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Marine Protected Areas of the Otway Bioregion

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2 Marine National Parks

2.1 Discovery Bay Marine National Park

Discovery Bay MNP is the one of two Marine National Parks in the Otway bioregion (Figure 2). The Otway Bioregion also contains Twelve Apostles MNP, and Merri and The Arches Marine Sanctuaries. Discovery Bay MNP is on the western side of Cape Duquesne. It is approximately 19 km west of Portland and 380 km west of Melbourne. The MNP covers 2830 hectares adjacent to Cape Bridgewater along the coast from Blacks Beach to Whites Beach and offshore to three nautical miles, the limit of Victorian waters (Figure 4 & Figure 5). Between Whites Beach and Cape Duquesne the park boundary commences 500 m from the coastline. Discovery Bay MNP abuts the Discovery Bay Coastal Park and includes the areas between high and low water mark that were formerly part of the Coastal Park (Parks Victoria 2007a). The main access to the MNP shore is via a short walk from Whites Beach and Blacks Beach (Parks Victoria 2007a). Boat access is from the beach at Bridgewater Bay and Portland Harbour boat ramp (Parks Victoria 2007a). The wrecks of three wooden sailing barques, the *Jane,* the *Ann* and the *Marie,* are thought to be in the vicinity of the MNP (Parks Victoria 2007a).

Aboriginal tradition indicates that the Discovery Bay MNP is part of Gunditjmara *Country* (Parks Victoria 2007a).

Important natural values of Discovery Bay MNP are its basalt and calcarenite intertidal and subtidal rocky reefs, extensive sandy subtidal soft sediment and the biota they support (ECC 2000; Carey *et al.* 2007b; Parks Victoria 2007a). The MNP is part of the largest coastal basalt formation in western Victoria, and among the highest wave energy environments in the State (ECC 2000; Carey *et al.* 2007b). It has rocky habitats of complex forms, including low profile calcarenite-capped basalt platforms, isolated low calcarenite reefs, and heavy sloping basalt walls (ECC 2000; Carey *et al.* 2007b). Its deep (33 - 55 m) calcarenite reefs with thick growths of sessile invertebrates (*e.g.* sponges, ascidians, bryozoans and gorgonians) are an important natural value (ECC 2000; Carey *et al.* 2007b), as are its shallow basaltic reefs covered by large kelps such as *Ecklonia radiata*. Its intertidal and shallow subtidal reefs have a high diversity of invertebrates (ECC 2000; Carey *et al.* 2007b; Parks Victoria 2007a). Its extensive subtidal soft sediments of mainly fine sand, with high (80%) carbonate content, is an important natural value (ECC 2000; Carey *et al.* 2007b). Its open waters support blue whale *Balaenoptera musculus* and white shark *Carcharodon carcharias* (ECC 2000; Carey *et al.* 2007b).

The Bonney Coast, from South Australia to Discovery Bay, is a productive area because of cold water upwellings (Edmunds *et al.* 2010a). These greatly influence primary productivity and maintain commercially important fisheries species such as blacklip abalone *Haliotis rubra* and the southern rock lobster *Jasus edwardsii* (Edmunds *et al.* 2010a). High productivity in the Bonney Coast is also an important feeding ground for seabirds, fur seals and whales (Edmunds *et al.* 2010a).

On the intertidal basalt reefs in the north of the MNP Neptune's necklace *Hormosira banksii* is common, along with sea lettuce *Ulva* sp., globe algae *Colpomenia sinuosa* and encrusting red algae (Plummer *et al.* 2003; Costa *et al.* 2010; O'Hara *et al.* 2010). Sessile invertebrates found on the intertidal rock platforms in the MNP include the anemones *Aulactinia veratra*, *Actinia tenebrosa* and *Anthothoe albocincta*, the surf *Catomerus polymerus*, honeycomb *Chamaesipho tasmanica* and rosette barnacles *Tetraclitella purpurascens,* and the mussels little black horse *Limnoperna pulex* and beaked *Austromytilus rostratus* (Costa *et al.* 2010; O'Hara *et al.* 2010). The purple rock crab *Leptograpsus variegatus* is also found on the intertidal reef of the MNP (Costa *et al.* 2010; O'Hara *et al.* 2010). The invertebrate fauna is

dominated by molluscs (Costa *et al.* 2010; O'Hara *et al.* 2010). This includes top shells *Austrocochlea* constricta and *A. odontis*, the false limpet *Siphonaria diemenensis*, true limpets *Cellana tramoserica* and *Patelloida latistrigata*, black nerite *Nerita atramentosa*, periwinkles *Austrolittorina praetermissa*, *A. unifasciata* and *Bembicium nanum,* and the predatory gastropods *Cominella lineolata*, *Lepsiella reticulata*, and *L. vinosa* (Costa *et al.* 2010; O'Hara *et al.* 2010). Intertidal fish include the blenny *Parablennius tasmanianus*, cling fish *Aspasmogaster tasmaniensis*, and weedfish including Johnston's *Heteroclinus johnstoni*, common *Heteroclinus perspicillatus* and crested *Cristiceps australis* (Plummer *et al.* 2003).

Bull kelp *Durvillaea potatorum* grows on the intertidal reef edge (Ball and Blake 2007; Costa *et al.* 2010; O'Hara *et al.* 2010). Mixed brown algae, including kelp *Ecklonia radiata* and crayweed *Phyllospora comosa,* form the canopy algae on the sand free basalt subtidal reefs in the south-east of Discovery Bay MNP (Ierodiaconou *et al.* 2007). Also growing on these reefs are the brown algae *Scytothalia*, *Sargassum* and giant kelp *Macrocystis pyrifera,* and green algae *Caulerpa* (Ball and Blake 2007; Holmes *et al.* 2007a). Sessile invertebrates, predominately compact sponges, become more dominant with depth (Ierodiaconou *et al.* 2007). Mobile invertebrates on these subtidal reefs include seastars, southern rock lobster *J. edwardsii* and blacklip abalone *H. rubra* (Plummer *et al.* 2003). On the deeper sand-inundated reefs in the west of the MNP sessile invertebrates dominate the reef where it is free of sand (Holmes *et al.* 2007a; Ierodiaconou *et al.* 2007; Monk *et al.* 2011). This includes abundant ascidians, hydroids, and bryozoans along with gorgonian soft corals, hard corals, *Tethya* sponges, zooanthids and the sea whip *Primnoella australasiae* (Holmes *et al.* 2007a; Ierodiaconou *et al.* 2007; Monk *et al.* 2011).

Large schools of purple wrasse *Notolabrus fucicola* and juvenile sea sweep *Scorpis aequipinnis* occur on the nearshore subtidal reefs (Plummer *et al.* 2003; Ball and Blake 2007). Also observed on these reefs are marble fish *Aplodactylus arctidens,* moonlighters *Tilodon sexfasciatus*, magpie perch *Cheilodactylus nigripes*, zebra fish *Girella zebra*, yelloweye mullet *Aldrichetta forsteri* and painted dragonets *Eocallionymus papilio* (Plummer *et al.* 2003). Other fish commonly found on the subtidal reefs of the MNP include the blue-throated wrasse *Notolabrus tetricus* and rosy wrasse *Pseudolabrus psittaculus* (Monk *et al.* 2010). Western blue gropers *Achoerodus gouldii* have been observed in the high profile reef systems in 50 m of water west of Cape Duquesne (Ierodiaconou *et al.* 2007).

Discovery Bay MNP provides important feeding and roosting habitat for fifteen threatened bird species listed under the *Flora and Fauna Guarantee* (*FFG*) *Act* (1998). Two of these are regarded as endangered; the wandering albatross *Diomedea exulans is* listed as endangered at the state level, while the southern giant-petrel *Macronectes giganteus* is endangered at the national level. The MNP protects feeding areas for ten internationally important migrant species protected under the Australia Migratory Bird Agreement with either China (CAMBA) or Japan (JAMBA). The intertidal reef provides an occasional haul-out area for state vulnerable New Zealand *Arctophoca forsteri* and Australian fur seals *Arctocephalus pusillus doriferus*. It is an important feeding ground for the nationally endangered blue whale *Balaenoptera musculus.* The MNP has one endemic crustacean, the southern hooded shrimp *Athanopsis australis.* Seven species of algae and one invertebrate are known or presumed to be at the limit of their distribution in the MNP.

Serious threats to the MNP include poaching of abalone and the limited ecological knowledge of important habitats, communities and processes. Climate change also poses a serious threat to the integrity of Discovery Bay MNP. Measures to address or minimise these threats form part of the management plan for Discovery Bay MNP (Parks Victoria 2007a). Specific research aims to increase ecological knowledge about the natural values of, and threats to Discovery Bay MNP.

2.1.1 PHYSICAL PARAMETERS & PROCESSES

The Discovery Bay MNP is 2830 hectares in size which makes it the eighth largest of the 24 Marine National Parks or Sanctuaries in Victoria (Table 1, Figure 4). The MNP is predominately > 30 m deep (Figure 4). The MNP is exposed to storms and southwesterly swells of the Southern Ocean, and resulting high deepwater wave energy. The Zeehan Current is influential moving water in a south-easterly direction through the MNP. The warm Leeuwin Current flows east along the southern coast of Australia and may influence water temperature in the MNP particularly during La Niña years (Parks Victoria 2007a). The continental shelf is relatively narrow near the MNP, extending only 50 km offshore. Wind driven coastal circulation across the shelf causes regular upwellings of cool nutrient rich water, particularly during spring and summer, known as the Bonney Upwelling. The upwelling has a major influence on the ecosystem. It stimulates phytoplankton and zooplankton blooms that form the basis of a rich pelagic food chain providing feeding grounds for seabirds, fish, blue whales *Balaenoptera musculus* and Australian fur seals *Arctocephalus pusillus doriferus*. Surface water temperatures are influenced by the cold Bonney Upwelling, with mean surface water temperature varying seasonally between 14 °C and 18 °C. Tidal variation is 0.8 m for spring tides and 0.4 m for neap tides (Plummer *et al.* 2003). Glenelg River discharges approximately 50 km to the west of Discovery Bay MNP and Fawthrop Lagoon discharges 19 km east of the MNP (Table 1). A number of freshwater springs flow from the cliff faces of Cape Bridgewater onto the basalt wavecut platforms within the park boundary (Parks Victoria 2007a).

The coastline in the Discovery Bay MNP consists of cliffed basalt which is capped by dune calcarenite (Bird 1993). The coast exposes a variety of volcanic lava structures such as pahoehoe or ropey lava, and lava blisters (Bird 1993). These have been dissected into cliffs and stone ledges, with blowholes, caves and clefts also present (Bird 1993). Cape Duquesne adjacent to Discovery Bay MNP is listed as state geological significance due to its calcarenite cliffs with caves and blowholes overlying basalt (Figure 6). To the east of the MNP Shelley Beach in Bridgewater Bay is listed as regionally significant due to its modern deposits of shells.

Figure 3. Discovery Bay Marine National Park. Photo by NRE.

Table 1. Physical attributes of the Discovery Bay Marine National Park.

Park Name	**Discovery Bay**
Conservation status	Marine National Park
Biophysical Region	Otway
Size	2830 ha (ranked 8th of 24)
Length of coastline	~ 2.3 km
Shoreline geology	Basalt and calcarenite limestone
Area with depth:	
Less than 10m	112.5 ha
Comprising: Intertidal (high res)	*(1.5 ha)*
Intertidal-5m (high res)	*(42 ha)*
5 - 10 m (high res)	*(61 ha)*
*0-10m (low res)**	*(8 ha)*
10-20 m	160 ha
20-30 m	363 ha
30-40 m	434 ha
40-50 m	305 ha
50-60m	915 ha
60-70m	465 ha
70-80m	77 ha
Mean tidal variation - spring	0.8 m
Mean tidal variation - neap	0.4 m
Mean water temp - summer	17.0°C
Mean water temp - winter	14.0°C
Adjacent catchment	Coastal Park
Discharges into MNP	None
Nearest major estuary (distance & direction)	Glenelg River 50km to the west Fawthrop Lagoon 19 km to the east

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

2.1.2 MARINE HABITAT DISTRIBUTION

Mapping of habitats (Figure 6, Figure 7 & Figure 8) 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 target management activities effectively, 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 main habitats present in Discovery Bay MNP include subtidal reef and soft sediment, and the water column. A relatively small amount of intertidal reef and beaches are also present in the MNP. In 2004 underwater video was used to groundtruth shallow water habitat mapping derived from aerial photos (Ball and Blake 2007). This shallow water mapping was only possible in the north-eastern section of the MNP between Whites and Blacks Beaches in Descartes Bay as the water depth quickly drops off along Cape Duquesne (Figure 4 & Figure 8). In 2005 the deep (>15 m) subtidal substrate and biota was surveyed (Figure 6 & Figure 7) and mapped acoustically (Holmes *et al.* 2007a; Ierodiaconou *et al.* 2007). Underwater video transects allowed the substrate and biota to be modelled for the areas not surveyed.

The MNP is shallower along its eastern edge and gets deeper as you move south-west (Holmes *et al.* 2007a). In the south of the MNP the water depth is 30 to 75 m and 14 to 55 m close to shore (Holmes *et al.* 2007a). The nearshore substrate is mixed solid reef and sand

to water depths of approximately 35 m; then there is a band of sand from 35 to 55 m, then a complex mosaic of sediment and broken reef out to the MNP boundary (Holmes *et al.* 2007a). Unconsolidated subtidal sediments (Figure 6) form the largest habitat class in the MNP (Ierodiaconou *et al.* 2007). The shallower north eastern area in Descartes Bay is largely composed of fine, well sorted sand flats with some fine rippling (Ball and Blake 2007; Holmes *et al.* 2007a; Ierodiaconou *et al.* 2007). The occurrence of ripples attests to the frequent movement and transport of sediment (Ierodiaconou *et al.* 2007). The nearshore substrate in the north-east is predominantly bare sand (Figure 8) extending offshore from the dunes and sand beach (Ball and Blake 2007). Sessile invertebrates occur in isolated areas within the sand band from 35 to 55 m depth, suggesting that the sediment is a thin veneer over hard substrate (Holmes *et al.* 2007a). In deeper areas to the west of the MNP (Figure 6), sediments tend to be coarser and form into broad (> 40 cm), well defined sand waves (Holmes *et al.* 2007a; Ierodiaconou *et al.* 2007).

In the south of Descartes Bay (Figure 6 & Figure 8) a narrow intertidal basalt reef extends offshore from the rocky cliffs of Cape Duquesne into a narrow band of shallow subtidal basalt reef (Ball and Blake 2007; Ierodiaconou *et al.* 2007). This reef is not inundated by sand like other reefs in the MNP (Holmes *et al.* 2007a; Ierodiaconou *et al.* 2007). These are very high profile reefs, with vertical walls and cliffs up to 30 m (Ierodiaconou *et al.* 2007). Massive basalt boulder fields occur at the base of these submarine cliffs over a bed of calcarenite reef and coarse sand (Ierodiaconou *et al.* 2007). Areas of mostly bare boulders also occur amongst the reef (Ball and Blake 2007). Lower profile (< 1 m – 5 m), sand inundated calcarenite reef characterize the western half of the MNP in depths ranging from 40 – 70 m (Ierodiaconou *et al.* 2007).

Habitat dominated by mixed brown algae, kelp *Ecklonia radiata* and crayweed *Phyllospora comosa* is confined to shallow (<20 m) high profile basalt peaks (Figure 7) in the south-east of the MNP (Ierodiaconou *et al.* 2007). The habitats are highly dynamic as a result of the wave and storm activity. Kelp beds are often decimated by storm activity (Parks Victoria 2007a). A sparse mixed red algal understorey becomes denser at the deeper margins of these reefs (Ierodiaconou *et al.* 2007). Sessile invertebrates, in the mixed brown algae beds, become more dominant with depth (Ierodiaconou *et al.* 2007). Deeper reefs in the west of the MNP consist of a sponge dominated habitat with other sessile invertebrates (Holmes *et al.* 2007a; Ierodiaconou *et al.* 2007; Monk *et al.* 2011). The sessile invertebrates are in highest densities on reef crests, ridges and high profile plateaus where the effects of sand inundation are mitigated by vertical relief (Ierodiaconou *et al.* 2007). Sponges occur at all depths in the MNP (Ierodiaconou *et al.* 2007). Red algae grows in depths up to 60 m and kelp *Ecklonia radiata* in up to 50 m, although both decrease in abundance with depth (Ierodiaconou *et al.* 2007). Bryozoans and gorgonians are found in depths >30 m. Ascidians were only observed in 30-40 m and the sea whip *Primnoella australasiae* is only found in depths >50 m (Ierodiaconou *et al.* 2007).

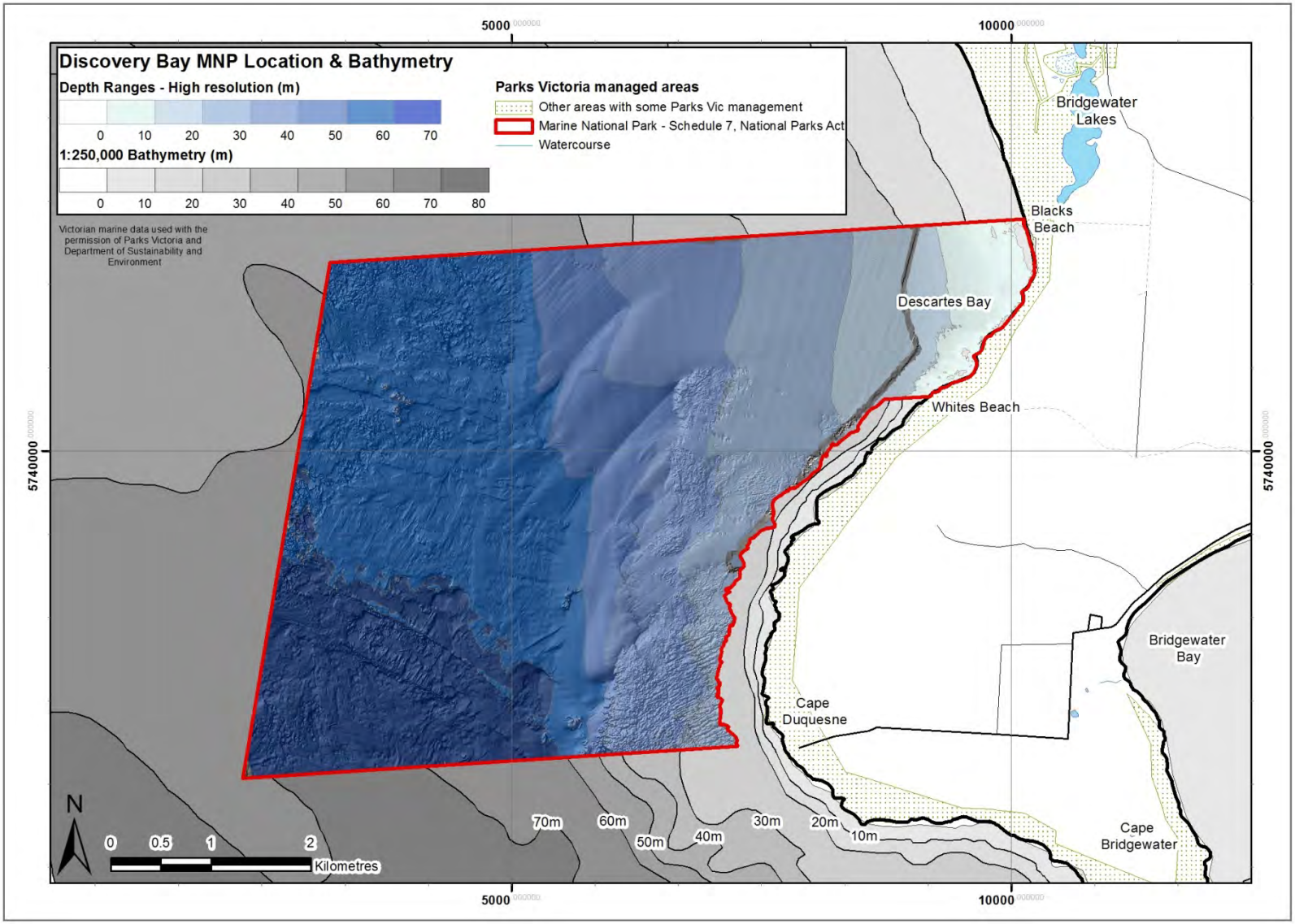

Figure 4. Location map of the Discovery Bay Marine National Park with bathymetry. There are no ongoing monitoring sites in the MNP.

Figure 5. Aerial photograph of the coastline of the Discovery Bay Marine National Park (Skyview Aviation 21/01/06). From Ball and Blake 2007.

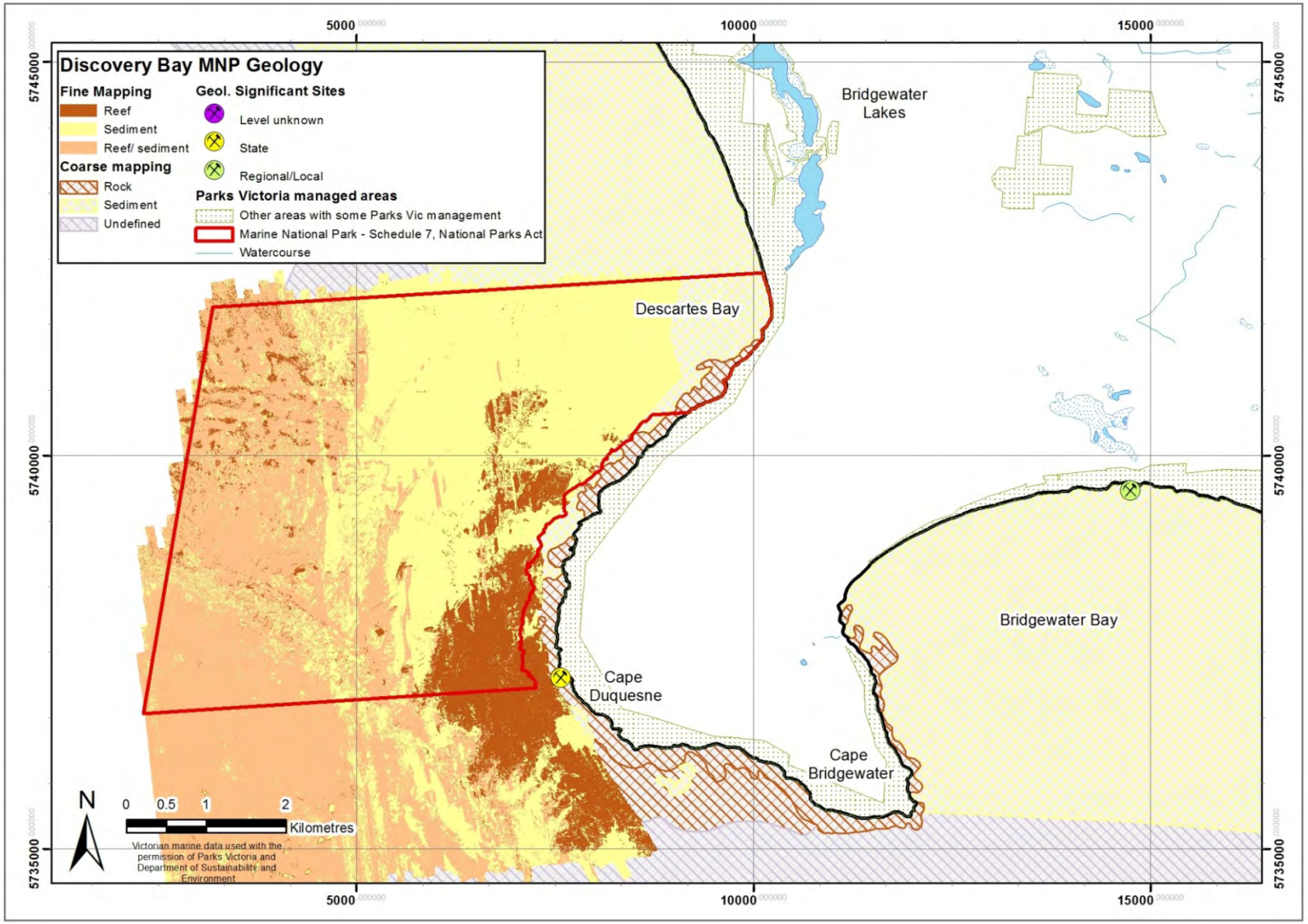

Figure 6. Substrate mapping of Discovery Bay Marine National Park and surrounds, showing sites of geological significance.

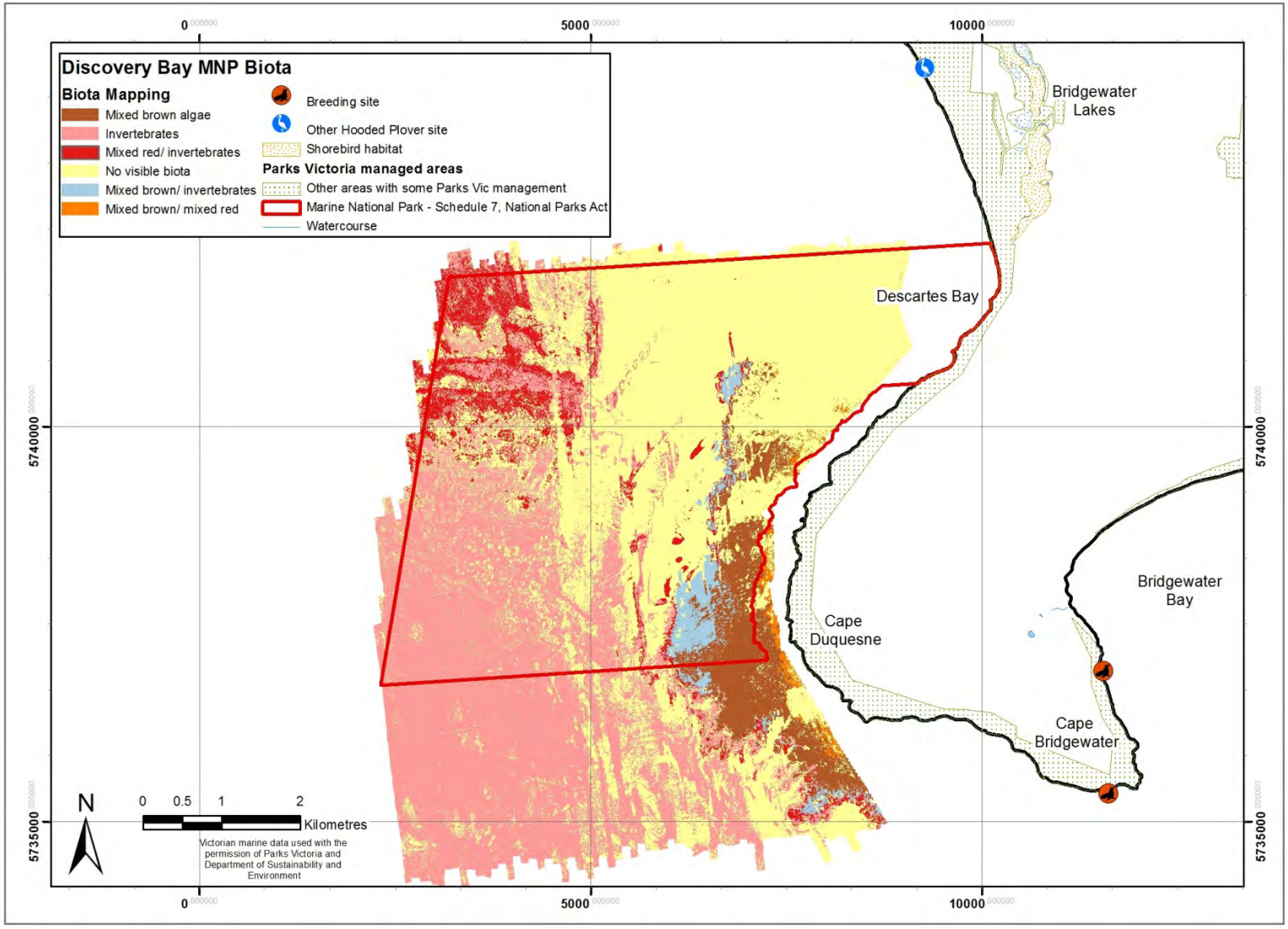

Figure 7. Biota mapping of the Discovery Bay Marine National Park and surrounds showing sites of biological significance.

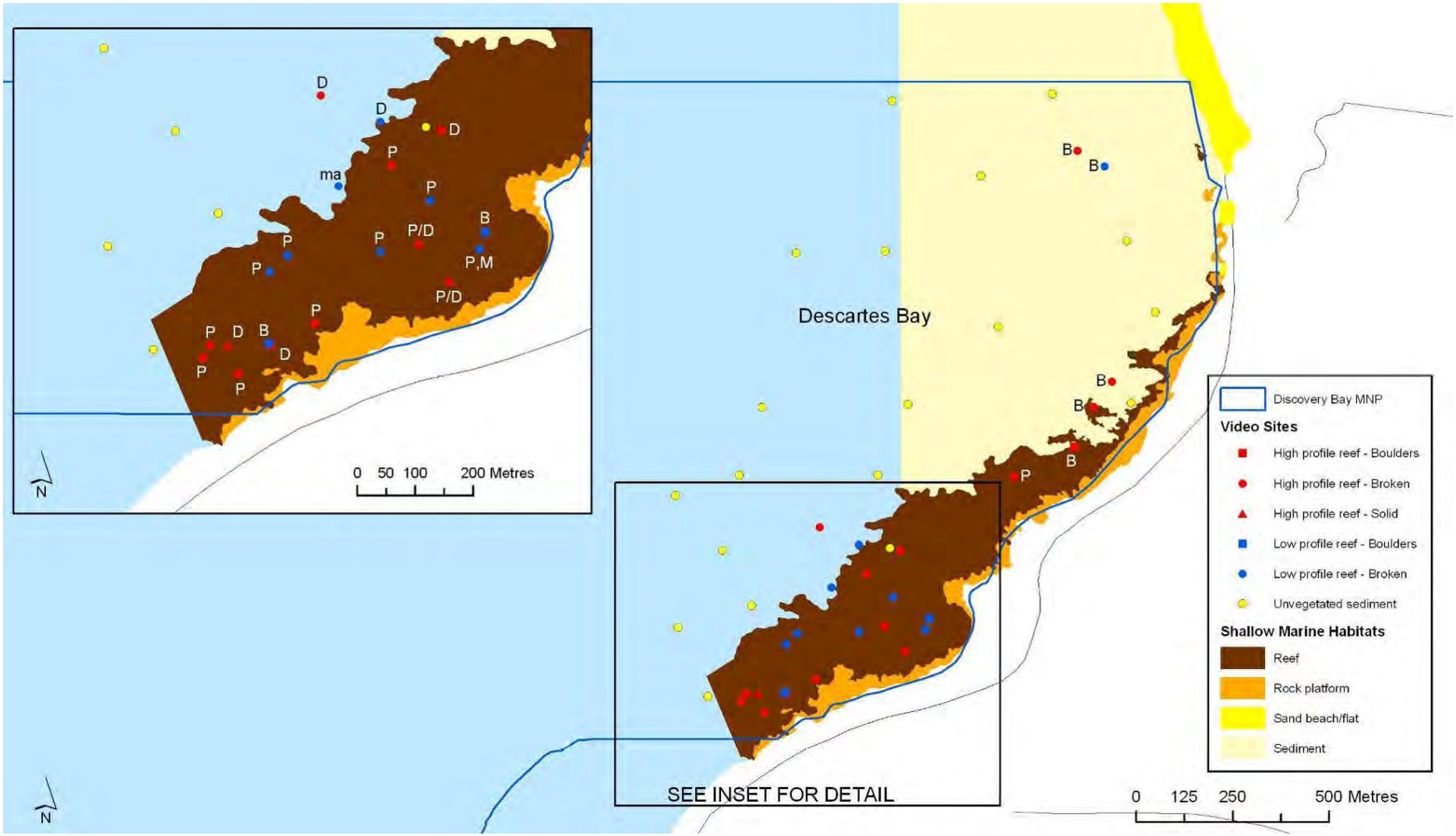

Figure 8. Detailed shallow substrate mapping of Discovery Bay Marine National Park from Ball and Blake 2007. Dominant biota categories on the map B = bare reef or sediment, D = *Durvillaea potatorum,* M = *Macrocystis pyrifera,* P = *Phyllospora comosa* and ma = mixed algae.

2.1.3 MARINE ECOLOGICAL COMMUNITIES

General

Since the first natural values report by Plummer *et al.* (2003), Parks Victoria has invested in detailed habitat mapping of the shallow (Ball and Blake 2007) and deep habitats of the MNP (Holmes *et al.* 2007c; Ierodiaconou *et al.* 2007). Intertidal biota has been surveyed as part of Museum of Victoria's large intertidal reef research (MAVRIC) study (Costa *et al.* 2010; O'Hara *et al.* 2010). Subtidal soft sediment fauna has been assessed as part of a statewide project (Coleman *et al.* 2007; Heislers and Parry 2007). Surveys in the MNP found that gastropods and birds dominate the number of species in Discovery Bay MNP (Table 2 & Appendix 1). Comprehensive surveys of the subtidal reef biota have not been done. There have been no surveys of the biota of the intertidal soft sediment.

Table 2. Summary of the number of species in major biotic groups from surveys in Discovery Bay Marine National Park.

Biotic Group	Number of Species
Macrophytes	**18**
Green algae	4
Brown algae	5
Red algae	9
Invertebrates	**48**
Cnidaria	5
Polychaetes	1
Barnacles	3
Decapod crustaceans	2
Chitons	4
Gastropods	31
Echinoderms	2
Vertebrates	**40**
Birds	33
Mammals	7

Intertidal

Soft sediment

Within the MNP intertidal soft sediment or beach only occurs in the north-east between Whites and Blacks Beaches (Figure 5, Figure 6 & Figure 8). Flora is restricted to macroalgae drift and macroalgal epiphytes. The invertebrates and fish of the intertidal soft sediment habitat in Discovery Bay MNP have not been surveyed. Beach-washed materials in sandy beach habitats are a significant source of food for scavenging birds, and contribute to the detrital cycle that nourishes many of the invertebrates, such as bivalves, living in the sand. The intertidal soft sediment is an important feeding and roosting habitat for shorebirds. There is no specific data on the biota of the beaches in the Discovery Bay MNP (Plummer *et al.* 2003).

Reef

Rocky intertidal reefs, also called rocky reefs or intertidal platforms, are generally found in Victoria on and near headlands with stretches of sandy beaches either side. Along with beaches, intertidal reefs are one of the most accessible components of the marine environment as they are the interface between the ocean and the land (Power and Boxshall

2007). As such they are valued as important habitats by people and tend to be visited more than other sections of the coast (Carey *et al.* 2007a; Carey *et al.* 2007b). This means they are often subjected to human pressures like harvesting, fossicking and trampling as well as pressures from pollution sources on land and in the sea (Power and Boxshall 2007).

Intertidal reef biota is exposed to large changes in physical conditions such as temperature and desiccation. There is great spatial and temporal variability in the life histories of the organisms and the environmental processes in reef habitats (Underwood and Chapman 2004). The recruitment of new biota onto the reef, largely from plankton, strongly influences the ecological patterns for individual species and assemblages. Interactions between biota on the reef also influence biota distribution. Resources which are often in short supply on intertidal reefs are space on which to live and food (Underwood and Chapman 2004).

Macroalgae and sessile invertebrates

A survey of the intertidal biota of Discovery Bay found eleven species of algae: three green, four brown and four red (Costa *et al.* 2010; O'Hara *et al.* 2010). Neptune's necklace *Hormosira banksii* is common along the intertidal rock platforms, along with sea lettuce *Ulva* sp. and encrusting red algae. Towards the lower intertidal zone, the bull kelp *Durvillaea potatorum* (Figure 9), giant kelp *Macrocystis pyrifera*, and green algae *Codium* sp. and *Caulerpa* sp. are also common (Plummer *et al.* 2003; Ball and Blake 2007). Freshwater springs on the cliff face support communities of green algae (Plummer *et al.* 2003). Sessile invertebrates found on the intertidal rock platforms in the MNP include the anemones *Aulactinia veratra*, *Actinia tenebrosa* and *Anthothoe albocincta*, including the surf *Catomerus polymerus*, honeycomb *Chamaesipho tasmanica* and rosette barnacles *Tetraclitella purpurascens,* and the mussels little black horse *Limnoperna pulex* and beaked *Austromytilus rostratus* (Costa *et al.* 2010; O'Hara *et al.* 2010).

Figure 9. Bull kelp *Durvillaea potatorum* on basalt subtidal reef in Discovery Bay Marine National Park. Photo by NRE.

Mobile invertebrates

A survey of the intertidal biota of Discovery Bay found forty-eight species of invertebrates, dominated by 37 species of molluscs (Costa *et al.* 2010; O'Hara *et al.* 2010). This includes top shells *Austrocochlea* constricta and *A. odontis*, the false limpet *Siphonaria diemenensis*, the true limpets *Cellana tramoserica* and *Patelloida latistrigata*, black nerite *Nerita atramentosa*, periwinkles *Austrolittorina praetermissa*, *A. unifasciata* and *Bembicium nanum,* and the predatory gastropods *Cominella lineolata*, *Lepsiella reticulata*, and *L. vinosa* (Costa *et al.* 2010; O'Hara *et al.* 2010). Also the purple rock crab *Leptograpsus variegatus* is also found on the intertidal reef of the MNP (Costa *et al.* 2010; O'Hara *et al.* 2010). The elephant snail *Scutus antipodes*, cowrie *Cypraea* sp., cone shell *Conus anemone*, urchin *Holopneustes* sp., biscuit star *Tosia australis,* tessellated sea star *Nectria* sp., hairy stone crab *Lomis hirta*, decorator crab *Notomithrax ursus* and cleft fronted shore crab *Paragrapsus quadridentatus* have also been found on the intertidal reefs in the MNP (Plummer *et al.* 2003).

Fish

A variety of fish live in intertidal pools and shallow subtidal gutters in the rock platform (Plummer *et al.* 2003). Common species are Tasmanian blenny *Parablennius tasmanianus*, cling fish *Aspasmogaster tasmaniensis*, juvenile sea carp *Cheilodactylus* sp. and weedfish including Johnston's *Heteroclinus johnstoni*, common *Heteroclinus perspicillatus* and crested *Cristiceps australis* (Plummer *et al.* 2003).

Subtidal

Soft sediment

Sessile invertebrates occur in isolated areas within the sand band from 35 to 55 m depth suggesting that the sediment is a thin veneer over hard substrate (Holmes *et al.* 2007a). Depth and sediment affect the distribution of benthic invertebrates along the Victorian coast. Coleman *et al.* (2007), and Heislers and Parry (2007) found that species richness was greater at 40 m compared to 10 or 20 m depth. Their coastal survey of benthic fauna included the benthos of Discovery Bay MNP. One transect in Discovery Bay MNP was sampled with two 0.1 m^2 grab samples in 10 and 20 m water depth. The sediment sampled was fine sand (Heislers and Parry 2007). The grab samples contained between 120 to 688 individuals and 23 to 35 species (Heislers and Parry 2007). There were more individuals and species in 20 m compared to ten metre grab samples. Crustaceans were the dominant taxa in each depth class, representing more than half (*i.e.* 5 and 8) of the most abundant families. The majority of these were amphipods, while isopods and cumaceans were also common. Polychaetes represented the bulk (*i.e.* 2 - 3) of the remaining families while molluscs were poorly represented. Six families were common in both depth classes, including four amphipod families (Phoxocephalidae, Urohaustoriidae, Bodotriidae, and Lysianassidae) and two polychaete families (Spionidae and Syllidae).

Reef

Subtidal reefs and their assemblages are strongly influenced by the position of the reef, its orientation, slope, depth, exposure and topography (Connell 2007). These physical parameters influence key physical processes such as light, water flow and sedimentation, and biological processes such as foraging and recruitment (Connell 2007). Biotic assemblages of algae and sessile invertebrates can form habitat and food sources for invertebrates and fish. Shallow (< 15 m) subtidal reefs are known for their high biological complexity, species diversity and productivity and in addition they have significant economic value through commercial and recreational fishing (outside of MPAs), diving and other tourism activities (Power and Boxshall 2007). Shallow subtidal reefs are often dominated by canopy forming algae. Deep reefs, where light penetration is limited, are often dominated by large sessile invertebrates such as massive sponges, whip corals, soft corals and colonial ascidians. Biotic assemblages can form habitat and food sources for other invertebrates and fish.

Flora

Seaweeds provide important habitat structure for other organisms on the reef. This habitat structure varies considerably, depending on the type of seaweed species present. Bull kelp *Durvillaea potatorum* grows on the intertidal reef edge (Ball and Blake 2007). Canopy forming algae on the shallow basalt subtidal reefs in Discovery Bay MNP are mixed brown algae, including kelp *Ecklonia radiata* and crayweed *Phyllospora comosa* (Ierodiaconou *et al.* 2007; Figure 10). *Caulerpa*, *Scytothalia*, and *Sargassum* also grow on the subtidal reef as do sparse stands of giant kelp *Macrocystis pyrifera* (Ball and Blake 2007; Holmes *et al.* 2007a). A sparse mixed red algal understorey becomes denser at the deeper margins of these basalt reefs (Ierodiaconou *et al.* 2007). Mixed red algae and mixed green algae often co-occur (Holmes *et al.* 2007a). Sessile invertebrates, in the mixed brown algae beds, become more dominant with depth (Ierodiaconou *et al.* 2007). Red algae grows in depths up to 60 m and kelp *Ecklonia radiata* in up to 50 m, although both decrease in abundance with depth (Ierodiaconou *et al.* 2007).

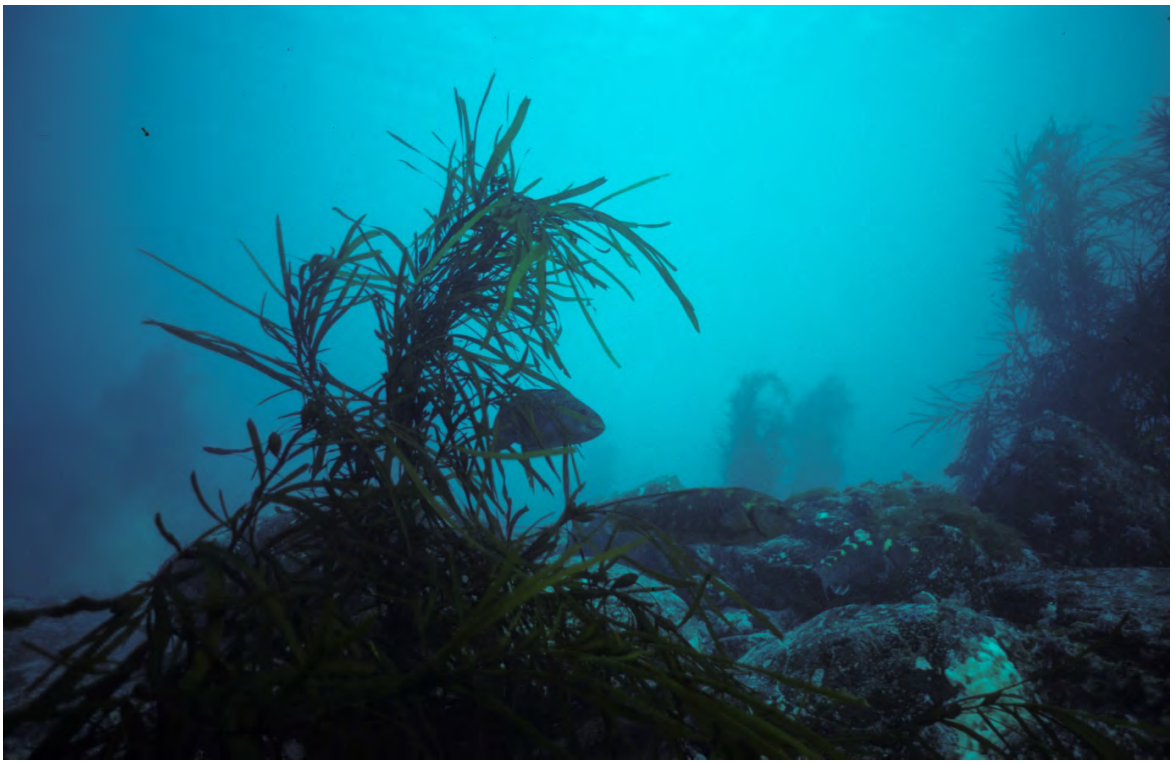

Figure 10. Crayweed *Phyllospora comosa* and wrasse on basalt subtidal reef in Discovery Bay Marine National Park. Photo by NRE.

Invertebrate fauna

A qualitative dive survey of an area of high-profile, high wave-energy basalt reef in 8 m of water in the MNP found small anemones and encrusting sponges under ledges and crevices along with a seastar species, possibly *Patiriella calcar* (Plummer *et al.* 2003). On the shallower basalt subtidal reefs sponges tend to display a more compact morphology than those on the deeper calcarenite reef systems, and are in highest densities in fissures, cracks and on vertical or inverted surfaces (Ierodiaconou *et al.* 2007). Deeper reefs in the west of the MNP consist of a sponge dominated habitat with other sessile invertebrates (Holmes *et al.* 2007a; Ierodiaconou *et al.* 2007; Monk *et al.* 2011). This includes abundant ascidians, hydroids, and bryozoans along with gorgonian soft corals, hard corals, *Tethya* sponges, zooanthids and sea whips (Holmes *et al.* 2007a; Ierodiaconou *et al.* 2007; Monk *et al.* 2011). The sessile invertebrates are in highest densities on reef crests, ridges and high profile plateaus where the effects of sand inundation are mitigated by vertical relief (Ierodiaconou *et al.* 2007). Sponges occur at all depths in the MNP (Ierodiaconou *et al.* 2007). Bryozoans and

gorgonians are found in depths > 30 m. Ascidians are only observed in 30 - 40 m and the sea whip *Primnoella australasiae* is only found in depths > 50 m (Ierodiaconou *et al.* 2007).

Fish

The blue-throated wrasse *Notolabrus tetricus* and rosy wrasse *Pseudolabrus psittaculus* are common on the subtidal reefs (Monk *et al.* 2010). Large schools of purple wrasse *Notolabrus fucicola* have been observed on the shallow nearshore subtidal reefs in approximately 7 to 10 m (Plummer *et al.* 2003; Ball and Blake 2007). Western blue gropers *Achoerodus gouldii* have been observed in the high profile reef systems in 50 m of water west of Cape Duquesne (Ierodiaconou *et al.* 2007). Sea sweep *Scorpis aequipinnis* and marble fish *Aplodactylus arctidens* occur on the reef (Plummer *et al.* 2003). Very high abundances of juvenile sea sweep *S. aequipinnis* congregate in shallow subtidal gutters in the near-shore rock platform during November (Plummer *et al.* 2003). Also observed in shallow waters in the MNP are moonlighters *Tilodon sexfasciatus*, magpie perch *Cheilodactylus nigripes*, zebra fish *Girella zebra*, yelloweye mullet *Aldrichetta forsteri* and painted dragonets *Eocallionymus papilio* (Plummer *et al.* 2003).

Water column

The water column is a large habitat in the MNP. It is important in different ways for many organisms including for transit or as a permanent home for particular stages of their life cycle. Organisms that use the water column environment can be broadly grouped into two categories based on mode of movement: either pelagic (actively swimming) or planktonic (drifting with the current). Larger species are often planktonic during early life stages before becoming pelagic as they grow. Smaller species tend to be planktonic but can influence their movement to some extent by controlling their height in the water column. Organisms that make their permanent home in the water column include sea jellies, salps, many fish, and both phytoplankton and zooplankton. Planktonic organisms play an important role in nutrient cycling, dispersal of species and providing food for larger animals, both within the MNP and more broadly in the marine environment. The water column is also used by fish, invertebrates and algae for transport and food (and other resources like oxygen). 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 seabirds and mammals are found in the waters of Discovery Bay MNP.

2.1.4 SPECIES OF CONSERVATION SIGNIFICANCE

The approach of managing MPAs for their marine ecological communities, rather than threatened species, is 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 Discovery Bay MNP.

Fish

The open waters of Discovery Bay MNP are a probable habitat for the FFG listed threatened migratory southern bluefin tuna *Thunnus maccoyii*. Likewise the open waters could be used by the grey nurse shark *Charcharias taurus* which is listed as threatened in Victoria (*FFG*) and critically endangered nationally (*EPBC*). The great white shark *Carcharodon carcharias* threatened in Victoria (FFG) and vulnerable nationally (EPBC) probably also uses the waters of Discovery Bay MNP.

Birds

Fifteen conservation listed shore or sea birds have been sighted in or in the immediate surrounds of the Discovery Bay MNP (Table 3). Ten are recognized as threatened in Victoria, listed under the *FFG Act 1988* or the Victorian Rare or Threatened Species (VROTS) list. Two of these are regarded as endangered; the wandering albatross *Diomedea exulans is* listed as endangered at the state level, while the southern giant-petrel *Macronectes giganteus* is endangered at the national level.. Five birds listed as vulnerable at the national level have been recorded in the MNP. Ten migratory birds are recognized internationally under either CAMBA or JAMBA.

There are no registered sites of biotic significance in Discovery Bay MNP. To the north of the MNP hooded plovers *Thinornis rubricollis* have been sighted on the beach (Figure 7).

Table 3. Conservation listed shorebird and seabird records from Discovery Bay Marine National Park and surrounds.

		Victorian listing		National listing	International treaty	
Common name	**Scientific name**	**FFG**	**VROTS**	**EPBC**	**CAMBA**	**JAMBA**
wandering albatross	*Diomedea exulans*	L	EN	VU		J
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
black-browed albatross	*Thalassarche melanophris*		VU	VU		J
blue petrel	*Halobaena caerulea*			VU		J
hooded plover	*Thinornis rubricollis*	L	VU			
Caspian tern	*Hydroprogne caspia*	L	NT		C	J
Pacific gull	*Larus pacificus*		NT			
sooty oystercatcher	*Haematopus fuliginosus*		NT			
black-faced cormorant	*Phalacrocorax fuscescens*		NT			
sooty shearwater	*Ardenna grisea*				C	J
short-tailed shearwater	*Ardenna tenuirostris*					J
flesh-footed shearwater	*Ardenna carneipes*					J
Wilson's storm-petrel	*Oceanites oceanicus*					J

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

Marine mammals

Southern right whales *Eubalaena australis*, blue whales *Balaenoptera musculus* and southern elephant seals *Mirounga leonina* have been recorded in or near the Discovery Bay MNP (Table 4). Both the southern right whale *E. australis* and blue whale *B. musculus* are listed as critically endangered in Victorian waters and endangered nationally. The southern elephant seal *Mirounga leonina* is listed as vulnerable and as a migratory species at the national level (Table 4).

The intertidal reefs provide occasional haul-out areas for Australian fur seals *Arctocephalus pusillus doriferus* (Figure 11). To the east of the MNP on Cape Bridgewater there are two haulout colonies Australian fur seals *A. pusillus doriferus* (Kirkwood *et al.* 2003). One haulout has established a small breeding colony and pups between November and December. They are protected species under the *Wildlife Act 1975* and listed under *FFG Act 1988.* New Zealand fur seals *A. forsteri* are also recorded as hauling out at these sites and have

established a small breeding colony (Kirkwood *et al.* 2009). A tourism operator offers boat based seal viewing tours of one colony and the other can be viewed from land (Kirkwood *et al.* 2003).

Table 4. Conservation listed marine mammal records from the Discovery Bay Marine National Park and surrounds.

		Victorian listing		National listing
Common name	**Scientific name**	**FFG**	**VROTS**	**EPBC**
southern right whale	*Eubalaena australis*	L	CE	EN
blue whale	*Balaenoptera musculus*	L	CE	EN
southern elephant seal	*Mirounga leonina*			VU, M
New Zealand fur seal	*Arctophoca forsteri*		VU	L
Australian fur seals	*Arctocephalus pusillus doriferus*			L

L= FFG listed, VU = Vulnerable, EN = Endangered, M = listed Migratory

Figure 11. Australian fur seals *Arctocephalus pusillus doriferus* on an intertidal reef in Discovery Bay Marine National Park. Photo by Marcel Hoog Antink, Parks Victoria.

Species distribution information

An assessment of distribution, endemism and rarity of biota across the state found that Discovery Bay MNP has one endemic crustacean, the southern hooded shrimp *Athanopsis australis,* which is *FFG* listed in Victoria (O'Hara and Barmby 2000; O'Hara and Poore 2000). Seven algae and one invertebrate (Table 5) are at or presumed to be at their distributional range in the MNP (O'Hara and Barmby 2000; O'Hara and Poore 2000). The green algae *Palmoclathrus stipitatus* is at its eastern distributional limit and five red algae are presumed to be at their eastern distributional limit. One brown algae and a seastar are

presumed to be at their western distributional limit. The distributional limits of the biota 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 5. Marine species at their distribution limits in Discovery Bay MNP (O'Hara and Barmby 2000; O'Hara and Poore 2000; O'Hara 2002).

Order	Family	Species	Common name	Category
Tetrasporales	Palmellaceae	*Palmoclathrus stipitatus*	green algae	RE
Ectocarpales	Chordariaceae	*Chordaria cladosiphon*	brown algae	PW
Ceramiales	Ceramiaceae	*Ceramium monacanthum*	red algae	PE
Ceramiales	Ceramiaceae	*Ptilocladia vestita*	red algae	PE
Gigartinales	Gigartinaceae	*Gigartina densa*	red algae	PE
Gigartinales	Sarcodiaceae	*Trematocarpus concinnus*	red algae	PE
Nemaliales	Liagoraceae	*Helminthocladia beaugleholei*	red algae	PE
Forcipulatida	Asteriidae	*Smilasterias multipara*	seastar	PW

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 statewide consultative process to identify threats to MPA's. Through public and agency workshops, the natural values in individual MPA's 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). Two hazards with the potential to be of extreme risk to the Discovery Bay MNP were identified by Carey *et al.* (2007b). It was generally agreed that because of its exposure and remoteness, the park was subject to fewer threats than many of the other MPAs in Victoria (Carey *et al.* 2007b). They are listed in rank order and the habitat or area at risk within the park is indicated in brackets:

1. Poaching of abalone near Blacks Beach resulting in decreased abalone populations in the park (intertidal and subtidal reef); and
2. Lack of ecological knowledge affecting park habitats, communities and processes (whole of MNP).

The introduction of marine pests also 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 limited to Port Phillip Bay (Parks Victoria 2003). No introduced species or marine pest has been recorded from the Discovery Bay MNP (Parks Victoria 2007a). An exotic marine pest survey of the Portland harbour to the east of the MNP found a total of nine exotic species: the toxic dinoflagellate *Alexandrium tamarense*; the bottom-dwelling sabellid tube worms *Euchone* sp.1 and *Myxicola infundibulum;* the bottom-dwelling molluscs *Corbula gibba, Musculista senhousia* and *Theora lubrica;* and the bryozoans *Bugula dentata, B. neritina* and *Watersipora subtorquata* (Parry *et al.* 1997). The small (25 mm) sabellid tube worm *Euchone* sp.1 was the only species abundant enough to cause a significant ecological impact in the harbour. *Grateloupia turuturu, Caulerpa racemosa* var. *cylindracea* and *Codium fragile* ssp. *fragile* were also recorded in Portland harbour in 2010 (John Lewis pers. comm.). Japanese kelp *Undaria pinnatifida* has recently been found in Apollo Bay harbour and there are grave

concerns about its spread to other MPAs on the west coast. It is thought that the introduced green shore crab *Carcinus maenas* is not found within the MNP as the coast is too rough. To the east in Flinders Bioregion the Northern Pacific seastar *Asterias amurensis* was found in Anderson Inlet and may have been eradicated in a broad-based community effort in 2004–05, led by DSE (Parks Victoria 2006a). *Asterias* was also found at San Remo jetty in late 2011. Further east in the Twofold bioregion the introduced New Zealand screw shell *Maoricolpus roseus* has been recorded in high densities (Holmes *et al.* 2007b). This species is regarded as a serious threat to the high diversity of infauna that is characteristic of much of Bass Strait (Patil *et al.* 2004; Heislers and Parry 2007). Other species of particular concern include the marine fanworm *Sabella spallanzanii* and broccoli weed *Codium fragile (subsp. fragile)* (Parks Victoria 2003).

A virus affecting abalone called abalone viral ganglioneuritus has been slowly spreading east along Victoria's west coast. This virus can kill a large percentage of abalone in an area and has been confirmed from Discovery Bay MNP to Cape Otway (DPI 2009). Its long term ecological consequences for rocky reef communities are unknown (DPI 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).

Measures to address or minimise these threats form part of the management plan for the Discovery Bay MNP (Parks Victoria 2007a). For example research is being conducted into marine pest species, and investigations into water quality issues have also been conducted in relation to park values. 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.

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 Discovery Bay 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 6 and Appendix 2).

The Discovery Bay MNP does not have an ongoing intertidal or subtidal reef monitoring program. A review of monitoring needs in relation to conservation outcomes for the park will be done by 2013. The major directions for monitoring include implementing an expanded and improved monitoring program following a review of the major findings taking into account knowledge generated since park declaration (Power and Boxshall 2007; Keough and Carnell 2009).

Table 6. Ongoing Research Partner Panel (and RPP-like) research projects and monitoring programs implemented in partnership with, or commissioned by, Parks Victoria relevant to Discovery Bay Marine National Park.

Ongoing RPP (and RPP-like) Projects
University of Melbourne: Kim Millers, Jan Carey, Mick McCarthy Optimizing the allocation of resources for defending Marine Protected Areas against invasive species.
Multiple Research Partners: Marine Monitoring and Marine Natural Values ***Deakin University:*** Jan Barton, Adam Pope, Gerry Quinn Marine Natural Values Reports for the Marine National Parks and Sanctuaries – Version 2. ***University of Melbourne:*** Jan Carey Developing Report Cards for the Marine National Parks.
Museum Victoria: Mark Norman, Julian Finn. ***Parks Victoria:*** Roger Fenwick Under the Lens - Natural History of Victoria's Marine National Park System.
University of Melbourne: Tarek Murshed, Jan Carey, Jacqui Pocklington Conceptual model development for marine habitats.
Ongoing Habitat Mapping Projects
DSE / DPI / Worley Parsons/ Deakin University LiDAR Mapping Project. Mapping of bathymetry and marine habitats along the Victorian coast

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 MPAs which are most at risk of invasion. This will help prioritise Parks Victoria surveillance monitoring efforts to MPAs where there is greatest potential for successful management.

2.1.7 KNOWLEDGE GAPS

Some quantitative information has been collected on the intertidal reef biota. Knowledge of the subtidal reef ecological communities is based on qualitative video sampling in which the dominate habitat forming biota have been identified. Smaller or more cryptic biota is not well sampled by this method. There is no quantitative data on fish abundances, distributions or interactions in the subtidal reef (Figure 12) or water column habitats. Some information exists for subtidal soft sediment. Limited information has been collected on the soft sediment. Major threats have been identified for the Discovery Bay MNP but we have limited knowledge of the effect on the natural values, particularly ecological communities.