STATE OF THE BAYS 2016 – SUMMARY

Commissioner *for* Environmental Sustainability Victoria

VICTORIA State Government

Traditional Owners

The Office of 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.

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FOREWORD

Dr Gillian Sparkes
Commissioner for
Environmental Sustainability

Victoria's first *State of the Bays* report is an historic baseline study of the health of Port Phillip Bay and Western Port. Based on existing marine science research, it is a timely stocktake of current knowledge on the two bays, and coincides with a period of sustained high levels of population and economic growth.

Port Phillip Bay and Western Port are at the centre of this growth in Victoria. With Victoria's population now 6 million, and growing at a rate of over 100,000 people per year – the highest increase in Australia – and the population of greater Melbourne over 4 million, our bays will need continued care and attention if they are to stay in good condition and continue to deliver the environmental, economic and social benefits they currently provide.

Recognising these pressures and the need to keep them in check, in 2014 the incoming Victorian Government committed to reporting on the state of the bays every five years. As Commissioner for Environmental Sustainability, I have been asked by the government to issue this, the first *State of the Bays* report. This report brings together what we know about both bays, based on existing research. It is intended as a baseline on which future reports will build and over time, include more of Victoria's marine environment.

The good news is that, despite their proximity to Victoria's largest cities, both Port Phillip Bay and Western Port generally demonstrate healthy systems.

We need to maintain a focus on sustaining the health of the bays and this is best achieved if we work together, and keep the interests of our community and the environment front and centre.

To develop this report, my office worked closely with the Victorian Department of Environment, Land, Water and Planning (DELWP), modelling an approach that can be applied in the future to other crucial environmental studies. I am pleased to have had the opportunity to lead this *State of the Bays* report, a positive and practical example of what can be achieved through collaboration and cooperation.

By bringing together and synthesising this marine science treasure trove, the *State of the Bays 2016* fulfils two critical outputs: 50 assessments of ecosystem health against 36 indicators, and identifying future priorities, to ensure we can maintain the health of the bays.

A third output, establishing a set of indicators for future reporting, will be available soon. The advice from DELWP is that work undertaken by CSIRO has confirmed a provisional set of indicators to take forward for consideration in future *State of the Bays* reporting. It is anticipated that these indicators for future reporting will be made available by DELWP, and published on the Office of the Commissioner for Environmental Sustainability (OCES) website, in mid-2017.

The *State of the Bays 2016* is a significant foundation for future studies and reports on the bays.

Equally as important, it also identifies knowledge gaps and recommends future priorities. To be effective environmental managers, we need an adaptive management framework built on a strong evidence base. This can only be done through increased and targeted research. Similarly, the proposed set of indicators for future reporting (available in 2017) will support a step-change in our approach to monitoring and ultimately managing the bays – a shift from reporting only on what we do know, to reporting on what we need to know.

A clear theme emerged through assessing the science in this report: the need to develop an ecosystem-wide approach to understanding the bays. It became apparent quite quickly that while we may know a lot about how habitats and species within the bays function, there is very little integrated research bringing all of this together. This report proposes a Marine Knowledge Framework be developed to guide an ecosystem-wide understanding of the bays and enable forward-looking and well-considered policy making – policy making that can account for economic and social benefits, as well as environmental; that can inform robust urban planning decisions, and positively and pre-emptively account for climate change impacts.

Digital technology is providing a new path to environmental understanding. Not only can our scientists benefit from using new sensor and monitoring technologies, our citizens will continue to play an important role too, by increasingly monitoring the environment around them, gathering data and participating in reporting. It is incumbent on governments to keep abreast of these technological advances.

The *State of the Bays 2016* has a defined scope. It focuses on bringing together science on the marine and intertidal environments, to assess the overall health of the two bays. It does not include recommendations for management interventions, socioeconomic indicators or comprehensive coastal considerations. However I do note that a large number of the pressures on our bays are derived from our activities on land, and I applaud a continued focus on management and regulatory actions that link activities in our catchments to benefits for Victoria's marine environment.

This report should be seen as the first phase in the move toward a 'state of the coasts' report. Considerable work is needed to develop coastal indicators and to understand and protect Victoria's coast line, which is vulnerable to climate change.

By collaborating with DELWP, other agencies and many of Victoria's marine science experts and academics, we modelled a rigorous, peer-reviewed synthesis reporting approach that can be used for future Victorian environmental reports. This process is set out in the *State and Benefit* framework for the 2018 State of the Environment report (www.ces.vic.gov.au/framework). The framework is the guiding document for my term as Commissioner. It has been endorsed and tabled by the Victorian Government, and roundly supported by key stakeholders including environmental advocacy groups.

I would like to thank the many marine science experts who contributed their time, academic work and generously helped peer review this report.

In addition, I would like to thank my own team and DELWP's dedicated and highly-skilled officers for their commitment to, and enthusiasm for, this project.

The Environmental Reporting Reference Group, the Project Control Board and the Technical Advisory Group also provided invaluable guidance and feedback.

I am pleased to present the inaugural *State of the Bays* report and trust it proves both informative for readers and useful for decision makers.

State of the Bays 2016 is also available in a simplified form and visual web pages with new marine photography from Museums Victoria (www.stateofthebays.vic.gov.au). This site aims to have Victorians care more, and know more, about our precious bays.

Dr Gillian Sparkes
Commissioner for Environmental Sustainability

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Contributors

The Commissioner for Environmental Sustainability, Dr Gillian Sparkes, thanks the following individuals and organisations for their considerable contribution to the development and review of the *State of the Bays 2016*.

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Finally, sincere thanks to the office staff Dr Scott Rawlings, Jenny Jelbart, Helen McInerney and Erin Seymour. In particular, Dr Rawlings' tireless dedication to writing and working with the science community has been key to delivering this report.

Parma victoriae
Scalyfin

SCOPE AND METHOD

Victoria's first *State of the Bays* report is an historic baseline study of the health of Port Phillip Bay and Western Port. It fulfils the Victorian Government's election commitment to deliver a five-yearly state of the bays report in the 2014 environmental platform, *Our Environment, Our Future*.[1]

As the first *State of the Bays* report, this document provides a rigorous scientific baseline against which future changes can be measured. As a stocktake report, it considers existing data for Port Phillip Bay and Western Port and makes 50 assessments across 36 indicators of ecosystem health. It focuses on condition and extent indicators of marine environmental assets and, where studies exist, includes the impacts of threats on condition and draws conclusions based on this information.

The Office of the Commissioner for Environmental Sustainability (OCES) process for developing environmental reports is set out in the *State and Benefit* framework for the 2018 *State of the Environment* report (www.ces.vic.gov.au/framework). The framework is the guiding document for environmental reporting by the Commissioner until 2018. It has been endorsed and tabled by the Victorian Government, and roundly supported by key stakeholders and environmental advocacy groups.

The Victorian Department of Environment, Land, Water and Planning (DELWP) developed an estuarine and marine data management system, which was essential for identifying the indicators and data for assessment. It was also important for confirming the scope of the *State of the Bays 2016*:

- **Geographically** – The report, which was initially a commitment to report on Port Phillip Bay only, also includes Western Port because significant data sets were available. The Gippsland Lakes were also considered, but the Lakes will be the subject of a subsequent report issued by East Gippsland Catchment Management Authority and will be considered for future state of the bays reports.
- **Biophysically** – The report generally focuses on marine ecosystems to the high-tide mark, with some exceptions. The report includes some erosion studies and saltmarsh and roosting shorebirds research, for example. The Commission aims to make coastal studies in Victoria a focus in the 2018 *State of the Environment* report. Similarly, estuarine research was excluded because it will be collated for the forthcoming Victorian Index of Estuarine Condition.

Ultimately, the *State of the Bays 2016* report brings together science on the marine and intertidal environments to assess the overall health of the two bays. It does not include recommendations for management interventions; nor does it consider socioeconomic indicators. The Port Phillip Bay Environmental Management Plan (due for release in 2017) will address management priorities for that bay.

Together, OCES and DELWP also developed an exploratory set of environmental–economic accounts for seagrass in Port Phillip Bay. It builds on and aims to shine a light on the work of the Victorian Government in environmental–economic accounting, to demonstrate the relationship between healthy bays and Victoria's economic and social wellbeing. It aligns with the environmental reporting reform articulated in the *State and Benefit* framework.

With an agreed framework and structure in place, OCES collaborated with Victoria's marine science experts and academics, particularly the contributors listed in the **Acknowledgements** (above) and the members of the Victorian Coastal Council's Science Panel. These scientists contributed their published literature and collected data sets, as well as their time to assess the proposed indicators, verify findings and peer review drafts of the report. The *State of the Bays 2016* would not have been possible without the valuable guidance and many contributions of Victoria's exceptional marine science community.

OCES also worked with DELWP and CSIRO on a process to identify indicators for future reporting on the state of the bays. At the time of writing, DELWP advises that work undertaken by CSIRO has confirmed a provisional set of indicators to take forward for consideration in future *State of the Bays* reporting. It is anticipated that these indicators for future reporting will be made available by DELWP, and published on the OCES website, mid-2017.

This proposed set of indicators suggests a step-change in our approach to monitoring and ultimately managing the bays – a shift from reporting only on what we do know, to reporting on what we should and need to know.

The collaboration with CSIRO followed a clear program logic to produce this set of future indicators:

- Develop a conceptual framework for selecting indicators for Port Phillip Bay and Western Port.
- Identify existing data relevant to indicators, and establish causality between pressure, indicator and management action.
- Convene workshops to bring together policy, management and technical specialists.

Effective environmental management needs an adaptive management framework built on a strong evidence base for the bays. This can only be achieved through targeted research directed at management outcomes. The proposed set of indicators for future reporting will reflect an aspirational scope of future scientific enquiry for the bays. The knowledge gaps identified in this report, and the future priorities based on those gaps, represent a pathway to a future scope and alignment with management outcomes.

The report identifies 30 knowledge gaps across the seven themes, which were drawn from multiple sources: the CSIRO-led process to establish future indicators; the indicator assessments from this report; engagement with marine scientists and stakeholders' and a literature review of published gap analyses on the bays.

The report consolidates these knowledge gaps into eight future priorities, based on peer review and further consultation with bay managers and marine experts and scientists. These priorities would form the basis of a Marine Knowledge Framework to provide the evidence base that will support the development of an adaptive management framework; and to assess the proposed future indicators on the state of the bays.

The future priorities fall into two categories:

- enabling better tools, to improve the monitoring and reporting system – two priorities
- improving our understanding of the ecological processes of the bays to build the evidentiary base for decision making – six priorities.

The methodology applied for this reporting process operationalises the environmental reporting vision of the *State and Benefit* framework. An approach to rigorous, peer-reviewed synthesis reporting provides a model for future Victorian environmental reports and improves public value and potential impact from the reporting effort.

Endnote

1 Victorian Labor Publications, ***Our Environment, Our Future*** 2014.

Plagusia chabrus
Red rock crab

EXECUTIVE SUMMARY

Victoria's first *State of the Bays* report is an historic baseline study of the health of Port Phillip Bay and Western Port. Based on existing marine science research, it is a timely stocktake of current knowledge on the two bays, and coincides with a period of sustained high levels of population and economic growth.

Recognising this pressure and the need to keep the bays healthy, the Victorian Government committed to reporting on the state of the bays every five years. The Commissioner for Environmental Sustainability releases this first *State of the Bays* report under the framework for the 2018 *State of the Environment* (SoE) report, *State and Benefit*.

The *State of the Bays 2016* considers existing data and identifies knowledge gaps. It then prioritises options for addressing these gaps, such as using smarter tools for data collection and coordinating research. It brings together the science on the marine environments of the two bays to assess their overall health. It does not include recommendations for management interventions, socioeconomic indicators or comprehensive coastal considerations.

The report assesses 36 indicators across seven marine-science themes that reflect current knowledge against the following criteria – status, trend direction and quality of the input data. The analysis has many knowledge gaps and a clear theme emerged: the need to develop an ecosystem-wide approach to understanding the bays. There is an imperative to align, target and coordinate research and monitoring effort to create longer-term trends and deeper ecosystem-interdependency knowledge, as well as better understand the nature of threats.

The report identifies the need to develop a Marine Knowledge Framework to ensure a coordinated, prioritised approach to marine science endeavour by the public sector. The Marine Knowledge Framework should, as a priority, focus on these two areas:

- Tools – Two priorities were identified which aim to improve the monitoring and reporting system. These tools include (i) improved monitoring technology, and (ii) expanding habitat mapping.
- Understanding – The report identifies six priority areas to target to improve our understanding of the ecosystems of the bays. They are the impacts of climate change, fisheries and aquaculture, marine pests and pollution, as well as a targeted research program to consider the system-wide dynamics of intertidal and subtidal habitats.

Together, these priorities represent a proposed strategy that will allow for the adaptive management of the bays and provide the evidence base for a suite of future indicators to better track bay health.

In addition to this more detailed report, the Office of the Commissioner for Environmental Sustainability developed a website www.stateofthebays.vic.gov.au. This website provides the community with information that is easy to access and easy to understand, along with striking marine life photography captured by Museums Victoria.

BACKGROUND OF THE BAYS

Victoria's Aboriginal people were the earliest occupants of the bays around south eastern Victoria. Three tribes from the Kulin Nation inhabited the coastlines of what is now Port Phillip Bay and Western Port – the Boonwurrung, the Bunnurong and the Wathaurung. European settlement drastically reduced the Aboriginal population to the extent that, by 1863, only 11 Bunnurong adults survived.

Scientists know the Port Phillip Bay basin dried out for a period between 2,800 and 1,000 years ago. This geomorphological history aligns with the Bunjil dreaming story recalling a time when Port Phillip Bay was a dry basin providing a fertile hunting ground.

Much of the Bunjil dreaming hunting ground now lies below the present water level of Port Phillip Bay's 1,934 km^2. With an average depth of 13 m, the bay and its 333 km of coastline supports over 1,000 species of marine plants and animals. Western Port has an area of 656 km with two large islands, French Island and Phillip Island. The length of coastline including the islands, is approximately 263 km and at 3 m, the average depth is much shallower than Port Phillip Bay.

The bays function differently in several ways determined by the depth, water movement, water clarity, influent water quality and the type and proximity of development. Port Philip Bay is a 'biologically' dominated system – that is, it is dominated by phytoplankton. Further, it has little flush and a lack of tidal range, so nutrients that enter the bay tend to stay in the bay. By contrast, Western Port is a 'biophysically' dominated system – that is, it is governed by shore morphology, wave dynamics, wind and light. It is a shallow, well-flushed, significantly-vegetated bay where large amounts of light reach the sediment.

These differences in the function of the bays create some surprising variations in ecological processes, particularly differences in nutrient cycling, habitat dominance, habitat variety, and species diversity. Given this, the report compares and contrasts the health of each bay in terms of seven key themes: nitrogen cycle, water quality, intertidal habitat, seagrass, reefs, fish and marine-dependent birds.

KEY FINDINGS

Despite their proximity to Victoria's largest cities, both Port Phillip Bay and Western Port generally demonstrate healthy systems. Specific threats linked to population growth include variations in recreational use and variations in litter, nutrients, sediment and pollutant loads to the bays (which may lead to more algal bloom events). Impacts are more significant around the mouths of creeks and drainage systems where human activity is more intense and where nutrients are transported to the bays.

Climate change impacts are likely to include peak rainfall events that transport high loads of nutrients and pollutants to the bays in short time periods, and sea level rise that encroaches on important habitat. Water chemistry, water temperature , wind and storm patterns also contribute to a complex mix of potential impacts.

Marine pests are also a threat. More than 100 introduced marine species (plants and animals) have become established in Port Phillip Bay. Marine pests can compete with native species, alter habitat, reduce important fish stocks and potentially disrupt nitrogen cycling processes. In Port Phillip Bay, an introduced sea star *(Asterias amurensis)* is outcompeting some bottom-dwelling fish for food, causing the populations of those fish to decline.

In future we need to develop a deeper and more timely understanding of the state of, and interactions between, habitats and their associated biotopes. A key finding of the report is to develop a Marine Knowledge Framework to facilitate a more integrated approach to our research effort and to undertake more frequent and extensive monitoring by embracing new technologies.

This study confirmed that our data collection regime is better within the Marine Protected Areas of Port Phillip Bay than in other parts.

Our indicator assessment summary captures the status, trends and existing data quality for 36 indicators.

Indicator	Status and trends (UNKNOWN / POOR / FAIR / GOOD)	Data quality
Nitrogen cycle Denitrification efficiency	GOOD: PPB	Good Good data quality but only at two sites
Nitrogen cycle Ratio of nitrogen fixation to denitrification	GOOD: WP	Poor
Water quality Nutrients	GOOD: PPB & WP	Good
Water quality Water clarity	POOR: WP; GOOD: PPB	Good
Water quality Salinity	GOOD: PPB & WP	Good
Water quality Dissolved oxygen	GOOD: PPB & WP	Good
Water quality pH	GOOD: PPB & WP	Poor
Water quality Metals	GOOD: PPB & WP	Good (WP – monitoring ceased due to low levels)
Water quality Algae	POOR: WP; GOOD: PPB	Good
Water quality Harmful algae blooms	FAIR: PPB	Good
Water quality Sediment contamination	FAIR: PPB & WP	Poor (random surveys)
Water quality Temperature	FAIR: PPB & WP	Good
Water quality *Enterococci* bacteria	GOOD: PPB	Good
Intertidal vegetation Saltmarsh and mangrove extent	FAIR: PPB	Good

Indicator	Status and trends				Data quality
	UNKNOWN	POOR	FAIR	GOOD	
Intertidal vegetation Saltmarsh condition				PPB	Fair
Intertidal vegetation Saltmarsh and mangrove extent			WP Saltmarsh	WP Mangrove	Good
Intertidal vegetation Saltmarsh condition			WP		Fair
Intertidal vegetation Status of foraging shore birds			PPB		Good
Seagrass Seagrass extent			? PPB Larger areas stable, other areas variable		Poor
Seagrass Seagrass condition				? PPB	Fair
Seagrass Seagrass dependent fish				PPB	Good
Seagrass Seagrass extent			WP		Fair
Subtidal reef Macro algae dominated beds			? NORTH PPB	SOUTH PPB	Poor (north) Good (south)
Subtidal reef Fish	? NORTH PPB			SOUTH PPB	Fair (north) Good (south)
Subtidal reef Mobile megafaunal invertebrates			PPB		Good
Subtidal reef Sea urchins		NORTH PPB		SOUTH PPB	Fair (north) no time series Good (south)

Indicator	Status and trends (UNKNOWN / POOR / FAIR / GOOD)	Data quality
Intertidal reef Macroalge	GOOD: PPB	Overall fair (Good in MPAs (Ricketts and Point Lonsdale) but lack of monitoring bay-wide)
Intertidal reef Sessile invertebrates	GOOD: PPB	Fair
Intertidal reef Mobile invertebrates	GOOD: PPB	Overall fair (marine parks) Good (Lack of bay-wide monitoring)
Fish King George whiting	GOOD: PPB Trend cyclic	Good
Fish Snapper	GOOD: PPB	Good
Fish Sand flathead	POOR: PPB	Good
Birds Status of roosting shorebirds	FAIR: PPB	Good
Birds Status of waterbirds	FAIR: WP	Good
Birds Status of piscivorous (fish-eating) birds	GOOD: WP	Good
Birds Status of little penguins	GOOD: PPB & WP	Good Poor (St Kilda)

The nitrogen cycle

Nutrients entering Port Phillip Bay can have a positive effect when conditions are nutrient-poor. Or, they can have a negative effect when levels are too high leading to algal blooms, particularly after heavy rainfall events. In the marine environment, nitrogen is a more important contributor to algal blooms than phosphorus.

Nitrogen denitrification and fixation are the critical nutrient cycle processes occurring in the bays. Denitrification removes nitrogen from the system while fixation incorporates it into the system. The bays process nitrogen differently because of their different water inflow quality, physical characteristics and ecosystems. Port Phillip Bay is a denitrification dominated system and Western Port a nitrogen fixation dominated system.

The denitrification efficiency process generally maintains the nutrients in Port Phillip Bay at an optimal level for biodiversity. Denitrification efficiency lower than 60% in Port Phillip Bay (40% for Hobsons Bay) indicates the denitrification process is disrupted.

By contrast, there is very little denitrification in Western Port, which is dominated by vegetated, shallow areas. Rather, nitrogen fixation governs its nitrogen cycle. For a healthy Western Port, the ratio of nitrogen fixation to denitrification should be higher.

Two indicators for nitrogen were identified and assessed on available data – one for each bay. The nitrogen cycle indicator for the condition of both bays is considered good.

Water quality

Water quality affects ecological processes and potentially human health.

The Victorian Environment Protection Authority (EPA) and Melbourne Water established monitoring and reporting systems for water quality in Port Phillip Bay and Western Port. Water quality objectives are set by the State Environment Protection Policy (Waters of Victoria) (SEPP WOV) and Australian and New Zealand guidelines for fresh and marine water quality (2000). The Yarra and Bay website (www.yarraandbay.vic.gov.au) publishes information about water quality for Port Phillip Bay during the summer period.

A range of indicators are monitored in Port Phillip Bay (at eight sites) and in Western Port (at three sites). The indicators monitor nutrient levels, water clarity, dissolved oxygen, salinity, algae, metals, water temperature and faecal contamination.

Understanding water quality in Port Phillip Bay and Western Port requires understanding where the water originates. Rural and urban land use activities like housing development and farming have led to broad scale increases in the nutrient loads from the catchments.

Excessive phytoplankton growth can potentially harm aquatic life and even human health. The EPA has been monitoring phytoplankton on a monthly basis at eight sites around Port Phillip Bay since 2008. A sudden increase in rainfall has been linked to rises in phytoplankton. The highest number of phytoplankton (total) was observed at the Hobsons Bay site in December 2009, coinciding with the break of the millennium drought and a 46 mm rainfall event occurring on 22 November 2009. Over the 2008–16 period, fewer than 10% of the samples collected had concerning levels of phytoplankton.

The number of beach advisory (recreational contact) alerts issued during each summer can vary greatly, depending on how much rain and stormwater enters Port Phillip Bay. Over the past three summers, most (94–97%) of the 36 beaches monitored in the bay met EPA's SEPP objectives for swimming.

Eleven water quality indicators were identified and assessed on available data. Water clarity and algae are considered poor in Western Port but good in Port Phillip Bay. Sediment contamination is fair in both bays. The remaining indicators are all considered good.

Intertidal habitat

Intertidal vegetation comprises three broad community types: seagrass, mangroves and saltmarsh. The non-vegetated intertidal zone is predominantly comprised of rocky reefs and soft sediments.

Compared with its state before European settlement, Port Phillip Bay has retained about 50% of its saltmarsh area. During the same period, Western Port retained 90–95% of its mangrove habitat, and 90–95% of its saltmarsh.

Research into the condition of saltmarsh revealed these ecosystems face some critical challenges. Time series data (2000–16) demonstrated sea level rise is affecting mangrove encroachment and expanding saltmarsh pools in the north of Western Port, fragmenting the saltmarsh. The invasive pest *Spartina* (cordgrass) is another threat.

The soft sediments are a poorly understood component of intertidal habitats – particularly given their predominance in Western Port. The status of foraging shorebirds is linked to intertidal habitat health.

Five intertidal habitat indicators were identified and assessed on available data – three for Port Phillip Bay and two for Western Port. Saltmarsh and mangrove extent are considered fair in Western Port. In Port Phillip Bay, saltmarsh extent is fair and mangrove extent is good. Saltmarsh condition is good in Port Phillip Bay and fair in Western Port. The status of foraging shore birds in Port Phillip Bay is fair.

Seagrass

Unlike seaweeds, seagrasses obtain most of their nutrients from the sediments in which they grow. They have extensive root systems that help stabilise coastal sediments and reduce erosion. Seagrasses act as ecosystem engineers, dramatically influencing biodiversity and ecosystem function. Seagrass meadows provide the majority of important habitat within the bays. Their three-dimensional structure protects juvenile fish from predators and seagrass plants support algae and invertebrates that are an important food source.

The seagrass meadows in Port Phillip Bay can be divided into three broad categories: persistent (relatively stable over time), ephemeral (nutrient-limited) and ephemeral (light-limited). Ephemeral beds are much more variable and have shown major increases and declines over the past half century.

During the last major drought (1997–2009), Port Phillip Bay lost large areas of seagrass. There is insufficient information to measure the extent of recovery since the drought ended in 2010.

In Western Port, seagrass declined in the mid-1970s to 1984, then increased in the mid-1990s to 1999. The causes of the decline are unclear, but recovery of seagrass is inhibited in Western Port by water quality, particularly dynamic factors such as suspended sediments that reduce light. Nutrient levels and nutrient availability are also important.

Fisheries Victoria monitored fish species, biomass and diversity within seagrass beds from 2008–12. The research concluded a loss of seagrass or reduction in seagrass condition at different depth ranges may affect different fish species to varying degrees. Shallow seagrass is particularly important for King George whiting.

The most predominant seagrass habitat in the bays, *Zostera*, has been found to be the most critical for fish biodiversity in Western Port because of its extensive spatial cover and unique role for fish larval settlement and development. It also supports unique species, particularly pipefish and seahorse.

Four seagrass indicators were identified and assessed on available data. Seagrass extent in both bays is fair and condition in Port Phillip Bay is good. The biomass of seagrass dependent fish species is good. Data quality for these indicators was variable, ranging from poor to good.

Reef habitats and dependent species

The intertidal, subtidal and deep reefs (including the deep canyon reef at Port Phillip Heads) are important ecological assets of Port Phillip Bay, providing valuable ecosystem services for Victorians.

Reefs act as a wave break protecting beaches from erosion, reef-associated algae act as a nutrient sink, and reefs are sites of detritus production that underpins the detrital food chain in soft bottom habitats.

Rocky reefs occupy only a very small part of Western Port, but three areas are notable — Crawfish Rock, an unusual habitat with very high biodiversity; a small reef near San Remo that is significant for its opisthobranchs; and intertidal reefs along the south western coast, particularly Honeysuckle Reef, that have a high biodiversity. Intertidal reefs in Western Port are likely to be highly vulnerable to sea level rise.

Intertidal reefs are the most accessible component of marine environments, so these habitats have important social and cultural values. Due to their accessibility, intertidal reefs are subject to human pressures, including collecting animals for food and fishing bait, trampling, and pollution from catchment discharges.

Research on reefs outside the marine protected areas has been fragmentary, and we have little information about the drivers influencing these reef communities and how they differ from the open coast.

PORT PHILLIP BAY NORTH

Most reefs in the north are low wave energy and have been permanently changed by native urchins and the highly-invasive Japanese kelp (*Undaria pinnatifida*), which exploits the disturbance caused by the urchins. The ecological status of this habitat is highly variable, trends are currently unknown and longer term monitoring is necessary to identify patterns.

The numbers of reef fish in the north are low but variable. The exception to this is snapper, which is declining. Limited fish monitoring occurs in the north of the bay.

Megafaunal invertebrates are very diverse in the north, in part due to the additional nutrients from the Western Treatment Plant, Yarra River and Kororoit Creek inflows. Urchin barrens and sessile sponge and coral communities benefit from the carpets of sediment-covering brown algae, and the diversity of red algae.

PORT PHILLIP BAY SOUTH

Monitoring in the south is better than in the north of Port Phillip Bay. The past decade demonstrates the southern reefs of Port Phillip Bay are healthy – with the exception of decreasing numbers of seastars.

Pope's Eye, the most popular dive site in Victoria, has been protected from all forms of fishing since 1978. Pope's Eye demonstrates great fish density and diversity.

Greenlip abalones are recovering in terms of abundance and size – both in the marine protected areas and at the reference sites outside these areas.

Seven indicators were identified and assessed on available data.

Subtidal reef communities have remained in good condition in the south and fair condition in the north of Port Phillip Bay (based on data for macroalgae, fish and mobile megafaunal invertebrate indicators from Parks Victoria's Subtidal Reef Monitoring Program). Urchins are abundant in the bay's south. However, they are overabundant in the north and numbers are increasing.

Intertidal reef communities in Port Phillip Bay (and Mushroom Reef Marine Sanctuary) have remained in good condition since 2003 (based on data for macroalgae, sessile and mobile invertebrate indicators from Parks Victoria's Intertidal Reef Monitoring Program).

Fish

A high proportion of Victoria's recreational fisheries catch is sourced from Port Phillip Bay and Western Port. This report focuses on King George whiting, snapper and sand flathead as key species that indicate the health of fish in the bays and other ecological processes:

- King George whiting show a long term increasing trend since 1978–79. Catch rates increased in 2015–16, after a recent low period from 2013–15.
- For snapper, the juvenile trawl surveys in Port Phillip Bay indicate good juvenile recruitment rates over the past 12 years, which are expected to maintain the stock in a healthy state over the coming years. Declines in adult catch rates over the past three years are evident for both the commercial and recreational fisheries in Port Phillip Bay. The decline should stabilise as the fishery transitions with the new wave of healthy recruitment over the past 12 years. None of the catch rate data show long term sustained declines.
- Trawl surveys of juvenile sand flathead show recruitment in Port Phillip Bay remains poor when compared with levels recorded in the late-1980s and 1990s. Recruitment over the past five years remains well below the long term average and the most recent year is one of the lowest recorded. Research indicates sand flathead recruitment in Port Phillip Bay is heavily influenced by climatic variability.

The abundance of a range of other benthic fish species (including rays, stingarees and gurnards) also declined substantially during the drought period, with the greatest declines occurring in the deeper, central parts of the bay. Step-change reductions in the abundance of three species that exhibited high dietary overlap with the introduced seastar *(Asterias amurensis)* was attributed to competition with this species in the deeper regions of the bay.

Port Phillip Bay and Western Port are important spawning areas for anchovy. In contrast to anchovy, pilchards spawn primarily in offshore coastal shelf waters and rarely in Port Phillip Bay. Both species are an important food source to predators such as squid, fish and seabirds (including little penguins). Anchovy populations in Port Phillip Bay exhibited consistent recruitment from 2008 to 2011. Port Phillip Bay supported the largest commercial anchovy fishery in Victoria, before phasing out of commercial fishing started in 2016.

The Western Port Science Review analysed recreational fishing research data obtained from boat ramp interviews, fish identification and fish measurements over a 15-year period. The result is some baseline information for assessing stocks of important recreational species, including new information on the spatial distribution and habitat use of important fish populations in Western Port. The results suggested variation in catches by recreational fishers was primarily influenced by the environmental drivers of recruitment of young fish to the Western Port ecosystem.

Three indicators were identified and assessed on available data. Based on good data quality, the status of King George whiting and snapper is assessed as good and sand flathead status is poor.

Marine-dependent birds

Information is available on the health of a range of waterbirds in Western Port, including fish-eating birds, while the Port Phillip Bay analysis is restricted to roosting and foraging shorebirds.

Shorebirds are declining around the world, including populations that spend the non-breeding period in Australia. Migratory shorebird conservation involves identifying important shorebird habitat, and monitoring changes in shorebird populations.

Red-necked stint, curlew sandpiper and sharp-tailed sandpiper are the three key species of roosting shorebirds for Port Phillip Bay. Shorebirds in Port Phillip Bay are declining in line with populations throughout the world in the past 20 years.

Annual summer count data of shorebirds was collected at key sites in the Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar site from 1981–2010. For 16 migratory shorebird species examined, 10 species (62%) had significantly declined since 1981, with curlew sandpipers and lesser sand plovers experiencing particularly strong declines.

Similarly, several species of water birds in Western Port experienced serious declines, and very few are increasing. Terns, cormorants and the Australian pelican are decreasing at Western Port, but increasing at West Corner Inlet. Falling tern numbers account for most of the decline in piscivorous (fish-eating) birds in Western Port. This result suggests feeding conditions for terns (and to a lesser extent for cormorants and pelicans) in Western Port have deteriorated compared with feeding conditions in the comparable site, West Corner Inlet.

The Phillip Island little penguin breeding population has experienced periods of decline and increase generally associated with their major food source, pilchards. However, climate change will be a critical and complex pressure on penguin communities. Warmer sea surface temperatures are likely to increase breeding productivity and first-year survival, but increased frequencies of fire, higher temperatures and drought will threaten adult penguin survival.

Gannets are an important, iconic species in the bays and a top predator. The gannets in Port Phillip Bay represent a large biomass and are an important indicator of the health of the bay. The total number of gannets breeding within the bay has not been surveyed for several decades and information on this species remains an important knowledge gap.

Four indicators were identified and assessed on available data. The status of roosting shorebirds in Port Phillip Bay and water birds in Western Port is fair, while piscivorous (fish-eating) birds in Western Port is good and little penguins in both bays is also good. Data quality for little penguins at St Kilda is poor, otherwise the available bird data was good.

Sabella spallanzanii
European fan worm

FUTURE PRIORITIES

The *State of the Bays* report presents 50 assessments against 36 diverse indicators across seven themes, to provide a baseline for understanding the state of the environmental health of Port Phillip Bay and Western Port. It establishes a foundation for future reports on the bays. The report also identifies knowledge gaps for future study that would improve our understanding and build on the existing scientific evidence base.

Building on the indicator assessments contained in this report, and the identified knowledge gaps, this chapter presents the need for a Marine Knowledge Framework for the bays encompassing eight future priorities. These priorities should inform the Government's marine research program and the (i) design of an adaptive management cycle and (ii) assessment of future indicators of the state of the bays.

At the time of writing the Department of Environment, Land, Water and Planning, Victoria (DELWP) confirms that work by CSIRO is underway to develop a provisional set of indicators for future *State of the Bays* reporting. It is anticipated that, these indicators for future reporting will be made available by DELWP, and published on the OCES website, in mid-2017.

It is also anticipated that the release of the Environmental Management Plan (EMP) for Port Phillip Bay (due in mid-2017) – together with the scientific baseline provided by this *State of the Bays* report and the pending, future indicators for reporting – will enable the development of an adaptive management cycle for the bays (see figure FP.1).

ADAPTIVE MANAGEMENT CYCLE

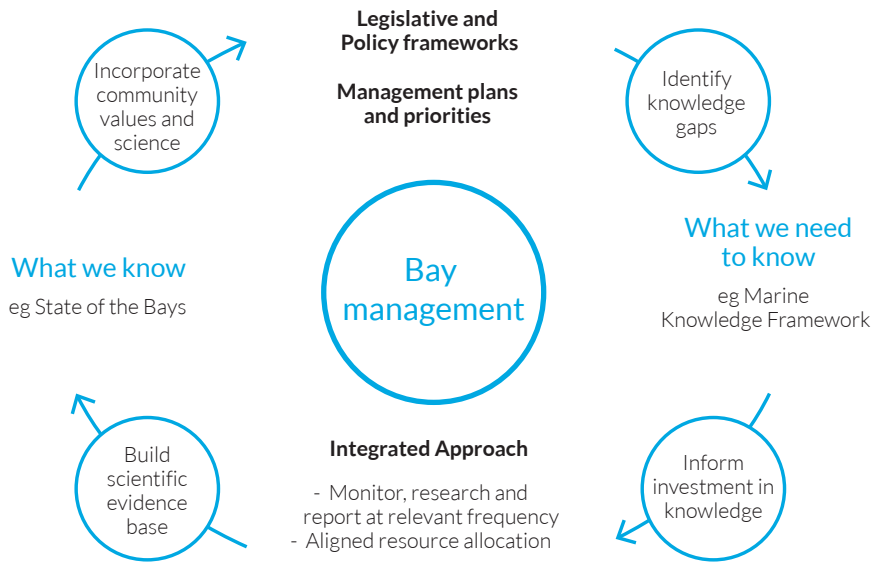

Figure FP.1: Adaptive Management Cycle; managing environmental health of the bays

The figure illustrates the importance of the shift in environmental reporting asserted in the *State and Benefit* framework. The shift from reporting on 'what we know' to 'what we need to know' to make better decisions. Reports like *State of the Bays* provide the evidence base, which, along with community values, inform government decision making and the formulation of management priorities. In turn, those management priorities lead to (i) direct interventions to improve environmental outcomes , and (ii) the establishing of a knowledge framework to address knowledge gaps, reduce uncertainties and form the future evidence base for assessing management interventions and environmental outcomes.

With regard to Port Phillip Bay and Western Port, a Marine Knowledge Framework for the bays (led by DELWP in collaboration with all responsible agencies) would set the agenda for future investment in environmental science. The framework aims to improve the evidence base, which in turn, would be used to implement and assess: management priorities for Port Phillip Bay; the existing strategies for Western Port; relevant State Environment Planning Policies; the Biodiversity Plan (due in 2017); and other related policy commitments.

This Marine Knowledge Framework must have clear objectives including the appropriate funding of critical marine research and a commitment to monitor and report on indicators and targets at relevant frequencies.

It is a priority for the new Marine and Coastal Act (due in 2017) to formalise these arrangements legislatively and to stipulate the requirement for a Marine Knowledge Framework to guide activity and investment to build our knowledge base with ecological, social and economic research that leads to environmental outcomes.

Similarly, the Biodiversity Plan should extend to the protection and conservation of marine as well as terrestrial landscapes and habitats. Marine habitats, particularly the benefits of blue carbon, should also be considered as a part of Victoria's climate adaptation and mitigation strategies.

The future priorities listed below recognise that research outcomes would benefit from better integration and coordination of effort and by embracing new technologies and methods, to enable more frequent and extensive monitoring and ultimately, improve understanding. The strategy to improve our knowledge of the future priorities should be set out in the Marine Knowledge Framework.

Future priorities fall into two categories:

- **TOOLS** – enabling better tools to improve the monitoring and reporting system – two priorities are listed.
- **UNDERSTANDING** – addressing critical gaps in understanding the ecological processes of the bays to build the evidentiary base for decision making – six priorities are listed.

MARINE KNOWLEDGE FRAMEWORK

As illustrated in figure FP.1, it is critical to develop a Marine Knowledge Framework for Port Phillip Bay and Western Port to ensure research and monitoring efforts are directed towards management priorities: addressing knowledge gaps, reducing uncertainties and forming the future evidence base for assessing management interventions and environmental outcomes.

The focus of the Framework should initially be the two bays but the scope could be extended to the broader Victorian marine environment in the future.

A coordinated approach to marine research is critical. Currently, marine science tends to be disaggregated, species-specific research, largely reflecting resource constraints. A strategic future program for marine research must understand the key habitats (seagrass, sediment, mangrove, saltmarsh, reef, and water column), and importantly, how the habitats interact. A systems approach to ecosystems will provide the evidence base for improved decision making and management interventions.

The key challenge for designing a Marine Knowledge Framework is the current absence of a management plan for marine environments – especially in Western Port. The Environmental Management Plan for Port Phillip Bay (due in 2017) will address this gap for Port Phillip Bay. But, ultimately, clear government policy and management priorities are needed for all marine assets across Victoria. Once clear management priorities are formalised, the Marine Knowledge Framework becomes an urgent deliverable to acquire the evidence base for assessing progress against the management priorities. It would be anticipated that the Framework would be implemented well before the next *State of the Bays* report to enable assessing the updated suite of indicators.

Coordinated research requires comparable methods of analysis among agencies and researchers, and undertaking studies that complement each other. Otherwise, excellent research is sometimes undermined by a lack of integration with pre-existing sites and data.

The proposed Marine Knowledge Framework would focus on developing the standards and protocols for marine research in the bays. It would emphasise the why and how of marine science and could address a number of the procedural gaps identified in this report, such as:

- meta-analysis of existing studies
- incorporating citizen science (Reef Watch, Sea Search, Birdlife Australia) into digital reporting and integrated monitoring regimes
- connecting marine practitioners (researchers, managers, stakeholders)
- ensuring management and policy outcomes are met through improved information and by identifying opportunities for delivering research to support outcomes
- institutional arrangements.

The approach to addressing the eight future priorities explained in detail below would also be formulated in the Marine Knowledge Framework.

The proposed Framework would build on the strong foundation of the existing monitoring programs of the Marine Protected Areas. It would also provide a strategic vision for integrating diverse research partnerships. Current partnerships such as the Victorian Marine Operational Model (VIC-MOM) and Integrated Marine Observing System (see **Water quality** chapter) are good examples of partnerships integrating marine research.

FUTURE PRIORITIES: TOOLS

MAINTAIN AND EXPAND MAPPING REGIMES

Ongoing marine monitoring of the bays requires periodically mapping habitats (seagrass, mangrove, saltmarsh etc.), to update the benchmark mapping of Boon et al. (2011)[1] and others, and to inform an adaptive management cycle.

The frequency of monitoring and mapping activity should allow researchers to identify natural cycles of habitat loss and recovery, and unnatural changes due to human impact. Mapping and remote sensing will help bay managers to understand the extent of pest invasion, and other threats to habitats, and identify early indicators of those threats.[2]

The proposed Marine Knowledge Framework would identify the critical areas for informing bay management, which could then be prioritised for strategic, frequent mapping. Other regions could be mapped less frequently. The seagrass maps used in this report were compiled over a four-year period (2008–11) and are now over five years old, for example. There is no ongoing mapping of seagrass extent, or monitoring of seagrass condition. This is a critical knowledge gap in our understanding of what drives seagrass health in Port Phillip Bay and Western Port.

Further, technologies like NearMap (already used in Western Port seagrass research) could supplement mapping, by repurposing existing aerial photography for different objectives. Similarly, existing research partnerships such as the CSIRO Landsat mapping of Western Port vegetation could be extended.

A robust marine mapping discipline will improve models of Victoria's marine environments. Higher resolution mapping will enable more complex hydrodynamic modelling, so we can better resolve coastal processes and understand the sensitivities of different marine systems. This modelling would include nutrients, suspended sediments and pollution events, among other things.

A strong mapping regime will enable a better understanding of the interdependencies of different marine ecosystems and their interaction with catchments. It will bring research of the marine environment more into line with studies of the biodiversity of terrestrial landscapes.

IMPROVED MONITORING TECHNOLOGY

Advances in monitoring technology include drones, 3D mosaic mapping, autonomous underwater vehicles (AUVs), bathymetric LiDAR (Light Detection and Ranging) and multi-beam sonar (for characterising the geophysical structure of reefs, biota and seabeds in general). Future monitoring regimes for the bays must consider adopting (or expanding the use of) these technologies that:

- allow for more comprehensive data from across the bays
- are less expensive and safer than conventional monitoring techniques
- provide data faster and at better resolution
- reduce human error
- challenge current monitoring conventions
- increase the scope and immediacy of digital reporting mediums.

A number of the current monitoring sites were established based on constraints such as human access, human resourcing and safety considerations. The emerging technology will allow monitoring to occur at different and more numerous sites and could replace time-intensive techniques such as quadrat monitoring.

Adopting emerging technologies will increase the frequency of reporting and will reduce the possibility that important assemblage transitions may be missed. Further, improved monitoring technology will aid the assessment of 'blue carbon' and the role of habitats in carbon sequestration.

The emerging technology will also enable researchers to reclassify old data and videos in new and dynamic ways, providing better trend and historical data. The improvements in mapping technologies will enable more sophisticated analysis of marine environments, which will improve understanding and management interventions.

FUTURE PRIORITIES: UNDERSTANDING

Understanding Impacts

IMPACT OF CLIMATE CHANGE

On the one hand, climate change will reduce rainfall, but increase the number of intense rainfall events, which in turn will cause higher event-related flows containing nutrients, sediments and other pollutants to the bays. Sea levels are expected to rise, which will affect Port Phillip Bay's extensive coastline and Western Port's gently sloping shoreline. Climate change will also impact catchment discharges, alter bay water chemistry, change sea surface temperature (SST) and influence changes to wind and storm patterns. Increased temperature and evaporation can cause desiccation on exposed mudflats.

On the other hand, EPA modelling[3] suggests sea level rise will reduce pressures from catchments. Specifically, catchment flows will enter a larger volume of embayment water and be diluted/mixed more than they are currently. Under this scenario, coastal processes – sea level rise and winds – will lead to increased wave energy, increased tidal flats exposure, coastal erosion and increased sediment re-suspensions, which in turn will affect the bays' water quality and habitats.

We need a strategic approach to improving our understanding of climate change impacts across all marine habitats. Better knowledge of the bays will help inform management options and create solutions that allow biodiversity to adapt to the changes. It will also help prevent catchment-based pollution, and increase the resilience and health of near-shore waters.

This report explored many examples – from how tidal inundation affects waterlogging and salinity regimes in saltmarshes, to the causal mechanisms of the influence of SST in Bass Strait on whiting recruitment.

The proposed Marine Knowledge Framework should also consider adaptation options – both social adaptation (for example, climate-resistant coastal infrastructure) and environmental adaptation (for example, improving resilience of species). Ultimately, a more nuanced understanding of climate change impacts will also improve the evidence base for system-wide management of landscapes from catchments to coasts.

IMPACT OF MARINE PESTS

Marine pests can affect habitats (particularly reefs) and processes (water quality and nutrient cycle). Denitrification remains potentially vulnerable to introduced marine pests (and some native species), for example.

Marine pests may affect nitrogen cycling by:

1. displacing or consuming the infauna living in the sediment
2. intercepting organic matter before it reaches the sediment (short circuiting denitrification), and/or
3. increasing nutrients in the water column by injecting wastes directly into the water column rather than into the sediment.

More research is required to understand the impact of specific pest species. No recent surveys have been taken of the distribution and abundance of any exotic species in Port Phillip Bay. The effect of future exotic species is also unknown.

IMPACT OF POLLUTION

Better understanding of how pollution affects marine ecosystems and how they recover over time is a key research priority. An example is understanding legacy toxicants in embayment sediments.

Understanding the impacts, extent and source of emerging chemicals (pharmaceuticals from storm waters, micro plastics, litter and toxicants) entering embayment waters and their effects on food webs, fish and marine fauna is particularly important. With better information, we can develop management options (for example, improved technology for litter removal, more sophisticated compliance regimes).

Similar to the research of climate change impacts, understanding pollution impacts will improve the evidence base for system-wide management of landscapes from catchments to coasts.

This research program would build on the VIC-MOM partnership, where relevant.

IMPACT OF FISHERIES, AQUACULTURE AND SHIPPING

Climate change, invasive pests and pollution are threats caused by changes to natural processes and catchment flows. But Victorians also impact on the bays directly through recreational and industrial uses of the bays.

Understanding the impact of recreational fishing on fish populations in the bays is critical. It is even more important now that commercial netting is being phased out in Port Phillip Bay and recreational fishing is expected to increase. Future research would depend on establishing a fish monitoring regime in Port Phillip Bay and Western Port within the proposed Marine Knowledge Framework. This approach would consolidate the current diverse monitoring approaches into a strategic system for different outcomes (for example, fisheries and catchment management). It is also important to understand the system-wide implications of pressures on existing fish stocks, and the implications for habitats and other species. The contribution of citizen science (especially ReefWatch and the Angler Diary Program) to this effort should also be assessed.

Understanding the impact of shipping and port infrastructure is also important. As population increases so will these activities, and continued diligence in monitoring and understanding the impact of shipping is required. Some of the deep reefs of Port Phillip Bay (such as the popular Cathedral Reef) are located on the edges of the shipping lanes.

Fishing and shipping also contribute to the threat of pollution directly through tackle line litter and oil spills.

Understanding Marine Systems

UNDERSTANDING THE INTERTIDAL SYSTEM

The intertidal system is a critical ecosystem within the marine environment, particularly in Western Port (see **Intertidal habitats and dependent species**). Understanding the interaction between seagrass, soft sediments, mangrove, saltmarsh and the water column habitats is critical for maintaining system health.

Research priorities for vegetated soft sediments include:

- understanding vegetated intertidal soft sediments, and establishing indicators based on seagrass, shorebirds and fish
- monitoring species, because the bays are home to rare species that have not been found elsewhere
- a survey to compare current biodiversity of soft sediments in Western Port with past records and adjacent bays. Researchers could also use this information to assess various disturbances and invasive species.
- understanding the functional roles of benthic organisms[4]
- exploring the sediment delivery to mangrove and saltmarsh
- examining the impact of elevated nutrients on vegetation structure.[5]

Further studies on how birds (and bats) use the intertidal habitats are also important. An estimated 30–40 species of birds inhabit the intertidal habitats of Port Phillip Bay and Western Port. These species are distributed across the habitats. Some are attracted to the exposed soft sediments, others to the fresh water inputs or the open saltmarsh (like the endangered orange-bellied parrot), and others to the ponding water, both fresh and salt.

The intertidal habitats are the most 'visible' marine environments, located adjacent to human population, but also the most vulnerable to development and other threats. Given this, further studies should consider coastal dynamics such as the link between sediment delivery and surface elevation, and erosion patterns in the bays, to improve coastal management and protection.

Erosion is complex and different erosion types have different effects. There needs to be better understanding of the role of elevation, erosion, sediment provenance (the original source of sediments being deposited), sedimentation rates, and the impacts of storm surges in intertidal habitats in the bays, as sea level rise impacts these ecosystems.

UNDERSTANDING THE SUBTIDAL SYSTEM

The current CSIRO study to propose future indicators for the bays (due in 2017) has provisionally recommended the following assessments for subtidal systems to improve management outcomes:

- For unvegetated subtidal soft sediments: indicators of ecosystem health based on nitrogen gas, ammonia in the sediment, and oxygen are the priority.
- For vegetated subtidal soft sediments: indicators of ecosystem health based on *Zostera* seagrass, epiphytic algae, and juvenile fishes are the priority.
- For vegetated subtidal rocky reefs: indicators of ecosystem health based on reef fish, urchin grazing pressure, and canopy forming algae are the priority.

There is very limited knowledge of the deep reefs, reducing the potential to effectively manage the bays. The social and economic value of these deep reefs is significant. They are tourist and recreational attractions – the most visited diving sites in Victoria – and some of the deep reefs lie within the shipping lanes. The deep reefs also impact on broader ecological processes in the region.

Possible further research includes understanding how sponge communities maintain water quality through filter feeding.

Endnotes

1 Boon PI 2011, 'Saltmarsh', in ***Understanding the Western Port environment: a summary of current knowledge and priorities for future research***, Melbourne Water, Melbourne, pp. 116–33.

2 Saintilan N, Rogers K and Tomkins K (in press), ***Mangroves, saltmarshes, sedimentation and sea level***, Macquarie University and University of Wollongong.

3 Yeates, P. and Okely, P. (2016) ***Western Port SEPP Loads Modelling Strategy, Development and Scenarios***, Report by Hydronumerics for EPA Victoria.

4 Melbourne Water 2011, ***Understanding the Western Port environment: A summary of current knowledge and priorities for future research***, Melbourne.

5 Saintilan N, Rogers K and Tomkins K (in press), ***Mangroves, saltmarshes, sedimentation and sea level***, Macquarie University and University of Wollongong.

6 DELWP advise that work undertaken by CSIRO has confirmed a provisional set of indicators for future *State of the Bays* reporting. These indicators will be published on the OCES website in 2017.

Aracana ornata
Ornate cowfish

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Spatial data is sourced from the Victorian Spatial Data Library.

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