*E. minor*) at the Phillip Island Nature Park rose and fell during the 1980s and 1990s but suffered a significant reduction in 1995 and 1998 after pilchard stocks were possibly decimated by a disease originating in fish meal used in tuna farms off the South Australian coast.¹⁴⁵ In recent years, penguin numbers have risen to 32,000 breeding adults.

St Kilda Harbour Breakwater

Penguins first appeared at the St Kilda Harbour breakwater in 1960, but nesting birds were not seen for another two to three years. Since then penguin numbers have steadily grown and are now estimated at 1,400. Volunteers from the local community group, Earthcare St Kilda, have for many years monitored the colony (including microchipping of birds and measuring their weight) and acted as guides for the many people who visit the colony each night. From 2007 to 2017,

volunteers microchipped 1,411 chicks, of which 522 returned to the colony- a return rate of least 36%. Monash University has also carried out surveys at the colony. As penguin numbers have grown, the colony has spread further along the breakwater.







Tourism sector promotion has encouraged more people to visit each night, increasing pressure on the colony. On winter nights there are 200 to 400 visitors, growing to 600 in summer and totalling approximately 140,000 per year.¹⁴⁶ Between 2013–14 and 2016–17, volunteers collected 6 km of fishing line and 372 hooks, as well as 2,500 kg of litter.¹⁴⁷ Penguin entanglements with recreational fishing lines and hooks and the presence of litter in burrows has also been reported, while the use of flash photography by tourists is also an ongoing problem impacting on the health of the penguin colony.

Other Marine and Coastal Areas

The Phillip Island and St Kilda penguin colonies are only two of more than twenty along the Victorian coast. Others include Lawrence Rocks, Deen Maar, Middle and Merri islands, the islands off Wilsons Promontory, and Gabo Island (the world’s largest known colony with 15,000–20,000 pairs).¹⁴⁸ Penguin surveys have been carried out at Gabo Island, at a small colony (68–70 active nests¹⁴⁹) at London Bridge (Port Campbell) and around Wilsons Promontory, but there is no systematic monitoring of the small-island colonies.

145. Ward TM, Hoedt F, McLeay L, Dimlich WF, Kinloch M, Jackson G, McGarvey R, Rogers PJ, Jones K 2001, 'Effects of the 1995 and 1998 mass mortality events on the spawning biomass of sardine, *Sardinops sagax*, in South Australian waters', *ICES Journal of Marine Science*, 58, pp. 865–875.

146. Earthcare St Kilda 2018, 'Penguin report 2016-17', St Kilda, Victoria.
 147. Ibid
 148. Birdlife International 2018, 'Data Zone', <http://datazone.birdlife.org/site/factsheet/gabo-and-tullaberga-islands-iba-australia/text> Accessed 4 December 2018.
 149. Berlincourt M, Arnould J 2014, 'At-sea associations in foraging little penguins', *PLoS ONE* 9(8), e105065.doi:10.1371/journal.pone.0105065 Accessed 4 December 2018

Indicator	Status				Trend	Data Quality
	UNKNOWN	POOR	FAIR	GOOD		
MC:14 Piscivorous (fish-eating) birds	 OMAC			 CI WPT	OMAC ? CI ↗ WPT ↘	 DATA QUALITY Good CI & WPT
						 DATA QUALITY Poor OMAC

Data Custodian ARI, Birdlife Australia; Deakin University

Rationale

Population numbers and trends in fish-eating birds can assist agencies in monitoring and management.

Summary

Western Port and West Corner Inlet

Trends in the numbers of piscivorous waterbirds have been assessed in Western Port from 1974, and in West Corner Inlet since 1987.¹⁵⁰ There were opposing population trends for each location, with terns (*Hydroprogne caspia*, *Thalasseus bergii*, *Sternula nereis* and *Sternula albifrons*), cormorants (*Phalacrocorax carbo*, *Phalacrocorax varius*, *Phalacrocorax sulcirostris*, *Microcarbo melanoleucos*, and *Phalacrocorax fuscescens*) and the Australian pelican (*Pelecanus conspicillatus*) decreasing at Western Port, while increasing in West Corner Inlet. Reduced tern numbers, especially for the crested (*T. bergii*) and fairy terns (*S. nereis*), accounted for most of the Western Port decline, most likely due to their reduced use of the bay for feeding, as breeding numbers increased substantially at its western entrance. The results suggest that feeding conditions for terns (and to a lesser extent for cormorants and pelicans) in Western Port have deteriorated compared with feeding conditions in West Corner Inlet.







Other Marine and Coastal Areas

The abundance, distribution and diversity of seabirds on 15 of Wilsons Promontory's offshore islands were surveyed in a Parks Victoria project.¹⁵¹ The results indicated that there were an estimated 839,034 short-tailed shearwaters (*A. tenuirostris*), 26,146 little penguins (*E. minor*), 19,025 common diving petrels (*Pelecanoides urinatrix*) and 4,082 fairy prion (*Pachyptila turtur*) breeding pairs in the region. Previous abundances for most species are not available; however, for the short-tailed shearwater, the estimated number of breeding pairs represents a decline of 36%.

However, there is insufficient data here and elsewhere to determine status and trends in other marine and coastal areas.

150. Menkhorst PW, Loyn RH, Liu C, Hansen B, Mackay M, Dann P 2015, 'Trends in numbers of piscivorous birds in Western Port and West Corner Inlet, Victoria, 1987–2012', Arthur Rylah Institute for Environmental Research, Unpublished client report, Heidelberg, Victoria.

151. Parks Victoria 2018, 'Seal and seabird research', <http://parkweb.vic.gov.au/park-management/environment/research-and-scientific-management/marine-research2/seal-and-seabird-research> Accessed 4 December 2018.

Indicator	Status				Trend	Data Quality
	UNKNOWN	POOR	FAIR	GOOD		
MC:15 Marine and coastal Waterbirds	 OMAC PPB		 WPT GLA		OMAC ? WPT ↓ PPB ? GLA (Trend depends on species)	 DATA QUALITY Good WPT & GLA  DATA QUALITY Poor OMAC & PPB
Data Custodian Birdlife Australia (Western Port Waterbird Survey)/DELWP						

Rationale

Maintaining a robust set of time-series data on waterbird numbers can assist agencies in monitoring and management.

1 species each of grebe, gull and heron.¹⁵³ The decline in waterbirds reflects diminishing wetland availability, local reductions in fish prey, increased predation pressure and changes in inland wetland resources.¹⁵⁴

Summary

Port Phillip Bay

Melbourne Water’s 2003 *Environment Improvement Plan for the Western Treatment Plant* aimed to reduce nutrient loads to the bay. A 12-year survey¹⁵² to determine whether this would impact waterfowl numbers concluded that they were more influenced by season and climate than actions to reduce nutrient discharges. There was an observed small declining trend in waterfowl numbers from 2000 to 2012 (mainly filter-feeding and diving ducks and coot). Ibis numbers dropped after the breaking of the millennium drought but the beginnings of a recovery were observed. The numbers of nesting pied cormorants doubled between 2002–2003 and 2010–2012.

Gippsland Lakes

The number of waterbirds in the Gippsland Lakes is related to a range of factors, including the availability of suitable habitat throughout their range in eastern Australia, which is quite variable in response to changes in rainfall. Although complete counts of waterbirds are not carried out across the larger expanse of the Gippsland Lakes, available data from the past five years record 79 waterbird species, 6 fewer than previously recorded.¹⁵⁵ The *Gippsland Lakes Condition Report* has assessed waterbird diversity (species richness) as ‘fair’, while there is insufficient data to assess waterbird abundance in the different functional groups, including fish-eating species, ducks, herbivores and waders.

Western Port

A 40 year study measuring trends in waterbird numbers in Western Port, that of 39 species (including 10 shorebirds), 22 species had declined, including four species of duck, five species of fish-eating bird (cormorants, terns and pelicans),

Other Marine and Coastal Areas

There is insufficient data to assess status and trends.

152. Loyn RH, Rogers DI, Swindley RJ, Stamation K, Macak P, Menkhorst P 2014, ‘Waterbird monitoring at the Western Treatment Plant, 2000–12: the effects of climate and sewage treatment processes on waterbird populations’, Arthur Rylah Institute for Environmental Research Technical Report Series No. 256, Heidelberg, Victoria.

153. Hansen BD, Menkhorst P, Moloney P, Loyn RH 2015, ‘Long-term declines in multiple waterbird species in a tidal embayment, south-east Australia’, *Austral Ecology*, 40(5), pp. 515–527.

154. Ibid

155. East Gippsland Catchment Management Authority, ‘State of the Gippsland Lakes: Technical Report’, (*Publication pending*).

Pressures

Victoria's marine and coastal environments face many pressures. Major have been outlined at the beginning of this chapter. They include coastal and catchment development, population growth, water pollution, fisheries, invasive and overabundant species, and climate change. This section assesses a brief list of pressure indicators, which could be reviewed and expanded on for the *State of the Marine and Coastal Environment 2021* report. The *State of the Bays 2016* report included a number of water quality indicators for Port Phillip Bay and Western Port. These have not been reproduced here.

Indicator	Status				Trend	Data quality
	UNKNOWN	POOR	FAIR	GOOD		
MC:16 Over-abundant sea urchins on subtidal reefs					OMAC ? NPPB ↘ BRMS ? SPPB → NMCP →	 DATA QUALITY Fair - SPPB, BRMS & NMCP NPPB DATA QUALITY Poor OMAC
	OMAC	NPPB	BRMS	SPPB NMCP		

Data Custodian PV and Reef Life Survey, Melbourne University and Fisheries Victoria also undertook a one-off snapshot monitoring exercise (2014).

Rationale

The monitoring of overabundant native sea urchins, which create urchin barrens, is critical to ensure management responses are effective in their control.

Summary

Port Phillip Bay

Grazing by increased numbers of the native purple sea urchin (*H. erythrogramma*) has led to a 90% reduction of kelp in Port Phillip Bay’s marine sanctuaries.¹⁵⁶ In March 2018, Parks Victoria, Deakin University and volunteer citizen scientists culled the urchins in Point Cooke and Jawbone Marine Sanctuaries. If successful, the culling program will be expanded to other areas in the bay. These sea urchins are not as abundant in the bay’s south.

Nooramunga Marine and Coastal Park

Thousands of purple sea urchins (*H. erythrogramma*) invaded meadows of the broadleaf *Posidonia australis* seagrass (important feeding, breeding and nursery areas for marine life) and created large areas of bare sand.¹⁵⁷ Parks Victoria staff, officers from the Victorian Fisheries Authority and volunteers used hammers to smash 57,000 urchins by hand in 2017. Parks Victoria has also worked with the Victorian Fisheries Authority and Seafood Industry Victoria to establish a short-term urchin fishery to help manage overabundant native urchins.

Other Marine and Coastal Areas

Urchins are also found in Beware Reef Marine Sanctuary, Cape Howe and Point Hicks marine national parks and the reefs outside their boundaries. Urchin culling was carried out early in 2018 by Parks Victoria staff in partnership with Friends of Beware Reef.¹⁵⁸ A native animal impact management plan has been prepared by Parks Victoria and further urchin management and monitoring is planned.

156. Deakin University 2018, 'Sea urchin cull in Port Phillip Bay to help restore kelp forests', Media release, 15 March 2018, Deakin University, Geelong, Victoria.
 157. Parks Victoria 2017, 'Seagrass meadows saved from sea urchin attack', Media release 28 July 2017, Melbourne, Victoria.

158. Parks Victoria 2018, 'United against the urchin front in East Gippsland', Media release, 16 May 2018, Melbourne, Victoria.

Indicator	Status				Trend	Data Quality
	UNKNOWN	POOR	FAIR	GOOD		
MC:17 Invasive marine species					OMAC ? PPB ↓	 DATA QUALITY Fair PPB DATA QUALITY Poor OMAC

Data Custodian DELWP Biodiversity; DEDJTR Biosecurity and Agriculture Services; PV

Rationale

Invasive marine species can change the ecology of areas affected. Monitoring is critical to determine whether their range is expanding, with new incursions requiring rapid management responses.

Summary

Port Phillip Bay

More than 160 introduced marine species are now resident in Port Phillip Bay. Those of greatest concern are the northern Pacific seastar (*Asterias amurensis*), European fan worm (*Sabella spallanzanii*), European green shore crab (*Carcinus maenas*), Japanese kelp (*Undaria pinnatifida*), New Zealand screw shell (*Maoricolpus roseus*) and the Pacific oyster (*Crassostrea gigas*).

Experiments manipulated the density of the European fan worm (*S. spallanzanii*) to determine its ecological impacts in Port Phillip Bay, with results showing changes in the composition of macrofauna in the surrounding sediments, providing habitat for epibiota (both fauna and flora) on *Sabella* tubes, and a reduction in the biomass of microphytobenthos on the surrounding sediments. Of greatest concern was the indirect impact on nutrient cycling.¹⁵⁹

The northern Pacific seastar (*A. amurensis*) was shown to have caused changes in fish populations in Port Phillip Bay, principally among fish species that feed on molluscs and polychaetes in areas where *A. amurensis* densities were highest.¹⁶⁰ The fish species impacted were the eastern shovelnose

stingaree (*Trygonoptera imitata*), southern eagle ray (*Myliobatis australis*) and globefish (*Diodon nicthemerus*).

Parks Victoria has studied *Undaria pinnatifida* in the marine sanctuaries of Port Phillip Bay and reported that eradication efforts have little impact on the kelp's overall abundance. The analysis also concluded that there was little evidence that the kelp had an ecological effect.¹⁶¹ The influences on *U. pinnatifida* abundance included urchin-grazing levels, the cover of canopy-forming algae, and wave and nutrient regimes.

Other Marine and Coastal Areas

Few areas along the Victorian coast have been surveyed for marine pests, but there has been a number of outbreaks beyond Port Phillip Bay:

- *U. pinnatifida* to Apollo Bay Harbour and Port Welshpool
- *A. amurensis* in San Remo, Inverloch (now eradicated), Waratah Bay, Tidal River (Wilson's Promontory) and Port Welshpool¹⁶²
- *S. spallanzanii* at Portland Harbour
- *C. gigas* in Western Port and the Gippsland Lakes.

A. amurensis has expanded its range due to anthropogenic factors such as translocation on vessels and larval dispersal, which have enabled its spread along the east coast of Victoria.¹⁶³

159. Ross J, Longmore A, Keough M 2013, 'Spatially variable effects of a marine pest on ecosystem function', *Oecologia*, 172(2), pp. 525-538.

160. Parry G, Hirst A 2015, 'Decadal decline in demersal fish biomass coincident with a prolonged drought and the introduction of an exotic starfish', *Marine Ecology Progress Series* 544, pp. 37-52.

161. Crockett P, Johnson K, Brenker M, Ierodiaganou D, Carnell P 2017, 'Undaria pinnatifida in Port Phillip Bay marine sanctuaries: removal strategies and interactions with the native algal canopy', Parks Victoria Technical Series No. 113, Melbourne, Victoria.

162. Parks Victoria 2018, 'Marine pests', Melbourne, Victoria <http://parkweb.vic.gov.au/park-management/environment/weeds-and-pests/marine-pests> Accessed 4 December 2018.

163. Richardson MF, Sherman CDH, Lee RS, Bott NJ, Hirst AJ 2016, 'Multiple dispersal vectors drive range expansion in an invasive marine species', *Molecular Ecology*, 25(20), pp. 5001-5014.

Indicator	Status				Trend	Data Quality
	UNKNOWN	POOR	FAIR	GOOD		
MC:18 Catchment inputs into coastal waters/ reefs					WPT ? GCMA ?	 DATA QUALITY Good - PPB & WPT & CMAs
		WPT GCMA	PPB CCMA WGCMA	EGCMA	PPB ↗ CCMA ? WGCMA ? EGCMA ?	
Data Custodian DELWP Catchments, Waterways, Cities and Towns; EPA Victoria						

Rationale

Sediments and other pollutants discharged from catchments into bays, estuaries and the open coast can severely impact water quality, with implications for marine life as well as the health of people engaged in water-based recreational activities. Regular monitoring can detect changes requiring management and planning responses.

Summary

Port Phillip Bay and Western Port

EPA Victoria has been producing report cards on the catchments of Port Phillip Bay and Western Port since 2012–13,¹⁶⁴ based on a water-quality index that combines the results from EPA Victoria’s monitoring sites. The report cards from 2012–13 to 2016–17 for Port Phillip Bay (five catchments discharge into the bay) have been summarised. (In general, the catchments with ‘very good’ and ‘good’ ratings are forested upper catchments, those with ‘fair’ ratings are in rural areas in the middle of the catchments, and those rated ‘poor’ to ‘very poor’ are in the lower reaches of rivers and creeks that flow through urban areas, especially small urban tributaries. However, when assessing the water-quality index at six monitoring sites within Port Phillip Bay’s waters, 19.6% of bay waters were rated as ‘very good’ (central bay to

the entrance), and 80.4% as ‘good’ (Hobsons Bay and eastern and western shores). No areas of the bay were rated as either ‘fair’, ‘poor’ or ‘very poor’ (and includes the 2016–17 Western Port catchment for comparison). For each year, the water quality index is separated into five ratings, based on water data collation and analysis, with an overall score presented as a percentage. The overall score combines the results of a number of standard water quality parameters: nutrients, water clarity, dissolved oxygen, salinity, pH, metals and algae. During this period, the combined ‘poor’ and ‘very poor’ ratings have changed little, although a greater percentage of the catchments were rated as ‘very poor’ (see Table MC.2 for ratings definition). The ‘good’ to ‘very good’ ratings have been relatively stable. In 2016–17 the combined ‘good’ to ‘very good’ rating for Port Phillip Bay was much higher than that for Western Port. EPA Victoria reported that ‘water quality in Port Phillip Bay had improved since 2002’.¹⁶⁵

In general, the catchments with ‘very good’ and ‘good’ ratings are forested upper catchments; those with ‘fair’ ratings are in rural areas in the middle of the catchments; and those rated ‘poor’ to ‘very poor’ are in the lower reaches of rivers and creeks that flow through urban areas, especially small urban tributaries. However, when assessing the water quality index at six monitoring sites within Port Phillip Bay’s waters, 19.6% of bay waters were rated as ‘very good’ (central bay to the entrance), and 80.4% as ‘good’ (Hobsons Bay and eastern and western shores). No areas of the bay were rated as either ‘fair’, ‘poor’ or ‘very poor’.

164. EPA 2018, ‘Port Phillip Bay, Western Port and Gippsland Lakes report cards’, <https://yarraandbay.vic.gov.au/report-card> Accessed 4 December 2018.

165. EPA 2018, ‘Port Phillip Bay report card for July 2016–June 2017’, https://yarraandbay.vic.gov.au/report-card/report-card-2017/port-philip/port-philip-bay#top_of_report Accessed 4 December 2018.

Table MC.1 Water-quality report card for Port Phillip Bay and its catchments, 2012–13 to 2016–17, with a comparison to Western Port for 2016–17¹⁶⁶

Water quality index rating	2012–13	2013–14	2014–2015	2015–16	2016–17	2016–17
	Port Phillip Bay	Port Phillip Bay	Port Phillip Bay	Port Phillip Bay	Port Phillip Bay	Western Port
	%	%	%	%	%	%
Very good	13.0	17.0	15.0	9.0	5.0	18.4
Good	20.0	24.0	25.0	26.0	32.8	2.9
Fair	29.0	21.0	21.0	25.0	22.4	40.4
Poor	15.0	23.0	8.0	12.0	9.0	22.6
Very poor	23.0	15.0	31.0	28.0	30.8	15.7

Table MC.2 EPA report card ratings and their descriptions

Rating	Description
Very good	Near-natural high-quality waterways
Good	Meets Victorian water-quality standards
Moderate	Some evidence of stress
Poor	Under considerable stress
Very Poor	Under severe stress

166. EPA 2018, 'Port Phillip Bay, Western Port and Gippsland Lakes report card', <https://yarraandbay.vic.gov.au/report-card> Accessed 4 December 2018.

Other Marine and Coastal Areas

The *Catchment Condition and Management Report 2017* from the Victorian Catchment Management Council (VCMC) assessed catchment condition across the state. The assessment presented here is only for the five regional catchments with coastal boundaries (see Table MC.3 Assessment of catchment condition for the five catchments with coastal boundaries by the Victorian Catchment Management Council).¹⁶⁷ This assessment is based on qualitative information drawn from the *Catchment Condition and Management Report 2017* and annual reports generated by each Catchment Management Authority for the past five years. Condition is rated on a three-point scale as 'good', moderate' or 'poor' for the years 2012 to 2016. The Glenelg Hopkins catchment rated 'poor' on water, biodiversity and coasts, while the Port Phillip and Western Port catchments were rated 'poor' on land and water, and East Gippsland received 'good' ratings for all but the coasts, which rated 'moderate'.

The report also analysed trends in catchment condition and catchment management. It concluded that between 1997 and 2017, catchment condition for land, biodiversity and coasts was 'declining' while for water it was 'stable'. Catchment management trends were positive for land and biodiversity, highly positive for water and neutral for coasts. The low ratings for biodiversity included

impacts of settlement, weather variability and climate change, continuing native vegetation loss, and the impacts of pest plants and animals.¹⁶⁸

A study of 14 Victorian estuaries showed that increased inorganic nitrogen loading from rivers was reflected in increased dominance of macroalgae over seagrass.¹⁶⁹ These findings underscore the critical role of catchment-derived nitrogen in contributing to primary producer communities and support the growing consensus that nitrogen loads (in addition to phosphorous) must be managed to effectively alleviate eutrophication in estuaries.¹⁷⁰

An analysis of eutrophication processes in estuaries compared the percentage of fertilised land within a catchment, dissolved inorganic nitrogen loads, catchment-to-estuary area ratio and flushing time as predictors of the proportion of macroalgae to total vegetation within 14 estuaries in south-eastern Australia.^{171,172,173} Results found that when the fertilised land in a catchment exceeded 24% of its area, macroalgae became dominant in estuaries.

In Corner Inlet, declines in seagrass, the key fish habitat, was intrinsically linked with the activities in the broader region through catchment runoff and addition of excess nutrients and sediments from land.¹⁷⁴

Table MC.3 Assessment of catchment condition for the five catchments with coastal boundaries by the Victorian Catchment Management Council¹⁷⁵

Regional catchment	Land	Water	Biodiversity	Coasts
Glenelg Hopkins	Moderate	Poor	Poor	Poor
Corangamite	Moderate	Moderate	Moderate	Moderate
Port Phillip and Western Port	Poor	Poor	Moderate	Moderate
West Gippsland	Moderate	Moderate	Moderate	Moderate
East Gippsland	Good	Good	Good	Moderate

167. Victorian Catchment Management Council 2017, 'Catchment condition and management report', Melbourne, Victoria.

168. Ibid

169. Woodland RJ, Thomson JR, Mac Nally R, Reich P, Evrard V, Wary FY, Walker JP, Cook PLM 2015, 'Nitrogen loads explain primary productivity in estuaries at the ecosystem scale,' *Limnology and Oceanography*, 60(5), pp.1751-1762.

170. Ibid

171. Cook PLM, Wary FY, Reich P, Mac Nally R, Woodland RJ 2018, 'Catchment land use predicts benthic vegetation in small estuaries', *PeerJ* 6, e4378; DOI 10.7717/peerj.4378 Accessed 4 December 2018.

172. From Wigan Inlet to the Moyne River.

173. Cook PLM, Wary FY, Reich P, Mac Nally R, Woodland RJ 2018, 'Catchment land use predicts benthic vegetation in small estuaries', *PeerJ* 6, e4378; DOI 10.7717/peerj.4378 Accessed 4 December 2018.

174. Ford J, Barclay K, Day R 2016, 'Using local knowledge to understand and manage ecosystem-related decline in fisheries productivity', Fisheries Research and Development Corporation Final Project Report, Melbourne, Victoria.

175. Victorian Catchment Management Council 2017, 'Catchment condition and management report', Melbourne, Victoria.

Indicator	Status				Trend	Data Quality
	UNKNOWN	POOR	FAIR	GOOD		
MC:19 Point source discharges to marine waters						 DATA QUALITY Poor
Data Custodian EPA Victoria						

Rationale

Sediments, litter and other pollutants discharged from stormwater outlets and coastal outfalls can severely impact water quality, with implications for marine life as well as the health of people engaged in water-based recreational activities. Regular monitoring can detect changes requiring management and planning responses.

Summary

The discharges of waste from 18 outfalls, including the Eastern and Western treatment plants, are regularly monitored by the agencies responsible for them, including data collection outside the mixing zones to establish background readings. Each outfall is licensed by EPA Victoria and must satisfy a number of licence conditions and submit an annual performance statement.

The Clean Ocean Foundation has developed a national oceans database that uploads discharge volumes, treatment levels and water-quality data for each outfall around the Australian coast. The base year for data on the website is 2015. The purpose of the database is to address the needs of government and the community to understand the health and environmental impacts that occur from sewerage outfalls around Australia.¹⁷⁶

Total annual discharges from the Victorian outfalls have been estimated at 323 GL, with annual total nitrogen loads of 3,811 tonnes and total phosphorous loads of 2,784 tonnes.¹⁷⁷ By far the two largest daily discharges, with approximate numbers, are at Boags Rock (0.35 GL) and the Werribee Treatment Plant (0.42 GL), followed by Black Rock (0.05 GL), Delray Beach (0.03 GL), McGaurans Beach (0.025 GL) and Warrnambool (0.013 GL). The daily discharges of the remaining outfalls range from 0.00007 GL to 0.003 GL.¹⁷⁸







A partial review of the annual performance statements for some of the outfalls was conducted for this chapter. Except for several odour complaints, each outfall was compliant with licence conditions. However, there is insufficient data to determine status and trends.

There is no data available on point-source stormwater discharges.

176. Clean Ocean Foundation 2018, <http://www.cleanocean.org/national-outfall-database.html> Accessed 4 December 2018.

177. Clean Ocean Foundation 2018, <http://www.cleanocean.org/news/the-national-outfall-database-community-report> Accessed 4 December 2018.

178. Ibid

Indicator	Status				Trend	Data Quality
	UNKNOWN	POOR	FAIR	GOOD		
MC:20 Harmful algae blooms reefs	 OMAC		 PPB GLA		OMAC ? PPB → GLA ?	 DATA QUALITY Good PPB & GLA  DATA QUALITY Poor OMAC

Data Custodian EPA Victoria

Rationale

Algal blooms can be harmful to marine species, ecosystems and human health (primary contact and seafood contamination). Monitoring their characteristics provides data for real-time advice to the community and to help determine management responses that minimise their impact and reduce the likelihood of their occurrence in the future.

Summary

Port Phillip Bay

Marine algae occur naturally in all marine waters and drive food webs. But under the right conditions they can rapidly increase to create an algal bloom. Algal blooms can develop in the days or weeks after heavy rain, particularly during periods of warm, sunny and calm weather. They generally dissipate within a few days and one to two weeks.¹⁷⁹ However, those that occur periodically in Hobsons Bay can produce paralytic shellfish poisoning toxins, which in the past have been at concentrations that could kill anyone who ate mussels from that region.¹⁸⁰

Gippsland Lakes







The Gippsland Lakes are periodically affected by algal blooms that can extend over large areas. There were seven algal blooms in the Gippsland Lakes between 1997 and 2016 but incomplete long-term records make it difficult to determine trends in frequency and extent.¹⁸¹

Other Marine and Coastal Areas

In response to research on the link between seagrass decline and fisheries productivity in Corner Inlet, the West Gippsland Catchment Management Authority stated that there was a clear link between catchment nutrients/sediment, algal blooms and seagrass decline. Prior to this research, there was limited documentation on the type and extent of algal blooms in Corner Inlet. Research has identified two types of blooms, one which appears to be fuelled by nutrients coming from the natural breakdown of seagrass and has been occurring for many decades, and the other fuelled by nutrients originating in the catchment and which is increasing in impact over the past decade. This information is important in informing the ongoing nutrient/sediment reduction work in the catchment and the associated monitoring requirements.¹⁸²

179. CES 2016, 'State of the Bays 2016', Melbourne, Victoria.
180. Australian Associated Press 2002, 'Shellfish warning for Port Phillip Bay', *The Age* 24 December 2002.

181. East Gippsland Catchment Management Authority, 'State of the Gippsland Lakes: Technical Report', (*Publication pending*).
182. Ford J, Barclay K, Day R 2016, 'Using local knowledge to understand and manage ecosystem-related decline in fisheries productivity', Fisheries Research and Development Corporation Final Project Report, Melbourne, Victoria.

Indicator	Status				Trend	Data Quality
	UNKNOWN	POOR	FAIR	GOOD		
MC:21 Enterococci bacteria	 OMAC			 PPB	OMAC ? PPB →	 DATA QUALITY Good PPB  DATA QUALITY Poor OMAC
Data Custodian EPA Victoria						

Rationale

Although *Enterococci* bacteria naturally occur in human intestines, elevated levels in coastal waters indicate faecal contamination and risks for people engaging in water-based recreation.

Summary






Port Phillip Bay

Each summer EPA Victoria monitors weekly *Enterococci* levels at 36 beach locations in Port Phillip Bay. From 2013–14 to 2017–18, water-quality objectives for swimming were met at 94–97% of the 36 Port Phillip Bay beaches monitored. The one beach that failed to meet the objectives by the end of the 2016–17 summer was Mordialloc Beach, which experienced a higher number of days with poor water quality (not the whole season) due to stormwater pollution from Mordialloc Creek. In the past, fewer Melbourne beaches met the objectives due to rainfall events: for example, in 2012 to 2013, only 67% of Melbourne’s beaches met the water quality objectives for swimming.¹⁸³

Other Marine and Coastal Areas

Enterococci bacteria are monitored for some of Victoria’s coastal outfalls, but data is limited.

183. EPA 2017, ‘Beach Report 2016–17 Summer Highlights Report’, Melbourne, Victoria <https://yarragandbay.vic.gov.au/beach-report/2016-17-summer-highlights-report> Accessed 4 December 2018.

Indicator	Status				Trend	Data Quality
	UNKNOWN	POOR	FAIR	GOOD		
MC:22 Impacts of fisheries production					?	 DATA QUALITY Poor
Data Custodian VFA						

Rationale

Assessing the ecological impacts of fisheries on biodiversity, ecological communities and ecosystem health can contribute to assessments of fisheries, ecological sustainability and support marine spatial planning and management.

Summary

Reduced fish populations, bycatch, entanglement of wildlife in discarded fishing gear, vessel impacts and changes to trophic structures are some of the impacts of fishing on marine and coastal environments. But the closure of most commercial fishing in Port Phillip Bay and Western Port, and lower catches elsewhere, has reduced the industry's pressure on fish stocks. Along with fisheries closures, commercial catches have declined due to:

- management responses to reduce pressure on fish stocks
- licence buybacks to improve fishery economic viability
- changes in fisher effort, such as moving to fisheries with better financial returns
- fishing practices and economic drivers
- closure of commercial fishing in bays and inlets to increase opportunities for recreational fishers
- spread of disease - for example abalone viral ganglioneuritis (AVG)
- grazing by overabundant native fauna - for example, sea urchins
- predation by or competition with invasive marine species - for example the northern Pacific seastar.

The fisheries closures will limit future catch data on fish stocks. Regular assessment of the ecological impacts of Victoria's commercial and recreational fisheries will require additional data, and its analysis and public reporting. The return of trawl surveys in Port Phillip Bay would help fill the data gap. A broadening of the recreational fishing surveys and angler diary programs, to open coast waters and include a larger number of participants, would also contribute to a better understanding. A national FRDC-funded project currently under way is considering practical bycatch monitoring and reporting priorities and approaches.¹⁸⁴ Reporting on interactions with protected species is now required for all relevant Victorian commercial fisheries and can inform the 2021 *State of the Marine and Coastal Environment* report.

Currently there is insufficient data to assess the various measures for this indicator.

184. FRDC 2018, 'Guidelines on a tiered, risk-based approach to bycatch management', <http://www.frdc.com.au/project?id=2918> Canberra, Australian Capital Territory.

Conservation in Protected Areas

In its 2017 *Catchment Condition and Management Report*, the VCMC was unable to make any sound assessment of the condition of coasts and marine areas, due to lack of information.¹⁸⁵ The report also noted that for coasts, monitoring of their condition is still very fragmented, focused on specific locations or issues. VCMC has used regional information to make a general assessment of the condition of coasts as 'declining' over the past 20 years.¹⁸⁶

The criterion used by the Council to assess the condition of coasts was mangrove and saltmarsh protection. This statewide report also noted coastal condition assessments made by some of the CMAs with coastal boundaries, which used the level of protection for coasts as their criteria. The Glenelg Hopkins CMA rated its coast as 'generally poor' and coastal vegetation as 'largely fragmented'. For the East Gippsland CMA, its coast was rated as in a 'stable' condition. The Corangamite CMA coast was assessed as 'moderate' to 'good' but in decline.

The VCMC report and the assessments by regional catchment authorities raises the issue of protection levels for mangrove and saltmarsh. In this section, that is broadened to consider the protection status for coastal EVCs and the five marine bioregions.

Assessing the status of the marine conservation estate can be done in several ways. One is to measure the estate against international benchmarks for levels of protection, such as those of the World Summit on Sustainable Development, the Convention on Biological Diversity's Aichi Targets, the Millennium Development Goals (now superseded by the Sustainable Development Goals), or targets established by the World Parks Congress and the IUCN World Conservation Congress. A second way of assessing the status of the marine conservation estate is to measure it

against the CAR Principles of comprehensiveness, adequacy and representativeness (the CAR Principles),¹⁸⁷ which together have provided the foundation for the National Representative System of Marine Protected Areas. The Australian Government, and all states and Northern Territory governments have together committed to its completion.

There have been no new marine or coastal conservation areas proclaimed since the 2008 *State of the Environment* report, and with the exception of cetaceans, seabirds, Australian fur seals and other charismatic fauna, there has been limited monitoring of threatened species within existing areas.

Actions to conserve marine and coastal ecosystems are not confined to protected areas, although they are a most effective way of conserving biodiversity and are the focus of this section. For example, the *Victorian Coastal Strategy 2014* provides guidance for agencies and statutory decision-making along the Victorian coast and in marine environments, with a primary principle to ensure the protection of significant environmental and cultural values. The new *Marine and Coastal Act 2018* and its associated policy and strategy (in preparation) aims to support this. There is a range of management tools that can – and are – used to address threats to the marine habitats, which are important for fishing and other values. These include reducing and intercepting catchment pollution and agricultural runoff; preventing marine pest introductions; giving protection to individual species such as blue groper; and restricting the take of species of stingrays, skates and guitar fish.

185. Victorian Catchment Management Council 2017, 'Catchment condition and management report', Melbourne, Victoria.

186. Ibid

187. ANZECC TFMPA 1998, 'Guidelines for establishing the National Representative System of Marine Protected Areas', Australian and New Zealand Environment and Conservation Council, Task Force on Marine Protected Areas, Canberra, Australian Capital Territory.

Indicator	Status				Trend	Data Quality
	UNKNOWN	POOR	FAIR	GOOD		
MC:23 Conservation of coastal ecosystems in protected areas						 DATA QUALITY Fair
Data Custodian DELWP Biodiversity						

Rationale

By assessing the area and type of coastal ecosystems with formal protection and the degree of protection, it is possible to then determine whether Australia (and Victoria) is meeting international benchmarks for protection and if the protected areas are, according to the principles of the National Representative System of Marine Protected Areas, comprehensive, adequate and representative (CAR).

Summary

The Port Phillip and Westernport CMA identified that between 2004 and 2007, the conservation status of 10 coastal EVCs on the Gippsland Plain bioregion had worsened, and three had improved (see Table MC.5).¹⁸⁸ Data of this kind is unavailable for other bioregions along the coast. Although many coastal EVCs are endangered or vulnerable, only two coastal communities are listed in the *Flora and Fauna Guarantee Act 1995*: coastal moonah woodland (coastal alkaline scrub) and warm temperate rainforest (coastal East Gippsland).

The protection levels for coastal ecological EVCs vary. Those that occur in the Wilsons Promontory bioregions have 100% of what remains in the bioregion protected within the Wilson’s Promontory National Park. However, others on the coastal plains receive far less protection. For example, remaining estuarine wetland has only 7%, 1%, 4% and 0% of its extent in conservation reserves on the Warrnambool Plain, Otway Ranges, Otway Plain and Victorian Volcanic Plain bioregions respectively. Parks Victoria manages around 70% of the Victorian coast as national and state parks

or as coastal reserves. However, analysis indicates that a number of coastal EVCs have limited coverage in protected areas (Table MC.5).

Coastal EVCs that are either vulnerable or endangered in two or more bioregions are coast banksia woodland, coastal saltmarsh, estuarine wetland, coastal headland scrub, coastal tussock grassland, coastal saltmarsh/mangrove shrubland mosaic, coastal alkaline scrub and coast banksia woodland/coastal dune scrub mosaic. Those that have experienced substantial declines in their extent, and which are endangered, vulnerable, depleted or rare with limited protection in conservation areas, are coastal dune scrub/coastal dune grassland mosaic, estuarine wetland, mangrove shrubland, coastal dune scrub, coastal headland scrub, coastal tussock grassland, brackish wetland, coastal alkaline scrub and coast banksia woodland/coastal dune scrub mosaic. These are largely the EVCs of the sand dunes and coastal wetlands. However, of the remaining estuarine wetland in those four bioregions, 23%, 40%, 55% and 17% respectively is on public land with the potential for increased protection. Although coast-specific EVCs have been impacted by changing coastal land use, hinterland EVCs such as woodlands and grasslands that range to the coast have also been impacted (these are not analysed here).

Of the 10 bioregions with coastal boundaries, those where vegetation loss is most pronounced are the Warrnambool Plain (between Portland and Princetown), the Otway Plain (largely from Aireys Inlet to Altona) and the Gippsland Plain (from eastern Melbourne to the Gippsland Lakes).

188. Port Phillip and Western Port CMA 2008, 'Summary of changes to the bioregional conservation status ratings resulting from updated 2007 native vegetation datasets - Port Phillip and Western Port CMA region', http://www.spiffa.org/uploads/2/6/7/5/2675656/native_veg_plan_changes_to_bioregional_conservation_status_ppwcma_region_010208.pdf Accessed 4 December 2018.

Parks Victoria manages around 70% of the Victorian coast as national and state parks or as coastal reserves. However, analysis indicates that a number of coastal EVCs have limited coverage in protected areas (Table MC.5). Coastal EVCs that are either vulnerable or endangered in two or more bioregions are coast banksia woodland, coastal saltmarsh, estuarine wetland, coastal headland scrub, coastal tussock grassland, coastal saltmarsh/mangrove shrubland mosaic, coastal alkaline scrub and coast banksia woodland/coastal dune scrub mosaic. Those that have experienced substantial declines in their extent, and which are endangered, vulnerable, depleted or rare with limited protection in conservation areas, are coastal dune scrub/coastal dune grassland mosaic, estuarine wetland, mangrove shrubland, coastal dune scrub, coastal headland scrub, coastal tussock grassland, brackish wetland, coastal alkaline scrub and coast banksia woodland/coastal dune scrub mosaic. These are largely the EVCs of the sand dunes and coastal wetlands.

Table MC.4 Changes in the conservation status of some Victorian coastal EVCs¹⁸⁹

EVC		Change in conservation status
Conservation status deteriorated		
1	Coastal dune scrub/coastal dune grassland mosaic	Least concern to depleted
12	Wet swale herbland	Rare to vulnerable
160	Coastal dune scrub	Least concern to depleted
163	Coastal tussock grassland	Least concern to vulnerable
858	Coastal alkaline scrub	Depleted to vulnerable
904	Coast banksia woodland/swamp scrub mosaic	Rare to vulnerable
906	Brackish grassland/swamp scrub mosaic	Rare to endangered
909	Coastal dune scrub/bird colony succulent herbland mosaic	Least concern to depleted
934	Brackish grassland	Rare to endangered
935	Estuarine wetland/estuarine swamp scrub mosaic	Least concern to depleted
Conservation status improved		
879	Coastal dune grassland	Endangered to depleted
900	Coastal saltmarsh/coastal dune grassland/coastal dune scrub/coastal headland scrub mosaic	Endangered to vulnerable
922	Coastal alkaline scrub/bird colony succulent herbland mosaic	Endangered to vulnerable

189. Ibid

Indicator	Status				Trend	Data Quality
	UNKNOWN	POOR	FAIR	GOOD		
<p>MC:24 Conservation of marine ecosystems in protected areas</p> <p>Data Custodian DELWP Biodiversity</p>						<p>DATA QUALITY</p> <p>Good</p>
	GLA and East Gippsland Inlets		Five marine bioregions			

Rationale

By assessing the area and type of marine ecosystems with formal protection, it is possible to then determine whether Australia (and Victoria) is meeting international benchmarks for marine protection and if the network is, according to the principles of the National Representative System of Marine Protected Areas, comprehensive, adequate and representative (CAR).

Summary

Parks Victoria manages 24 marine national parks and sanctuaries established in 2002. Extractive resource use is not permitted in these parks, which cover 53,076 hectares or 5.2% of Victoria’s marine waters. Another six marine protected areas, established in 1986 and 1991 in South and West Gippsland, allow extractive commercial and recreational use and cover 53,030 hectares,¹⁹⁰ or also 5.2% of marine waters, and provide only partial protection. In total, Victoria’s marine protected areas cover 106,106 hectares or 10.4% of state waters.

The final report of VEAC’s *Statewide Assessment of Public Land* noted in 2017 that it is evident from preliminary assessments based on available information that the existing system of no-take marine protected areas has some gaps in representation, and individual marine protected areas may not meet the adequacy criterion.¹⁹¹ The report recommended that, Victoria’s marine environment be reviewed for the comprehensiveness, adequacy and representativeness of its marine protected areas when current work on marine habitat mapping and classification is completed and available.¹⁹²

An analysis of the protection levels provided in each of the five marine bioregions — and Shallow Inlet, the Gippsland Lakes and the inlets of East Gippsland — for this chapter has indicated that on a bioregional basis, Victoria’s marine protected areas fall below the Aichi Target of 10% and likely do not satisfy the CAR Principles of the National Representative System of Marine Protected Areas. Percentage protection levels for the Otway, Central and Twofold Shelf marine bioregions are considerably lower than the Aichi Target 11, while the Flinders and Victoria Embayments bioregion only reach the target with the inclusion of partially protected areas. Such protection levels are seen as having fewer conservation benefits than high-level protection.¹⁹³ The Gippsland Lakes and East Gippsland inlets have no marine protected area coverage.

190. This figure excludes the terrestrial areas in the Corner Inlet, Shallow Inlet and Nooramunga Marine and Coastal Parks which comprise 10%, 20% and 40% of each, respectively (data in VEAC’s 2014 Marine investigation, p.99).

191. VEAC 2017, ‘Statewide assessment of public land’, Melbourne, Victoria.
 192. Ibid

193. Denny C, Babcock R 2004, ‘Do partial marine reserves protect reef fish assemblages?’ *Biological Conservation*, 116, pp. 119–29.

Table MC.5 Coastal EVCs and their conservation status by bioregion¹⁹⁴

Ecological Vegetation Class	Pre-1750s	Current
	(ha)	(ha)
1 Coastal Dune Scrub/Coastal Dune Grassland Mosaic	18,255	12,140
2 Coast Banksia Woodland	9,676	6,090
5 Coastal Sand Heathland	154	145
9 Coastal Saltmarsh	15,813	12,471
10 Estuarine Wetland	10,276	8,484
11 Coastal Lagoon Wetland	863	852
12 Wet Swale Herbland	4,768	4,768
140 Mangrove Shrubland	5,387	4,243
144 Coast Banksia Woodland/Warm Temperate Rainforest Mosaic	244	148
154 Bird Colony Shrubland	413	411
160 Coastal Dune Scrub	5,320	4,119
161 Coastal Headland Scrub	8,218	5,677
162 Coastal Headland Scrub/Coastal Tussock Grassland Mosaic	2,151	1,331
163 Coastal Tussock Grassland	2,484	2,087
181 Coast Gully Thicket	346	219
302 Coastal Saltmarsh/Mangrove Shrubland Mosaic	5,928	4,508
309 Calcareous Swale Grassland	559	559
311 Berm Grassy Shrubland	191	125
656 Brackish Wetland	1,314	662
665 Coastal Mallee Scrub	597	337
858 Coastal Alkaline Scrub	29,910	17,122
876 Spray-zone Coastal Shrubland	155	141
900 Coastal Saltmarsh/Coastal Dune Grassland/Coastal Dune Scrub/Coastal Headland Scrub Mosaic	153	63
904 Coast Banksia Woodland/Swamp Scrub Mosaic	327	65
906 Brackish Grassland/Swamp Scrub Mosaic	153	15
909 Coastal Dune Scrub/Bird Colony Succulent Herbland Mosaic	148	131
914 Estuarine Flats Grassland	560	157
919 Coastal Headland Scrub/Coast Banksia Woodland Mosaic	357	66
921 Coast Banksia Woodland/Coastal Dune Scrub Mosaic	1,288	876
922 Coastal Alkaline Scrub/Bird Colony Succulent Herbland Mosaic	120	53
934 Brackish Grassland	749	59
935 Estuarine Wetland/Estuarine Swamp Scrub Mosaic	533	160
TOTAL Pre-1750s cover	127,410	
TOTAL current cover		88,384
Remaining (%)		69.4

194. Shears NT, Grace RV, Usmar NR, Kerr V, Babcock RC 2006, 'Long-term trends in lobster populations in a partially protected vs. no-take marine park', *Biological Conservation*, 132(2), pp. 222–231.

* *table continued on following page*

SCIENTIFIC ASSESSMENTS Part III Marine and Coastal Environments

	Glenelg Plain	Warrnambool Plain	Otway Ranges	Otway Plain	Victorian Volcanic Plain	Gippsland Plain
1		V 67/51/9/7	D 86/28/50/8	D 75/37/31/7	D 91/0/91/0	D 50/32/7/11
2						V 41/13/8/20
5	R 98/0/98/0					
9				E 26/4/12/10	V 51/22/10/19	LC 86/53/8/25
10		D 83/7/23/53	E 80/1/40/39	E 89/4/55/30	E 19/0/17/2	LC 81/31/16/34
11						V 93/0/69/24
12						V 100/100/0/0
140				V 96/0/72/24	V 59/5/7/47	LC 79/56/6/17
144						E 100/0/98/1
154		R 72/72/0/0		R 85/85/0/0		
160		D 72/6/35/31				D 20/13/4/3
161	E 84/37/29/18	V 61/47/6/8	D 83/32/13/39	V 87/57/18/12	V 35/0/27/7	D 59/41/12/8
162		V 88/78/4/7				D 44/14/13/18
163		V 88/78/4/7	V 92/48/4/40	V 72/14/25/33	V 54/13/33/9	V 84/72/3/10
181		E 64/44/8/12				
302				E 81/10/46/25	E 63/11/19/33	V 69/30/2/37
309						V 100/100/0/0
311				E 58/58/0/0		E 66/2/39/25
656	V 99/0/95/4				E 51/0/3/48	E 17/0/14/3
665	E 56/33/1/22					
858	E 64/52/2/10			E 31/1/8/22	E 22/11/7/4	V 56/40/2/14
876	E 89/77/9/2					
900					E 9/4/3/2	V 48/14/15/20
904						V 20/2/13/4
906					E 2/0/1/1	E 28/0/6/21
909						D 89/85/0/3
914					NS 0/0/0/0	E 28/4/7/17
919						V 19/0/16/3
921					V 27/0/16/11	V 68/3/54/12
922						V 44/23/1/20
934						E 8/0/5/3
935						D 30/15/2/13
TOTAL	1,462	9,818	1,978	12,575	4,981	62,802
TOTAL	1,083	6,921	1,657	7,384	2,486	39,971
(%)	74.1	70.5	83.8	58.7	49.9	63.6

Future Focus

Create a Marine and Coastal Knowledge Framework

The key recommendation of *State of the Bays 2016* was the development of a marine framework as a mechanism for 'addressing knowledge gaps, reducing uncertainties and forming the future evidence base for assessing management interventions and environmental outcomes'.¹⁹⁵ DELWP has begun the development of the Marine Knowledge Framework, which is specific to marine science in Western Port and Port Phillip Bay.

In preparation for the State of the Marine and Coastal Environment 2021 report, the framework needs to be expanded to include:

- the development and implementation of a marine and coastal knowledge strategy with clear goals, actions, outcomes, timelines and evaluation that integrates agency and academic research, citizen science and Traditional Owner ecological knowledge
- a comprehensive review of marine and coastal indicators, with the data needs of the indicators given priority in data collection, analysis and reporting, and the indicators measured regularly to identify trends
- measurement of ecological function, condition and changes in marine and coastal ecosystems (including the 95% of coastal waters outside parks and sanctuaries, which are rarely monitored)
- assessment of the distribution of marine species responding to climate change
- understanding of marine and coastal attitudes, perceptions of, and connections for, Victorians (through polling)
- assessment of the ecological impacts of commercial and recreational fisheries

- assessment of the impacts of coastal urbanisation, development, population growth and increasing number of visitors to the coast
- assessment of water quality along the open coast.

Recommendation 10: That DELWP expand the Marine Knowledge Framework to include all state marine and coastal environments.

195. Lester S, Halpern B 2008, 'Biological responses in marine no-take reserves versus partially protected areas', *Marine Ecology Progress Series*, 367, pp. 49–56.

Accounting for the Environment

Coastal and marine accounts can be used to assess the socio-economic benefits coastal and marine ecosystems provide to Victoria, such as recreation, tourism, aquaculture and protection of coastal built and natural assets.

Coastal and marine accounts can be linked to land accounts, water accounts and waste (residual flow) accounts to enhance understanding of the links between asset management in catchment areas and the marine environment. By linking economic activity associated with land use in catchments – via water and waste accounts – to the condition of coastal and marine ecosystems, it is possible to build a more comprehensive picture of the impact of land use (see land accounts discussion in the Land chapter) on ecosystem services and benefits.

Coastal and marine ecosystems provide a wide range of ecosystem services. The quantity of ecosystem services produced is dependent on the extent and condition of ecosystem assets. The extent and condition of coastal and marine assets is impacted by a range of factors including climate change, flows of nutrients, sediments, toxicants and pathogens from catchments, and invasive species. A qualitative example of ecosystem accounting – from assets to benefits – is set out in Table MC.6.

Table MC.6 Qualitative example of ecosystem accounting for Victorian coastal and marine areas

Asset extent	Asset condition	Ecosystem services	Benefits
Cliffs	There is no universal condition metric for coastal and marine ecosystem assets.	Plants, algae and animals for food	Food for human and animal consumption
Dunes		Nutrients for aquaculture	Avoided impacts of climate change
Beach	Potential metrics include:	Climate regulation	Coastal asset protection
Saltmarsh		Water quality regulation	Recreation and tourism
Mangrove	• habitat hectares (for EVCs in coastal areas)	Water flow regulation	Avoided health impacts
Seagrass	• denitrification efficiency (muddy sediments)	Opportunities for recreation and tourism	Information and knowledge
Reef	Condition measure should relate to ecosystem services produced by the asset.	Opportunities for cultural connection	Cultural connection
Macroalgae		Landscape	Visual amenity
Sandy sediments			
Muddy sediments			

There is growing interest in coastal and marine ecosystem accounting around the world, reflecting a growing appreciation of the significant role these ecosystems play in supporting economies, communities and climate regulation.

Victorian marine and coastal assets can be classified using the hierarchical Combined Biotope Classification Scheme (CBiCS).¹⁹⁶ CBiCS provides a unified scheme for classifying all marine habitats and biotopes and is consistent with the terrestrial classification of vegetation biotopes and biotope complexes (for example, EVCs and EVC communities in Victoria). In 2016, CBiCS was used to produce pilot ecosystem accounts for Port Phillip Bay.¹⁹⁷ Using a hierarchical classification system such as CBiCS means that data can be aggregated to higher levels for reporting purposes (Figure MC.2 Combined Biotope Classification Scheme (CBiCS) hierarchy). This means that data collected at more granular levels can be aggregated and used for a variety of purposes.

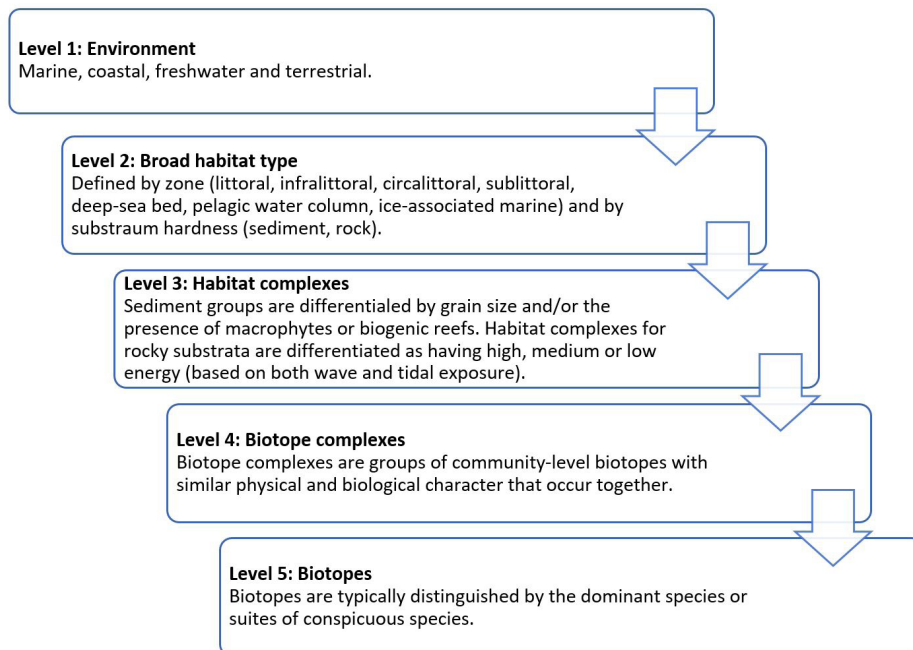


Figure MC.2 Combined Biotope Classification Scheme (CBiCS) hierarchy¹⁹⁸

196. Franco AD, Bussotti S, Navone A 2009, 'Evaluating effects of total and partial restrictions to fishing on Mediterranean rocky-reef fish assemblages', *Marine Ecology Progress Series*, 387, pp. 275–285.

197. Sciberras M, Jenkins SR, Mant R, Kaiser MJ, Hawkins SJ, Pullin AS 2015, 'Evaluating the relative conservation value of fully and partially protected marine areas', *Fish and Fisheries*, 16(1), pp. 58–77.

198. VEAC 2017, 'Statewide assessment of public land', Melbourne, Victoria.

Case Study: Marine and Coastal Ecosystem Accounting for Port Phillip Bay

Pilot ecosystem accounts were developed for Port Phillip Bay in 2016 to support State of the Bays reports.¹⁹⁹ For this study, Port Phillip Bay was divided into five geographic areas: Central, Corio, Exchange, Hobsons and Intertidal (see Figure MC.3 Geographic aggregations for Port Phillip Bay accounts).

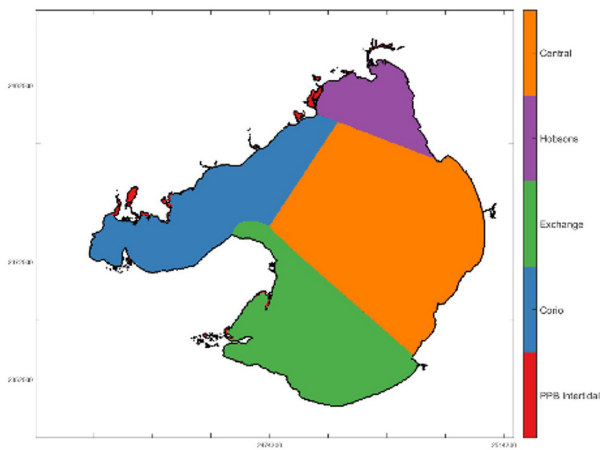


Figure MC.3 Geographic aggregations for Port Phillip Bay accounts²⁰⁰

Bay habitats (illustrated in Figure MC.4 Port Phillip Bay habitats) show very large areas of muddy sediment in the centre of the bay and in Corio Bay (in the western arm of the bay), which are responsible for water filtration services (the removal of nitrogen from the water). On the western side of the bay, there are also large areas of seaweed communities, seagrass and coastal salt marshes, which are important habitat for a number of species.

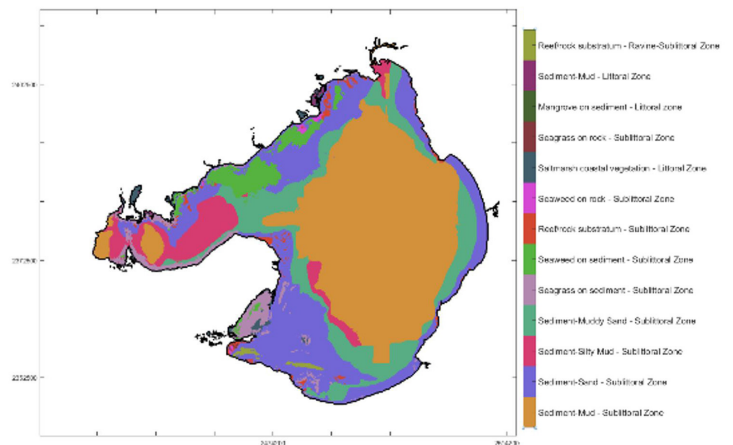


Figure MC.4 Port Phillip Bay habitats²⁰¹

Port Phillip Bay ecosystem assets are classified under CBiCS (Table MC.7 Port Phillip Bay ecosystem assets) and presented at the broad habitat level and habitat complex level. This could be further disaggregated to biotope complex level, where it can be used to inform decision-making.

199. Commissioner for Environmental Sustainability 2016, 'State of the Bays 2016', Commissioner for Environmental Sustainability, Melbourne, p.205.
 200. Combined Biotope Classification Scheme 2018, www.cbics.org Accessed 4 December 2018.

201. Eigenraam M, McCormick F, Contreras Z 2016, 'Marine and coastal ecosystem accounting: Port Phillip Bay', DELWP, Melbourne, Victoria.

Table MC.7 Port Phillip Bay ecosystem assets²⁰²

Broad habitat	Habitat complex	Central (ha)	Corio (ha)	Exchange (ha)	Hobsons (ha)	Intertidal (ha)	Total (ha)
Littoral sediment	Mangrove					4	4
	Mud					274	275
	Saltmarsh		87	475	5	1,868	2,435
<i>Total littoral sediment</i>			87	475	5	2,147	2,714
Sublittoral rock	Ravine			798		11	809
	Rock (unclassified)	299	471	760	902	48	2,481
	Seagrass			209			209
	Seaweed		298	64	3	5	369
<i>Total sublittoral rock</i>		299	769	1,832	904	63	3,868
Sublittoral sediment	Mud	69,923	3,391	7,393	3,922	234	84,863
	Muddy sand	8,935	5,898	10,656	3,872	8	29,369
	Sand	5,800	11,064	23,458	6,921	312	47,555
	Seagrass	1	3,280	3,524	123	209	7,138
	Seaweed		7,087	352	431	14	7,884
	Silty mud	141	9,737	2,113	905	28	12,925
<i>Total sublittoral sediment</i>		84,800	40,457	47,498	16,175	804	189,734
Total		85,099	41,313	49,804	17,085	3,014	196,315

With the availability of time-series data, changes in asset type could be recorded and used to track and evaluate the impacts of policy and programs.

Where information is available, it is possible to assess the ecosystem services provided by environmental assets and value the benefits to people. For example, it is estimated that Port Phillip Bay processes over 5,000 tonnes of nitrogen per year. The value of this service is estimated at around \$11 billion per year, which represents the costs that would be incurred to achieve equivalent denitrification through alternative means, such as upgrading infrastructure or wetland enhancement.

A case study of ecosystem services provided by seagrass in Port Phillip Bay was undertaken in 2016 (Figure MC.5 Seagrass in an environmental-economic accounting framework, Port Phillip Bay). Services and benefits listed are those that could be identified, quantified or valued in the study. It is not an exhaustive list.

202. Adapted from Edmunds M, Flynn A 2015, 'A Victorian marine biotope classification scheme', Australian Marine Ecology Report, Melbourne, Victoria.

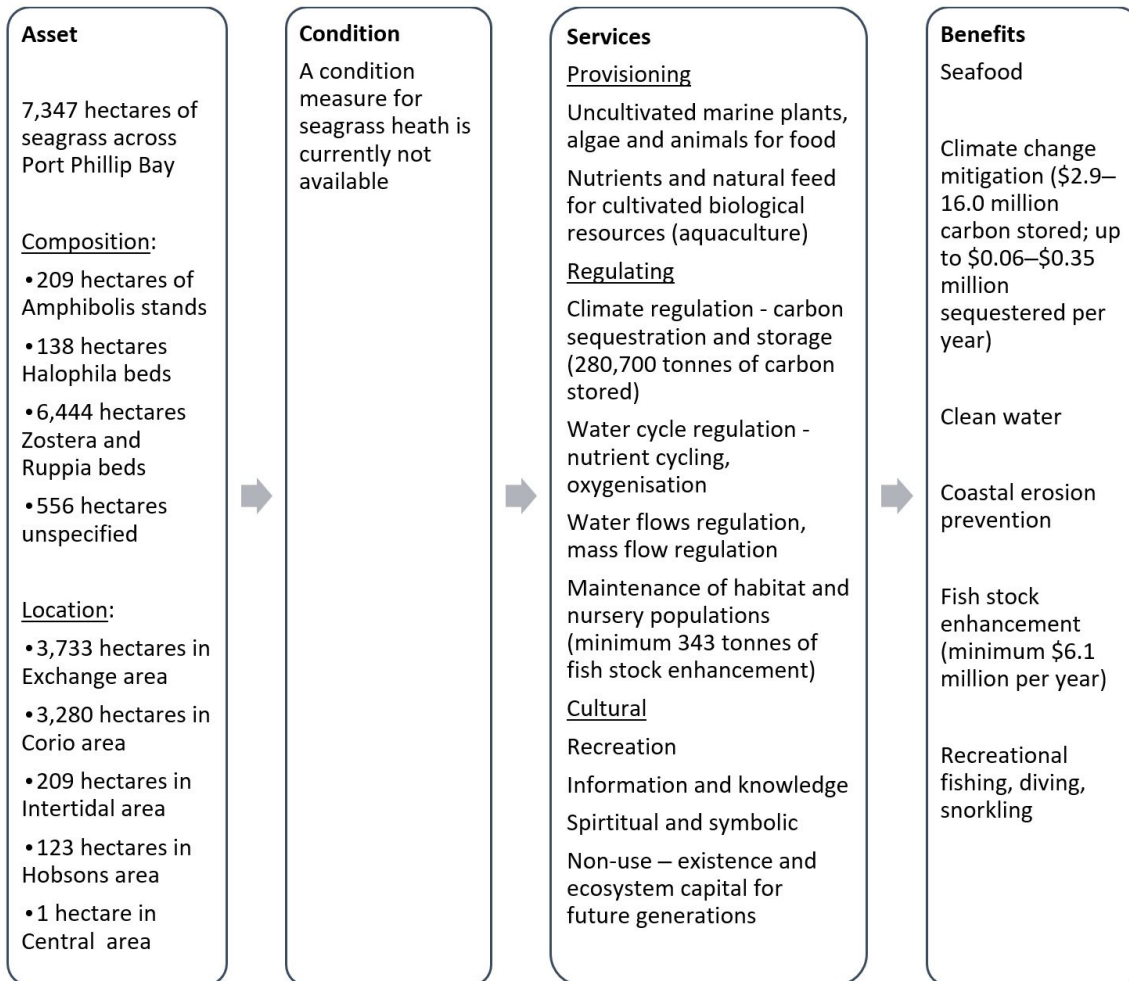


Figure MC.5 Seagrass in an environmental-economic accounting framework, Port Phillip Bay²⁰³

203. Eigenraam M, McCormick F, Contreras Z 2016, 'Marine and coastal ecosystem accounting: Port Phillip Bay', DELWP, Melbourne, Victoria.