

PARKS VICTORIA TECHNICAL SERIES

NUMBER 78

# Marine Natural Values Study Vol 2: Marine Protected Areas of the Victorian Embayments Bioregion Part 2 Western Port Bay & Corner Inlet

*Jan Barton, Adam Pope and Steffan Howe*

*August 2012*

State Government Victoria

Parks Victoria

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First published 2012

Published by Parks Victoria
Level 10, 535 Bourke Street, Melbourne Victoria 3000



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National Library of Australia
Cataloguing-in-publication data

Includes bibliography
ISSN 1448-4935

**Citation**

Barton, J., Pope, A. and S. Howe (2012) Marine Natural Values Study Vol 2: Marine Protected Areas of the Victorian Embayments Bioregion, Part 2 Western Port Bay & Corner Inlet. Parks Victoria Technical Series No. 78. Parks Victoria, Melbourne.

Printed on environmentally friendly paper

Parks Victoria Technical Paper Series No. 78

# Marine Natural Values Study (Vol 2)

# Marine Protected Areas of the Victorian Embayments Bioregion

## Part 2
## Western Port Bay & Corner Inlet

**Jan Barton, Adam Pope and Steffan Howe***

**School of Life & Environmental Sciences**
**Deakin University**
***Parks Victoria**

**August 2012**

# EXECUTIVE SUMMARY

Along Victoria's coastline there are 30 Marine Protected Areas (MPAs) that have been established to protect the state's significant marine environmental and cultural values. These MPAs include 13 Marine National Parks (MNPs), 11 Marine Sanctuaries (MSs), 3 Marine and Coastal Parks, 2 Marine Parks, and a Marine Reserve, and together these account for 11.7% of the Victorian marine environment. The highly protected Marine National Park System, which is made up of the MNPs and MSs, covers 5.3% of Victorian waters and was proclaimed in November 2002. This system has been designed to be representative of the diversity of Victoria's marine environment and aims to conserve and protect ecological processes, habitats, and associated flora and fauna. The Marine National Park System is spread across Victoria's five marine bioregions with multiple MNPs and MSs in each bioregion, with the exception of Flinders bioregion which has one MNP. All MNPs and MSs are "no-take" areas and are managed under the *National Parks Act (1975) - Schedules 7 and 8* respectively.

This report updates the first Marine Natural Values Study (Plummer *et al.* 2003) for the MNPs in the Western Port Bay (WP) and Corner Inlet (CI) areas of the Victorian Embayments bioregion. It covers Yaringa, French Island, Churchill Island and Corner Inlet MNPs. This report is one of a series of five reports covering Victoria's Marine National Park System. It uses the numerous monitoring and research programs that have increased our knowledge since declaration and aims to give a comprehensive overview of the important natural values of each MNP.

The Victorian Embayments bioregion is a discontinuous region that includes all Victorian bays, inlets and estuaries to a minimum water area of > 1 $km^2$ (IMCRA 1998b; IMCRA 2006). In this bioregion only Port Phillip Bay, Western Port Bay and Corner Inlet contain MPAs. The bioregion has a moist temperate climate, varying west to east in runoff and seasonality, and has more variable water temperature and salinity than the open coast. The embayments vary in form but their maximum depth is generally < 20 m. The biota of the Victorian embayments include a diverse range of biotic assemblages found in estuarine and open coast environments depending on the water body's characteristics (Parks Victoria 2003; IMCRA 2006).

Aboriginal tradition indicates that Yaringa, French Island and Churchill Island MNPs are all part of *Country* of Boonwurrung people. Corner Inlet MNP is part of *Country* of *Yiruk* for the Gunai / Kurnai and *Wamoom* for the Boonwurrung Indigenous people.

All four MNPs are within the Ramsar wetlands of Western Port and CI, and form part of the East Asian-Australasian Flyway for migratory waders (Parks Victoria 2005; Parks Victoria 2007). All the MNPs also include Special Protection Areas for Natural Values to protect wading bird habitat. In WP MNPs this covers saltmarsh and mangrove areas and access is prohibited; in Corner Inlet all of the MNP, except Bennison Channel is covered and the area is designated to protect seagrass as well as bird habitat.

Important natural values of WP and CI MNPs include and are associated with saltmarsh, mangroves, sheltered intertidal mud and sand flats, seagrass beds and subtidal soft sediments. The MNPs are heavily influenced by tides that expose and submerge large expanses of mudflats and associated seagrass beds with subtidal areas largely confined to channels. French Island, Churchill Island and Corner Inlet MNPs all have sandy beaches and spits, and cobbly or gravelly intertidal and subtidal reefs; particularly around the islands in French Island and Corner Inlet MNPs. Solid subtidal reefs also occur in Corner Inlet MNP.

Saltmarsh (where present), mangrove, seagrass and mudflat habitats have been mapped within the four MNPs (Ball *et al.* 2010; Victorian Saltmarsh Study 2011). Small areas of

saltmarsh communities are important in Yaringa, Churchill and Corner Inlet MNPs. Yaringa MNP saltmarsh consists of at least five different saltmarsh types with small patches of Wet Saltmarsh Herbland occuring in Churchill Island and Corner Inlet MNPs (Victorian Saltmarsh Study 2011). Specific studies of the flora and fauna of these saltmarsh habitats have not been undertaken in the MNPs, but generally they are considered breeding and nursery grounds for many organisms including microcrustacea, bivalves and fish.

Mangroves are important natural values of Yaringa and French Island MNPs, with small areas also found in Churchill Island and Corner Inlet MNPs (Victorian Saltmarsh Study 2011). Yaringa MNP has the most extensive area of mangroves in WP. The Mangrove Shrublands in all four MNPs consists of the white mangrove *Avicennia marina* subsp. *australasica,* the only species of mangrove in Victoria. In Churchill Island MNP the dominant mangrove epifauna is the barnacle *Elminius covertus*, also common is the littorinid *Bembicium auratum* (Satumanatpan *et al.* 1999). Its mangrove fringes are also inhabited by crabs and, at high tide, by fish such as gobies, mullet and toadfish. Little specific information is known for the flora and fauna of the Mangrove Shrublands of the other MNPs.

The Corner Inlet region is the only Victorian Embayment containing the large seagrass *Posidonia australis*; in the northern part of Corner Inlet MNP it is found in extensive beds (Ball *et al.* 2010). Other seagrasses *Zostera muelleri, Heterozostera nigricaulis* and *Halophila australis* are also important natural values in all four MNPs (Blake and Ball 2001; Ball *et al.* 2010). The short eelgrass *Zostera muelleri* tends to be the dominant intertidal seagrass in all four MNPs but is indistinguishable from long eelgrass *Heterozostera nigricaulis* in aerial mapping. Dense *Zostera/Heterozostera* beds are extensive in Churchill Island MNP and large beds are also found in French Island MNP along with areas of less dense seagrass and algae (Ball *et al.* 2010). Yaringa seagrass beds consist of sparse to medium density *Zostera/Heterozostera* with very little algae (Blake and Ball 2001). *Zostera/Heterozostera* occurs in patchy beds of all densities in Corner Inlet MNP (Ball *et al.* 2010). Patches of the paddleweed *Halophila australis* grow in French Island and Corner Inlet MNPs (Ball *et al.* 2010). The intertidal soft sediments of Churchill Island are known to have abundant microalgae growing on their surface (Butler and Bird 2010).

Common in the intertidal seagrass beds in French Island and Corner Inlet MNPs are the pulmonate gastropod family Amphibolidae, and pandalid and hippolytid shrimps (Ball *et al.* 2010). The dialid gastropods are also common in Corner Inlet MNP (Ball *et al.* 2010). The ghost shrimp *Biffarius arenosus* can be abundant in the intertidal mudflats of Yaringa and French Island MNPs (Butler and Bird 2010). Also common are the polychaete worms *Barantolla lepte* and *Lumbrineris* sp. in Yaringa, French and Churchill Island MNPs. The sentinel crab *Macrophthalamus latifrons* is common in both Yaringa and Churchill Island MNP, along with the bivalve molluscs *Musculista senhousia* in Yaringa MNP and *Tellina deltoids* in Churchill Island MNP (Butler and Bird 2010). The horseshoe worm *Phoronopsis albomaculata* is also common in Churchill Island MNP (Butler and Bird 2010). The assemblage structure of epifaunal communities in the intertidal seagrass beds in Corner Inlet MNP is determined more by tidal immersion and location than by seagrass species and physical structure (Ball *et al.* 2010).

Subtidal seagrass generally supports much higher densities of invertebrates than intertidal seagrass beds (Ball *et al.* 2010). Dialids, mysid shrimps and dexaminid amphipods are at much higher densities in the subtidal seagrass than in the intertidal seagrass in French Island (Ball *et al.* 2010). Mysids are the most abundant invertebrate in the *P. australis* beds in Corner Inlet. Also abundant are shrimps from the Pandalidae and Hippolytidae families, amphipods from the Dexaminidae and Corophiidae families and top shells from the family Trochidae (Ball *et al.* 2010).

Subtidal seagrass beds are important fish habitats (Figure 1). In Yaringa MNP they are an important habitat of yelloweye mullet *Aldrichetta forsteri* and smooth toadfish *Tetractenos glaber* are abundant, along with common galaxid *Galaxias maculatus*, short fin eel *Anguilla australis*, tupong *Pseudaphritis urvillii,* gobies, bridled *Arenigobius bifrenatus,* eastern blue spot *Pseudogobius* and glass *Gobiopterus semivestitus* (Warry and Reich 2010). Specific fish surveys have not been done in the other MNPs but the seagrass beds are regarded as important nursery areas for many fish, leatherjackets, conservation listed syngnathids (seahorses and pipefish) and small juvenile fish. Rock flathead *Platycephalus laevigatus* and juvenile whiting *Sillaginodes punctata* are also associated with seagrass beds in French Island and Corner Inlet MNPs (Ball *et al.* 2010). Fish associated with the subtidal sediments and in the channels, include stingrays, perch, flathead, and gobies (Parks Victoria 2005; Parks Victoria 2007).

Subtidal habitat in all four MNPs is a mix of channels and flats. The WP MNPs have shallow channels, with extensive flats in Churchill MNP. Corner Inlet MNP northern section has shallow subtidal flats and channels with some deep subtidal channels contrasting with the predominantly intertidal southern section. The dendritic networks of subtidal channels in the MNPs provide a habitat for a range of fish and invertebrate species. The sea pen *Sarcoptilus grandis* and the brachiopod lamp shell *Magellania flavescens* are abundant in French and Churchill Island MNPs (Parks Victoria 2007). The brooch shell *Neotrigonia margaritacea* and the mud ark *Anadara trapezia* are also found in French Island MNP (Parks Victoria 2007). Subtidal habitat in the MNPs can be seagrass beds or bare sediment, channels are often bare (Blake and Ball 2001; Ball *et al.* 2010).

The sediment in the deeper channels tends to be coarse because of the strong currents and has a different fauna than the shallow mudflats. Gastropods, sea stars, urchins and ascidians are often found on the surface of the channel sediment in Corner Inlet MNP (Parks Victoria 2005). Subtidal cobbly reef occurs around the islands in French Island and Corner Inlet MNP. Sections of deep, continuous, subtidal reef are found along the shore of Bennison Channel in the northern section of Corner Inlet MNP. There have been no surveys of subtidal reef flora or fauna in the MNPs.

All the MNPs support species of high conservation significance. The MNPs and their surrounds provide important feeding and roosting habitat for conservation listed shore and sea birds, from 24 species in Corner Inlet MNP to 41 in Churchill Island MNP. All four MNPs protect feeding areas of internationally important migrant birds, from 14 species in Corner Inlet MNP to 29 species in Churchill Island MNP. Thirty two to 40 species of marine flora and fauna could be at their distributional limits within the three WP MNPs, and ten in Corner Inlet MNP.

Specific threats to individual MPAs include increased sediment and nutrient inputs from their catchments or activities outside the MNPs, invasive marine pests (two species so far established in Churchill Island and Corner Inlet MNPs, as well *Musculista senhousia* in Yaringa MNP), marine pollution, coastal erosion, litter, increasing urbanisation, disturbance of shorebirds by humans and foxes and propeller scour (Carey *et al.* 2007b). Climate change also represents a serious threat to marine ecosystems but the specific ecological consequences are not well understood in marine systems. Predicted changes in physical environmental conditions have the potential to impact all marine habitats, causing loss of habitats, decreases in productivity and reproduction and distribution of species. Species thought to be at the limit of their distributional range in the bioregion could be particularly vulnerable to climate change.

Parks Victoria has established research programs for the MPAs that address important management challenges, focussing both on improving baseline knowledge of the MPAs as well as applied management questions not being addressed by others. This knowledge will continue to enhance Parks Victoria's capacity to implement evidence-based management through addressing critical knowledge gaps. Much of the research has been undertaken as part of the Parks Victoria's Research Partners Panel program involving collaboration with research institutions. Statewide projects are currently underway to photograph and document marine natural values, to determine which MPAs are most at risk from introduced species and to detect poaching.

Most of our detailed knowledge about the flora and fauna of the MPAs is from individual recent research projects; apart from Sea Search in Corner Inlet there are no ongoing marine monitoring programs and at present we have limited knowledge of the specific flora and fauna of the subtidal zone. Major gaps in our understanding of the natural values of Victorian Embayments MPAs are the lack of knowledge about the species associated with mangroves, unvegetated subtidal sediments, deeper subtidal channels, and limited intertidal and subtidal reefs. Whilst threats to the MPAs have been identified we have limited knowledge of the effect of those threats on natural values.

**Figure 1**. Banded stingaree *Urolophus cruciatus* in Corner Inlet Marine National Park. Photo by Mark Norman, Museum of Victoria.

# ACKNOWLEDGEMENTS

This project was undertaken for Parks Victoria and principally managed by Steffan Howe. We would also like to thank Tony Varcoe for his project management. Thank you to Parks Victoria's research partners who implemented many of the research projects cited in this report. Thank you to Anthony Boxshall who managed many of the earlier research partner projects cited in the report. Thank you to Richard Zavalas for creating the maps, Jacquomo Monk and Alex Rattray for GIS assistance and Margie Morrice for her fine editing. Thank you to all that generously made their photos available for this report.

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# ACRONYMS

AME - Australian Marine Ecology
C - listed under CAMBA
CAMBA - Chinese Australia Migratory Bird Agreement
CR - Critically Endangered
CSIRO - Commonwealth Scientific and Industrial Research Organisation
DPI - Department of Primary Industries
DSE - Department of Sustainability & Environment
EAC - East Australian Current
ECC – Environment Conservation Council
EN - Endangered
EPBC - *Environment Protection Biodiversity Conservation Act 1999*
FFG - *Flora and Fauna Guarantee Act 1988*
GIS - Geographic Information System
J - listed under JAMBA
JAMBA - Japan Australia Migratory Bird Agreement
IMCRA - Integrated Marine and Coastal Regionalisation of Australia
IRMP - Intertidal Reef Monitoring Program
IUCN - International Union for Conservation of Nature
L - listed under FFG
LCC - Land Conservation Council
LiDAR - Light Detection And Ranging
MAFRI - Marine & Freshwater Research Institute,
MAVRIC - Monitoring and Assessment of Victoria's Rocky Intertidal reefs
MNP - Marine National Park
MNVS - Marine Natural Values Study
MPA - Marine Protected Area
MS - Marine Sanctuary
MV - Museum Victoria
NT - Near Threatened
PE – presumed to be at or near eastern limit in MPA
PIRVic - Primary Industries Research Victoria
PN – presumed to be at or near northern limit in MPA
PPB – Port Phillip Bay
PW – presumed to be at or near western limit in MPA
PV Parks Victoria
RE – recorded to be at eastern limit in MPA
RPP – Research Partners Panel
RW – recorded to be at western limit in MPA
ROV - remote operated vehicle
SRMP - Subtidal Reef Monitoring Program
VU - Vulnerable
VROTS - Victorian Rare or Threatened Species
WPB – Western Port Bay

# 1 Introduction

## 1.1 Victoria's Marine Protected Areas

Victoria's marine environment has been classified into five bioregions (Otway, Central Victoria, Flinders, Twofold Shelf and Victorian Embayments (Figure 2, IMCRA 2006). Within each marine bioregion there is a variety of distinct and unique habitats and biological communities, structured by a combination of physical, chemical and biological processes (Parks Victoria 2003). These bioregions reflect how physical processes, in particular, have influenced the distribution of ecosystems and biodiversity over scales of 100 – 1000 km (mesoscales). General habitats include intertidal rocky reefs, shallow rocky reefs, deep rocky reefs, pelagic waters, intertidal sandy (beaches) and muddy (mudflats) soft sediments and subtidal sandy and muddy soft sediments. Habitats are also formed by certain types of plant and animal species. Biological habitats include kelp forests on shallow rocky reefs, sponge and coral gardens on deep rocky reefs, seagrass on sandy sediments and rocky reefs, and mangrove and saltmarsh on sheltered intertidal sediments. The flora and fauna is generally quite different between these habitat types. The types of species and their abundances in any particular habitat can vary along more subtle environmental gradients, particularly gradients in wave exposure, depth and light availability (Parks Victoria 2003).

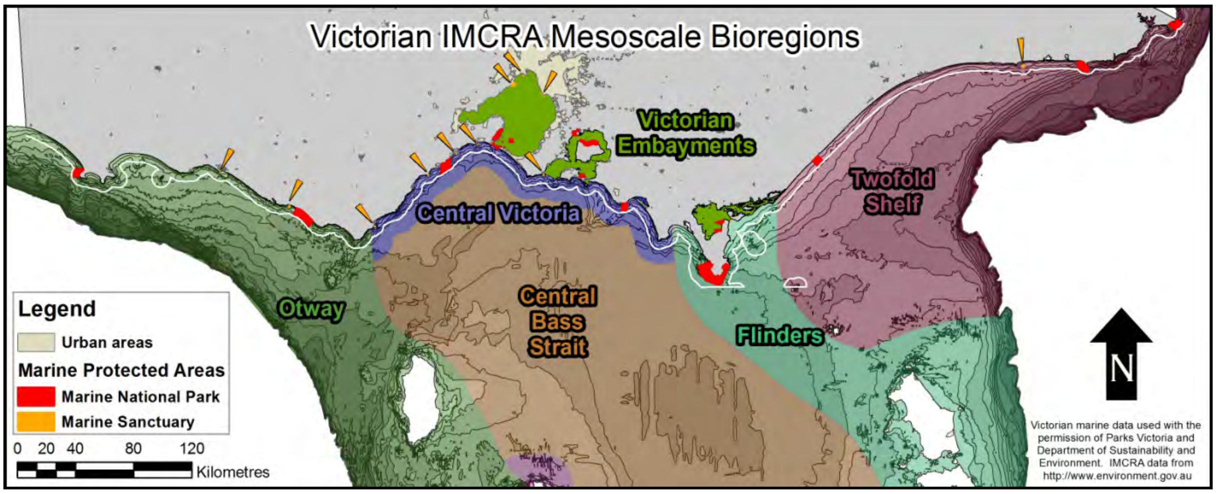


**Figure 2**. Locations of IMCRA mesoscale (*i.e.* 100 - 1000km) bioregions (IMCRA 2006 v4)

Victoria's system of Marine National Parks (MNPs) and Marine Sanctuaries (MSs) was established under the *National Parks Act (1975)* and gazetted in November 2002 (Power and Boxshall 2007). It was established to conserve and protect the diversity of Victoria's marine environment, its ecological processes, habitats and associated flora and fauna (Parks Victoria 2003).

Sites for the Marine Protected Areas (MPAs) were chosen to be representative of the diversity of Victoria's marine environment (ECC 2000) and the 24 parks are spread across Victoria's five marine bioregions (Figure 2). More than one park and/or sanctuary was usually selected within each bioregion, to reflect as far as possible the range of habitats and biological communities within each, to incorporate the variability within habitats, and to insure against loss due to unforeseen or future catastrophic events (Parks Victoria 2003). These parks and sanctuaries now protect 5.3 % of Victoria's coastal waters, incorporating important marine habitats and species, significant natural features, cultural heritage and aesthetic values (Parks Victoria 2003). The MPAs are highly protected areas where no fishing, extractive or damaging activities are allowed but to which access is unrestricted. Recreation, tourism, education and research are encouraged and properly managed (Power and Boxshall 2007). Marine Sanctuaries are much smaller than MNPs. MPAs are generally classified Category II (MNP) and III (MS) under the International Union for Conservation of Nature (IUCN) classification (Power and Boxshall 2007); the exceptions are Point Cooke, Ricketts Point and Beware Reef MSs which are all IUCN Category II. There are also Marine Parks, Marine Reserves, and Marine and Coastal Parks which have the primary objective of conservation but allow a larger range of ecologically sustainable uses than MNPs or MSs (Parks Victoria 2003).

## 1.2 Purpose of Report

Since declaration of Victoria's system of MPAs and release of the first Marine Natural Values Study (MNVS) in September 2003 (Plummer *et al.* 2003) there have been ongoing monitoring and research programs aiming to increase our knowledge about the MPAs. Programs commissioned by Parks Victoria include habitat mapping, intertidal and subtidal reef monitoring, statewide and individual MPA risk assessment as well as various research projects (reports from which are available online at http://www.parkweb.vic.gov.au). These programs have considerably increased our knowledge of the habitats, and flora and fauna of Victoria's 13 MNPs and 11 MSs. The primary aim of this report is to add this new knowledge to the identification and description of the natural values associated with Victoria's MPAs.

Natural values are defined as the parts of the environment valued by people and are considered to be a proxy for biodiversity and natural processes. They are also the basis of Parks Victoria's Adaptive Management Framework (Power and Boxshall 2007). The natural values of Victoria's MPA system incorporate qualities such as distinct physical environments and processes, the diversity and arrangement of marine habitats, ecological communities (including their diversity, richness and important biological processes) as well as species of particular conservation significance (Power and Boxshall 2007).

This report updates the first MNVS (Plummer *et al.* 2003) for the Victorian Embayments bioregion specifically the MPAs within PPB and is one of a series of five reports covering Victoria's MPAs. It aims to give a comprehensive overview of the important natural values of each MPA that will assist in park management within the region. The report will also provide a resource for education and public recognition of the natural values of the MPAs in the Flinders and Twofold Shelf bioregions.

## 1.3 Structure

This report firstly describes the Victorian Embayments bioregions and the MPAs within PPB. This report then identifies and describes the specific natural values on a park by park basis, including maps of the available spatial data. Research undertaken within each MPA is identified and the findings of that research in relation to the parks' natural values are discussed. The report also discusses the major threats to the natural values as identified by a comprehensive risk assessment conducted by Carey *et al.* (2007a; 2007b). Knowledge gaps for each MPA are identified and highlighted. Marine Parks, Reserves and Marine and Coastal Parksare not specifically addressed in this report.

## 1.4 Methods

The information within the original MNVS (Plummer *et al.* 2003) was used as a starting point and guide for this report. Bioregional scale physical, habitat and biota assemblage characteristics were derived from mostly pre-declaration sources (*i.e.* LCC 1993; ECC 2000; Ferns and Hough 2000; IMCRA 2006). Technical reports and papers from the Parks Victoria MPA monitoring and research programs and other research conducted since the first natural values report were reviewed and incorporated. The aim was to achieve consistency in the basic level of information presented for each MPA and to highlight knowledge gaps.

This report used existing spatial data in a geographic information system (GIS) format to assist in determining the physical and biological characteristics of natural values for each MPA. The available spatial layers included:

- MNP and MS boundary (for calculating areas of MPAs; Parks Victoria, PV);
- Victorian Coastline at 1:25,000 (for calculating shoreline lengths; Department of Sustainability & Environment, DSE);
- Marine substrata for Victoria's open coast (derived from Landsat imagery and hydro-acoustic mapping, Marine & Freshwater Research Institute, MAFRI and CSIRO);
- Marine substrata for shallow marine habitats (derived from aerial photography and Landsat imagery and video ground truthing; Primary Industries Research Victoria, PIRVic for PV);
- Marine substrata and habitats in Victoria MNPs (from hydro-acoustic mapping, video ground truthing and modelling as part of a joint venture between Parks Victoria and the Coastal CRC; involving the University of Western Australia, Fugro Pty Ltd and Deakin University);
- Bathymetry for Bass Strait (1:250,000) and bays and inlets (1:25,000) (MAFRI database and sourced from Victorian Channel Authority and Australian Hydrographic Office databases);
- Detailed bathymetry for shallow waters from Light Detection And Ranging (LiDAR) (DSE);
- Shoreline coastal type (Oil Spill Response Atlas – MAFRI);
- Vicmap watercourse 1:25000 (used to identify fresh water sources; metadata at http://www.giconnections.vic.gov.au/content/vicgdd/record/ANZVI0803002490.htm);
- Shorebird habitats and roosts (Oil Spill Response Atlas and DSE);
- Victorian Threatened Fauna database point records (DSE);
- Atlas of Victorian Wildlife point records (DSE); and
- Sites of Geological and Geomorphological Sites of Significance (Minerals and Petroleum Victoria).

In addition to these spatial databases, a number of digital datasets provided quantitative and descriptive information about habitats and species in and around the MNPs and MSs. The primary datasets used in this study:

- Intertidal and Subtidal Marine Monitoring Programs (IRMP and SRMP, Australian Marine Ecology for PV);
- Sea Search Community Based Monitoring Program (PV); and
- Monitoring and Assessment of Victoria's Rocky Reefs (Monitoring and Assessment of Victoria's Rocky Intertidal reefs, MAVRIC, Museum Victoria).

The assessment of marine habitat distribution included new shallow (< 10 m) and deeper subtidal mapping of bathymetry, substrates and biota as well as previous mapping. Not all MPAs had the same data from monitoring, survey or research so a tiered approach was taken, especially with the substrate and habitat descriptions and maps. All MPAs have broad level (*i.e.* 1:250,000 scale) bathymetry and substrate mapping. All MPAs also have high resolution bathymetric mapping in shallow waters derived from aerial LiDAR surveys. Some MPAs have high resolution hydroacoustic mapping that, with video ground truthing, allows the bathymetry and substrate to be mapped and modelled respectivelyat finer scales. This substrate mapping and modelling can be extended to broad habitat mapping for some MPAs. Descriptions of marine ecological communities were derived from new monitoring and mapping reports as these generally had a greater level of detail and more sites than previous research.

Detailed multi-category Ecological Vegetation Class mapping in the Victorian Saltmarsh Study (2011) was reclassified to allow clearer display on the maps as follows:

- Any mapped area containing Mangrove Shrubland, either singly or in mosaic were grouped as ‘Mangrove’;
- Any mapped area containing Estuarine Wetland or Saline Aquatic Meadow, either single or in mosaic were grouped as as ‘Wetland’; and
- All remaining mapped areas (except bare and terrestrial categories) were grouped as ‘Saltmarsh’.

Species of conservation significance, particularly species distribution information, were derived from new research, monitoring and mapping reports. Species from the Atlas of Victorian Wildlife recorded near and within MPAs were included in the lists of species of conservation significance for each MPA. Constraints were made on the database searches to ensure all records were for animals in the marine habitats in or near (*i.e.* within 5 km) individual MPAs. All animals not found below the high water limit were excluded. Records of dead animals were not included in this report.

Threats to natural values were derived from lists of hazards and associated risks in Carey *et al.* (2007b). These were the result of a statewide consultative process to identify threats to MPAs. Through public and agency workshops, the natural values in individual MPAs and the threats that could affect them over the next 10 years were identified. This list of hazards was then ranked (low, medium, high and extreme) by the risk posed by each hazard (Carey *et al.* 2007b). The threats listed in this report are the hazards identified as having an extreme risk. The outputs from the workshops have informed Parks Victoria in their management planning process and prioritisation of research gaps and on ground works.

Data gaps were identified for each MPA as existing information was reviewed.

Results from Parks Victoria monitoring and research programs and other databases were used to produce a non-comprehensive checklist of species known to be part of the intertidal and subtidal reef flora and fauna in MPAs in the Port Phillip Bay section of the Victorian Embayments bioregion (Appendix 1, Figure 3).

**Figure 3**. Great spider crab *Leptomithrax gaimardii* in French Island Marine National Park. Photo by Julian Finn, Museum of Victoria.

## 1.5 Victorian Embayments Bioregion

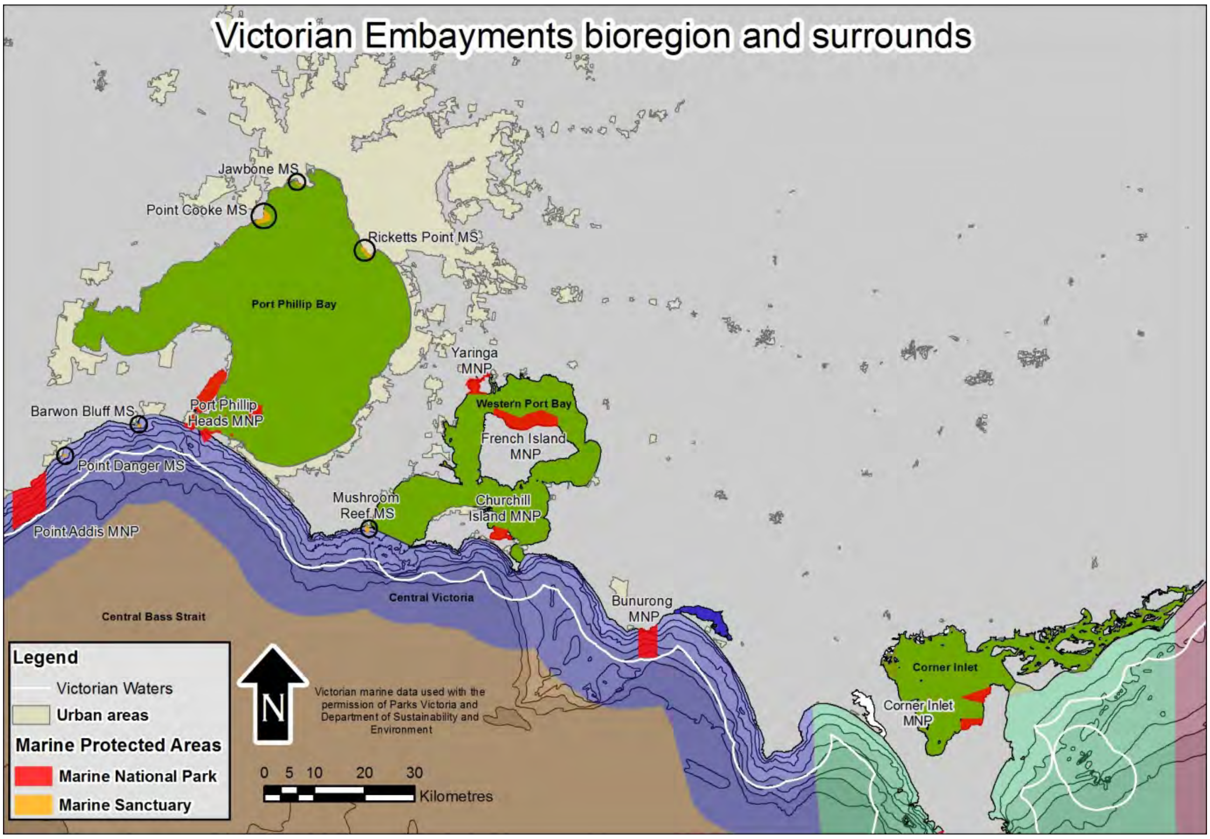


**Figure 4**. Victorian Embayments with IMCRA mesoscale bioregions, Marine National Parks and Marine Sanctuaries.

The Victorian Embayments bioregion is a discontinuous region that contains the major embayments, inlets and some of the major estuaries along the Victorian coast (Figure 4, IMCRA 2006). Within the bioregion, there are five MNPs, Port Phillip Heads in Port Phillip Bay, Yaringa, French Island, Churchill Island in Western Port, and Corner Inlet. Port Phillip Heads MNP is discontinuous and consists of six sites in the southern region of Port Phillip Bay. Three MSs, Point Cooke, Jawbone and Ricketts Point in Port Phillip Bay, also occur in the bioregion. The climate is moist temperate, with a pronounced west to east variation in catchment run off and seasonality. Variations in salinity and temperature are much higher than on the open coast (Parks Victoria 2003). The embayments have a variety of forms from drowned river valleys to impounded drainage behind dune barrier systems, their maximum depth is generally less than 20 m, but reaches depths of approximately 50 metres in Port Phillip Heads. They have low energy coastlines with large tides, influencing the extensive areas of subtidal and intertidal sediments. Rock outcrops are limited mainly to the margins (IMCRA 2006). Some shallow reef areas are present in Port Phillip and Western Port (Parks Victoria 2003). The biota of the Victorian embayments include a diverse range of biotic assemblages found in estuarine and open coast environments depending on the embayments morphological and hydrological characteristics (Parks Victoria 2003; IMCRA 2006). Port Phillip Bay is a marine embayment with deep central muds; eastern sandy shores, *Pyura* beds and shallow reef habitats; and sheltered reef, seagrass, drift algae and estuarine habitats in the west. The benthic assemblages in the muddy central region are distinct from those in the sand to the west and east. The areas of Swan Bay, Mud Islands and along the west coast support important bird habitat and are listed as Ramsar Sites.

Western Port Bay and Corner Inlet are large muddy estuaries with extensive mudflats, mangroves, saltmarshes and seagrass beds (IMCRA 2006). Western Port is a highly tidal environment characterised by a network of sediment channels and intertidal mud flats.

Significant tracts of mangroves and saltmarsh habitat occurs around the fringes of Western Port and remnant patches of intertidal and shallow subtidal seagrass occur on the mudflats. Western Port is an important bird feeding and roosting area and is a Ramsar wetland site. Significant marine communities include those of Crawfish Rock, San Remo and sediment channels. The rare and listed ghost shrimps *Michelea microphylla*, *Eucalliax tooradin* and *Paraglypturus Tooradin* are only known from the North Arm sediment channel of Western Port (Edmunds *et al.* 2010a).

Corner Inlet and Nooramunga has very large intertidal mudflat areas and substantial fringing mangrove stands. The intertidal and subtidal sediment banks also support stands of four species of seagrass, including significant stands of *Posidonia australis* which is largely restricted to Corner Inlet in Victoria (Edmunds *et al.* 2010a). Corner Inlet also has an extensive network of sediment channels. This inlet is listed as a Ramsar wetland, being a significant wetland for waterfowl. Listed species include the sea cucumber *Trochodota shepherdi* in seagrass beds of Nooramunga and Corner Inlet and the brittlestars *Amphiura trisacantha* and *Ophiocomina australis* in seagrass beds of Nooramunga (Edmunds *et al.* 2010a).

Gippsland Lakes includes a system of estuarine lakes with considerable areas of seagrass, estuarine grass *Ruppia* spp*.* and saltmarsh habitat (Edmunds *et al.* 2010a). This region is listed as a Ramsar site. The environment in Gippsland Lakes has been highly modified through construction of the permanent opening to the sea at Lakes Entrance and changes to riparian vegetation and river flows. The smaller Andersons Inlet, Shallow Inlet and Mallacoota Inlet are important wetland and water fowl sites.

## 1.6 Other Victorian Bioregions

The Otway Marine bioregion extends from Cape Jaffa in South Australia to Apollo Bay and the western Bass Strait islands such as King Island (IMCRA 2006, Figure 2). In Victoria it contains two MNPs, Discovery Bay and Twelve Apostles, and two MSs, Merri and The Arches. It has a cool temperate climate and waters, with localised coastal upwellings in the west. The sea temperature is generally 2 – 3 °C lower than in the other Victorian bioregions (Parks Victoria 2003). The tidal range is microtidal (0.8 to 1.2 m). It is subject to the greatest wave action in Victoria, being nearly continuously subjected to large predominantly south-west swells generated in the Southern Ocean (Parks Victoria 2003). Its high energy coastline has headlands of volcanic outcrops and limestone cliffs. Sandy beaches and dunes are common in the western region and cliffed shorelines are common elsewhere (IMCRA 2006). Marine habitats also include rocky rubble, steep drop-offs at the base of cliffs, sandy soft sediments and extensive offshore reefs (Parks Victoria 2003). Seagrass beds occur in the lee of reefs (IMCRA 2006). The biota of this region consists predominantly of cosmopolitan, southern temperate and western temperate species that are well adapted to the colder, rough water conditions (Parks Victoria 2003). For many macroalgal communities, this region forms the westward limit of a number of species (IMCRA 2006). Plant species diversity is very high, particularly among the red algae. Fish and plant species-richness are both high compared to other South Australian, Victorian and Tasmanian regions (IMCRA 2006).

The Central Victorian Bioregion extends from Apollo Bay to Cape Liptrap, it does not include Port Phillip Bay and Western Port, which are included in the Victorian Embayments Bioregion (IMCRA 1998a). Within the Central Victoria Bioregion, there are two MNPs, Point Addis and Bunurong, and five MSs, Marengo Reef, Eagle Rock, Point Danger, Barwon Bluff and Mushroom Reef. It has a temperate climate with moist winters and warm summers. The shore is characterised by cliffs with sandy beaches and has the western-most occurrence of granites in its eastern region. Offshore gradients are steep in the east to very steep in the west (IMCRA 1998a). It is relatively exposed to swells and weather from the south-west, but less so than the Otway Bioregion (Parks Victoria 2003). Sea surface temperatures are representative of Bass Strait waters and wave energy is moderate (IMCRA 1998a). Tides change from twice to four times a day from west to east (IMCRA 1998a). The habitats include shallow near-shore reefs and sandy beaches along with large areas of subtidal sandy sediment and patchy, low profile subtidal reef. Reefs can be limestone, basalt, granite or mudstone (Parks Victoria 2003). The limestone reefs are usually offshore from a surf beach and readily erode to provide a complex habitat for a diverse array of macroalgae, sponges, bryozoans, corals and ascidians as well as mobile crevice dwellers (Parks Victoria 2003). The dominant biota of this region consists of a diverse mixture of species from all of the adjacent biogeographical provinces – western, eastern and southern temperate species – in addition to cosmopolitan southern Australian species (Parks Victoria 2003).

The Flinders Bioregion encompasses Wilsons Promontory and the eastern Bass Strait islands of the Furneaux Group in Tasmania (IMCRA 2006; Figure 2). In Victoria, it contains one MNP, Wilsons Promontory, and no Marine Sanctuaries. It has a cold temperate climate. It has less exposure to swells compared with the other bioregions (Parks Victoria 2003). However, this region is subject to high current flows and high winds, with some influences from local and regional upwellings and current boundaries (*e.g.* East Australian Current, EAC). The winds can create substantial surface waves, affect local currents and cause turbidity (Parks Victoria 2003). Wave exposure is moderate but higher on the western side of Wilsons Promontory than on the eastern side. The tidal range is macrotidal. The coastline is predominantly granite headlands and promontories with long sandy beaches in between. Shores plunge steeply onto a sandy sea floor (IMCRA 2006). The reefs consist of a variety of forms: smooth, featureless reef; deep vertical walls; fissures and pinnacles; boulder fields (with boulders ranging from 1 – 5 m in size) creating extensive overhang and cavern spaces; and rubble beds (0.1 – 1 m cobble and boulders) (Parks Victoria 2003). There are extensive deepwater and shallow sandy beds. The biota is cool temperate with low numbers of warm-temperate species that are commonly found in New South Wales (IMCRA 2006). Although the dominant biota of this region consists of a mixture of species from all of the adjacent biogeographical provinces, the eastern and southern provincial species appear to be more prevalent than the western province species (Parks Victoria 2003).

The Twofold Shelf Bioregion extends east of Wilsons Promontory (including the Kent Group Islands in Tasmania) to Tathra in southern New South Wales (IMCRA 2006; Figure 2). Within Victorian waters there are three MNPs, Ninety Mile Beach, Point Hicks and Cape Howe, and one MS, Beware Reef. Its climate is moist cool temperate. Water temperatures are generally warmer than elsewhere on the Victorian open coast due to the influence of the EAC (Parks Victoria 2003). These waters are also seasonally and periodically influenced by the boundary of the EAC with the more southern subtropical convergence (Harris *et al.* 1987). The continental slope is quite close to the far eastern Victorian shore and cold-water upwellings are frequent (Parks Victoria 2003). These upwellings provide nutrients to inshore ecosystems, contributing to higher productivity. Wave energy is relatively low. The coastline is dominated by dunes and sandy shorelines, with granite outcrops (IMCRA 2006). There are extensive areas of inshore and offshore sandy soft sediments. This region also has occasional strips of low-relief calcarenite reef immediately behind the surf zone (7 – 25 m deep) (Parks Victoria 2003). The continental shelf becomes broader and shallower in the west. Reefs are generally dominated by warm temperate species. The fauna is characterised by distinctive assemblages of reef fish, echinoderms, gastropods and bivalves. Southern NSW species occur in Victorian waters. In particular the large sea urchin *Centrostephanus rodgersii,* which removes macroalgae from shallow reefs creating a coralline algal encrusted habitat, occurs on the reefs in the east (IMCRA 2006).

# 2 Marine National Parks

## 2.1 Yaringa Marine National Park

Yaringa Marine National Park (MNP) (Figure 7) is one of five MNPs in the Victorian Embayments bioregion. The other MNPs are Port Phillip Heads, French Island, Churchill Island and Corner Inlet (Figure 4). Three Marine Sanctuaries in the bioregion are all in Port Phillip Bay (PPB) and include Point Cooke, Jawbone and Ricketts Point MSs. Yaringa MNP (980 ha) is located in Watsons Inlet between Watsons Creek and Quail Island (Figure 7), about 9 km south-west of Tooradin and 50 km south-east of Melbourne (Parks Victoria 2007). The MNP extends from the high water mark along 20 km of the Watsons Inlet coastline (Parks Victoria 2007). Its southern boundary is between the shore north of the Yaringa Marina channel and the southern tip of Quail Island (Parks Victoria 2007). Access to the MNP is only by boat (Parks Victoria 2007).

Aboriginal tradition indicates that Yaringa Marine National Park is part of *Country* of Boonwurrung people (Parks Victoria 2007).

Yaringa MNP includes areas between the high and low water mark that were formerly part of the Western Port Nature Conservation Reserve (Parks Victoria 2007). It is part of three special protection areas that cover Western Port Bay (WP). These include the Western Port Ramsar site, which recognises it as a wetland of international significance, the East Asian-Australasian Flyway for migratory waders, and Mornington Peninsula and Western Port UNESCO Biosphere Reserve (Parks Victoria 2007). Western Port Bay is also listed on the Register of the National Estate in recognition of its natural values and heritage importance (Parks Victoria 2007). Within the MNP a Special Protection Area for Natural Values covers the saltmarsh and mangrove areas, extending seaward from the high water mark to the edge of the vegetated intertidal area (Parks Victoria 2007). This covers 645 ha of the MNP, and public access is prohibited including all vessels, and the landing and launching of vessels (Parks Victoria 2007). A relict multiple curved sand spit at Bungower Point is adjacent to the MNP and is of regional geological significance (Parks Victoria 2007).

Important natural values of Yaringa MNP are its saltmarsh, mangroves, sheltered intertidal mudflats, seagrass beds and subtidal soft sediments in shallow tidal channels (ECC 2000; Carey *et al.* 2007b; Parks Victoria 2007). The relatively inaccessible and undisturbed mangrove and saltmarsh communities of Watson Inlet and Quail Island are of State significance (ECC 2000). Yaringa MNP has the most extensive area of mangroves in WP (Victorian Saltmarsh Study 2011). Its habitats support algae, invertebrate and fish communities (ECC 2000; Carey *et al.* 2007b; Parks Victoria 2007). Yaringa MNP is heavily influenced by tidal activities that expose and submerge large expanses of mudflats and associated seagrass beds (Parks Victoria 2007). These provide a foraging habitat for migratory waders and the surrounding saltmarsh and mangroves provide roosting areas (ECC 2000; Parks Victoria 2007).

Saltmarsh, mangrove, seagrass and mudflat habitats have been mapped within the MNP. Yaringa MNP saltmarsh consists of at least five different saltmarsh communities dominated by *Tetricornia arbuscula*, or *Gahnia filum* (Victorian Saltmarsh Study 2011). The Mangrove Shrublands consist of the white mangrove *Avicennia marina* subsp. *australasica,* the only species of mangrove in Victoria (Victorian Saltmarsh Study 2011). The seagrass beds consist of sparse to medium density *Zostera/Heterozostera* with very little algae (Blake and Ball 2001). The intertidal sediment is sandy (Coleman and Poore 1980). The subtidal habitat is essentially the moderately deep channels that drain the intertidal mud flats. General statements can be made about the flora and fauna that would be expected to live in these habitats but for most little specific detail has been collected.

Over 31 macroinvertebrate species live in the vegetated and unvegetated intertidal mudflats of Yaringa MNP (Butler and Bird 2010). The most common are the ghost shrimp *Biffarius arenosus,* sentinel crab *Macrophthalamus latifrons,* polychaete worms *Barantolla lepte* and *Lumbrineris* sp. and bivalve mollusc *Musculista senhousia* (Butler and Bird 2010). In these habitats yelloweye mullet *Aldrichetta forsteri* and smooth toadfish *Tetractenos glaber* are abundant, along with common galaxid *Galaxias maculatus*, short fin eel *Anguilla australis* and tupong *Pseudaphritis urvillii* (Warry and Reich 2010). Three gobies, bridled *Arenigobius bifrenatus,* eastern blue spot *Pseudogobius* and glass *Gobiopterus semivestitus,* are also found in the MNP (Warry and Reich 2010).

Yaringa MNP provides important feeding and roosting habitat for 39 conservation listed bird species such as the orange-bellied parrot *Neophema chrysogaster,* grey-tailed tattler *Heteroscelus brevipes* and the intermediate egret *Ardea intermedia*, which are listed under the *Flora and Fauna Guarantee* (*FFG*) Act (1998) and regarded as critically endangered in Victoria. The MNP protects feeding areas for 27 internationally important migrant species protected under the Australia Migratory Bird Agreement with either China (CAMBA) or Japan (JAMBA). Potentially 32 species of marine flora and fauna are at their distributional limits in Western Port Bay and could occur within the MNP.

Serious threats to the Yaringa MNP include coastal erosion, litter, sediment and nutrients from the land and increasing urbanisation, vessels disturbing shorebirds, marine pollution, invasive marine pests and climate change (Carey *et al.* 2007b). In addition limited ecological knowledge of important processes including hydrology and slow social change can lead to inadequate management of threats to the MNPs natural values (Carey *et al.* 2007b). Measures to address or minimise these threats form part of the management plan for Yaringa MNP (Parks Victoria 2007). Specific research aims to increase ecological knowledge about the natural values of, and threats to Yaringa MNP.

**Figure 5.** Aerial view of Yaringa Marine National Park. Photo Tim Allen.

### 2.1.1 PHYSICAL PARAMETERS & PROCESSES

Yaringa MNP is 776 hectares in size which makes it the twelfth largest of the 24 Marine National Parks or Sanctuaries in Victoria. Over 82% of the MNP (660 ha) is intertidal (Table 16).
Table **16**. Physical attributes of the Corner Inlet Marine National Park.

The subtidal area of the MNP is 42 ha, and is essentially the channels that drain the intertidal mud flats. The channel depths have been recorded as greater than 6.6 m but less than 11.6 m. Recent mapping with LiDAR and other technologies has resulted in improved bathymetry showing that nearly 100 ha of the MNP is above mean spring high waters.

The MNP has an unequal semidiurnal tidal pattern, with a higher and lower flooding and ebbing event daily. Tidal variation within the MNP is large with 2.6 metres for spring tides and 0.9 metres for neap tides (Plummer *et al.* 2003). The MNP is not subject to large waves or swell and the large tides are the major driving force. The Western Port Sediment Study (Wallbrink and Hancock 2003) found that persistent high turbidity in WP arises from daily reworking and re-suspension of fine sediment by tidal, wind and wave action. Surface water temperatures average 20.5 °C in the summer and 11.5 °C in the winter (Plummer *et al.* 2003).

Watsons Creek flows into Yaringa MNP north of Bungower Rd in Watsons Inlet. Watsons Creek drains predominantly semi-rural agricultural and urban areas, its water quality is poor with high nutrient levels (Melbourne Water & EPA 2009). Langwarrin Creek flows into the MNP in the north west and Cannon Creek from behind Quail Island in the north east.

**Table 1.** Physical attributes of the Yaringa Marine National Park.

| Park Name | Yaringa |
|---|---|
| Conservation status | Marine National Park |
| Biophysical Region | Victorian Embayments |
| Size | 776 ha (ranked 12th of 24) |
| Length of coastline | ~20 km |
| Shoreline geology | sedimentary |
| Area with depth: | |
| *(high res)* Supratidal | 99.36 ha |
| Intertidal | 630.03 ha |
| Intertidal-2 m | 26.14 ha |
| *(low res)* <1.6 m (~Intertidal)* | 4.91 ha |
| 1.6-3.6 m | 6.14 ha |
| 3.6-6.6 m | 8.04 ha |
| 6.6-11.6 m | 1.22 ha |
| Mean tidal variation - spring | 2.6 m |
| Mean tidal variation - neap | 0.9 m |
| Mean water temp - summer | 20.5°C |
| Mean water temp - winter | 11.5°C |
| Adjacent catchment | Agriculture<br>Urban |
| Discharges into MNP | Watsons Creek<br>Langwarrin Creek<br>Cannon Creek |
| Nearest major estuary<br>(distance & direction) | Cardina Creek ~16 km east |

* artefact of combining different resolutions of bathymetric mapping, coarse mapping could not be separated into smaller depth categories

The mangrove fringed saltmarshes around Quail Island (Figure 8) enclose low undulating areas of quartzose dune sand (Bird 1993). Watson Inlet and Quail Island are of geolomorphological State significant as a relatively undisturbed mangrove and salt marsh area. To the east of the MNP Chinaman Island to Blind Point is of regional geological significance due to its ferruginous sandstones and relict spits. Bungower Point, to the south west of the MNP, is a relict multiple recurved sand spit that lies inland of the broad saltmarsh and mangrove area and is of State significance (Figure 8). The spit was formed before the development of the mangrove and saltmarsh fringe and the onset of muddy sedimentation, and indicates hydrological and sea level changes in WP (Bird 1993).

### 2.1.2 MARINE HABITAT DISTRIBUTION

Mapping of habitats is important for understanding and communicating the distribution of natural values within Marine National Parks and Sanctuaries, particularly as the marine environment is not as easily visualised as the terrestrial environment (Parks Victoria 2003). For management purposes, knowledge of the distribution and extent of habitats is required to effectively target management activities, including emergency response, monitoring and research. Mapping of marine habitats provides a baseline inventory, allows the identification of suitable monitoring sites and possible tracking of environmental change, as well as identifying areas vulnerable to particular threats or suitable for recreational activities.

Yaringa seagrass habitat was mapped from aerial photography and ground-truthed by site visits and underwater video transects in 1999 (Blake and Ball 2001). This method of mapping could not distinguish *Zostera* from *Heterozostera*, so they were mapped as one habitat class, *Zostera/Heterozostera* (Blake and Ball 2001). Its saltmarsh and mangrove habitat was also mapped from aerial photography and ground-truthed by site visits (Victorian Saltmarsh Study 2011).

Yaringa is characterised by a variety of marine habitats ranging from subtidal channels and mudflats to extensive intertidal seagrass and mudflats fringed by mangrove and saltmarsh, all of which incorporate many microhabitats (Parks Victoria 2007). Western Port Bay has a large amount of its original saltmarsh and mangroves remaining (Victorian Saltmarsh Study 2011). These mangroves and saltmarsh occupy a narrow elevation range, generally extending from around 0.3 m above mean sea level (MSL) to 1.8 m above MSL (Victorian Saltmarsh Study 2011). The bulk of this range, from around 0.3 m above MSL to 1.2 m MSL, some 0.9 m is occupied by mangroves (Victorian Saltmarsh Study 2011).

Yaringa MNP (Figure 9) has some saltmarsh in and behind the seaward fringe of mangroves, the majority of saltmarsh in the area is outside the MNP boundaries (Victorian Saltmarsh Study 2011). The major saltmarsh community in the MNP is Wet Saltmarsh Shrubland (new EVC) community dominated by *Tetricornia arbuscula* (Victorian Saltmarsh Study 2011). Around the small island north west of Quail Island at least three different saltmarsh communities (all new EVCs) grow in the MNP including Saline Aquatic Meadow, Estuarine Wetland dominated by *Juncus kraussi* and Wet Saltmarsh Herbland dominated by *Sarcocornia quinqueflora* (Victorian Saltmarsh Study 2011). Coastal Saltmarsh Aggregate community (new EVC)is found in patches along the south east border of the MNP in between the Wet Saltmarsh Shrubland and the Mangrove Shrubland (Victorian Saltmarsh Study 2011).

The white mangrove *Avicennia marina* subsp. *australasica* is the only species of mangrove to occur in Victoria, where it reaches its most southern extent of distribution (Victorian Saltmarsh Study 2011). Western Port Bay has communities of *A. marina* that are the most extensive and well developed in Victoria and are considered of State significance (Parks Victoria 2007; Victorian Saltmarsh Study 2011). The *A. marina* Mangrove Shrubland (EVC 140) community at Yaringa MNP (Figure 9) grows on the sediment on intertidal mudflats in front of the saltmarsh communities fringing the seagrass beds (Victorian Saltmarsh Study

2011). The mangroves within Yaringa MNP act as a land-building agent and sedimentation has proceeded more rapidly in the mangrove fringe than on the saltmarshes behind the mangroves (Bird 1993). In the southwest corner of Quail Island between 1973 and 1999 mangrove vegetation has extended up the creeks and displaced saltmarsh vegetation (Saintilan and Rogers 2001a). Mangrove vegetation has also been prograding in a seaward direction (Saintilan and Rogers 2001a; Rogers *et al.* 2005; Rogers *et al.* 2006; Rogers and Saintilan 2008).

Seagrass cover in WP varies from site to site and through time (Ball *et al.* 2010). In Yaringa MNP west between Watson Channel and the Mangrove Shrubland grow sparse beds of *Zostera/Heterozostera* (Blake and Ball 2001). East of Watson Channel and the Mangrove Shrubland adjacent to Quail Island the *Zostera/Heterozostera* beds (Figure 9) are denser (medium density) with patches of sparse growth up against the mangroves (Blake and Ball 2001). In the south of the MNP to the west of Watsons Channel a dense bed of *Zostera/Heterozostera* grows between the sparse and medium density beds. The seagrass beds do not have much algae (Blake and Ball 2001). Seagrass cover in Yaringa MNP can be between 60 to 80% (Butler and Bird 2010). This is high compared to many other sites in WP, but similar to that found in some parts of Churchill Island MNP, Rhyll and Stony Point (Butler and Bird 2010). Seagrass beds in Western Port declined by approximately 70 % between 1971 and 1985 (DSE 2003). The greatest loss of seagrass occurred in intertidal areas. A survey in 1995 indicated that between 20 and 30% of the degraded areas had revegetated (Melbourne Water & EPA 2009).

The sediment on the intertidal flats of Yaringa MNP (Figure 8) is sand (Coleman and Poore 1980). The sediments in the deeper channels in WP are coarse shelly sand (Coleman and Poore 1980). The subtidal habitat is essentially the moderately deep channels that drain the intertidal mud flats.

**Figure 6**. Sandy intertidal sediments in Yaringa Marine National Park. Photo by Adam Pope, Deakin University.

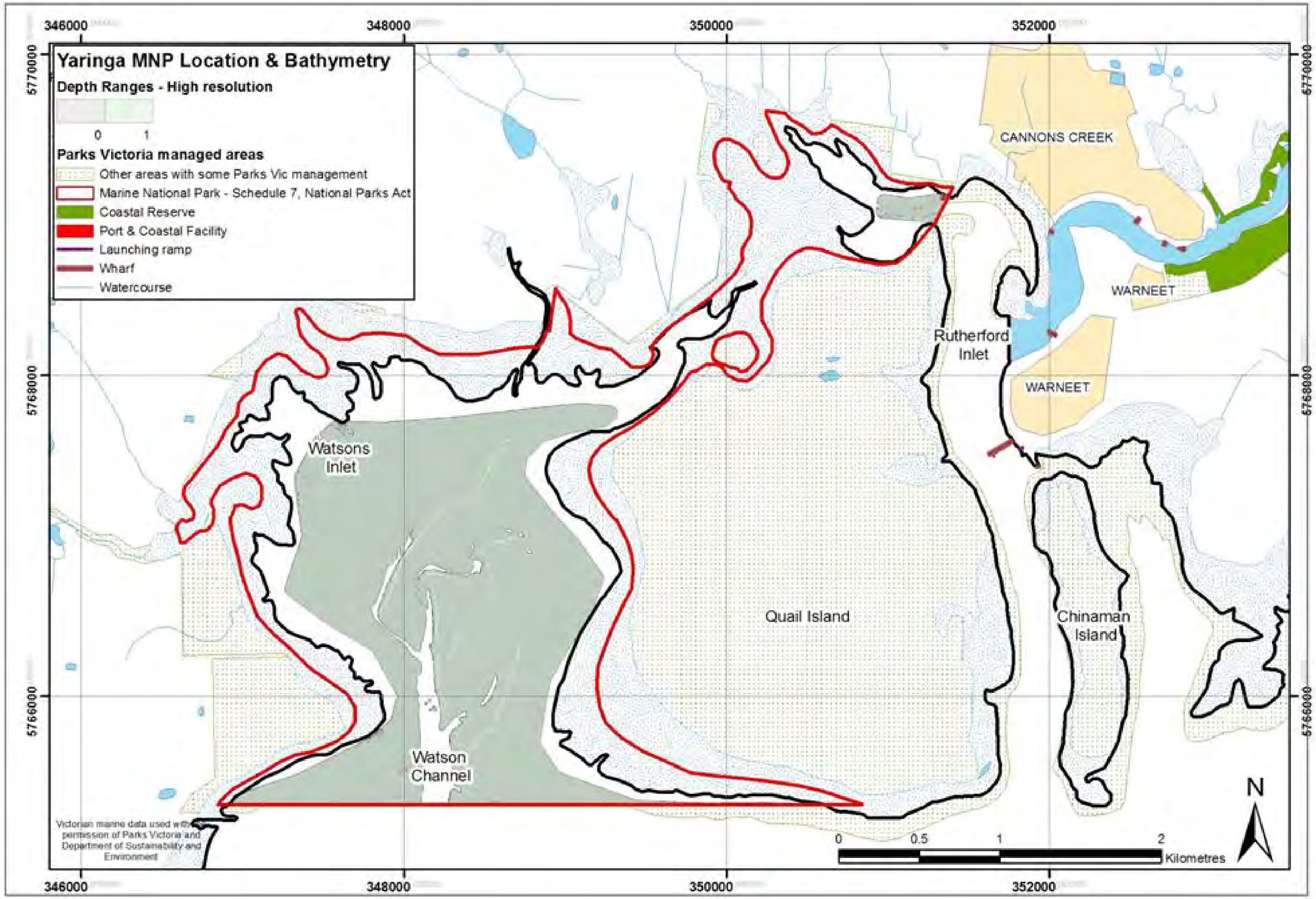


**Figure 7.** Location map of Yaringa Marine National Park with bathymetry. There are no intertidal or subtidal reef monitoring sites in the MNP.

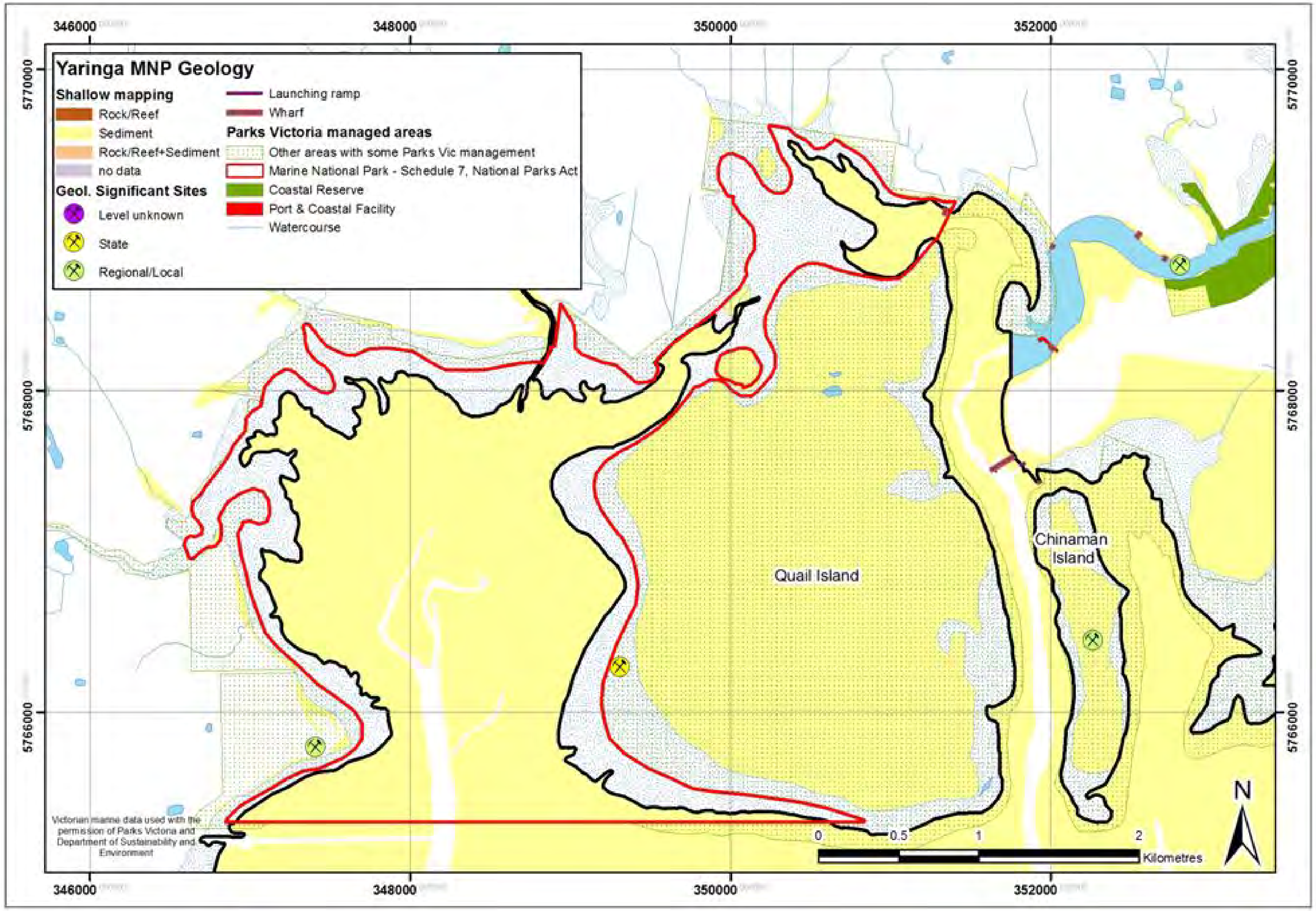


**Figure 8.** Substrate mapping of Yaringa Marine National Park and surrounds, showing sites of geological significance.

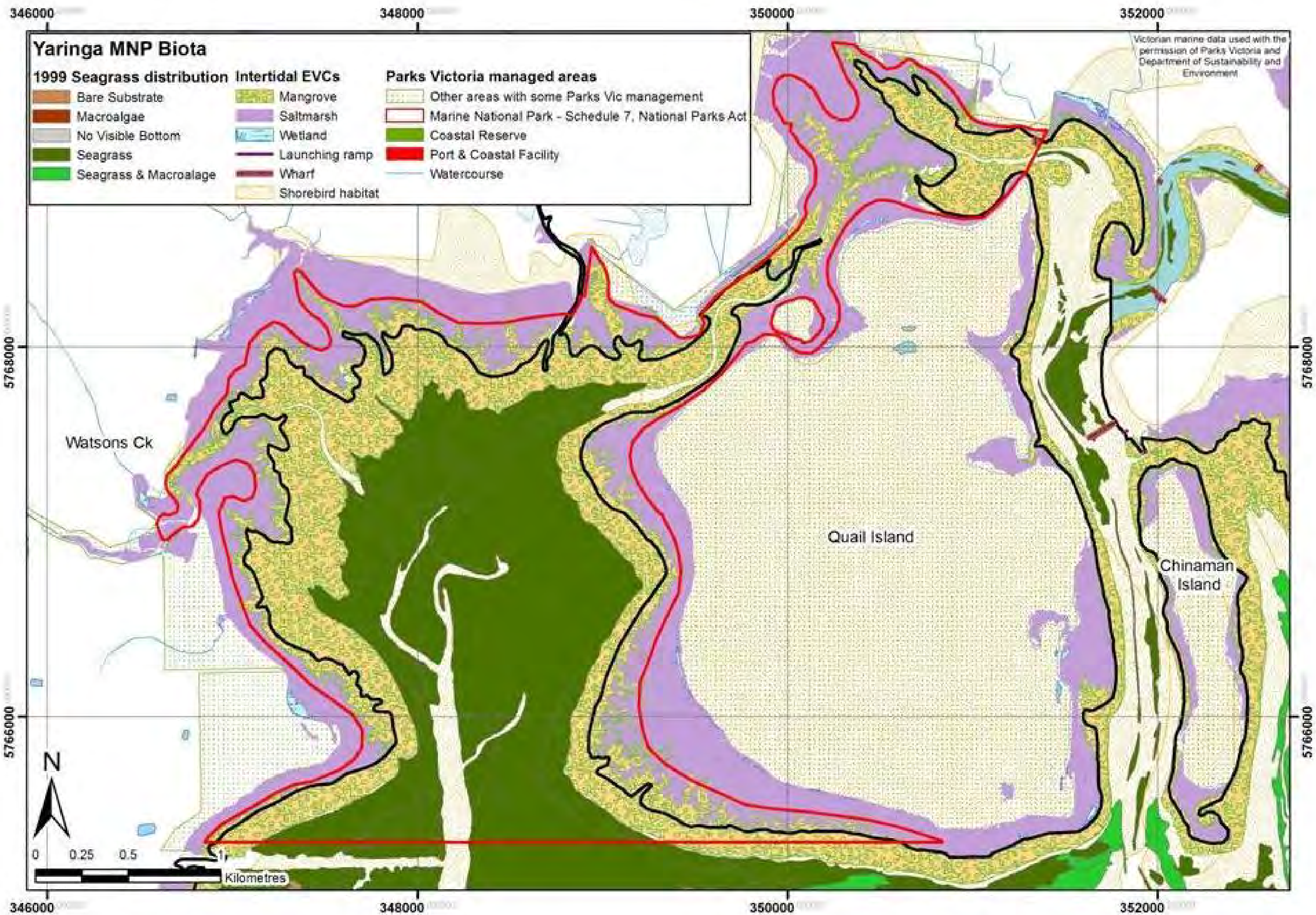


**Figure 9**. Biotic mapping of Yaringa Marine National Park and surrounds.

### 2.1.3 MARINE ECOLOGICAL COMMUNITIES

#### General

Although there have been many studies in WP, few studies have focused on the biota within the MNP (Plummer *et al.* 2003; Parks Victoria 2007). Research has been concentrated in more accessible areas of WP such as Warneet (Boon *et al.* 1997b; Saintilan and Rogers 2001a; Hindell and Jenkins 2004; Butler and Bird 2007; Butler and Bird 2008) and Tooradin (Edgar *et al.* 1994). Within the MNPs major areas of research include mangroves and saltmarsh (Saintilan and Rogers 2001a; Victorian Saltmarsh Study 2011; Figure 9) invertebrate infauna (Butler and Bird 2010) and fish (Warry and Reich 2010). Since the first natural values report by Plummer *et al.* (2003), Parks Victoria has supported research in Yaringa MNP including a new survey in 2006 and 2007 of the biota of the soft sediments (Butler and Bird 2010). There have been no new surveys of the biota of the saltmarsh, mangroves, seagrass or the pelagic habitats. As part of the implementation trial of the Index of Estuary Condition (Arundel *et al.* 2009), fish have been sampled in the MNP into Watsons Inlet (Warry and Reich 2010). From database records of species recorded in Yaringa MNP it is obvious that historically there has been a bias to bird surveys (Table 2, Appendix 1).

Yaringa MNP is part of the Western Port Ramsar area (DSE 2003; Kellogg Brown & Root 2010) recognising its importance as shorebird habitat for resident and migratory birds (Figure 9). There are no specific significant biota sites in the MNP.

**Table 2.** Summary of database records of the number of species in major biotic groups in Yaringa Marine National Park (see Appendix 1). WP indicates that the location in Western Port Bay was not specified.

| Biotic group | Number of species | |
|---|---|---|
| | Yaringa | WP |
| **Macrophytes** | **0** | **41** |
| yellow-green algae | 0 | 1 |
| green algae | 0 | 1 |
| brown algae | 0 | 7 |
| red algae | 0 | 32 |
| **Invertebrates** | **1** | **25** |
| cnidarians | 1 | 0 |
| decapod crustaceans | 0 | 8 |
| chitons | 0 | 1 |
| gastropods | 0 | 14 |
| bivalves | 0 | 1 |
| echinoderms | 0 | 1 |
| **Vertebrates** | **64** | **6** |
| fish | 0 | 6 |
| birds | 65 | 0 |
| mammals | 1 | 0 |

#### Intertidal

Yaringa MNP saltmarsh consists of numerous saltmarsh communities this includes extensive Wet Saltmarsh Shrubland dominated by *Tetricornia arbuscula* and/or *Scarcocornia quinqueflora,* Saline Aquatic Meadow dominated by *S. quinqueflora,* Wet Saltmarsh Herbland dominated by *S. quinqueflora,* Estuarine Wetland, Estuarine Shrubland, Coastal Tussock Saltmarsh dominated by *Gahnia filum* and Coastal Saltmarsh Aggregate (Victorian

Saltmarsh Study 2011; Figure 15). Two new species of gall midges that burrow into *S. quinqueflora* have been identified in the saltmarshes of the MNP (Veenstra-Quah *et al.* 2007). Specific studies of the fauna found in the saltmarshes of Yaringa MNP have not been conducted.

The *Avicennia marina* Mangrove Shrubland community at Yaringa MNP grows on the sediment on intertidal mudflats in front of the saltmarsh communities (Victorian Saltmarsh Study 2011). The trunks and pneumatophores of mangroves provide habitat for epiphytic filamentous algae, gastropods, barnacles, and mussels (Figures 10, 13 and 16). The mangrove fringes are inhabited by crabs and at high tide fish such as gobies, mullet, and toadfish. Specific studies of the flora and fauna found in the Mangrove Shrublands of Yaringa MNP have not been conducted.

**Figure 10.** Barnacles on the pneumatophores of the mangrove *Avicennia marina* at high tide in Yaringa Marine National Park. Photo by Julian Finn, Musuem of Victoria.

Seagrass beds are complex and extremely productive environments which play an important role in the ecology of the MNP (Parks Victoria 2007). Seagrass beds stabilise the sediment and remove dissolved nutrients from the water, forming one of the basic levels of the food chain (Blake and Ball 2001). The majority of Yaringa MNP, bar Watsons Channel and the intertidal shoreline are *Zostera* sp. (Blake and Ball 2001). In the north west of the MNP there is a large bed of seagrass *Zostera/Heterozostera* (Blake and Ball 2001). Seagrass beds provide habitat for epiphytic algae, hydroids, ascidians, diatoms and sponges, and grazing invertebrates including many molluscs, crustaceans, polychaetes and crabs. They are important nursery areas for many fish including conservation listed syngnathids (Parks Victoria 2007). Specific studies of the flora and fauna found in the seagrass beds of Yaringa MNP have not been conducted.

Large areas of unvegetated mud and sand support invertebrates, microphytobenthos and demersal fish. Benthic invertebrates in both unvegetated and vegetated mudflats are an important food resource for the many migratory shore bird species that use WP (DSE 2003; Kellogg Brown & Root 2010). Characteristics of the mudflats influence the biota found on and in these sediments. Butler and Bird (2010) found that the organic content, grain size, temperature and redox potential of the sediment influence the community composition of the mudflat macroinvertebrates.

**Figure 11**. Worm holes in the soft sediment of Yaringa Marine National Park. Photo by Julian Finn, Museum of Victoria.

Of the 31 macroinvertebrate species found in the mudflats of Yaringa MNP by Butler and Bird (2010), the most common were the ghost shrimp *Biffarius arenosus,* sentinel crab *Macrophthalamus latifrons,* polychaete worms *Barantolla lepte* and *Lumbrineris* sp. and bivalve mollusc *Musculista senhousia* (Butler and Bird 2010; Figure 11). The ghost shrimp *Trypaea australiensis* was not found in the MNP and *B. arenosus* abundance was significantly less than that found at Tooradin or Warneet (Butler and Bird 2010). The sentinel crab *M. latifrons* had a similar abundance in the MNP to the mudflats of Tooradin and slightly less than Warneet (Butler and Bird 2010). The polychaete *Lumbrineris* sp. is particularly abundant in the MNP compared to other sites in WP, with its abundance varying from year to year (Butler and Bird 2010).

Ghost shrimps are important ‘ecosystem engineers’ changing the sediment environment through their burrowing, which can lead to changes in invertebrate community composition (Butler and Bird 2010). They are also important as a food source for migratory shorebirds and fish (Butler and Bird 2010). The sentinel crab *M. latifrons* is common on the mudflats of WP, Andersons Inlet and Corner Inlet in Victoria, but is not found elsewhere in Victoria or Australia (Butler and Bird 2010). It is commonly found burrowing in soft-sediment intertidal areas. It is a very important food resource for a number of internationally important shore bird species such as the double-banded plover *Charadrius bicinctus*, rednecked stint *Calidris ruficollis* and curlew sandpipers *Calidris ferruginea* (Dann 1991; Dann 2000). The polychaete worm *Lumbrineris* sp. is generally thought to be a detritivore in soft-sediment environments (Butler and Bird 2010). There is very little known about the biology of *Lumbrineris* sp. in Australia (Butler and Bird 2010).

The most abundant of the 13 species of fish sampled by Warry and Reich (2010) over seagrass and unvegetated soft sediment in Yaringa MNP were the yelloweye mullet *Aldrichetta forsteri* and smooth toadfish *Tetractenos glaber*. Also widespread were common galaxid *Galaxias maculatus*, short fin eel *Anguilla australis* and tupong *Pseudaphritis urvillii*. Also present were the black bream *Acanthopagrus butcheri*, greenback flounder *Rhombosolea tapirina,* skipjack trevally *Pseudocaranx wrighti* and Western Australian salmon *Arripis truttaceus.* Three species of goby, the bridled *Arenigobius bifrenatus,* eastern blue spot *Pseudogobius* and the glass *Gobiopterus semivestitus* were also sampled from the MNP (Warry and Reich 2010). The introduced mosquito fish *Gambusia* was also found (Warry and Reich 2010). Intertidal rocky reef does not occur in Yaringa MNP.

**Figure 12**. Oyster blennie *Omobranchus anolius* in Yaringa Marine National Park. Photo by Julian Finn, Museum of Victoria.

## Subtidal

Subtidal seagrass beds in WP are dominated by *Heterozostera nigricaulis* (Ball *et al.* 2010). Most of the subtidal habitat in the MNP is on the edge or in the deeper channels that drain the intertidal mudflats. A lot of the subtidal soft sediment in the MNP is unvegetated (Blake and Ball 2001). Fish associated with the subtidal sediments and in the channels include stingrays, perch, flathead and gobies (Figure 12). Specific studies of the flora and fauna found in the subtidal habitat of Yaringa MNP have not been conducted. Subtidal rocky reef does not occur in Yaringa MNP.

## Water column

The water column habitat of the MNP is dominated by drifting planktonic species, which rely on currents for movement, nutrients and food. Many intertidal and subtidal organisms spend the early stage of their life in the water column environment and currents assist the distribution of recruits back to intertidal and subtidal habitats. Common plankton found in the water column include phytoplankton such as diatoms, and zooplankton including copepods, jellyfish and ctenophores. Highly mobile fish, sharks and stingrays probably inhabit the water column habitat of the MNP (Parks Victoria 2007). Post-larvae of King George whiting *Sillaginodes punctatus* appear in WP from September to November each year from adults spawning in South Australia and far western Victoria (Jenkins *et al.* 2000). Parks Victoria does not currently monitor the water column as a habitat (Power and Boxshall 2007). As described in the following section a wide variety of shorebirds, seabirds and fish of conservation significance are found in the waters of Yaringa MNP. Specific studies of the flora and fauna found in the water column of Yaringa MNP have not been conducted.

**Figure 13**. Periwinkle *Austrocochlea* sp. on submerged mangrove leaves in Yaringa Marine National Park. Photo by Julian Finn, Museum of Victoria.

### 2.1.4 SPECIES OF CONSERVATION SIGNIFICANCE

The approach of managing MPAs for their marine ecological communities, rather than threatened species, is also likely to protect and enhance threatened species populations (Power and Boxshall 2007). Whole – of – habitat management may also result in the protection of species not yet identified because of their rarity or cryptic nature (Power and Boxshall 2007).

#### Flora

No conservation listed marine flora has been recorded in Yaringa MNP (Parks Victoria 2007).

#### Invertebrates

*Flora and Fauna Guarantee (FFG) Act 1988* listed stalked hydroid species *Ralpharia coccinea* has been recorded at Crawfish Rocks but not from Yaringa MNP.

#### Fish

Under the Victorian *Fisheries Act* 1995 all syngnathid species are listed as Protected Aquatic Biota. Nationally they are listed as threatened under the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*. Syngnathids are known from seagrass beds in WP (Edgar and Shaw 1995). They are potentially in Yaringa MNP but have not been recorded. The *FFG Act (1988)* listed pale mangrove goby *Mugilogobius platynotus* has been recorded in Yaringa MNP.

#### Birds

Thirty-nine conservation listed shore or sea birds have been sighted in or in the immediate surrounds of Yaringa MNP (Table 3). Twenty-nine are recognized as threatened in Victoria, listed under the *FFG Act (1988)* or the Victorian Rare or Threatened Species (VROTS) list. Three, the orange-bellied parrot *Neophema chrysogaster,* grey-tailed tattler *Heteroscelus brevipes* and the intermediate egret *Ardea intermedia* are regarded as critically endangered. *N. chrysogaster* is also listed as critically endangered nationally under the *EPBC Act 1999.* This species migrates annually to coastal Victoria between March and October and has been sighted in Yaringa MNP in the intertidal saltmarsh (Parks Victoria 2007).

Twenty-seven birds (Table 3) are recognized internationally under the Australia Migratory Bird Agreement with either China (CAMBA) or Japan (JAMBA). Many of these birds feed on the intertidal mudflats and roost on the saltmarsh or mangroves (Parks Victoria 2007). Yaringa MNP is within the WP Ramsar Site (DSE 2003). The bay is of international importance for seven wader species, the eastern curlew *Numenius madagascariensis*, common greenshank *Tringa nebularia*, rednecked stint *Calidris ruficollis,* curlew sandpiper *Calidris ferruginea,* double-banded plover *Charadrius bicinctus*, hooded plover *Thinornis rubricollis* and pied oystercatcher *Haematopus longirostris*, and national importance for Pacific golden plover *Pluvialis fulva* (Loyn *et al.* 2001). It also attracts high proportions of populations of whimbrel *Numenius phaeopus*, grey-tailed tattler *Heteroscelus brevipes* and masked lapwing *Vanellus miles* in coastal Victoria (Loyn *et al.* 2001). Mangroves (Figure 13) limit where waders can feed for long periods on each tidal cycle, this limits the number of small waders that use the mudflats (Loyn *et al.* 2001). Common greenshank *T. nebularia* occur mainly in the mangrove-lined inner parts of the bay (Loyn *et al.* 2001). Some species roost on saltmarshes, notably the eastern curlew and masked lapwing *V. miles*, or isolated banks of mangroves, such as the grey-tailed tattler *H. brevipes* and terek sandpiper *Xenus cinereus,* the Pacific golden plover *P. fulva* roosts in both habitats (Loyn *et al.* 2001).

**Table 3.** Conservation listed shorebird and seabirds records from Yaringa Marine National Park and surrounds.

| | | Victorian listing | | International treaty | |
|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **FFG** | **VROTS** | **CAMBA** | **JAMBA** |
| orange-bellied parrot | *Neophema chrysogaster* | L | CE | | |
| grey-tailed tattler | *Heteroscelus brevipes* | L | CE | C | J |
| intermediate egret | *Ardea intermedia* | L | CE | | |
| great knot | *Calidris tenuirostris* | L | EN | C | J |
| terek sandpiper | *Xenus cinereus* | L | EN | C | J |
| little egret | *Egretta garzetta* | L | EN | | |
| australasian bittern | *Botaurus poiciloptilus* | L | EN | | |
| fairy tern | *Sternula nereis* | L | EN | | |
| Caspian tern | *Hydroprogne caspia* | L | NT | C | J |
| latham's snipe | *Gallinago hardwickii* | | NT | C | J |
| Pacific golden plover | *Pluvialis fulva* | | NT | C | J |
| red knot | *Calidris canutus* | | NT | C | J |
| grey plover | *Pluvialis squatarola* | | NT | C | J |
| white-winged black tern | *Chlidonias leucopterus* | | NT | C | J |
| eastern curlew | *Numenius madagascariensis* | | NT | C | J |
| black-faced cormorant | *Phalacrocorax fuscescens* | | NT | | |
| pied cormorant | *Phalacrocorax varius* | | NT | | |
| Pacific gull | *Larus pacificus* | | NT | | |
| sooty oystercatcher | *Haematopus fuliginosus* | | NT | | |
| nankeen night heron | *Nycticorax caledonicus* | | NT | | |
| eastern great egret | *Ardea modesta* | L | VU | C | J |
| little tern | *Sternula albifrons* | L | VU | C | J |
| white-bellied sea-eagle | *Haliaeetus leucogaster* | L | VU | C | |
| Baillon's crake | *Porzana pusilla* | L | VU | | |
| common sandpiper | *Actitis hypoleucos* | | VU | C | J |
| black-tailed godwit | *Limosa limosa* | | VU | C | J |
| whimbrel | *Numenius phaeopus* | | VU | C | J |
| lesser sand plover | *Charadrius mongolus* | | VU | C | J |
| royal spoonbill | *Platalea regia* | | VU | | |
| common tern | *Sterna hirundo* | | | C | J |
| cattle egret | *Ardea ibis* | | | C | J |
| ruddy turnstone | *Arenaria interpres* | | | C | J |
| bar-tailed godwit | *Limosa lapponica* | | | C | J |
| red-necked stint | *Calidris ruficollis* | | | C | J |
| sharp-tailed sandpiper | *Calidris acuminata* | | | C | J |
| curlew sandpiper | *Calidris ferruginea* | | | C | J |
| common greenshank | *Tringa nebularia* | | | C | J |
| short-tailed shearwater | *Ardenna tenuirostris* | | | | J |
| Arctic jaeger | *Stercorarius parasiticus* | | | | J |

L= listed, NT = Near Threatened, VU = Vulnerable, EN = Endangered, CE = Critically Endangered, C = Listed under the CAMBA treaty, J = Listed under the JAMBA treaty

## Marine mammals

Yaringa MNP is shallow and dominated by intertidal and subtidal mudflats. It does not provide habitat for large marine mammals.

## Species distribution information

An assessment of distribution, endemism and rarity of biota across the state did not identify any biota endemic to Yaringa MNP (O'Hara and Barmby 2000; O'Hara and Poore 2000; O'Hara 2002).

**Table 4**. Marine species potentially at their distribution limits in Western Port Bay that may be found in Yaringa Marine National Park (O'Hara and Barmby 2000; O'Hara and Poore 2000; O'Hara 2002).

| Phylum | Order | Family | Species | Common name | Category |
|---|---|---|---|---|---|
| Chlorophyta | Caulerpales | Caulerpaceae | *Caulerpa remotifolia* | green algae | RE* |
| Phaeophyta | Dictyotales | Dictyotaceae | *Distromium multifidum* | brown algae | PE |
| Phaeophyta | Fucales | Cystoseiraceae | *Myriodesma integrofolium* | brown algae | PE |
| Phaeophyta | Sphacelariales | Sphacelariaceae | *Sphacelaria carpoglossi* | brown algae | PE |
| Phaeophyta | Fucales | Fucaceae | *Xiphophora gladiata* | brown algae | PN |
| Rhodophyta | Ceramiales | Dasyaceae | *Dasya hookeri* | red algae | RE* |
| Rhodophyta | Ceramiales | Ceramiaceae | *Anotrichium elongatum* | red algae | PE |
| Rhodophyta | Ceramiales | Ceramiaceae | *Anotrichium licmophorum* | red algae | PE |
| Rhodophyta | Ceramiales | Ceramiaceae | *Ceramium excellens* | red algae | PE |
| Rhodophyta | Ceramiales | Ceramiaceae | *Shepleya verticillata* | red algae | PE |
| Rhodophyta | Rhodymeniales | Lomentariaceae | *Semnocarpa corynephora* | red algae | PE |
| Rhodophyta | Rhodymeniales | Rhodymeniaceae | *Gloiocladia polycarpa* | red algae | PE |
| Crustacea | Dendrobranchiata | Penaeidae | *Penaeus latisulcatus* | prawn | PW |
| Crustacea | Thalassinidea | Laomediidae | *Laomedia healyi* | ghost shrimp | PW |
| Crustacea | Thalassinidea | Callianassidae | *Eucalliax tooradin* | ghost shrimp | PE |
| Crustacea | Brachyura | Hymenosomatidae | *Trigonoplax longirostris* | crab | PE |
| Crustacea | Brachyura | Majidae | *Huenia halei* | crab | PE |
| Mollusca | Gastropoda | Columbellidae | *Anachis smithi* | marine snail | PW |
| Mollusca | Gastropoda | Olividae | *Zemira australis* | marine snail | PW |
| Mollusca | Gastropoda | Vermetidae | *Serpulorbis hedleyi* | marine snail | PW |
| Mollusca | Gastropoda | Calyptraeidae | *Cheilea flindersi* | marine snail | PE |
| Mollusca | Gastropoda | Cancellariidae | *Cancellaria (Nevia) spirata* | nutmeg shell | PE |
| Mollusca | Gastropoda | Cancellariidae | *Cancellaria (Sydaphera) lactea* | nutmeg shell | PE |
| Mollusca | Gastropoda | Cancellariidae | *Cancellaria (Sydaphera) purpuriformis* | nutmeg shell | PE |
| Mollusca | Gastropoda | Eatoniellidae | *Eatoniella victoriae* | marine snail | PE* |
| Mollusca | Gastropoda | Epitoniidae | *Epitonium platypleura* | marine snail | PE |
| Mollusca | Gastropoda | Cerithiopsidae | *Zaclys angasi* | marine snail | PB |
| Mollusca | Polyplacophora | Lepidopleuridae | *Leptochiton liratus* | chiton | PE |
| Echinodermata | Holothuroidea | Phyllophoridae | *Lipotrapeza ventripes* | sea cucumber | PE |
| Chordata | Atheriniformes | Atherinidae | *Kestratherina esox* | pikehead hardyhead | PE |
| Chordata | Perciformes | Gobiidae | *Arenigobius frenatus* | half bridled goby | RW |
| Chordata | Perciformes | Sillaginidae | *Sillago bassensis* | silver whiting | PE |

* recorded from Crawfish Rocks, RE = recorded eastern limit of distribution, RW = recorded western limit of distribution, PE = presumed eastern limit of distribution, PW = presumed western limit of distribution, PN = presumed northern limit of distribution.

Over sixty-nine species of biota (Appendix 2) have been described as having their distributional limit in Western Port (Appendix 2, O'Hara and Barmby 2000; O'Hara and Poore 2000; O'Hara 2002). Twenty-five of these species are algae, predominately red algae, and were recorded at Crawfish Rocks off the north west coast of French Island. There is limited specific information on species at their distributional limit in Yaringa MNP. Potentially thirty-two species at their distributional limit in Western Port could be found in Yaringa MNP (Table 4) (O'Hara and Barmby 2000; O'Hara and Poore 2000; O'Hara 2002). The distributional limits of the biota listed in Table 4 may reflect collection effort in this area rather than actual Victorian distributions. Many areas of the Victorian coast have never been sampled and therefore biota ranges may be much greater than those suggested.

**Figure 14**. Submerged mangrove *Avicennia marina* seedling in Yaringa Marine National Park. Photo by Julian Finn, Museum of Victoria.

### 2.1.5 MAJOR THREATS

Threats to natural values were derived from lists of hazards and associated risks in Carey *et al.* (2007b). These were the result of a state wide consultative process to identify threats to MPAs. Through public and agency workshops, the natural values in individual MNPS and MSs and the threats that could affect them over the next 10 years were considered and ranked to identify hazards. This list of hazards was then ranked (low, medium, high and extreme) by the risk posed by each hazard (Carey *et al.* 2007b). Thirteen hazards with the potential to be of extreme risk were identified by Carey *et al.* (2007b). They are listed in rank order and the habitat or area at risk within the MNP is indicated in brackets:

1. Coastal erosion causing smothering slime over seagrass, resulting in seagrass dieback (intertidal and subtidal);
2. Lack of resources for compliance and enforcement leading to broader ecological impacts (all of MNP);
3. Sedimentation from development corridor causing loss of seagrass (intertidal and subtidal);
4. Lack of integrated arrangements/management leading to negative impacts on MNPs (all of MNP);
5. Increasing pressure from urban activities impacting on MNPs (all of MNP);
6. Lack of knowledge of marine ecosystems leading to poor management decisions and loss of biodiversity (all of MNP);
7. Impacts of farm effluents and contaminants on marine flora and fauna (intertidal and subtidal);
8. Lack of perception of importance of values at all social and political levels, leading to lack of coordinated and effective management, reducing conservation of natural values (all of MNP);
9. Poor uptake of information/education within catchment on impacts of poor land management and tools/strategies that could improve land management and affect inputs to MNPs (all of MNP);
10. Noisy and fast moving vessels disturbing birds, leading to reduced shore-bird abundance (intertidal);
11. Increased recreational usage (in & around MNPs) causing increased negative impacts *e.g.* litter and contaminants (all of MNP);
12. Exotic marine species from commercial shipping/ recreational boating/ aquaculture causing change in species composition in MNPs (all of MNP); and
13. Lack of knowledge about the way changes in hydrology (including the rate of siltation) impact on flora and fauna in the MNPs (all of MNP).

Parks Victoria’s internal review of threats occurring within the Yaringa MNP included marine exotics (Carey *et al.* 2007b). It also recognised the threat of marine pollution incidents (Carey *et al.* 2007b).

The introduction of marine pests threatens marine biodiversity and may reduce the social and economic benefits derived from the marine environment (Parks Victoria 2003). Most marine pests known from Victorian waters are found in Port Phillip Bay (Parks Victoria 2003). The introduced bivalve mollusc, *Musculista senhousia,* has been found in Yaringa MNP (Butler and Bird 2010). Other species of concern include the Northern Pacific seastar *Asterias amurensis,* which was found at San Remo in September 2011, European fan worm *Sabella spallanzanii* and broccoli weed *Codium fragile (subsp. fragile)* (Parks Victoria 2003).

Poor water quality from Watsons Creek poses a risk to Yaringa MNP and market gardens contribute to the high nutrient and pesticide levels in the creek (Melbourne Water & EPA 2009).

**Climate Change**

Climate change represents a serious threat to marine ecosystems (McLeod *et al.* 2009) but specific ecological consequences of accelerating climate change are not well understood in marine systems, particularly in temperate systems. Climate change is predicted to increase water temperature, alter chemical composition (salinity, acidity and carbonate saturation), change circulation and productivity, increase frequencies of extreme weather events and exposure to damaging ultraviolet light (UVB), and increase air temperature, cloud cover and sea levels (conservatively 80 cm by 2100; CSIRO-BoM 2007; Fine and Franklin 2007; VCC 2008; McLeod *et al.* 2009). A combined increase in cloud cover and sea level could result in decreased light availability potentially changing benthic flora. Increased storm surges and ocean current changes also have the potential to change the distribution of fauna and flora and could result in loss of habitats (CSIRO-BoM 2007). Intertidal communities will face increased desiccation, storm wave exposure and habitat shift. Changes in the relationship between climate and annual life-history events may force major change in functional groups and consequent ecosystem function (Fine and Franklin 2007). Climate change is also anticipated to modify species recruitment and habitat connectivity, species interactions and disturbance regimes in the marine environment (CSIRO-BoM 2007; Fine and Franklin 2007). A number of species are presumed to be at the eastern or western limit of their distributional range in Western Port, and may be found in Yaringa MNP, and such species would be particularly vulnerable to climate change.

Measures to address or minimise these hazards form part of the management plan for Yaringa MNP (Parks Victoria 2007). For example, research has been targeted at marine pest species, and water quality issues which may impact on park natural values. Management actions have been implemented to minimise these threats (Parks Victoria 2007). Parks Victoria has also undertaken a strategic climate change risk assessment to identify the risks and stressors for natural values in the MPAs through assessment at the habitat level for parks in each marine bioregion. Parks Victoria will use an adaptive management approach to develop responses and actions that focus on priority climate change issues such as extreme weather events and existing risks that will likely be exacerbated by climate change.

### 2.1.6 CURRENT RESEARCH AND MONITORING

Parks Victoria has established extensive marine monitoring and research programs for the MPAs that address important management challenges, focussing both on improving baseline knowledge of the MPAs as well as applied management questions not being addressed by others. This knowledge will continue to enhance Parks Victoria's capacity to implement evidence-based management through addressing critical knowledge gaps. The research and monitoring programs have been guided by the research themes outlined as part of Parks Victoria's Research Partners Panel (RPP) program, a Marine Research and Monitoring Strategy 2007-2012 and Marine National Park and Marine Sanctuary Monitoring Plan 2007-2012 (Power and Boxshall 2007). Much of the research has been undertaken as part of the RPP program involving collaboration with various research institutions. The research relevant to Yaringa MNP has been published in Parks Victoria's Technical Series available on Parks Victoria's website (http://www.parkweb.vic.gov.au). As most research in the MNP has been carried out under permits issued by DSE, the permit database was also used to identify relevant projects for this report (see Table 5 & Appendix 3).

Yaringa MNP does not have ongoing intertidal (IRMP) and a shallow subtidal (SRMP) reef monitoring program as these habitats do not occur within the MNP. A survey of macroinvertebrates inside and outside the Western Port MNPs has been undertaken as a possible baseline for future monitoring (Butler and Bird 2010).

**Table 5.** Ongoing Research Partner Panel (and RPP-like) research projects implemented in partnership with, or commissioned by, Parks Victoria relevant to Yaringa Marine National Park.

| **Ongoing RPP (and RPP-like) Projects** |
|---|
| ***University of Melbourne:*** Kim Millers, Jan Carey, Mick McCarthy<br>Optimising the allocation of resources for defending Marine Protected Areas against invasive species. |
| ***Multiple Research Partners:*** Marine Monitoring and Marine Natural Values<br>***University of Melbourne:*** Jan Carey<br>Developing Report Cards for the Marine National Parks |
| ***Museum Victoria:*** Mark Norman, Julian Finn. ***Parks Victoria:*** Roger Fenwick<br>Under the Lens - Natural History of Victoria's Marine National Park System. |
| ***University of Melbourne:*** Tarek Murshed, Jan Carey, Jacqui Pocklington<br>Conceptual model development for marine habitats. |
| **Ongoing Habitat Mapping Projects** |
| ***DSE / DPI / Worley Parsons/ Deakin University***<br>LiDAR Mapping Project. Mapping of bathymetry and marine habitats along the Victorian coast |

There is no current Friends Group for the MNP (Parks Victoria 2007). Data collected by the Bird Observers Club of Australia, Australian Wader Studies Group and the Victorian Wader Study Group within the MNPs and adjacent areas, including the Western Port Ramsar Site, have contributed significantly to an understanding of the importance of Western Port as a Ramsar Site and as part of the East Asian–Australasian Flyway (Parks Victoria 2007).

Statewide, the Museum of Victoria is collecting additional data on the marine natural values of Victoria's MPAs. They are gathering information about natural history through video and photos, and using semi-quantitative methods to determine spatial and temporal changes across the system in response to threats, including marine pests and climate change. Jan Carey (University of Melbourne) is conducting research focussing on marine pest species which may impact on park values, and the MNPs and MSs which are most at risk of invasion. This will help prioritise Parks Victoria surveillance monitoring efforts to MPAs most at risk to improve the likelihood of early detection and successful management.

**Figure 15**. Intertidal bare sediment and mangroves in Yaringa Marine National Park. Photo by Adam Pope, Deakin University.

### 2.1.7 KNOWLEDGE GAPS

A lot of assumptions have been made in previous descriptions of the natural values of Yaringa MNP as they were largely based on surveys from elsewhere in WP, rather than surveys within the MNP itself. Basic habitat mapping has been done in Yaringa MNP but there have been limited surveys that identify what species are found in the MNP, even for large charismatic fauna such as birds. Surveys of the soft sediment invertebrate fauna (Butler and Bird 2010) and fish (Warry and Reich 2010) have been undertaken along with the dominate flora of mangrove and saltmarsh habitats (Victorian Saltmarsh Study 2011). Intertidal surveys of the fauna of the saltmarsh, mangroves and specifically seagrass beds have not been undertaken in the MNP. The algae growing intertidally and subtidally has not been identified. No surveys have been conducted of the ecological communities of the deeper subtidal soft sediments or water column. Major threats have been identified for Yaringa MNP but we have limited knowledge of the effect on the natural values, particularly ecological communities.

**Figure 16.** The white mangrove *Avicennia marina* in Yaringa Marine National Park. Photo Julian Finn, Museum of Victoria.

## 2.2 French Island Marine National Park

French Island Marine National Park (Figure 20) is one of five MNPs in the Victorian Embayments bioregion. The other MNPs are Port Phillip Heads, Yaringa, Churchill Island and Corner Inlet. Three Marine Sanctuaries in the bioregion are all in Port Phillip Bay (PPB) and include Point Cooke, Jawbone and Ricketts Point MSs (Figure 4). French Island MNP is in the north-west of Western Port Bay (WP), approximately 10 km south of Tooradin and 60 km south-east of Melbourne (Parks Victoria 2007). It extends offshore from the high water mark for 15 km along the northern shore of French Island, from Scrub to Palmer Points (Parks Victoria 2007). The MNPs northern boundary surrounds Barrallier Island and follows North Arm and the Horseshoe Channels aligning with their southern navigation markers (ECC 2000; Parks Victoria 2007). French Island National Park abuts the MNP (Parks Victoria 2007). The MNP is accessible by boat from Warneet, Blind Bight, Tooradin and other WP shore jetties (ECC 2000; Parks Victoria 2007).

Aboriginal tradition indicates that French Island Marine National Park is part of *Country* of Boonwurrung people (Parks Victoria 2007).

French Island MNP includes the intertidal areas that were formerly part of French Island National Park (Parks Victoria 2007). It is part of three special protection areas that cover WP. These include the WP Ramsar site, which recognises it as a wetland of international significance, the East Asian-Australasian Flyway for migratory waders, and Mornington Peninsula and WP UNESCO Biosphere Reserve (Parks Victoria 2007). Western Port Bay is also listed on the Register of the National Estate in recognition of its natural values and heritage importance (Parks Victoria 2007). Within the MNP a Special Protection Area for Natural Values of 450 ha (16 %) covers the saltmarsh and mangrove areas, extending seaward from the high water mark to the edge of the vegetated intertidal area (Parks Victoria 2007). An additional Special Protection Area of 7 ha surrounds Barrallier Island including all the intertidal shoreline extending 150 m seaward of the high water mark (Parks Victoria 2007). Public access is prohibited in both these areas including all vessels, and the landing and launching of vessels (Parks Victoria 2007). Palmer Point and Barrallier Island have sand ridges that display relict geomorphological processes and are of regional significance (Parks Victoria 2007). The north shore of French Island is one of the major areas of saltmarsh and mangrove in Victoria and is of State significance (ECC 2000; Carey *et al.* 2007b; Parks Victoria 2007).

Important natural values of French Island MNP are its mangroves, sandy beaches and spits, sheltered intertidal mudflats, seagrass beds, subtidal soft sediments and tidal channels (ECC 2000; Carey *et al.* 2007b; Parks Victoria 2007; Edmunds *et al.* 2010a). These habitats support algae, invertebrate and fish communities (ECC 2000; Carey *et al.* 2007b; Parks Victoria 2007). French Island MNP is heavily influenced by tidal activities that expose and submerge large expanses of mudflats and associated seagrass beds (Parks Victoria 2007). These provide a foraging habitat for migratory waders, and the surrounding saltmarsh and mangroves provide roosting areas (ECC 2000; Parks Victoria 2007). The MNP includes the waters around the small gravelly Barrallier Island, one of the bay's 13 high tide roost sites for waders (ECC 2000). A dendritic network of moderately deep tidal channels provide deepwater habitat for fish and invertebrates including a high abundance of the seapen, *Sarcoptilus grandis* along with the brooch shell *Neotrigonia margaritacea*, the Mud Ark *Anadara trapezia* and the brachiopod lamp shell *Magellania flavescens* (Parks Victoria 2007). King George whiting *Sillaginodes punctatus*, and rock flathead *Platycephalus laevigatus*, are found in the deeper channels towards the edge of the MNP (ECC 2000).

The Mangrove Shrublands consist of the white mangrove *Avicennia marina* subsp. *australasica,* the only species of mangrove in Victoria (Victorian Saltmarsh Study 2011). *A. marina* grows up to 4.4 m tall in the MNP (Saintilan and Rogers 2001b). Extensive intertidal

*Zostera muelleri* and subtidal *Heterozostera nigricaulis* beds cover approximately a third of the MNP (Blake and Ball 2001; Ball *et al.* 2010). Sparse patches of the seagrass *Halophlia australis* with algae are present east of Post Office Channel near the centre of the MNP (Blake and Ball 2001). Approximately a third of the MNP, predominately in the north west, is covered by beds of unidentified algae. Algae also grows in amongst seagrass (Blake and Ball 2001). Common in the intertidal seagrass beds are the pulmonate gastropod family Amphibolidae, Pandalid and Hippolytid shrimps (Ball *et al.* 2010). Of the 28 species found in the intertidal mudflats of French Island MNP by Butler and Bird (2010), the most common was the ghost shrimp *Biffarius arenosus.* Also common were the polychaete worms *Barantolla lepte* and *Lumbrineris* sp. (Butler and Bird 2010). Dialids, Mysid shrimps and Dexaminid amphipods are at much higher densities in the subtidal seagrass than in the intertidal seagrass (Ball *et al.* 2010). The MNP includes some tidal channels of varying depth, profiles and orientations (ECC 2000). Deep channel WP habitat is not represented in the MNP (Edmunds *et al.* 2010a).

French Island MNP provides important feeding and roosting habitat for forty conservation listed bird species such as the orange-bellied parrot *Neophema chrysogaster,* grey-tailed tattler *Heteroscelus brevipes* and the intermediate egret *Ardea intermedia*, which are listed under the *Flora and Fauna Guarantee* (*FFG*) Act (1998) and regarded as critically endangered in Victoria. The MNP protects feeding areas for twenty-seven internationally important migrant species protected under the Australia Migratory Bird Agreement with either China (CAMBA) or Japan (JAMBA). Potentially 40 species of marine flora and fauna are at their distributional limits in Western Port Bay and could occur within the MNP

Serious threats to the French Island MNP include coastal erosion, litter, sediment and nutrients from the land and increasing urbanisation, vessels disturbing shorebirds, marine pollution, invasive marine pests and climate change (Carey *et al.* 2007b). In addition limited ecological knowledge of important processes including hydrology and slow social change can lead to inadequate management and threats to the MNPs natural values (Carey *et al.* 2007b). Measures to address or minimise these threats form part of the management plan for French Island MNP (Parks Victoria 2007). Specific research aims to increase ecological knowledge about the natural values of, and threats to French Island MNP.

**Figure 17**. Unidentified anenomes in French Island Marine National Park. Photo by Julian Finn, Museum of Victoria.

### 2.2.1 PHYSICAL PARAMETERS & PROCESSES

French Island MNP (Figure 18) is 2978 hectares in size which makes it the seventh largest of the 24 Marine National Parks or Sanctuaries in Victoria. Over 73% of the MNP (2173 ha) is intertidal (Table 6 & Figure 21). The majority (616 ha) of the subtidal area of the MNP (780 ha) is shallow (< 3.6 m) mudflats. The remainder of the subtidal area is essentially the channels that drain the intertidal mud flats. The maximum channel depths recorded in the MNP are around 12 m. Recent mapping with LiDAR and other technologies has resulted in improved bathymetry showing that nearly 16 ha of the MNP is above mean spring high waters.

The MNP (Table 6 and Figure 20) has an unequal semidiurnal tidal pattern, with a higher and lower flooding and ebbing event daily. Tidal variation within the MNP is large, 2.6 metres for spring tides and 0.9 metres for neap tides (Plummer *et al.* 2003). The MNP is not subject to large waves or swell and the large tides are the major driving force. Water moves through WP in a clockwise direction around French Island (Wallbrink and Hancock 2003). The WP Sediment Study (Wallbrink and Hancock 2003) found that persistent high turbidity arises from daily reworking and re-suspension of fine sediment by tidal, wind and wave action. Surface water temperatures average 20.8 °C in the summer and 11.3 °C in the winter (Plummer *et al.* 2003). There are no rivers or creeks that flow directly into the MNP.

**Table 6**. Physical attributes of the French Island Marine National Park.

| Park Name | French Island |
|---|---|
| Conservation status | Marine National Park |
| Biophysical Region | Victorian Embayments |
| Size | 2978 ha (ranked 7$^{th}$ of 24) |
| Length of coastline | ~14.5 km |
| Shoreline geology | sedimentary |
| Area with depth: | |
| *(high res)* Supratidal | 15.47 ha |
| Intertidal | 1552 ha |
| Intertidal-2 m | 478.4 ha |
| *(low res)* <1.6 m (~Intertidal)* | 621.15 ha |
| 1.6-3.6 m | 137.5 ha |
| 3.6-6.6 m | 112.54 ha |
| 6.6-11.6 m | 57.37 ha |
| >11.6 m | 3.97 ha |
| Mean tidal variation - spring | 2.6 m |
| Mean tidal variation - neap | 0.9 m |
| Mean water temp - summer | 20.8°C |
| Mean water temp - winter | 11.3°C |
| Adjacent catchment | National Park |
| Discharges into MNP | none |
| Nearest major estuary (distance & direction) | Cardinia Creek ~7.5 km north<br>Deep Creek ~ 7.5 km north<br>Bunyip River ~7.5 km north |

* artefact of combining different resolutions of bathymetric mapping, coarse mapping could not be separated into smaller depth categories

French Island, adjacent to the MNP consists of a broad ridge of Cretaceous rock bordered and overlain by Tertiary sands and clays with a fringe of older volcanics and extensive areas of Pleistocene quartzose dunes (Bird 1993). Mudflats surround outcrops of weathered basalt and spreads of ferruginous sandstone gravel and sand piled up by wave action into ridges (Bird 1993). Such processes have built Barrallier Island, which French Island MNP surrounds in the north west (Bird 1993). This island is of regional importance as one of the small gravelly islands in WP and its configuration changes in response to weather influences

(Bird 1993). Palmer Point sand ridges are also of regional significance as they display a relict geomorphic process (Figure 21). The north shore of French Island is one of the major areas of saltmarsh and mangrove in Victoria and is of State geomorphological significance (ECC 2000; Carey *et al.* 2007b; Parks Victoria 2007).

**Figure 18.** French Island Marine National Park. Photo by Chris Hayward, Parks Victoria.

### 2.2.2 MARINE HABITAT DISTRIBUTION

Mapping of habitats (Figure 21) is important for understanding and communicating the distribution of natural values within Marine National Parks and Sanctuaries, particularly as the marine environment is not as easily visualised as the terrestrial environment (Parks Victoria 2003). For management purposes, knowledge of the distribution and extent of habitats is required to effectively target management activities, including emergency response, monitoring and research. Mapping of marine habitats provides a baseline inventory, allows the identification of suitable monitoring sites and possible tracking of environmental change, as well as identifying areas vulnerable to particular threats or suitable for recreational activities.

The mangroves in French Island MNP have been mapped, and their change over time assessed (Saintilan and Rogers 2001a; Victorian Saltmarsh Study 2011). French Island seagrass habitat was mapped from aerial photography and ground-truthed by site visits and underwater video transects (Blake and Ball 2001). It is not possible to distinguish *Zostera muelleri* from *Hetrozostera nigricaulis* with the mapping techniques used, so both species are included in a combined *Zostera/Heterozostera* category. Mapping seagrass cover in WP is challenging due to the large tidal variation and typically poor water clarity. Seagrass at Chicory Lane in French Island MNP could not be accurately mapped from aerial photography due to difficulties in distinguishing it from the dark underlying mudflats (Ball *et al.* 2010). Some of the mapping at Scrub Point to the west of the MNP includes substrate in the MNP (Ball *et al.* 2010).

The MNP encompasses the seaward fringe of the Mangrove Shrubland community (EVC 140) along the north shores of French Island National Park (Figure 21) but no significant areas of saltmarsh (Victorian Saltmarsh Study 2011). The edge of patches of Wet Saltmarsh Herbland (new EVC) dominated by *Sarcocornia quinqueflora* are within the southeast boundary of the MNP (Victorian Saltmarsh Study 2011). The white mangrove *Avicennia marina* subsp. *australasica* is the only species of mangrove to occur in Victoria, where it reaches its most southern extent of distribution (Victorian Saltmarsh Study 2011). Western Port has communities of *A. marina* that are the most extensive and well developed in Victoria and are considered of State significance (Parks Victoria 2007; Victorian Saltmarsh Study 2011). The *A. marina* dominated Mangrove Shrubland community at French Island MNP grows on the sediment on intertidal mudflats (Victorian Saltmarsh Study 2011). Between 1967 and 1999, primarily between 1973 and 1999, mangrove vegetation along the shore of French Island MNP has increased (Saintilan and Rogers 2001a). Mangrove expansion primarily occurred along the tidal creeks by displacing saltmarsh and by prograding in a shoreward direction (Saintilan and Rogers 2001a; Rogers *et al.* 2005; Rogers *et al.* 2006; Rogers and Saintilan 2008).

The intertidal seagrass beds (Figure 19 and 21) are dominated by *Z. muelleri,* and subtidal seagrass beds by *H. nigricaulis,* covering up to a third of the MNP (Blake and Ball 2001; Ball *et al.* 2010). In the east of the MNP where the water is shallower and the substrate could be mapped, there are large patches of dense *Zostera/Heterozostera* with algae surrounded by patches of lesser density (Blake and Ball 2001). Along the edges of the channels are beds of algae, the identity of which could not be determined as part of the mapping. In the middle of the MNP, to the east of Post Office Channel, there are two patches of sparse *Halophila australis* with algae. South west of these patches are some small patches of unvegetated intertidal sediment beds along French Island's shoreline. To the west of these unvegetated patches are large patches of dense *Zostera/Heterozostera* and algae, which is sparser adjacent to the mangrove shoreline. West of the centre of the MNP, in the slightly deeper waters the sediment is dominated by algae. Another large patch of dense *Zostera/Heterozostera* with algae grows on the shallower sediment north west of Chicory Lane channel. In the far south west of the MNP small *Zostera/Heterozostera* patches with algae grow in amongst sediment dominated by algae. Barrallier Island in the north west of the MNP is surrounded by bare intertidal sediment. North of the island are small beds of *Zostera/Heterozostera* with algae (Blake and Ball 2001). Immediately west of the island are two small stands of Mangrove Shrubland (Victorian Saltmarsh Study 2011). Bulthuis *et al.* (1984) observed that the mudflats adjacent to Inside Channel in the MNP could be vegetated with seagrass or unvegetated even though they had similar sediment type. Bare mudflats were slightly less elevated and appeared more pockmarked by small depressions than the vegetated flats (Bulthuis *et al.* 1984). The flats without seagrass beds had only scattered patches of the green macroalgae *Caulerpa cactoides* (Bulthuis *et al.* 1984).

Seagrass cover in French Island MNP (Figure 21) varies from site to site and through time (Ball *et al.* 2010; Butler and Bird 2010). Subtidal *H. nigricaulis* cover at Chicory Lane between 2004 and 2007 was low (< 40 %), compared to elsewhere in Western Port and Port Phillip Bays, although cover exceeded 80 % in summer 2006 (Ball *et al.* 2010). Both intertidal *Z. muelleri* and subtidal *H. nigricaulis* below ground seagrass biomass (rhizomes) can be up to twice that of above ground (shoots) biomass (Ball *et al.* 2010). Epiphytic macroalgal cover is variable and can be from 0 to 50 %; on intertidal *Z. muelleri* beds it rarely exceeded 30 % (Ball *et al.* 2010). Drift macroalgal cover on the seagrass beds was also variable and up to 25 % on intertidal *Z. muelleri* beds but less on subtidal *H. nigricaulis* beds (Ball *et al.* 2010). Seagrass beds in WP declined by approximately 70 % between 1971 and 1985 (DSE 2003). The greatest loss of seagrass occurred in intertidal areas. More nutrients and suspended solids move off denuded soft sediments than seagrass covered sediments (Bulthuis *et al.* 1984). The MNP includes some areas of seagrass beds where little loss of seagrass has been recorded (ECC 2000).

The sediment distribution in the MNP reflects both the hydrodynamics and terrigenous inputs of sediment. In 1975 the west and north of French Island, and along inshore areas and channel margin banks was sand (Wallbrink and Hancock 2003). This reflects the high energy of water movement in this area (Wallbrink and Hancock 2003). The sediment on the tidal flats of French Island MNP (Figure 21) is sand (Coleman and Poore 1980). The MNP includes some tidal channels of varying depth, profiles and orientations (ECC 2000). The deep channel habitat is not represented in the MNP (Edmunds *et al.* 2010a). The vegetation of the subtidal channels has not been mapped as they are too turbid and deep to be interpreted from aerial photos (Blake and Ball 2001; Ball *et al.* 2010). This includes a lot of the subtidal area in the far north east of the MNP (Blake and Ball 2001). In the deep tidal channel the sediments in WP are coarse shelly sand (Coleman and Poore 1980).

**Figure 19.** Seagrass and algae in French Island Marine National Park. Photo by Chris Hayward, Parks Victoria.

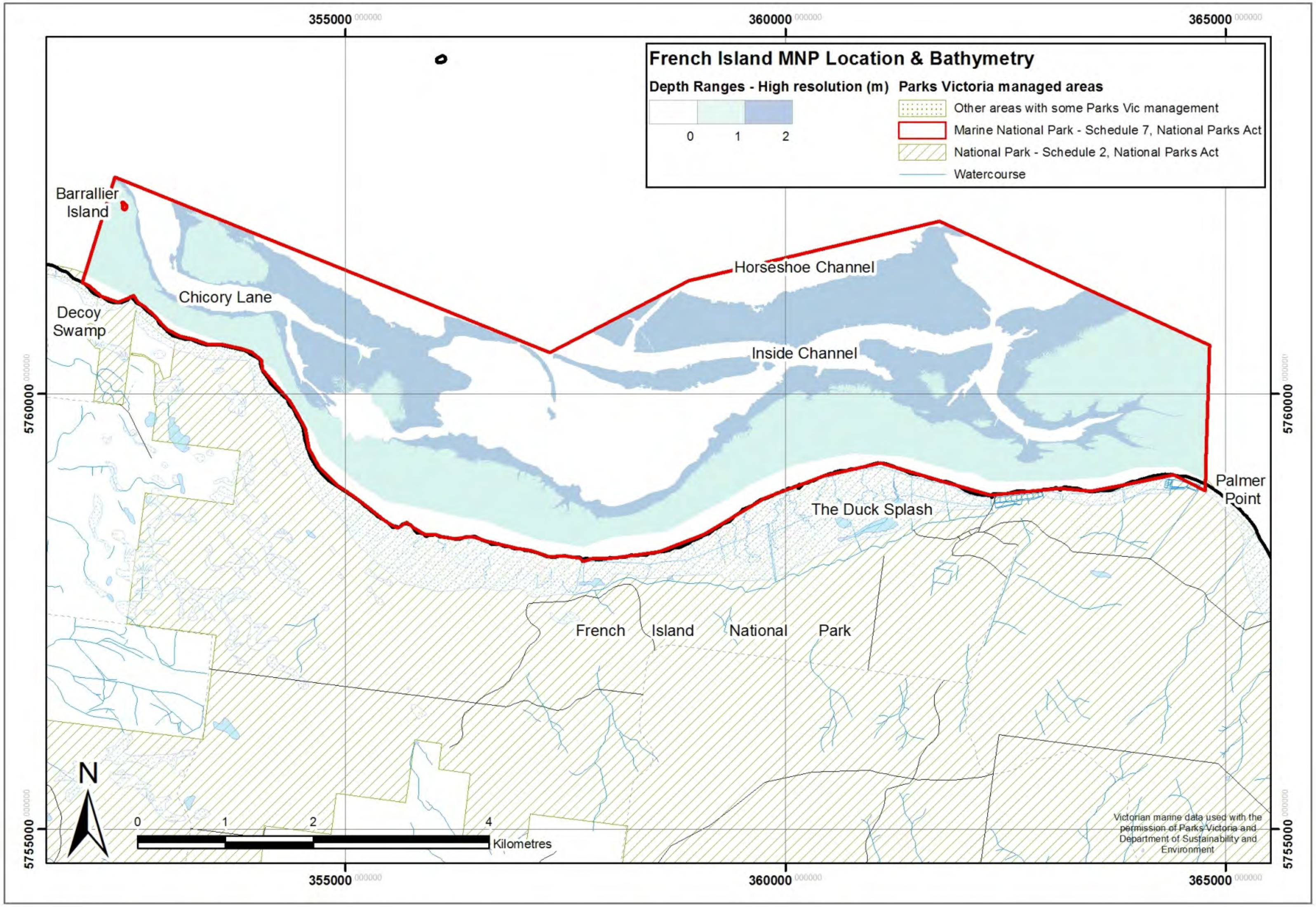


**Figure 20**. Location map of French Island Marine National Park with bathymetry. There are no intertidal or subtidal reef monitoring sites in the MNP.

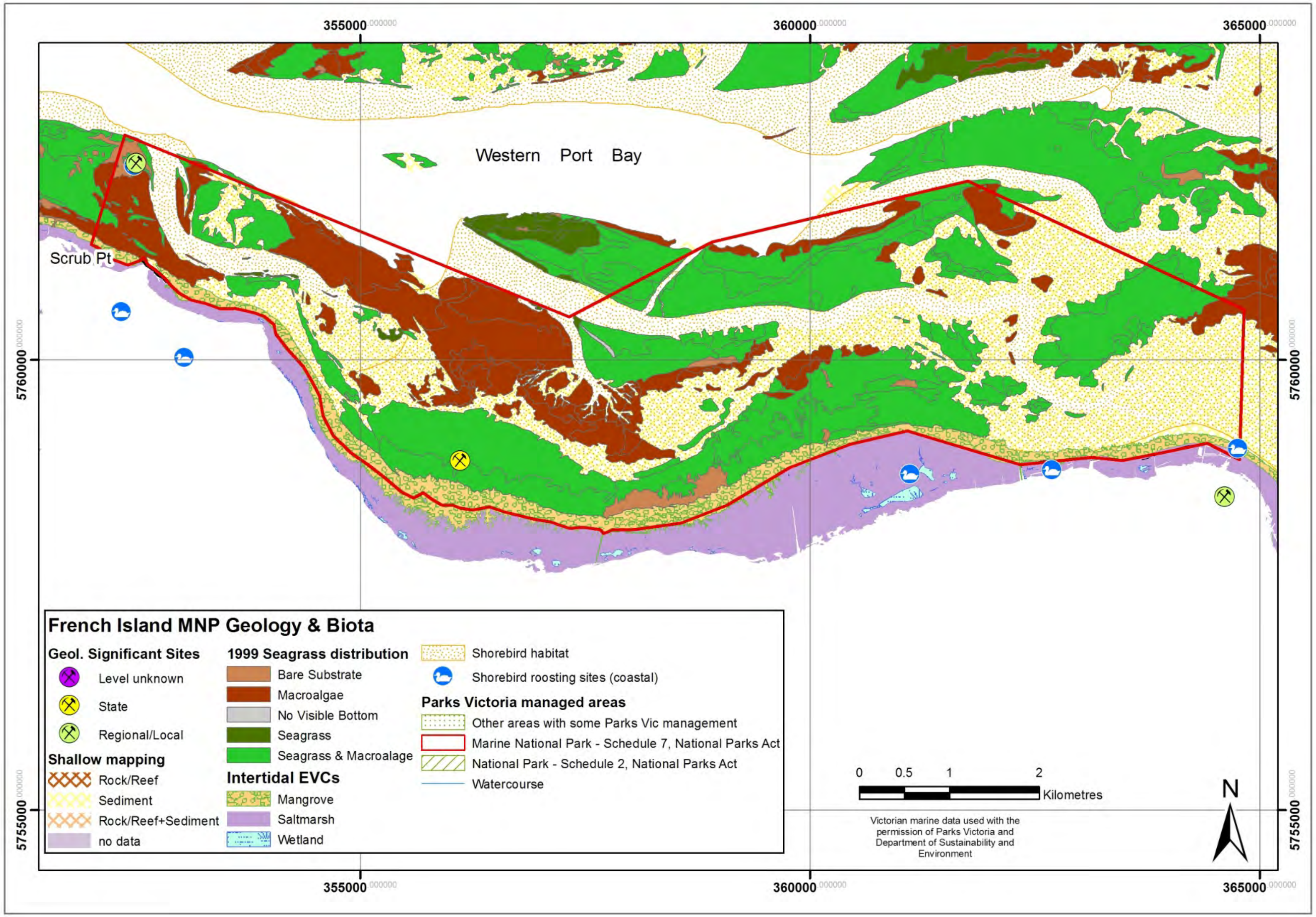


**Figure 21**. Substrate mapping of French Island Marine National Park and surrounds, showing sites of geological and biotic significance.

### 2.2.3 MARINE ECOLOGICAL COMMUNITIES

#### General

Although there have been many studies in WP, few studies have focused on the biota within the MNP (Plummer *et al.* 2003; Parks Victoria 2007). Major areas of research in the park includes mangroves and saltmarsh, and associated flora, fauna and ecological processes (Saintilan and Rogers 2001a; Victorian Saltmarsh Study 2011); seagrass and associated epifauna (Blake & Ball 2001), and invertebrate infauna (Butler and Bird 2010). From database records of species recorded in French Island MNP it is obvious that historically there has been a bias to bird surveys (Table 7, Appendix 1).

**Table 7.** Summary of database records of the number of species in major biotic groups in French Island Marine National Park (see Appendix 1). WP indicates that the location in Western Port Bay was not specified.

| Biotic group | Number of species | |
|---|---|---|
| | French Island | WP |
| **Macrophytes** | **0** | **41** |
| yellow-green algae | 0 | 1 |
| green algae | 0 | 1 |
| brown algae | 0 | 7 |
| red algae | 0 | 32 |
| **Invertebrates** | **1** | **25** |
| decapod crustaceans | 0 | 8 |
| chitons | 0 | 1 |
| gastropods | 0 | 14 |
| bivalves | 0 | 1 |
| echinoderms | 1 | 1 |
| **Vertebrates** | **66** | **6** |
| fish | 0 | 6 |
| birds | 66 | 0 |

Since the first natural values report by Plummer *et al.* (2003) Parks Victoria has supported research in French Island MNP including a new survey in 2006 and 2007 of the biota of the soft sediments (Butler and Bird 2010). Change in seagrass cover, biomass, epiphytes and epifauna was measured five times over two and a half years at Chicory Lane in the north west part of the MNP as part of a larger study across Port Phillip Bay (PPB), Western Port Bay and Corner Inlet (CI) (Ball *et al.* 2010). There have been no new surveys of the biota of the saltmarsh, mangroves or pelagic habitats. French Island MNP is part of the Western Port Ramsar area (DSE 2003; Kellogg Brown & Root 2010) recognising its importance as shorebird habitat for resident and migratory birds (Table 8 & Figure 21). Within the MNP the mangroves at Palmer Point are a significant pied cormorant *Phalacrocorax varius* roosting site. Adjacent to the MNP there are many significant shorebird roosting sites. Barrallier Island is one of the bay's 13 high tide roost sites (ECC 2000). Four inland wetlands provide major shorebird roosting sites as does the saltmarsh adjacent to the MNP (Table 8).

#### Intertidal

The *Avicennia marina* Mangrove Shrubland community in French Island MNP grows on the sediment on intertidal mudflats in front of the saltmarsh communities (Victorian Saltmarsh Study 2011). *A. marina* grows up to 4.4 m tall in the MNP (Saintilan and Rogers 2001b). The trunks and pneumatophores of mangroves provide habitat for epiphytic filamentous algae, gastropods, barnacles, and mussels. The mangrove fringes are inhabited by crabs and at high tide fish such as gobies, mullet, and toadfish. Specific studies of the flora and fauna found in the Mangrove Shrublands of French Island MNP have not been conducted.

Seagrass beds are complex and extremely productive environments which play an important role in the ecology of the MNP (Parks Victoria 2007). Seagrass beds stabilise the sediment and remove dissolved nutrients from the water, forming one of the basic levels of the food chain (Blake and Ball 2001). Dense beds of *Zostera/Heterozostera* with algae occur in the MNP, as well as two small patches of *Halophila australis* (Blake and Ball 2001). Intertidal seagrass beds of *Zostera muelleri* and subtidal beds of *Heterozostera nigricaulis* cover approximately a third of the MNP (Blake and Ball 2001; Ball *et al.* 2010). Drift macroalgal cover on the seagrass beds is also variable and can be up to 25% on intertidal *Z. muelleri* beds (Ball *et al.* 2010). Seagrass beds provide habitat for epiphytic algae, hydroids, ascidians, diatoms and sponges, and grazing invertebrates including many molluscs (Figure 22), crustaceans, polychaetes and crabs. Common in the intertidal seagrass beds are the pulmonate gastropod family Amphibolidae, Pandalid and Hippolytid shrimps (Ball *et al.* 2010). Tidal immersion and location are important factors in determining the assemblage structure of epifaunal communities in seagrass (Ball *et al.* 2010). Seagrass beds are important nursery areas for many fish including conservation listed syngnathids (Parks Victoria 2007). Specific studies of the fish found in the seagrass beds or soft sediments of French Island MNP have not been completed.

**Figure 22.** Wavy volute *Amoria undulata* on the soft sediment in French Island Marine National Park. Photo by Julian Finn, Museum of Victoria.

Large areas of unvegetated mud and sand support invertebrates, microphytobenthos and demersal fish. Benthic invertebrates in both unvegetated and vegetated mudflats are an important food resource for the many migratory shore bird species that use WP (DSE 2003; Kellogg Brown & Root 2010). Butler and Bird (2010) found that the organic content, grain size, temperature and redox potential of the sediment influence the community composition of the mudflat macroinvertebrates in the MNP. Of the 28 species found in the mudflats of French Island MNP by Butler and Bird (2010), the most common was the ghost shrimp *Biffarius arenosus.* Also common were the polychaete worms *Barantolla lepte* and *Lumbrineris* sp. (Butler and Bird 2010). The ghost shrimps *Trypaea australiensis* and *Bi. arenosus* are not as abundant in the MNP as they are in Tooradin and Warneet (Coleman and Poore 1980; Butler and Bird 2010). *T. australiensis* has a patchy distribution in WP, it is only found in sand, with no or moderate vegetation cover and is abundant in 3 to 10 m water depth (Coleman and Poore 1980; Boon *et al.* 1997a). The crab *Macrophthalmus latifrons* and polychaete *Lumbrineris* sp. are not as common in French Island MNP compared to Yaringa MNP (Butler and Bird 2010).

Intertidal gravel-cobble reef occurs around Barrallier Island and along the shores of French Island (Bird 1993) but there is no information on its flora or fauna. Shorebirds and waders use the reef and sand shoals to roost (ECC 2000).

### Subtidal

Subtidal seagrass beds are predominately *H. nigricaulis* (Ball *et al.* 2010). Their epifaunal assemblage of 15 to 20 different taxa is distinct from that found in intertidal *Z. muelleri* beds (Ball *et al.* 2010). Dialids, Mysid shrimps and Dexaminid amphipods are at much higher densities in the subtidal seagrass than in the intertidal seagrass (Ball *et al.* 2010). The abundance of epifaunal animals on the seagrass varies considerably with time (Ball *et al.* 2010). Algae tends to be dominant in the deeper channels along with *H. nigricaulis* (Ball *et al.* 2010).

Subtidal soft sediments in the channels are generally coarse sand (Figure 24). Infauna would include invertebrates such as polychaetes, crustaceans (Figure 23), bivalves and gastropods (Parks Victoria 2007). Epifaunal species living on the subtidal channel sediments in WP include gastropods, sea stars, urchins and ascidians. Seapens *Sarcoptilus grandis* can be abundant along with the brooch shell *Neotrigonia margaritacea*, the Mud Ark *Anadara trapezia* and the brachiopod lamp shell *Magellania flavescens* (Parks Victoria 2007). Fish associated with the subtidal sediments and in the deep channels would include stingrays, perch and gobies. The MNP used to be fished recreationally for King George whiting *Sillaginodes punctatus*, and rock flathead *Platycephalus laevigatus*, mostly in the deeper channels towards the edge of the MNP (ECC 2000).

Subtidal gravel-cobble reef is thought to occur around Barrallier Island (Bird 1993), but there is no information on the biota found in this habitat.

### Water column

The water column habitat of the MNP is dominated by drifting planktonic species, which rely on currents for movement, nutrients and food. Many intertidal and subtidal organisms spend the early stage of their life in the water column environment and currents assist the distribution of recruits back to intertidal and subtidal habitats. Common plankton found in the water column include phytoplankton such as diatoms, and zooplankton including copepods, jellyfish and ctenophores. Highly mobile fish, sharks and stingrays inhabit the water column habitat of the MNP (Parks Victoria 2007). Post-larvae of King George whiting *Sillaginodes punctatus* appear in WP water column from September to November each year from adults spawning in South Australia and far western Victoria (Jenkins *et al.* 2000). The MNP used to be fished recreationally for King George whiting *S. punctatus*, snapper *Pagrus auratus* and southern sea garfish *Hyporhamphus melanochir* mostly in the deeper channels towards the edge of the MNP (ECC 2000). As described in the following section a wide variety of shorebirds, seabirds and fish of conservation significance are found in the waters of French Island MNP. Parks Victoria does not currently monitor the water column as a habitat (Power and Boxshall 2007).

**Figure 23**. Stalked barnacle *Smillium peronii* in French Island Marine National Park. Photo by Julian Finn, Museum of Victoria.

### 2.2.4 SPECIES OF CONSERVATION SIGNIFICANCE

The approach of managing MPAs for their marine ecological communities, rather than threatened species, is also likely to protect and enhance threatened species populations (Power and Boxshall 2007). Whole-of-habitat management may also result in the protection of species not yet identified because of their rarity or cryptic nature (Power and Boxshall 2007).

#### Flora

No conservation listed marine flora has been recorded in French Island MNP (Parks Victoria 2007).

#### Invertebrates

The brittle star *Amphiura triscacantha* is listed under the *Flora and Fauna Guarantee (FFG) Act 1988* and has been recorded in French Island MNP. *FFG Act 1988* listed stalked hydroid species *Ralpharia coccinea* has been recorded in Crawfish Rocks but not from French Island MNP.

#### Fish

Under the Victorian *Fisheries Act* 1995 all syngnathid species are listed as Protected Aquatic Biota. Nationally they are listed as threatened under the *Environment Protection and Biodiversity Conservation* (*EPBC) Act 1999*. Syngnathids are known from seagrass beds in WP (Edgar and Shaw 1995). They are potentially in French Island MNP but have not been recorded. The *FFG Act (1988)* listed pale mangrove goby *Mugilogobius platynotus* is thought to occur in French Island MNP.

#### Birds

French Island is part of the WP Ramsar site (DSE 2003). Forty conservation listed shore or sea birds have been sighted in or in the immediate surrounds of French Island MNP (Table 8). Thirty are recognized as threatened in Victoria, listed under the *FFG Act 1988* or the Victorian Rare or Threatened Species (VROTS) list. Three, the orange-bellied parrot *Neophema chrysogaster,* grey-tailed tattler *Heteroscelus brevipes* and the intermediate egret *Ardea intermedia* are regarded as critically endangered. *N. chrysogaster* is also listed as critically endangered nationally under the *EPBC Act 1999.* It migrates annually to coastal Victoria between March and October (Parks Victoria 2007).

Twenty-seven birds (Table 8) are recognized internationally under the Australia Migratory Bird Agreement with either China (CAMBA) or Japan (JAMBA). The bay is of international importance for seven wader species, the eastern curlew *Numenius madagascariensis*, common greenshank *Tringa nebularia*, rednecked stint *Calidris ruficollis,* curlew sandpiper *Calidris ferruginea,* double-banded plover *Charadrius bicinctus*, hooded plover *Thinornis rubricollis* and pied oystercatcher *Haematopus longirostris*, and national importance for Pacific golden plover *Pluvialis fulva* (Loyn *et al.* 2001). It also attracts high proportions of populations of whimbrel *Numenius phaeopus*, grey-tailed tattler *Heteroscelus brevipes* and masked lapwing *Vanellus miles* in coastal Victoria (Loyn *et al.* 2001). Mangroves limit where waders can feed for long periods on each tidal cycle, this limits the number of small waders that use the mudflats (Loyn *et al.* 2001). Common greenshank *T. nebularia* occur mainly in the mangrove-lined inner parts of WP (Loyn *et al.* 2001). Some species roost on saltmarshes notably the eastern curlew *N. madagascariensis*, masked lapwing *V. miles* and or isolated banks of mangroves grey-tailed tattler *H. brevipes* and terek sandpiper *Xenus cinereus* (Loyn *et al.* 2001). The Pacific golden plover *P. fulva roosts* in both environments (Loyn *et al.* 2001).

**Table 8**. Conservation listed shorebird and seabird records from French Island Marine National Park and surrounds.

| | | Victorian listing | | International treaty | |
|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **FFG** | **VROTS** | **CAMBA** | **JAMBA** |
| orange-bellied parrot | *Neophema chrysogaster* | L | CE | | |
| grey-tailed tattler | *Heteroscelus brevipes* | L | CE | C | J |
| intermediate egret | *Ardea intermedia* | L | CE | | |
| great knot | *Calidris tenuirostris* | L | EN | C | J |
| terek sandpiper | *Xenus cinereus* | L | EN | C | J |
| fairy tern | *Sternula nereis* | L | EN | | |
| little egret | *Egretta garzetta* | L | EN | | |
| gull-billed tern | *Gelochelidon nilotica* | L | EN | | |
| eastern great egret | *Ardea modesta* | L | VU | C | J |
| little tern | *Sternula albifrons* | L | VU | C | J |
| white-bellied sea-eagle | *Haliaeetus leucogaster* | L | VU | C | |
| Baillon's crake | *Porzana pusilla* | L | VU | | |
| black-tailed godwit | *Limosa limosa* | | VU | C | J |
| common sandpiper | *Actitis hypoleucos* | | VU | C | J |
| whimbrel | *Numenius phaeopus* | | VU | C | J |
| greater sand plover | *Charadrius leschenaultii* | | VU | C | J |
| lesser sand plover | *Charadrius mongolus* | | VU | C | J |
| royal spoonbill | *Platalea regia* | | VU | | |
| Caspian tern | *Hydroprogne caspia* | L | NT | C | J |
| eastern curlew | *Numenius madagascariensis* | | NT | C | J |
| red knot | *Calidris canutus* | | NT | C | J |
| Latham's snipe | *Gallinago hardwickii* | | NT | C | J |
| Pacific golden plover | *Pluvialis fulva* | | NT | C | J |
| grey plover | *Pluvialis squatarola* | | NT | C | J |
| glossy ibis | *Plegadis falcinellus* | | NT | C | |
| Pacific gull | *Larus pacificus* | | NT | | |
| sooty oystercatcher | *Haematopus fuliginosus* | | NT | | |
| pied cormorant | *Phalacrocorax varius* | | NT | | |
| nankeen night heron | *Nycticorax caledonicus* | | NT | | |
| whiskered tern | *Chlidonias hybridus* | | NT | | |
| red-necked stint | *Calidris ruficollis* | | | C | J |
| curlew sandpiper | *Calidris ferruginea* | | | C | J |
| bar-tailed godwit | *Limosa lapponica* | | | C | J |
| sharp-tailed sandpiper | *Calidris acuminata* | | | C | J |
| common greenshank | *Tringa nebularia* | | | C | J |
| cattle egret | *Ardea ibis* | | | C | J |
| ruddy turnstone | *Arenaria interpres* | | | C | J |
| common tern | *Sterna hirundo* | | | C | J |
| short-tailed shearwater | *Ardenna tenuirostris* | | | | J |
| Arctic jaeger | *Stercorarius parasiticus* | | | | J |

L= listed, NT = Near Threatened, VU = Vulnerable, EN = Endangered, CE = Critically Endangered, C = Listed under the CAMBA treaty, J = Listed under the JAMBA treaty

Barrallier Island, which is surrounded by French Island MNP, is the second largest wader roost in WP (Figure 21), and along with Yallock Creek helps serve the vast areas of mudflat in the North Arm and north of French Island (Loyn *et al.* 2001). Most waders roost in dense flocks on stony beaches and sandbanks on the eastern side of the 1 ha island (Loyn *et al.* 2001). Common greenshank *T. nebularia* prefer to roost on the western side, often standing in shallow water close to mangroves (Loyn *et al.* 2001). Three pairs of pied oystercatchers *H. longirostris* are resident on different parts of the island (Loyn *et al.* 2001). Waders roosting on Barrallier Island usually feed nearby as the tide drops and then disperse more widely to mudflats north of French Island (Loyn *et al.* 2001). Common greenshank *T. nebularia* feed along the mangrove-lined north shore of French Island as the tide drops (Loyn *et al.* 2001).
There appears to have been a shift in breeding of pelicans *Pelecanus conspicillatus* from the Duck Splash adjacent to the French Island MNP to Mud Islands in Port Phillip Heads MNP (O'Brien *et al.* 2010). Pelicans *P. conspicillatus* have not bred on French Island since 2000 (O'Brien *et al.* 2010).

## Marine mammals

French Island MNP is shallow and dominated by intertidal and subtidal mudflats. It does not provide habitat for large marine mammals.

## Species distribution information

An assessment of distribution, endemism and rarity of biota across the state did not identify any biota endemic to French Island MNP (O'Hara and Barmby 2000; O'Hara and Poore 2000; O'Hara 2002).

Over sixty-nine species of biota (Appendix 2) have been described as having their distributional limit in WP (O'Hara and Barmby 2000; O'Hara and Poore 2000; O'Hara 2002). Twenty-five of these species are algae, predominately red algae, recorded at Crawfish Rocks off the north west coast of French Island. There is limited specific information on species at their distributional limit in French Island MNP. Potentially forty species (Table 9) are at their distributional limit in Western Port and could be found in French Island MNP (O'Hara and Barmby 2000; O'Hara and Poore 2000; O'Hara 2002). The distributional limits of the biota listed in Table 9 may reflect collection effort in this area rather than actual Victorian distributions. Many areas of the Victorian coast have never been sampled and therefore biota ranges may be much greater than those suggested.

**Table 9**. Marine species potentially at their distribution limits in Western Port Bay that may be found in French Island Marine National Park (O'Hara and Barmby 2000; O'Hara and Poore 2000; O'Hara 2002).

| Phylum | Order | Family | Species | Common name | Category |
|---|---|---|---|---|---|
| Chlorophyta | Caulerpales | Caulerpaceae | *Caulerpa remotifolia* | green algae | RE* |
| Phaeophyta | Dictyotales | Dictyotaceae | *Distromium multifidum* | brown algae | PE |
| Phaeophyta | Fucales | Cystoseiraceae | *Myriodesma integrofolium* | brown algae | PE |
| Phaeophyta | Sphacelariales | Sphacelariaceae | *Sphacelaria carpoglossi* | brown algae | PE |
| Phaeophyta | Fucales | Fucaceae | *Xiphophora gladiata* | brown algae | PN |
| Rhodophyta | Ceramiales | Dasyaceae | *Dasya hookeri* | red algae | RE* |
| Rhodophyta | Gigartinales | Hypneaceae | *Hypnea valentiae* | red algae | RE* |
| Rhodophyta | Rhodymeniales | Rhodymeniaceae | *Gloiocladia fruticulosa* | red algae | RE* |
| Rhodophyta | Ceramiales | Ceramiaceae | *Anotrichium elongatum* | red algae | PE |
| Rhodophyta | Ceramiales | Ceramiaceae | *Anotrichium licmophorum* | red algae | PE |
| Rhodophyta | Ceramiales | Ceramiaceae | *Ceramium excellens* | red algae | PE |

| | | | | | |
|---|---|---|---|---|---|
| Rhodophyta | Ceramiales | Ceramiaceae | *Shepleya verticillata* | red algae | PE |
| Rhodophyta | Gigartinales | Kallymeniaceae | *Austrophyllis alcicornis* | red algae | PE* |
| Rhodophyta | Rhodymeniales | Lomentariaceae | *Semnocarpa corynephora* | red algae | PE |
| Rhodophyta | Rhodymeniales | Rhodymeniaceae | *Gloiocladia polycarpa* | red algae | PE |
| Crustacea | Dendrobranchiata | Penaeidae | *Penaeus latisulcatus* | prawn | PW |
| Crustacea | Thalassinidea | Laomediidae | *Laomedia healyi* | ghost shrimp | PW |
| Crustacea | Thalassinidea | Callianassidae | *Eucalliax tooradin* | ghost shrimp | PE |
| Crustacea | Brachyura | Majidae | *Anacinetops stimpsoni* | shaggy seaweed crab | RE |
| Crustacea | Brachyura | Hymenosomatidae | *Trigonoplax longirostris* | crab | PE |
| Crustacea | Brachyura | Majidae | *Huenia halei* | crab | PE |
| Crustacea | Caridea | Alpheidae | *Alpheus astrinx* | narrow snapping shrimp | RE |
| Mollusca | Gastropoda | Columbellidae | *Aesopus plurisulcatus* | marine snail | PW |
| Mollusca | Gastropoda | Columbellidae | *Anachis smithi* | marine snail | PW |
| Mollusca | Gastropoda | Olividae | *Zemira australis* | marine snail | PW |
| Mollusca | Gastropoda | Turridae | *Austrodrillia angasi* | marine snail | PW |
| Mollusca | Gastropoda | Vermetidae | *Serpulorbis hedleyi* | marine snail | PW |
| Mollusca | Gastropoda | Calyptraeidae | *Cheilea flindersi* | marine snail | PE |
| Mollusca | Gastropoda | Cancellariidae | *Cancellaria (Nevia) spirata* | nutmeg shell | PE |
| Mollusca | Gastropoda | Cancellariidae | *Cancellaria (Sydaphera) lactea* | nutmeg shell | PE |
| Mollusca | Gastropoda | Cancellariidae | *Cancellaria (Sydaphera) purpuriformis* | nutmeg shell | PE |
| Mollusca | Gastropoda | Eatoniellidae | *Eatoniella victoriae* | marine snail | PE* |
| Mollusca | Gastropoda | Epitoniidae | *Epitonium platypleura* | marine snail | PE |
| Mollusca | Gastropoda | Cerithiopsidae | *Zaclys angasi* | marine snail | PB |
| Mollusca | Polyplacophora | Lepidopleuridae | *Leptochiton liratus* | chiton | PE |
| Echinodermata | Holothuroidea | Phyllophoridae | *Lipotrapeza ventripes* | sea cucumber | PE |
| Chordata | Atheriniformes | Atherinidae | *Kestratherina esox* | pikehead hardyhead | PE |
| Chordata | Perciformes | Tripterygiidae | *Lepidoblennius haplodactylus* | jumping joey | PW |
| Chordata | Perciformes | Gobiidae | *Arenigobius frenatus* | half bridled goby | RW |
| Chordata | Perciformes | Sillaginidae | *Sillago bassensis* | silver whiting | PE |

* recorded from Crawfish Rocks, RE = recorded eastern limit of distribution, PE = presumed eastern limit of distribution, PW = presumed western limit of distribution

**Figure 24.** Sea anenome *Anthothoe albocincta* in French Island Marine National Park. Photo by Julian Finn, Museum of Victoria.

### 2.2.5 MAJOR THREATS

Threats to natural values were derived from lists of hazards and associated risks in Carey *et al.* (2007b). These were the result of a statewide consultative process to identify threats to MPAs. Through public and agency workshops, the natural values in individual MNPs and MSs and the threats that could affect them over the next ten years, were considered and ranked to identify hazards. This list of hazards was then ranked (low, medium, high and extreme) by the risk posed by each hazard (Carey *et al.* 2007b). Thirteen hazards with the potential to be of extreme risk were identified by Carey *et al.* (2007b). They are listed in rank order and the habitat or area at risk within the MNP is indicated in brackets:

1. Coastal erosion causing smothering slime over seagrass, resulting in seagrass dieback (intertidal and subtidal);
2. Lack of resources for compliance and enforcement leading to broader ecological impacts (all of MNP);
3. Sedimentation from development corridor causing loss of seagrass (intertidal and subtidal);
4. Lack of integrated arrangements/management leading to negative impacts on MNPs (all of MNP);
5. Increasing pressure from urban activities impacting on MNPs (all of MNP);
6. Lack of knowledge of marine ecosystems leading to poor management decisions and loss of biodiversity (all of MNP);
7. Impacts of farm effluents and contaminants on marine flora and fauna (intertidal and subtidal);
8. Lack of perception of importance of values at all social and political levels, leading to lack of coordinated and effective management, reducing conservation of natural values (all of MNP);
9. Poor uptake of information/education within catchment on impacts of poor land management and tools/strategies that could improve land management and affect inputs to MNPs (all of MNP);
10. Noisy and fast moving vessels disturbing birds, leading to reduced shore-bird abundance (intertidal);
11. Increased recreational usage (in & around MNPs) causing increased negative impacts *e.g.* litter and contaminants (all of MNP);
12. Exotic marine species from commercial shipping/ recreational boating/ aquaculture causing change in species composition in MNPs (all of MNP); and
13. Lack of knowledge about the way changes in hydrology (including the rate of siltation) impact on flora and fauna in the MNPs (all of MNP).

Parks Victoria's internal review of threats occurring within the French Island MNP included marine exotics (Carey *et al.* 2007b). It also recognised the threat of marine pollution incidents, illegal recreational and commercial fishing, and commercial operations in breach or outside of permits in the MNP (Carey *et al.* 2007b).

The introduction of marine pests threatens the integrity of marine biodiversity and may reduce the social and economic benefits derived from the marine environment (Parks Victoria 2003). Most marine pests known from Victorian waters are found in Port Phillip Bay (Parks Victoria 2003). No introduced species are known to be found within French Island MNP (Parks Victoria 2007). Species of concern include the Northern Pacific seastar *Asterias amurensis,* which was found at San Remo in September 2011, European fan worm *Sabella spallanzanii* and broccoli weed *Codium fragile (subsp. fragile)* (Parks Victoria 2003).

**Climate Change**
Climate change represents a serious threat to marine ecosystems (McLeod *et al.* 2009) but specific ecological consequences of accelerating climate change are not well understood in marine systems, particularly in temperate systems. Climate change is predicted to increase

water temperature, alter chemical composition (salinity, acidity and carbonate saturation), change circulation and productivity, increase frequencies of extreme weather events and exposure to damaging ultraviolet light (UVB), and increase air temperature, cloud cover and sea levels (conservatively 80 cm by 2100; CSIRO-BoM 2007; Fine and Franklin 2007; VCC 2008; McLeod *et al.* 2009). A combined increase in cloud cover and sea level could result in decreased light availability potentially changing benthic flora. Increased storm surges and ocean current changes also have the potential to change the distribution of fauna and flora and could result in loss of habitats (CSIRO-BoM 2007). Intertidal communities will face increased desiccation, storm wave exposure and habitat shift. Changes in the relationship between climate and annual life-history events may force major change in functional groups and consequent ecosystem function (Fine and Franklin 2007). Climate change is also anticipated to modify species recruitment and habitat connectivity, species interactions and disturbance regimes in the marine environment (CSIRO-BoM 2007; Fine and Franklin 2007). A number of species that maybe at the eastern or western limit of their distributional range at French Island MNP would be particularly vulnerable to climate change.

Measures to address or minimise these hazards form part of the management plan for French Island MNP (Parks Victoria 2007). For example, research has been targeted at marine pest species, and water quality issues which may impact on park natural values. Management actions have been implemented to minimise these threats (Parks Victoria 2007). Parks Victoria has also undertaken a strategic climate change risk assessment to identify the risks and stressors for natural values in the MPAs through assessment at the habitat level for parks in each marine bioregion. Parks Victoria will use an adaptive management approach to develop responses and actions that focus on priority climate change issues such as extreme weather events and existing risks that will likely be exacerbated by climate change.

**Figure 25.** Pencil urchin *Goniocidaris* sp. in French Island Marine National Park. Photo by Julian Finn, Museum of Victoria.

### 2.2.6 CURRENT RESEARCH AND MONITORING

Parks Victoria has established extensive marine monitoring and research programs for the MPAs that address important management challenges, focussing both on improving baseline knowledge of the MPAs as well as applied management questions not being addressed by others. This knowledge will continue to enhance Parks Victoria's capacity to implement evidence-based management through addressing critical knowledge gaps. The research and monitoring programs have been guided by the research themes outlined as part of Parks Victoria's Research Partners Panel (RPP) program, a Marine Research and Monitoring Strategy 2007-2012 and Marine National Park and Marine Sanctuary Monitoring Plan 2007-2012 (Power and Boxshall 2007). Much of the research has been undertaken as part of the RPP program involving collaboration with various research institutions. The research relevant to French Island MNP has been published in Parks Victoria's Technical Series available on Parks Victoria's website (http://www.parkweb.vic.gov.au). As most research in the MNP has been carried out under permits issued by DSE, the permit database was also used to identify relevant projects for this report (see Table 10 & Appendix 3).

**Table 10.** Ongoing Research Partner Panel (and RPP-like) research projects implemented in partnership with, or commissioned by, Parks Victoria relevant to French Island Marine National Park.

| **Ongoing RPP (and RPP-like) Projects** |
|---|
| ***University of Melbourne:*** Kim Millers, Jan Carey, Mick McCarthy<br>Optimising the allocation of resources for defending Marine Protected Areas against invasive species. |
| ***Multiple Research Partners:*** Marine Monitoring and Marine Natural Values<br>***University of Melbourne:*** Jan Carey<br>Developing Report Cards for the Marine National Parks |
| ***Museum Victoria:*** Mark Norman, Julian Finn. ***Parks Victoria:*** Roger Fenwick<br>Under the Lens - Natural History of Victoria's Marine National Park System. |
| ***University of Melbourne:*** Tarek Murshed, Jan Carey, Jacqui Pocklington<br>Conceptual model development for marine habitats. |
| **Ongoing Habitat Mapping Projects** |
| ***DSE / DPI / Worley Parsons/ Deakin University***<br>LiDAR Mapping Project. Mapping of bathymetry and marine habitats along the Victorian coast |

French Island MNP does not have ongoing intertidal (IRMP) and a shallow subtidal (SRMP) reef monitoring program as these habitats are minimal within the MNP. A survey of macroinvertebrates inside and outside the Western Port MNPs has been undertaken as a possible baseline for future monitoring (Butler and Bird 2010).

There is no current Friends Group for the MNP (Parks Victoria 2007). The Victorian Wader Study Group monitors migratory and resident wading birds at Barrallier Island within French Island MNP (Parks Victoria 2007). Data collected by the Bird Observers Club of Australia, Australian Wader Studies Group and the Victorian Wader Study Group within the MNPs and adjacent areas, including the Western Port Ramsar Site, have contributed significantly to an understanding of the importance of Western Port as a Ramsar Site and as part of the East Asian–Australasian Flyway (Parks Victoria 2007).

Statewide, the Museum of Victoria is collecting additional data on the marine natural values of Victoria's MPAs. They are gathering information about natural history through video and photos (Figures 25 and 26), and using semi-quantitative methods to determine spatial and temporal changes across the system in response to threats, including marine pests and climate change. Jan Carey (University of Melbourne) is conducting research focussing on marine pest species which may impact on park values, and the MNPs and MSs which are most at risk of invasion. This will help prioritise Parks Victoria surveillance monitoring efforts to MPAs most at risk to improve the likelihood of early detection and successful management.

### 2.2.7 KNOWLEDGE GAPS

A lot of assumptions have been made in previous descriptions of the natural values of French Island MNP as they were largely based on surveys from elsewhere in WP, rather than surveys within the MNP itself. Basic habitat mapping has been done in French Island MNP but not surveys that identify what species are found in the MNP even for large fauna such as fish and birds. Surveys of the soft sediment invertebrate fauna have been undertaken (Butler and Bird 2010) along with the dominate flora of mangrove and saltmarsh habitats (Victorian Saltmarsh Study 2011). Intertidal surveys of the fauna of the mangroves have not been undertaken in the MNP. The algae growing intertidally and subtidally has not been identified. No surveys have been conducted of the ecological communities of the deeper subtidal soft sediments or water column. Major threats have been identified for French Island MNP but we have limited knowledge of the effect on the natural values, particularly ecological communities.

**Figure 26**. Sea squirt colony *Sycozoa pulchra* in French Island Marine National Park. Photo by Julian Finn, Museum of Victoria.

## 2.3 Churchill Island Marine National Park

Churchill Island Marine National Park (Figure 27, 28 and 30) is one of five Marine National Parks in the Victorian Embayments bioregion. The other MNPs are Port Phillip Heads, Yaringa, French Island, and Corner Inlet. Three Marine Sanctuaries in the bioregion are all in Port Phillip Bay (PPB) and include Point Cooke, Jawbone and Ricketts Point MSs. Churchill Island MNP is located south of Rhyll on the eastern shore of Phillip Island near the township of Newhaven, 85 km south-east of Melbourne (Parks Victoria 2007). The MNP extends from the high water mark along 11 km of the Swan Bay coastline (Parks Victoria 2007). The north boundary of the MNP is between Long Point on Phillip Island and North Point on Churchill Island (Parks Victoria 2007). The intertidal areas of Churchill Island MNP can only be accessed from the cobble and shingle beaches and the rest of the MNP by boat (Parks Victoria 2007).

Aboriginal tradition indicates that Churchill Island Marine National Park is part of *Country* of Boonwurrung people (Parks Victoria 2007).

The MNP includes intertidal areas that were formerly part of Churchill Island Heritage Farm (Parks Victoria 2007). It is part of three special protection areas that covers Western Port (WP). These include the WP Ramsar site, which recognises it as a wetland of international significance, the East Asian-Australasian Flyway for migratory waders, and Mornington Peninsula and WP UNESCO Biosphere Reserve (Parks Victoria 2007). Western Port is also listed on the Register of the National Estate in recognition of its natural values and heritage importance (Parks Victoria 2007). The mudflats, mangroves and saltmarsh of Churchill Island and Swan Bay are recognised as locally significant on the National Trust Register (Parks Victoria 2007). Within the MNP a Special Protection Area for Natural Values covers the saltmarsh and mangrove areas, extending seaward from the high water mark to the edge of the intertidal vegetation (Parks Victoria 2007). This covers 20 ha (3 %) of the MNP, and public access is prohibited including all vessels; the landing and launching of non-motorised vessels is allowed from the unvegetated shingle and cobble beaches (Parks Victoria 2007). Active and reflective cliffs indicative of higher sea levels at Swan Corner, and raised beach and emerged coastal forms between Chambers Point and Long Point are significant geological features within the MNP, the first of regional and the second of State significance (Parks Victoria 2007).

Important natural values of Churchill Island MNP are its saltmarsh, mangroves, cobble and shingle beaches, sheltered intertidal mudflats, seagrass beds, subtidal soft sediments and tidal channels (ECC 2000; Parks Victoria 2007; Edmunds *et al.* 2010a). Its habitats support algae, invertebrate fish and bird communities (ECC 2000; Parks Victoria 2007). Churchill Island MNP is heavily influenced by tidal activities that expose and submerge large expanses of mudflats and associated seagrass beds (Parks Victoria 2007). These provide a foraging habitat for migratory waders and are recognised as areas of State and regional significance (ECC 2000; Parks Victoria 2007). The surrounding saltmarsh and mangroves provide roosting areas, and are of State significance (ECC 2000; Parks Victoria 2007). Dense populations of the highly unusual and rare 'living fossil' lampshell or brachiopod *Magellania flavescens* are found on the subtidal sediments in the MNP (Parks Victoria 2007). The dendritic network of tidal channels provide a habitat for a range of fish and invertebrate species including a high abundance of the seapen *Sarcoptilus grandis* (Parks Victoria 2007).

The major habitats in the MNP (66%) are subtidal flats and shallow channels, with approximately 32 % intertidal (Table 11 & Figure 30). Maximum channel depths have been recorded as < 3.6 m. Small patches of saltmarsh communities in Swan Bay and Renison Bight are included in the MNP (Victorian Saltmarsh Study 2011). The majority of the saltmarsh in the MNP is Wet Saltmarsh Herbland community with cover dominated by

*Scarcocornia quinqueflora* (Victorian Saltmarsh Study 2011). The MNP takes in the edge of some of the Mangrove Shrubland community along the southern shore of Renison Bight, western shoreline of Swan Bay and Long Point (Victorian Saltmarsh Study 2011). The soft sediment of the MNP is covered by dense beds of *Zostera/Heterozostera* and algae (Blake and Ball 2001). Both of the seagrasses *Zostera muelleri* and *Heterozostera nigricaulis* grow within the MNP (ECC 2000). The dominant epifaunal organism on the pneumatophores, lower parts of mangrove trees and mangrove seedlings is the barnacle *Elminius covertus*, also common is the littorinid *Bembicium auratum* (Satumanatpan *et al.* 1999). The mangrove fringes of the MNP are also inhabited by crabs and at high tide fish such as gobies, mullet and toadfish (Satumanatpan *et al.* 1999).

The intertidal soft sediments of Churchill Island have abundant microalgae growing on their surface (Butler and Bird 2010). Of the 17 macroinvertebrate species found in the intertidal mudflats of Churchill Island MNP, the most common are the sentinel crab *Macrophthalamus latifrons* and the Phoronids *Phoronopsis albomaculata* (Butler and Bird 2010). Also common are the polychaete worms *Barantolla lepte* and *Lumbrineris* sp., and the bivalve mollusc *Tellina deltoids* (Butler and Bird 2010).

The majority of the MNP is subtidal habitat and is covered with dense beds of *Zostera*/*Heterozostera* and algae. Fish associated with the subtidal sediments and in the channels, include stingrays, perch, flathead, and gobies (Parks Victoria 2007).

Churchill Island MNP provides important feeding and roosting habitat for forty-one conservation listed bird species such as the orange-bellied parrot *Neophema chrysogaster* and grey-tailed tattler *Heteroscelus brevipes*, which are listed under the *Flora and Fauna Guarantee* (*FFG*) Act (1998) and regarded as critically endangered in Victoria. The MNP and surrounds is the feeding area for twenty-nine internationally important migrant species protected under the Australia Migratory Bird Agreement with either China (CAMBA) or Japan (JAMBA). Potentially 32 species of marine flora and fauna are at their distributional limits in Western Port Bay and could occur within the MNP

Serious threats to the Churchill Island MNP include oil spills, invasive marine pests, human disturbance of birds and fox predation, excessive nutrients and sediments from the catchment and climate change, which all pose serious threats to the integrity of the MNP (Carey *et al.* 2007b). Measures to address or minimise these threats form part of the management plan for Churchill Island MNP (Parks Victoria 2007). Specific research aims to increase ecological knowledge about the natural values of, and threats to Churchill Island MNP.

**Figure 27**. Churchill Island Marine National Park. Photo by Chris Hayward, Parks Victoria.

### 2.3.1 PHYSICAL PARAMETERS & PROCESSES

Churchill Island MNP is 670 hectares in size which makes it the thirteenth largest of the 24 Marine National Parks or Sanctuaries in Victoria. Over 60 % of the MNP is shallow subtidal habitat (Table 11 and Figure 30). The MNP has an unequal semidiurnal tidal pattern, with a higher and lower flooding and ebbing event daily. Tidal variation within the MNP is large, but not as large as in the north of WP. Spring tides are 2.0 m and neap tides 0.8 m, and the tides are the major driving force in the MNP (Plummer *et al.* 2003). The WP Sediment Study (Wallbrink and Hancock 2003) found that the persistent high turbidity in WP arises from daily reworking and re-suspension of fine sediment by tidal, wind and wave action. Churchill Island MNP is protected from prevailing south-westerly winds, but is exposed to some wind-driven waves (Satumanatpan *et al.* 1999). Surface water temperatures average 20.4 °C in summer and 11.7 °C in winter (Plummer *et al.* 2003). There are no rivers or creeks that flow directly into the MNP. Stormwater is discharged into waters adjacent to the MNP (Parks Victoria 2007).

Churchill Island, adjacent to the MNP, is an embayed hilly island of weathered Older Volcanics, basalt and tuff (Bird 1993). The shallow strait between Churchill Island and Newhaven is basalt overlain by mudflats (Bird 1993). Low bluffs and promontories of weathered basalt and tuff occur along the shore to the south of Churchill Island, and at Chambers, Pleasant and Long Points (Bird 1993). The silty-clay mudflats of the MNP are mainly reworked sediment derived from Phillip Island and the South Gippsland Highlands 5000 years ago (Harris *et al.* 1979).

The shoreline of the MNP has three sites of geological significance (Figure 31). Churchill Island shorelines are indicative of a higher sea level and are of regional significance (Bird 1993; Parks Victoria 2007). Swan Corner within Swan Bay has active and relict cliffs of regional significance, and between Chambers Point and Long Point has features that suggest a higher Holocene sea level and are of State significance (Bird 1993; ECC 2000; Parks Victoria 2007).

**Table 11**. Physical attributes of the Churchill Island Marine National Park

| **Park Name** | **Churchill Island** |
|---|---|
| Conservation status | Marine National Park |
| Biophysical Region | Victorian Embayments |
| Size | 670 ha (ranked 13th of 24) |
| Length of coastline | ~11 km |
| Shoreline geology | Basalt & sedimentary |
| Area with depth: | |
| *(high res)* Supratidal | 12.91 ha |
| Intertidal | 173.33 ha |
| Intertidal-2 m | 382.86 ha |
| *(low res)* <1.6 m (~Intertidal)* | 39.47 ha |
| 1.6-3.6 m | 61.32 ha |
| Mean tidal variation - spring | 2.0 m |
| Mean tidal variation - neap | 0.8 m |
| Mean water temp - summer | 20.4°C |
| Mean water temp - winter | 11.7°C |
| Adjacent catchment | Urban<br>Agricultural |
| Discharges into MNP | none |
| Nearest major estuary<br>(distance & direction) | Bass River ~6.6 km east |

* artefact of combining different resolutions of bathymetric mapping, coarse mapping could not be separated into smaller depth categories

**Figure 28**. Aerial view of Churchill Island on the eastern boundary of Churchill Island Marine National Park. Photo by Tim Allen.

### 2.3.1 MARINE HABITAT DISTRIBUTION

Mapping of habitats is important for understanding and communicating the distribution of natural values within Marine National Parks and Sanctuaries, particularly as the marine environment is not as easily visualised as the terrestrial environment (Parks Victoria 2003). For management purposes, knowledge of the distribution and extent of habitats is required to effectively target management activities, including emergency response, monitoring and research. Mapping of marine habitats provides a baseline inventory, allows the identification of suitable monitoring sites and possible tracking of environmental change, as well as identifying areas vulnerable to particular threats or suitable for recreational activities.

The bathymetry of the shallow waters of the MNP have been mapped with LiDAR. Intertidal and shallow subtidal habitat in Churchill Island MNP was mapped from aerial photography and ground-truthed by site visits and underwater video transects (Blake and Ball 2001). This method of mapping could not distinguish the seagrass *Zostera* from *Heterozostera*, so they were mapped as one habitat class *Zostera/Heterozostera* (Blake and Ball 2001). The MNPs saltmarsh and mangrove Ecological Vegetation Communities (EVCs) were also mapped from aerial photography and ground-truthed by site visits (Victorian Saltmarsh Study 2011).

The major habitats in the MNP are subtidal flats and shallow channels (Table 11 and Figure 30) that cover 444 ha (66 %). Maximum channel depths have been recorded as > 1.6 m but < 3.6 m. The channels terminate in the MNP in Swan Bay, to the west, and Renison Bight to the east. Approximately 32 % of the MNP (213 ha) is intertidal (Figure 29). Recent mapping with LiDAR and other technologies has resulted in improved bathymetry showing that nearly 13 ha of the MNP is above mean spring high waters.

Patches of saltmarsh communities grow behind the Mangrove Shrubland (EVC 140). Small patches in Swan Bay and Renison Bight are included in the MNP (Victorian Saltmarsh Study

2011). The majority of the saltmarsh in the MNP is Wet Saltmarsh Herbland community (new EVC) with cover dominated by *Scarcocornia quinqueflora* (Victorian Saltmarsh Study 2011). Along the southern shoreline of Renison Bight is a small patch of Coastal Dry Saltmarsh community (new EVC) dominated by *S. quinqueflora* and *Disphyma crassifolium.* Beside that is Wet Saltmarsh Herbland community. In the south east of Swan Bay the MNP encompass a small part of a large patch of Wet Saltmarsh Herbland community with cover dominated by *S. quinqueflora* (Victorian Saltmarsh Study 2011). In the north east of Swan Bay, the MNP covers a small part of a complex patch of saltmarsh communities. This includes Saline Aquatic Meadow (EVC 842) community surrounded by Wet Saltmarsh Herbland community with cover dominated by *S. quinqueflora*, which is surrounded by Coastal Tussock Saltmarsh community (new EVC) with cover dominated by *Gahnia filum* and *Austrostipa stipoides*. The vegetation of the shoreline of the MNP where it joins Phillip and Churchill Islands has not been mapped.

The MNP encompasses very limited areas of Mangrove Shrubland along the shores of Phillip Island (Edmunds *et al.* 2010a; Victorian Saltmarsh Study 2011). The MNP takes in the edge of some of the Mangrove Shrubland community along the southern shore of Renison Bight, western shoreline of Swan Bay and Long Point (Victorian Saltmarsh Study 2011). Basalt shingle and cobble spits provide hard intertidal and some subtidal habitat in the MNP off the bluffs and promontories.

The majority of the soft sediment of the MNP, where the water is shallow and clear enough to be mapped is covered by dense beds of *Zostera/Heterozostera* and algae (Blake and Ball 2001). There are patches of sparse *Zostera/Heterozostera* around the edges of this large central patch, particularly in Renison Bight (Blake and Ball 2001). Both of the seagrasses *Zostera muelleri* and *Heterozostera nigricaulis* grow within the MNP (ECC 2000). *Z. muelleri* beds have been observed off the north west coast of Churchill Island (Harris *et al.* 1979). Churchill Tidal Flats mudflats to the north of the MNP are typically basin-shaped with central areas at a (slightly) lower elevation than the bank margins, retaining a shallow covering of water at low tide (Dann 2000). The exposed intertidal areas of Churchill Tidal Flats are largely bare of vegetation or have sparse cover of the seagrass *Z. muelleri* (Dann 2000).

**Figure 29**. Intertidal flats are important bird habitat in Churchill Island Marine National Park. Photo by Chris Hayward, Parks Victoria.

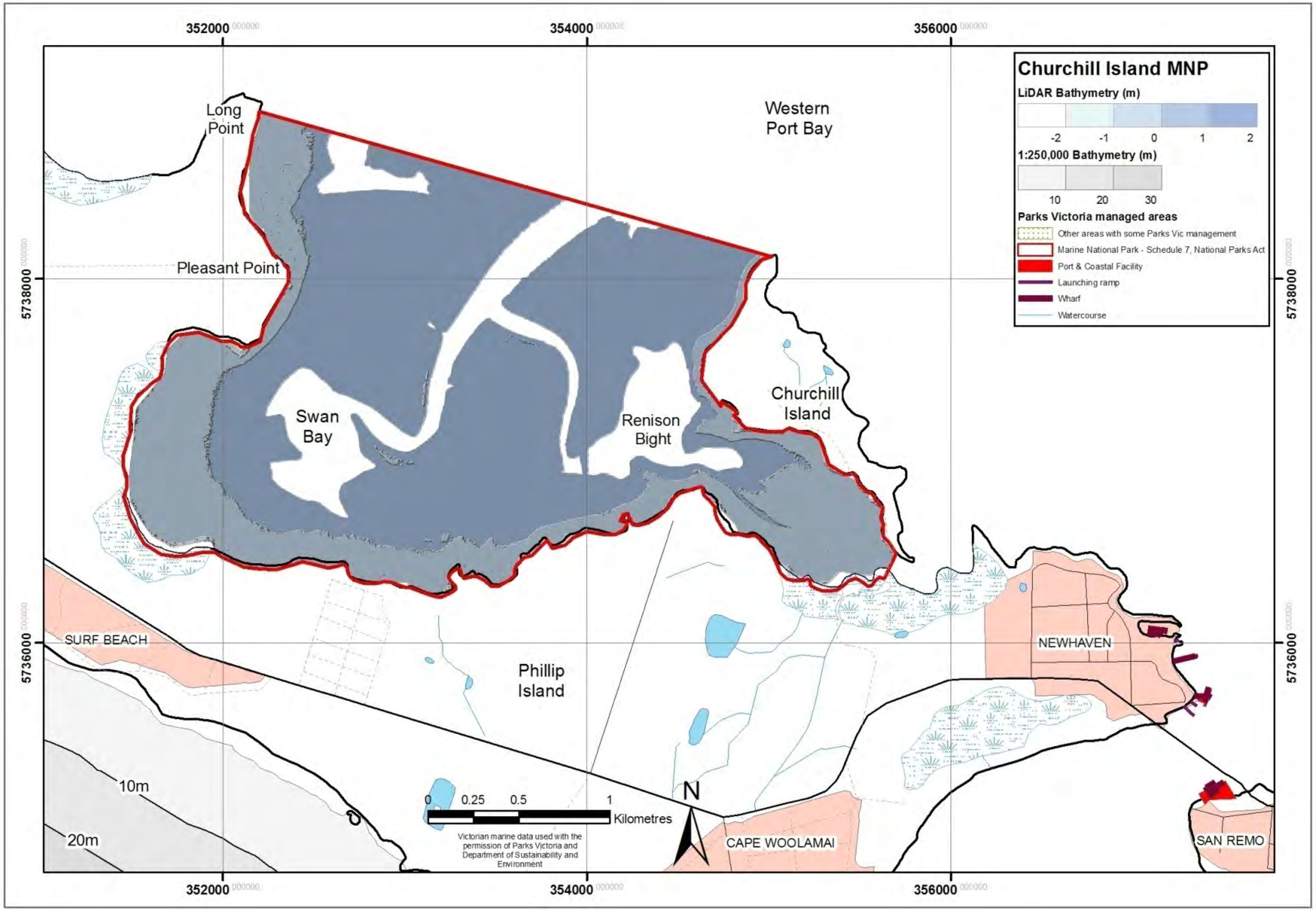


**Figure 30.** Location map of Churchill Island Marine National Park with bathymetry. There are no intertidal or subtidal reef monitoring sites in the MNP.

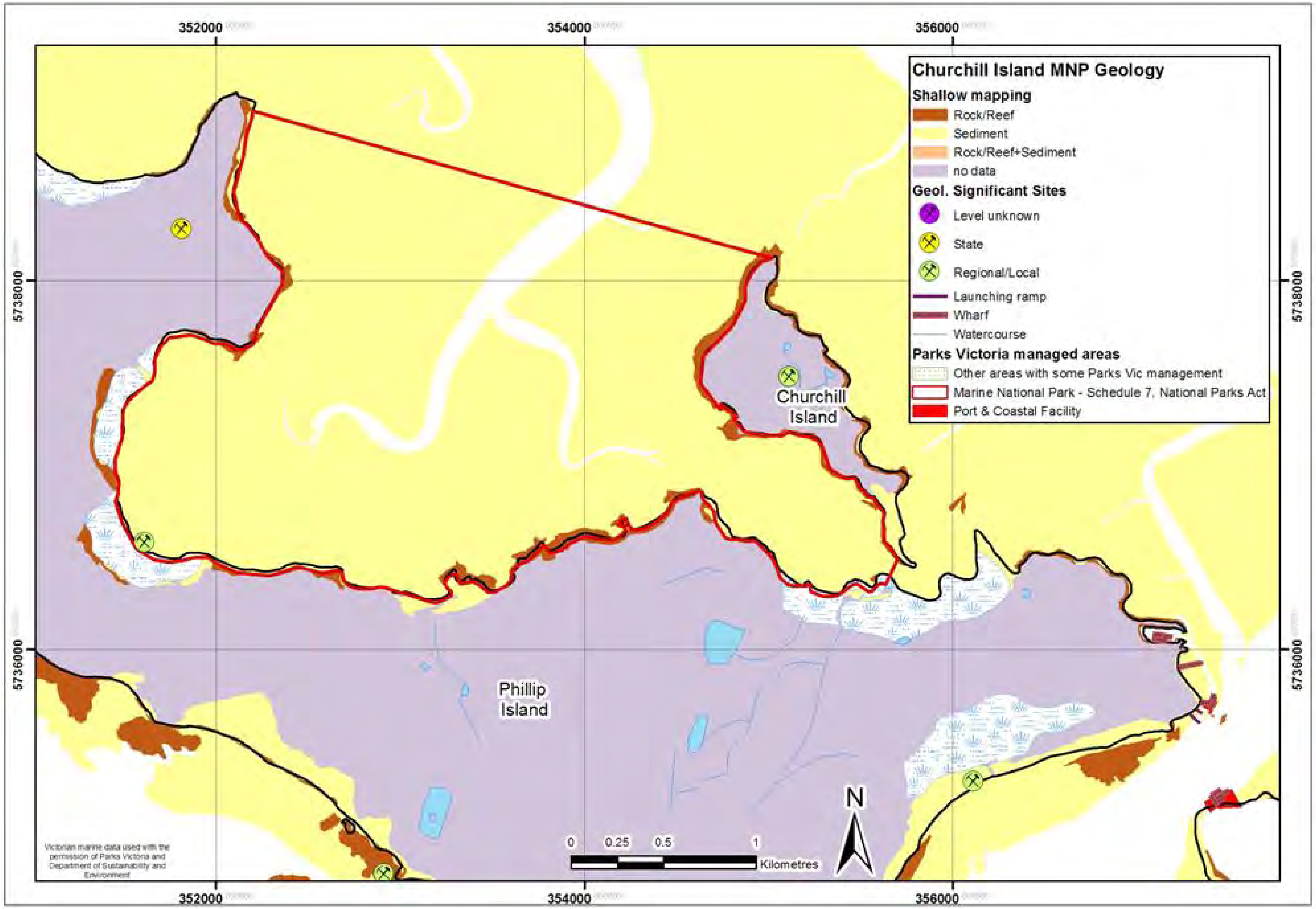


**Figure 31**. Substrate mapping of Churchill Island Marine National Park and surrounds, showing sites of geological and biotic significance.

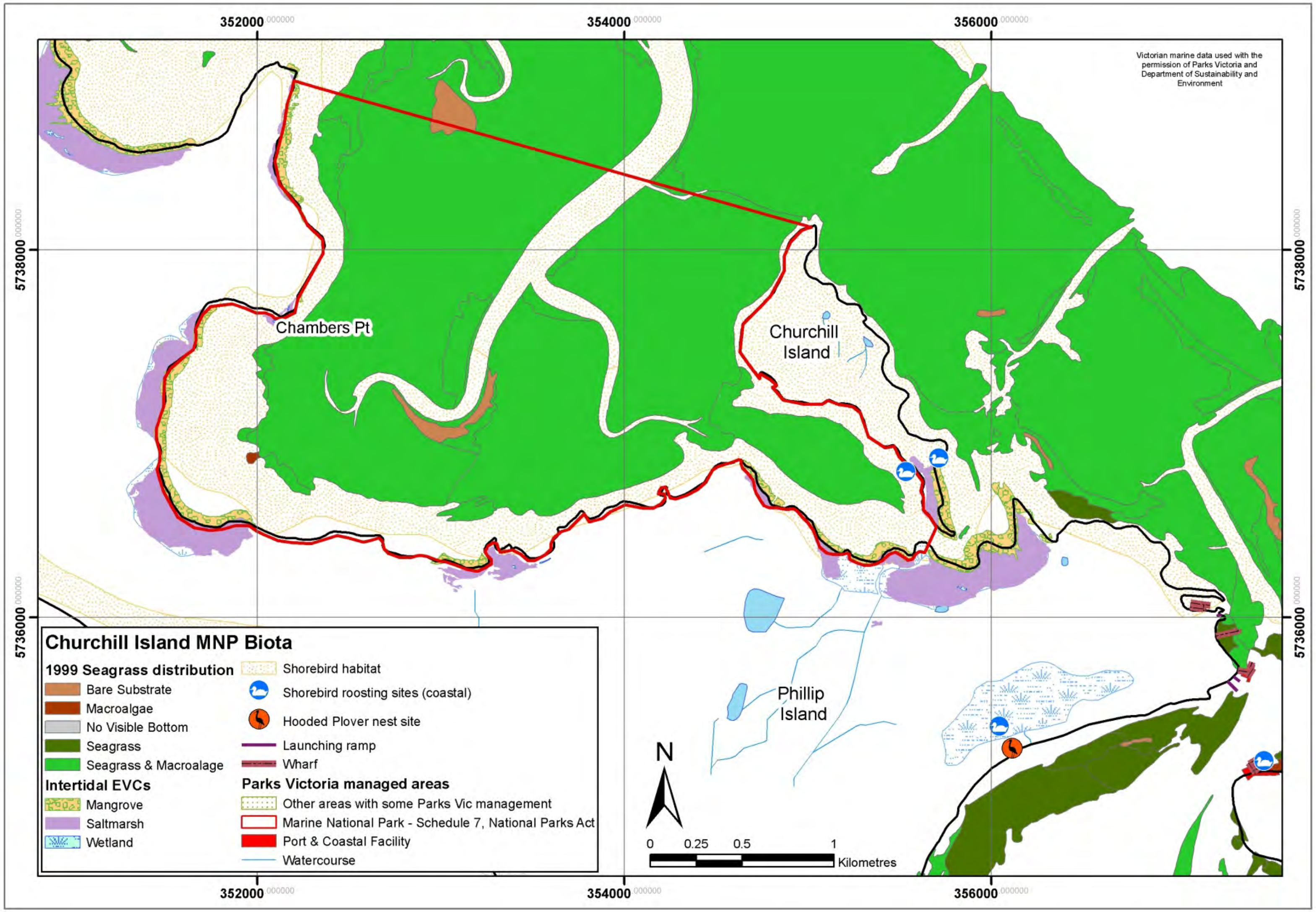


**Figure 32.** Biotic mapping of Churchill Island Marine National Park and surrounds.

## 2.3.2 MARINE ECOLOGICAL COMMUNITIES

### General

Although there have been many studies in Western Port, few studies have focused on the biota within the MNP (Plummer *et al.* 2003; Parks Victoria 2007; Figure 32). Research has been concentrated in more accessible areas of Western Port such as Newhaven (Campbell and Miller 2002; Hindell and Jenkins 2004) and Rhyll (Van der Valk and Attiwill 1984; Watson *et al.* 1984; Dann 1991; Edgar *et al.* 1994; Jenkins *et al.* 2000; Saintilan and Rogers 2001a). Major areas of research in the MNP include mangroves and saltmarsh and associated flora, fauna and ecological processes (Satumanatpan *et al.* 1999; Victorian Saltmarsh Study 2011); seagrass and associated epifauna (Blake & Ball 2001); and invertebrate infauna (Butler and Bird 2010). From database records of species recorded in Churchill Island MNP it is obvious that historically there has been a bias to bird surveys (Table 12, Appendix 1).

**Table 12**. Summary of database records of the number of species in major biotic groups in Churchill Island Marine National Park (see Appendix 1). WP indicates that the location in Western Port Bay was not specified.

| Biotic group | Number of species | |
|---|---|---|
| | Churchill Island | WP |
| **Macrophytes** | **0** | **41** |
| yellow-green algae | 0 | 1 |
| green algae | 0 | 1 |
| brown algae | 0 | 7 |
| red algae | 0 | 32 |
| **Invertebrates** | **2** | **25** |
| decapod crustaceans | 0 | 8 |
| chitons | 0 | 1 |
| gastropods | 0 | 14 |
| bivalves | 0 | 1 |
| sea slugs | 2 | 0 |
| echinoderms | 0 | 1 |
| **Vertebrates** | **80** | **6** |
| fish | 0 | 6 |
| birds | 71 | 0 |
| mammals | 9 | 0 |

Since the first natural values report by Plummer *et al.* (2003) Parks Victoria has supported research in Churchill Island MNP including a new survey in 2006 and 2007 of the biota of the soft sediments (Butler and Bird 2010). There have been no new surveys of the biota of the seagrass, mangroves or the pelagic habitats. The MNP is part of the Western Port Ramsar wetland site (ECC 2000). Important locations for some birds are shown in Figure 32. The south west cobble and shingle shore of Churchill Island in the MNP is recognised as significant because of pied oystercatcher *Haematopus longirostris* nesting sites. It is also a discrete roost location within the larger Rhyll to Newhaven, Phillip Island feeding area. Outside of the MNP, on the south east coast of Churchill Island, McLeod Point is a pelican *Pelecanus conspicillatus* roosting site, with up to 100 birds. At San Remo, the pier is a commercial pelican feeding site. The wetland at Newhaven is a secondary roosting site. On the southern shore of Phillip Island are two hooded plover *Thinornis rubricollis* nesting sites. The intertidal mud flats extending from Rhyll to Newhaven are of State Significance, and the area from Rhyll to Churchill Island is of national significance as part of a group of primary foraging areas for the migratory waders found in Western Port (ECC 2000). Whimbrels *Numenius phaeopus* and bartailed godwits in particular use these mudflats (ECC 2000). From database records of species recorded in Churchill Island MNP it is obvious that historically only birds have been specifically surveyed (Table 12, Appendix 1).

## Intertidal

Small patches of saltmarsh growing behind mangroves are included in the MNP in Swan Bay and Renison Bight (Victorian Saltmarsh Study 2011). The majority of the saltmarsh in the MNP is Wet Saltmarsh Herbland community with cover dominated by *Scarcocornia quinqueflora* (Victorian Saltmarsh Study 2011). Three other saltmarsh communities, Coastal Dry Saltmarsh, Saline Aquatic Meadow and Coastal Tussock Saltmarsh also grow in the MNP with dominant species including *Disphyma crassifolium, Gahnia filum* and *Austrostipa stipoides* (Victorian Saltmarsh Study 2011). Specific studies of the fauna found in the saltmarshes of Churchill Island MNP have not been conducted.

The white mangrove *Avicennia marina* subsp. *australasica* is the only species of mangrove to occur in Victoria, where it reaches its most southern extent of distribution (Figure 33). The Mangrove Shrubland community in Churchill Island MNP grows on the sediment on intertidal mudflats. The MNP boundaries encompass very limited areas of Mangrove Shrubland (Edmunds *et al.* 2010a; Victorian Saltmarsh Study 2011). The width of the Mangrove Shrubland at Reid Bight is about 50 – 70 m, from the landward to the seaward edges, and the trees are generally only a few metres high, with pneumatophores protruding 15 cm above the sediment surface (Satumanatpan *et al.* 1999). The barnacle *Elminius covertus* is the only barnacle growing on the mangroves (Satumanatpan *et al.* 1999). It is the dominant epifaunal organism on pneumatophores, the lower parts of mangrove trees and on mangrove seedlings at the seaward edge of the forest (Satumanatpan *et al.* 1999). Also found in the Mangrove Shrublands are the common littorinid *Bembicium auratum* (Satumanatpan *et al.* 1999). The trunks and pneumatophores of mangroves also provide habitat for epiphytic filamentous algae, gastropods and mussels. The mangrove fringes of the MNP are also inhabited by crabs and at high tide fish such as gobies, mullet, and toadfish (Satumanatpan *et al.* 1999). Specific studies of the flora and fauna found in the Mangrove Shrublands of Churchill Island MNP have not been conducted.

**Figure 33.** Mangroves *Avicennia marina* fringing Churchill Island Marine National Park. Photo Chris Hayward, Parks Victoria.

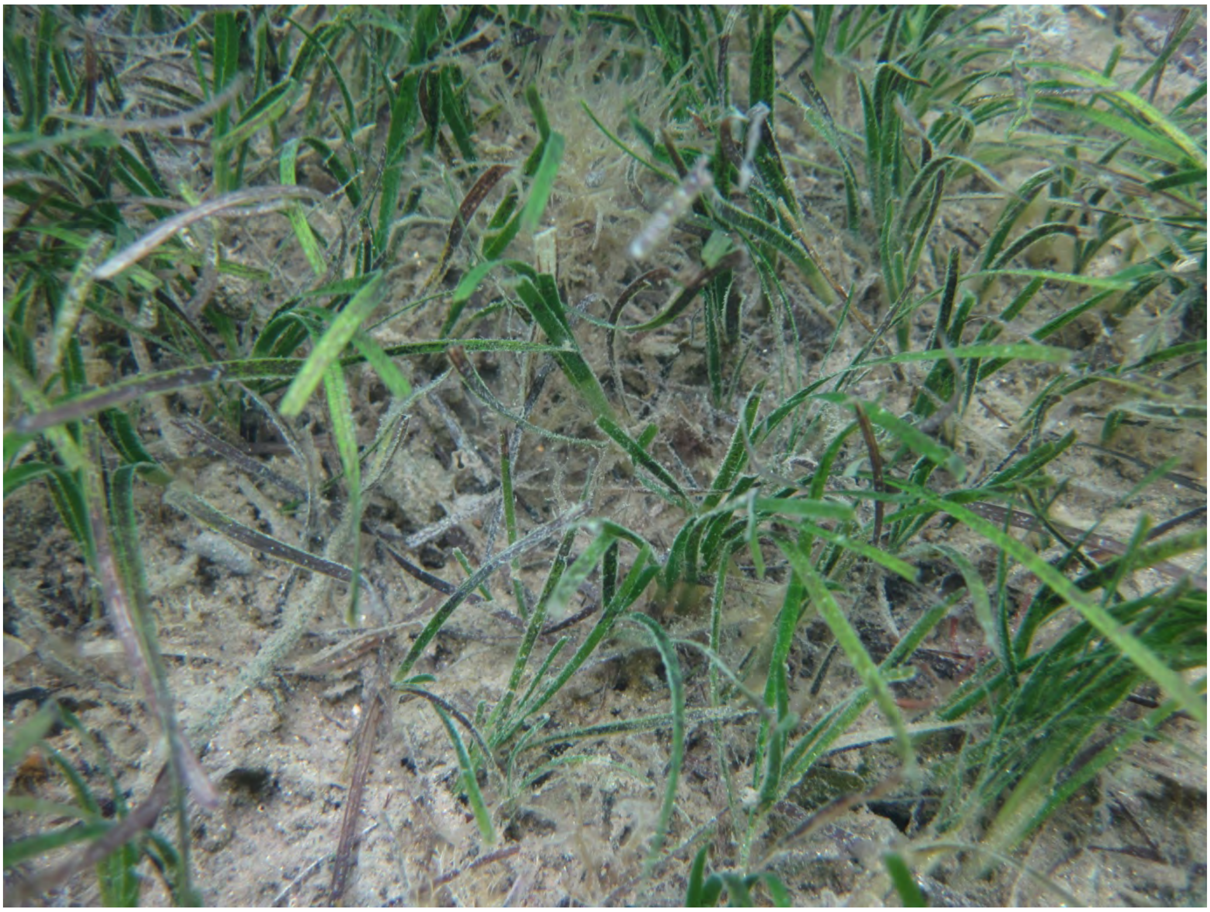

**Figure 34.** Seagrass *Zostera/Heterozostera* in Churchill Island Marine National Park. Photo by NRE.

Seagrass beds are complex and extremely productive environments which play an important role in the ecology of the MNP (Parks Victoria 2007; Figure 34). Seagrass beds stabilise the sediment and remove dissolved nutrients from the water, forming one of the basic levels of the food chain (Blake and Ball 2001). The majority of the soft sediment of Churchill Island MNP is covered by dense beds of *Zostera* / *Heterozostera* and algae. Seagrass beds provide habitat for epiphytic algae, hydroids, ascidians, diatoms and sponges, and grazing invertebrates including many molluscs, crustaceans, polychaetes and crabs. They are important nursery areas for many fish including conservation listed syngnathids.

The soft sediments of Churchill Island have abundant microalgae growing on their surface, considerably more than many other areas in Western Port (Butler and Bird 2010). Of the 17 macroinvertebrate species found in the mudflats of Churchill Island MNP by Butler and Bird (2010), the most common were the sentinel crab *Macrophthalamus latifrons* and the Phoronids *Phoronopsis albomaculata*. Also common were the polychaete worms *Barantolla lepte* and *Lumbrineris* sp. and the bivalve mollusc *Tellina deltoids* (Butler and Bird 2010). The ghost shrimps *Trypaea australiensis* and *Biffarius arenosus* are not common in the MNP and the polychaete *Lumbrineris* sp. is not as common as in Yaringa MNP (Butler and Bird 2010). Studies just north of the MNP have shown that the sentinel crab *M. latifrons* are an important food item for double-banded plovers *Charadrius bicinctus* (Dann 1991; Butler and Bird 2010). On Churchill Tidal Flats just north of the MNP small Fossaridae gastropods, generally < 1 mm long occur in high densities on the surface of the mud or amongst seagrass and are a major prey item of Stints (Dann 2000). Nereidae polychaetes are an important part of the diet of curlew sandpipers (Dann 2000). No specific information is available on the fish that use the intertidal or subtidal soft sediment, including seagrasses.

**Figure 35.** Intertidal barnacles and gastropods on the basalt cobble reef in Churchill Island Marine National Park. Photo by Chris Hayward, Parks Victoria.

Basalt shingle and cobble spits provide hard intertidal habitat in the MNP off the bluffs and promontories (Figure 35). No information is available about the biota of these habitats in the MNP.

**Figure 36.** Subtidal brachiopod *Magellania flavescens* beds in Churchill Island Marine National Park. Photo by NRE.

## Subtidal

The majority of the MNP is subtidal habitat and is covered with dense beds of *Zostera*/*Heterozostera* and algae. Dense populations of the highly unusual and rare 'living fossil' lampshell or brachiopod *Magellania flavescens* are found on the subtidal sediments in the MNP (Parks Victoria 2007; Figure 36). Lampshells are found in densities of up to 250 $m^2$ in Churchill Island MNP (Parks Victoria 2007). The dendritic network of tidal channels provide a habitat for a range of invertebrate species such as gastropods, sea stars, urchins, ascidians the seapen *Sarcoptilus grandis* (Parks Victoria 2007). Fish associated with the subtidal sediments and in the channels, include stingrays, perch, flathead, and gobies (Parks Victoria 2007). Basalt shingle and cobble spits provide hard subtidal habitat in the MNP off the bluffs and promontories. No information is available about the biota of these habitats in the MNP.

## Water column

The water column habitat of the MNP is dominated by drifting planktonic species, which rely on currents for movement, nutrients, and food. Many intertidal and subtidal organisms spend the early stage of their life in the water column environment and currents assist the distribution of recruits back to intertidal and subtidal habitats. Common plankton found in the water column includes phytoplankton such as diatoms and zooplankton including copepods, jellyfish, and ctenophores (Figure 37). Highly mobile fish, sharks and stingrays inhabit the water column habitat of the MNP. Post - larvae of King George whiting appear in Western Port from September to November each year from adults spawning in South Australia and far western Victoria (Jenkins *et al.* 2000). Parks Victoria does not currently monitor the water column as a habitat (Power and Boxshall 2007). As described in the following section a wide variety of shorebirds, seabirds and fish of conservation significance are found in the waters of Churchill Island MNP.

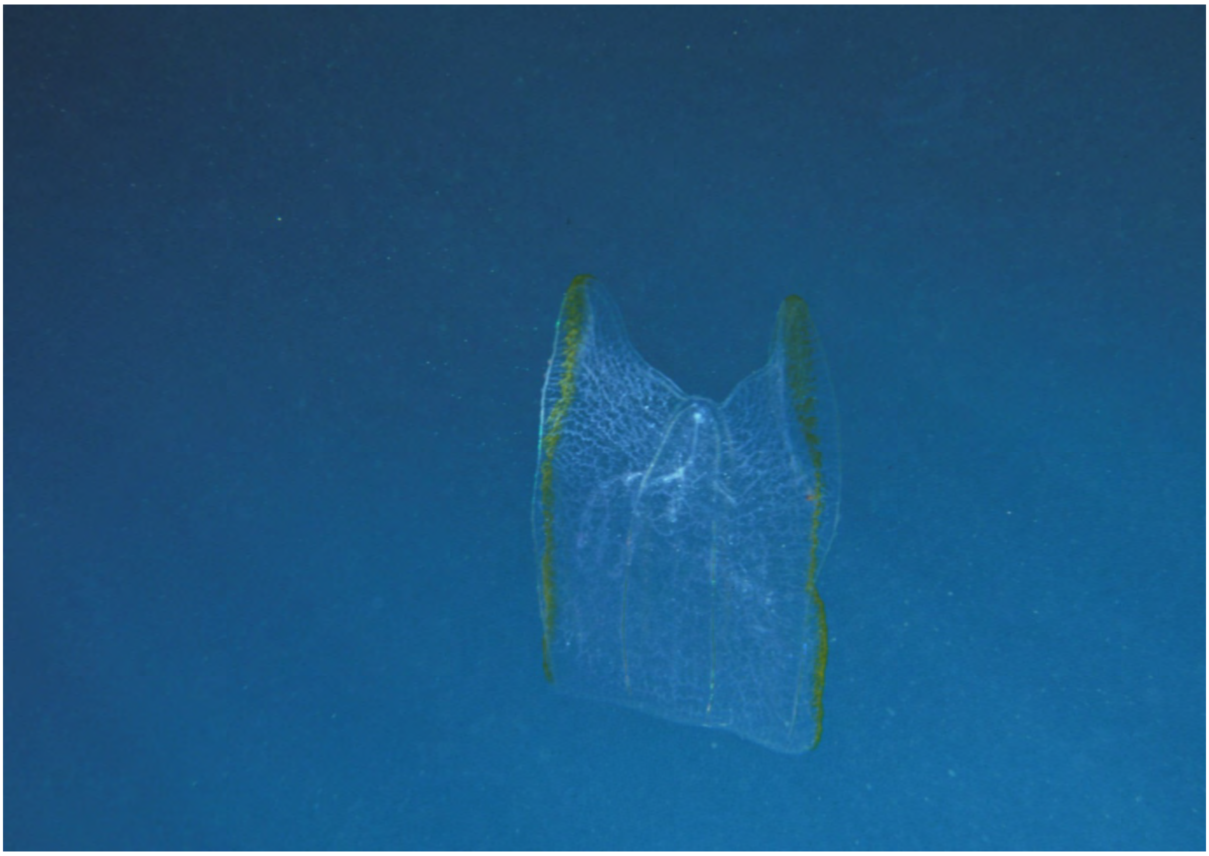

**Figure 37.** Ctenophore in the waters of Churchill Island Marine National Park. Photo by NRE.

### 2.3.3 SPECIES OF CONSERVATION SIGNIFICANCE

The approach of managing MPAs for their marine ecological communities, rather than threatened species, is also likely to protect and enhance threatened species populations (Power and Boxshall 2007). Whole-of-habitat management may also result in the protection of species not yet identified because of their rarity or cryptic nature (Power and Boxshall 2007).

#### Flora

No conservation listed marine flora has been recorded in Churchill Island MNP (Parks Victoria 2007).

#### Invertebrates

No conservation listed invertebrate species have been recorded in Churchill Island MNP. The marine opisthobranchs *Rhodope sp.* and *Platydoris galbanus* are listed as vulnerable in Victoria and are thought to be restricted to the San Remo area to the east of Churchill Island MNP (O'Hara and Barmby 2000). Dense populations of the highly unusual and rare ‘living fossil’ lampshell or brachiopod *Magellania flavescens* are found on the subtidal sediments in the MNP (Parks Victoria 2007; Figure 38).

**Figure 38.** The 'living fossil' lampshell or brachipod *Magellania flavescens* on subtidal sediments in Churchill Island Marine National Park. Photo by NRE.

#### Fish

Under the Victorian *Fisheries Act* 1995 all syngnathid species are listed as Protected Aquatic Biota. Nationally they are listed as threatened under the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*. Syngnathids are known from seagrass beds in Western Port (Edgar and Shaw 1995). They are potentially in Churchill Island MNP but have not been recorded.

## Birds

Churchill Island is part of the Western Port Ramsar site (DSE 2003). Forty-one conservation listed shore or sea birds have been sighted in or in the immediate surrounds of Churchill Island MNP (Table 13). Twenty-nine are recognized as threatened in Victoria, listed under the *Flora and Fauna Guarantee* (*FFG) Act 1988* or the Victorian Rare or Threatened Species (VROTS) list. Two, the orange-bellied parrot *Neophema chrysogaster* and grey-tailed tattler *Heteroscelus brevipes* are critically endangered. *N. chrysogaster* is also listed as critically endangered nationally under the *EPBC Act 1999.* It migrates annually to coastal Victoria between March and October to the intertidal saltmarsh in 1988 (Parks Victoria 2007). Three are regarded as endangered in Victoria, the great knot *Calidris tenuirostris*, fairy tern *Sternula nereis* and little egret *Egretta garzetta*. The southern giant-petrel *Macronectes giganteus* is regarded as endangered nationally and six other birds are regarded as vulnerable nationally (Table 13).

**Table 13**. Conservation listed shorebird and seabird records from Churchill Island Marine National Park and surrounds.

| | | Victorian listing | | National listing | International treaty | |
|---|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **FFG** | **VROTS** | **EPBC** | **CAMBA** | **JAMBA** |
| orange-bellied parrot | *Neophema chrysogaster* | L | CE | CE | | |
| grey-tailed tattler | *Heteroscelus brevipes* | L | CE | | C | J |
| great knot | *Calidris tenuirostris* | L | EN | | C | J |
| fairy tern | *Sternula nereis* | L | EN | | | |
| little egret | *Egretta garzetta* | L | EN | | | |
| southern giant-petrel | *Macronectes giganteus* | L | VU | EN | | |
| shy albatross | *Thalassarche cauta* | L | VU | VU | | J |
| yellow-nosed albatross | *Thalassarche chlororhynchos* | L | VU | VU | | J |
| fairy prion | *Pachyptila turtur* | | VU | VU | | J |
| black-browed albatross | *Thalassarche melanophris* | | VU | VU | | J |
| little tern | *Sternula albifrons* | L | VU | | C | J |
| eastern great egret | *Ardea modesta* | L | VU | | C | J |
| white-bellied sea-eagle | *Haliaeetus leucogaster* | L | VU | | C | |
| hooded plover | *Thinornis rubricollis* | L | VU | | | |
| common sandpiper | *Actitis hypoleucos* | | VU | | C | J |
| whimbrel | *Numenius phaeopus* | | VU | | C | J |
| royal spoonbill | *Platalea regia* | | VU | | | |
| northern giant-petrel | *Macronectes halli* | L | NT | VU | | J |
| Caspian tern | *Hydroprogne caspia* | L | NT | | C | J |
| eastern curlew | *Numenius madagascariensis* | | NT | | C | J |
| Latham's snipe | *Gallinago hardwickii* | | NT | | C | J |
| red knot | *Calidris canutus* | | NT | | C | J |
| Pacific golden plover | *Pluvialis fulva* | | NT | | C | J |
| Pacific gull | *Larus pacificus* | | NT | | | |
| sooty oystercatcher | *Haematopus fuliginosus* | | NT | | | |
| black-faced cormorant | *Phalacrocorax fuscescens* | | NT | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| pied cormorant | *Phalacrocorax varius* | | NT | | | |
| common diving-petrel | *Pelecanoides urinatrix* | | NT | | | |
| nankeen night heron | *Nycticorax caledonicus* | | NT | | | |
| blue petrel | *Halobaena caerulea* | | | VU | | J |
| ruddy turnstone | *Arenaria interpres* | | | | C | J |
| common tern | *Sterna hirundo* | | | | C | J |
| red-necked stint | *Calidris ruficollis* | | | | C | J |
| curlew sandpiper | *Calidris ferruginea* | | | | C | J |
| bar-tailed godwit | *Limosa lapponica* | | | | C | J |
| sharp-tailed sandpiper | *Calidris acuminata* | | | | C | J |
| common greenshank | *Tringa nebularia* | | | | C | J |
| marsh sandpiper | *Tringa stagnatilis* | | | | C | J |
| Arctic jaeger | *Stercorarius parasiticus* | | | | | J |
| short-tailed shearwater | *Ardenna tenuirostris* | | | | | J |
| flesh-footed shearwater | *Ardenna carneipes* | | | | | J |

L= listed, NT = Near Threatened, VU = Vulnerable, EN = Endangered, CE = Critically Endangered, C = Listed under the CAMBA treaty, J = Listed under the JAMBA treaty

Twenty-nine birds are recognized internationally (Table 13) under the Australia Migratory Bird Agreement with either China (CAMBA) or Japan (JAMBA). The bay is of international importance for seven wader species, the eastern curlew *Numenius madagascariensis*, common greenshank *Tringa nebularia*, rednecked stint *Calidris ruficollis,* curlew sandpiper *Calidris ferruginea,* double-banded plover *Charadrius bicinctus*, hooded plover *Thinornis rubricollis* and pied oystercatcher *Haematopus longirostris* and national importance for Pacific golden plover *Pluvialis fulva* (Loyn *et al.* 2001). It also attracts high proportions of the estimated populations of whimbrel *Numenius phaeopus*, grey-tailed tattler *Tringa brevipes* and masked lapwing *Vanellus miles* in coastal Victoria (Loyn *et al.* 2001). Mangroves limit where waders can feed for long periods on each tidal cycle, this limits the number of small waders that use the mudflats (Loyn *et al.* 2001). Common greenshank occur mainly in the mangrove-lined inner parts of the bay (Loyn *et al.* 2001). Some species roost on saltmarshes notably the eastern curlew, masked lapwing and Pacific golden plover or isolated banks of mangroves grey-tailed tattler, Pacific golden plover and terek sandpiper *Tringa cinerea* (Loyn *et al.* 2001). Double-banded plovers, breed in New Zealand and occur in Western Port in autumn and winter during their non-breeding season (Dann 1991). The mudflats between Rhyll and Churchill Island (Figure 32) are a major feeding site for large waders that roost on Observation Point on the east coast of Churchill Island (Loyn *et al.* 2001).

### Marine mammals

Churchill Island MNP is shallow and dominated by intertidal and subtidal mudflats. It does not provide habitat for large marine mammals.

### Species distribution information

An assessment of distribution, endemism and rarity of biota across the state did not identify any biota endemic to Churchill Island MNP (O'Hara and Barmby 2000; O’Hara and Poore 2000; O'Hara 2002).

Over 69 species of biota (Appendix 2) have been described as having their distributional limit in Western Port (O'Hara and Barmby 2000; O’Hara and Poore 2000; O'Hara 2002). Twenty-five of these species are algae, predominately red algae, recorded at Crawfish Rocks off the north west coast of French Island (Table 14). There is limited specific information on species at their distributional limit in Churchill Island MNP. Potentially thirty-eight species at their distributional limit in Western Port could be found in Churchill Island MNP (Table 14) (O'Hara and Barmby 2000; O’Hara and Poore 2000; O'Hara 2002). The distributional limits of the biota listed in Table 14 may reflect collection effort in this area rather than actual Victorian distributions. Many areas of the Victorian coast have never been sampled and therefore biota ranges may be much greater than those suggested.

**Table 14**. Marine species at their distribution limits in Western Port Bay that may be found in Churchill Island Marine National Park (O'Hara and Barmby 2000; O’Hara and Poore 2000; O'Hara 2002).

| Phylum | Order | Family | Species | Common name | Category |
|---|---|---|---|---|---|
| Chlorophyta | Caulerpales | Caulerpaceae | *Caulerpa remotifolia* | green algae | RE* |
| Phaeophyta | Dictyotales | Dictyotaceae | *Distromium multifidum* | brown algae | PE |
| Phaeophyta | Fucales | Cystoseiraceae | *Myriodesma integrofolium* | brown algae | PE |
| Phaeophyta | Sphacelariales | Sphacelariaceae | *Sphacelaria carpoglossi* | brown algae | PE |
| Phaeophyta | Fucales | Fucaceae | *Xiphophora gladiata* | brown algae | PN |
| Rhodophyta | Ceramiales | Dasyaceae | *Dasya hookeri* | red algae | RE* |
| Rhodophyta | Gigartinales | Hypneaceae | *Hypnea valentiae* | red algae | RE* |
| Rhodophyta | Rhodymeniales | Rhodymeniaceae | *Gloiocladia fruticulosa* | red algae | RE* |
| Rhodophyta | Ceramiales | Ceramiaceae | *Anotrichium elongatum* | red algae | PE |
| Rhodophyta | Ceramiales | Ceramiaceae | *Anotrichium licmophorum* | red algae | PE |
| Rhodophyta | Ceramiales | Ceramiaceae | *Ceramium excellens* | red algae | PE |
| Rhodophyta | Ceramiales | Ceramiaceae | *Shepleya verticillata* | red algae | PE |
| Rhodophyta | Gigartinales | Kallymeniaceae | *Austrophyllis alcicornis* | red algae | PE* |
| Rhodophyta | Rhodymeniales | Lomentariaceae | *Semnocarpa corynephora* | red algae | PE |
| Rhodophyta | Rhodymeniales | Rhodymeniaceae | *Gloiocladia polycarpa* | red algae | PE |
| Crustacea | Dendrobranchiata | Penaeidae | *Penaeus latisulcatus* | prawn | PW |
| Crustacea | Brachyura | Majidae | *Anacinetops stimpsoni* | shaggy seaweed crab | RE |
| Crustacea | Brachyura | Hymenosomatidae | *Trigonoplax longirostris* | crab | PE |
| Crustacea | Brachyura | Majidae | *Huenia halei* | crab | PE |
| Crustacea | Caridea | Alpheidae | *Alpheus astrinx* | narrow snapping shrimp | RE |
| Mollusca | Gastropoda | Columbellidae | *Aesopus plurisulcatus* | marine snail | PW |
| Mollusca | Gastropoda | Columbellidae | *Anachis smithi* | marine snail | PW |
| Mollusca | Gastropoda | Olividae | *Zemira australis* | marine snail | PW |
| Mollusca | Gastropoda | Turridae | *Austrodrillia angasi* | marine snail | PW |
| Mollusca | Gastropoda | Vermetidae | *Serpulorbis hedleyi* | marine snail | PW |
| Mollusca | Gastropoda | Calyptraeidae | *Cheilea flindersi* | marine snail | PE |
| Mollusca | Gastropoda | Cancellariidae | *Cancellaria (Nevia) spirata* | nutmeg shell | PE |
| Mollusca | Gastropoda | Cancellariidae | *Cancellaria (Sydaphera) lactea* | nutmeg shell | PE |
| Mollusca | Gastropoda | Cancellariidae | *Cancellaria (Sydaphera) purpuriformis* | nutmeg shell | PE |
| Mollusca | Gastropoda | Eatoniellidae | *Eatoniella victoriae* | marine snail | PE* |
| Mollusca | Gastropoda | Epitoniidae | *Epitonium platypleura* | marine snail | PE |
| Mollusca | Gastropoda | Cerithiopsidae | *Zaclys angasi* | marine snail | PB |

| | | | | | |
|---|---|---|---|---|---|
| Mollusca | Polyplacophora | Lepidopleuridae | *Leptochiton liratus* | chiton | PE |
| Echinodermata | Holothuroidea | Phyllophoridae | *Lipotrapeza ventripes* | sea cucumber | PE |
| Chordata | Atheriniformes | Atherinidae | *Kestratherina esox* | pikehead hardyhead | PE |
| Chordata | Perciformes | Tripterygiidae | *Lepidoblennius haplodactylus* | jumping joey | PW |
| Chordata | Perciformes | Gobiidae | *Arenigobius frenatus* | half bridled goby | RW |
| Chordata | Perciformes | Sillaginidae | *Sillago bassensis* | silver whiting | PE |

* recorded from Crawfish Rocks, RE = recorded eastern limit of distribution, RW = recorded western limit of distribution, PE = presumed eastern limit of distribution, PW = presumed western limit of distribution, PN = presumed northern limit of distribution.

### 2.3.4 MAJOR THREATS

Threats to natural values were derived from lists of hazards and associated risks in Carey *et al.* (2007b). These were the result of a statewide consultative process to identify threats to MPAs. Through public and agency workshops, the natural values in individual MNPs and MSs and the threats that could affect them over the next ten years, were considered and ranked to identify hazards. This list of hazards was then ranked (low, medium, high and extreme) by the risk posed by each hazard (Carey *et al.* 2007b). Nine hazards with the potential to be of extreme risk were identified by Carey *et al.* (2007b). These hazards are listed in rank order and the habitat or area at risk within the MNP is indicated in brackets:

1. Oil spill greater than 10 litres from tanker loading/unloading operations and potentially causing the death of any bird (water column and intertidal);
2. Invasion/introduction of (Northern Pacific) seastar affecting ecosystem processes (subtidal soft sediment);
3. Arrival of marine exotic species (all of MNP);
4. Onshore visitor activities affecting shorebirds (intertidal);
5. Increased concentration of nitrogen and phosphorus from rivers and streams potentially causing algal blooms that kill fish (all of MNP);
6. Sediment load from rivers and streams (all of MNP);
7. Boat-based visitor activities affecting seabirds (intertidal and water column);
8. Fox predation on migratory seabirds resulting in nonviable populations (intertidal); and
9. Hydrocarbon pollution from boats harming benthic and pelagic microbes (all of MNP).

Parks Victoria's internal review of threats occurring within the Churchill Island MNP included marine exotics and pollution from marine incidents (Carey *et al.* 2007b). It also recognised the threat of onshore fires, litter, driving vehicles and dogs, illegal recreational fishing and shellfish collection and commercial fishing (Carey *et al.* 2007b).

The introduction of marine pests threatens the integrity of marine biodiversity and may reduce the social and economic benefits derived from the marine environment (Parks Victoria 2003). Most marine pests known from Victorian waters are found in Port Phillip Bay (Parks Victoria 2003). The introduced green shore crab *Carcinus maenas* is found within Churchill Island MNP. The broccoli weed *Codium fragile (subsp. fragile)* is thought to be in the MNP as it has been found to the east at Newhaven (Parks Victoria 2007). Species of concern include the Northern Pacific seastar *Asterias amurensis*, which was found at San Remo in September 2011, and European fan worm *Sabella spallanzanii* (Parks Victoria 2003).

**Climate Change**

Climate change represents a serious threat to marine ecosystems (McLeod *et al.* 2009) but specific ecological consequences of accelerating climate change are not well understood in marine systems, particularly in temperate systems. Climate change is predicted to increase water temperature, alter chemical composition (salinity, acidity and carbonate saturation), change circulation and productivity, increase frequencies of extreme weather events and exposure to damaging ultraviolet light (UVB), and increase air temperature, cloud cover and sea levels (conservatively 80 cm by 2100; CSIRO-BoM 2007; Fine and Franklin 2007; VCC 2008; McLeod *et al.* 2009). A combined increase in cloud cover and sea level could result in decreased light availability potentially changing benthic flora. Increased storm surges and ocean current changes also have the potential to change the distribution of fauna and flora and could result in loss of habitats (CSIRO-BoM 2007). Intertidal communities will face increased desiccation, storm wave exposure and habitat shift. Changes in the relationship between climate and annual life-history events may force major change in functional groups and consequent ecosystem function (Fine and Franklin 2007). Climate change is also anticipated to modify species recruitment and habitat connectivity, species interactions and disturbance regimes in the marine environment (CSIRO-BoM 2007; Fine and Franklin 2007). A number of species are presumed to be at the eastern or western limit of their distributional range in Western Port Bay, and may be found in Churchill Island MNP, and such species would be particularly vulnerable to climate change.

Measures to address or minimise these hazards form part of the management plan for Churchill Island MNP (Parks Victoria 2007). For example, research has been targeted at marine pest species, and water quality issues which may impact on park natural values. Management actions have been implemented to minimise these threats (Parks Victoria 2007). Parks Victoria has also undertaken a strategic climate change risk assessment to identify the risks and stressors for natural values in the MPAs through assessment at the habitat level for parks in each marine bioregion. Parks Victoria will use an adaptive management approach to develop responses and actions that focus on priority climate change issues such as extreme weather events and existing risks that will likely be exacerbated by climate change.

### 2.3.5 CURRENT RESEARCH AND MONITORING

Parks Victoria has established extensive marine monitoring and research programs for the MPAs that address important management challenges, focussing both on improving baseline knowledge of the MPAs as well as applied management questions not being addressed by others. This knowledge will continue to enhance Parks Victoria's capacity to implement evidence-based management through addressing critical knowledge gaps. The research and monitoring programs have been guided by the research themes outlined as part of Parks Victoria's Research Partners Panel (RPP) program, a Marine Research and Monitoring Strategy 2007-2012 and Marine National Park and Marine Sanctuary Monitoring Plan 2007-2012 (Power and Boxshall 2007). Much of the research has been undertaken as part of the RPP program involving collaboration with various research institutions. The research relevant to Churchill Island MNP has been published in Parks Victoria's Technical Series available on Parks Victoria's website (http://www.parkweb.vic.gov.au). As most research in the MNP has been carried out under permits issued by DSE, the permit database was also used to identify relevant projects for this report (see Table 15 & Appendix 3).

Churchill Island MNP does not have ongoing intertidal (IRMP) and a shallow subtidal (SRMP) reef monitoring program as these habitats are minimal within the MNP. A survey of macroinvertebrates inside and outside the Western Port MNPs has been undertaken as a possible baseline for future monitoring (Butler and Bird 2010).

**Table 15**. Ongoing Research Partner Panel (and RPP-like) research projects implemented in partnership with, or commissioned by, Parks Victoria relevant to Churchill Island Marine National Park.

| **Ongoing RPP (and RPP-like) Projects** |
|---|
| ***University of Melbourne:*** Kim Millers, Jan Carey, Mick McCarthy<br>Optimising the allocation of resources for defending Marine Protected Areas against invasive species. |
| ***Multiple Research Partners:*** Marine Monitoring and Marine Natural Values<br>***University of Melbourne:*** Jan Carey<br>Developing Report Cards for the Marine National Parks. |
| ***Museum Victoria:*** Mark Norman, Julian Finn. ***Parks Victoria:*** Roger Fenwick<br>Under the Lens - Natural History of Victoria's Marine National Park System. |
| ***University of Melbourne:*** Tarek Murshed, Jan Carey, Jacqui Pocklington<br>Conceptual model development for marine habitats. |
| **Ongoing Habitat Mapping Projects** |
| ***DSE / DPI / Worley Parsons/ Deakin University***<br>LiDAR Mapping Project. Mapping of bathymetry and marine habitats along the Victorian coast |

There is no current Friends Group for the MNP (Parks Victoria 2007). Data collected by the Bird Observers Club of Australia, Australian Wader Studies Group and the Victorian Wader Study Group within the MNPs and adjacent areas, including the Western Port Ramsar Site, have contributed significantly to an understanding of the importance of Western Port as a Ramsar Site and as part of the East Asian–Australasian Flyway (Parks Victoria 2007).

Statewide, the Museum of Victoria is collecting additional data on the marine natural values of Victoria's MPAs. They are gathering information about natural history through video and photos, and using semi-quantitative methods to determine spatial and temporal changes across the system in response to threats, including marine pests and climate change. Jan Carey (University of Melbourne) is conducting research focussing on marine pest species which may impact on park values, and the MNPs and MSs which are most at risk of invasion. This will help prioritise Parks Victoria surveillance monitoring efforts to MPAs most at risk to improve the likelihood of early detection and successful management.

### 2.3.6 KNOWLEDGE GAPS

A lot of assumptions have been made in previous descriptions of the natural values of Churchill Island MNP as they were largely based on surveys from elsewhere in WP. Basic habitat mapping has been done in Churchill MNP but no surveys that identify the species found in the MNP even for large fauna such as fish and birds. Surveys of the invertebrate fauna of the soft sediment (Butler and Bird 2010) and mangroves (Satumanatpan *et al.* 1999) and the dominant flora of mangrove and saltmarsh habitats have been undertaken (Victorian Saltmarsh Study 2011). Intertidal surveys of the fauna of the saltmarsh and specifically seagrass beds have not been undertaken in the MNP. The algae growing intertidally and subtidally has not been identified. No surveys have been conducted of the ecological communities of deeper subtidal soft sediments or the water column. Major threats have been identified for Churchill MNP but we have limited knowledge of the effect on the natural values, particularly ecological communities.

## 2.4 Corner Inlet Marine National Park

Corner Inlet Marine National Park (MNP) is one of five MNPs in the Victorian Embayments bioregion. The other MNPs are Port Phillip Heads, Yaringa, French Island and Churchill Island (Figure 4). Three Marine Sanctuaries (MS) in the bioregion are all in Port Phillip Bay (PPB) and include Point Cooke, Jawbone and Ricketts Point MS. Corner Inlet MNP is 180 km southeast of Melbourne in Corner Inlet adjacent to the Wilsons Promontory National Park (Figure 44) and integrally linked to Corner Inlet Marine and Coastal Park (Parks Victoria 2005).

Corner Inlet MNP comprises two separate sections in the south-east coast of Corner Inlet (Parks Victoria 2005). The northern section of the MNP (Figure 44) extends west from near White Dog Point to a point approximately 6 km offshore and then back to the shore at Tin Mine Cove (Parks Victoria 2005). Its near shore includes the deep waters of Bennison Channel. The southern section of the MNP (Figure 44) extends west from the southern part of Chinaman Long Beach to Bennison Island, and from Bennison Island south to Barry Hill (Parks Victoria 2005). The landward boundary of both sections is the mean high water mark adjoining Wilsons Promontory National Park and excludes the islands (Parks Victoria 2005). The coast of the northern section includes Freshwater Cove, Chinaman Beach, Shallow Bight and Tin Mine Cove, the coast of the southern section includes part of Chinaman Long Beach (Parks Victoria 2005). Access to Corner Inlet MNP is by boat, or by foot from Wilsons Promontory National Park (Parks Victoria 2005).

Aboriginal tradition indicates that the Marine National Park is part of *Country* of *Yiruk* for the Gunai / Kurnai and *Wamoom* for the Boonwurrung Indigenous people (Parks Victoria 2005).

Corner Inlet natural values include a wide variety of marine habitats ranging from deep channels to extensive shallow seagrass beds, tidal sand and mud flats, sandy beaches, and some rocky reefs, mangroves and saltmarsh, (ECC 2000; Molloy *et al.* 2005; Parks Victoria 2005). An important natural value of the MNP is its extensive beds of the seagrass *Posidonia australis*, the only ones in Victoria (ECC 2000; Molloy *et al.* 2005; Carey *et al.* 2007b; Mount and Ogier 2011). This seagrass community supports the most faunally diverse of all marine habitats studied in the Corner Inlet (ECC 2000). Other seagrass found in the MNP include *Zostera muelleri, Heterozostera nigricaulis* and *Halophila australis.* The soft sediments are thought to have a high diversity of invertebrates (ECC 2000; Carey *et al.* 2007b). The species composition of Corner Inlet MNP results in part from the overlap of the distributions of warm water species characteristic of the NSW coast and cool water species found throughout Victoria (Molloy *et al.* 2005; Parks Victoria 2005). Its intertidal flats form part of internationally significant feeding areas for migratory waders (Molloy *et al.* 2005; Carey *et al.* 2007b).

Intertidal habitat in Corner Inlet MNP includes bare sand and mud flats, sandy beaches and some cobbly reefs, mangroves and saltmarsh (Figures 39 and 40). The saltmarsh community of Wet Herbland dominated by beaded glasswort *Sarcocornia quinqueflora* is found on the southern shore of the southern section of the MNP, the majority of saltmarsh in the area is outside the MNP boundaries (Victorian Saltmarsh Study 2011). The Mangrove Shrubland community on the shoreward edge of the saltmarsh is dominated by *Avicennia marina.* Specific studies of the flora and fauna found in these habitats has not been undertaken in Corner Inlet MNP, but they are considered breeding and nursery grounds for many organisms including microcrustacea, bivalves and fish (Parks Victoria 2005). Intertidal seagrass fauna is dominated by Amphibolidae pulmonate and Dialidae gastropods, Pandalid and Hippolytid shrimps (Ball *et al.* 2010). Tidal immersion and location are more important factors than seagrass species and physical structure in determining the assemblage structure of epifaunal communities in the intertidal seagrass beds in Corner Inlet MNP (Ball *et al.* 2010). The large areas of unvegetated mud and sand support invertebrates, microphytobenthos and demersal fish. Both unvegetated and vegetated mudflats are important food resources and roosts for shore birds. Intertidal cobbly reef occurs around Granite and Bennison Islands and along the shore in the northern section but there is no information on its fauna or fauna.

Dominant subtidal habitats in the northern section of the MNP are *P. australis* seagrass beds and deep channel bare sediments. In the southern section of the MNP bare shallow sediments dominate. Subtidal seagrass beds provide the largest area of 'hard substrate' within Corner Inlet MNP and are habitat for a variety of encrusting organisms (O'Hara *et al.* 2002). Subtidal seagrass generally supports much higher densities of invertebrates than intertidal seagrass beds (Ball *et al.* 2010). Around 15 to 20 different taxa of macroinvertebrates live in *P. australis* beds in the MNP (Ball *et al.* 2010). The most abundant are mysids, a shrimp like crustacea. Also abundant are shrimps from the Pandalidae and Hippolytidae families, and amphipods from the Dexaminidae and Corophiidae families (Ball *et al.* 2010). Top shells from the family Trochidae are also abundant (Ball *et al.* 2010). Seagrass beds are important nursery areas for many fish, including leatherjackets, conservation listed syngnathids (seahorses and pipefish) and small juvenile fish (Ball *et al.* 2010). Rock flathead *Platycephalus laevigatus* and juvenile whiting *Sillaginodes punctata* are also associated with seagrass beds (Molloy *et al.* 2005).

The sediment in the deeper channels tends to be coarse because of strong currents and has a different fauna than shallow mudflats (Parks Victoria 2005). Gastropods, sea stars, urchins and ascidians are often found on the surface of the channel sediment in Corner Inlet along with stingrays, perch, flathead, and gobies (Parks Victoria 2005). Specific surveys of this habitat in Corner Inlet MNP have not been conducted. Subtidal cobbly reef occurs around Granite and Bennison Islands and on the shore of the northern section but there have been no specific surveys of its flora or fauna.

Corner Inlet MNP forms part of an area across Corner Inlet that has been recognised as a wetland of international significance under Article 2 of the Ramsar Convention (ECC 2000; Molloy *et al.* 2005; Parks Victoria 2005). It is especially significant for over-wintering migratory wading birds, supporting up to 50 % of Victoria's migratory waders and 20 % of Victoria's total wader population (ECC 2000). It is part of the East Asian-Australasian Flyway for migratory waders (Parks Victoria 2005). A special Protection Area – Natural Values Area management overlay covers all the MNP except Bennison Channel, to protect the significant seagrass beds and wading bird habitats from disturbance (Parks Victoria 2005). Motorised vessels are encouraged to avoid the shallow and exposed intertidal areas of the MNP during and two hours either side of low tide (Parks Victoria 2005). Access to Bennison Island is restricted to the small beach on the island, and public access to Granite Island is not permitted (Parks Victoria 2005).

Corner Inlet MNP habitats provide important feeding and roosting habitat for twenty-four conservation listed bird species such as the orange-bellied parrot *Neophema chrysogaster,* which is listed under the *Flora and Fauna Guarantee* (*FFG*) *Act (1998)* and regarded as critically endangered both in Victoria and nationally. The MNP protects feeding areas for fourteen internationally important migrant species protected under the Australia Migratory Bird Agreement with either China (CAMBA) or Japan (JAMBA). Ten species of marine flora and fauna are believed to be at their distributional limits within the MNP.

The waters of Corner Inlet, including the MNP, are part of the Port of Corner Inlet and Port Albert (Parks Victoria 2005). These Ports are bases for vessels engaged in coastal trade, the Bass Strait oil and gas fields and the fishing industry (Molloy *et al.* 2005). Larger commercial and recreational vessels are known to anchor in the northern section of the MNP, as shelter can be found there during easterly weather (Parks Victoria 2005).

Serious threats to the Corner Inlet MNP include limited ecological knowledge of important processes. Increased sediment and nutrients from the catchment, seawalls, invasive marine pests, changed catchment hydrology, dredging, propeller scour, oil or chemical spills and inadequate management and climate change all pose serious threats to the integrity of the MNP (Carey *et al.* 2007b). Measures to address or minimise these threats form part of the management plan for Corner Inlet MNP (Parks Victoria 2005).

**Figure 39.** Wavy volute *Amoria undulata* on the intertidal sediment in the northern section of Corner Inlet Marine National Park. Photo by Friends of Corner Inlet.

### 2.4.1 PHYSICAL PARAMETERS & PROCESSES

Corner Inlet Marine National Park (MNP) is 1333 hectares in size which makes it the eleventh largest of the 24 Marine National Parks or Sanctuaries in Victoria (Figure 44 & Table 16). Sixty percent of the MNP is subtidal (791 ha) and 40 percent, predominately in the southern section, intertidal (542 ha) (Figure 44 & Table 16). Recent mapping with LiDAR and other technologies has resulted in improved bathymetry showing that nearly 0.5 ha of the MNP is above mean spring high waters (Table 16). On the ebbing tide a system of channels drains the shallow (< 2 m) mudflats and sand banks. Most of the channels within the MNP are between 1 and 10 m deep. Over 120 ha of the channels are deeper than 11.4 m and some parts of Bennison Channel in the northern section are up to 30 m deep (Parks Victoria 2005). The scouring effect of the tidal currents maintains the channels, and distinct ebb and flood channels have developed on the shallower banks (Plummer *et al.* 2003; Parks Victoria 2005). Channels depths and position may change slowly in response to sedimentation patterns or other hydrodynamic processes (Parks Victoria 2005).

**Figure 40**. Intertidal mudflats in the southern section of Corner Inlet Marine National Park. Photo by Adam Pope, Deakin University.

The MNP is south of the 40 m deep and 2 km wide entrance of Corner Inlet into Bass Strait (Molloy *et al.* 2005). The proximity of the entrance to the MNP creates strong currents in the MNP, particularly in the northern section, and a complete exchange of water occurs every 24 hours (Parks Victoria 2005). Tidal range in the MNP varies by as much as 2.5 metres between high and low tides (Plummer *et al.* 2003; Parks Victoria 2005). The MNP has an unequal semidiurnal tidal pattern, with a higher and lower flooding and ebbing event daily (Plummer *et al.* 2003). Sequential low tide levels may vary by over a metre (Parks Victoria 2005). Tidal variations are further complicated by changes in wind speed and direction, high and low pressure systems, wave action and storm surges (Parks Victoria 2005). This leads to large variations in the width of the intertidal zone in the MNP (Parks Victoria 2005). The shallow water in the MNP warms rapidly, with a surface water temperature range of 12 –20 °C (Table 16), Corner Inlet is the warmest of Victoria's large bays (Plummer *et al.* 2003; Parks Victoria 2005). The higher temperatures is one of the factors that allow *Posidonia australis* seagrass to survive within Corner inlet (Parks Victoria 2005).

Direct discharges into the MNP (Table 16) include Chinaman Creek and several intermittent creeks from Wilsons Promontory National Park (Parks Victoria 2005). Some major streams (Franklin, Agnes, Albert and Tarra Rivers, Deep and Stockyard Creeks) and numerous smaller streams discharge into the Corner Inlet and Nooramunga area outside the MNP (Parks Victoria 2005). About 30 stormwater and agricultural drains and three treated wastewater outfalls also discharge into Corner Inlet. Water quality within Corner Inlet is influenced by all these sources, and the potential for altered water quality in the MNP is high (Molloy *et al.* 2005; Parks Victoria 2005).

The southern section of the MNP straddles three sites of geological and geomorphological significance: Chinaman Creek Delta, Barry Hill to Bennison Point, and Bennison Island (Parks Victoria 2005; Figure 45). Chinaman Creek Delta is of state significance, providing an example of an active delta infilling a former embayment. Between Barry Hill and Bennison Point is a regionally significant area of weathered granite shore platform and active granite sand spit development. This area is a good example of a dynamic coast showing evidence of recent and rapid change. The tidal flats to the south of Bennison Island are a good example of a pool and channel drainage system, and are regionally significant (Parks Victoria 2005).

**Table 16**. Physical attributes of the Corner Inlet Marine National Park.

| Park Name | Corner Inlet (All) |
|---|---|
| Conservation status | Marine National Park |
| Biophysical Region | Victorian Embayments |
| Size | 1333 ha (ranked 11th of 24) |
| Length of coastline | ~12.9 km |
| Shoreline geology | Granite |
| Area with depth: | |
| *(high res)* Supratidal | 0.55 ha |
| Intertidal | 27.88 ha |
| Intertidal-2 m | 321.3 ha |
| 2-4 m | 33.1 ha |
| 4-6 m | 17.5 ha |
| 6-8 m | 17.4 ha |
| 8-10 m | 21.5 ha |
| *(low res)* <1.4 (~Intertidal)* | 513.2 ha |
| 1.4-3.4 m | 0.35 ha |
| 3.4-6.4 m | 0.27 ha |
| 6.4-11.4 m | 6.87 ha |
| 11.4-16.4 m | 94.26 ha |
| 21.4-31.4 m | 27.46 ha |
| Mean tidal variation - spring | 2.1 m |
| Mean tidal variation - neap | 1.0 m |
| Mean water temp - summer | 20.0°C |
| Mean water temp - winter | 12.0°C |
| Adjacent catchment | National Park |
| Discharges into MNP | Chinaman Creek<br>Intermittent Creeks |
| Nearest major estuary | Chinaman Creek |

* artifact of combining different resolutions of bathymetric mapping, coarse mapping could not be separated into smaller depth categories

### 2.4.2 MARINE HABITAT DISTRIBUTION

Mapping of habitats is important for understanding and communicating the distribution of natural values within Marine National Parks and Sanctuaries, particularly as the marine environment is not as easily visualised as the terrestrial environment (Parks Victoria 2003). Knowledge of the distribution and extent of habitats is required to more effectively target management activities, including emergency response, and monitoring and research. Mapping of marine habitats provides a baseline inventory, allows the identification of suitable monitoring sites and possible tracking of environmental change, as well as identifying areas vulnerable to particular threats or suitable for recreational activities. The saltmarshes and mangroves in Corner Inlet MNP have been mapped from aerial photography (Victorian Saltmarsh Study 2011). Corner Inlet seagrass habitat has been mapped from aerial photography and ground-truthed by site visits and underwater video transects (Ball and Blake 2007; Ball *et al.* 2010). As it is not possible to distinguish *H. nigricaulis* from *Z. muelleri* with the mapping techniques used, both species were included in a combined category *Zostera/Heterozostera*.

Corner Inlet MNP is characterised by a wide variety of marine habitats ranging from deep channels to extensive seagrass and mudflats fringed by mangrove to sandy beaches. Sandy beaches occur below the granitic slopes of Wilsons Promontory National Park, as small isolated beaches between headlands in the northern section and as Chinaman Long Beach in the southern section (Bird 1993; Plummer *et al.* 2003).

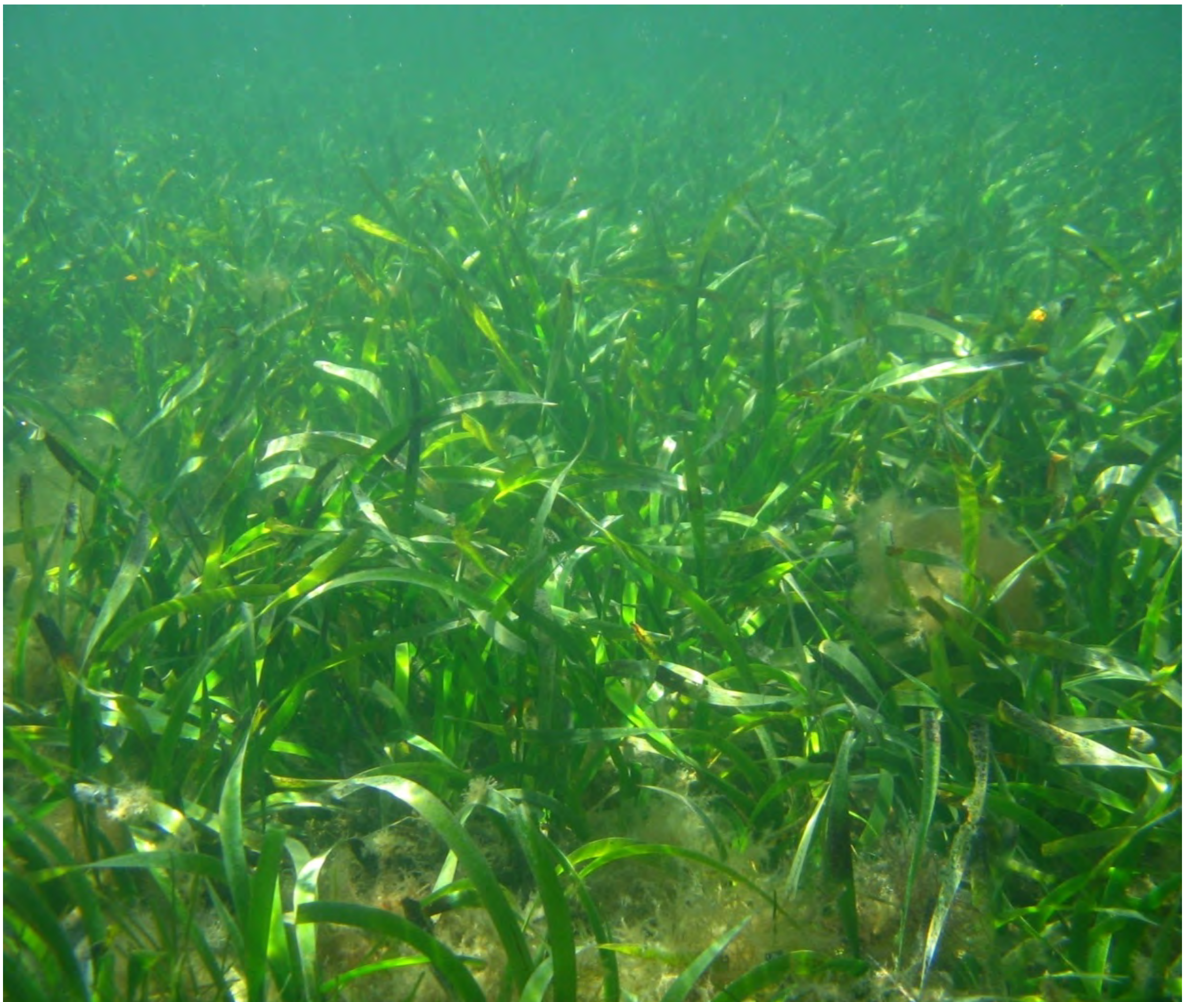

**Figure 41**. *Posidonia australis* seagrass meadow in Corner Inlet Marine National Park. Photo by Friends of Corner Inlet.

Small amounts of saltmarsh are found within the boundaries of Corner Inlet MNP (Figure 46) along the southern coast of the southern section (Victorian Saltmarsh Study 2011). The majority of the saltmarsh in this area is outside the MNP boundaries, in Wilsons Promontory National Park around the mouth of Chinaman Creek (Victorian Saltmarsh Study 2011). In the MNP the dominant saltmarsh community is Wet Saltmarsh Herbland dominated by beaded glasswort *Sarcocornia quinqueflora* (Victorian Saltmarsh Study 2011).

The white mangrove *Avicennia marina* subsp. *australasica* is the only species of mangrove to occur in Victoria, and in Corner Inlet MNP it reaches the most southern extent of its distribution (Bird 1993; Victorian Saltmarsh Study 2011). The *A. marina* Mangrove Shrubland community grows on the sediment on intertidal mudflats on the shores of the southern section (Victorian Saltmarsh Study 2011). Mangrove Shrubland (Figure 46) in the MNP fringes the seaward edge of saltmarsh. It is also adjacent to the MNP in Wilsons Promontory National Park, along the shore, around the islands and up Chinaman Creek (Victorian Saltmarsh Study 2011).

Four of Victoria's five main species of seagrass form meadows in Corner Inlet MNP (Molloy *et al.* 2005; Parks Victoria 2005; Ball and Blake 2007; Hindell *et al.* 2009). The seagrasses grow in separate beds although there may be patches of one species among larger meadows of others (Molloy *et al.* 2005; Ball and Blake 2007). The short eelgrass *Zostera muelleri* forms dense mats around the intertidal fringes and frequently lies exposed at low tide (Hindell *et al.* 2009). The long eelgrass *Heterozostera nigricaulis* (Figure 46) is found in slightly deeper water (4 m), and is common on the top and around the base of submerged banks (Molloy *et al.* 2005; Hindell *et al.* 2009). Broad-leaf seagrass or strapweed *Posidonia australis* (Figure 46) is the dominant seagrass on the submerged banks. The long flat fronds sprout from a thick rhizome lying deep within the sediment (Koss *et al.* 2005a; Hindell *et al.* 2009). *P. australis* spreads via its rhizomes and reinvades disturbed areas very slowly, with seedlings rarely observed (O'Hara *et al.* 2002). The southern paddleweed *Halophila australis* (Figure 42) grows as pairs of small oval leaves snaking out along long slender rhizomes (O'Hara *et al.* 2002; Koss *et al.* 2005a; Hindell *et al.* 2009). It occurs sparsely around broad-leaf *P. australis* seagrass beds or across sandy patches, although it can be locally common (Hindell *et al.* 2009). *P. australis* is considered to be a "keystone" species that provides shelter and food for many other creatures in Corner Inlet (Parks Victoria 2005; Hindell *et al.* 2009).

**Figure 42.** Southern paddleweed *Halophila australis* growing on the soft sediments of Corner Inlet Marine National Park. Photo by Mark Norman, Museum of Victoria.

Seagrass cover in Corner Inlet MNP (Figure 46) is extensive west of Bennison Channel in the northern section of the MNP (Ball and Blake 2007). The seagrass is predominately *Posidonia australis* (Ball and Blake 2007). In the northern section patches of *Zostera/Heterozostera* grow in the south-west and in dense beds along the shore (Ball and Blake 2007). In the southern section of the MNP patches of *Zostera/Heterozostera* grow in the north west corner near Bennison Island and the north east shore (Ball and Blake 2007). The majority of the southern section is bare sediment (Figure 46) that is exposed at low tide (Ball and Blake 2007). Bare subtidal sediment also dominates Bennison Channel in the northern section (Ball and Blake 2007). Bare subtidal substrate occurs predominantly in deeper channel areas that drain the shallow banks and intertidal areas.

The longest section of rocky coastline in Corner Inlet occurs in the northern section of the MNP and consists of steeply plunging granite headlands separated by sandy beaches (Parks Victoria 2005). Areas of the intertidal rocky shores of Granite and Bennison Islands are also within the MNP (Parks Victoria 2005). Small areas of subtidal reef occur mostly in shallow waters (< 5 m), but at least one area occurs in the deeper waters of Bennison Channel. The headland separating Tin Mine Cove and Chinaman Long Beach is the main example of a deep subtidal rocky reef within the MNP (Parks Victoria 2005). Diverse marine life is present in these habitats (Plummer *et al.* 2003).

**Figure 43.** Silver sweep *Scorpis lineolata* over sponge dominated deep subtidal reef in Corner Inlet Marine National Park. Photo by Mark Norman, Museum of Victoria.

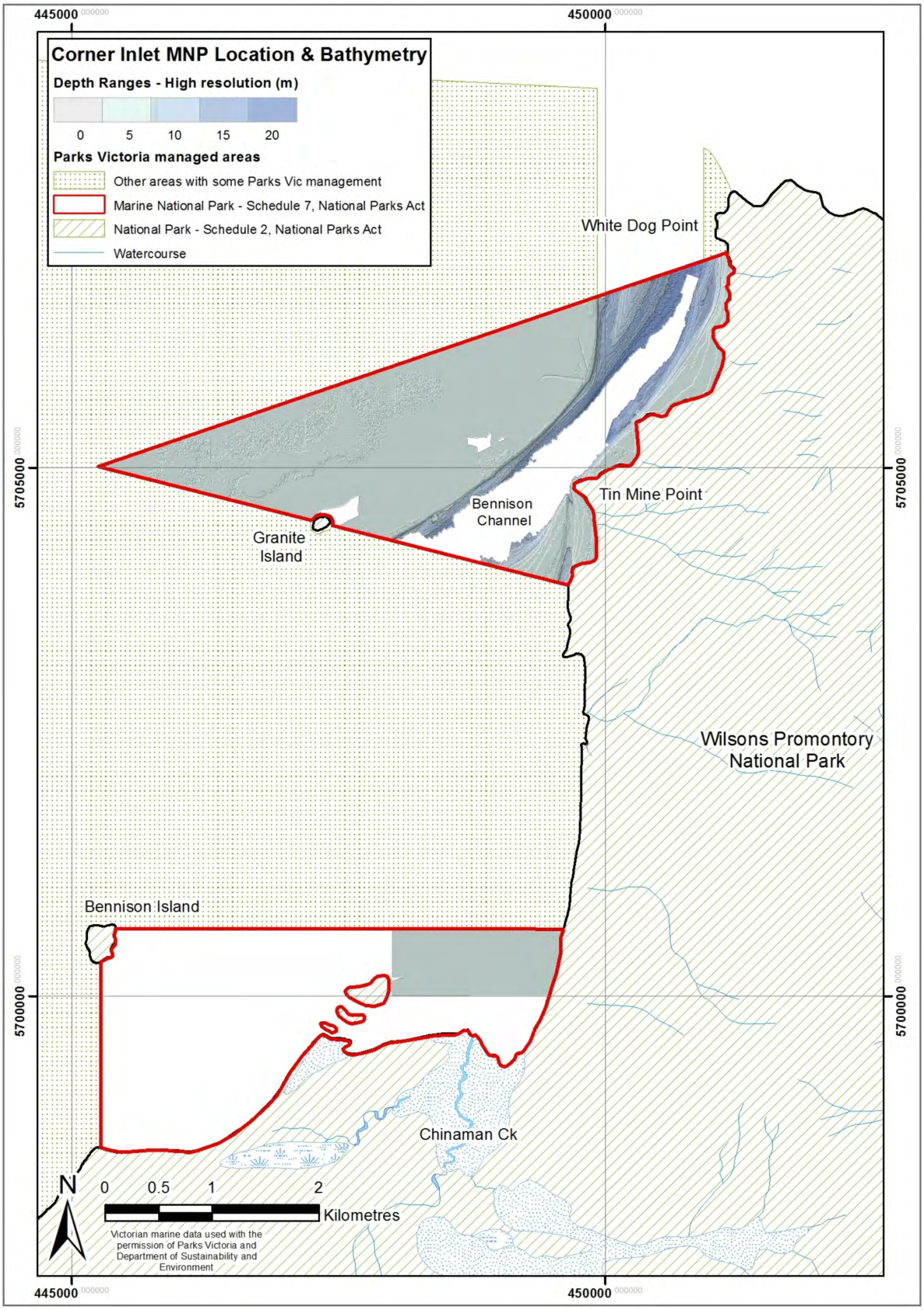


**Figure 44.** Location map of Corner Inlet Marine National Park with bathymetry, showing the northern and southern sections. There are no intertidal or subtidal reef monitoring sites in the MNP.

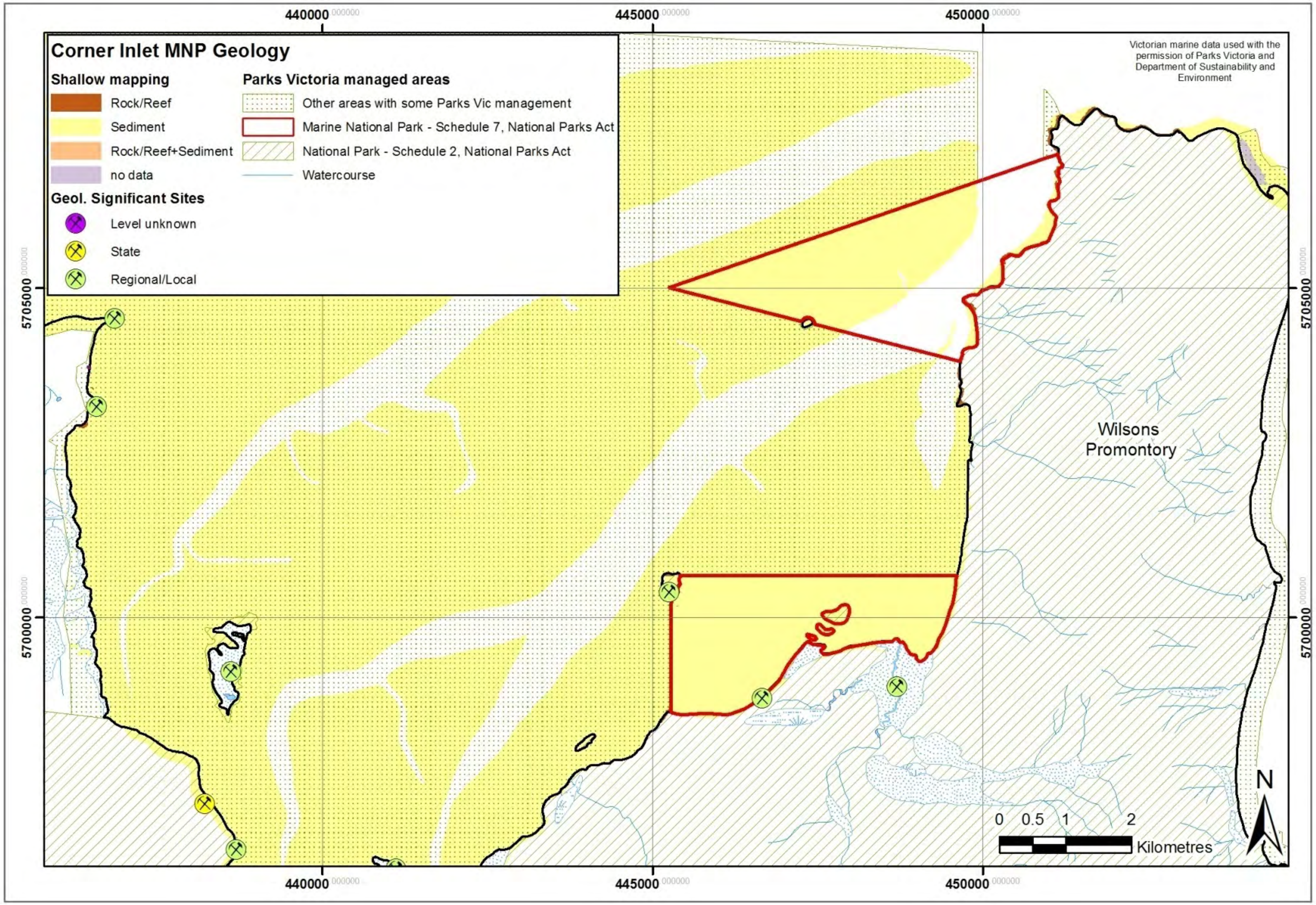


**Figure 45**. Substrate mapping of Corner Inlet Marine National Park and surrounds, showing sites of geological significance.

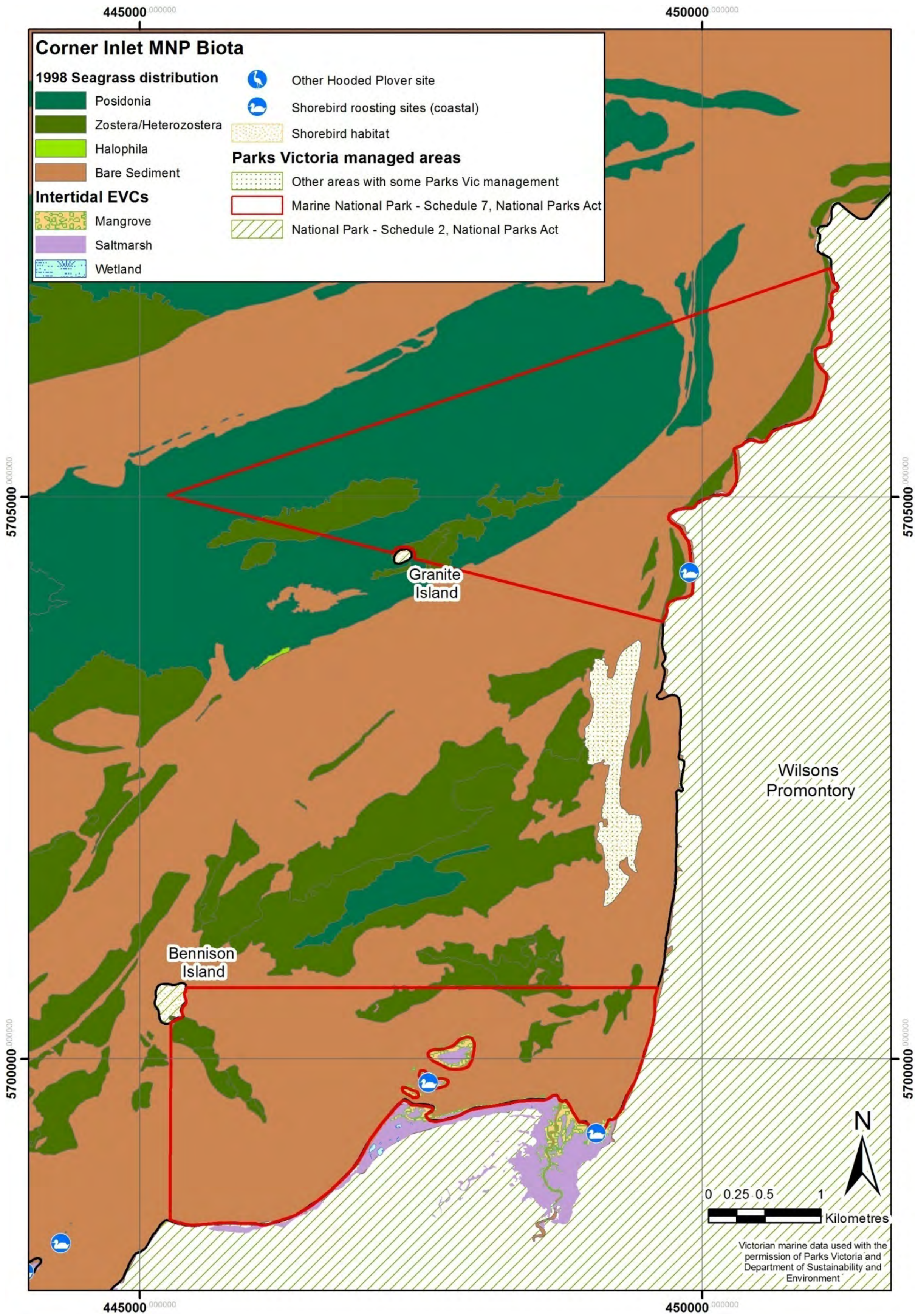


**Figure 46**. Biotic mapping of Corner Inlet Marine National Park and surrounds showing sites of biological significance.

### 2.4.3 MARINE ECOLOGICAL COMMUNITIES

#### General

Since the first natural values report by Plummer *et al.* (2003), Parks Victoria and the state government have invested in research in Corner Inlet MNP. This includes a new seagrass survey (Hindell *et al.* 2009; Ball *et al.* 2010; Figure 46). This survey measured the change in seagrass cover, biomass, epiphytes and epifauna five times over two and a half years at Granite Island in the north section of the MNP as part of a larger study across Port Phillip Bay and Western Port Bay (Hindell *et al.* 2009; Ball *et al.* 2010). The fauna in Corner Inlet has affinities both with the cool-temperate fauna of western Victoria and the warm-water fauna of east Gippsland (O'Hara *et al.* 2002). Gastropods dominate the diversity of invertebrates and birds the vertebrates from recorded number of species in Point Addis MNP (Table 17, Appendix 1). There have been no new surveys of the biota of the saltmarsh, mangroves or pelagic habitats. Corner Inlet MNP is part of the Corner Inlet Ramsar area (DNRE 2002) recognising its importance as shorebird habitat for resident and migratory birds (Figure 46). There is one recognised significant shorebird roosting site in the southern section of Corner Inlet MNP and one in the northern section, both are minor roosts (Figure 46). The major roost site on twin mangrove islands is in Wilsons Promontory National Park not the MNP.

**Table 17.** Summary of database records of the number of species in major biotic groups in Corner Inlet Marine National Park (see Appendix 1).

| Biotic group | Number of species |
|---|---|
| **Macrophytes** | **4** |
| green algae | 1 |
| brown algae | 2 |
| red algae | 2 |
| **Invertebrates** | **31** |
| cnidarians | 2 |
| polychaetes | 1 |
| barnacles | 3 |
| decapod crustaceans | 3 |
| gastropods | 16 |
| bivalves | 1 |
| echinoderms | 4 |
| ascidians | 1 |
| **Vertebrates** | **48** |
| fish | 1 |
| birds | 43 |
| mammals | 4 |

#### Intertidal

Mangrove and saltmarsh communities in and adjacent to the MNP are important because they contribute organic matter to Corner Inlet, are breeding and nursery grounds for many organisms including microcrustacea, bivalves and fish, and act as filters for sediments and other matter (Parks Victoria 2005). Corner Inlet MNP has a small amount of saltmarsh, Wet Saltmarsh Herbland dominated by the beaded glasswort *Sarcocornia quinqueflora* (Victorian Saltmarsh Study 2011). Specific studies of the fauna found in the saltmarshes of Corner Inlet MNP have not been conducted.

The *Avicennia marina* Mangrove Shrubland community in Corner Inlet MNP grows on the sediment on intertidal mudflats in front of the saltmarsh communities (Victorian Saltmarsh Study 2011). The trunks and pneumatophores of mangroves provide habitat for epiphytic filamentous algae, gastropods, barnacles, and mussels. The mangrove fringes are inhabited by crabs and at high tide fish such as gobies, mullet and toadfish. Specific studies of the flora and fauna found in the Mangrove Shrublands of Corner Inlet MNP have not been conducted.

Seagrass beds are complex and extremely productive environments which play an important role in the ecology of the MNP (Parks Victoria 2005; Figure 47). Seagrass beds stabilise the sediment and remove dissolved nutrients from the water, forming one of the basic levels of the food chain (Blake and Ball 2001). Seagrass beds provide habitat for epiphytic algae, hydroids, ascidians, diatoms and sponges, and grazing invertebrates including many molluscs, crustaceans, polychaetes and crabs. Intertidal cores from the seagrass beds near Granite Island in Corner Inlet MNP had up to 18 families of macroinvertebrates (Ball *et al.* 2010). It was dominated by four families, Amphibolidae pulmonate and Dialidae gastropods, and Pandalid and Hippolytid shrimps (Ball *et al.* 2010). Tidal immersion and location are more important factors than seagrass species and physical structure in determining the assemblage structure of the epifaunal communities in intertidal seagrass beds in Corner Inlet MNP (Ball *et al.* 2010).

**Figure 47**. Soldier crab *Mictyris platycheles* on a *Zostera/Heterozostera* intertidal seagrass bed in Corner Inlet Marine National Park. Photo by Adam Pope, Deakin University.

Large areas of unvegetated mud and sand support invertebrates, microphytobenthos and demersal fish (Figure 49). Benthic invertebrates in both unvegetated and vegetated mudflats are an important food resource for the many migratory shore bird species that use Corner Inlet. Intertidal cobbly reef occurs around Granite and Bennison Islands and along the shore in the northern section but there is limited information on its flora or fauna (Figure 48). Shorebirds use the reef and sand shoals to roost.

**Figure 48.** The brown algae Neptune's necklace *Hormosira banksii* on the intertidal reef in the northern section of Corner Inlet Marine National Park. Photo by Jon Mackie, Deakin University.

**Figure 49.** Sandy intertidal beach in southern Corner Inlet Marine National Park. Photo by Adam Pope, Deakin University.

## Subtidal

Subtidal seagrass beds are an ecologically significant marine habitat, and serve as a nursery area for juvenile marine animals, as well as providing food and shelter (Koss *et al.* 2005a; Figures 53 and 58). They also help stabilise sediments and trap suspended particles (O'Hara *et al.* 2002; Koss *et al.* 2005a). The seagrass itself is an important food source, providing the bulk of organic matter when broken down (O'Hara *et al.* 2002). During winter, *Posidonia australis* leaf tips die and substantial amounts of leaf break off (O'Hara *et al.* 2002).

Subtidal seagrass beds provide the largest area of ‘hard substrate’ within Corner Inlet MNP and are habitat for a variety of encrusting organisms (O'Hara *et al.* 2002). A variety of macroalgae are associated with seagrass beds, where they grow on the seagrass, shells or stones (Parks Victoria 2005). Subtidal seagrass generally supports much higher densities of invertebrates than intertidal seagrass beds (Ball *et al.* 2010). Around 15 to 20 different taxa of epifaunal animals grow on *P. australis* in the MNP, dominated by six families (Ball *et al.* 2010). The most abundant macroinvertebrates are mysids, a shrimp like crustacea that often forms swarms. Other abundant macroinvertebrates include the carid shrimp Pandalidae and hippolytid shrimp Hippolytidae (Figure 50), and amphipods from the families Dexaminidae and Corophiidae (Ball *et al.* 2010). The gastropod mollusc Trochidae or top shell is also abundant and like the other dominant taxa their abundance varies considerably with time (Ball *et al.* 2010).

**Figure 50**. Weed shrimp *Hippolyte australiensis* on a *Posidonia australis* blade in Corner Inlet Marine National Park. Photo by Julian Finn, Museum of Victoria.

Seagrass beds are important nursery areas for many fish (Parks Victoria 2005). Leatherjackets (Figure 52), conservation listed syngnathids (seahorses and pipefish; Figure 51) and small juvenile fish are found in *P. australis* beds (Ball *et al.* 2010). Rock flathead *Platycephalus laevigatus* are permanent residents of seagrass beds (Molloy *et al.* 2005). Juvenile whiting *Sillaginodes punctata* also have an association with seagrass beds (Molloy *et al.* 2005). Spawning, settlement success and subsequent recruitment for many fish species in seagrass beds is greatly influenced by environmental and habitat factors (Molloy *et al.* 2005).

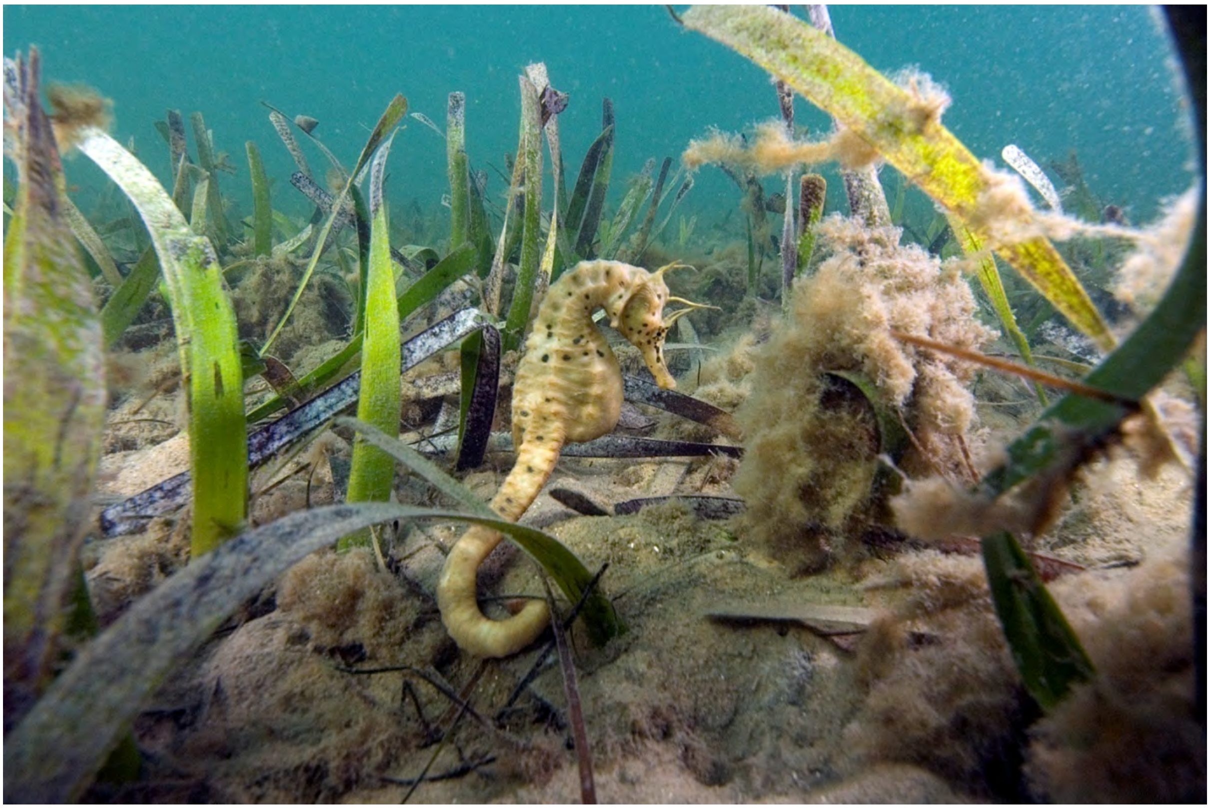

**Figure 51**. Potbellied seahorse *Hippocampus abdominalis* in *Posidonia australis* seagrass bed in Corner Inlet Marine National Park. Photo by Mark Norman, Museum of Victoria.

**Figure 52.** Six-spine leatherjacket *Meuschenia freycinetti* above *Posidonia australis* seagrass bed in Corner Inlet Marine National Park. Photo by Mark Norman, Museum of Victoria.

**Figure 53**. Southern calamari squid *Sepioteuthis australis* over the soft sediments of Corner Inlet Marine National Park. Photo by Mark Norman, Museum of Victoria.

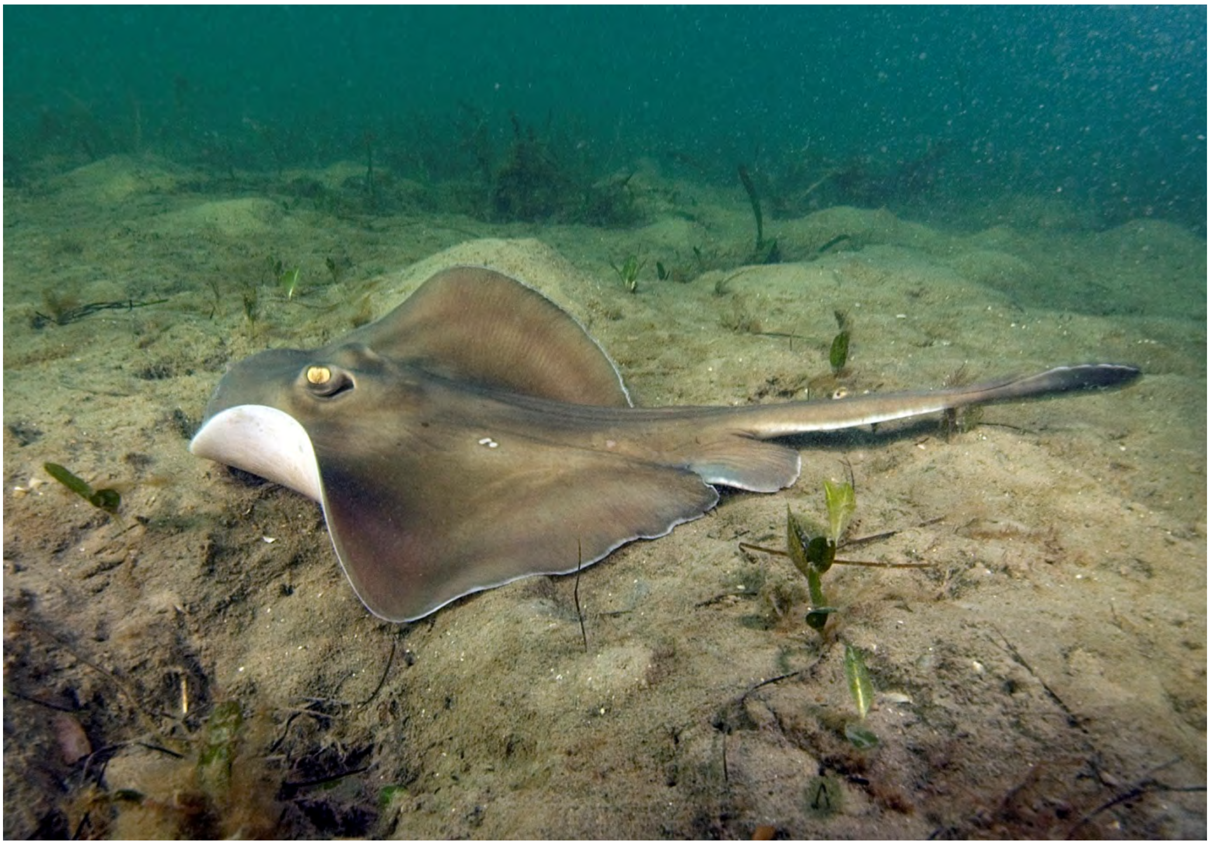

**Figure 54.** Sparsely spotted stingaree *Urolophus paucimaculatus* over the subtidal soft sediment of Corner Inlet Marine National Park. Photo by Mark Norman, Museum of Victoria.

Strong currents have sorted a coarser sand substrate in the deep subtidal channels than the finer muddy substrate of the sheltered intertidal mudflats (Parks Victoria 2005). The grain size and physical structure of the sediment define the composition of species, and provide habitat in the spaces between the sand grains for numerous species of infaunal invertebrates such as polychaetes, crustaceans, bivalves and gastropods (Parks Victoria 2005). Epifaunal species of Corner Inlet include gastropods, sea stars, urchins and ascidians (Parks Victoria 2005). Fish associated with the subtidal sediments and in the deep channels of Corner Inlet include stingrays (Figure 54), perch, flathead, and gobies (Parks Victoria 2005). Specific surveys of the fauna of subtidal unvegetated sediments in Corner Inlet MNP have not been conducted.

Subtidal reef occurs along the shore in the northern section of Corner Inlet MNP and can be quite deep near Tin Mine Cove (Parks Victoria 2005; Figures 55, 56, 57 and 61). Subtidal cobbly reef occurs around Granite and Bennison Islands and on the shore of the northern section but there have been no specific surveys of its flora or fauna.

**Figure 55.** Silver sweep *Scorpis lineolata* over a sponge dominated deep subtidal reef in Corner Inlet Marine National Park. Photo by Mark Norman, Museum of Victoria.

**Figure 56.** Solitary corals *Culicia australiensis* on subtidal reef in Corner Inlet Marine National Park. Photo by Julian Finn, Museum of Victoria.

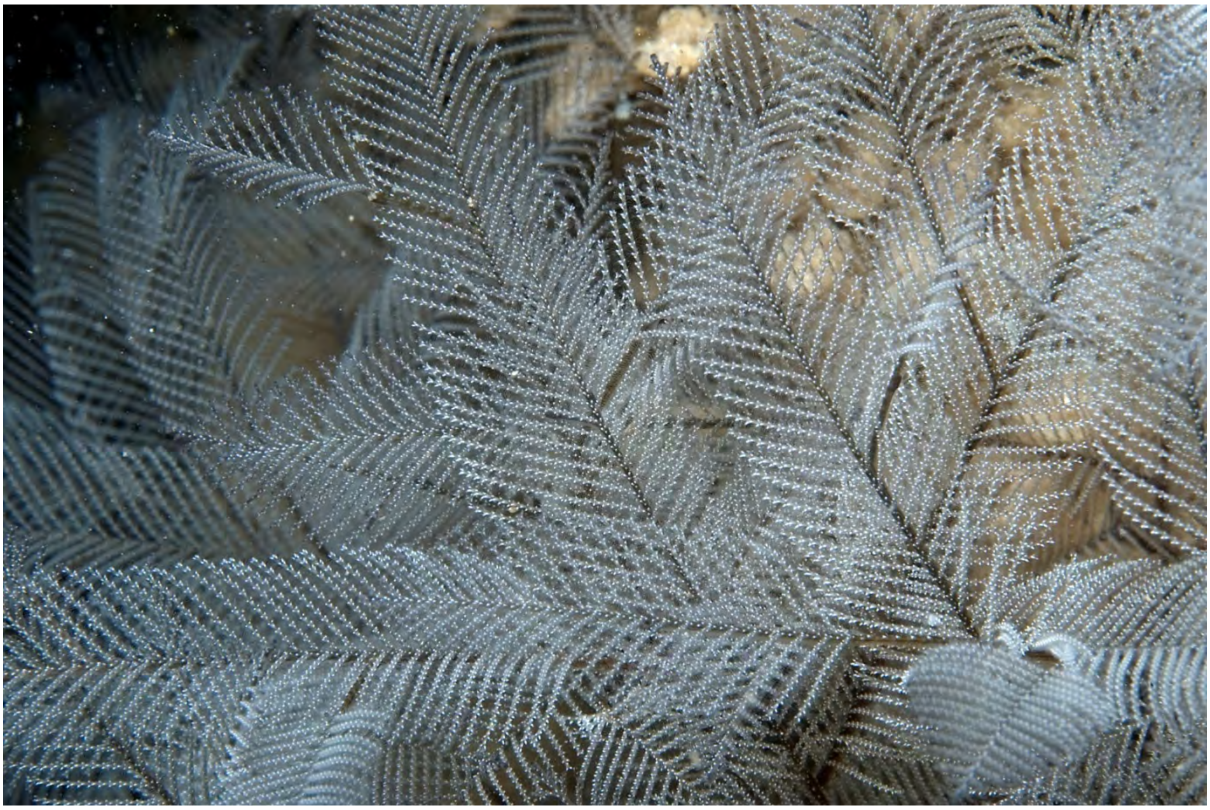

**Figure 57.** Feather coral in Corner Inlet Marine National Park. Photo by Julian Finn, Museum of Victoria.

## Water column

The water column habitat of Corner Inlet MNP is dominated by drifting planktonic species, which rely on currents for movement, nutrients and food. Many intertidal and subtidal organisms spend the early stage of their life in the water column environment and currents assist the distribution of recruits back to intertidal and subtidal habitats. Common plankton found in the water column includes phytoplankton such as diatoms and zooplankton including copepods, jellyfish and ctenophores. Highly mobile fish, sharks and stingrays inhabit the water column habitat of Corner Inlet MNP (Parks Victoria 2005). As described in the following section a variety of seabirds are found in the waters of Corner Inlet MNP. Parks Victoria does not currently monitor the water column as a habitat (Power and Boxshall 2007).

**Figure 58**. Short tailed nudibranch *Ceratosoma brevicaudatum* in *Posidonia australis* seagrass bed in Corner Inlet Marine National Park. Photo by Friends of Corner Inlet.

### 2.4.4 SPECIES OF CONSERVATION SIGNIFICANCE

The approach of managing MPAs for their marine ecological communities, rather than threatened species, is also likely to protect and enhance threatened species populations (Power and Boxshall 2007). Whole-of-habitat management may also result in the protection of species not yet identified because of their rarity or cryptic nature (Power and Boxshall 2007).

#### Flora

No conservation listed marine flora has been recorded in Corner Inlet MNP (Parks Victoria 2005). The seagrass *Posidonia australis* is of regional significance being the only large stand in Victoria and the southern-most stand in Australia (ECC 2000).

#### Invertebrates

To the east of Corner Inlet MNP near Snake Island in Nooramunga the FFG listed sea cucumber *Trochodota shepherdi* has been recorded (O'Hara and Barmby 2000; O'Hara 2002; O'Hara *et al.* 2002). It has not been recorded from Corner Inlet MNP (O'Hara *et al.* 2002; Edmunds *et al.* 2010a). This rare species is thought to be dependent on foliose algae *Lobospira bicuspidata*, which is epiphytic on *Heterozostera* seagrass adjacent to *P. australis* beds (O'Hara *et al.* 2002).

#### Fish

Under the Victorian *Fisheries Act* 1995 all syngnathid species (seahorses and pipefish; Figures 59 and 63) are listed as Protected Aquatic Biota. Nationally they are listed as threatened under the *EPBC Act 1999*. Syngnathids have been recorded from *P. australis* seagrass beds within the MNP (Ball *et al.* 2010).

**Figure 59.** Conservation listed sygnathid spotted pipefish *Stigmatopora argus* beneath a *Posidonia australis* blade in Corner Inlet Marine National Park. Photo by Julian Finn, Museum of Victoria.

## Birds

The Corner Inlet Ramsar Site extends across Corner Inlet excluding the major shipping lanes and including Corner Inlet MNP (DNRE 2002). As listed in the Atlas of Victorian Wildlife, twenty-four conservation listed shore or sea birds have been sighted in or in the immediate surrounds of Corner Inlet MNP (Table 18). Seventeen are recognized as threatened in Victoria, listed under the *FFG Act 1988* or the Victorian Rare or Threatened Species (VROTS) list. The orange-bellied parrot *Neophema chrysogaster* is regarded as critically endangered both in Victoria and nationally. It migrates annually to coastal Victoria between March and October (Parks Victoria 2005). Three birds, the fairy tern *Sternula nereis,* little egret *Egretta garzetta* and gull-billed tern *Gelochelidon nilotica* are regarded as endangered in Victoria. One, the fairy prion *Pachyptila turtur* is regarded as vulnerable both in Victoria and nationally. Fourteen birds (Table 18) are recognized internationally under the Australia Migratory Bird Agreement with either China (CAMBA) or Japan (JAMBA).

**Table 18**. Conservation listed shorebird and seabirds records from Corner Inlet Marine National Park and surrounds.

| | | Victorian listing | | National listing | International treaty | |
|---|---|---|---|---|---|---|
| **Common name** | **Scientific name** | **FFG** | **VROTS** | **EPBC** | **CAMBA** | **JAMBA** |
| orange-bellied parrot | *Neophema chrysogaster* | L | CE | CE | | |
| fairy tern | *Sternula nereis* | L | EN | | | |
| little egret | *Egretta garzetta* | L | EN | | | |
| gull-billed tern | *Gelochelidon nilotica* | L | EN | | | |
| fairy prion | *Pachyptila turtur* | | VU | VU | | J |
| eastern great egret | *Ardea modesta* | L | VU | | C | J |
| white-bellied sea-eagle | *Haliaeetus leucogaster* | L | VU | | C | |
| hooded plover | *Thinornis rubricollis* | L | VU | | | |
| black-tailed godwit | *Limosa limosa* | | VU | | C | J |
| royal spoonbill | *Platalea regia* | | VU | | | |
| Caspian tern | *Hydroprogne caspia* | L | NT | | C | J |
| eastern curlew | *Numenius madagascariensis* | | NT | | C | J |
| red knot | *Calidris canutus* | | NT | | C | J |
| Pacific gull | *Larus pacificus* | | NT | | | |
| sooty oystercatcher | *Haematopus fuliginosus* | | NT | | | |
| black-faced cormorant | *Phalacrocorax fuscescens* | | NT | | | |
| pied cormorant | *Phalacrocorax varius* | | NT | | | |
| red-necked stint | *Calidris ruficollis* | | | | C | J |
| curlew sandpiper | *Calidris ferruginea* | | | | C | J |
| bar-tailed godwit | *Limosa lapponica* | | | | C | J |
| sharp-tailed sandpiper | *Calidris acuminata* | | | | C | J |
| common greenshank | *Tringa nebularia* | | | | C | J |
| cattle egret | *Ardea ibis* | | | | C | J |
| short-tailed shearwater | *Ardenna tenuirostris* | | | | | J |

L= listed, NT = Near Threatened, VU = Vulnerable, EN = Endangered, CE = Critically Endangered, C = Listed under the CAMBA treaty, J = Listed under the JAMBA treaty

## Marine mammals and reptiles

The deeper channels in the northern section of Corner Inlet MNP provides occasional habitat for large marine mammals (Figure 60). Two conservation listed whales, the southern right *Eubalaena australis* and humpback *Megaptera novaeangliae* have been recorded from the MNP (Table 19).

Table 19. Conservation listed mammal records from Corner Inlet Marine National Park and surrounds.

| Common name | Scientific name | FFG | VROTS | EPBC |
|---|---|---|---|---|
| southern right whale | *Eubalaena australis* | L | CE | EN |
| humpback whale | *Megaptera novaeangliae* | L | VU | VU |

**Figure 60.** A vagrant juvenile southern elephant seal *Mirounga leonina* hauled out on the intertidal reef in Corner Inlet Marine National Park. Photo by Mark Norman, Museum of Victoria.

## Species distribution information

An assessment of distribution, endemism and rarity of biota across the state did not identify any biota endemic to Corner Inlet MNP (O'Hara and Barmby 2000; O’Hara and Poore 2000; O'Hara 2002).

Eleven biota (Table 20) are presumed to be at their distributional limit in Corner Inlet MNP (O'Hara and Barmby 2000; O’Hara and Poore 2000). A bivalve *Saccostrea glomerata* is presumed to be at the western limit of its distribution in Corner Inlet MNP. Ten species, two red algae, three crustacea, two sea cucumbers, two brittle stars and a toadfish are presumed to be at the eastern limit of their distribution in Corner Inlet MNP (O'Hara and Barmby 2000; O’Hara and Poore 2000). The distributional limits of the biota listed in Table 20 may reflect collection effort in this area rather than actual Victorian distributions. Many areas of the Victorian coast have never been sampled and therefore biota ranges may be much greater than those suggested.

**Table 20**. Marine species at their distribution limits in Corner Inlet Marine National Park (O'Hara and Barmby 2000; O'Hara and Poore 2000; O'Hara 2002).

| Phylum | Order | Family | Species | Common name | Category |
|---|---|---|---|---|---|
| Rhodophyta | Corallinales | Corallinaceae | *Lithothamnion indicum* | Red algae | PE |
| Rhodophyta | Corallinales | Corallinaceae | *Lithothamnion muelleri* | Red algae | PE |
| Crustacea | Brachyura | Goneplacidae | *Litocheira bispinosa* | Crab | PE |
| Crustacea | Brachyura | Xanthidae | *Megametope rotundifrons* | Crab | PE |
| Crustacea | Caridea | Crangonidae | *Philocheras victoriensis* | Shrimp | PE |
| Mollusca | Bivalvia | Ostreidae | *Saccostrea glomerata* | Bivalve | PW |
| Echinodermata | Holothuroidea | Caudinidae | *Paracaudina australis* | Sea Cucumber | PE |
| Echinodermata | Holothuroidea | Chiridotidae | *Trochodota shepherdi* | Sea Cucumber | PE |
| Echinodermata | Ophiuroidea | Amphiuridae | *Amphiura (Amphiura) trisacantha* | Brittle star | PE |
| Echinodermata | Ophiuroidea | Ophiocomidae | *Ophiocomina australis* | Brittle star | PE |
| Chordata | Tetraodontiformes | Tetraodontidae | *Contusus richei* | Barbed Toadfish | PE |

**Figure 61.** Doughboy scallops *Chlamys asperrimus* on subtidal reef in Corner Inlet Marine National Park. Photo by Mark Norman, Museum of Victoria.

### 2.4.5 MAJOR THREATS

Threats to natural values were derived from lists of hazards and associated risks in Carey *et al.* (2007b). These were the result of a statewide consultative process to identify threats to MPAs. Through public and agency workshops, the natural values in individual MPAs and the threats that could affect them over the next 10 years, were considered and ranked to identify hazards. This list of hazards was then ranked (low, medium, high and extreme) by the risk posed by each hazard (Carey *et al.* 2007b). Ten hazards with the potential to be of extreme risk were identified by Carey *et al.* (2007b). They are listed in rank order and the habitat or area at risk within the MNP is indicated in brackets:

1. Sediments and nutrients in catchment runoff affecting water quality and seagrass in Corner Inlet MNP (all of MNP);
2. Presence of seawalls affecting breeding of fish such as shark and flounder (intertidal and subtidal soft sediment);
3. Exotic species and pathogens introduced via ballast water or recreational boating, affecting biodiversity by competing with local species in Corner Inlet MNP (all of MNP);
4. Logging of plantations across the upper catchment of Corner Inlet, leading to sedimentation effects on seagrass, sand slugs from in-stream habitat releasing nutrients to MNP, and nutrients stored in the sediments of MNP affecting algal communities and seagrass (all of MNP);
5. Altered timing and flow of freshwater into Corner Inlet affecting ecological processes in Corner Inlet MNP including fish breeding and occurrence of micro and macro algal blooms (all of MNP);
6. Dredging operations in Corner Inlet affecting water quality and seagrass beds and disturbing shorebirds and seabirds in MNP (all of MNP);
7. Nutrients from septic tanks and secondary sewage treatment plants affecting seagrass in Corner Inlet MNP (all of MNP);
8. Propeller scour affecting seagrass beds and bare mudflats (intertidal and subtidal soft sediments);
9. High profile of MNPs leading to reduced management and/or environmental focus on surrounding marine areas, to the subsequent detriment of the MNPs (all of MNP); and
10. Major oil or chemical spill from vessel damaging seagrass and mudflat habitats in Corner Inlet MNP (all of MNP).

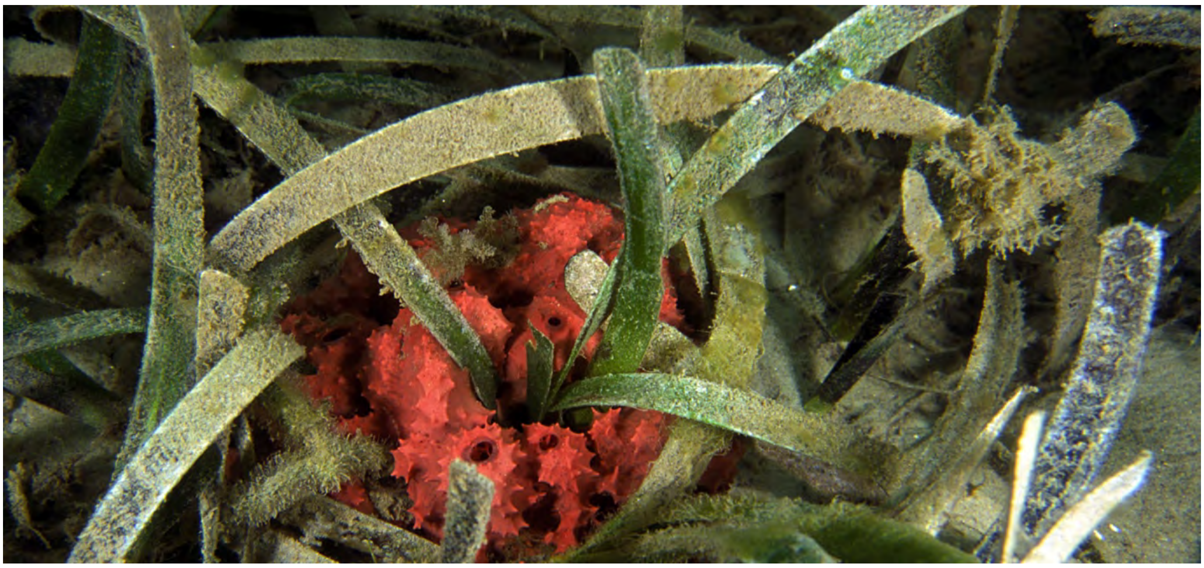

**Figure 62.** Sponge growing in *Posidonia australis* seagrass bed in Corner Inlet Marine National Park. Photo by Mark Norman, Museum of Victoria.

The introduction of marine pests threatens the integrity of marine biodiversity and may reduce the social and economic benefits derived from the marine environment (Parks Victoria 2003; Molloy *et al.* 2005). Two marine pests, the green shore crab *Carcinus maenas* and broccoli weed *Codium fragile (subsp. fragile),* have been recorded in Corner Inlet MNP (Molloy *et al.* 2005; Parks Victoria 2005; Mount and Ogier 2011). Once established, introduced marine pests are almost impossible to eradicate (Parks Victoria 2005). The green crab *C. maenas* and broccoli weed *C. fragile* are unlikely to be eradicated from the MNP or Corner Inlet as a whole using current technologies (Parks Victoria 2005). Recreational or commercial vessels could introduce new marine pests into the MNP in ballast water or as fouling organisms on hulls or equipment (Parks Victoria 2005). Outside the MNP cordgrass *Spartina anglica* is already established in northern Corner Inlet in the Marine and Coastal Park (Victorian Saltmarsh Study 2011). A number of Victoria's other introduced marine pests have the potential to colonise Corner Inlet MNP including the northern Pacific seastar *Asterias amurensis*, European fan worm *Sabella spallanzanii* and Japanese kelp *Undaria pinnatifida* (Parks Victoria 2003; Parks Victoria 2005). Prevention of marine pest invasions is the most effective management option (Parks Victoria 2005).

Since the 1970s large areas of *Posidonia australis* (Figure 62) have been lost in Corner Inlet through dieback, particularly in the west (Molloy *et al.* 2005; Parks Victoria 2005). The most probable causes of the loss are thought to be associated with the increased sediment and nutrient loads (Molloy *et al.* 2005; Hindell *et al.* 2009). *P. australis* loss has not been observed in the MNP, although the potential for it to occur is a significant threat to the MNP's natural values (Molloy *et al.* 2005; Parks Victoria 2005).

**Climate Change**

Climate change represents a serious threat to marine ecosystems (McLeod *et al.* 2009) but specific ecological consequences of accelerating climate change are not well understood in marine systems, particularly in temperate systems. Climate change is predicted to increase water temperature, alter chemical composition (salinity, acidity and carbonate saturation), change circulation and productivity, increase frequencies of extreme weather events and exposure to damaging ultraviolet light (UVB), and increase air temperature, cloud cover and sea levels (conservatively 80cm by 2100, CSIRO-BoM 2007; Fine and Franklin 2007; VCC 2008; McLeod *et al.* 2009). A combined increase in cloud cover and sea level could result in decreased light availability potentially changing benthic flora. Increased storm surges and ocean current changes also have the potential to change the distribution of fauna and flora and could result in loss of habitats (CSIRO-BoM 2007). Intertidal communities will face increased desiccation, storm wave exposure and habitat shift. Changes in the relationship between climate and annual life-history events may force major change in functional groups and consequent ecosystem function (Fine and Franklin 2007). Climate change is also anticipated to modify species recruitment and habitat connectivity, species interactions and disturbance regimes in the marine environment (CSIRO-BoM 2007; Fine and Franklin 2007). A number of species are presumed to be at the eastern or western limit of their distributional range at Corner Inlet MNP and such species would be particularly vulnerable to climate change.

Measures to address or minimise these hazards form part of the management plan for Corner Inlet MNP (Parks Victoria 2005). For example, research is being conducted into marine pest species, as well as into water quality issues. Management actions have been implemented to minimise these threats (Parks Victoria 2005). Parks Victoria has also undertaken a strategic climate change risk assessment to identify the risks and stressors to natural values in the MPAs through assessment at the habitat level for parks in each marine bioregion. Parks Victoria will use an adaptive management approach to develop responses and actions that focus on priority climate change issues such as extreme weather events and existing risks that will likely be exacerbated by climate change.

**Figure 63.** Potbellied seahorses *Hippocampus abdominalis* in Corner Inlet Marine National Park. Photo by Julian Finn, Museum of Victoria.

### 2.4.6 CURRENT RESEARCH AND MONITORING

Parks Victoria has established extensive marine monitoring and research programs for the MPAs that address important management challenges, focussing both on improving baseline knowledge of the MPAs as well as applied management questions not being addressed by others. This knowledge will continue to enhance Parks Victoria's capacity to implement evidence-based management through addressing critical knowledge gaps. The research and monitoring programs have been guided by the research themes outlined as part of Parks Victoria's Research Partners Panel (RPP) program, a Marine Research and Monitoring Strategy 2007-2012 and Marine National Park and Marine Sanctuary Monitoring Plan 2007-2012 (Power and Boxshall 2007). Much of the research has been undertaken as part of the RPP program involving collaboration with various research institutions. The research relevant to Corner Inlet MNP has been published in Parks Victoria's Technical Series available on Parks Victoria's website (http://www.parkweb.vic.gov.au). As most research in the MNP has been carried out under permits issued by DSE, the permit database was also used to identify relevant projects for this report (Table 21, Appendix 2).

**Table 21.** Ongoing Research Partner Panel (and RPP-like) research projects and monitoring programs implemented in partnership with, or commissioned by, Parks Victoria relevant to Corner Inlet Marine National Park.

| **Ongoing RPP (and RPP-like) Projects** |
|---|
| ***University of Melbourne:*** Kim Millers, Jan Carey, Mick McCarthy<br>Optimising the allocation of resources for defending Marine Protected Areas against invasive species. |
| ***Multiple Research Partners:*** Marine Monitoring and Marine Natural Values<br>***University of Melbourne:*** Jan Carey<br>Developing Report Cards for the Marine National Parks |
| ***Museum Victoria:*** Mark Norman, Julian Finn. ***Parks Victoria:*** Roger Fenwick<br>Under the Lens - Natural History of Victoria's Marine National Park System. |
| ***University of Melbourne:*** Tarek Murshed, Jan Carey, Jacqui Pocklington<br>Conceptual model development for marine habitats. |
| **Ongoing Habitat Mapping Projects** |
| DSE / DPI / Worley Parsons/ Deakin University<br>LiDAR Mapping Project. Mapping of bathymetry and marine habitats along the Victorian coast |
| **Active Monitoring Programs** |
| ***Community Based Monitoring***<br>Sea Search - Seagrass |

Corner Inlet MNP does not have ongoing intertidal (IRMP) or shallow subtidal (SRMP) reef monitoring programs.

Friends of Corner Inlet MNP are involved in Sea Search community seagrass monitoring in the MNP (Koss *et al.* 2005a; Koss *et al.* 2005b). The Victorian Wader Study Group monitors migratory and resident wading birds in Corner Inlet MNP (Parks Victoria 2005). Data collected within the MNP and adjacent areas has contributed significantly to an understanding of the importance of Corner Inlet as a Ramsar site and as part of the East Asian – Australasian Flyway (Parks Victoria 2005).

Statewide, the Museum of Victoria is collecting additional data on the marine natural values of Victoria's MPAs. They are gathering information about natural history through video and photos (Figure 64), and using semi-quantitative methods to determine spatial and temporal changes across the system in response to threats, including marine pests and climate change. Jan Carey (University of Melbourne) is conducting research focussing on marine pest species which may impact on park values, and the MPAs which are most at risk of invasion. This will help prioritise Parks Victoria's surveillance monitoring efforts to MPAs where there is greatest potential for successful management.

### 2.4.7 KNOWLEDGE GAPS

Few surveys have been conducted of the ecological communities of Corner Inlet MNP. For example, only bird surveys and habitat mapping have been conducted for the bare soft sediment, intertidal and subtidal habitats. So far the flora and fauna of the intertidal and subtidal reefs have not been surveyed, nor fauna of the saltmarsh and mangrove habitats. No information exists at present for water column assemblages. Major threats have been identified for Corner Inlet MNP but we have limited knowledge of the effect on the natural values, particularly ecological communities.

**Figure 64.** Sea squirt colonies in Corner Inlet Marine National Park. Photo by Julian Finn, Museum of Victoria

# SUMMARY

Along Victoria's coastline there are 30 Marine Protected Areas (MPAs) that have been established to protect the state's significant marine environmental and cultural values. These MPAs include 13 Marine National Parks (MNPs), 11 Marine Sanctuaries (MSs), 3 Marine and Coastal Parks, 2 Marine Parks, and a Marine Reserve, and together these account for 11.7% of the Victorian marine environment. The highly protected Marine National Park System, which is made up of the MNPs and MSs, covers 5.3% of Victorian waters and was proclaimed in November 2002. This system has been designed to be representative of the diversity of Victoria's marine environment and aims to conserve and protect ecological processes, habitats, and associated flora and fauna. The Marine National Park System is spread across Victoria's five marine bioregions with multiple MNPs and MSs in each bioregion, with the exception of Flinders bioregion which has one MNP. All MNPs and MSs are "no-take" areas and are managed under the *National Parks Act (1975) - Schedules 7 and 8* respectively.

This Victorian Embayments Part 2 report updates the first Marine Natural Values Study (Plummer *et al.* 2003) and is one of a series of five bioregional reports covering all of Victoria's MNPs and MSs. It covers MNPs in the Western Port Bay (WP) and Corner Inlet (CI) areas of the Victorian Embayments bioregion inlcuding Yaringa, French Island, Churchill Island and Corner Inlet MNPs. The separate Embayments Part 1 report considers the marine natural values of the Victorian Embayment MPAs in Port Phillip Bay and includes Port Phillip Heads MNP and Point Cooke, Jawbone and Ricketts Point MSs. This report uses the numerous monitoring and research programs that have increased our knowledge since declaration and aims to give a comprehensive overview of the important natural values of each MNP.

The Victorian Embayments bioregion is a discontinuous region that includes all Victorian bays, inlets and estuaries to a minimum water area of >1km$^2$. In this bioregion only PPB, Western Port Bay and Corner Inlet contain MPAs. The bioregion has a moist temperate climate, varying west to east in runoff and seasonality, and has more variable water temperature and salinity than the open coast. The embayments vary in form but their maximum depth is generally < 20 m. The biota of the Victorian embayments include a diverse range of biotic assemblages found in estuarine and open coast environments depending on the water body's morphological and hydrological characteristics. Both Western Port Bay and Corner Inlet support important bird habitat which is included in Ramsar Sites. The flora and fauna composition of Corner Inlet MNP reflects the overlap of the distributions of warm water species characteristic of the NSW coast and cool water species found throughout Victoria.

French Island (2978 ha), Corner Inlet (1333 ha), Yaringa (776 ha) and Churchill Island (670 ha) MNPs range from the seventh to the twelfth largest of the 24 MPAs in Victoria. Intertidal habitat dominates the MPAs in WP, ranging from over 34 % in Churchill Island 73 % in French Island to over 82 % in Yaringa MNP. Corner Inlet is predominantly subtidal (60 %) and the majority of this is in the northern section of the MNP. The subtidal habitat in all of the MNPs consists mainly of channels that drain the intertidal flats. These are generally less than 15 m deep in WP MNPs and are up to 30 m deep in Bennison Channel in Corner Inlet MNP. Tide is a major influence on the ecology of the MNPs in WP and CI, more so than in PPB. Spring tide range is over two metres in both WP and CI and less than 1 m in PPB, with the MNPs in the north of WP having the largest tides.

Aboriginal tradition indicates that Yaringa, French Island and Churchill Island MNPs are all part of *Country* of Boonwurrung people. Corner Inlet MNP is part of *Country* of *Yiruk* for the Gunai / Kurnai and *Wamoom* for the Boonwurrung Indigenous people.

Both WP and CI are listed as Ramsar wetlands, recognising their international significance. All four MNPs are within these Ramsar sites as well as part of the East Asian-Australasian Flyway for migratory waders. All the MNPs also include Special Protection Areas for Natural Values to protect wading bird habitat (Parks Victoria 2005; Parks Victoria 2007). In WP MNPs these areas include the saltmarsh and mangrove areas only, as well as an additional area around Barriallier Island in French Island MNP. All of Corner Inlet MNP, except Bennison Channel, is covered and the area is designated to protect seagrass as well as bird habitat. In the WP Special Protected Areas public access is prohibited including all vessels, except for launching from the unvegetated beach in Churchill Island MNP. In Corner Inlet MNP motorised vessels are encouraged to avoid the shallow and exposed intertidal areas for two hours either side of low tide. The three MNPs in WP are also part of the Mornington Peninsula and Western Port UNESCO Biosphere Reserve.

There are sites of regional geological significance in or near all MNPs in Western Port: a relict multiple curved sand spit at Bungower Point adjacent to Yaringa MNP; sand ridges that display relict geomorphological processes at Palmer Point and Barrallier Island in French Island MNP; and the active and reflective cliffs indicative of historically higher sea levels at Swan Corner in Churchill Island MNP. Areas of State-level significance are found at the north shore of French Island MNP, with one of the major aggregations of saltmarsh and mangrove in Victoria; the raised beach and emerged coastal forms between Chambers Point and Long Point in Churchill Island MNP are significant geological features; in Corner Inlet MNP the Chinaman Creek Delta provides a significant example of an active delta infilling a former embayment. Churchill Island MNP also has two regionally significant areas, the weathered granite shore platform and active granite sand spit development between Barry Hill and Bennison Point and the pool and channel drainage system of the tidal flats to the south of Bennison Island.

Important natural values of all four MNPs are sheltered intertidal mud and sand flats, seagrass beds and subtidal soft sediments in tidal channels. The MNPs are heavily influenced by tides that expose and submerge large expanses of mudflats and associated seagrass beds. French Island, Churchill Island and Corner Inlet MNPs all have sandy beaches and spits, and cobbly or gravelly intertidal and subtidal reefs, particularly around the islands in French Island and Corner Inlet MNPs. Solid subtidal reefs also occur in Corner Inlet MNP.

Saltmarsh (where present), mangrove, seagrass and mudflat habitats have been mapped within the four MNPs (Ball *et al.* 2010; Victorian Saltmarsh Study 2011). Small areas of saltmarsh communities are important in Yaringa, Churchill and Corner Inlet MNPs (Victorian Saltmarsh Study 2011). Yaringa MNP saltmarsh consists of at least five different saltmarsh communities dominated by *Tetricornia arbuscula* or *Gahnia filum.* Small patches of Wet Saltmarsh Herbland community with cover dominated by *Scarcocornia quinqueflora* occur in Churchill Island and Corner Inlet MNPs (Victorian Saltmarsh Study 2011). Specific studies of the flora and fauna of the saltmarsh habitats has not been undertaken in the MNPs, but they are considered breeding and nursery grounds for many organisms including microcrustacea, bivalves and fish.

Mangroves are important natural values of Yaringa and French Island MNPs, with small areas also found in Churchill Island and Corner Inlet MNPs (Victorian Saltmarsh Study 2011). The mangrove communities of Yaringa and Corner Inlet MNP are relatively inaccessible and undisturbed. Yaringa MNP has the most extensive area of mangroves in WP. The Mangrove Shrublands in all four MNPs consists of the white mangrove *Avicennia marina* subsp. *australasica,* the only species of mangrove in Victoria. *A. marina* is at the southern edge of its distribution in the MNPs and this is reflected in the short tree height although it grows up to 4.4 m tall in French Island MNP (Satumanatpan *et al.* 1999). In Churchill Island MNP the dominant epifaunal organism on the pneumatophores, the lower parts of mangrove trees and mangrove seedlings is the barnacle *Elminius covertus*, also common is the littorinid *Bembicium auratum* (Satumanatpan *et al.* 1999). The mangrove fringes of Churchill Island MNP are also inhabited by crabs and, at high tide, fish such as gobies, mullet and toadfish. Little specific information is known for the flora and fauna of the Mangrove Shrublands of the other MNPs.

An important natural value of Corner Inlet MNP is its extensive beds of seagrass *Posidonia australis*, the only ones in Victoria. Other seagrasses *Zostera muelleri, Heterozostera nicragulis* and *Halophila australis* are also important natural values in all four MNPs (Blake and Ball 2001; Ball *et al.* 2010). The short eelgrass *Zostera muelleri* tends to be the dominant intertidal seagrass in all four MNPs but is indistinguishable from long eelgrass *Heterozostera nigricaulis* in aerial mapping. *Zostera/Heterozostera* beds are extensive in French Island and Churchill Islands (Ball *et al.* 2010). Yaringa seagrass beds consist of sparse to medium density *Zostera/Heterozostera* with very little algae (Blake and Ball 2001). *Zostera/Heterozostera* occurs in both the north and southern sections of Corner Inlet MNP (Ball *et al.* 2010). It is sparse in the southern section and occurs in patches in the northern section. Common in the intertidal seagrass beds in French Island and Corner Inlet MNPs are the pulmonate gastropod family Amphibolidae, and pandalid and hippolytid shrimps (Ball *et al.* 2010). The Dialidae gastropods are also common in Corner Inlet MNP. The ghost shrimp *Biffarius arenosus* can be abundant in the intertidal mudflats of Yaringa and French Island MNPs (Butler and Bird 2010). Also common are the polychaete worms *Barantolla lepte* and *Lumbrineris* sp in Yaringa, French Island and Churchill Island MNPs. The sentinel crab *Macrophthalamus latifrons* is common in both Yaringa and Churchill Island MNP, along with the bivalve molluscs *Musculista senhousia* (introduced) in Yaringa MNP and *Tellina deltoids* in Churchill Island MNP. The crab *M. latifrons* and polychaete *Lumbrineris* sp. are not as common in French Island MNP compared to Yaringa MNP (Butler and Bird 2010). The horseshoe worm *Phoronopsis albomaculata* is common in Churchill Island MNP (Butler and Bird 2010). The intertidal soft sediments of Churchill Island have abundant microalgae growing on their surface. The assemblage structure of epifaunal communities in the intertidal seagrass beds in Corner Inlet MNP is determined more by tidal immersion and location than by seagrass species and physical structure (Ball *et al.* 2010). Intertidal cobbly reef occurs in three of these MNPs but there is no information on its fauna or fauna.

Subtidal habitat in all four MNPs is a mix of channels and flats. Yaringa MNP has moderately deep channels that drain the intertidal mud flats. French Island MNP has tidal channels of varying depth, profiles and orientations. Subtidal flats and shallow channels dominate Churchill Island MNP. The northern section of Corner Inlet MNP is shallow subtidal flats and channels with some deep subtidal channels. The dendritic networks of subtidal channels in the MNPs provide a habitat for a range of fish and invertebrate species including a high abundance of the seapen *Sarcoptilus grandis* and the brachiopod lamp shell *Magellania flavescens* in French Island and Churchill Island MNPs (Parks Victoria 2007). It is also an important habitat for the brooch shell *Neotrigonia margaritacea* and the mud ark *Anadara trapezia* in French Island MNP (Parks Victoria 2007). Subtidal habitat in the MNPs can be seagrass beds or bare sediment, channels are often bare (Blake and Ball 2001; Ball *et al.* 2010). Extensive subtidal *Heterozostera nigricaulis* beds are found in French Island and Corner Inlet MNPs (Ball *et al.* 2010). The northern section of Corner Inlet MNP is characterised by extensive *Posidonia australia* beds. Patches of the paddleweed *Halophila australis* grow in French Island and Corner Inlet MNP. Approximately a third of French Island MNP, predominantly in the north west, is covered by beds of unidentified algae, which also grows in amongst seagrass (Ball *et al.* 2010). Churchill MNP subtidal flats have dense beds of *Zostera/Heterozostera* and algae (Blake and Ball 2001).

Subtidal seagrass generally supports much higher densities of invertebrates than intertidal seagrass beds (Ball *et al.* 2010). Dialids, mysid shrimps and dexaminid amphipods are at much higher densities in the subtidal seagrass than in the intertidal seagrass in French

Island (Ball *et al.* 2010). Mysids are the most abundant invertebrate in the *P. australis* beds in Corner Inlet (Ball *et al.* 2010). Also abundant are shrimps from the Pandalidae and Hippolytidae families, amphipods from the Dexaminidae and Corophiidae families and top shells from the family Trochidae (Ball *et al.* 2010).

Subtidal seagrass beds are important fish habitats. In Yaringa MNP they are an important habitat of yelloweye mullet *Aldrichetta forsteri* and smooth toadfish *Tetractenos glaber,* which are abundant, along with common galaxid *Galaxias maculatus*, short fin eel *Anguilla australis*, tupong *Pseudaphritis urvillii,* gobies, bridled *Arenigobius bifrenatus,* eastern blue spot *Pseudogobius* and glass *Gobiopterus semivestitus* (Warry and Reich 2010). Specific fish surveys have not been done in the other MNPs but the seagrass beds are regarded as important nursery areas for many fish, leatherjackets, conservation listed syngnathids (seahorses and pipefish) and small juvenile fish. Rock flathead *Platycephalus laevigatus* and juvenile whiting *Sillaginodes punctata* are also associated with seagrass beds in French Island and Corner Inlet MNPs (Ball *et al.* 2010). Fish associated with the subtidal sediments and in the channels, include stingrays, perch, flathead, and gobies (Parks Victoria 2005; Parks Victoria 2007).

The sediment in the deeper channels tends to be coarse because of the strong currents and has a different fauna than the shallow mudflats. Gastropods, sea stars, urchins and ascidians are often found on the surface of the channel sediment in Corner Inlet MNP (Parks Victoria 2005). Subtidal cobbly reef occurs around the islands in French Island and Corner Inlet MNP. Sections of deep, continuous, subtidal reef are found along the shore of Bennison Channel in the northern section of Corner Inlet MNP. Specific surveys of subtidal reef flora or fauna are lacking in the MNPs.

Tidally-exposed flats and seagrass beds provide a foraging habitat for migratory waders and the surrounding saltmarsh and mangroves as well as exposed spits and beaches provide roosting areas. The four MNPs provide important habitat for conservation listed birds, for 39 to 41 species in the WP MNPs and 24 species in Corner Inlet MNP. All four MNPs are important for the critically endangered orange-bellied parrot *Neophema chrysogaster* listed under the *Flora and Fauna Guarantee* (*FFG*) Act (1998)*.* All three WP MNPs are also important for the critically endangered grey-tailed tattler *Heteroscelus brevipes* and the intermediate egret *Ardea intermedia*. All four MNPs protect feeding areas of internationally important migrant species protected under Australia Migratory Bird Agreements with either China (CAMBA) or Japan (JAMBA). In WP, the MNPs protect the feeding areas of 27 to 29 species of migratory birds, and 14 species in Corner Inlet MNP. Potentially 32 to 40 species of marine flora and fauna could be at their distributional limits within the three WP MNPs, and ten in Corner Inlet MNP.

Threats to the MNPs can come from limited ecological knowledge of important processes including hydrology, and slow social change leading to inadequate management (Carey *et al.* 2007b). All four MNPs are threatened by increased sediment and nutrient inputs from their catchments, invasive marine pests, marine pollution and climate change. In addition Yaringa and French Island MNPs natural values are threatened by coastal erosion, litter, increasing urbanisation and vessels disturbing shorebirds. In Churchill Island MNP human disturbance and fox predation are seen as serious threats to shore birds. The impact of seawalls and dredging outside Corner Inlet MNP are seen as threats to natural values within the MNP, along with propeller scour occurring in the MNP. Measures to address or minimise these threats form part of the management plans for these MNPs. Specific research aims to increase ecological knowledge about the natural values of, and threats to the MNPs.

Parks Victoria has established research programs for the MPAs that address important management challenges, focussing both on improving baseline knowledge of the MPAs as well as applied management questions not being addressed by others. This knowledge will continue to enhance Parks Victoria's capacity to implement evidence-based management through addressing critical knowledge gaps. The research program has been guided by the research themes outlined as part of Parks Victoria's Research Partners Panel (RPP) program, a Marine Research and Monitoring Strategy 2007-2012 and Marine National Park and Marine Sanctuary Monitoring Plan 2007-2012 (Power and Boxshall 2007). Much of the research has been undertaken as part of the RPP program involving collaboration with various research institutions. Seagrass monitoring in Corner Inlet has been undertaken as part of community based Sea Search monitoring program. Statewide projects are currently underway to photograph and document their marine natural values, to determine which MPAs are most at risk from introduced species and to detect poaching.

Most of our detailed knowledge about the flora and fauna (Figure 65) of the MPAs is from specific research projects and the level of detail is not consistent or wide spread across all four MNPs. Surveys of the fauna of mangrove habitats has not been undertaken. Algae on soft sediments or associated with seagrass beds have not been described for the MNPs. Surveys of seagrass fauna have not been undertaken in either Yaringa MNP or Churchill Island MNP. Intertidal soft sediment macroinvertebrates have been surveyed in the WP MNPs but not in Corner Inlet MNP. Subtidal soft sediment fauna has not been specifically surveyed, both on the flats and in the channels in all four MNPs. Flora and fauna of the cobbly/gravelly reefs in most of the MPAs and the continuous, deeper reef of Corner Inlet MNP have not been surveyed. Specific knowledge of fish in the MNPs is limited except for Yaringa MNP. A major gap in our understanding of the natural values of Victorian Embayments MPAs as a whole is the lack of knowledge about the habitat values and species associated with soft sediment seafloors and open waters. Whilst some threats to the MPAs have been identified we have limited knowledge of the effect of those threats on the natural values.

**Figure 65**. Sea urchin *Heliocidaris erythrogramma* in Corner Inlet Marine National Park. Photo by Julian Finn, Museum of Victoria.

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# APPENDIX 1

Compilation of species from databases from:

- the Atlas of Victorian Wildlife (Fauna 100, records within 5km of all MPAs, excluding terrestrial areas)
- the first Marine Natural Values reports; (MAFRI MNV v1, all MPAs, Westernport MPAs not individually identified);
- MAVRIC (Monitoring and Assessment of Victoria's Rocky Intertidal Coast – Corner Inlet MNP only);
- PV intertidal reef monitoring program (IRMP 02-04 none sampled);
- PV subtidal reef monitoring program (SRMP_All, none sampled); and
- The Seasearch volunteer monitoring program (none sampled).

Summary of number of species listed by data source and MPA:

| Source | **Habitat(s)** | **WPB MPAs (unspecified)** | **French Island MNP** | **Yaringa MNP** | **Churchill Island MNP** | **Corner Inlet MNP** |
|---|---|---|---|---|---|---|
| Fauna100_5kmSea | All | | 67 | 67 | 82 | 47 |
| MAFRI distribution MNV v1 | All | 69 | | | | 11 |
| MAFRI endemic MNV v1 | All | 4 | | | | 1 |
| MAVRIC | Rocky Intertidal | | | | | 26 |

A “1” in the respective column indicates a record from that MPA. Some species listed in the body of the report above were not included in these datasets at the time of compilation. WPB N/S – Westernport Bay, MNP Not Specified; Yar –Yaringa MNP; FI – French Island MNP; ChI – Churchill Island MNP; CIn – Corner Inlet MNP.

| | | | | WPB | | | | |
|---|---|---|---|---|---|---|---|---|
| **Biotic group** | **Family** | **Species** | **Common Name** | **N/S** | **Yar** | **FI** | **Ch I** | **C In** |
| **Yellow-green algae** | Vaucheriaceae | *Vaucheria glomerata* | Blue-green alga | 1 | | | | |
| **Total yellow-green algae** | | | | **1** | **0** | **0** | **0** | **0** |
| **Green algae** | Caulerpaceae | *Caulerpa remotifolia* | Green alga | 1 | | | | |
| | Codiaceae | *Codium fragile* | Dead man's fingers | | | | | 1 |
| **Total green algae** | | | | **1** | **0** | **0** | **0** | **1** |
| **Brown algae** | Cystoseiraceae | *Myriodesma integrofolium* | Brown alga | 1 | | | | |
| | Dictyotaceae | *Dictyota furcellata* | Brown alga | 1 | | | | |
| | | *Dilophus gunnianus* | Brown alga | 1 | | | | |
| | | *Distromium multifidum* | Brown alga | 1 | | | | |
| | Ectocarpaceae | *Ectocarpus fasciculatus* | Brown alga | | | | | 1 |
| | Fucaceae | *Xiphophora gladiata* | Brown alga | 1 | | | | |
| | Hormosiraceae | *Hormosira banksii* | Neptune's necklace | | | | | 1 |
| | Sargassaceae | *Sargassum paradoxum* | Brown alga | 1 | | | | |
| | Sphacelariaceae | *Sphacelaria carpoglossi* | Brown alga | 1 | | | | |
| **Total brown algae** | | | | **7** | **0** | **0** | **0** | **2** |
| **Red algae** | Areschougiaceae | *Tikvahiella candida* | Red alga | 1 | | | | |
| | Bangiaceae | *Porphyra lucasii* | Red alga | 1 | | | | |
| | Ceramiaceae | *Anotrichium elongatum* | Red alga | 1 | | | | |
| | | *Anotrichium licmophorum* | Red alga | 1 | | | | |
| | | *Antithamnion delicatulum* | Red alga | 1 | | | | |
| | | *Ballia marina* | Red alga | 1 | | | | |
| | | *Bornetia binderiana* | Red alga | 1 | | | | |
| | | *Callithamnion violaceum* | Red alga | 1 | | | | |
| | | *Ceramium excellens* | Red alga | 1 | | | | |

| Biotic group | Family | Species | Common Name | WPB N/S | Yar | Fl | Ch I | C In |
|---|---|---|---|---|---|---|---|---|
| | | *Crouania shepleyana* | Red alga | 1 | | | | |
| | | *Dasythamniella latissima* | Red alga | 1 | | | | |
| | | *Gattya pinnella* | Red alga | 1 | | | | |
| | | *Gulsonia annulata* | Red alga | 1 | | | | |
| | | *Macrothamnion pectenellum* | Red alga | 1 | | | | |
| | | *Mazoyerella australis* | Red alga | 1 | | | | |
| | | *Medeiothamnion halurus* | Red alga | 1 | | | | |
| | | *Medeiothamnion protensum* | Red alga | 1 | | | | |
| | | *Shepleya verticillata* | Red alga | 1 | | | | |
| | | *Spongoclonium australicum* | Red alga | 1 | | | | |
| | | *Spyridia tasmanica* | Red alga | 1 | | | | |
| | | *Lithothamnion indicum* | Red alga | | | | | 1 |
| | | *Lithothamnion muelleri* | Red alga | | | | | 1 |
| | | *Spongites hyperellus* | Red alga | 1 | | | | |
| | Dasyaceae | *Dasya cresens* | Red alga | 1 | | | | |
| | | *Dasya hookeri* | Red alga | 1 | | | | |
| | | *Dasya wilsonis* | Red alga | 1 | | | | |
| | Halymeniaceae | *Cryptonemia undulata* | Red alga | 1 | | | | |
| | Hypneaceae | *Hypnea valentiae* | Red alga | 1 | | | | |
| | Kallymeniaceae | *Austrophyllis alcicornis* | Red alga | 1 | | | | |
| | | *Kallymenia tasmanica* | Red alga | 1 | | | | |
| | Lomentariaceae | *Semnocarpa corynephora* | Red alga | 1 | | | | |
| | Rhodymeniaceae | *Gloiocladia fruticulosa* | Red alga | 1 | | | | |
| | | *Gloiocladia polycarpa* | Red alga | 1 | | | | |
| | | *Rhodymeniocolax austrina* | Red alga | 1 | | | | |
| **Total red algae** | | | | **32** | **0** | **0** | **0** | **2** |
| **Cnidaria** | Actiniidae | *Actinia tenebrosa* | Anemone | | | | | 1 |
| | | *Aulactinia veratra* | Anemone | | | | | 1 |

| Biotic group | Family | Species | Common Name | N/S | WPB<br>Yar | FI | Ch I | C In |
|---|---|---|---|---|---|---|---|---|
| | Tubulariidae | *Ralpharia coccinea* | Hydroid | | 1 | | | |
| **Total cnidarians** | | | | **0** | **1** | **0** | **0** | **2** |
| **Polychaetes** | Serpulidae | *Galeolaria caespitosa* | Tubeworm | | | | | 1 |
| **Total polychaetes** | | | | **0** | **0** | **0** | **0** | **1** |
| **Barnacles** | Chthamalidae | *Chthamalus antennatus* | Acorn barnacle | | | | | 1 |
| | Iblidae | *Ibla quadrivalvis* | Goose barnacle | | | | | 1 |
| | Tetraclitidae | *Tetraclitella purpurascens* | Acorn barnacle | | | | | 1 |
| **Total barnacles** | | | | **0** | **0** | **0** | **0** | **3** |
| **Decapod crustaceans** | Alpheidae | *Alpheus astrinx* | Snapping shrimp | 1 | | | | |
| | Callianassidae | *Eucalliax tooradin* | Ghost shrimp | 1 | | | | |
| | Crangonidae | *Philocheras victoriensis* | Shrimp | | | | | 1 |
| | Dromiidae | *Epipedodromia thomsoni* | Flat sponge-crab | 1 | | | | |
| | Goneplacidae | *Litocheira bispinosa* | Two-spined slender-clawed crab | | | | | 1 |
| | Hymenosomatidae | *Trigonoplax longirostris* | Spider crab | 1 | | | | |
| | Laomediidae | *Laomedia healyi* | Pink mangrove lobster | 1 | | | | |
| | Majidae | *Anacinetops stimpsoni* | Spider crab | 1 | | | | |
| | | *Huenia halei* | Spider crab | 1 | | | | |
| | Penaeidae | *Penaeus latisulcatus* | Western king prawn | 1 | | | | |
| | Xanthidae | *Megametope rotundifrons* | Smooth Forehead crab | | | | | 1 |
| **Total decapod crustaceans** | | | | **8** | **0** | **0** | **0** | **3** |
| **Chitons** | Lepidopleuridae | *Leptochiton liratus* | Chiton | 1 | | | | |
| **Total chitons** | | | | **1** | **0** | **0** | **0** | **0** |
| **Gastropods** | Buccinidae | *Cominella eburnea* | Whelk | | | | | 1 |
| | | *Cominella lineolata* | Whelk | | | | | 1 |
| | Calyptraeidae | *Cheilea flindersi* | Slipper shell | 1 | | | | |
| | Cancellariidae | *Nevia spirata* | Nutmeg snail | 1 | | | | |
| | | *Sydaphera lactea* | Nutmeg snail | 1 | | | | |

| Biotic group | Family | Species | Common Name | WPB N/S | Yar | FI | Ch I | C In |
|---|---|---|---|---|---|---|---|---|
| | | *Sydaphera purpuriformis* | Nutmeg snail | 1 | | | | |
| | Cerithiopsidae | *Zaclys angasi* | Gastropod | 1 | | | | |
| | Columbellidae | *Aesopus plurisulcatus* | Dove shell | 1 | | | | |
| | | *Anachis smithi* | Dove shell | 1 | | | | |
| | Eatoniellidae | *Eatoniella victoriae* | Gastropod | 1 | | | | |
| | Epigridae | *Epigrus apicilata* | Gastropod | 1 | | | | |
| | Epitoniidae | *Epitonium platypleura* | Gastropod | 1 | | | | |
| | Littorinidae | *Austrolittorina unifasciata* | Periwinkle | | | | | 1 |
| | | *Bembicium melanostoma* | Periwinkle | | | | | 1 |
| | | *Bembicium nanum* | Periwinkle | | | | | 1 |
| | Muricidae | *Lepsiella reticulata* | Gastropod | | | | | 1 |
| | | *Lepsiella vinosa* | Gastropod | | | | | 1 |
| | Neritidae | *Nerita atramentosa* | Nerite | | | | | 1 |
| | | *Nerita morio* | Nerite | | | | | 1 |
| | Olividae | *Zemira australis* | Gastropod | 1 | | | | |
| | Onchidiidae | *Onchidella patelloides* | Pulmonate sea slug | | | | | 1 |
| | Siphonariidae | *Siphonaria diemenensis* | Pulmonate limpet | | | | | 1 |
| | | *Siphonaria funiculata* | Pulmonate limpet | | | | | 1 |
| | Skeneidae | *Cirsonella microscopia* | Gastropod | 1 | | | | |
| | Trochidae | *Austrocochlea porcata* | Top shell | | | | | 1 |
| | | *Chlorodiloma adelaidae* | Top shell | | | | | 1 |
| | | *Chlorodiloma odontis* | Top shell | | | | | 1 |
| | | *Diloma concamerata* | Wavy top shell | | | | | 1 |
| | Turridae | *Austrodrillia angasi* | Gastropod | 1 | | | | |
| | Vermetidae | *Serpulorbis hedleyi* | Worm Shells | 1 | | | | |
| **Total gastropods** | | | | **14** | **0** | **0** | **0** | **16** |
| **Bivalves** | Galeommatidae | *Mysella dromanaensis* | Bivalve | 1 | | | | |
| | Ostreidae | *Saccostrea glomerata* | Sydney Rock Oyster | | | | | 1 |

| Biotic group | Family | Species | Common Name | WPB<br>N/S | Yar | FI | Ch I | C In |
|---|---|---|---|---|---|---|---|---|
| **Total bivalves** | | | | **1** | **0** | **0** | **0** | **1** |
| **Sea slugs** | Discodorididae | *Platydoris galbana* | Nudibranch | | | | 1 | |
| | Rhodopidae | *Rhodope* sp. | Nudibranch | | | | 1 | |
| **Total sea slugs** | | | | **0** | **0** | **0** | **2** | **0** |
| **Echinoderms** | Amphiuridae | *Amphiura trisacantha* | Brittle Star | | | 1 | | 1 |
| | Caudinidae | *Paracaudina australis* | Sea Cucumber | | | | | 1 |
| | Chiridotidae | *Trochodota shepherdi* | Sea Cucumber | | | | | 1 |
| | Ophiocomidae | *Ophiocomina australis* | Brittle Star | | | | | 1 |
| | Phyllophoridae | *Lipotrapeza ventripes* | Sea Cucumber | 1 | | | | |
| **Total echinoderms** | | | | **1** | **0** | **1** | **0** | **4** |
| **Ascidian** | Pyuridae | *Pyura stolonifera* | Cunjevoi | | | | | 1 |
| **Total ascidians** | | | | **0** | **0** | **0** | **0** | **1** |
| **Fish** | Antennariidae | *Echinophryne reynoldsi* | Sponge Anglerfish | 1 | | | | |
| | Atherinidae | *Kestratherina esox* | Pikehead Hardyhead | 1 | | | | |
| | Gobiidae | *Arenigobius frenatus* | Halfbridled Goby | 1 | | | | |
| | Scyliorhinidae | *Asymbolus analis* | Grey Spotted Catshark | 1 | | | | |
| | Sillaginidae | *Sillago bassensis* | Southern School Whiting | 1 | | | | |
| | Tetraodontidae | *Contusus richei* | Barred Toadfish | | | | | 1 |
| | Tripterygiidae | *Lepidoblennius haplodactylus* | Eastern Jumping Blenny | 1 | | | | |
| **Total fish** | | | | **6** | **0** | **0** | **0** | **1** |
| **Birds** | Accipitridae | *Haliaeetus leucogaster* | White-bellied Sea-Eagle | | 1 | 1 | 1 | 1 |
| | Anatidae | *Cygnus atratus* | Black Swan | | 1 | 1 | 1 | 1 |
| | Anhingidae | *Anhinga novaehollandiae* | Australasian Darter | | 1 | | | |
| | Ardeidae | *Ardea ibis* | Cattle Egret | | 1 | 1 | | 1 |
| | | *Ardea intermedia* | Intermediate Egret | | 1 | 1 | | |
| | | *Ardea modesta* | Eastern Great Egret | | 1 | 1 | 1 | 1 |
| | | *Ardea pacifica* | White-necked Heron | | 1 | 1 | | 1 |

| Biotic group | Family | Species | Common Name | N/S | WPB<br>Yar | Fl | Ch I | C In |
|---|---|---|---|---|---|---|---|---|
| | | *Botaurus poiciloptilus* | Australasian Bittern | | 1 | | | |
| | | *Nycticorax caledonicus* | Nankeen Night Heron | | 1 | 1 | 1 | |
| | Charadriidae | *Charadrius bicinctus* | Double-banded Plover | | 1 | 1 | 1 | 1 |
| | | *Charadrius leschenaultii* | Greater Sand Plover | | | 1 | | |
| | | *Charadrius mongolus* | Lesser Sand Plover | | 1 | 1 | | |
| | | *Charadrius ruficapillus* | Red-capped Plover | | 1 | 1 | 1 | 1 |
| | | *Elseyornis melanops* | Black-fronted Dotterel | | 1 | 1 | 1 | |
| | | *Erythrogonys cinctus* | Red-kneed Dotterel | | 1 | 1 | | |
| | | *Pluvialis fulva* | Pacific Golden Plover | | 1 | 1 | 1 | |
| | | *Pluvialis squatarola* | Grey Plover | | 1 | 1 | | |
| | | *Thinornis rubricollis* | Hooded Plover | | | | 1 | 1 |
| | | *Vanellus miles* | Masked Lapwing | | 1 | 1 | 1 | 1 |
| | Ciconiiformes | *Egretta garzetta* | Little Egret | | 1 | 1 | 1 | 1 |
| | | *Egretta novaehollandiae* | White-faced Heron | | 1 | 1 | 1 | 1 |
| | Diomedeidae | *Thalassarche cauta* | Shy Albatross | | | | 1 | |
| | | *Thalassarche chlororhynchos* | Yellow-nosed Albatross | | | | 1 | |
| | | *Thalassarche melanophris* | Black-browed Albatross | | | | 1 | |
| | Haematopodidae | *Haematopus fuliginosus* | Sooty Oystercatcher | | 1 | 1 | 1 | 1 |
| | | *Haematopus longirostris* | Pied Oystercatcher | | 1 | 1 | 1 | 1 |
| | Laridae | *Chlidonias hybridus* | Whiskered Tern | | | 1 | | |
| | | *Chlidonias leucopterus* | White-winged Black Tern | | 1 | | | |
| | | *Chroicocephalus novaehollandiae* | Silver Gull | | 1 | 1 | 1 | 1 |
| | | *Gelochelidon nilotica* | Gull-billed Tern | | | 1 | | 1 |
| | | *Hydroprogne caspia* | Caspian Tern | | 1 | 1 | 1 | 1 |
| | | *Larus dominicanus* | Kelp Gull | | | | 1 | |
| | | *Larus pacificus* | Pacific Gull | | 1 | 1 | 1 | 1 |
| | | *Sterna bergii* | Crested Tern | | 1 | 1 | 1 | 1 |
| | | *Sterna hirundo* | Common Tern | | 1 | 1 | 1 | |

| Biotic group | Family | Species | Common Name | N/S | WPB<br>Yar | Fl | Ch I | C In |
|---|---|---|---|---|---|---|---|---|
| | | *Sternula albifrons* | Little Tern | | 1 | 1 | 1 | |
| | | *Sternula nereis* | Fairy Tern | | 1 | 1 | 1 | 1 |
| | Meliphagidae | *Epthianura albifrons* | White fronted Chat | | 1 | 1 | 1 | 1 |
| | Pelecanidae | *Pelecanus conspicillatus* | Australian Pelican | | 1 | 1 | 1 | 1 |
| | Phalacrocoracidae | *Microcarbo melanoleucos* | Little Pied Cormorant | | 1 | 1 | 1 | 1 |
| | | *Phalacrocorax carbo* | Great Cormorant | | 1 | 1 | 1 | 1 |
| | | *Phalacrocorax fuscescens* | Black-faced Cormorant | | 1 | | 1 | 1 |
| | | *Phalacrocorax sulcirostris* | Little Black Cormorant | | 1 | 1 | 1 | 1 |
| | | *Phalacrocorax varius* | Pied Cormorant | | 1 | 1 | 1 | 1 |
| | Podicipedidae | *Podiceps cristatus* | Grest Crested Grebe | | | 1 | | |
| | | *Poliocephalus poliocephalus* | Hoary-headed Grebe | | 1 | 1 | 1 | 1 |
| | Procellariidae | *Aphrodroma brevirostris* | Kerguelen Petrel | | | | 1 | |
| | | *Ardenna carneipes* | Flesh-footed Shearwater | | | | 1 | |
| | | *Ardenna tenuirostris* | Short-tailed Shearwater | | 1 | 1 | 1 | 1 |
| | | *Fulmarus glacialoides* | Southern Fulmar | | 1 | | 1 | |
| | | *Halobaena caerulea* | Blue Petrel | | | | 1 | |
| | | *Macronectes giganteus* | SouthernGiant-Petrel | | | | 1 | |
| | | *Macronectes halli* | Northern Giant Petrel | | | | 1 | |
| | | *Pachyptila belcheri* | Slender-billed Prion | | | | 1 | |
| | | *Pachyptila desolata* | Antarctic Prion | | | | 1 | |
| | | *Pachyptila turtur* | Fairy Prion | | | | 1 | 1 |
| | | *Pelecanoides urinatrix* | Common Diving-petrel | | | | 1 | |
| | | *Pterodroma macroptera* | Great-winged Petrel | | | | 1 | |
| | Psittacidae | *Neophema chrysogaster* | Orange-bellied Parrot | | 1 | 1 | 1 | 1 |
| | | *Neophema chrysostoma* | Blue-winged Parrot | | 1 | 1 | 1 | |
| | Rallidae | *Fulica atra* | Eurasian Coot | | 1 | 1 | 1 | |
| | | *Gallirallus philippensis* | Buff-banded Rail | | | | 1 | |
| | | *Porzana fluminea* | Australian Spotted Crake | | 1 | 1 | 1 | |

| Biotic group | Family | Species | Common Name | N/S | WPB<br>Yar | Fl | Ch I | C In |
|---|---|---|---|---|---|---|---|---|
| | | *Porzana pusilla* | Baillon's Crake | | 1 | 1 | | |
| | Recurvirostridae | *Himantopus himantopus* | Black-winged Stilt | | 1 | 1 | 1 | |
| | | *Recurvirostra novaehollandiae* | Red-necked Avocet | | | 1 | | |
| | Scolopacidae | *Actitis hypoleucos* | Common Sandpiper | | 1 | 1 | 1 | |
| | | *Arenaria interpres* | Ruddy Turnstone | | 1 | 1 | 1 | |
| | | *Calidris acuminata* | Sharp-tailed Sandpiper | | 1 | 1 | 1 | 1 |
| | | *Calidris canutus* | Red Knot | | 1 | 1 | 1 | 1 |
| | | *Calidris ferruginea* | Curlew Sandpiper | | 1 | 1 | 1 | 1 |
| | | *Calidris ruficollis* | Red-necked Stint | | 1 | 1 | 1 | 1 |
| | | *Calidris tenuirostris* | Great Knot | | 1 | 1 | 1 | |
| | | *Gallinago hardwickii* | Latham's snipe | | 1 | 1 | 1 | |
| | | *Heteroscelus brevipes* | Grey-tailed Tattler | | 1 | 1 | 1 | |
| | | *Limosa lapponica* | Bar-tailed Godwit | | 1 | 1 | 1 | 1 |
| | | *Limosa limosa* | Black-tailed Godwit | | 1 | 1 | | 1 |
| | | *Numenius madagascariensis* | Eastern Curlew | | 1 | 1 | 1 | 1 |
| | | *Numenius phaeopus* | Whimbrel | | 1 | 1 | 1 | |
| | | *Tringa nebularia* | Common Greenshank | | 1 | 1 | 1 | 1 |
| | | *Tringa stagnatilis* | Marsh Sandpiper | | | | 1 | |
| | | *Xenus cinereus* | Terek Sandpiper | | 1 | 1 | | |
| | Spheniscidae | *Eudyptes chrysocome* | Western Rockhopper Penguin | | | | 1 | |
| | | *Eudyptula minor* | Little Penguin | | 1 | 1 | 1 | 1 |
| | Stercorcariidae | *Stercorarius parasiticus* | Arctic Jaeger | | 1 | 1 | 1 | |
| | | *Stercorarius skua* | Great Skua | | | | | 1 |
| | Sulidae | *Morus serrator* | Australasian Gannet | | 1 | 1 | 1 | 1 |
| | Threskiornithidae | *Platalea regia* | Royal Spoonbill | | 1 | 1 | 1 | 1 |
| | | *Plegadis falcinellus* | Glossy Ibis | | | 1 | | |
| | | *Threskiornis molucca* | White Ibis | | 1 | 1 | 1 | 1 |
| **Total birds** | | | | **0** | **65** | **66** | **71** | **43** |

| Biotic group | Family | Species | Common Name | N/S | Yar | FI | Ch I | C In |
|---|---|---|---|---|---|---|---|---|
| | | | | | WPB | | | |
| **Mammals** | Balaenidae | *Eubalaena australis* | Southern Right Whale | | | | 1 | 1 |
| | Balaenopteridae | *Megaptera novaeangliae* | Humpback Whale | | 1 | | 1 | 1 |
| | Delphinidae | *Delphinus delphis* | Common Dolphin | | | | 1 | 1 |
| | | *Tursiops truncatus* | Bottlenose Dolphin | | | | 1 | |
| | Otariidae | *Arctocephalus pusillus* | Australian Fur-seal | | | | 1 | |
| | | *Neophoca cinerea* | Australian Sea Lion | | | | 1 | |
| | Phocidae | *Hydrurga leptonyx* | Leopard Seal | | | | 1 | 1 |
| | Physeteridae | *Kogia breviceps* | Pygmy Sperm Whale | | | | 1 | |
| | | *Physeter macrocephalus* | Sperm Whale | | | | 1 | |
| **Total mammals** | | | | **0** | **1** | **0** | **9** | **4** |

# APPENDIX 2

Species reported to be at their distributional limit in Western Port (O'Hara and Barmby 2000; O'Hara and Poore 2000; O'Hara 2002).

| Phylum | Order | Family | Species | Common name | Category |
|---|---|---|---|---|---|
| Chrysophyta | Vaucheriales | Vaucheriaceae | *Vaucheria glomerata* | blue green algae | RE* |
| Chlorophyta | Caulerpales | Caulerpaceae | *Caulerpa remotifolia* | green algae | RE* |
| Phaeophyta | Dictyotales | Dictyotaceae | *Dictyota furcellata* | brown algae | PE* |
| Phaeophyta | Dictyotales | Dictyotaceae | *Dilophus gunnianus* | brown algae | PE* |
| Phaeophyta | Dictyotales | Dictyotaceae | *Distromium multifidum* | brown algae | PE |
| Phaeophyta | Fucales | Cystoseiraceae | *Myriodesma integrofolium* | brown algae | PE |
| Phaeophyta | Fucales | Sargassaceae | *Sargassum paradoxum* | brown algae | PE* |
| Phaeophyta | Sphacelariales | Sphacelariaceae | *Sphacelaria carpoglossi* | brown algae | PE |
| Phaeophyta | Fucales | Fucaceae | *Xiphophora gladiata* | brown algae | PN |
| Rhodophyta | Ceramiales | Ceramiaceae | *Antithamnion delicatulum* | red algae | RE* |
| Rhodophyta | Ceramiales | Ceramiaceae | *Crouania shepleyana* | red algae | RE* |
| Rhodophyta | Ceramiales | Ceramiaceae | *Dasythamniella latissima* | red algae | RE* |
| Rhodophyta | Ceramiales | Ceramiaceae | *Macrothamnion pectenellum* | red algae | RE* |
| Rhodophyta | Ceramiales | Ceramiaceae | *Mazoyerella australis* | red algae | RE* |
| Rhodophyta | Ceramiales | Ceramiaceae | *Medeiothamnion protensum* | red algae | RE* |
| Rhodophyta | Ceramiales | Ceramiaceae | *Spongoclonium australicum* | red algae | RE* |
| Rhodophyta | Ceramiales | Ceramiaceae | *Spyridia tasmanica* | red algae | RE* |
| Rhodophyta | Ceramiales | Dasyaceae | *Dasya cresens* | red algae | RE |
| Rhodophyta | Ceramiales | Dasyaceae | *Dasya hookeri* | red algae | RE* |
| Rhodophyta | Gigartinales | Hypneaceae | *Hypnea valentiae* | red algae | RE* |
| Rhodophyta | Rhodymeniales | Rhodymeniaceae | *Gloiocladia fruticulosa* | red algae | RE* |
| Rhodophyta | Rhodymeniales | Rhodymeniaceae | *Rhodymeniocolax austrina* | red algae | RE* |
| Rhodophyta | Corallinales | Corallinaceae | *Spongites hyperellus* | red algae | PW* |
| Rhodophyta | Bagiales | Bangiaceae | *Porphyra lucasii* | red algae | PE* |
| Rhodophyta | Ceramiales | Ceramiaceae | *Anotrichium elongatum* | red algae | PE |
| Rhodophyta | Ceramiales | Ceramiaceae | *Anotrichium licmophorum* | red algae | PE |
| Rhodophyta | Ceramiales | Ceramiaceae | *Ballia marina* | red algae | PE |
| Rhodophyta | Ceramiales | Ceramiaceae | *Bornetia binderiana* | red algae | PE |
| Rhodophyta | Ceramiales | Ceramiaceae | *Callithamnion violaceum* | red algae | PE |
| Rhodophyta | Ceramiales | Ceramiaceae | *Ceramium excellens* | red algae | PE |
| Rhodophyta | Ceramiales | Ceramiaceae | *Gattya pinnella* | red algae | PE* |
| Rhodophyta | Ceramiales | Ceramiaceae | *Gulsonia annulata* | red algae | PE |
| Rhodophyta | Ceramiales | Ceramiaceae | *Medeiothamnion halurus* | red algae | PE |
| Rhodophyta | Ceramiales | Ceramiaceae | *Shepleya verticillata* | red algae | PE |
| Rhodophyta | Ceramiales | Dasyaceae | *Dasya wilsonis* | red algae | PE |
| Rhodophyta | Gigartinales | Areschougiaceae | *Tikvahiella candida* | red algae | PE* |
| Rhodophyta | Gigartinales | Halymeniaceae | *Cryptonemia undulata* | red algae | PE* |

| | | | | | |
|---|---|---|---|---|---|
| Rhodophyta | Gigartinales | Kallymeniaceae | *Austrophyllis alcicornis* | red algae | PE* |
| Rhodophyta | Gigartinales | Kallymeniaceae | *Kallymenia tasmanica* | red algae | PE* |
| Rhodophyta | Rhodymeniales | Lomentariaceae | *Semnocarpa corynephora* | red algae | PE |
| Rhodophyta | Rhodymeniales | Rhodymeniaceae | *Gloiocladia polycarpa* | red algae | PE |
| Crustacea | Dendrobranchiata | Penaeidae | *Penaeus latisulcatus* | prawn | PW |
| Crustacea | Thalassinidea | Laomediidae | *Laomedia healyi* | ghost shrimp | PW |
| Crustacea | Thalassinidea | Callianassidae | *Eucalliax tooradin* | ghost shrimp | PE |
| Crustacea | Brachyura | Majidae | *Anacinetops stimpsoni* | shaggy seaweed crab | RE |
| Crustacea | Brachyura | Dromiidae | *Epipedodromia thomsoni* | sponge crab | PE |
| Crustacea | Brachyura | Hymenosomatidae | *Trigonoplax longirostris* | crab | PE |
| Crustacea | Brachyura | Majidae | *Huenia halei* | crab | PE |
| Crustacea | Caridea | Alpheidae | *Alpheus astrinx* | narrow snapping shrimp | RE |
| Mollusca | Gastropoda | Columbellidae | *Aesopus plurisulcatus* | marine snail | PW |
| Mollusca | Gastropoda | Columbellidae | *Anachis smithi* | marine snail | PW |
| Mollusca | Gastropoda | Olividae | *Zemira australis* | marine snail | PW |
| Mollusca | Gastropoda | Turridae | *Austrodrillia angasi* | marine snail | PW |
| Mollusca | Gastropoda | Vermetidae | *Serpulorbis hedleyi* | marine snail | PW |
| Mollusca | Gastropoda | Calyptraeidae | *Cheilea flindersi* | marine snail | PE |
| Mollusca | Gastropoda | Cancellariidae | *Cancellaria (Nevia) spirata* | nutmeg shell | PE |
| Mollusca | Gastropoda | Cancellariidae | *Cancellaria (Sydaphera) lactea* | nutmeg shell | PE |
| Mollusca | Gastropoda | Cancellariidae | *Cancellaria (Sydaphera) purpuriformis* | nutmeg shell | PE |
| Mollusca | Gastropoda | Eatoniellidae | *Eatoniella victoriae* | marine snail | PE* |
| Mollusca | Gastropoda | Epitoniidae | *Epitonium platypleura* | marine snail | PE |
| Mollusca | Gastropoda | Cerithiopsidae | *Zaclys angasi* | marine snail | PB |
| Mollusca | Polyplacophora | Lepidopleuridae | *Leptochiton liratus* | chiton | PE |
| Echinodermata | Holothuroidea | Phyllophoridae | *Lipotrapeza ventripes* | sea cucumber | PE |
| Chordata | Atheriniformes | Atherinidae | *Kestratherina esox* | pikehead hardyhead | PE |
| Chordata | Perciformes | Tripterygiidae | *Lepidoblennius haplodactylus* | jumping joey | PW |
| Chordata | Perciformes | Gobiidae | *Arenigobius frenatus* | half bridled goby | RW |
| Chordata | Carchariniformes | Scyliorhinidae | *Asymbolus analis* | dark spotted catshark | RW |
| Chordata | Lophiiformes | Antennariidae | *Echinophryne reynoldsi* | sponge anglerfish | PE |
| Chordata | Perciformes | Sillaginidae | *Sillago bassensis* | silver whiting | PE |

*recorded from Crawfish Rocks

# APPENDIX 3

Completed research, mapping and monitoring projects carried out under *National Parks Act 1975* research permits in or relevant to Central Victoria bioregion with associated reports. Research Partner Panel (and RPP-like) research projects, mapping projects and monitoring surveys were implemented in partnership with, or commissioned by, Parks Victoria. Several other research projects were also carried out independently under *National Parks Act 1975* permits.

**1. Yaringa MNP**

**Completed RPP (and RPP-like) Projects and Associated Reports**

***Department of Primary Industries:*** Anthony Plummer, Liz Morris, Sean Blake, David Ball
Marine Natural Values Study. Victorian Marine National Parks and Sanctuaries.

Plummer, A., Morris, L., Blake, S. and Ball, D. (2003). Marine Natural Values Study, Victorian Marine National Parks and Sanctuaries. Parks Victoria Technical Series No. 1, Parks Victoria, Melbourne.

***University of Melbourne:*** Jan Carey, Mark Burgman
Risk Assessment for Marine National Parks and Sanctuaries.

Carey, J.M., Burgman, M.A., Boxshall, A., Beilin, R., Flander, L., Pegler, P. and White, A.K. (2007). *Identification of threats to natural values in Victoria's Marine National Parks and Marine Sanctuaries.* Parks Victoria Technical Series No.33. Parks Victoria, Melbourne.

Carey, J.M., Boxshall, A., Burgman, M.A., Beilin, R. and Flander, L. (2007) *State-wide synthesis of threats to natural values in Victoria's Marine National Parks and Marine Sanctuaries*. Parks Victoria Technical Series No. 34. Parks Victoria, Melbourne.

Carey, J.M., Beilin, R., Boxshall, A. Burgman, M.A. and Flander, L. (2007). Risk-Based Approaches to Deal with Uncertainty in a Data-Poor System: Stakeholder Involvement in Hazard Identification for Marine National Parks and Marine Sanctuaries in Victoria, Australia. *Risk Analysis* 27(1), 271-281.

Carey, J.M. and Burgman, A. (2008) Linguistic Uncertainty in Qualitative Risk Analysis and How to Minimize It. *Annals of the* New York *Academy of Sciences* 1128: 13–17.

***La Trobe University (and Museum Victoria):*** Sarah Butler, Fiona Bird, Julie Mondon, Gary Poore
Developing a rapid assessment technique to investigate ecological condition of soft-sediment habitats in marine protected areas.

Butler, S. (2008). Developing a monitoring tool for the macroinvertebrates and the soft-sediment environments of marine national parks in Western Port, Victoria. Ph.D. Thesis. Department of Zoology, La Trobe University.

Butler, S. and Bird, F.L. (2010). Monitoring the macroinvertebrates and soft sediments in the Marine National Parks in Western Port. Parks Victoria Technical Series No. 60. Parks Victoria, Melbourne.

***University of Melbourne:*** Masters students from Industry Project in Science program
Investigation and assessment of Water Quality Issues affecting Natural Values in the Parks Victoria Managed Estuaries and Marine Protected Areas.

Colautti, A., Errey, J., Chi Lam, M., Lewis, M., Michael, M. and Wright, M. (2010). Investigation and Assessment of Water Quality Issues Affecting Natural Values in the Parks Victoria Managed Estuaries and Marine Protected Areas. University of Melbourne MSc Industry Project.

**Habitat Mapping Projects and Associated Reports**

***Department of Primary Industries:*** David Ball, Sean Blake
Shallow Water Habitat Mapping at Victorian Marine National Parks and Sanctuaries.

Ball, D., Blake, S. and Plummer, A. (2006). Review of Marine Habitat Classification Systems. Parks Victoria Technical Series No. 26. Parks Victoria, Melbourne.

| **Monitoring Reports** |
|---|
| Power, B. and Boxshall, A. (2007). Marine National Park and Sanctuary Monitoring Plan 2007-2012. Parks Victoria Technical Series No. 54. Parks Victoria, Melbourne. |
| **Other reports produced for other research under *National Parks Act 1975* permits** |
| Veenstra-Quah, A.A., Milne, J. and Kolesik, P. (2007). Taxonomy and biology of two new species of gall midge (Diptera: Cecidomyiidae) infesting *Sarcocornia quinqueflora* (Chenopodiaceae) In Australian salt marshes. *Australian Journal* of *Entomology* 46: 198-206.<br>Wei Xin Sue (2008). Optimization of Sea Search for Seagrass Monitoring Protocol in Yaringa Marine National Park. Submitted in partial fulfilment of the requirements for the Bachelor of Science (Honours). School of Botany, University of Melbourne. |

## 2. French Island MNP

| Completed RPP (and RPP-like) Projects and Associated Reports |
|---|
| ***Department of Primary Industries:*** Anthony Plummer, Liz Morris, Sean Blake, David Ball<br>Marine Natural Values Study. Victorian Marine National Parks and Sanctuaries.<br><br>Plummer, A., Morris, L., Blake, S. and Ball, D. (2003). Marine Natural Values Study, Victorian Marine National Parks and Sanctuaries. Parks Victoria Technical Series No. 1, Parks Victoria, Melbourne. |
| ***University of Melbourne:*** Jan Carey, Mark Burgman<br>Risk Assessment for Marine National Parks and Sanctuaries.<br><br>Carey, J.M., Burgman, M.A., Boxshall, A., Beilin, R., Flander, L., Pegler, P. and White, A.K. (2007). *Identification of threats to natural values in Victoria's Marine National Parks and Marine Sanctuaries.* Parks Victoria Technical Series No.33. Parks Victoria, Melbourne.<br><br>Carey, J.M., Boxshall, A., Burgman, M.A., Beilin, R. and Flander, L. (2007) *State-wide synthesis of threats to natural values in Victoria's Marine National Parks and Marine Sanctuaries*. Parks Victoria Technical Series No. 34. Parks Victoria, Melbourne.<br><br>Carey, J.M., Beilin, R., Boxshall, A. Burgman, M.A. and Flander, L. (2007). Risk-Based Approaches to Deal with Uncertainty in a Data-Poor System: Stakeholder Involvement in Hazard Identification for Marine National Parks and Marine Sanctuaries in Victoria, Australia. *Risk Analysis* 27(1), 271-281*.*<br><br>Carey, J.M. and Burgman, A. (2008) Linguistic Uncertainty in Qualitative Risk Analysis and How to Minimize It. *Annals of the* New York *Academy of Sciences* 1128: 13–17. |
| ***La Trobe University (and Museum Victoria):*** Sarah Butler, Fiona Bird, Julie Mondon, Gary Poore<br>Developing a rapid assessment technique to investigate ecological condition of soft-sediment habitats in marine protected areas.<br><br>Butler, S. (2008). Developing a monitoring tool for the macroinvertebrates and the soft-sediment environments of marine national parks in Western Port, Victoria. Ph.D. Thesis. Department of Zoology, La Trobe University.<br><br>Butler, S. and Bird, F.L. (2010). Monitoring the macroinvertebrates and soft sediments in the Marine National Parks in Western Port. Parks Victoria Technical Series No. 60. Parks Victoria, Melbourne. |
| ***University of Melbourne:*** Masters students from Industry Project in Science program<br>Investigation and assessment of Water Quality Issues affecting Natural Values in the Parks Victoria Managed Estuaries and Marine Protected Areas.<br><br>Colautti, A., Errey, J., Chi Lam, M., Lewis, M., Michael, M. and Wright, M. (2010). Investigation and Assessment of Water Quality Issues Affecting Natural Values in the Parks Victoria Managed Estuaries and Marine Protected Areas. University of Melbourne MSc Industry Project. |
| **Habitat Mapping Projects and Associated Reports** |
| ***Department of Primary Industries:*** David Ball, Sean Blake<br>Shallow Water Habitat Mapping at Victorian Marine National Parks and Sanctuaries.<br><br>Ball, D., Blake, S. and Plummer, A. (2006). Review of Marine Habitat Classification Systems. Parks Victoria Technical Series No. 26. Parks Victoria, Melbourne. |
| **Monitoring Reports** |
| Power, B. and Boxshall, A. (2007). Marine National Park and Sanctuary Monitoring Plan 2007-2012. Parks Victoria Technical Series No. 54. Parks Victoria, Melbourne. |
| **Other reports produced for other research under *National Parks Act 1975* permits** |
| Veenstra-Quah, A.A., Milne, J. and Kolesik, P. (2007). Taxonomy and biology of two new species of gall midge (Diptera: Cecidomyiidae) infesting *Sarcocornia quinqueflora* (Chenopodiaceae) In Australian salt marshes. *Australian Journal* of *Entomology* 46: 198-206. |

### 3. Churchill Island MNP

**Completed RPP (and RPP-like) Projects and Associated Reports**

***Department of Primary Industries:*** Anthony Plummer, Liz Morris, Sean Blake, David Ball
Marine Natural Values Study. Victorian Marine National Parks and Sanctuaries.

> Plummer, A., Morris, L., Blake, S. and Ball, D. (2003). Marine Natural Values Study, Victorian Marine National Parks and Sanctuaries. Parks Victoria Technical Series No. 1, Parks Victoria, Melbourne.

***University of Melbourne:*** Jan Carey, Mark Burgman
Risk Assessment for Marine National Parks and Sanctuaries.

> Carey, J.M., Burgman, M.A., Boxshall, A., Beilin, R., Flander, L., Pegler, P. and White, A.K. (2007). *Identification of threats to natural values in Victoria's Marine National Parks and Marine Sanctuaries.* Parks Victoria Technical Series No.33. Parks Victoria, Melbourne.

> Carey, J.M., Boxshall, A., Burgman, M.A., Beilin, R. and Flander, L. (2007) *State-wide synthesis of threats to natural values in Victoria's Marine National Parks and Marine Sanctuaries*. Parks Victoria Technical Series No. 34. Parks Victoria, Melbourne.

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**4. Corner Inlet MNP**

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*Parks Victoria is responsible for managing the Victorian protected area network, which ranges from wilderness areas to metropolitan parks and includes both marine and terrestrial components.*

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