Nature Conservation Review:
Marine and Coastal Issues Paper

Appendices

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1.1 Twofold Shelf Bioregion

1.1.1 Key Environmental Features

The Twofold Shelf bioregion extends from McLoughlins Beach in the west to Twofold Bay in New South Wales. It also extends southward, along the eastern edge of the Finders Bioregion, to encompass the Kent Group in eastern Bass Strait. The continental shelf is relatively wide in the Ninety Mile Beach region, from McLoughlins Beach to Lakes Entrance, extending up to 120 kilometres offshore. From Cape Contran to Cape Howe, the shelf break is only 20-30 km offshore. The edge of the continental shelf off the Gippsland coast is indented by canyons, including adjacent to Deal Island, Lakes Entrance and Point Hicks. These canyons join to form the Bass Canyon and have a significant influence on the productivity of the coastal and shelf ecosystems through influencing the oceanography.

The East Australia Current (EAC) is a dominant oceanographic influence in the Twofold Shelf bioregion. Although it is relatively warm, it is depauperate in nutrients. The EAC is stronger in summer and, although it separates from the coast in New South Wales, westward incursions along the Twofold Shelf coasts occur in summer. The EAC creates warm core, anticyclonic eddies in both winter and summer which can travel along the shelf break.

During winter, there is a predominant easterly flow of denser, saline and colder water through Bass Strait (Baines *et al.* 1991). This flow is diverged at Flinders Island to the south through Banks Strait and to the north along the shelf at Ninety Mile Beach. This denser water drains down the Bass Canyon system, producing the Bass Cascade. The downward flow causes increased mixing on the shelf to augment the winter overturn (Tomczak 1985; Gibbs *et al.* 1986). Winter overturn in the region is also induced by storms and currents around warm core eddies from the EAC.

Cold water upwellings frequently occur during summer along the coast between Lakes Entrance and Gabo Island. This upwelling has a substantial effect on surface temperature, which can be 14-15º C compared with 20-23º C offshore (Rochford 1977). This upwelling introduces considerable nutrients to coastal waters, with nitrate concentrations of 2-1 ug/L compared with < 0.5 ug/L in surrounding surface waters (Rochford 1977). The upwelling is caused by counter-currents caused by warm core eddies or the detachment point of the EAC from the shelf break. These processes draws water from below 100 m depth up the canyons indented in the continental slope,

typically in the Point Hicks region. This upwelling is not thought to be wind driven (Rochford 1977).

These oceanographic processes elevating nutrient levels result in the Twofold Shelf region being a hotspot of biological productivity (Prince 2001).

The Twofold Shelf coast has a predominance of southwesterly and easterly weather patterns in summer, with a predominance of southwesterly to northerly winds in winter. The region is highly exposed to swells from the southern ocean to the south and the Tasman Sea to the east and southeast. The temperature range is generally 13-14 degrees in winter to 19-21 degrees in summer.

1.1.2 Coastal Landscape and Shore Habitats

A prominent feature of the Twofold Shelf bioregion is Ninety Mile Beach, a long beach with southeasterly aspect extending from McLoughlins Beach to Lakes Entrance and Red Bluff. The beach is backed by a dune barrier formation and encloses coastal lakes, lagoons and marshes from Seaspray to Lakes Entrance. The dune barrier is comprised of 1-13 parallel dune ridges. The foredune is up to 5-8 m high and is generally vegetated by an *Acacia* or *Leptospermum* scrub, or grasses in places. The beach habitat is highly dynamic, with beach ridges being formed during calmer weather, typically summer and being cut away during storms. There is a predominant transport of sand to the northeast from prevailing south westerly weather, however easterly weather can reverse this process. Sand bars and gutters can occur within the surf zone.

Lakes Entrance consists of an artificial cut in the foredunes in 1889, creating a shipping channel to Gippsland Lakes. Just inside the cut are a series of channels and waterways with sandy shores. Either side of the cut is lined with rocky rubble, with a groyne at the western side of the entrance. The channel is regularly dredged.

Red Bluff, near Lake Tyers is a sandstone marine cliff with lenses of pebbles, clay and gravel. The cliff has a shore platform at the base is the only naturally occurring intertidal rocky habitat in the Lakes Entrance region.

A dune capped sand barrier formation extends for approximately 50 km from Red Bluff to Point Ricardo, east of Marlo. This dune barrier encloses a complex of swamps and lagoons and block or divert the mouth of several creeks and rivers. The dune is fronted by a narrow steeply sloped beach.

The section of Croajingolong Coast from Point Ricardo to Rame Head consists of southerly aspect sandy beaches with hind dunes punctuated by occasional rocky points, including Cape Conran, Pearl Point and Point Hicks. There are outlets to streams and creeks along each of these beaches, with beach barriers often creating estuarine lagoons.

The larger lagoons and inlets include Sydenham Inlet (Bemm River) and Tamboon Inlet (Cann River).

Point Hicks is a prominent granitic headland with highly exposed shores on the south and east. The intertidal shore is steeply sloped, dissected with gutters and gulches and is subject to high wave action, which is made more turbulent by bombies and barrier reefs 10s of metres offshore.

From Rame Head to Little Rame Head, the coast has a similar beach/headland morphology, but with a southeasterly aspect. Prominent features include Wingan Inlet, with The Skerries, a group of low reefs immediately offshore.

The 18 km of coast between Little Rame Head and Mallacoota consists of strongly folded Ordovician sandstones, shales, slates and cherts. There are boulder and cobble beaches and rocky shore platforms. The shore platforms are highly serrated and intersected by gutters and rock stacks. There are only small patches of sandy beach, which create bars across small lagoons at the mouth of creeks. The shore platforms are backed by a low terrace, possibly a relict marine platform.

Bastion Point is a prominent feature at Mallacoota and consists of low rocky reef backed by cliffs and bluffs extending to the north, to form a moderately sheltered cove to the east. Sandy beaches are present either side of Bastion Point.

Mallacoota Inlet is fronted by a dune covered spit with a tidal delta just inside the entrance. This delta has sandy spits and bars as well as more stable islands supporting saltmarsh habitat. The sandy outlet barrier often fully blocks the inlet entrance.

A sandy beach with grassy foredunes extends northeastward from the entrance to Mallacoota Inlet. Sandy cuspate projections extend seaward in the lee of Tullaberga and Gabo Islands. Freshwater lakes, Lake Barracoota and Lake Wau Wauka occur behind the dune system with occasional drainage of Lake Wau Wauka across the beach.

Tullaberga Island consists of outcrops of Ordovician rocks and red Devonian granite. Gabo Island consists of dune covered granite.

Higher dunes with blowouts are present from Telegraph Point to Cape Howe. The foreshore in this region is predominantly sandy except for a small rocky outcrop at Iron Prince Reef, consisting of tilted sandstone and shale. Much of the intertidal shoreline from Iron Prince Reef to Cape Howe consists of steeply sloping boulder and cobble beach. Woodland scrub and swamp habitat occurs behind the dune system of this region.

1.1.3 Seascapes and Benthic Habitats

The seabed offshore from Ninety Mile Beach is predominantly moderately sorted fine to medium grained sand beds. These sediments have a moderate carbonate content of 10-50 % (Roob *et al.* 1999). This habitat slopes gently across a relatively wide section of continental shelf. The depth is 25-30 m at the edge of State waters, 3 nautical miles offshore.

Low profile outcrops of calcarenite reef occur parallel to the shore along the Ninety Mile Beach coast. These reefs occur in depths of 10-20 m, to approximately five kilometres offshore and are periodically scoured and inundated by sand. The full extent of these low profile reefs is unknown, however they appear to be more prevalent along the Seaspray to Paradise Beach area (Roob 2000). Patches are also known to occur offshore from Lakes Entrance (being popular fishing grounds). These intermediate depth, sandy reefs support predominantly sessile invertebrate habitat, in addition to thallose red algae habitat.

Lakes Entrance consists of relatively shallow tidal channels linking the sea with Gippsland Lakes. The channels are sandy, 1-4 m in depth, with sandy bars and banks. Seagrass beds are present on more stable sandy banks in places (Edmunds *et al.* 2007). The main channels are subject to scouring during occasional flood events and periods of high turbidity during plankton blooms arising in Gippsland Lakes (Judd *et al.* 2008). A bar-way and ebb-tide delta is present on the seaward side of the cut to Lakes Entrance. The delta creates a steeper sloped sediment bank with the toe occurring in 20 m depth, approximately 700 m offshore (Edmunds *et al.* 2007). Ebb-tide deltas are also present at the inlets at McLoughlins Beach and McGaurans Beach, but not at the inlets east of Lakes Entrance.

The sediment beds from Lakes Entrance to Cape Howe are generally medium to coarse grained sands with a low (< 10 %) carbonate content (Roob *et al.* 1999). Sediment beds comprise much of the seabed area in this coast section. The slope is relatively gentle between Lakes Entrance and Pearl Point (west of Point Hicks), with a depth of 35-40 m approximately 5 km offshore. The seabed slope is relatively steeper and more varied from Point Hicks to Cape Howe, ranging from 50 to 80 m depth at 5 km offshore (the State limit).

Reef habitats along the Corajingolong coast occur in isolated patches bounded by sand, generally around headlands such as Cape Conran, Pearl Point, Point Hicks, Petrel Point, Rame Head, Sandpatch Point and from Little Rame Head to Mallacoota Airport, Gabo Island and Cape Howe (McShane *et al.* 1986; Roob *et al.* 2000; Edmunds *et al.* 2001). Much of the reef area is medium to high profile in less than 10 m depth. The reef structures include flat reef, ridges, bombies, gutters and sand gutters. The subtidal reefs support a variety of kelp bed communities. Some patches at Bemm River, Petrel Point

and Island Point have low to medium profile reef extending into 15-20-30 m depth, supporting *Ecklonia* kelp bed communities.

The shallow reefs of Tullaberga consist of highly structured bedrock with tilted layers forming outcrops, gullies and flat surfaces. The reefs surrounding Gabo Island consist of areas of smooth, sloped bedrock, domed bombies with steep sides and boulder fields with interstices. The reefs of both of these islands have considerable areas of sea urchin barrens habitat, where high densities of long-spined urchin *Centrostephanus rodgersii* maintain reef surfaces denuded of thallose seaweeds and generally colonised by encrusting coralline algae. Gabo Island also has kelp habitat on the more exposed southern and eastern reefs. Patches of urchin barren habitat also occur in the Cape Howe and Beware Reef areas (O'Hara 2000; Edmunds *et al.* 2001).

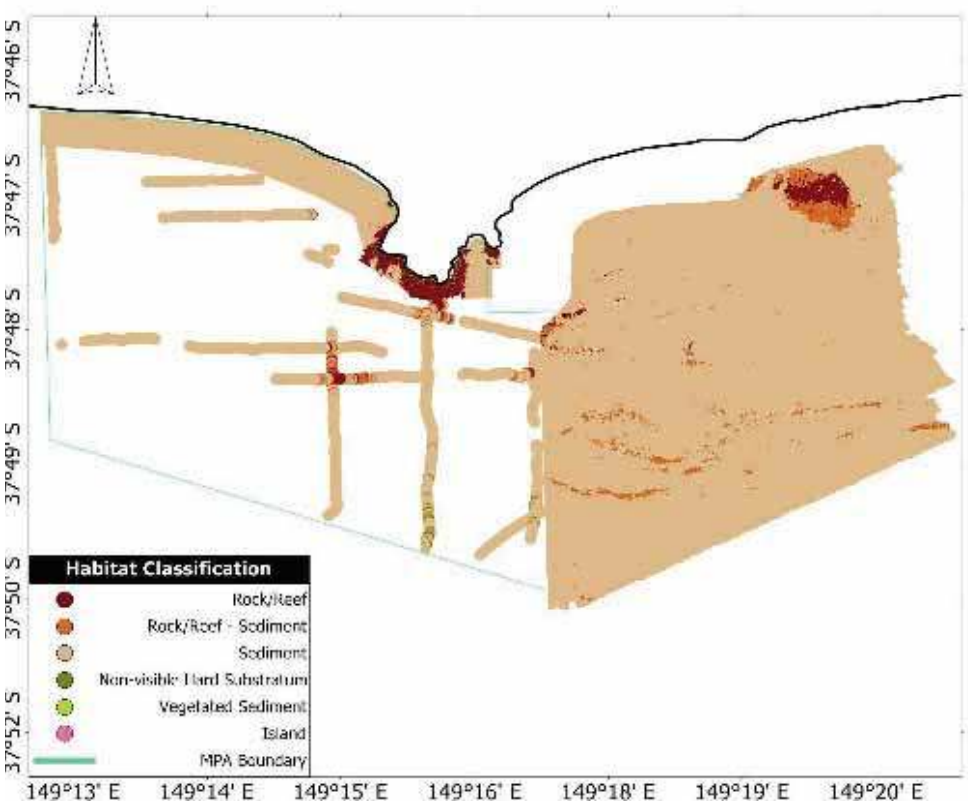
Complex reef habitats occur at Beware Reef, Sensation Reef (just west of Point Hicks) and at Point Hicks. These reefs have structures of high relief, including steep walls, bombies, pinnacles and gutters. Beware reef is a rocky outcrop situated 5 km southeast of Cape Conran. The basal area of the reef, at 30 m depth, is a strip approximately 500 m long and 100 m wide. The northwestern end of the reef has a peak rising to 2 m above sea level. The upper reef area supports high exposure kelp communities with the less exposed intermediate depths having urchin barrens and mixed thallose algae and sessile invertebrate habitat. Sessile invertebrate (sponge garden) habitat dominates the deep reef substratum.

Sensation Reef, 1.5 km to the east of Point Hicks, is a steeply sided reef complex, approximately 500 m across, extending up to 14 m depth. The top of this reef supports intermediate depth *Ecklonia* kelp bed habitat. Immediately below this habitat, on the granite slopes is a mixed invertebrate and diverse thallose algal habitat, grading into sessile invertebrate habitat deeper down (Edmunds *et al.* 2001).

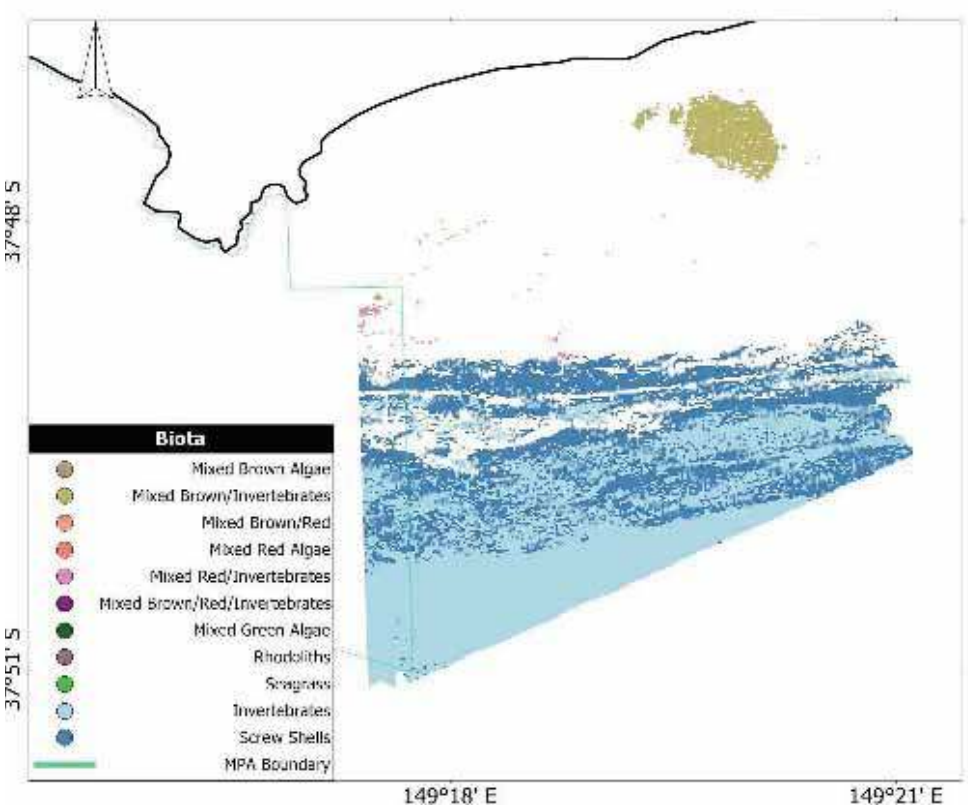
Point Hicks has a variety of reef substratum structures, including flat platform reefs bordered by sand, pinnacles and bombies, gutters, large boulders and highly dissected slopes (Figure 1). The subtidal reefs are highly exposed, which is reflected in the types of kelp habitats present (Figure 2-3). A notable feature are the front reefs and Whaleback Rock, which have high relief gutters of 1-15 m and a high area of sessile invertebrate habitat on the vertical walls (O'Hara 2000; Edmunds *et al.* 2001). Deep reef sessile invertebrate habitat occurs at 30 m depth occurs immediately south and southeast of Point Hicks and in deeper waters 2 km to the southwest (Ball and Blake 2007; Holmes *et al.* 2007 vol. 1). The characteristics of these reefs are presently undescribed.

Relatively extensive deep reef habitat also occurs offshore from Iron Prince and Cape Howe (Roob, Blake and Parry 1999; Roob *et al.* 2000). These two areas have 1.5-2 km long patches of low profile sedimentary reef with parallel ridges 0.5 m high and 3 m

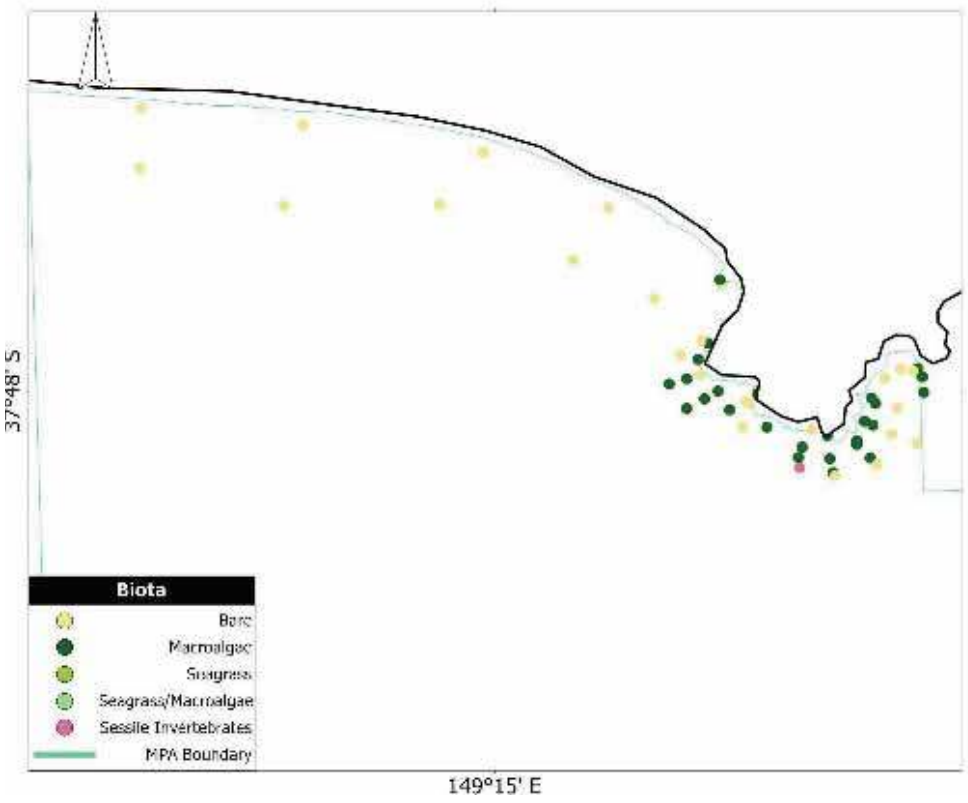
wide with gutters in between (Figure 4). The gutters at the Iron Prince deep reef are filled with sand. These reefs provide extensive habitat for sessile invertebrate biota (Figure 5; Roob, Blake and Parry 1999).



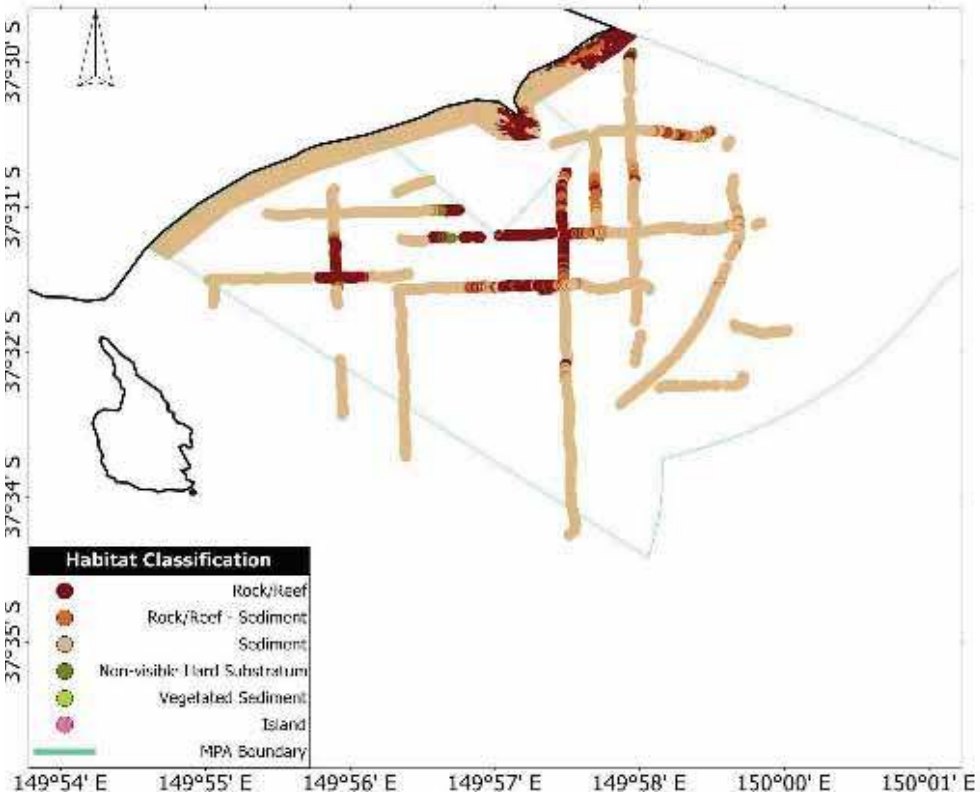
Appendix Figure 1. Reef and soft sediment habitats in the Point Hicks region.



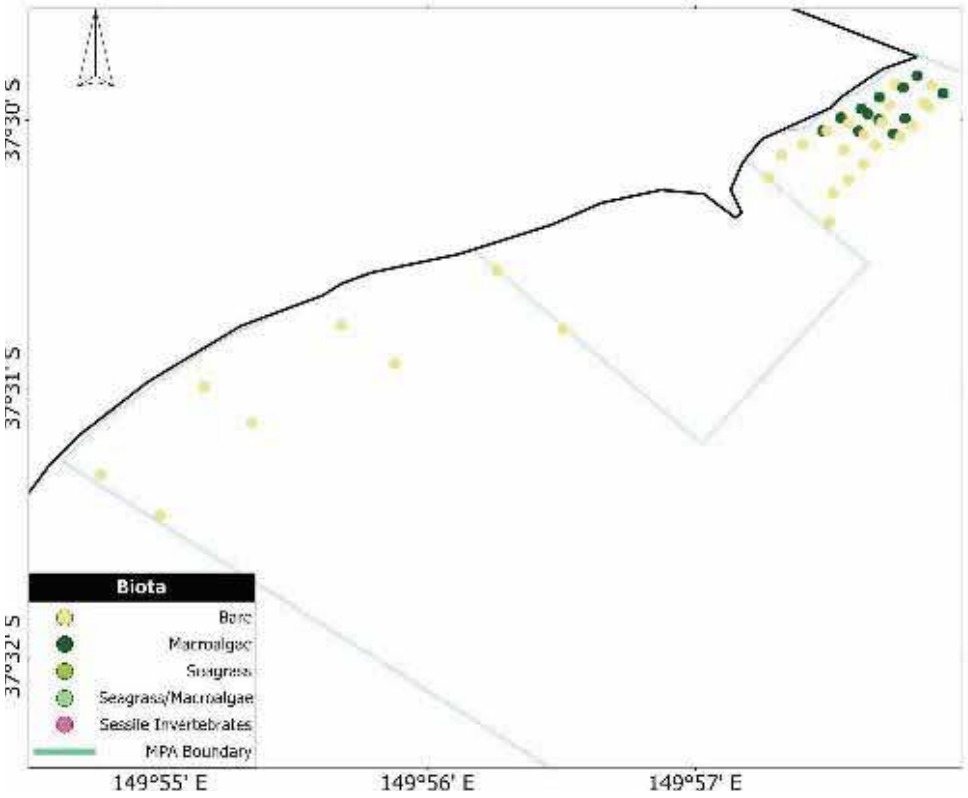
Appendix Figure 2. Habitat classifications at Point Hicks region showing biota predominantly of Screw shell areas and Invertebrates, a patch of mixed brown algae/invertebrates present closer to shore.



Appendix Figure 3. Point sampling studies at Point Hicks.



Appendix Figure 4. Reef and soft sediment habitats in the Cape Howe region.



Appendix Figure 5. Point sampling studies at Cape Howe.

1.1.4 Communities and Biodiversity

Intertidal Reefs

The intertidal communities of the Twofold Bioregion are different to most communities observed in the Otway and Central Victoria bioregions. Two exceptions are affinities with the community structure at Skenes Point and Artillery Rocks, in the western Central Victoria region. The communities share a resemblance with the less exposed sites of Wilsons Promontory, including Rabbit Island, Whisky Point and Waterloo Bay (unpublished data courtesy of Dr Tim O'Hara, Museum Victoria).

There are considerable differences in community structures between the rocky shores from Cape Conran to Gabo Island. Reefs at Cape Conron, Pearl Point and Rame Head have a dominance of the barnacles *Chamaesipho tasmanica*, *Chthalamus antennatus* and *Catomerus polymerus*. Communities on the far eastern coast, at Secret Beach and Bastion Point, also have a dominance of *C. tasmanica*, but in abundances half to a third of that present to the west. Characteristic species of the far east coast include the barnacle *Tetraclitella purpurascens* and snails *Nerita morio* and *Austrocochlea camerata* and the and limpet *Patelloida latistrigata*. The community on Gabo Island, near the eastern border of Victoria, is considerably different to the mainland communities, being more similar to Waterloo Bay and Whisky Point at Wilsons Promontory, having much higher abundances of the barnacles *C. tasmanica* and *C. attennatus* and the gastropod *Austrolittorina unifasciata*. The species richness of the intertidal communities tend to be higher to the east, between Rame Head and Bastion Point. Gabo Island has comparatively low species richness (unpublished data courtesy of Dr Tim O'Hara, Museum Victoria).

Subtidal Reefs

Communities of subtidal reefs in the Twofold Shelf Bioregion are distinctive in having a high component of eastern temperate species, in addition to many southern temperate and cosmopolitan species. Kelp beds comprised of the cosmopolitan species crayweed *Phyllospora comosa* and common kelp *Ecklonia radiata* are the principal canopy species throughout the region. Monospecific stands of *P. comosa* are prevalent in the far-east, at Iron Prince and Cape Howe reefs, and mixed *E. radiata* and *P. comosa* stands further to the west, from Cape Conran to Petrel Reef (Williams *et al.* 2007). Other habitat forming species include the string kelp and the bull kelp *Durvillaea potatorum*. The string kelp *Macrocystis angustifolia* has been abundant in Old Jetty Bay on the western shore of Point Hicks, providing vertical habitat structure from 2001 to 2006. It has since declined in abundance, as with most areas in Victoria, and was not present in 2008 and 2009 (Edmunds *et al.* 2001, Williams *et al.* 2007; Edmunds pers. obs.). Bull kelp *Durvillaea potatorum* is present throughout the bioregion, inhabiting the turbulent white water areas immediately below the intertidal zone. This habitat is largely restricted in area to the reef fringe, except for the more extensive shallow reef

complexes of Beware Reef offshore from Cape Conran, the tops of bombies around Point Hicks and Durvillaea Flats, immediately east of Point Hicks. Recent research indicated that the eastern populations of *Durvillaea potatorum* are genetically distinct from central and western Victoria and is possibly a different species (Fraser *et al.* 2009). This is of particular significance given large contractions in the range of *Durvillaea* in New South Wales.

A distinctive habitat modifier in the Twofold Shelf Bioregion is the presence of the sea urchin *Centrostephanus rodgersii*, which causes grazing barrens, bare of erect seaweeds. The urchin barrens generally occur as patches of metres to tens of metres interspersed by kelp canopy. The size of barrens is generally greater in areas of reduced water movement, including on intermediate depth reef, below 10 m depth, and on more sheltered reef. Urchin barrens are prevalent in the far eastern region, particularly at Cape Howe and around Gabo and Tullaberga Islands. Considerable sized urchin barrens are also present at Beware Reef and Cape Conran in the west. Only relatively small patches of urchin barrens are present amongst kelp habitat between these eastern and western regions, although there is anecdotal evidence that these patches have become more numerous and larger in size in recent years.

The seaweed communities of Twofold Shelf are distinguished in having a lack of green algae, as well as and filamentous turf and epiphytic brown ectocarp and red “acrochaetioid” algae (Kraft 2001). The Point Hicks region has a high biomass and diversity of thallose red algae understorey species, which can also form turfs where there is a break in the kelp canopy. Characteristic species include *Rhodymenia obtusa*, *R. linearis* and *Lophurella periclados* ((Edmunds *et al.* 2005). The flora indicate that reefs in the Point Hicks region are relatively pristine, stable, “climax” communities which contain rare and unusual species (Kraft 2001). Collections from just one excursion in 2001 discovered at least four new species and four rare species from the Bemm Reef to Point Hicks region (Kraft 2001; Australian Marine Ecology herbarium). The understorey algae in the Cape Howe region are generally much lower in biomass and slightly lower in species richness than the Point Hicks region.

1.1.5 Listed Species and Communities

The Twofold shelf bioregion contains habitats for five listed coastal and sea birds as well as two listed fish species. The Regent Honeyeaster (*Xanthomyza phyrgia*), Eastern Bristlebird (*Dasyomis brachypterus*) and Chatham Albatross (*Thalassarche eremite*) are listed as endangered under the EPBC. The Antipodean Albatross (*Diomedea antipodensis*) and White-capped Albatross (*Thalassarche steadi*) are considered vulnerable under the EPBC. Ewens Pygmy Perch, h is listed under both the EPBC and FFG Acts.

1.1.6 Ecosystem Services and Processes

A long stretch of sandy beaches backed by dune barriers with scrub vegetation and enclosing a complex of coastal lakes, lagoons and swamps occurs at the ninety mile beach region and from Red Bluff to Point Ricardo. The sandy beaches serve as recreational areas while the vegetated dunes help stabilize the coastline, prevent erosion and protect against flooding. The enclosed lagoons and wetlands provide sheltered habitats for fish, invertebrates and shorebirds. Coastal wetlands in these areas and at Mallacoota Inlet also capture and filter sediments and organic waste from the land to the ocean, helping to regulate water quality and reduce coastal water pollution. A number of estuarine lagoons occur along Croajingalong coast such as Sydenham Inlet and Tamboon Inlet. These estuarine environments, along with Mallacoota Inlet, are high in nutrients because of inputs from both freshwater and marine sources. Estuaries also serve as nurseries for juvenile fish and invertebrates. The Twofold shelf region is a productive, nutrient-rich area because of the upwellings that occur along the coast between Lakes Entrance and Gabo Island. Primary productivity in this area is greatly influenced by upwelling events and serves as important feeding grounds for seabirds, fish and marine mammals. The sandy beaches along this bioregion and the low profile reefs that occur parallel to the shore along the Ninety-mile beach area serve as important recreational and fishing spots.

1.2 Flinders Bioregion

1.2.1 Key Environmental Features

The Flinders bioregion encompasses a large granite mass that extends from north-east Tasmania, including Wilsons Promontory and eastern Bass Strait Islands of the Curtis, Hogan and Furneaux Groups. The northern part of Wilsons Promontory consists of an isthmus (Yanakie Isthmus) of marine and non-marine sediments and dune deposits. This connects the mainland with the eroded granitic masif that structures the southern section of the promontory.

The western coast of the promontory is exposed to the prevailing westerly and southwesterly weather, as well as swells entering western Bass Strait. The east coast is generally in the lee of prevailing strong winds, but is exposed to southeasterly and easterly weather patterns. The east coast is also subject to swells from the Tasman Sea.

The degree of wave exposure increases considerably from the north to the south of the coast, on both the eastern and western sides. Although the southern coast is exposed to both east and westerly swells, the highest energy coasts are with a southwest aspect: Point Oberon to Southwest Point and the west coasts of the islands.

Wilsons Promontory marks the eastern-most range of the eastward flowing South Australia Current waters. The promontory is also under the influence of East Australia Current Water from the east, Northern Bass Strait Water and sub-Antarctic surface waters which enter Bass Strait in winter and spring. The Central Tasman Water also influences Wilsons Promontory from the southeast.

Relatively strong tidal and wind currents are present along the south coast and around the Glennie Group, of 1-2-2.5 knots. The temperature range is approximately 13-18 degrees, but can be occasionally up to 20 degrees in summer.

1.2.2 Coastal Landscape and Shore Habitats

The western coast of the Yanakie Isthmus consists of a 15 km beach punctuated by the entrance to Shallow Inlet. Vegetated dunes occur behind the isthmus beach, with the vegetation grading into coastal heathland and scrub. Along the southern extent of the isthmus beach (Darby Beach) are calcarenite cliffs up to 50 m high, along approximately 6 km of coast. The cliffs have flat, sandy platforms at the base with rocky slabs and debris along the shore. The calcarenite cliffs abut the western granite coast at the mouth of the Darby River, just north of Tongue Point. The mid-western coast consists of sandy beaches within bays segregated by a series of rocky, steep-sided points. Vegetated dunes occur behind each of the beaches, which grade into heathland

and scrub. A small estuarine lagoon is present at the mouth of Tidal River, to the south and east of Pillar Point.

The southwestern and southern coast, from Oberon Point to South East Point, consists of seacliffs and steeply sloped shores which are highly exposed to swells and seas. Boulder beaches are present at the base of steep coast south of Sea Eagle Bay and west of South East Point. Coastal vegetation in this area consists mainly of coastal scrub communities interspersed with heathlands.

Four groups of islands occur off the west coast: Shellback Island, Norman Island, Glennie Group and the Anser Group. These islands are relatively high (65-138 m elevation), providing a range of exposed and sheltered conditions between the leeward and windward sides. These islands, along with the points and rocky shores of the promontory, have steep, plunging shores on their exposed aspects. A boulder beach is present on the western shores of Norman Island and Great Glennie Island. Large seabird populations are supported by Norman Island, the islands in the Glennie Group, Anser Island, Kanowna Island and Anderson Islet in the Anser Group. A small colony of Australian Fur Seals is present on Norman Island while a large seal population occupies Kanowna Island and Andersaon Islet, both within the Anser Group.

The exposed western shores of Wilsons Promontory are subject to considerable swash and spray from swells breaking or running up the steep slopes. The islands and headlands are also subject to salt spray and salt laden winds and are typically inhabited by coastal tussock grassland.

The southeast coast of the promontory is generally sheltered from southwesterly swells, with refraction around the southern coast being restricted dampened by the Anser Group and South East Point. This coast is exposed to swells and weather from the east and Tasman Sea, but is the exposure energy is considerably less than on the southwestern side. The southeastern coast consists of steep, wooded slopes and rock shores, with small bights and bays, from South East Point to Waterloo Point and from Cape Wellington to Refuge Cove. Waterloo Bay, between Waterloo Point and Cape Wellington has beach habitat at the southern end, with boulder and steep bedrock shores along the north and heathland on the west. The coastline at the southern tip of Wilsons Promontory consists mainly of coastal scrub communities while the coastline from Southeast Point to Waterloo Bay is mainly woodlands.

Immediately north of Cape Wellington is a series of moderately exposed, steep shores interspersed with sheltered sandy bays, including Bareback Bay, Refuge Cove and Sealers Cove. The mid to northern shores, north of Sealers Cove, are predominantly sandy beaches with a rocky section at Monkey Point and Rabbit Island.

Seal Islands is a group of five small granite islands approximately 16 km east of Rabbit Island. These islands support a seal colony and seal haul outs as well as seabird colonies.

The granite rocky shores of Wilsons Promontory are typically smooth and relatively steep, plunging surfaces. There are no intertidal rocky platforms present, the calcarenite platforms at Darby Beach being sand affected, and the total intertidal rocky habitat area is relatively small. As mentioned above, the western and southern shores are subject to considerable wave swash and seaspray. This is reflected in much higher boundaries of terrestrial vegetation and a prevalence of distinctive coastal lichens on the bare, supralittoral rocks.

1.2.3 Seascapes and Benthic Habitats

Low to medium profile calcarenite reef is present offshore from the isthmus beach, from 10 km southeast of Shallow Inlet to Darby River (Roob 2000). These reefs are flat-topped with the low relief reef having a high sediment cover. The depth range is generally 10-20 m. Some areas have high complexity with stepped reef 1-1.5 m high with vertical cracks and gutters. The vertical faces of these steps and blocks are highly eroded and undercut, providing a high density of caves and crevices. These reefs support kelp bed habitat on the horizontal surfaces and sessile invertebrate habitat on the vertical surfaces (Edmunds, Chidgey and Willcox 2000).

The seascapes of the mid-western points, Tongue Point, Leonard Point, Pillar Point and Norman Point, each have a variety of granite reef habitat structures, varying over tens of metres. These include: smooth sloping bedrock, flat sandy bedrock, bedrock with deep vertical cracks, gutters and steps, massive boulders with caverns and crevices at the base, vertical pinnacles and boulder fields. Notable features include the pinnacles and caverns at the end of Pillar Point. The reefs of these points are bounded by sand within tens of metres from the shore with seaward depths of 10-15 m. these points support predominantly kelp bed habitats, in addition to significant areas of subtidal crevice and cavern flora and fauna.

The islands along the western and south coast of Wilsons Promontory all have very steep, high profile reefs on the seaward coasts. These reefs drop to sand at 25 to 50 m depth and include vertical walls, pinnacles and deep gutters. The faces of these steep or vertical reefs are generally smooth and provide habitat for high energy seaweed communities in the subtidal region (0-15 m) and sessile invertebrate communities in the intermediate and deep reef sections (10-30-50 m). Boulder fields with sand patches are often present at the base of these deep reefs.

Very deep bedrock and medium relief reef, 30-50 m depth, is present between the islands of the Anser Group (Anser Is, Kanowna Is, Cleft Is and Carpentaria Rock). This substratum is dominated by *Ecklonia* kelp bed habitat.

The sheltered coasts of Great Glennie Island and Norman Island have moderate relief structures that drop to sand in shallower water (5-15 m depth) close to shore. Shellback Island, the northernmost and less exposed island, differs from the other islands in having large boulder habitat on the southeast side and boulder-rubble habitat on the northern side. These leeward and boulder field reefs support subtidal kelp bed habitats.

The southernwestern region of the promontory, from Oberon Point to South Point generally has high relief, vertical reef face, massive boulder and stepped reef seascapes dropping steeply to sand at 40 metres depth. Subtidal boulder fields are present in the bays, including Sea Eagle Bay. Boulder fields are also present on the south coast in Roaring Meg Bay and west of South East Point. The south coast drops steeply to 30 m with a mixture of smaller seaweed and sessile invertebrate habitats. Boulder fields and low to medium profile reef outcrops occur to hundreds of metres south of the shore, supporting seaweed and sessile invertebrate habitats.

The more exposed reefs of the southeastern coast, from Southeast Point to Refuge Cove tend to be less complex, smoother and slope more gently than the western coast reefs. Vertical steps gutters and bombies are also present, providing medium and high relief structures. An exception is north Waterloo Bay and Cape Wellington, where there are steep drop-offs and ledges with complex structure. These reefs are dominated by kelp bed habitat.

More sheltered subtidal reef habitat is present within Fenwick Bight (north of Fenwick Point, southern and northern Waterloo Bay, Bareback Bay, Horn Bay and north Horn Point. These areas support non-kelp bed seaweed communities. The reefs further north, at The Hat, Monkey Point and leeward side of Rabbit Island are relatively sheltered and non-complex (smooth) reef structures. These reefs are also subject to higher water turbidity from Corner Inlet and generally support sparse or mixed seaweed habitats (O'Hara 2000; Edmunds, Roob and Ferns 2000). An exception is the seaward, exposed side of Rabbit Island, which supports an *Ecklonia* kelp bed (O'Hara 2000).

Sediment beds predominate around Wilsons Promontory. The sediments on the western and southern areas are generally 40-70 m deep, from within 1-2 km of the shore. These sediments are generally coarser with a composition of high shell fragments. Despite the high exposure of this area, resuspended sediments tend to settle quickly, contributing to high clarity water conditions. The shell fragments provide substratum for sponge and sessile invertebrate communities, particularly at and beyond 50 m depth (Wilson *et al.* 1983).

The sediment beds on the eastern side are generally shallower, 20-50 m depth. Shallow sandy banks are present north of Rabbit Island, near the entrance to Corner Inlet.

Heterozostera seagrass habitats are present at Shellback Island, Norman Bay, Oberon Bay and Refuge Cove (Wilson *et al.* 1983; O'Hara 2000). *Amphibolis* and *Halophila* seagrass beds are present at Shellback Island and in southern Waterloo Bay (Roob, Blake and Parry 1999; O'Hara 2000). *Amphibolis* is also present on eastern Great Glennie Island (O'Hara 2000).

1.2.4 Listed Species and Communities

The Flinders bioregion which includes Wilsons Promontory has numerous species of marine species at their easternmost or westernmost distribution ranges, however there are no listed marine invertebrates to date in this bioregion. The habitat of the endangered Eastern Bristlebird is likely to occur in the southeast half of Victoria, from the eastern side of Wilsons Promontory. The Wilsons Promontory national park also contains the southernmost stands of White Mangroves in the world.

1.3 Central Victoria Bioregion

1.3.1 Key Environmental Features

The central region of Victoria is from Apollo Bay in the west to Cape Liptrap in the east. The major bay regions of Port Phillip Bay and Western Port that are located in central Victoria are discussed separately in the Bays and Estuaries Section. Most of the coast within this area is sub-maximally exposed.

The region is divided into two general aspects on either side of the central bays. To the west of Port Phillip Bay the coast has a southeasterly aspect while to the east of Western Port the coast generally faces southwest. The two aspects are subject to very different wave environments. The southeast aspect is less exposed to the high energy waves from the southern ocean, although waves do refract around Cape Otway. The southwest facing coast is subject to high incident wave energy as southwesterly winds, with speeds of up to 25 metres per second, dominate. Wave heights along this southwest facing coast have a mean of 2 m with maximum wave heights up to 7.7 m (Harrison *et al.* 2008).

The central Victorian region is influenced by currents in Bass Strait. Currents in Bass Strait are predominately tidal. These tidal currents move between Cape Otway and Cape

Liptrap in a clockwise (southeasterly) and anti-clockwise (northwesterly) direction during flooding and ebbing tides respectively. The wind driven currents can be superimposed over the tidal oscillations. Water composition in Bass Strait is influenced mainly by the South Australian Current from the west, which is strongest in the winter, and to a lesser extent by the Sub-Antarctic Surface Waters from the south. The waters of Bass Strait are well mixed with little stratification over winter and most of spring, while in summer the Bass Strait waters nearer to the eastern side becomes stratified. Northern Bass Strait waters can stagnate with little flushing during calmer wind periods.

Sea surface temperatures in central Victoria vary seasonally between 12-21° C (Harrison *et al*. 2008).

The Nobbies on the western side of Phillip Island supports the largest population of Australian fur seals in Australia, while Mud Islands in the Port Phillip Heads region provides important nesting habitat for many seabirds.

1.3.2 Coastal Landscape and Shore Habitats

Hayleys Point is located in Marengo marine sanctuary. It is a rocky sandstone outcrop. The next 2 km east, to Point Bunbury, the coast consists of high limestone cliffs. Point Bunbury marks the beginning of Apollo Bay. Bund the point a main breakwater faces the west with a smaller breakwater to the east enclosing a 19 ha shallow water marina. Apollo Bay is a well protected, crescent shaped sandy beach with some rocky limestone areas at its eastern end.

Lorne is situated approximately 50 km east of Apollo Bay. Along this area of coast is the beginning of the Angahook-Lorne State Park. The park includes 21 359 ha from Apollo Bay in the south west to Anglesea further east. Lorne has protected flat sandy beach area that has been well developed. The vegetation is heathy due to the combination of low nutrient soils with relatively low annual rainfall (800 mm per year). This area contains the Coastal Moonah Woodland community which is listed as a threatened community under the *Flora and Fauna Guarantee Act 1988.*

The coastal areas between Lorne and Torquay include the main coastal towns of Aireys Inlet, Anglesea and Point Addis. The area is characterised by cliffs, dune systems, sandy beaches and shore platforms. Exposed calcarenite cliffs face the ocean, followed by dunes containing Coastal Dune Grassland and Coastal Dune Scrub. Headland Scrub follows including Coast Dabush, Coast Tea-tree, Coast Wattle, Coast Beard-heath. The area contains Coastal Moonah Woodland, listed as threatened under the Victorian Flora and Fauna Gurantee Act, 1988. The coast between Point Grey in Lorne and Split Point just before Aireys Inlet is concave. Eagle Rock Marine Park is located approximately 1 km off shore. Anglesea is 10 km east of Aireys inlet. Anglesea has beaches sheltered

by Point Roadknight. Sandstone cliffs are found along the coast to Point Addis. *Grevillea infecunda* is a coastal species that is endemic to the Anglesea area. It is listed under both the Australian Environment Protection and Biodiversity Conservation Act 1999 as "threatened" as well as under the Flora and Fauna Guarantee Act 1988, Victoria. Point Addis is situated 7 km east of Anglesea. This area has sandstone cliffs that overlook sandy beaches. The Point Addis Marine National Park covers nine kilometres of coastline centred on Point Addis from east of Anglesea to Bells Beach including three nautical miles offshore. The intertidal reef off the coast consists of limestone (O'Hara *et al.* 2002). Bells Beach is connected to Point Addis by 5 km of cliffs, located approximately half way between Anglesea and Torquay. There are many intertidal platforms along bells beach including Winki Pop. The cliffs have low vegetation and continue to Torquay. Torquay has flat sandy beaches that reach to the base of the cliffs.

Barwon Heads is situated approximately 20 km east of Torquay. The Barwon Bluff Sanctuary extends off large rocky headlands. The majority of the cliffs are limestone. The area has more than 80 indigenous species of grasses; herbs, twiners, ground covers, shrubs and spectacular coastal wildflowers. There are diverse plant communities including Prickly Stipa grassland. The western side has a large intertidal sandstone platform that slopes gradually to 10 m depth subtidally. The Barwon River runs into the sea at the eastern side of Barwon Heads.

Port Phillip Heads is located at the southern end of Port Phillip Bay. The heads are between Point Lonsdale and Point Nepean, forming the narrow entrance to Port Phillip Bay. Point Lonsdale is located 20 km east of Barwon Heads, it includes 3 km of coastline and Point Nepean includes 6 km of coastline. The peninsulas consist of weathering dune limestone cliffs. In Point Lonsdale the cliffs are up to 15 m high. Shore platforms extend into the intertidal areas of the Rip. The intertidal reef platforms at Point Lonsdale and Point Nepean are calcarenite. They contain the highest invertebrate diversity of any calcarenite reef in Victoria.

Mornington Penninsula includes the coastline stretching from Port Phillip Bay to Western Port Bay. It consists of a long stretch of beaches and cliffs. From Point Nepean to Cape Schank the coastline has tall basalt cliffs reaching the water. The Point Nepean National Park covers this coastline. Cape Schank is approximately 29 km from the Port Phillip Heads. It is a protruding point of basalt cliff. A well known attraction of the area is Cape Schank Lighthouse which was built in 1859.

The coast from Cape Schank to West Head is rocky cliff. West Head is a protruding point similar to Cape Schank and is the western entrance to Western Port Bay. Mushroom Reef Marine Sanctuary is situated along Mornington Peninsula before West Head. The area has sandy beaches as well as basalt pebble grounds backed by steep

rocky cliffs made of limestone overlaying basalt. Separating the reef from the shore is a cobble strip. The intertidal area is made from ancient basalt platforms from solidified lava. Flinders is just east on Mushroom reef along the Peninsula, forming part of the western entrance to Western Port. Flinders Foreshore Reserve includes rocky and sandy beaches backed by low dunes covered in coastal dune grasses. The area is a development of shore platforms consisting of sloping ramp, then a flat platform followed by the eroding seaward edge that meets the base of the highland cliffs. The foreshore within this area is highly modified including infrastructure such as pier and boat ramp.

Bass coast encompasses a diverse coastline including Phillip Island, Kilcunda, Wonthaggi then Inverloch. It includes Bunurong Marine Park which stretches 17 kilometres along the coast.

Phillip Island is approximately 26 kilometres long and 9 kilometres wide, located at the entrance of Western Port Bay. It is connected to the mainland town of San Remo via a bridge on the eastern side. The Nobbies, on the western side of Phillip Island is known as one of the most viewed coastal landscape in Victoria. It is famous for having the largest population of Australian fur seals worldwide. The coastal cliffs are made of basalt which has been fractured by the strong wave action in the area. On this point there are extensive intertidal basal platforms. Smith beach lies along the southern Phillip Island coast. It is listed as a site of significance due the presence of its quartzite ridge. The tough quartzite protrudes from the basalt shore platform. It is 2.5 m high and is the only example of its kind in Victoria. This platform extends for 10 m and is covered by water at most stages of the tide. Cape Woolami is situated further east along the southern edge of the island. It is an example of a tombolo system, defined as a spit which joins an island to the mainland. It includes an area where the granite of the main body of the island reaches volcanic rock, meeting dunes and beaches. San Remo lies on the eastern coast of the mainland where the bridge connects to the island. The basalt cliffs are an example of lava flows of the Older Volcanics.

Griffith Point is south of San Remo. From Griffith to Black Point to the east is rough cliff area. Cliffs continue from Black Point to Coal Point. On the other side of Coal Point there is intertidal reef, which is common throughout the Bunurong region.

Bunurong Marine National Park runs along the South Gippsland coast for about 17 km, from Coal Point, east of Cape Patterson, to Wreck Creek just before Inverloch in the east. The coastline is covered in rugged sandstone cliffs and sandy coves. The vegetation in the area is tussock grasses and low growing shrubs. Around the steeper cliffs there is Correa and Heath, within sheltered areas Coastal Banksia, Tea-tree and Boobialla. The marine park features extensive intertidal rock platforms and subtidal rocky reefs which extend several kilometres from shore, covered in relatively shallow

water. The Hooded Plover (*Charadrius rubricolis*) is a significant species within the area. Usually there are only a couple of pairs of these birds but it an important refuge area as the species are listed as vulnerable. The areas along Bunurong have sandstone intertidal platforms which are uncommon for the Victorian Coast.

The area from Coal Point consists of layered hard limestone and calcrete with ancient soils (paleosols) forming the dunes. Toward the east of the coastline is Harmers haven. This area is surrounded by submerged platforms. There are still some old tram trails from the 1850's that can be seen here.

The coastline between Cape Paterson and Inverloch is exposed. There are small sandy beaches backed by steep high cliffs formed by Cretaceous rock covered by little vegetation. Inverloch is where you will find Andersons Inlet. Sand banks in the Inlet are exposed during low tide and the banks are constantly changing due to strong water flows in the area. Along the foreshore small sandy beaches occur with heavy vegetation at the high tide mark. Dominant plant communities are Coast Wattle and Coast Tea Tree, along with saltmarsh. Coast Manna Gums are an integral part of the overstorey in Andersons Inlet.

Venus Bay is just over 25 km east of Inverloch. It is characterised by sandy beach coast up until Cape Liptrap where it becomes rocky shoreline. Just off the beach in Venus Bay there is a band of grassland, which is now dominated by an introduced species called Marram Grass. Inland behind the coastal shrub area consist of Coast Banksia growing above Coast Tea-tree, Coast Wattle, Coast Beard-heath, Swamp Paperbark, Sweet Bursaria, Drooping She-oak.

Cape Liptrap is a narrow peninsula. The coast is characterised by steep cliffs formed of folded marine sediment. There is a coastal park in the area that is dominated by heathlands consisting of Scented Paperbark, Common Heath, Scrub She-oak, Dwarf She-oak, Pink Swamp-heath, Prickly Tea-tree, Silver Banksia and Bushy Hakea. There are several rare fauna species which occur in the park thirty being threatened fauna species, including ten species listed as threatened under the *Flora and Fauna Guarantee Act 1988* Victoria. This area has outstanding exposure of Lower Palaeozoic rocks which make it a site of geomorphological importance.

Waratah Bay encompasses the coastline from Point Smyth to Sandy Point east, including Shallow Inlet. It is a secluded area of sandy beach backed by coastal shrub. Significant flora along the coast includes Bitter-bush, Marsh Saltbush, Slender Caladenia, Bog Gum, Currant-wood, Heathland Leek Orchid.

1.3.3 Seascapes and Benthic Habitats

The seascapes from Cape Marengo, just south of Apollo Bay, to Aireys Inlet generally consist of fringing shore platforms and reefs of low relief (Figures 6-12). The area of the inshore subtidal reefs is relatively insubstantial, meeting sand at or close to shore in a few metres of depth. Isolated patches of low profile reef occur to 10 m depth. The rocky points have greater areas of subtidal reef to sand at 5-10 m depth, particularly at Marengo (Storm Point to Haley Point), Apollo Bay, Sugarloaf Hill and Cape Patton (McShane *et al.* 1986; Roob 2000). Prominent subtidal reef structures on this coastal section are around the Little Henty Reefs, just offshore from Marengo, and extending 2.5 km offshore to Henty reef, which rises up to 5 m depth from 37 m depth. Such reefs are generally medium relief with bombies, gutters and sand gutters. There are areas of deeper reef along this coast, as indicated by lobster fishing and marine charts, however these areas have not been mapped or investigated in any detail.

Subtidal reef is more extensive along the coast from Spout Creek (Aireys Inlet) to Point Addis and from Point Danger to Point Lonsdale (Figures 10-19). These reefs either extend from the shore at the base of cliffs or bluffs, or occur behind sandy surf break areas along beaches (McShane *et al.* 1986; Ball and Blake 2007 vol 1). These reefs are generally low profile (< 1 m high), highly fragmented patches and sand affected, with sandy veneers in places. Some reefs are of higher profile, with steps and faces 1.5-2 m high and having highly eroded vertical faces crevices and undercuts. These occur between Ocean Grove and Point Lonsdale. Notable offshore structures include the small Ingoldsby and Olives Reefs at Point Addis and Charlemont Reef at Barwon Head.

Little is known about deeper reefs in the Aireys Inlet to Barwon Heads region. An exception is the offshore area within the Point Addis Marine National Park. A wide range of seascapes are present, including submerged river channels and shore platforms, as well as stepped and flat reefs (Kennedy 2005). All reef structures are low profile and generally sand influenced. This area has extensive patches of intermediate depth low profile reef with kelp and thallose red algal habitat. Deeper areas have rhodolith rubble fields, low relief parallel ridges with sand in the trough and sponge gardens on flat bedrock with sandy veneer habitat (Holmes *et al.* 2007 vol 3).

The Port Phillip Heads region, in the vicinity of Point Lonsdale and Point Nepean, is subject to very strong currents, generally 6 knots, with tidal waters having to pass through an entrance only 3 km wide. The area also has a southwesterly aspect and is highly exposed to prevailing southwesterly swells and winds. Interactions between swell, currents and winds at the Entrance make this area frequently turbulent, with a strong gradient of wave energy from outside the entrance to sheltered regions in the south of Port Phillip Bay. A substantial amount of sediment-laden water also passes through the entrance, from sediments entrained by eastward long-shore drift along

Lonsdale Back Beach, sediments suspended by heavy wave action and sediments resuspended from the Great Sands and associated channels during ebb tides.

The Port Phillip Heads region has particularly unique seascape and habitats. The seaward region of the entrance consists of an intermediate depth bank of rock (Rip Bank), at approximately 16 m depth. This bank slopes gradually to seaward to a depth of 30-40 m approximately 6 km offshore. Undersea banks are also present as westward projections of Point Nepean (Nepean Bank) and Point Lonsdale (Lonsdale Wall and Rip Bank). The banks provide habitat for kelp beds and seagrasses where there is a veneer of sand on the reef.

A steep sided canyon, 300 m wide and up to 100 m deep, meanders between these banks for approximately 1.5 km into the bay. The Entrance Canyon contains a diverse range of seascapes and seabed structures, including steep sided drop offs, gullies, rubble slopes, pinnacles, ridges, bluffs and overhangs (Edmunds, Gilmour *et al.* 2007). The vertical reef faces are highly eroded to cracks, crevices and deep caverns. The canyon widens and shallows to the north of the end of Point Nepean. Other deep reef wall and slope structures are present at Spec and Farside Reefs, further in the bay south of Queenscliff, and at Portsea Hole near Portsea. Low profile deep reef outcrops occur at Schnapper Deep in South Channel, north of Blairgowrie (Elias *et al.* 2004). All of these deep reefs support a range of sessile invertebrate ('sponge garden') habitats.

Other seascape features of Port Phillip Heads region are the sandy banks, including the Great Sands, Middle Ground and South Sand, and the tidal channels, including South, West, Symmonds, Pinnace and Sorrento Channels. These banks and channels form a flood-tide delta which extends eastwards to Rosebud and northwestward to St Leonards. The sandy banks support seagrass and seasquirt-*Pyura* (cunjevoi reef) habitats while the channels support bare, sponge and seapen habitats and communities. Mud Islands are low sandy islands vegetated with the largest stands of Coast Saltbush *Atriplex cinerea* in Victoria and are important seabird habitat. The islands are anchored in the middle of the Great Sands by phosphate rock, formed from seabird guano deposits.

Much of the area of shallow reef habitat in Port Phillip Heads is confined to Lonsdale Bight, however a diverse range of reef types are present in the region. This includes man-made islands at The Annulus and South Channel Fort, cobble and low profile reef at Shortland Bluff, patchy flat, sand affected reef at Nepean Bay and Portsea and high wave-exposed medium profile reefs on the seaward side of Point Lonsdale. These reefs support a range of kelp bed, seaweed and *Amphibolis* seagrass communities.

The seaward coast from Point Nepean to Cape Schanck is highly wave exposed. Although there are extensive lengths of intertidal reef along the shore, much of the subtidal surf zone consists of highly mobile sandy substratum or sand affected reef.

Although some shallow reefs are highly structured and of moderate relief, they are highly scoured by sand and heavy wave action. There is an extensive strip of calcarenite reef along this coast, from 12 m depth (Roob, Blake and Parry 1999). This reef generally includes low relief (< 1 m) flat and stepped structures, as well as patches of medium relief stepped and eroded reef (Chidgey *et al.* 1998). There are sandy patches throughout this reef system. Small patches of medium to high relief occur along the length of this coast, with an extensive complex reef substratum occurring between the Sorrento and Rye back beaches. The vertical faces of these higher relief reefs are highly eroded to form undercuts, caves and crevices. These reefs support kelp beds, mixed algal habitats and cavern fauna. Low profile calcarenite reef extends into deep water at the state limit (40-50 m depth). The type of habitat present at these depths consists of cobble and rubble with a high sand coverage and patches of low relief bedrock. The less sand affected rock supports red algae and sessile invertebrates (Roob, Blake and Parry 1999).

The Cape Schanck to West Head coast of Mornington Peninsula has extensive areas of subtidal reef. Much of the inshore substratum structure is medium to high relief and highly structured with outcrops, boulders, ridges and gutters (Figure 20). The reefs support kelp beds, however the inshore section is under cliffs and high shores and are highly shaded in winter. This reduced light climate is reflected in the type of seaweed communities present (Figure 21). Extensive areas of intermediate and deep reef are present further offshore. A large area of higher profile reef is present between 20 and 35 m depth, supporting kelp bed habitat (Roob, Blake and Parry 1999). Smaller patches of medium profile reef occurring to 50 m depth at the State limit. This deeper zone, 35-50 m depth, is predominantly low profile cobble, rubble and low bedrock habitat with varying degrees of sand cover. Sessile invertebrate habitats are on the higher relief patches and the cobble patches with reduced sand cover.

Flinders Bank is an extensive sandy bank, 21-23 m depth, extending to seaward from between West Head and Point Grant on Phillip Island.

There are extensive areas of subtidal and intermediate depth reefs along the southern coast of Phillip Island, interspersed by areas of sand. These reefs are generally of medium relief steps, outcrops and gutters or low relief platforms, but there are also many high relief reef pinnacles and bombies. Some nearshore coves and bays have sandy, cobble and boulder beaches that extend subtidally. Kelp beds are supported on the higher profile reefs, with the low profile reefs tending to be heavily scoured and sand affected. Little is known of the deeper offshore reefs, but there are areas that extend down to 30-40 m.

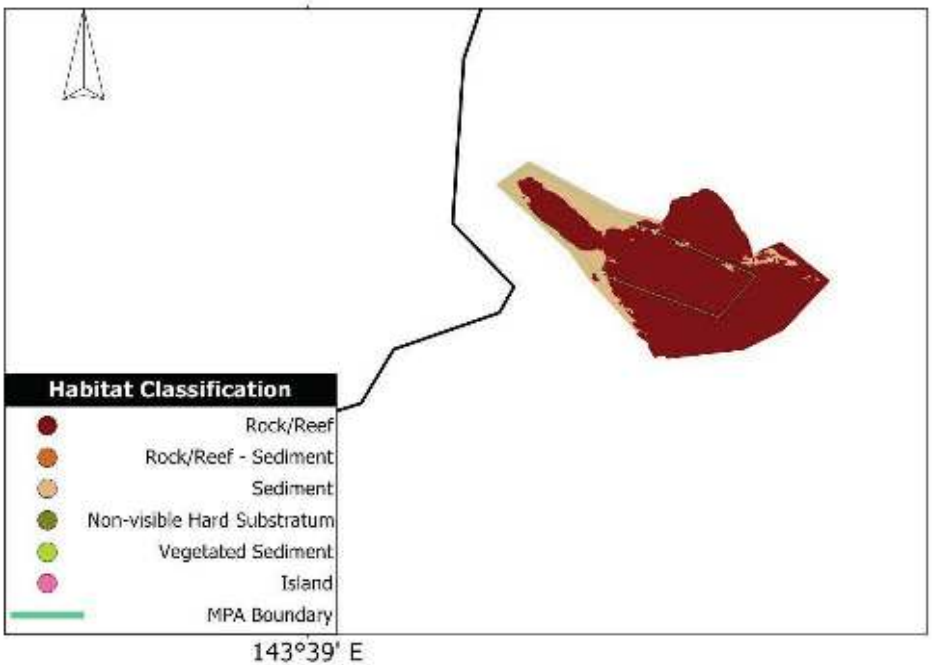
The Bass Coast from Griffith Point to Coal Point is predominantly sandy shoreline with patches of subtidal reef to 10 m depth. Surveys near the Powlett River indicate reef area

is generally more extensive behind the surf break (10-15 m depth), including moderate relief (1-2 m high) and low relief (< 1 m high) reef structures with sandy patches present and sandy veneers on some flatter reefs. These inshore higher profile reefs support kelp beds (Chidgey *et al.* 2008). Further offshore, approximately 20-25 m depth, the reef is lower profile with some outcrops, but a higher degree of sand coverage. These reefs support a mixture of red algae and sessile invertebrate habitat. The sand coverage increases in deeper water (> 25 m depth), with generally smaller patches of low profile reef and rubble patches with some outcrops. This reef supports sessile invertebrate habitat. The seaward extents of the reef substrata are unknown. The State limit is approximately 45 m depth.

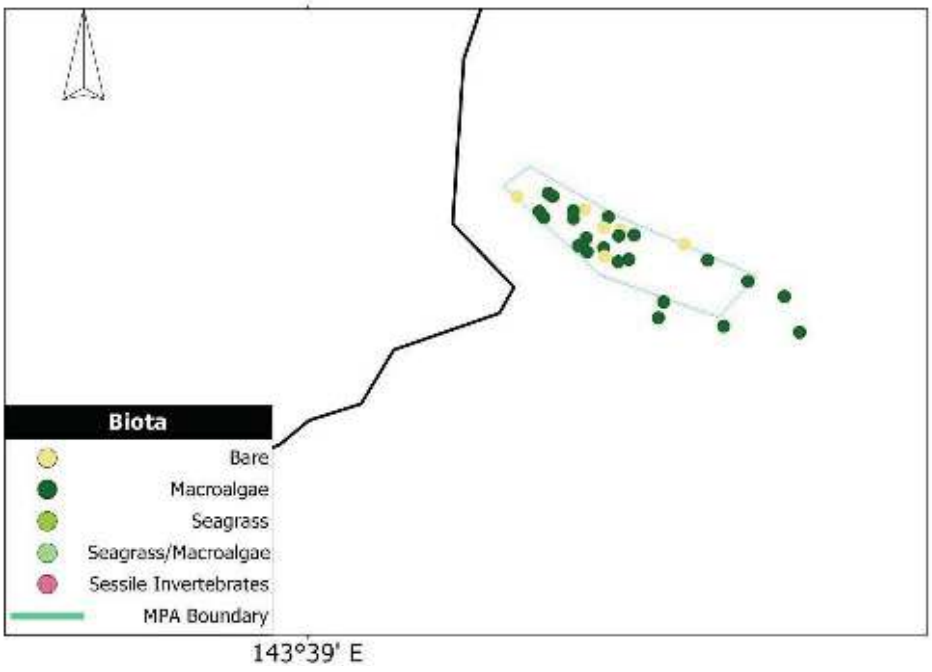
The subtidal habitat along the Bunurong coast, from Coal Point to Inverloch, consists of mosaics of low to medium profile reefs interspersed by sand patches. The shore generally consists of a platform at the base of cliffs and the seaward edges of these platforms generally drop steeply to 4-7 m, close to the shore. Many reefs abutting the shore consist of gutters, large rock slaps and eroded caverns and caves. Much of the subtidal and intermediate depth reef at Bunurong is low profile reef, including flat bedrock, low steps and rocky rubble, interspersed by sand patches (Ferns and Hough 2002). These reefs do not support kelp bed habitat, supporting a mixed algal habitat instead. Reefs with a higher sand exposure support extensive areas of *Amphibolis* seagrass beds. There are occasional higher relief structures offshore, largely formed by 1-2 m steps with vertical cracks and gullies and a high degree of undercutting. The substratum deeper than 30 m is generally small areas of sand affected low profile reef and cobble amongst sand beds. There are occasional emergent boulders and small reefs that support sessile invertebrates.

Sandy substratum is present along the coast of Venus Bay, from Inverloch to Arch Rock. Patches of complex reef are present at Arch Rock from 10 to 20 m depth, surrounded by sand.

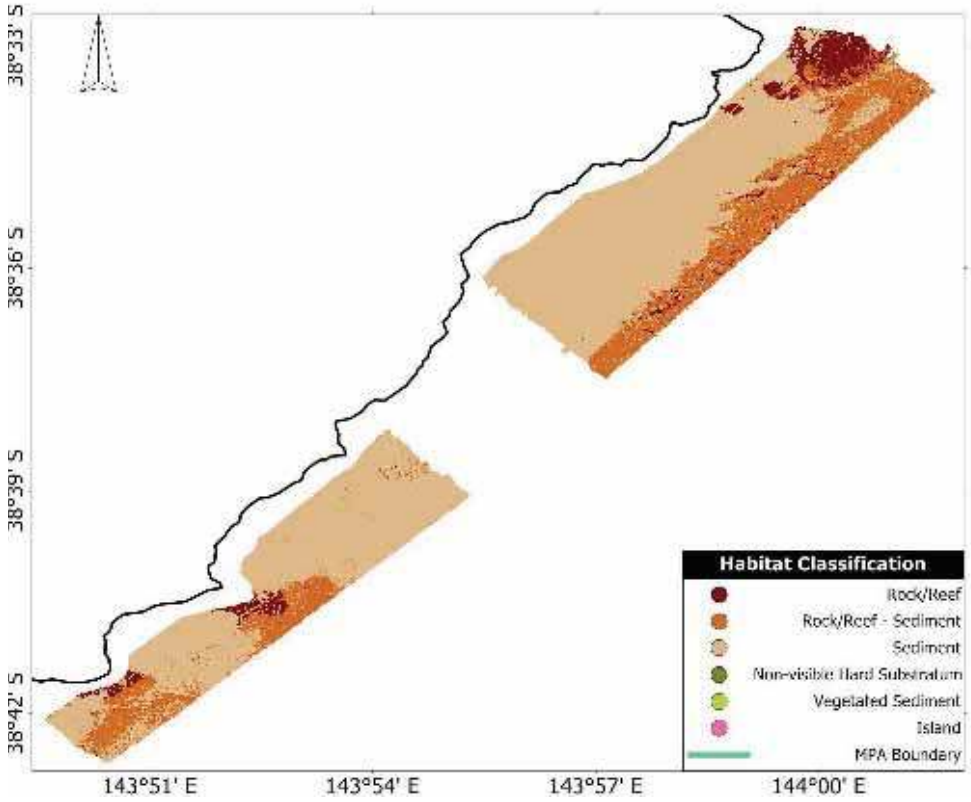
Cape Liptrap has considerable areas of subtidal and intermediate depth reef. The reefs on the southern section are generally moderate relief with slabs and gutters or roughly textured unbroken reef. Kelp bed habitats are present to 25 m depth. The substratum from 30 to 45 m depth is predominantly cobbles to pebbles embedded in sand with occasional low profile reef (Roob, Blake and Parry 1999). The cobbles are encrusted in coralline algae (rhodoliths) and a sparse community of sessile invertebrates and seaweeds is present. Low profile, sand affected reef is present along the shore from Cape Liptrap to Walkerville.



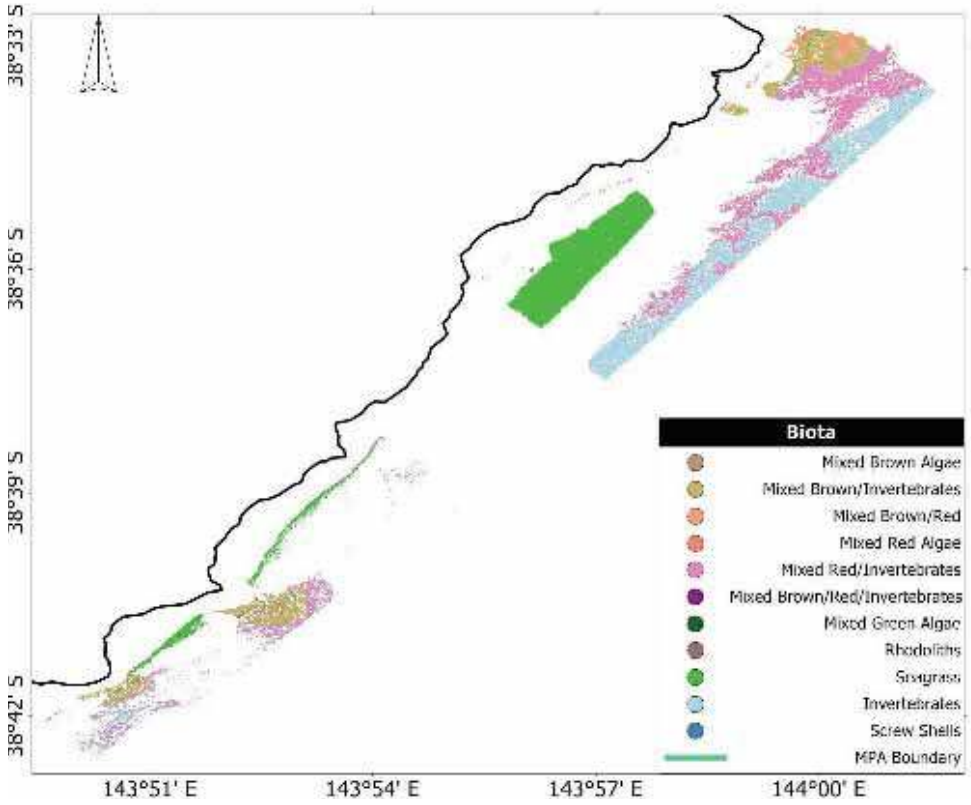
Appendix Figure 6. Substratum present at Marengo Reefs Marine Sanctuary.



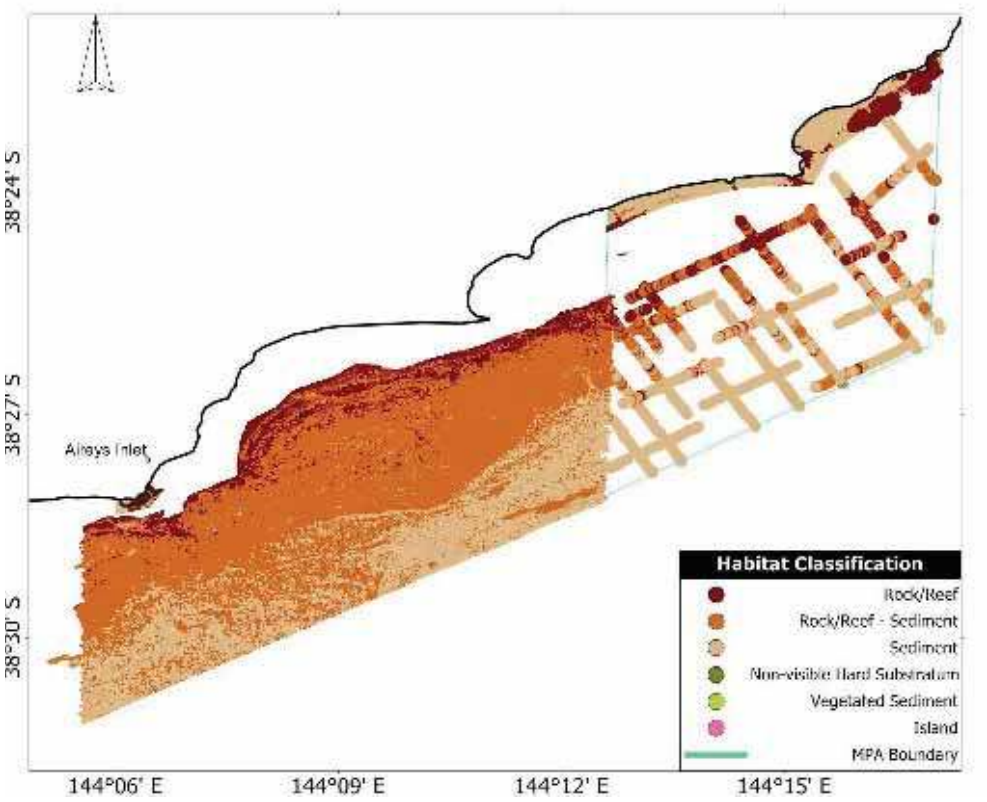
Appendix Figure 7. Biota present from point sampling studies at Marengo Reefs Marine Sanctuary.



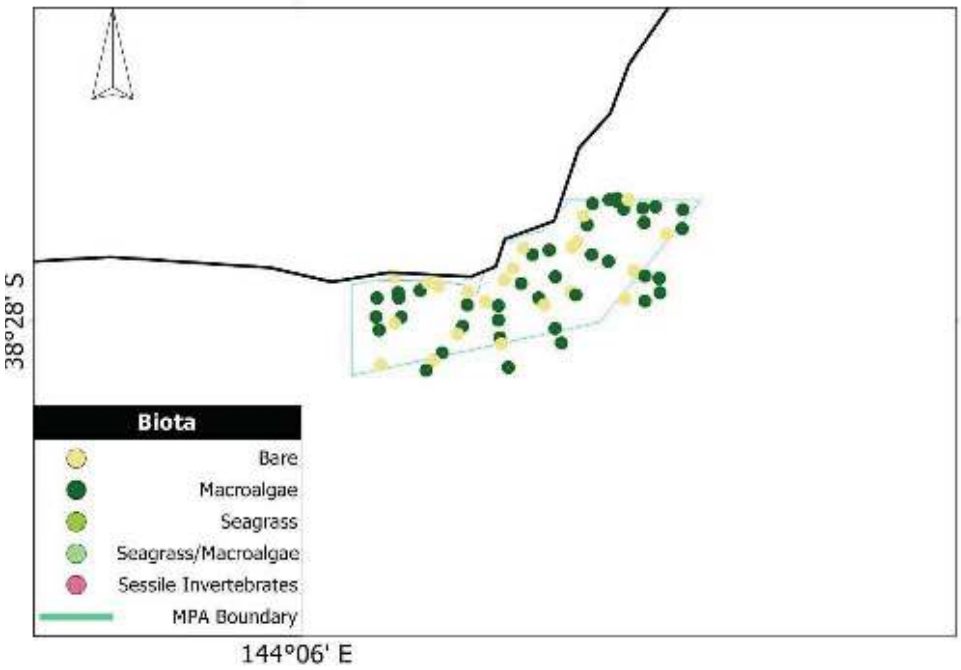
Appendix Figure 8. Substratum present at Kennett River and Point Grey.



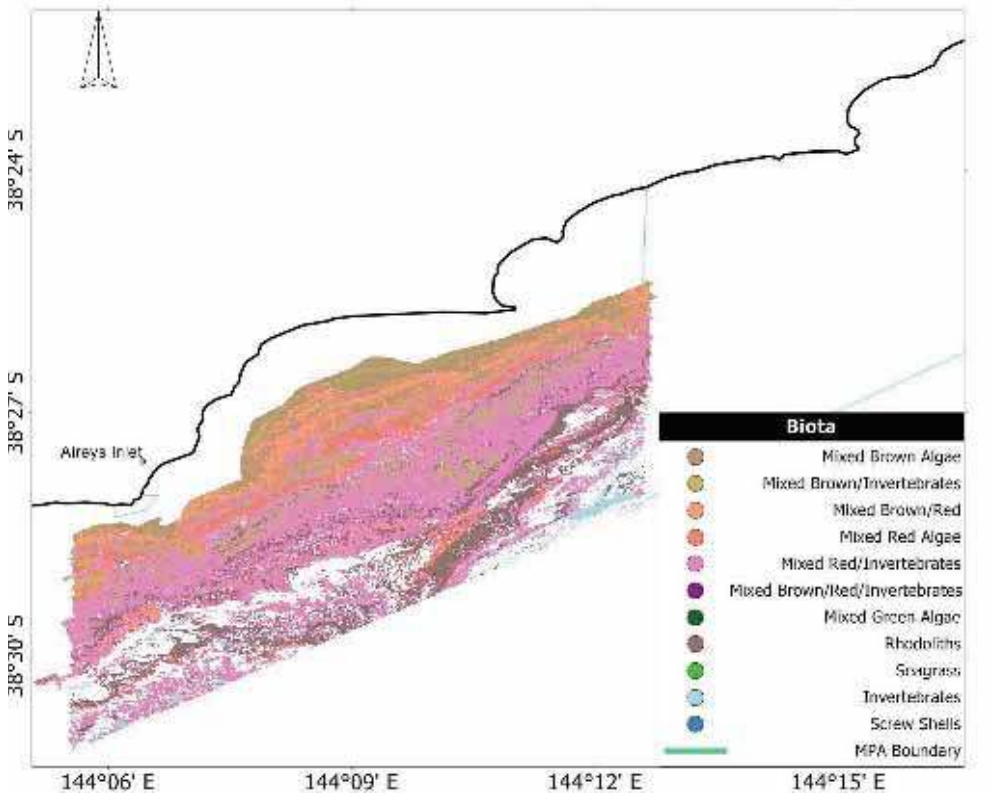
Appendix Figure 9. Habitat type off shore at Point Grey and Kennett River.



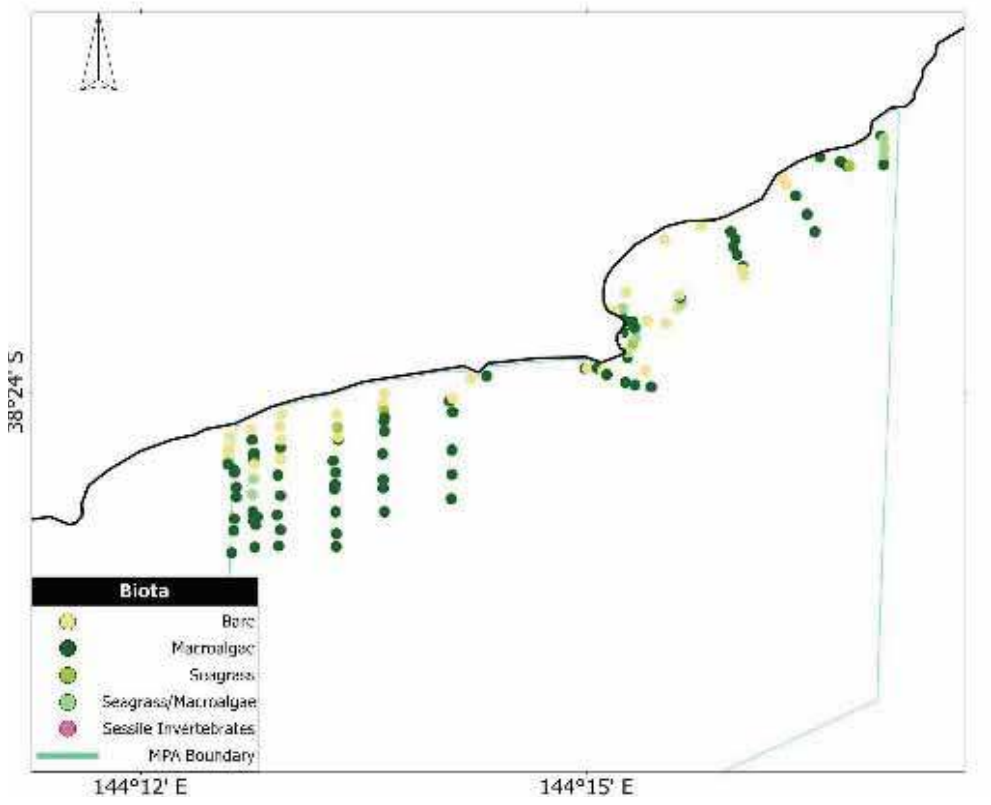
Appendix Figure 10. Substratum present between Eagle Rock Marine Sanctuary and Pt Addis Marine National Park.



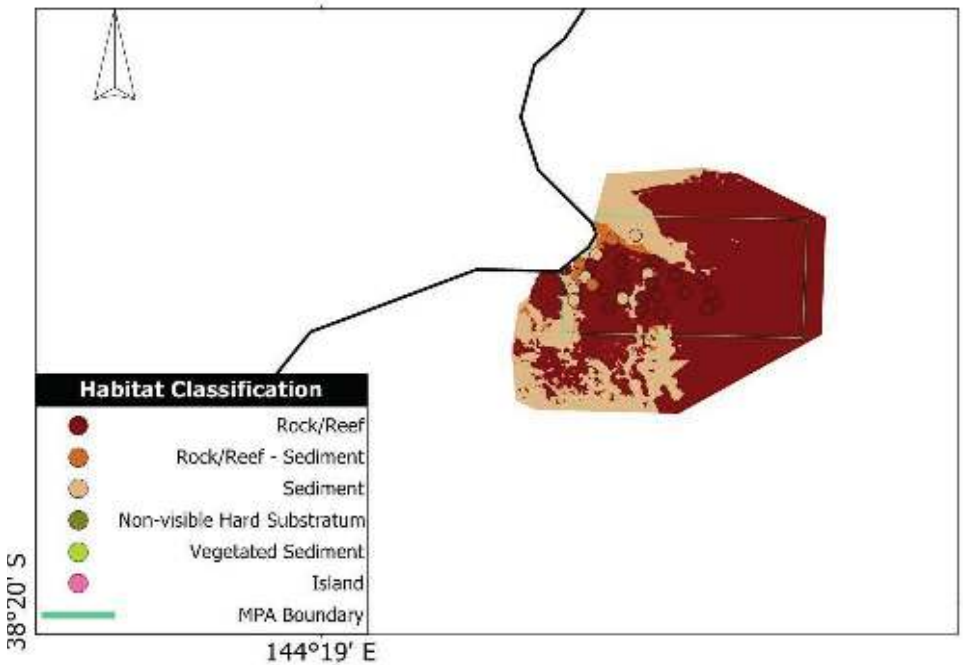
Appendix Figure 11. Biota present from point sampling studies at Eagle Rock Marine Sanctuary.



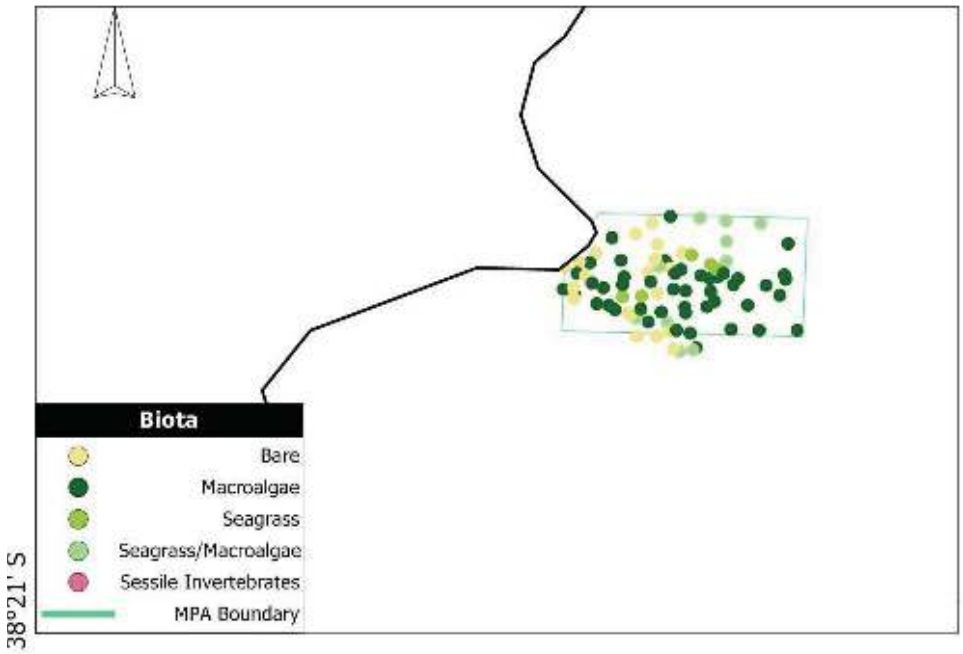
Appendix Figure 12. Habitat types present between Eagle Rock and Anglesea.



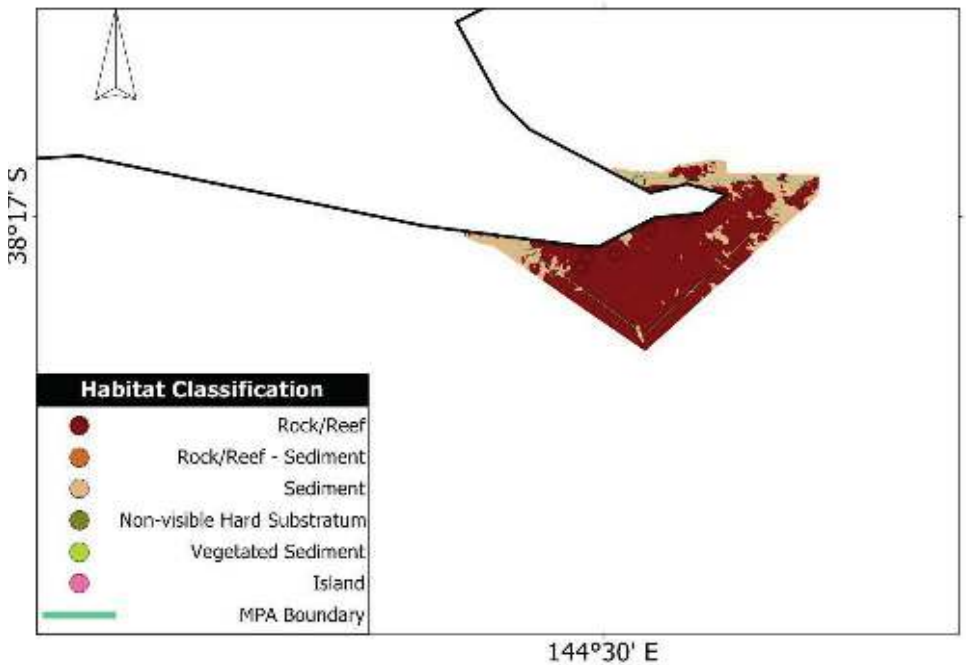
Appendix Figure 13. Biota present from point sampling studies at Point Addis Marine National Park.



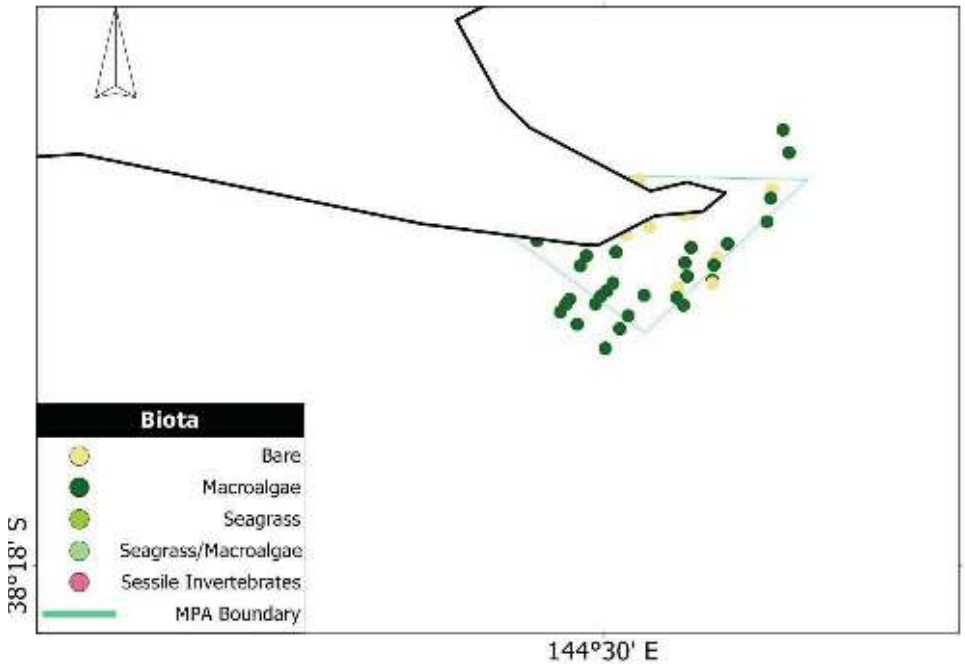
Appendix Figure 14. Substratum present at Point Danger Marine Sanctuary.



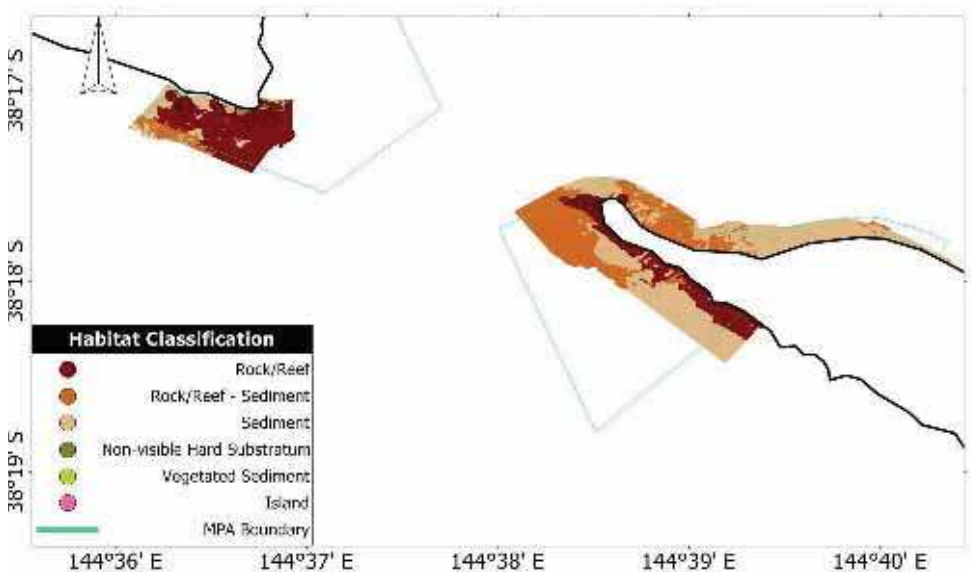
Appendix Figure 15. Biota present from point sampling studies at Point Danger Marine Sanctuary.



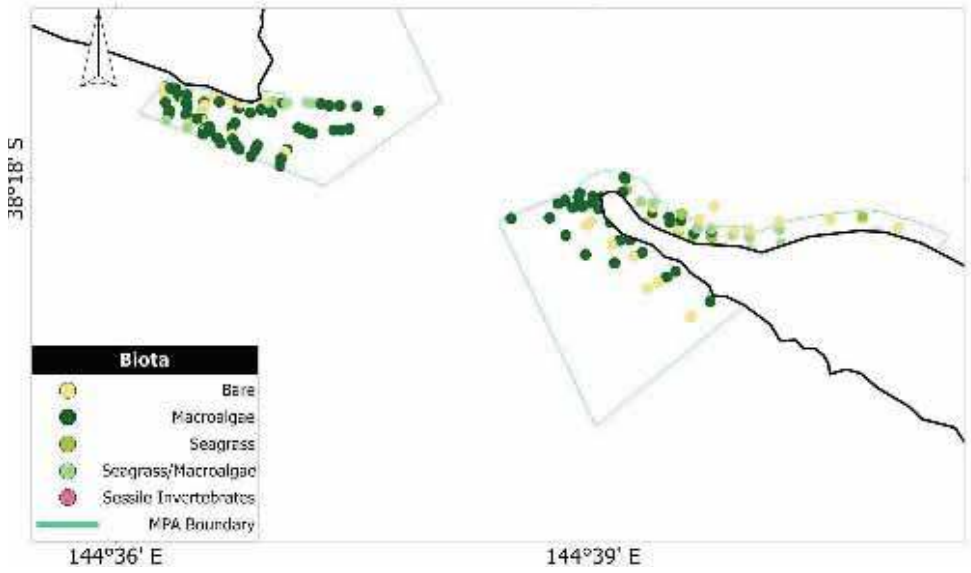
Appendix Figure 16. Substratum present at Barwon Bluff Marine Sanctuary.



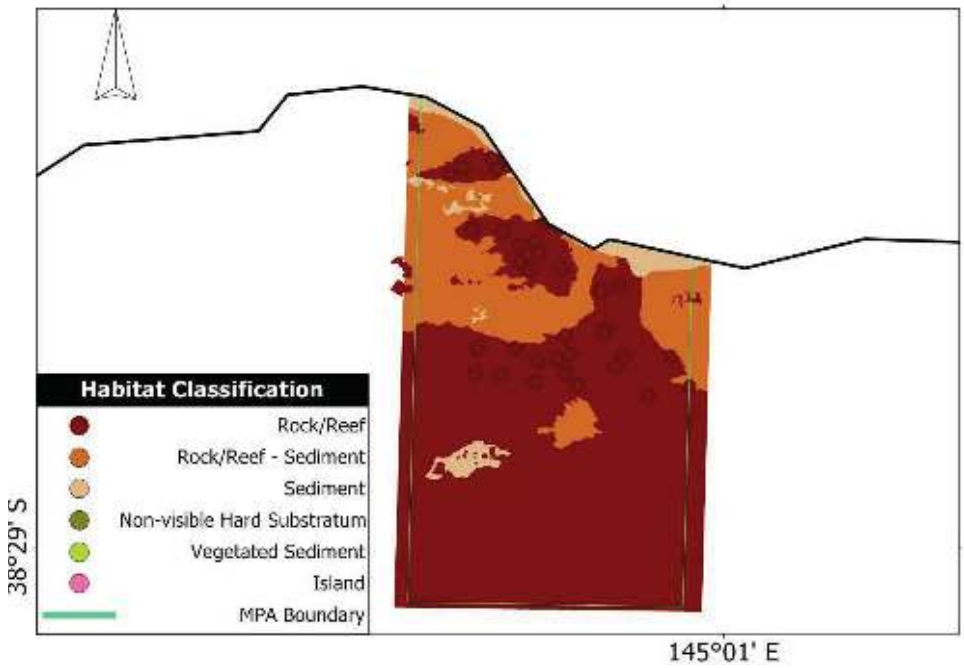
Appendix Figure 17. Biota present from Point sampling studies at Barwon Bluff Marine Sanctuary.



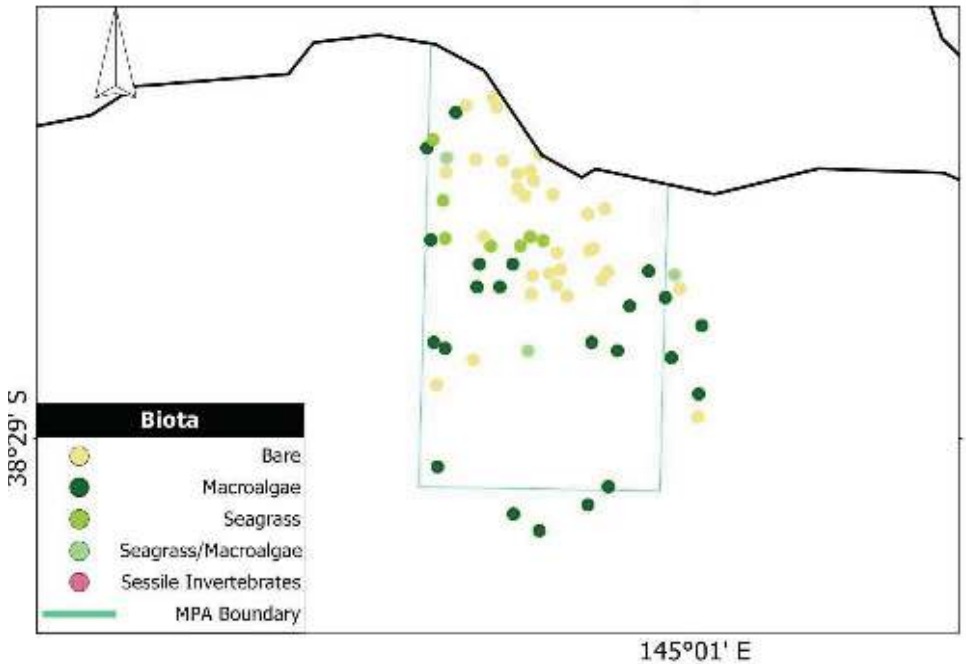
Appendix Figure 18. Substratum present at Port Phillip Heads Marine National Park.



Appendix Figure 19. Biota present from point sampling studies at Port Phillip Heads Marine National Park.



Appendix Figure 20. Substratum present at Mushroom Reef Marine Sanctuary.



Appendix Figure 21. Biota present from point sampling studies at Mushroom Reef Marine Sanctuary.

1.3.4 Listed Species and Communities

Four threatened (FFG) marine invertebrates can only be found in the Central Victoria bioregion, two sea cucumbers, a chiton and an opisthobranch. One of the sea cucumber species (*Pentocnus bursatus*) is only known from Cape Paterson in Victoria, and is also found in South Australia and Western Australia. The other sea cucumber (*Apsolidium densum*), is a Victorian endemic known from three locations, two of which are in Central Victoria. These two locations are Mushroom Reef and Honeysuckle Reef. The rare chiton, *Bassethullia glypta*, has a restricted distribution, and has only been found in the Port Phillip Heads region and at West Head in Flinders. Only one record of the marine opisthobranch *Rhodope genus* has been found in Australia at San Remo in Central Victoria. However, this is a cryptic species and may potentially occur in other areas of Victoria. The FFG has listed the San Remo Marine Community in Central Victoria as a threatened community. This is an intertidal and subtidal marine community consisting of an extremely rich assemblage of marine biota. This small area of 600 by 300 metres lies off the coast near the township of San Remo, extending from the coastline out to the edge of a deep channel with fast flowing currents.

1.3.5 Ecosystem Services and Processes

The area in between Apollo Bay to Torquay has long stretches of sandy beaches backed by dunes and interspersed with high cliffs. The sandy beaches serve as popular recreational areas, with Bells Beach and Torquay being known as surfing spots, boosting tourism in those areas. The cliffs and dunes form a natural barrier, protecting against floods and coastal storms. Coastal heathland and scrub are also common in this area, including the threatened coastal Moonah Woodland community. The coastal heathland and scrub vegetation are important stabilizers of the coastline, helping to prevent erosion. Intertidal reefs occur along Bells Beach, Port Phillip Heads and Bunurong. These reefs serve as recreational and educational research areas as well as provide habitat for numerous marine invertebrates and algal species. The sandy beaches, cliffs, dunes and coastal vegetation at Bunurong is an important habitat for shore birds, in particular the vulnerable Hooded Plover. Extensive subtidal reefs occur from Aireys Inlet to Point Addis, Point Danger to Point Lonsdale, at Port Phillip Heads, from Cape Schanck to West Head and at Phillip Island. Subtidal reefs provide sheltered habitats and food for fish and invertebrate species. These reefs serve as recreational areas and provide opportunities for research to be done. Seagrass beds occur at Port Phillip Heads and also at Bunurong, helping to stabilize sediments and contributing to water quality. Seagrass beds are also important nursery areas for commercially important juvenile fish and invertebrates. Some salt marsh habitats occur between Cape Paterson and Inverloch, providing habitat for aquatic plants and animals as well as shore birds. Salt marshes have an important role in nutrient cycling of nitrogen and phosphorus, essential

biological regulators. Salt marshes also help in pollution control by acting as a sink for pollutants such as pesticides and heavy metals.

1.4 Otway Bioregion

1.4.1 Key Environmental Features

The Otway bioregion extends from Cape Jaffa in South Australia to Apollo Bay, just east of Cape Otway, as well as the western Bass Strait islands. This coast has extensive lengths of sedimentary cliffs, particularly at Cape Bridgewater, Cape Nelson, Port Campbell, Twelve Apostles and Moonlight Head. Sandy beaches and dunes also occur in successive bays between prominent headlands from Discovery Bay to just east of Warrnambool (Cupper *et al.* 2003).

The Otway coastline has a predominantly south westerly aspect and is highly exposed to southern ocean swells. The maximum significant wave height in this region is higher than elsewhere in the state, reaching between seven and eight metres high. The high energy of these waves is responsible for eroding and shaping the cliffs and rock formations in the Bay of Islands and Port Campbell area. The eastern coast of Cape Otway has a southeast aspect and is less exposed than to the west of the Cape, with a maximum significant wave height of 5-6 metres.

The Bonney Coast, from Robe in South Australia to Portland in Victoria, has significant upwelling of colder, nutrient rich deep water during summer in this region (Butler *et al.* 2002). During summer, the prevailing winds on the Bonney Coast are south easterlies, which push warmer surface waters offshore and advect deeper water to the surface at the coast (Prince 2001; Butler *et al.* 2002). The upwelling can cause sea surface temperatures to decrease by 3° C compared with offshore waters (13-14° C compared to 17-18° C respectively). In winter, the prevailing winds are westerly and drive South Australian Current Waters drive eastwards to Victoria. The South Australian Current Waters are the tail end of the Leeuwin Current and are nutrient poor. Particularly strong storm westerlies during winter can also drive nutrient enriched Sub-Antarctic Waters up onto the shelf (Prince 2001).

As a result of the nutrient rich upwelling plumes in summer, and occasionally in winter, the area is highly productive. This coast provides a feeding ground for seabirds, fur seals and whales, as well as support commercially important fisheries species such as abalone and the southern rock lobster.

1.4.2 Coastal Landscape and Shore Habitats

The Discovery Bay coastline is of dynamic mobile sand dunes up to 60 m high that stretch as far as three kilometres inland. The dune complexes are mainly irregular transverse dunes with areas of arcuate dunes and blowouts (Cupper *et al.* 2003). The dune fields behind Discovery Bay and Bridgewater Bay constitute the largest area of mobile sand dunes in Victoria. The coastal vegetation in this region is generally low and although there are seventeen ecological vegetation classes present, calcarenite dune woodland dominates (62 %). The Discovery Bay Coastal Park was first established in 1979 and has since grown to cover approximately 10 460 ha. The Park provides habitat for threatened fauna species including the hooded plover and orange-bellied parrot (Parks Victoria, 2004).

The peninsulas of Cape Bridgewater, Cape Nelson and Cape Sir William Grant are the principal sites where the Western Victorian volcanic systems meet the Southern Ocean. At Cape Bridgewater the coastal cliffs expose rock formed by volcanic ash (tuff) overlain with cemented dune limestone (calcarenite). The cliffs here are the highest in the state at up to 135 m above sea level. They also provide a viewing platform for the Australian fur-seal colony below. A small number of New Zealand fur seals are also reported to come ashore at Cape Bridgewater. The nearby Cape Duquesne (on Cape Bridgewater) displays other rare coastal limestone features including sea caves, blowholes and a “petrified forest”, which is not actually made of fossils but of rhizocretions (Cupper *et al.* 2003). There are also examples of dunes and transverse ridges located on cliff tops 30 to 50 m above the present sea level and other formations are the tufa (‘flowstone’) and stalactites found on the sea cliffs. There are wave cut intertidal platforms at the base of the cliffs.

Cape Nelson is separated from Cape Bridgewater by the low-lying Bridgewater Bay. Cape Nelson and Cape Sir William Grant are also peninsulas of volcanic rocks overlaid by sedimentary rocks, mainly limestone and calcarenite dune limestone. Cape Sir William Grant has three parasitic eruption cones called “The Wells” which are built on the flank of a larger extinct volcano. Cape Nelson is part of the Discovery Bay Coastal Park but also has a State Park (Cape Nelson State Park; 210 ha) and Reserve (Cape Nelson Lighthouse Reserve; 21.9 ha) on it. The vegetation of the park is dominated by coastal mallee shrub (73 %). Cape Nelson is also home to the only known stand of the soap mallee community in Victoria (PV 2004).

Point Danger, located approximately 6 km southeast of the town of Portland supports the only mainland colony of Australasian gannets in Australia. The vegetation community at Point Danger is wet and dry heath.

Lawrence Rocks lies offshore approximately 2 km to the southeast of Point Danger and consists of a larger outer and smaller inner island/rock. The outer island has a seaward and landward rise of similar heights connected by a saddle of loose soil and the

succulent plant *Mesembryanthemum*. The inner island is bare rock (Jones 1937). They are the highest offshore point of a mostly submerged volcanic caldera beneath Nelson Bay and are of State geological and geomorphological significance. The rocks support the largest colony of gannets in Australia, as well as breeding colonies of other seabirds including little penguin, fairy prion and common diving petrel.

The Portland coast is a wide bay with low coastal cliffs and slopes that meet the flat foreshore. It forms a basin into which a number of rivers and waterways feed into the ocean, including Surrey River, Fitzroy River and Eumarella River. Portland Harbour is a modified environment that supports fisheries, coastal shipping and an industrial aluminium smelter. Much of the Portland coast has been cleared to support pastoral land use and settlements.

Deen Maar Island (Lady Julia Percy Island), located 8 km offshore and 21 km west of Port Fairy, is the only major basalt island off the Western Victorian coast. It is a low, flat island 2 km long and 1 km wide at the south western end tapering towards the north east. The plateau surface averages 30 to 40 m above sea level and is bounded by cliffs on all sides. Shore platforms and reefs prevent boat landings apart from a sheltered cove on the northern side. Deen Maar Island supports a large Australian fur seal breeding colony. It also provides habitat for bird species including little penguin, diving petrel, peregrine falcon, short tailed shearwater, white fronted chats, fairy prion, Australian pipits and the sooty oyster catcher.

Yambuk Lake is located 17 km west of Port Fairy. It is a barrier estuary system that is periodically closed to the sea by a sand bar. It contains an extensive wetland system formed from the meeting of the Shaw and Eumeralla Rivers. Yambuk Lake estuary and wetlands are listed in the Directory of Important Wetlands as an area of national significance. The estuary and wetlands lie behind a series of dunes and calcarenite formations on low lying land. Major ecological vegetation classes include coastal dune heathland, estuarine wetland and swamp scrub. Seagrass, *Zostera*, and estuarine grass, *Ruppia*, are also present. Yambuk Lake provides habitat for threatened bird species including the orange-bellied parrot as well as the threatened fish dwarf galaxias (Glenelg Hopkins CMA 2004).

The Crags are a rocky limestone outcrop located 12 km west of Port Fairy. It consists of high jagged cliff formations fronted by fallen boulders of dune sandstone with pools and clefts. The site has important aboriginal cultural features and is a coastal reserve. Plant species found in the area include seabox, white correa, coast beard heath, coast tea tree, cushion bush, coast everlasting and prickly spear grass (Moyne Shire Council 2003).

Port Fairy lies on the Western District Volcanic Plains on a 300 000 year old basalt flow extending along the ancient Moyne River Valley. The flow is mostly covered by

Holocene sand dunes, except where it is exposed as coastal platforms and reefs. Port Fairy is partially sheltered by the Griffiths Island headland and adjacent Moyne River breakwaters. Griffiths Island supports a shearwater rookery and is the site of a historic lighthouse. Port Fairy has two beach areas, South Beach and East Beach. South Beach is made up of volcanic rock which creates small, sheltered bays with sandy beaches and intertidal rock pools. The East Beach is a sandy beach that sweeps in a curve from the river breakwaters up to Reef Point in the north east where it is more exposed. It is backed by sand dunes of up to 8 m in height. Erosion of the sand and dunes at East Beach are of concern.

The section of coastline between Port Fairy and Warrnambool is a large sweeping beach and dune system. This is interrupted in the Killarney area by a lava flow which has formed numerous small enclosed bays and reef systems.

Closer to the city of Warrnambool the coastline changes from sand dunes, up to 20 m high near Levy's Point, to the rocky dune limestone or calcarenite cliffs of Thunder Point. Warrnambool is a coastal city located between the two rivers, Merri (west) and Hopkins (east). The Merri marine sanctuary is at the mouth of the Merri River and includes Merri and Middle Islands, which are the remains of a fossilised sand dune once connected at Pickering Point. Middle Island supports a colony of little penguins, short-tailed shearwaters and black-faced cormorants. Warrnambool's Lady Bay is a sandy beach and dune system sheltered in the west by the breakwater. To the east of the Hopkins River mouth is Logan's Beach which has an observing platform to view southern right whales.

The Bay of Islands Coastal Park spans the coast from Warrnambool to Peterborough and the Port Campbell National Park continues from Peterborough to Princetown. Known as the Shipwreck Coast, the coastline in this area is characterised by precipitous or undercut cliffs up to 60 m high and offshore rock formations that are exposed to high wave energy. The geology is of marine limestone and calcareous silts of the Tertiary age overlain with Pleistocene dune limestone which erode to create the cliff and rock formations. These formations will continue to erode and break away with time. Popular examples of rock formations including rock stacks, sea caves and gorges are at The Grotto, London Bridge, The Arches, Loch Ard Gorge and the Twelve Apostles. There are relatively few beaches due to the lack of sand in the eroding cliffs and the beaches present are generally narrow. There are a limited number of sites with beach access such as at Childers Cove and Loch Ard Gorge. The region contains some of the largest and most important areas of native vegetation remaining between Portland and the Otways. The communities include: estuarine swamp sedgeland; cliff top grassland/shrubland; sand dune shrubland; heathland; open forest; riparian open forest; dune-swale community; swamp communities; eucalyptus low woodland; low heath; coastal heath;

dune complex; and wetlands. Mutton Bird Island, near Loch Ard Gorge, is a nesting place for short-tailed shearwaters.

Point Ronald is situated south of Princetown at the mouth of the Gellibrand River. The major part of the cliffs here consists of aeolian calcarenite. The river mouth can be blocked to the ocean by a sand bar during times of low freshwater flow. To the south east of Point Ronald, the limestone cliffs are replaced by small promontories that encompass sandy beaches and dunes.

The Pebble Point region (from Point Margaret to Point Lucton) is the largest and most extensive set of clearly defined slump terraces on the Victorian coast. These active landslip sites play a major role in shaping the configuration of this coastal site.

The west Cape Otway National Park consists of coastal plains on Tertiary marine sediments. The plains end with vertical sea cliffs with numerous caves along them. Moonlight Head, Lion Headland and Dinosaur Cove have all been identified as important sites for their unique characters and the occurrence of fossils. Moonlight Head is a vertical and in places overhanging cliff that is 50 m high and provides one of the best vertical exposures of Otway Group sediments along the entire coast. Just to the east of Moonlight Head is possibly the largest single landslip area on the Victorian coast. From Moonlight Head to Milanesia Beach and Lion Headland to Slippery Point the coast is characterised by outcrops and landslips. The outcropping rocks are Otway Group sediments of two main types, either channel, sandstone, or floodplain and overbank spill deposits. This section of coast is one of the most active cliff sections in Australia. Dinosaur Cove is a site of significant discoveries of dinosaur fossils.

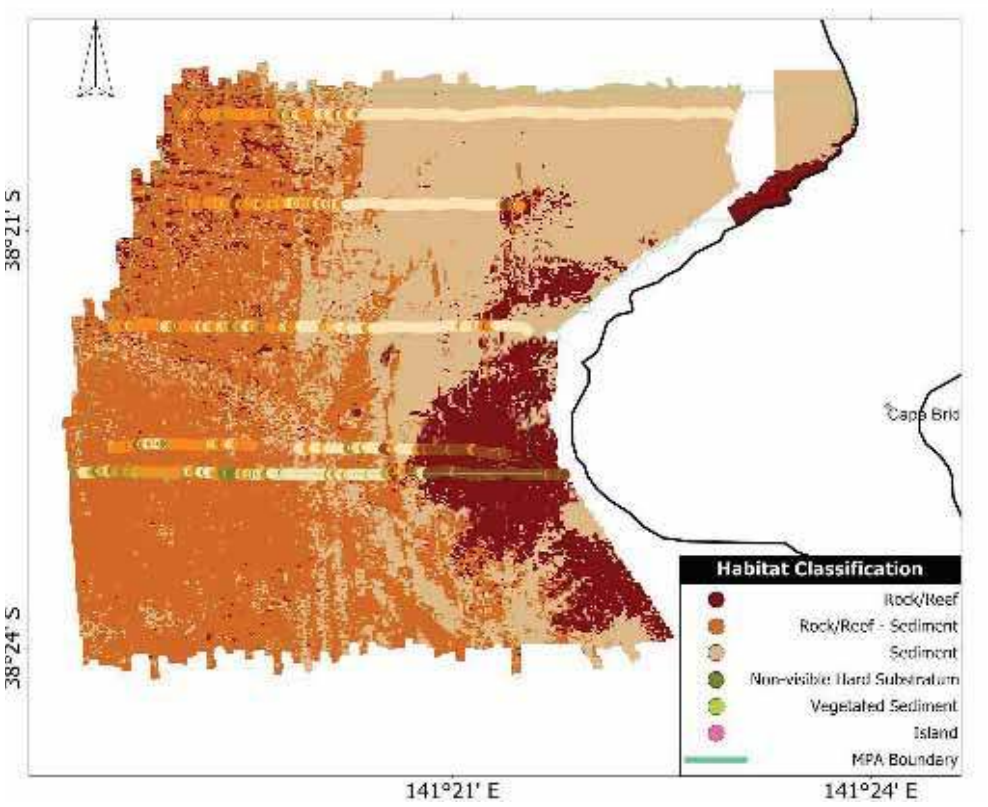
Other characters and features of Cape Otway include: dune limestone and younger dune sands overlaying Mesozoic and Tertiary rock; the sandy and dune backed alluvial basin at the converging of the Aire, Calder and Ford rivers; and more sites of dinosaur fossil discoveries.

Between Swell Point and Storm Point is a coastal terrace backed by an escarpment ending in a bluff or low cliff. There are also several prominent boulder beaches at this location.

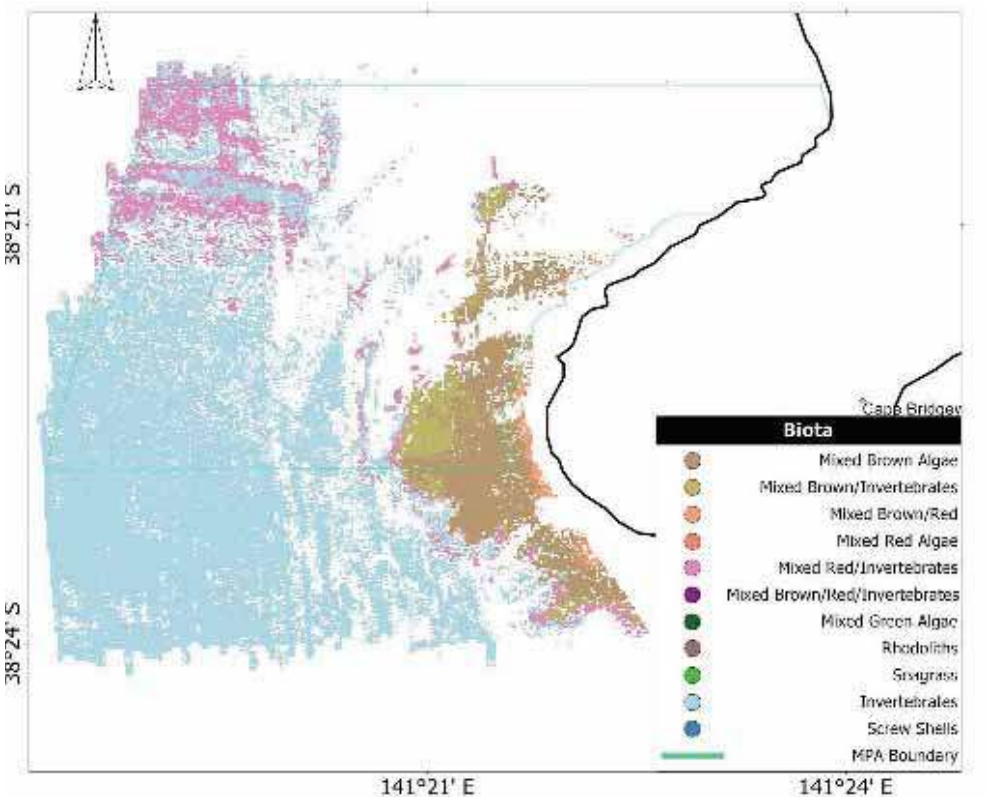
1.4.3 Seascapes and Benthic Habitat

The Otway Bioregion has extensive areas of inshore and offshore rocky reefs, much of which have yet to be mapped, as well as sandy habitats. There is a high diversity of seascapes, largely structured through volcanic basalt and weathered limestone formations.

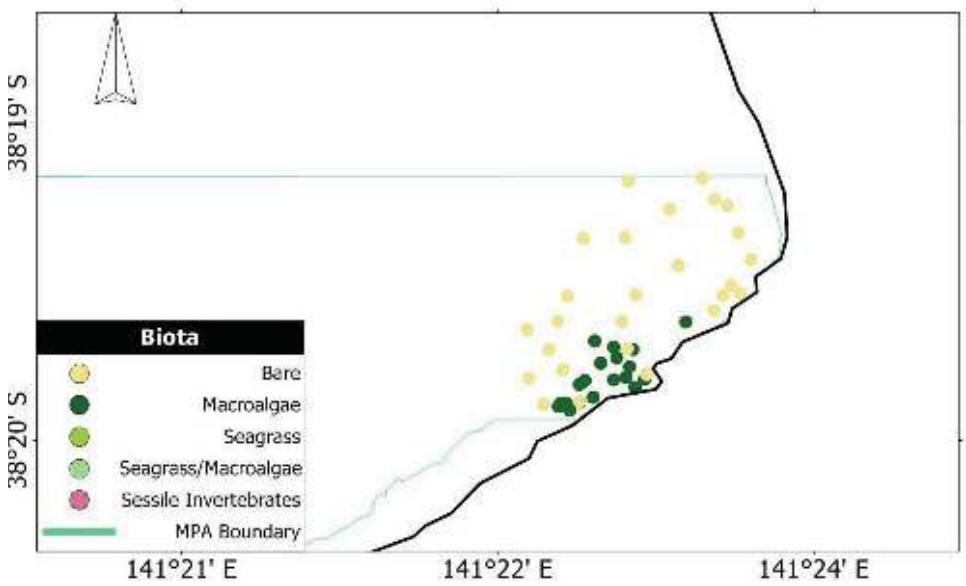
Habitats in the Otway bioregion include bands of crayweed *Phyllospora* and bull kelp *Durvillaea* kelp beds on nearshore reefs, common kelp *Ecklonia* beds extending to depths of 30-40 m and red beds. Sessile invertebrate habitats are present on deeper reefs from approximately 30 m depth. The inshore limestone reefs typically consist of flat or gently sloping bedrock pavements, intersected by gullies, steps and dropoffs. The reef steps are typically undercut or have eroded walls with a high diversity of sessile invertebrates. Extensive areas of sessile invertebrate (sponge garden) habitat are present in Discovery Bay (Figure 23), while much of the deep reef habitat along the Twelve Apostles coast is structured by red algae (Figure 33).



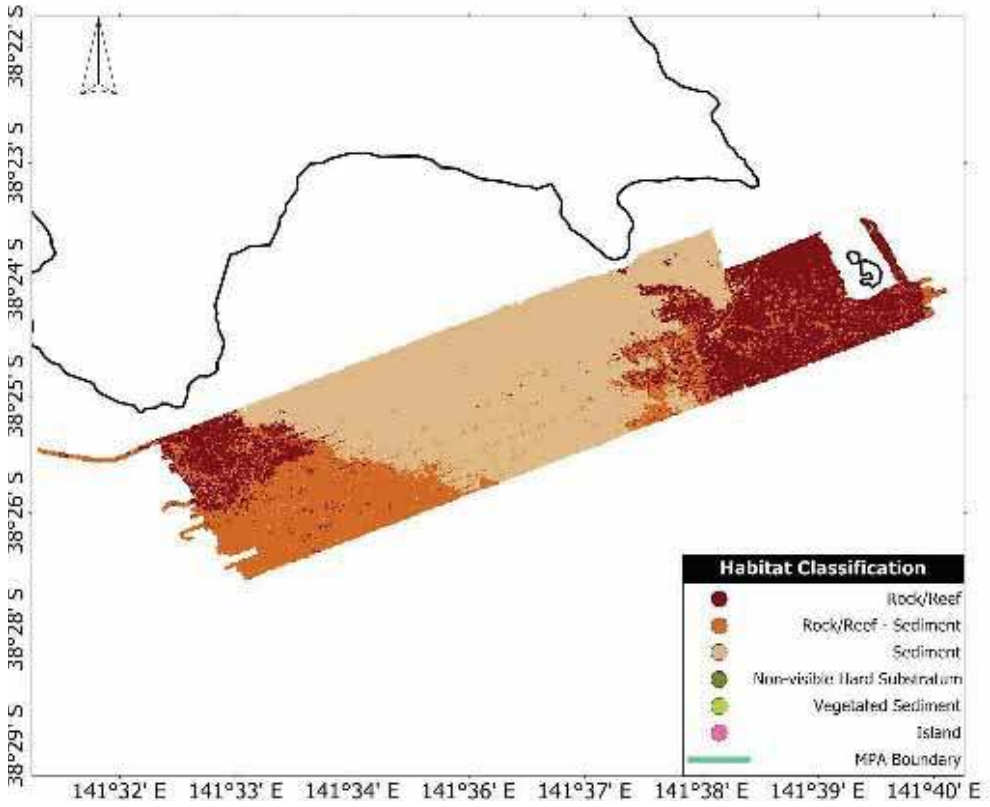
Appendix Figure 22. Substratum present at Discovery Bay Marine National Park.



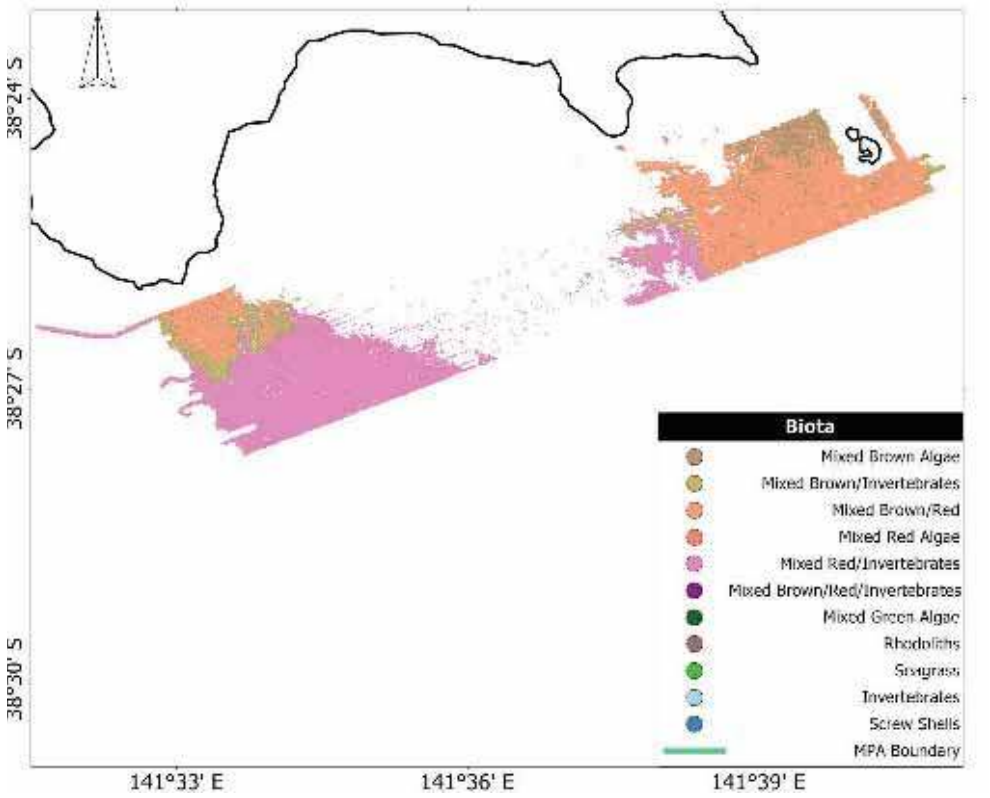
Appendix Figure 23. Habitat type off shore at Discovery Bay Marine National Park.



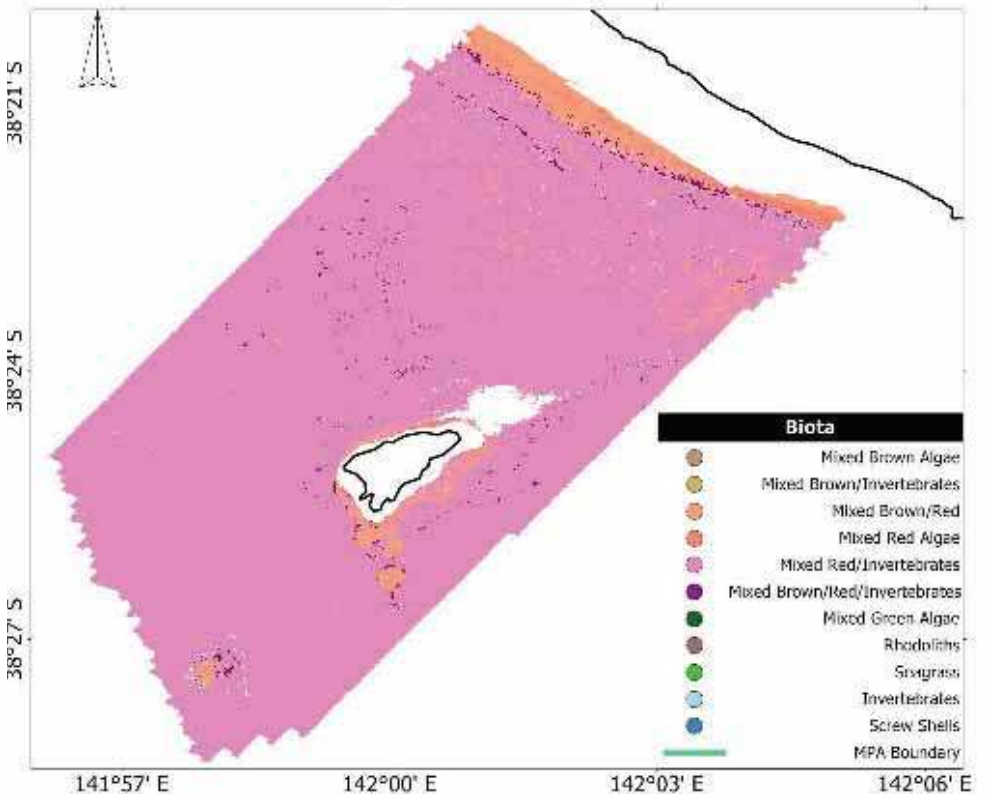
Appendix Figure 24. Biota present from point sampling studies at Discovery Bay Marine National Park.



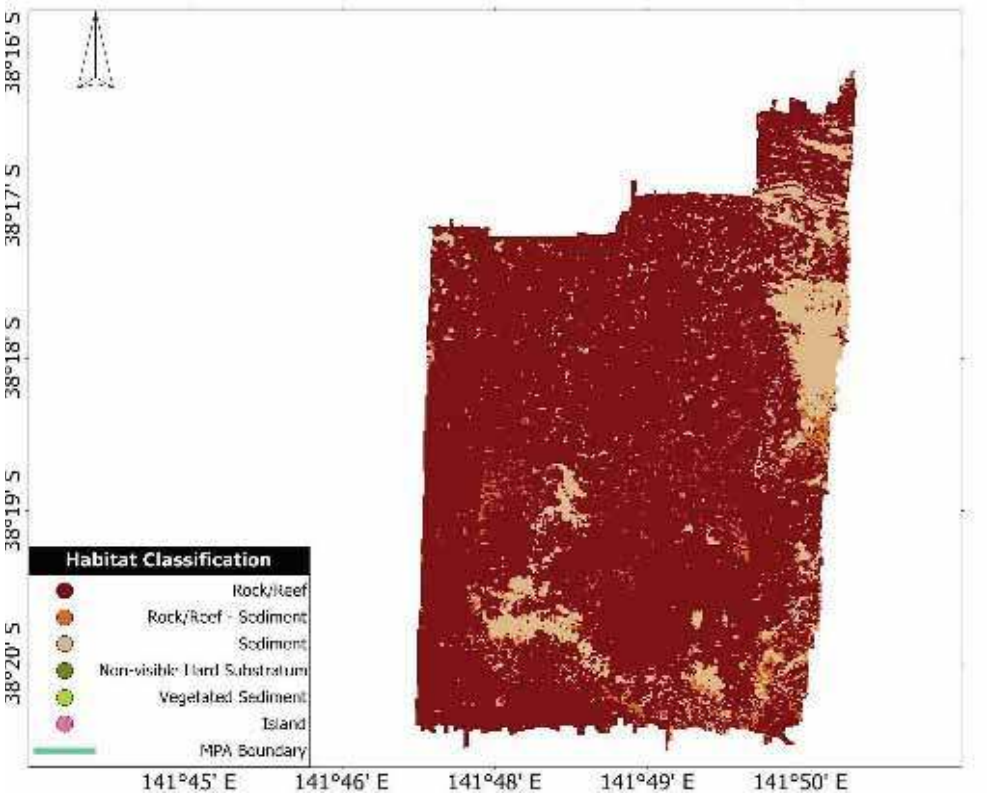
Appendix Figure 25. Substratum present at Cape Nelson.



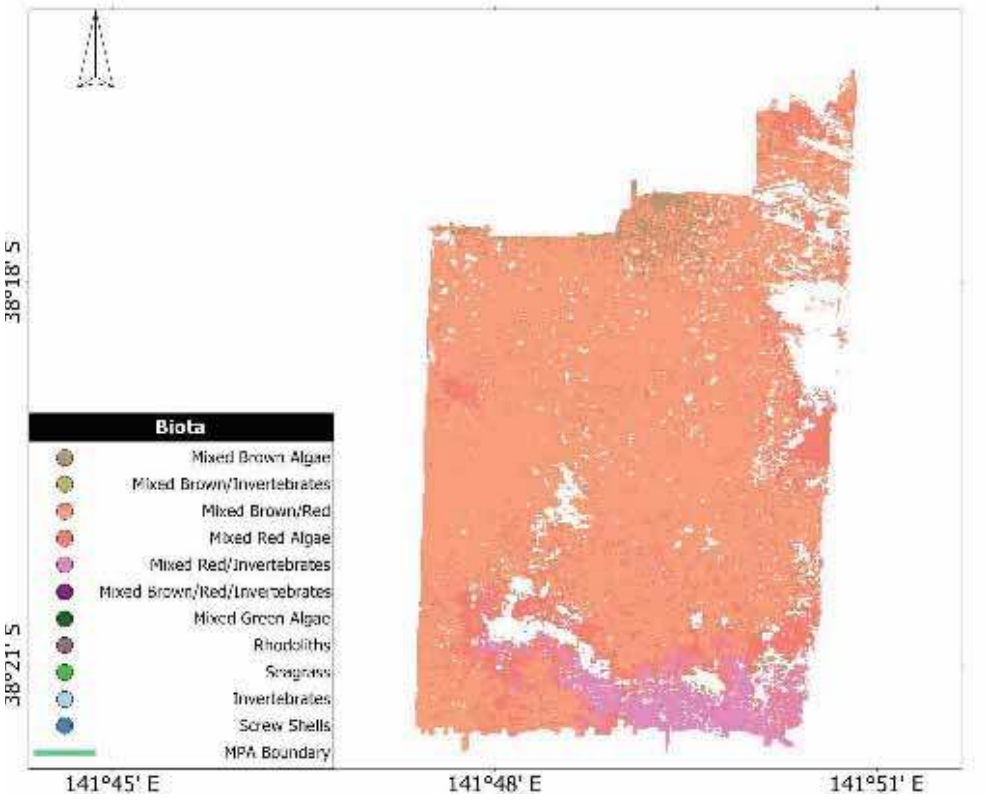
Appendix Figure 26. Habitat type off shore at Cape Nelson.



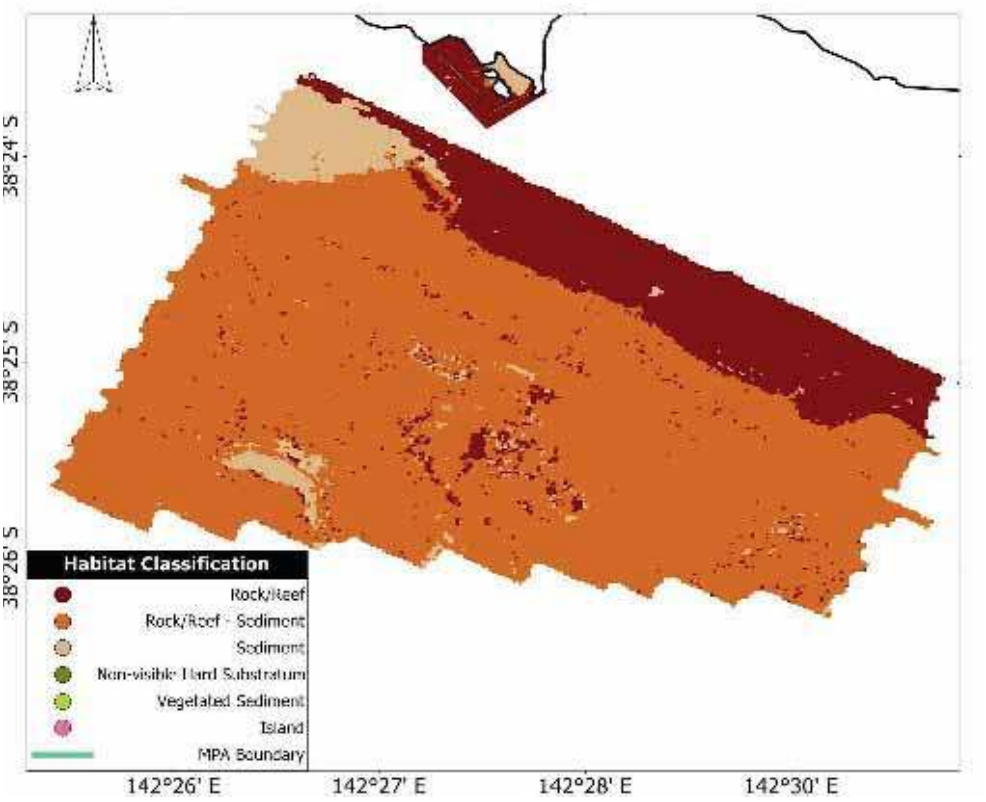
Appendix Figure 27. Habitat type off shore at Deen Maar.



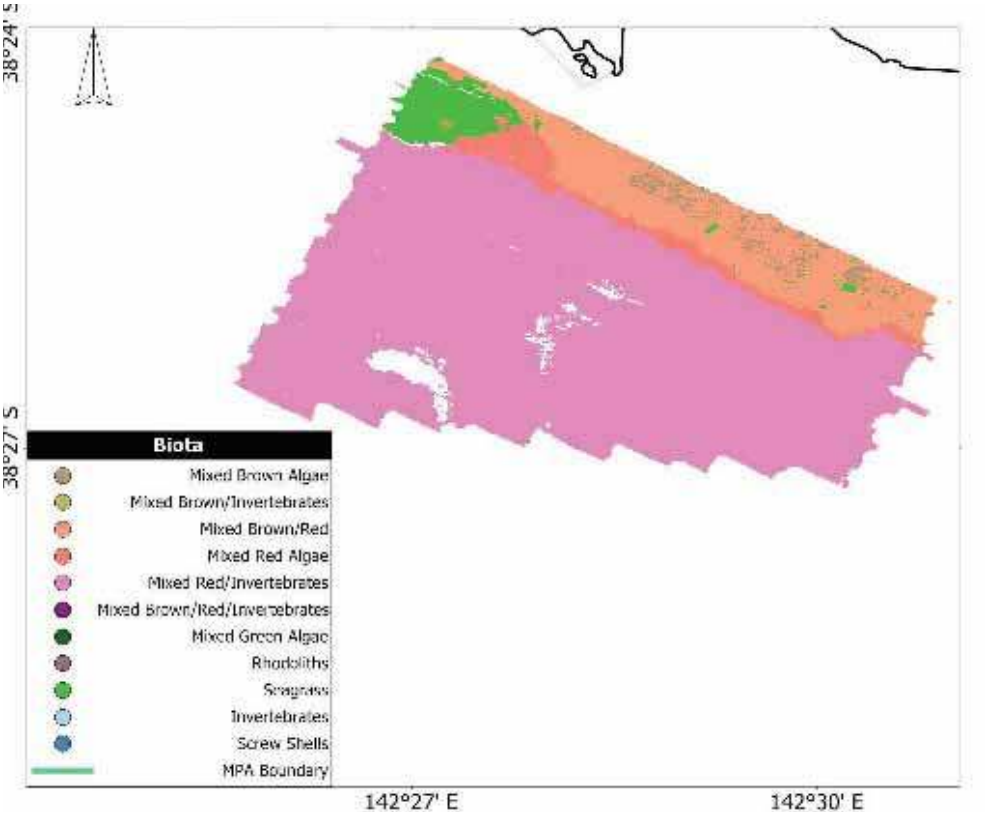
Appendix Figure 28. Substratum present at Tyrendarra.



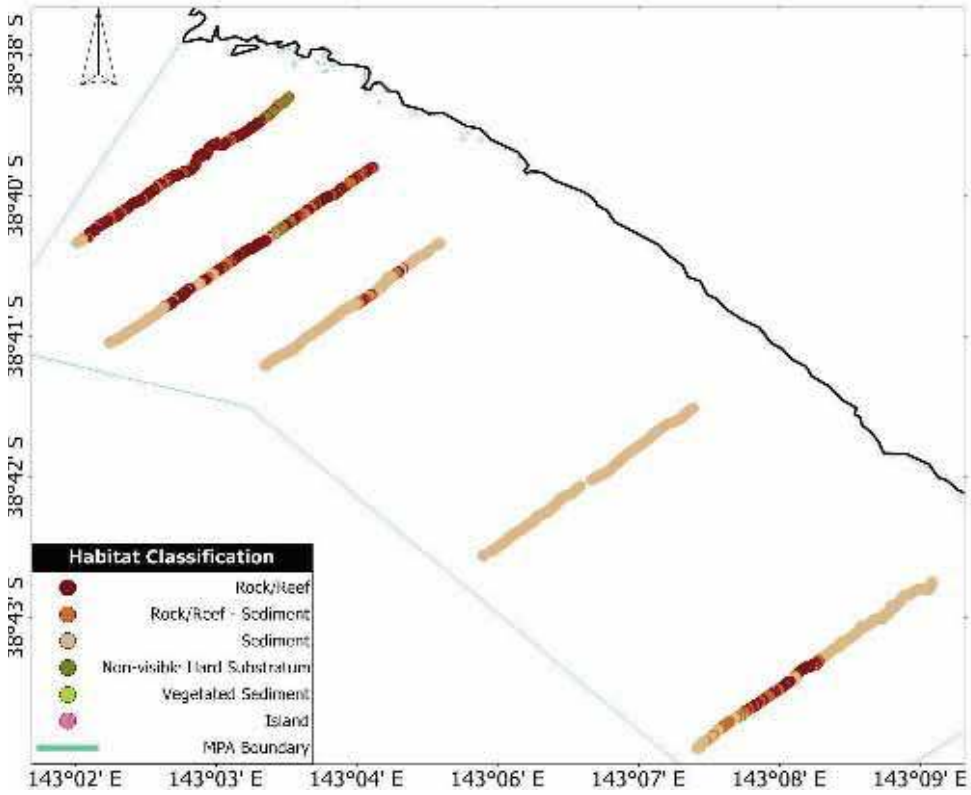
Appendix Figure 29. Habitat type off shore at Tyrendarra.



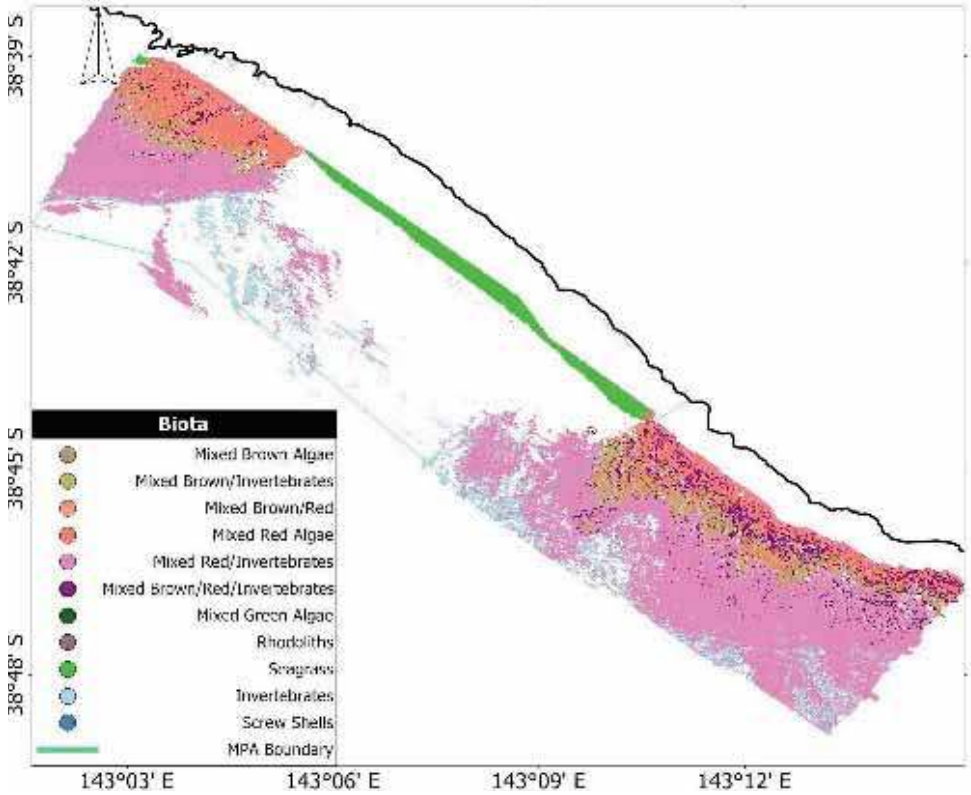
Appendix Figure 30. Substratum present at Merri Marine Sanctuary.



Appendix Figure 31. Habitat type off shore at Merri Marine Sanctuary.



Appendix Figure 32. Substratum present at Twelve Apostles Marine National Park.



Appendix Figure 33. Habitat type off shore at Twelve Apostles Marine National Park.

1.4.4 Listed Species and Communities

The coastal and marine environment in the Otway bioregion of Victoria has several listed species as well as one listed community. The Southern Bent-wing Bat (*Miniopterus schreibersii bassanii*) is listed as critically endangered under the EPBC and has possible breeding sites near Warrnambool at Starlight Cave. Breeding sites of the endangered Red-tailed Black Cockatoo (*Calypotorhynchus banksii graptogyne*) are also likely to occur in this bioregion. The Soft-plumaged Petrel (*Pterodroma mollis*) is a vulnerable bird which uses habitats in southwestern Victoria. A vulnerable plant species, the Limestone Spider-orchid (*Caladenia calcicola*) is likely to occur in this bioregion. There are four listed marine species in the Otway bioregion consisting of two fishes and two invertebrates. The two fish species are Orange Roughy (*Hoplostethus atlanticus*) and Ewens Pygmy Perch (*Nannoperca variegate*). The two invertebrate species, the Southern Hooded Shrimp (*Athanopsis Australia*) and a sea cucumber (*Apsolidium densum*) are considered Victorian endemics with restricted distributions. A specimen of the Southern Hooded Shrimp was collected near Horseshoe reef in Bridgewater Bay, while the sea cucumber is only known from three locations, one of which is Mullet Hole, northeast of Apollo Bay. A coastal Moonah (*Melaleuca lanceolata subsp. Lanceolata*) Woodland Community is listed as threatened in the Apollo Bay area of Victoria under the FFG.

1.4.5 Ecosystem Services and Processes

The coastline along the Otway bioregion has high cliffs and sand dunes, which act as a coastal barrier and protects against flooding and storms. The sandy beaches and dunes along the western coastline provide ecosystem services in the form of recreation and tourism as well as habitat provision for a variety of organisms. The Bonney coast is a productive area because of upwellings, which greatly influences primary productivity and helps maintain commercially important fisheries species such as abalone and the southern rock lobster. High productivity in the Bonney coast is also an important feeding ground for seabirds, fur seals and whales. The coastal heath and scrubs along the coast provide habitats and help to stabilize the shoreline and prevent erosion. Estuaries along the Otway bioregion, such as Yambuk Lake estuary provides shelter for estuarine plants and animals, and is an important nursery area for juvenile fish. The numerous wetland habitats along the Otway bioregion (at Yambuk Lake and along Shipwreck coast) help act as nitrogen and phosphate sinks, reducing coastal water pollution. The Shipwreck coast along the eastern side of the Otway bioregion is a major tourism area, with the Great Ocean Road and the rock formations such as the Twelve Apostles attracting many visitors. Lawrence Rocks, off the coast at Portland, is a popular diving site and the island supports the largest colony of gannets in Australia, as well as breeding colonies of other seabirds.

1.5 Victorian Embayments Bioregion

1.5.1 Key Environmental Features

The Victorian Embayments bioregion encompasses the bays, inlets and estuaries, including Port Phillip Bay, Western Port, Corner Inlet, Nooramunga and Gippsland Lakes. These bays and inlets contain important wetland, sediment and seagrass habitats. All of them contain Ramsar sites and have coastal populations of salt marsh and mangroves.

Port Phillip Bay

Port Phillip Bay is a sheltered, circular embayment with a narrow opening to Bass Strait located in the south. Circulation in the southern-most parts of the bay are dominated by strong tidal currents while currents in the main body of the bay are weaker and predominantly driven by wind. In summer, there is one main gyre throughout the bay flowing in a clockwise direction, with freshwater inputs from the Yarra River and Werribee flowing down along the eastern coastline of Port Phillip Bay. Two main gyres form in winter with a stronger coastal flow down the eastern coastline of Port Phillip Bay. The gyre in the north of the bay flows in an anti-clockwise direction. In the southern bay, another gyre forms in a clockwise direction. A front lies in between these two gyres, in the middle of the bay. This front, an area of high productivity, becomes a feeding area for many seabirds. Across the south of the bay, near the entrance, currents are strongly influenced by tides rather than winds. Water temperatures in the bay vary from about 11° C in winter to 21° C in summer (Harris *et al*. 1996). In shallower areas of Port Phillip Bay and the Great Sands region, coarser sediments of sand, silt and clay occur while finer sediments occur in the deeper regions of the bay. Much of the coastline of the bay is modified urban, industrial or agricultural environment.

Western Port

Western Port is located 60 km southeast of Melbourne in the central region of the Victorian coastline. Western Port has two large Islands, French Island to the north and Phillip Island across the entrance, as well as a number of smaller outcroppings such as Crawfish Rock and Barrallier Island.

Western Port is subject to the maximum tidal range on the Victorian coast, of up to three metres (DSE 2003). Large tidal waves can penetrate the whole of Western Port with relatively little attenuation due to the wide entrance of the bay and its relatively small surface area. The circulation of water around the bay is influenced by tides in Bass Strait, the shape and bed characteristics of Western Port, winds and pressure systems and river inflows (May and Stephens 1996). The principal driving mechanism for currents in Western Port is tidal. The currents generally travel in a clockwise direction, entering through the western entrance and circulating around the northern

coast of French Island. Water currents in the channels are strong, reaching up to 1.3 m s^{-1} in the water column and 0.7 m s^{-1} on the seabed (May and Stephens 1996).

The large tidal range in Western Port creates a range of marine habitats, from mangrove and saltmarsh fringes, tidal mudflats and seagrass meadows to subtidal reefs and deep water channels.

The bay receives drainage water from Mornington Peninsula and the Western Port catchment. Rivers and drains that open to Western Port include Bass River, Lang Lang River, Yallock Creek, Bunyip Main Drain and Cardinia Creek. The land surrounding the bay is used for agriculture and horticulture and is being increasingly urbanised. The primary sources of nutrients into the bay are through rivers and streams that drain urban and agricultural areas. Nutrient concentrations are consistently higher in the Corinella area of the bay, east of French Island (May and Stephens 1996).

Increased turbidity as a result of sedimentation is of particular concern in Western Port. The extensive loss of seagrass in the 1970s and 1980s is thought to have been caused by increased turbidity (May and Stephens 1996). The cause of persistent high turbidity in the north and eastern segments is due to daily wind and tidal driven resuspension of sediments, not continual sediment inputs (Wallbrink *et al*. 2003).

Sea surface temperatures in Western Port range between 20-24° C in January to 10-12° C in July.

Corner Inlet

Corner Inlet is a shallow, circular marine embayment with a network of tidal channels converging to a single eastern opening into Bass Strait. The coastline is sheltered and generally flat with a few areas of rocky outcrops. Most of the shoreline comprises of extensive intertidal mudflats, mangrove and salt marsh areas (Parks Victoria 2005). The shoreline and seabed of Corner Inlet consists mainly of Quaternary sediments formed during the Pleistocene periods. Water temperature in Corner Inlet ranges from 12° C in winter to 20° C in summer. Corner Inlet has considerable tidal flow through the channels and is a high energy marine environment. Sediments in the northern areas consist of fine silt while in the south the sediments are coarser with a sandy colour (Roob *et al*. 1998).

Nooramunga

Nooramunga, east of Corner Inlet, is a sheltered embayment protected from the large swells of Bass Strait by barrier islands. The area is dominated by low sandy islands with channels that drain out through four entrances. The southern and western areas of Nooramunga consists of courser sand sediments while in the northern parts, the sediments consists of fine silt and mud.

Gippsland Lakes

The Gippsland Lakes are a system of coastal lagoons in the southeast of Victoria. The lagoons are separated from the ocean by dune covered barriers which in turn are bordered to the sea by the Ninety Mile Beach. The absolute form of the lakes is actively modified by erosion and deposition of sand and sediments. The main lakes are Lake Wellington in the west, which feeds to the centrally located Lake Victoria which is connected to Lake King to the east and north. There are also a number of smaller lagoons associated with swamps and low-lying areas including Lake Reeve which runs parallel to Ninety Mile Beach. The entrance to the lakes is through the artificially created and maintained Lakes Entrance, east of Lake King. The lakes are fed by five main river systems, the Latrobe and Avon Rivers flow into Lake Wellington and the Mitchell, Nicholson and Tambo Rivers flow into Lake King.

The hydrology of Gippsland Lakes is influenced by the inflowing rivers, the local climate and the entrance. The artificial entrance requires frequent dredging to maintain the opening against the deposition of sand. A mobile sand bar is located just offshore from the entrance. Water moves in and out of the entrance according to the relative levels of the lakes and sea. The spring tide range at Lakes Entrance is approximately one metre, but the tidal movement does not progress far into the lakes. The currents produced by the tides in the entrance can reach velocities of up to 5 knots and strong winds can create similar velocities. The prevailing winds are westerly although easterly winds will blow during summer (Bird 1978).

The lakes are subject to flooding events which can alter the structure of the seabed substantially by scouring away sand and seagrass beds. Flooding also raises the water level inside the lakes and lead to algal blooms due to an excess of nutrients in the water.

1.5.2 Coastal Landscape and Shore Habitats

Port Phillip Bay

Port Phillip Bay is a large marine embayment in Central Victoria about 1 930 km^2 in area with a coastline length of 264 km (Harris *et al*. 1996). Port Phillip Bay has a relatively shallow body of water with a maximum depth of 24 m in the centre of the Bay. The Great Sands region lies at the south of the bay and forms a flood tide delta. This region consists of sand bars and shallows dissected by deeper channels, which restricts exchange between Bass Strait and the main bay. South of the Great Sands region is the entrance to the bay, a narrow opening of around 3 km with strong tidal currents.

Swan Bay, a Ramsar site, is a shallow embayment with a constricted tidal entrance at the south-western end of Port Phillip Bay. Swan Bay is fed by Yarram Creek and

contains one of the most extensive salt marsh sites in the bay. The coast is fringed by *Sclerostegia arbuscula* (Shrubby Glasswort) forming tall shrubland. A degraded bluff 5-8 m high backs the western coastline, in front of which salt marsh material, alluvial fan deposits, weathered slope deposits and shallow lagoons enclosed by broad low sand ridges have developed. Edwards Point at the northern end of Sway Bay is a compound, branching spit system with three major ridge systems separated by marshy swales and consists of many small lagoons. These ridges are composed of sand, shell fragments and ironstone gravels.

Geelong Arm and Corio Bay are on the western side of Port Phillip Bay, with a shallow bar restricting exchange between Corio Bay and the body of Geelong Arm. Corio Bay is a shallow embayment less than nine metres deep and encompasses important sites such as the Ramsar site from Limeburners Bay to Point Wilson and the northern end of Geelong Arm (including The Spit Wildlife Reserve). Limeburners Bay, one of three remnant mangrove communities in Port Phillip Bay, is a funnel-shaped estuary at the mouth of Hovells Creek that also has salt marsh habitats. Point Wilson and the Sand Hummocks (part of The Spit Wildlife Reserve) up to Werribee have important salt marsh areas and is an important habitat for the endangered Orange-bellied Parrot.

Werribee in northern Port Phillip Bay includes the Western Treatment Plant with lagoons, swamps and intertidal mud flats, all of which are important habitats for shorebirds and hence is a Ramsar site. A zone of parallel sand ridges 250 m wide occurs northeast of Werribee to Point Cooke, where the Point Cooke Marine Sanctuary (MS) is located. From Point Cook to the mouth of Skeleton Creek the shoreline consists mainly of wetlands. Intertidal shore platforms of basalt blocks occur at Altona, east of which is Williamstown. Jawbone MS in Williamstown has the largest surviving stand of mangroves in northern Port Phillip Bay, occurring along a 200 m section of the coast. The white mangrove *Avicennia marina* grows in a muddy intertidal lagoon and on rocky platforms of basalt boulders, uncommon along Victorian coasts. Port Melbourne occurs at the northernmost tip of Port Phillip Bay and is a major port area with small strips of sandy beaches along the coast. The north east beaches have groynes with modified urban areas behind, such as at Port Melbourne, St Kilda, Brighton down to Sandringham. The coast between Sandringham and Ricketts Point consists of bluffs and beaches and some rocky debris at the base.

Ricketts Point, at Beaumaris has an extensive area of shore platform. The shore platform extends over 150 m seaward when exposed at low tide, the widest of any platform on the eastern coast of Port Phillip Bay. The platform is of hard, ferruginous Black Rock Sandstone and the outer edges are covered by coarse rubble. A low bluff covered by dunes and beach sand sits inland of Ricketts Point. immediately to the east

of Ricketts Point are vertical cliffs of Table Rock Point. These cliffs are mainly Black Rock Sandstone.

The eastern coast of Port Phillip Bay is mainly comprised of sandy beaches interspersed with cliffs, such as at Pelican Point and Manyung Rocks at Mount Eliza, Red Bluff and Schnapper Point in Mornington, as well as Harmon Rocks and Balcombe Point at Mount Martha. These beaches also have groynes and jetties spaced out along the coast with seaside towns behind the beaches. A large barrier (sand ridges) and wetland complex dominates the area between Mordialloc and Frankston which is a highly modified coastline due to urban modifications. Roads have been built out to the coast, as well as buildings, caravan parks, seawalls and breakwaters. The coastline has been turned into recreational areas supporting major seaside towns attracting many visitors.

Southwest from Frankston to Dromana, the coastline consists of granite and Baxter sandstone cliffs with shore platforms and small sections of sandy beaches in between. Anthonys nose in Dromana is a steep slope exposing Dromana Granite (the intrusion that forms Arthurs Seat) overlain by unconsolidated sand deposits. West of Dromana is the peninsula extending to Point Nepean. The shorelines here are mainly sandy beaches modified by groins and small jetties. White Cliffs, located 1 km west of the Rye Jetty, has high calcarenite cliffs. This outcrop is the most northerly coastal exposure of calcarenite in Port Phillip Bay. West of White Cliffs, the sandy beaches interspersed with groins and jetties continue until the end of Portsea. Immediately west of Portsea is Nepean Peninsula (bounding the eastern side of the entrance to Port Phillip Bay). Nepean Peninsula has restricted public access and the coastline consists of sandy beaches with calcarenite dunes, cliffs and shore platforms.

Western Port

Southeast of Port Phillip Bay and separated by the Mornington Peninsula lies Western Port, covering 680 km^2. Western Port is a listed Ramsar wetland of international importance for its significant contributions as a foraging and roosting site for migratory birds, extensive saltmarsh community and its sites of geomorphological significance. Within Western Port, minor faulting has resulted in a central uplifted block, forming French Island and Phillip Island. French Island occupies the central region of the bay and Phillip Island forms a barrier across the entrance. Tidal exchange occurs with Bass Strait to the west between Flinders and to the east between Newhaven and San Remo. Western Port has a complex network of dendritic channels that drain the intertidal mudflats and habitats.

French Island has cliffs in Baxter Formation, sandy beaches and pockets of mangroves and salt marsh. The north coast consists of mangrove-fringed salt marsh and is a predominant stronghold of mangrove and salt marsh habitat in Victoria. Red Bluff on French Island is an active cliff with a wide shore platform. Phillip Island has coastal

bluffs, sandy beaches, rock platforms and mangrove and salt marsh fringes. At Rhyll, there is the only Paleozoic outcrop of Silurian mudstones and sandstones known on Phillip Island.

The southwestern part of Western Port is an area from Flinders to Sandy Point, which consists of coastal bluffs and beaches. Flinders has a well defined coastal bluff with marine cliffs cut in strongly jointed basalt and agglomerate, and beaches with rocks just offshore of the coast. East of Flinders lays basalt cliffs at Shoreham and a cobble beach at Point Leo. Next to Point Leo, Merricks has a sequence of coastal slopes varying from active marine cliffs to degraded coastal bluffs. Merricks is geologically significant as it shows a weathering erosion sequence of marine cliffs, bluffs and dune accumulation. There is also an intertidal shallow rock platform at Merricks which has the only recorded population of the sea cucumber *Apsolidium handrecki* (O'Hara and Barmby 2000). The area from Merricks to Somers is mainly beaches as well as the opening of Merricks Creek while at Somers, the coastline has coastal bluffs. These bluffs form part of the complex depositional system that comprises Sandy Point.

Sandy Point is one of the largest spit systems on the Victorian coast and has complex sand beach ridges extending more than 4 km east from the base of Western Hill, a coastal bluff. Sandy Point also has a fringe of mangroves with a broad salt marsh area. Stony Point, ferruginous sandstones of Baxter Formation, also has a fringe of mangroves.

The coastline north of Sandy Point consists mainly of wetland habitats. Yaringa, Watson Inlet and the area from Lyall Inlet to Bunyip River all have salt marsh zones fringed with mangroves extending along tidal creeks to the north of the South Gippsland Highway. Yallock Creek at Tooradin retains one of the few remnants of extensive swamp areas that existed to the northeast of Western Port.

Crawfish Rock, in the main tidal channel of the North Arm, is an outcrop of ferruginous Baxter Formation sandstone and is considered a special management area. The strong currents and deep surrounding areas create a special environment for deep water species such as sponges and algae to occur at unusually shallow depths. Barrallier Island, just east of Crawfish Rock, is a small gravel island derived from ferruginous sandstone. The island has mangroves on the sheltered southern shore and two gravel spits extending from the island. Northwest of Barrallier Island is a small rocky outcrop called Eagle Rock.

Northeast of French Island is a major tidal divide system of international significance. The nature of tidal flow in other parts of Western Port Bay is governed by the dynamics of this area and is one of the most well studied tidal watershed system on the Australian

coast. This is a large area of intertidal mudflats drained by dendritic network of channels.

Southeast of French Island are Pelican Island and Elizabeth Island. Pelican Island is an accumulation of basalt rubble on rocky substrates and contains salt marsh vegetation and several gravel spits towards the east. Elizabeth Island has a narrow rock-strewn shore platform cut in basalt and Mesozoic sediments. The eastern coastline of the island also has a small pocket of mangroves and salt marsh.

San Remo lies at the southern end of Western Port and is connected to Phillip Island by a bridge. The northern coast of the San Remo Peninsula is a high coast formed in older volcanic basalt. The coast has an intertidal shallow reef flat with pebbles covering most of the platform. This reef flat has thirteen species of opisthobranchs that have only been recorded at this locality and are mostly undescribed (O'Hara and Barmby 2000). Churchill Island, off the east of Phillip Island, consists of weathered basalt which crop out around most of the shoreline. Most of the island is bounded by coastal bluffs, with beach ridges of coarse gravel and cobbles in the south and a small mangrove area northwest of South Point. A broad intertidal flat of mainly clay-sized material also surrounds Churchill Island.

Corner Inlet

Corner Inlet is a wetland listed as a Ramsar site and contains the most extensive intertidal mudflats in Victoria. Corner Inlet also has the most southerly occurrence of White Mangrove (*Avicenna marina*) in the world.

The northern coast of Corner Inlet is the longest section of rocky coastline with steeply plunging granite headlands separated by sandy beaches. Starting from the northeast coast of Corner Inlet is Toora Channel, 2 km southeast of Toora Beach. This is mainly a sandy intertidal area linked by shallow channels forming a tidal drainage system. Nearby is Toora Island, a small mangrove and salt marsh island surrounded by a broad sandy intertidal flat. Mangrove Island, 2 km south of Toora Beach is covered with dense strands of mangrove mostly 1 m high. This island, of state significance, is an example of the early formation of marsh islands. West of Mangrove Island is Franklin Island, located 1 km south of Port Franklin. This is a large marsh island with a central salt marsh area. An intertidal zone of large shell banks occurs on the southwestern coastline of the island.

Tea-Tree Point (a tidal peninsula on the western coast of Corner Inlet) and Tea-Tree Island (just offshore from the peninsula) consist mainly of tidal wetlands with mangrove, salt marsh and small areas of *Melaleuca* swamp. Most of the western coastline of Corner Inlet consists of coastal cliffs and bluffs. However, shore platform outcrops and reefs of harder rock also occur at Chalk Cliffs (south of Tea-Tree Island),

and a 30 m wide zone of mangroves in front of a narrow sand beach on the eastern side of the coastal cliffs occurs at Red Bluff (on the southwestern coast of Corner Inlet).

At the southern end of Corner Inlet (on Wilsons Promontory) is Millers Landing, an area with granite outcrops and mangroves growing around boulders and on the shore platform. Millers Landing is only one of three recorded sites along the Victorian coast where mangroves grow on rocky shoreline. Northeast of Millers Landing is an area from Barry Hill to Bennison Point, a dynamic coastal section 2 km long. Weathered granite shore platforms and active granite sand spit developments characterise this area. East of Bennison Point lies Chinaman Creek Delta. This is an active delta infilling a former embayment, fringed with a wide mangrove zone, salt marsh and brackish water swamp. Bennison Island, 2 km north of Barry Hill is the only granite island in Corner Inlet with a beach. This granite island contains sandy tidal flats with pool and channel drainage patterns.

Nooramunga

Nooramunga consists of a network of waterways, isolated granite islands, intertidal mudflats and a complex of over forty sand barrier islands. There are four tidal drainage systems that open to Bass Strait through shallow sand inlets. These are Port Albert Entrance, Kate Kearney Entrance, Shallow Inlet and New Entrance. Snake Island, 3 km south of Port Welshpool, is a large barrier island built of a complex series of sand ridges. Sandy beaches occur on the western and southern shoreline, while the northern sheltered shoreline consists of mangrove fringed tidal embayments. The southeast shoreline of Gellions Run (on the central northern coastline of Nooramunga) comprises eroded older barrier dunes with inter-dune swamps. The shoreline southwest of Gellions Run is fringed by a wide salt marsh and mangrove area, while northeast towards Albert Estuary the marsh is eroded and mangroves are being buried by sand spits and cheniers (ridges of coarse sand and shell fragments).

Gippsland Lakes

The Gippsland Lakes is an estuarine system created by the deposition of successive sandy barriers during the Pleistocene and Holocene, interspersed with lagoons and swamps (Roob and Ball 1997). The main lakes, Lakes Wellington in the southwest, Victoria and King to the northeast, cover an area of 340 km2 and have a shoreline of 320 km (DSE 2003).

An outer barrier of sandy dunes separates the lake system from the ocean in the southwest. The barrier is bounded to the north by Lake Reeve and to the south by Ninety Mile Beach. The zone behind the outer barrier ridges to the salt marsh on the shore of Lake Reeve is a sandy terrain of variable width. For approximately 5 km northeast of Seaspray, located at the southern end of Ninety Mile Beach, the outer barrier is a single sand ridge, steeply cliffed on the seaward edge and from 5 to 8 m

high. The dunes there are relatively young and vegetated by dune grasses. Approximately 27 km northeast of Seaspray around Golden and Paradise Beaches, is the widest section of the outer barrier. The area here has the greatest number of parallel dune ridges (10-13) found along the Ninety Mile Beach stretch.

Lake Reeve extends behind the outer barrier for over 60 km from Seaspray in the southwest to Rotomah Island in the northeast. Along much of the shoreline are sets of low, curving parallel ridges, often cresting only 5 to 40 cm above the intervening swales. They are created by the action of waves during periods of high water level in the lake which are then stranded as the water level recedes. They indicate a progressive reclamation of Lake Reeve by the shoreline. The vegetation is of Salicornia or Hemichroa becoming more complex salt marsh with distance from the lake.

Lake Wellington is the southern most of the three main lakes with Lake Victoria to the east and Lake King east and north of Lake Victoria making up the other two. The Latrobe River flows into the west of Lake Wellington and the Avon River into the north. The Latrobe River has a delta of two silt jetties that extend over 2 km into Lake Wellington and the Avon River delta extends 600 m. These are formed by the growth of reed swamp, consisting of Phragmites, Cladium and Typha which traps river silt and builds up the lake floor to such a level that Melaleuca swamp can form. The deltas are under threat of, or have begun eroding due to die back of the reed swamp probably resulting from increasing salinity.

The southern shoreline of Lake Wellington, east from the Latrobe River entrance and incorporating Lake Coleman, has the largest area of freshwater swampland in and around the Gippsland Lakes. The northern shoreline from Swell Point to Roseneath Point is of a young beach ridge plain composed of gravely sand backed by an old sand plain and low bluff. McLennans Isthmus is a long, sandy promontory that runs southwest from Roseneath Point. The Isthmus is a narrow and gently curving beach backed by low beach ridges that ends in the southeast as a sandy pit which continues to grow as sediments from Lake Wellington are deposited by waves from westerly winds.

Lake Wellington and Lake Victoria are connected by a narrow but deep residual channel, McLennans Strait, which runs through immediately south of McLennans Isthmus. It maintains sufficient flow to prevent the sand spit from extending to completely cut off Lake Wellington.

The southern shoreline of Lake Victoria ends at Sperm Whale Head in the east. Sperm Whale Head has approximately 15 low and wide, predominately sandy, parallel ridges. Much of the northern shore of Sperm Whale Head is eroding to expose cliff sections. The northern shoreline of Lake Victoria has a number of cuspate forelands including from west to east, Storm Point, Waddy Point, Wattle Point and Tannin Point. Together

they create alternating small embayments and sandy headlands which beach accretion on their eastern flanks and erosion on their western flanks. The points have been migrating eastwards. Banksia Peninsula in the northeast of Lake Victoria is a remnant of the earliest barrier system in the Gippsland Lakes basin. Its surface is of low, widely spaced ridges of sand and gravel with the swales between the ridges being 1 to 2 m above the level of Lake Victoria. A cliffed section on the eastern side of Banksia Peninsula near Point Turner is the best example of the prior barrier.

Rotomah Island is located at the mouth where Lake Reeve meets Lake Victoria. It is a low and sandy island with beach ridge formations on the northern side and salt marsh on the more sheltered southern side.

Raymond Island is located just offshore from Paynesville and divides Lakes Victoria and King. The island supports a large colony of koalas. Point Scott in the southeast is a sandy foreland around which wave refraction builds ridges in the east and is eroded to the west.

Waters from the Mitchell, Nicholson and Tambo Rivers drain into the northern section of Lake King. The Mitchell River delta in the west, extends south from around Bairnsdale before jutting eastwards as silt jetties that extend almost 8 km into the lake. The formation of such a delta was enabled primarily by the low degree of tidal currents in Lake King and the presence of the shoreline reed swamp to trap sediment. The Nicholson River delta, now east of Nugents Bay, is only small and has been severely eroded. The Tambo River delta is elongate and protrudes 2.5 km to the southwest into Lake King. The southern arm extends 160 m further than the northern arm. The Tambo delta is an area of low relief and includes lagoonal and swamp zones. All these river deltas have been and are continuing to be eroded.

South of the Tambo River delta is Tambo Bluff, a long and well defined bluff up to 30 m high and with cliffs in the upper section. Tambo Bluff marks the entrance shoreline to Lake King. The bluff curves and has both westerly and southerly aspects which encounter different environmental conditions. The base of the cliff with the westerly aspect is protected from waves by a continuous sandy beach, but where the bluff faces south, the beach is reduced and there are wave cut cliffs. In this area is an irregular and narrow shore platform which fringes the cliff base. Southeast from Tambo Bluff at Metung is a narrow peninsula projecting south into Lake King called Shaving Point. This spit is built from longshore drifting of beach gravel and is surrounded by eroding sand and gravel beaches.

Lakes Entrance is the artificial entrance created in 1889 located to the northeast of the Gippsland Lakes system. The entrance is protected by a series of wooden jetties, granite walls and concrete piers. On either side of the entrance piers, which project over 100 m

seaward, shoreline accretion has created sandy forelands backed by dunes that extend up to 150 m beyond that of the 1879 shoreline.

The entrance quickly divides into four channels, Hopetoun Channel (west), The Narrows (northwest), North Arm (northeast) and Cunninghame Arm (east). A series of islands, Flannagan, Fraser and Rigby, divide the channels in the west and Bullock Island is located at the entrance to the divide between the channels in the east. The Boole Boole Peninsula protrudes southwest from near Lakes Entrance and forms the southeastern shoreline of Lake Victoria/ Lake King and the northern shoreline of the Bunga Arm. The peninsula is mostly swampy terrain and dune ridges. Jemmys Point is a steep bluff with cliffed sections which lies to the north of the entrance. It is made from Jemmys Point Formation which is calcareous silty sandstone with sandy calcarenite and cemented concretionary layers. Shell beds with mollusc shells embedded in a sandy calcareous matrix are also present. The base of the bluff is undercut by wave action.

Red Bluff is an active marine cliff northeast of Lakes Entrance. The cliff is of Jemmys Point Formation and is undercut by wave action. There is an irregular shore platform at its base.

Lake Tyers, 8 km northeast of Lakes Entrance, is often closed to the ocean by a barrier beach. Past tidal influxes have formed a sandy tidal delta in the lower region of the lake. The delta consists of two groups of islands, an inner group of four islands which were formed in the past when the entrance was open more frequently and a group that lies immediately behind the barrier beach which represents deposition from the infrequent periods the entrance now opens. The inner group are vegetated by sedges, reeds, grasses and banksias, while the outer group are of migrating sandy shoals and bars.

Gippsland Lakes is a Ramsar wetland of international importance. It is also listed in both the Japan Australia Migratory Bird Agreement (JAMBA) and the China Australia Migratory Bird Agreement (CAMBA). These recognise the contribution of the Gippsland Lakes in supporting large numbers of migratory and other wetland bird species. Within the Lakes there are also 41 species (6 flora and 35 fauna) listed under the Flora and Fauna Guarantee Act 1988.

1.5.3 Seascapes and Benthic Habitats

Port Phillip Bay

Most of the seabed of Port Phillip Bay is predominantly sediment beds ranging from silt to sands (Edmunds *et al*. 2006). Near the entrance of the bay are shallow rocky reef as well as deep reefs (more than 20 m) and sponge gardens, especially in the canyon of The Rip, described in detail in section 2.2.2 Central Victoria. These reefs are exposed to strong tidal currents and extreme swell and wave conditions. North of the entrance is

Swan Bay, a shallow embayment with large areas of seagrass beds southeast of Saint Leonards.

On the west of Port Phillip Bay is Geelong Arm with shallow seagrass beds along the southern and northern shores. The northwest side of Port Phillip Bay, from Point Wilson to Altona has drift algal beds on sand from 2-10 m depth, occurring alongside patches of shallow rocky reefs at Point Wilson, Point Cooke and Altona. *Pyura* beds with macroalgal can be found in the subtidal area from Point Cook to Altona. From Altona to Williamstown, the seascape consists mainly of bare high profile reefs (Figure 34).

Hobsons Bay at the northern tip of Port Phillip Bay encompasses Williamstown and Port Melbourne. Williamstown Channel, maintained at a depth of 13.1 m, starts at the mouth of the Yarra River and goes in a southeast direction until it joins up with the Port Melbourne Channel. The Port Melbourne Channel, maintained at a depth of 10.9 m, starts off in a southwards direction from the two piers at Port Melbourne, Station Pier and Princes Pier. Hobsons Bay does not have subtidal vegetation and consists mainly of sediment beds (Blake and Ball 2001).

Southeast of Port Melbourne, from Saint Kilda to Ricketts Point, bare rocky reef and algal reefs dominates the subtidal environment, with the seascape consisting of a sloping reef which gets deeper towards the centre of the bay. The northeast area of Sandringham has patches of *Pyura* beds in shallow sand as well as small isolate patches of drift algal beds. The areas between Ricketts Point and Halfmoon Bay (southeast of Sandringham), has shallow rocky reefs near the shore. Ricketts Point and Table Rock Point in Beaumaris has small isolated patches of seagrass. Table Rock Point to Daveys Bay (just north of Mount Eliza) consists mainly of bare sediment beds with few subtidal features.

The seascape for eastern Port Phillip Bay consists mainly of sand beds, bare reefs and algal reefs, with small patches of *Pyura* on the shallow sand beds. The sediment beds and reefs slope down getting deeper towards the centre of the bay. Going southeast from Daveys Bay to Dromana, bare reefs and algal reefs dominate the area.

Southern Port Phillip Bay has many shallow sand areas as well as seagrass beds and some deep reef areas (previously mentioned in the previous seascapes and benthic habitats component of Section 2.2.2 Central Victoria). The Great Sands region, with shallow sand banks and deeper channels in between, occupies the area east of Swan Bay across a significant portion of southern Port Phillip Bay and is detailed in the previous seascapes and benthic habitats component of Section 2.2.2 Central Victoria. Seagrass beds occur in southern Port Phillip Bay at several sites from Rosebud Pier to Portsea, at Point Franklin and Nepean Bay. Patches of macroalgal reefs can also be found at these areas.

Western Port

Western Port has two entrances, the large Western Entrance and small Eastern Entrance on either side of Phillip Island (Figure 35).

Western Port has four distinctive regions. In clockwise order, these are: lower North Arm (west of French Island); upper North Arm (north of French Island); Corinella Segment (east of French Island) and Rhyll Segment (south of French Island) - which connects to both the entrances.

Western Port is characterised by extensive intertidal mudflats (270 km^2). These mudflats are likely to support communities of surface microalgae and sediment infauna. The intertidal and shallow subtidal zones supported a large area (250 km^2) of seagrass beds and macrophytes in 1973 which had declined by 70 % in area by 1983. In 2001 the seagrass beds had partially recovered in some areas to 130 km^2. Various seagrass habitats inhabit the entrances and lower North Arm of Western Port. North of French Island, the sediments support macroalgae. In the tidal watershed area (northeast of French Island) and east of French Island the intertidal mudflats are essentially bare (Figure 35; Blake and Ball 2001).

The sandy seabed off Cribb Point, northeast of Somers, supports two species of ghost shrimp that are listed under the *Flora and Fauna Guarantee Act* 1988.

There is only a small amount of subtidal reef habitat in Western Port. Most reefs are as scattered outcrops in the deep North Arm waters, the main ones being Crawfish Rock and Barrallier Island located above the northernmost tip of French Island. These rocks support macroalgal assemblages in the surface waters, which grade with depth to sessile invertebrate communities similar to those found in deeper water sites. This rapid transition is a reflection of the higher turbidity of Western Port waters. Other smaller rocks, such as Eagle Rock northwest of Barrallier Island, may also support subtidal reef communities.

Deep, current affected tidal channels occur in the North Arm adjacent to Hastings and at Crawfish Rock where the depth is 10-20 m.

Along the north facing aspect at San Remo, there is a diverse substrata including sand, mud, boulders and weathered basalt in close proximity to a fast flowing tidal channel. The site supports a diverse invertebrate community of bryozoans and opisthobranchs which is particularly rich adjacent to the channel.

Corner Inlet

Much of the area of Corner Inlet consists of large sand or mud banks less than 2 m deep. Some of these become exposed at low tide while others remain permanently submerged

(O'Hara *et al*. 2002). These banks are dissected by channels with strong currents that drain out through the entrance between Wilson's Promontory and Snake Island (Figure 36; Roob *et al*. 1998). Most channels are 3-10 m deep and become shallower towards the northern and western sides of the inlet. The channel at the entrance of Corner Inlet is 40 m deep (Singapore Deep) with the main channels in Corner Inlet generally being 10-20 m deep. Large seagrass meadows (up to 6 m depth) occur on the submerged banks as well as some intertidal banks. A major seagrass bed occurs in the central area of Corner Inlet just north of Franklin Channel. Other patches of seagrass beds occur alongside the channels (especially at Toora, Bennison and Middle Channel) and at the ends of most channels. Bennison Channel runs from the south of Corner Inlet up to the northwest side of Bennison Island, south of Granite Island and up along the northeastern tip of Wilson's Promontory to the main channel at the entrance to Bass Strait (Figures 36-38). Middle Channel starts south of Duck Point and runs in a northeast direction to join up to the main channel. Doughboy Channel (north of Doughboy Island) and Stockyard Channel (south of Foster Beach) runs east to join up with Franklin Channel which starts southeast of Port Franklin. Franklin Channel runs easterly and joins up with the main channel leading out of Corner Inlet (Roob *et al*. 1998). Toora Channel, starting west of Barry Point runs in a southeasterly direction to the main entrance.

Nooramunga

Nooramunga is dominated by low, sandy islands with mud and sand banks in between these islands, these banks supporting seagrass meadows (Figure 36). Deeper channels flow around the banks draining into four tidal drainage systems that open out into Bass Strait. Seagrass meadows occur on the submerged banks and some intertidal banks. In western Nooramunga, Lewis Channel curves around the north of Little Snake Island (the westernmost island in Nooramunga) to the southwest where it joins the main entrance channel of Corner Inlet. South of Little Snake Island is Snake Island a large island that extends to the south of Nooramunga. Northeast of Snake Island, in the central region of Noorammunga is Sunday Island. Clumps Channel runs from the northern tip of Sunday Island down to the western side, where it joins up with Snake Channel that runs in between Snake Island and Sunday Island out into Bass Strait. Drum Channel starts south of Port Albert (on the northeastern coastline of Nooramunga) and runs in a southwesterly direction along the eastern side of Sunday Island towards Snake Channel (Roob *et al*. 1998).

Gippsland Lakes

Gippsland Lakes consists of three big estuarine lakes, Lake King and Lake Victoria and Lake Wellington, as well as Lake Reeve which is parallel to Ninety-mile beach (Figure 39). Lake Victoria and Lake King meet at the entrance to Bass Strait (known as Lakes Entrance), and therefore have more saline environments compared to Lake Wellington (Roob and Ball 1997). The floor of Lake Reeve, the southernmost part of Gippsland

Lakes, consists of sand, shell and mud at an average depth of 2 m. Lake Reeve is a narrow and very shallow lagoon with extensive saline mud and sand flats.

Lake Wellington is the westernmost big lake with an average depth of 3 m. Lake Wellington is a flat-bottomed basin of fairly uniform depth comprising mainly of organic-rich, soft mud or sandy mud. Lakes Wellington and Victoria are connected by McLennans Strait, a channel 5 m deep that maintains sufficient current flow to prevent extension of the sand spit that would result in complete closure of Lake Wellington (DSE 2003). The deep bed of McLennans Strait is of coarse, clean sand which reflects the high current energy in the channel (Poore 1982).

Lake Victoria has a maximum depth of 9 m, with channels and shallow sand banks near the eastern end. These shallow sand banks support several seagrass species as well as algae (Figure 39). Central Lake Victoria has fine, organic-rich mud with a high clay content, while the sediment in southeastern Lake Victoria contains a significant amount of shell debris.

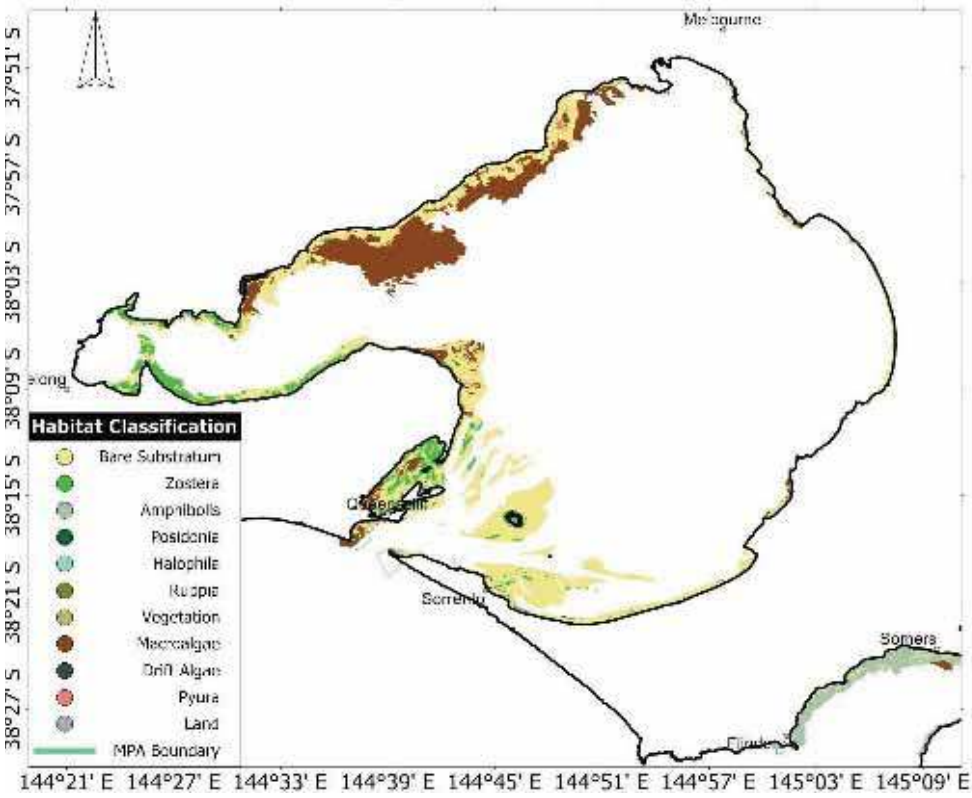
Situated at the northeastern end of Lake Victoria is Lake King. The sediments at Lake King are predominantly organic-rich fine mud with high clay content. Shallower areas of Lake King, especially near the shoreline consists more of sand sediments supporting seagrass and algae (Figure 39). One such area is at Point Fullerton on the southwest shore of Lake King. At Metung, southeast of Lake King is a narrow peninsula called Shaving Point. Southeast of Shaving Point is a hole in the floor of Lake King that rapidly deepens to over 15 m. East of Metung is Reeve Channel which connects to Lakes Entrance.

Reeve Channel has a maximum depth of 7 m and the sediments are well-sorted medium sand with low organic and clay fractions. Shallower areas of Reeve Channel have coarser sand sediments supporting stands of seagrass. Fraser Island, Flannagan Island and Rigby Island occur south of Reeve Channel. These islands have channels and shallow sand banks extending from the shores which support patches of seagrass.

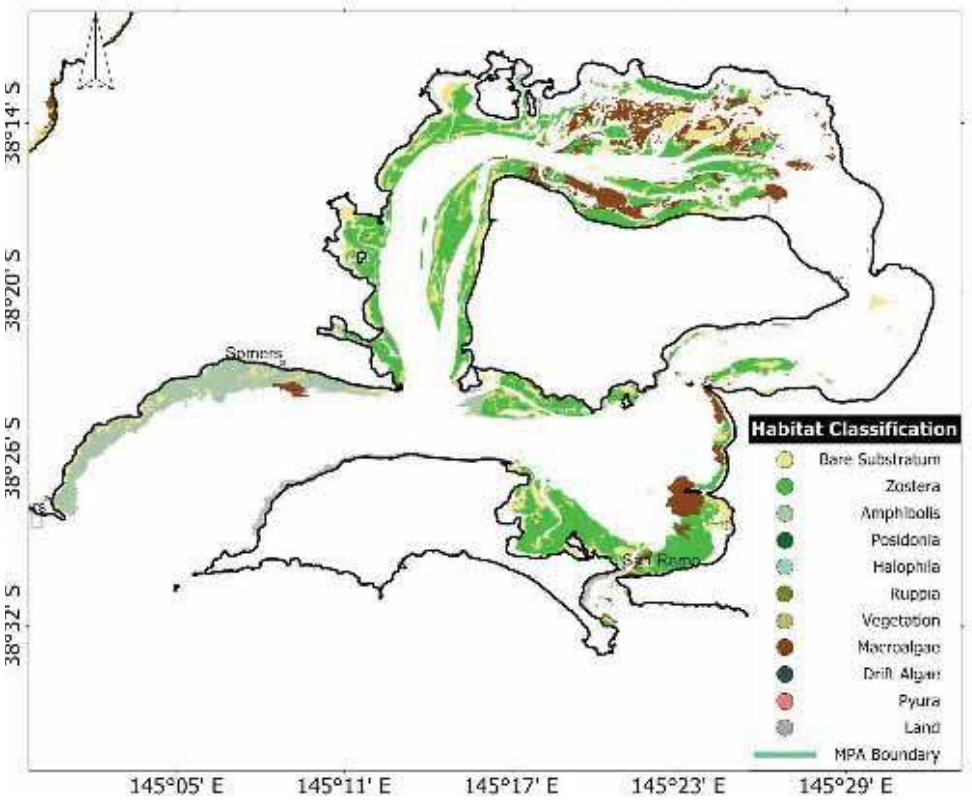
Lakes Entrance consists of a main channel, The Narrows, leading south to The Entrance which connects Lakes Entrance with Bass Strait. Three smaller channels are joined to The Narrows, Hopetoun Channel on the west side and both North Arm and Cunninghame Arm on the east side of The Narrows. The Northern tip of The Narrows has seagrass stands on shallow sand banks while the rest of The Narrows consists only of bare shallow sand banks and sand channels that lead to The Entrance (Judd *et al.* 2008). Along the southern shoreline of the central part of The Narrows, some dark patches of sand with high organic content were found. Hopetoun Channel on the west side of Lakes Entrance is a wide tidal channel with broad sandy tidal flats flanked by narrow ebb spits and swash bars. Most of Hopetoun Channel consists of deeper sandy

channels with shallow sand banks supporting seagrass beds. The northern shoreline of Hopetoun channel also has some seagrass beds lining the edge of the deeper sand channels. North Arm comprises predominantly of a darker shallow sand bank with a high organic content, along with some sparse seagrass beds near the northern shoreline. Cunninghame Arm on the east side of Lakes Entrance is a segmented coastal lagoon consisting mainly of shallow sand banks. Some darker patches of sand with a high organic content were also found in Cunninghame Arm (Judd *et al*. 2008).

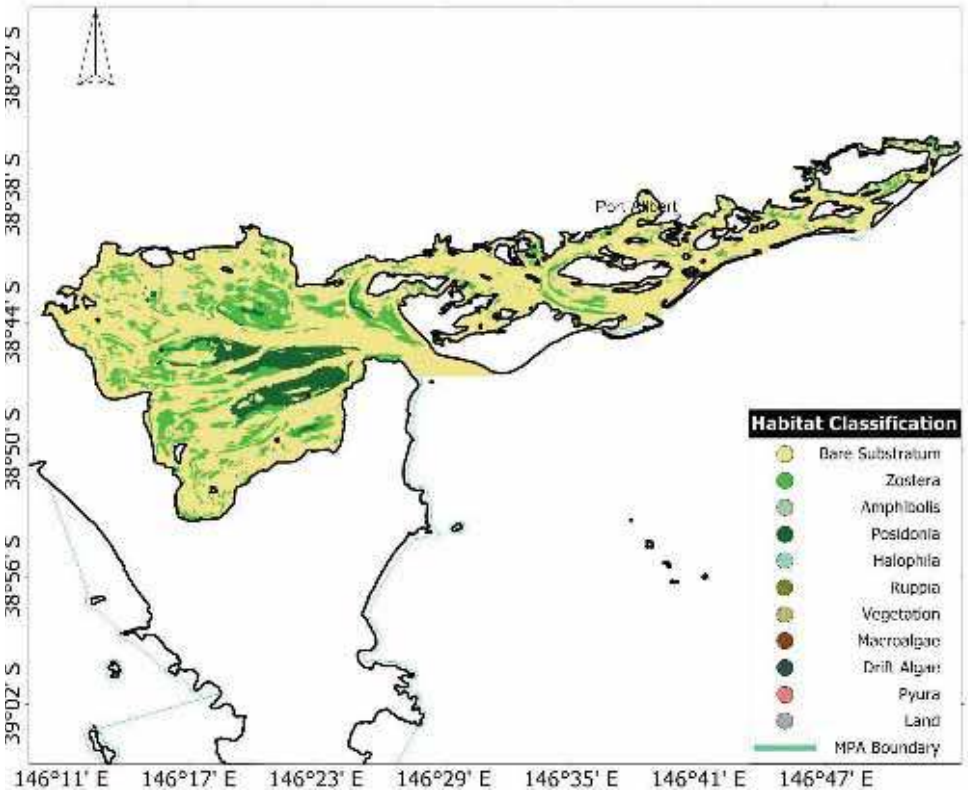
Further east of Lakes Entrance lies Lake Tyers, the entrance of which is frequently closed by a barrier beach for long periods. A sandy, tidal delta occurs in the lower lake, with four delta islands and migrating sandy shoals and bars that lie behind the barrier beach. The floor of Lake Tyers is generally flat and Lake Tyers has two arms going further inshore, Toorloo Arm at the northwest and Nowa Nowa Arm at the northeast. Both arms have long reaches of sheltered waterways. The floor of Nowa Nowa Arm is 'V' shaped, plunging steeply up to 7 m deep. The upper section of the Nowa Nowa Arm also has two holes (Devils Hole) up to 20 m deep.



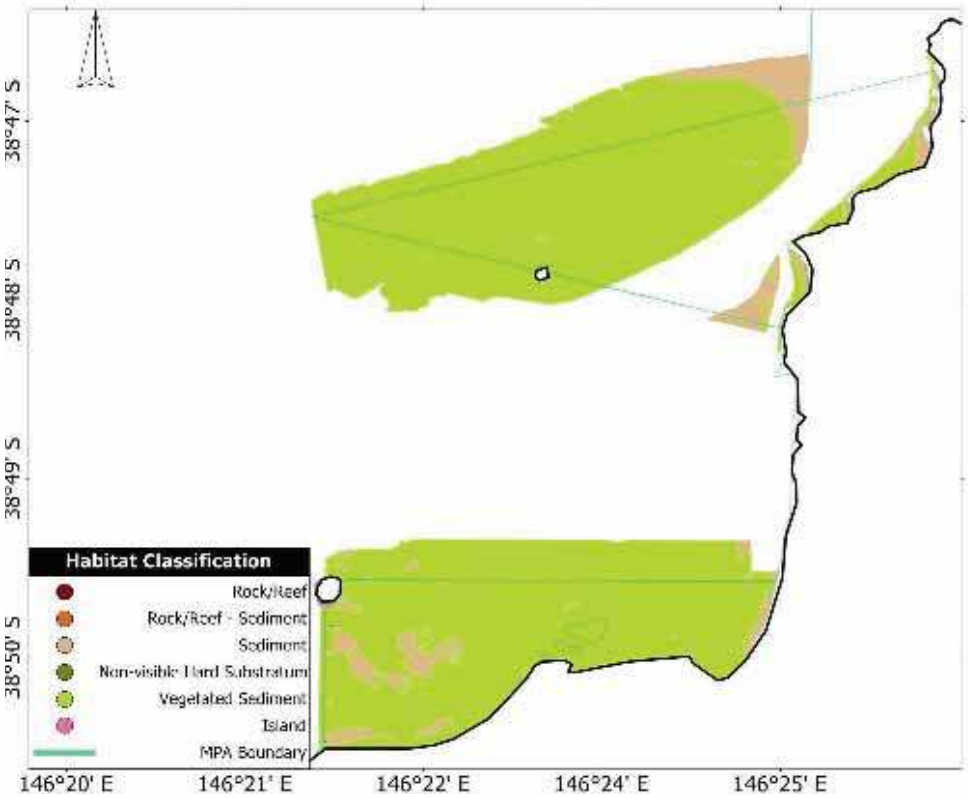
Appendix Figure 34. Substratum present in Port Phillip Bay



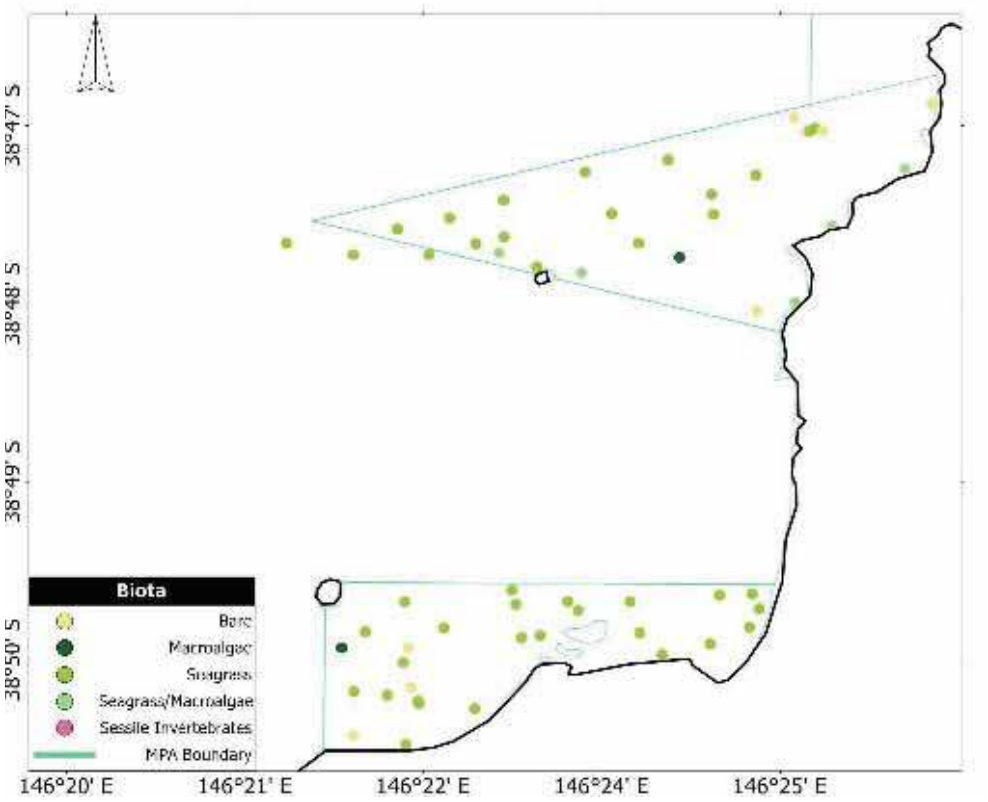
Appendix Figure 35. Substratum present in Western Port.



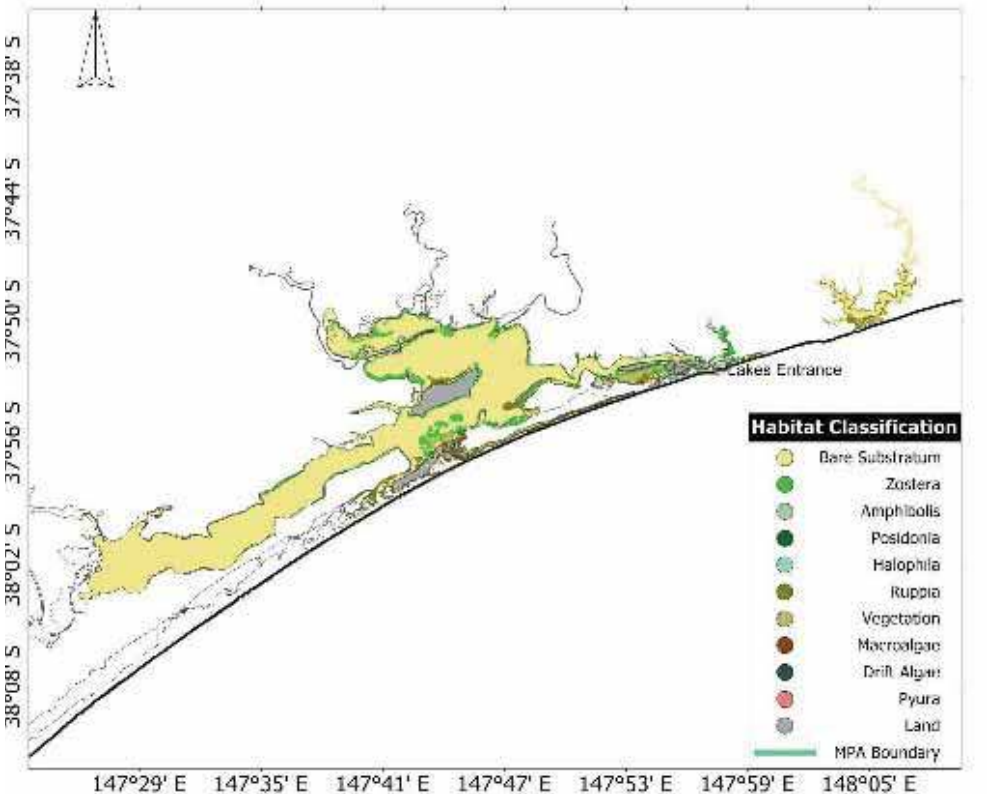
Appendix Figure 36. Substratum present at Corner Inlet.



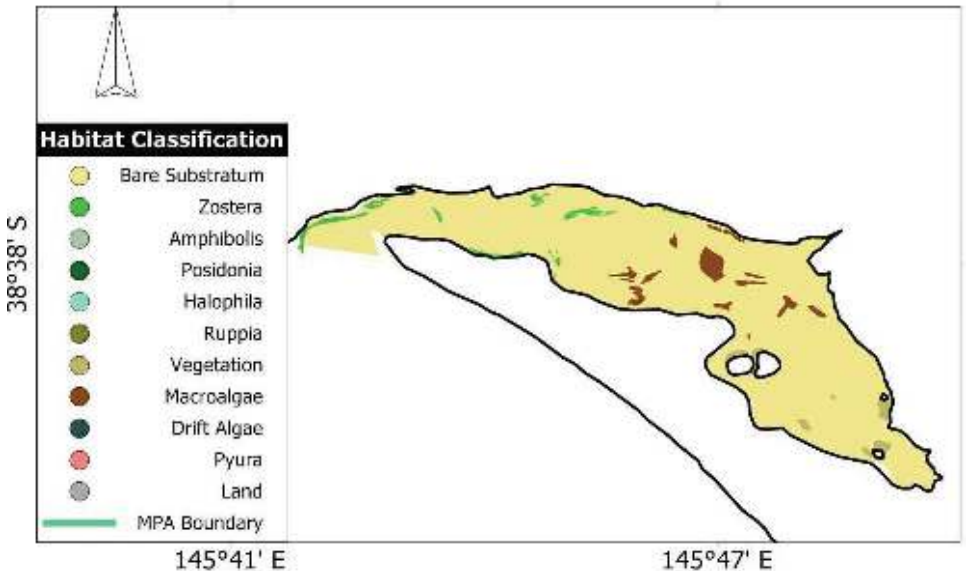
Appendix Figure 37. Substratum present at Corner Inlet Marine National Park.



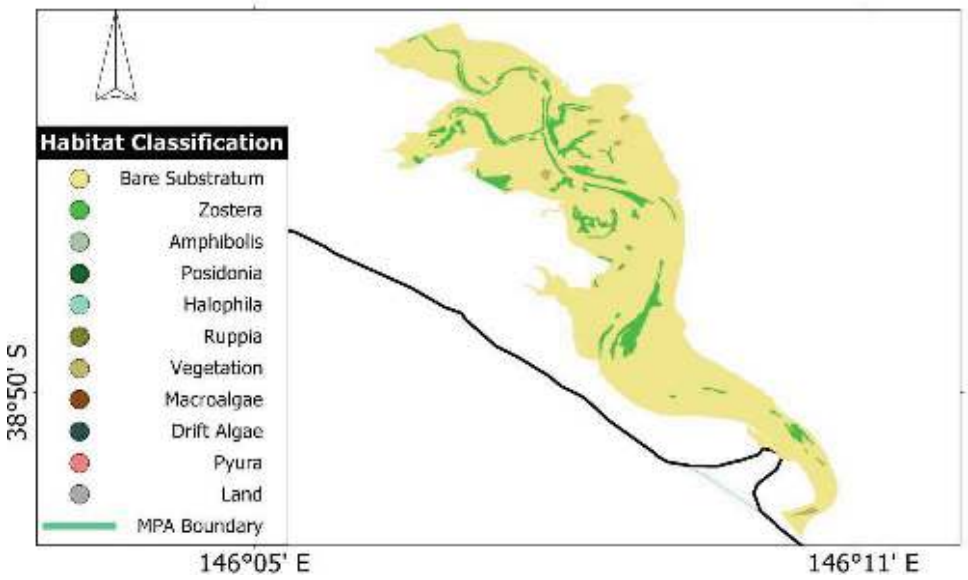
Appendix Figure 38. Biota present from point sampling studies at Corner Inlet Marine National Park



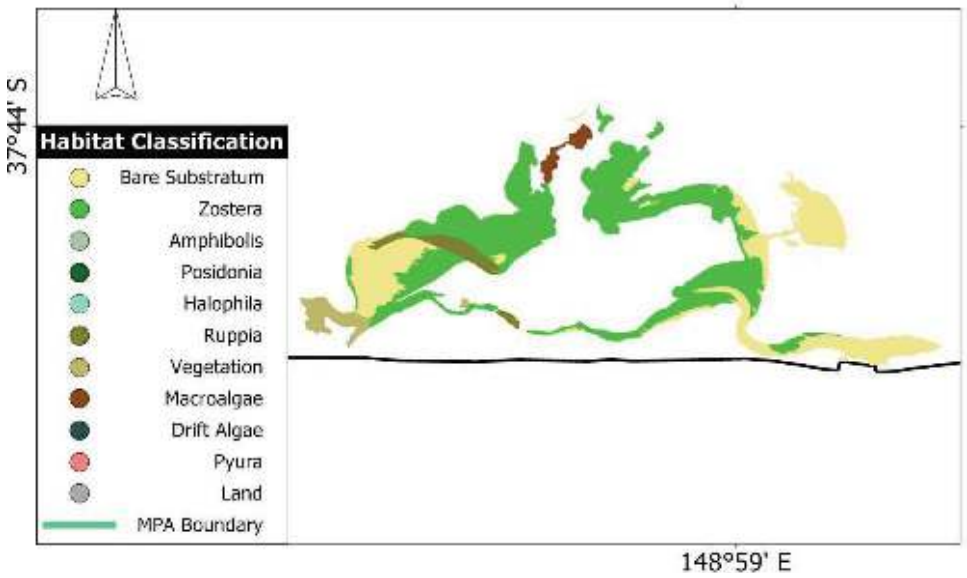
Appendix Figure 39. Substratum present at Gippsland Lakes Coastal Park.



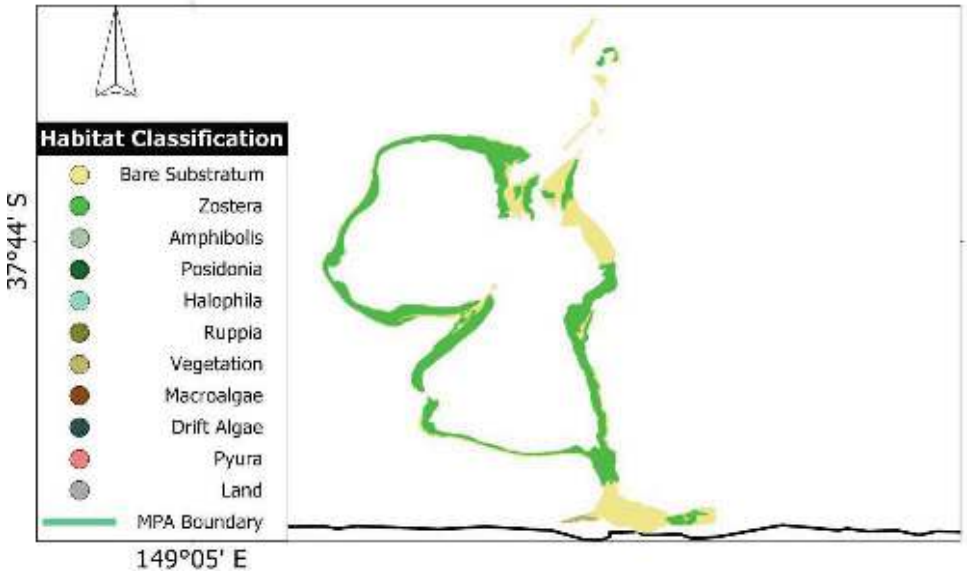
Appendix Figure 40. Substratum present at Anderson Inlet



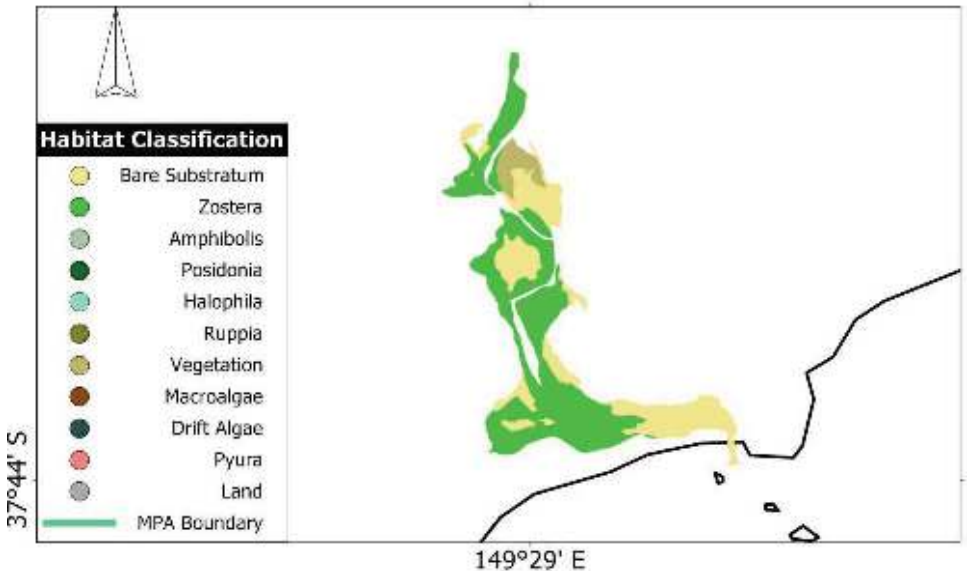
Appendix Figure 41. Substratum present at Shallow Inlet



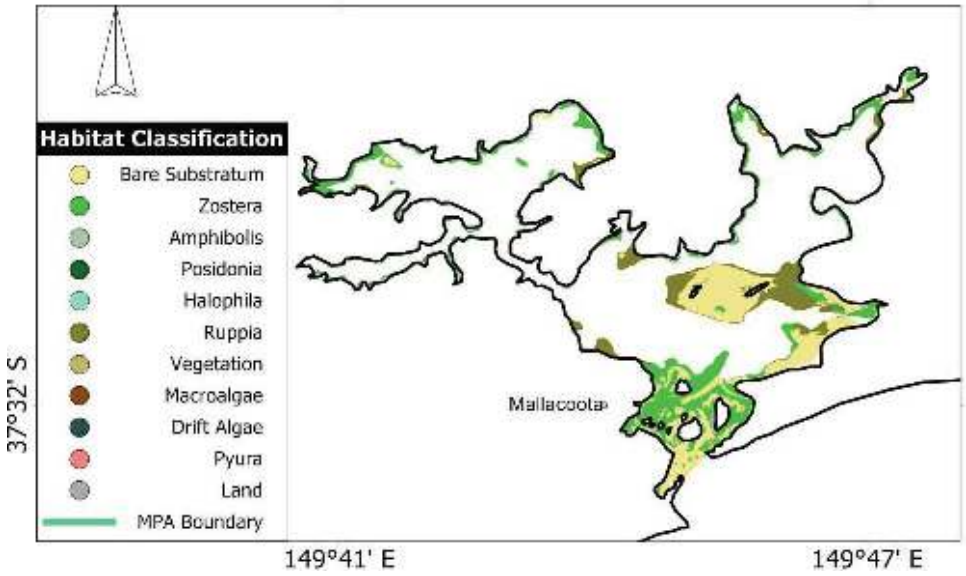
Appendix Figure 42. Substratum present at Sydenham Inlet



Appendix Figure 43. Substratum present at Tamboon Inlet.



Appendix Figure 44. Substratum present at Wingan Inlet



Appendix Figure 45. Substratum present at Mallacoota Inlet

1.5.4 Listed Species and Communities

All Victorian bays and inlets are considered important RAMSAR wetland habitats for birds. Juveniles of the Southern Bluefin Tuna, listed as threatened under the FFG, occur in nursery areas in Port Phillip Bay. There are twelve threatened invertebrate marine species in Victoria's bays and inlets, all of which have recently been listed under the FFG. Of the twelve invertebrate species, there are four sea cucumbers, three shrimps, two brittle stars, one stalked hydroid, one chiton and one opisthobranch. The four sea cucumber species are *Apsolidium densum* and *Apsolidium handrecki* in Westernport, *Thyone nigra* from Port Phillip Bay and *Trochodota shepherdi* from Nooramunga and Corner Inlet. The three shrimp species are *Athanopsis Australia* from Port Phillip Bay, *Michelea microphylla* from Crib Point in Westernport and *Paraglypturus tooradin* from Crib Point and Swan Bay. The two brittle stars, *Amphiura triscacantha* and *Ophiocomina australis* are known from Nooramunga, with *Ophiocomina australis* also occurring in Corner Inlet. The stalked hydroid has only been found at Crawfish Rock in northern Westernport and is possibly endemic to Westernport. The chiton *Bassethullia glypta* has a restricted distribution, only being found in the Port Phillip Heads region.

1.5.5 Ecosystem Services

Extensive salt marsh areas can be found in Port Phillip Bay (example at Swan Bay and Northern Port Phillip Bay which is an important habitat for the endangered Orange-Bellied Parrot), Corner Inlet, Gippsland Lakes and Western Port (example French Island, Phillip Island and Sandy Point). Salt marshes provide several ecosystem services, the first of which is as a natural barrier. Salt marsh vegetation stabilizes the shoreline and limits flooding of coastal cities and towns. Salt marshes also help in pollution control by acting as sinks for a number of pollutants such as pesticides and heavy metals. Pollution regulation coupled with trapping of sediments by salt marsh vegetation help to improve water quality of coastal and estuarine ecosystems. Healthy salt marsh habitats have an important role in nutrient cycling of nitrogen and phosphorus, necessary for regulating biological productivity.

In Port Phillip Bay, mangroves can be found in Limeburners Bay and in Jawbone marine sanctuary in Williamstown. Mangrove pockets also occur at several places in Corner Inlet (such as Chalk Cliffs and Millers Landing), Western Port (example French Island, Phillip Island, Barallier Island and Sandy Point) and parts of Nooramunga. Mangroves help absorb pollutants through processes involving the mangrove plants, microorganism and sediments. Mangrove habitats are also sources of nutrients to marine and terrestrial ecosystems through active and passive transport, and provide habitats for aquatic life.

Broad seagrass beds can be found in southern Port Phillip Bay, Corner Inlet, Western Port, Nooramunga and Gippsland Lakes. Seagrass beds help stabilize and trap sediments, helping to improve water quality. They also provide nursery areas for commercially important juvenile fish and invertebrates, as well as supporting a variety of marine and estuarine species.

Swamp areas are present in Gippsland Lakes and at Yallock Creek in Western Port. These habitats help to trap sediments and provide habitats for waterbirds, fish and crustaceans.

Numerous stretches of sandy beaches occur in southern Port Phillip Bay, Western Port (example Phillip Island), Corner Inlet and Nooramunga. These provide recreational ecosystem services to human populations and also help the tourism industry.

Sediment channels are important in areas near ports where they are used for transport. In Port Phillip Bay, South Channel and the Port of Melbourne Channel are used by big commercial ships to transport goods in and out of Melbourne. The North Arm in Western Port is used for transport to and from the Port of Hastings, another important port in Victoria.

1.5.6 Classification of Estuary Condition

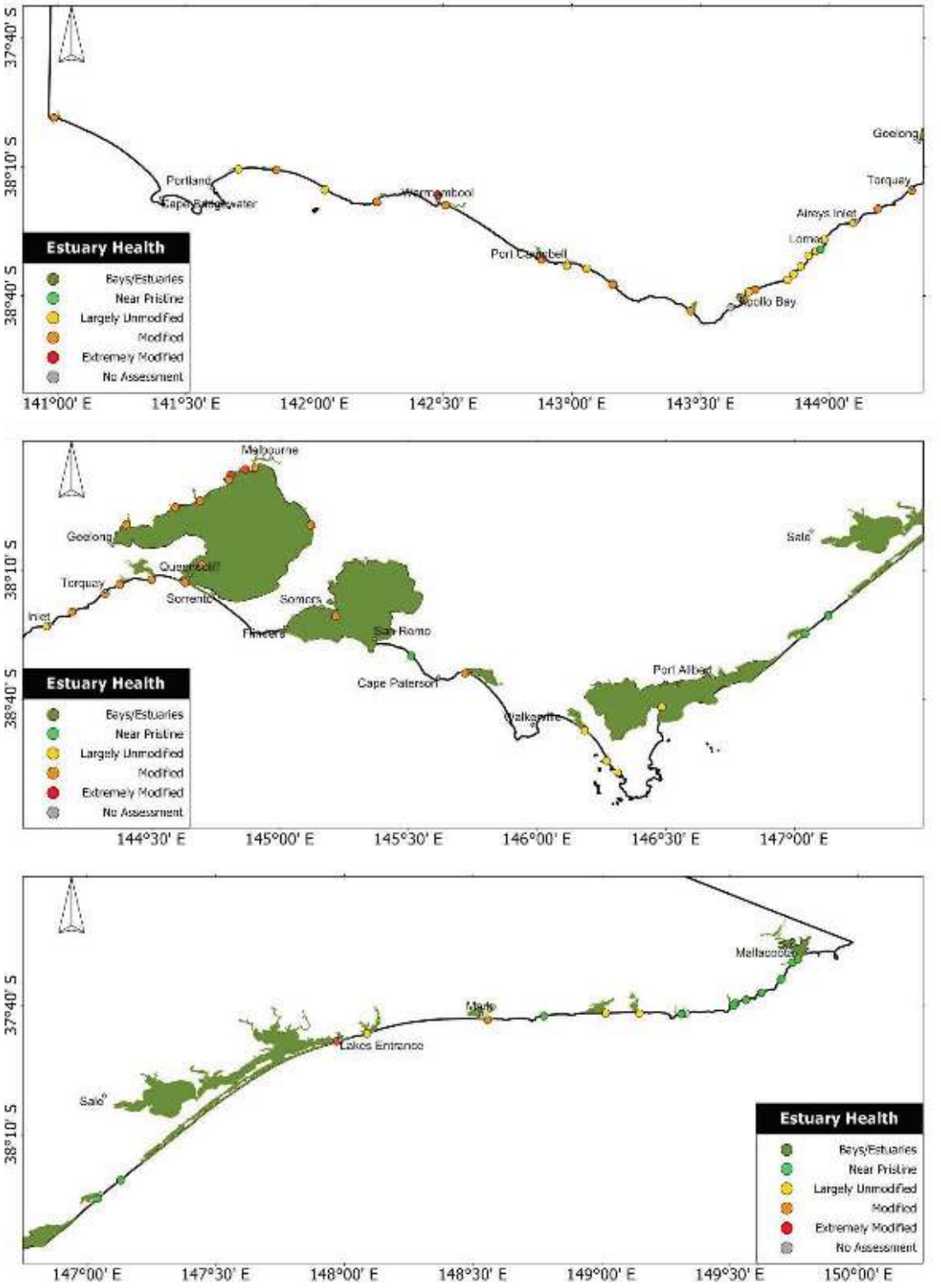
Unknown	Status unknown
Near pristine	Community structure and function similar to pre-European human arrival. Difficult to assess as very poor baseline information.
Altered but functional	Community with most functional elements intact. Some components/species lost. Fished populations at maximum sustainable yield. Altered trophodynamics – fished stocks may be substantially reduced but production may be increased. Populations with changed size/age structures.
Moderately degraded	Area or extent of habitat may be depleted to some extent. Community may be missing some functional and structural (biodiversity) elements leading to altered dynamics and interactions. Dominant structural characteristics present but minor components or functions absent. Physical habitat structure unaltered but may be exposed to considerable environmental stresses (*e.g.* reduced light climate, increased nutrient loadings or presence of toxicants) – with these stressors affecting functional capacity (such as reduced primary production). This state encompasses 'ghosting', where unaltered principal characteristics mask less apparent changes of ecological importance or significance.
Highly degraded	Area or extent of habitat may be substantially depleted. Community may have missing or changed dominant functional and structural (biodiversity) elements. Populations unstable or in decline. Physical and/or biogenic habitat structure may be considerably altered. Invasions of other species, including exotics may be present.
Remnant/Non-recoverable	Loss of most of area, extent, biodiversity of processes and/or functions. Previous areas may be replaced by other natural communities or new communities with exotic marine species. Remnant areas have only a fraction of the elements that previously defined the community.

Extinct	Existed in the past but no longer evident.

Classification of Conservation Status

Very High	Most of community or population contained in no-take MPA and/or with high degree of specific management control.
High	Sustainable proportion of community or population contained in no-take MPA or with .
Moderate	Representation within reserve but
Low	Populations present in reserve but either the proportion or the degree of management or control of threats is ineffective or insignificant.

1.5.7 Estuary Health



Appendix Figure 46. Health of Victorian estuaries and embayments, as assessed by the Coastal Cooperative Research Centre (OzCoasts, 2008).

Appendix 2: Commonwealth and State Marine Protected Areas Policy Context

Australia's Oceans Policy

The Commonwealth Government released Australia's Ocean Policy in December 1998, which continues to guide the direction of the Australian Government's programs in the marine environment. The policy describes the vision for Australia's marine waters as healthy oceans: cared for, understood and used wisely for the benefit of all, now and in the future. Australia's oceans policy has the following broad goals:

- To exercise and protect Australia's rights and jurisdiction over offshore areas, including offshore resources
- To meet Australia's international obligations under the *United Nations Convention on the Law of the Sea* and other international treaties
- To understand and protect Australia's marine biological diversity, the ocean environment and its resources, and ensure ocean uses are ecologically sustainable
- To promote ecologically sustainable economic development and job creation
- To establish integrated oceans planning and management arrangements
- To accommodate community needs and aspirations
- To improve our expertise and capabilities in ocean-related management, science, technology and engineering
- To identify and protect our natural and cultural marine heritage
- To promote public awareness and understanding

Central to the policy is ecosystem-based management of Australia's marine territory to be implemented through a regional marine planning process. Regional Marine Plans, based on large marine ecosystems, are intended to integrate sectoral commercial interests and conservation requirements. The Commonwealth sought the participation of relevant states and territories in developing Regional Marine Plans to ensure, as far as possible, the integration of planning and management across State and Commonwealth waters (Environment Conservation Council, 2000).

Australia's Ocean Policy, is implemented through regional marine planning that tailors its objectives to specific regional needs. However regional marine plans have no standing under existing statutes, and their implementation hinges on the ongoing agreement of various ministers and agencies (and ultimately, jurisdictions). Regional marine plans must therefore achieve their objectives in the absence of legislative standing and enforceability. This leads to duplication of effort, inconsistency in application and performance, conflicting policy and decision making, and no

meaningful mechanism to hold agencies accountable for the impact that their decisions have beyond their jurisdictions (Smyth, C., Prideaux, M., Davey, K. and Grady, M., 2003).

However although the policy is comprehensive it is not integrated, the institutional arrangements are insufficient, and the regional marine planning process, including the South-east Regional Marine Plan, has failed to establish integrated, intersectoral and ecosystem-based planning and management. The lack of effective intergovernmental legislative arrangements, and the consequent complex and occasionally conflicting administrative arrangements could undermine future oceans planning and management (Australian Conservation Foundation and National Environmental Law Association, 2006).

National Parks Act 1975

The National Parks Act 1975 provides a consistent approach to the establishment and management of Victoria's National Parks. The Act sets out provisions for particular parks and establishes offences and enforcement in marine national parks and marine sanctuaries. The provisions relating to marine parks were brought in 2002 by the *National Parks (Marine National Parks and Marine Sanctuaries) Bill 2002*, creating Victoria's current system of 13 marine national parks and 11 marine sanctuaries.

The Act establishes the National Parks Advisory Council; sets out provisions for the creation of Crown Land Reserves; sets out and describes allowable activities and uses for the various classes of parks; and describes how land adjacent to parks should be managed. The National Parks Act controls the works that can be carried out within a park and makes provision for licenses of special conditions to be granted (Australian Conservation Foundation, 2005).

The Act creates categories known as "marine national parks" and "marine sanctuaries" which the Secretary is under a duty to control and manage in accordance with the objects of the Act, to provide the public with use and enjoyment of the parks, and to promote understanding of their purpose and significance. Additionally, the Secretary must prepare a management plan for each of these areas (Australian Conservation Foundation, 2005). The Minister can appoint advisory committees for a particular park or parks to make recommendations to the Secretary.

The objects of the Act with respect to Marine National Parks and Marine Sanctuaries are:

- The preservation and protection of the natural environment including wilderness areas and remote and natural areas in those parks;

- The protection and preservation of indigenous flora and fauna and of features of scenic or archaeological, ecological, geological, geomorphological, historic or other scientific interest in those parks;
- The prevention of the introduction of exotic flora and fauna into the park; and
- The eradication or control of exotic flora and fauna found in the park; and
- The use, enjoyment and understanding of marine national parks and marine sanctuaries by the public; and
- To promote an understanding of the purpose and significance of marine national parks and marine sanctuaries; and
- The study of ecology, geology, botany, zoology and other sciences relating to the conservation of the natural environment in those parks; and
- The responsible management of the lands and waters in those parks.
- Preparation of a plan of management in respect of each marine national park and each marine sanctuary.

There is no explicit "duty to consider objects" obligation on decision-makers (Australian Conservation Foundation, 2005).

The Act makes it an offence in marine national parks and marine sanctuaries to fish without a permit; use, form or create a habitat for hatching, breeding fish or fish bait; and to use certain boats or equipment in certain areas of marine parks. The Secretary has the power to issue permits allowing fishing in marine national parks and marine sanctuaries for the purpose of study, research or investigation that is considered appropriate and does not detrimentally affect the marine park or sanctuary. Authorized officers have the power to direct a person who is engaging in an unauthorized activity to stop that activity.

Petroleum exploration leases, licenses and permits granted under the *Petroleum (Submerged Lands) Act* 1982 are subject to conditions, including that exploration is not done in a way that is detrimental to the seabed, flora or fauna of the park. Pipelines and seafloor cables are not to be laid without the consent of the Minister, who can impose any conditions they see fit.

Commonwealth Environment Protection and Biodiversity Conservation Act 1999

This Act came into force in July 2000 and identifies six matters of national environmental significance (NES):

- World Heritage properties
- Wetlands of international Importance (RAMSAR wetlands)
- Nationally threatened species and ecological communities
- Internationally listed migratory species
- Nuclear actions
- Commonwealth marine areas

Major activities and actions in Victoria, with a potential significant impact on a matter of NES in the marine and coastal environment, are subject to assessment and approval under the Act unless State assessment processes have been accredited by the Commonwealth. It is therefore possible that new developments, such as marine aquaculture operations, may require assessment and approval under the Act if, for example, the proposal is in a RAMSAR listed area (Environment Conservation Council, 2000).

The Act requires that each reserve or zone should be managed in accordance with the Australian IUCN Reserve Management Principles and that these management principles are reflected in the management plan. *The Environment Protection and Biodiversity Conservation Regulations 2000* set out the Australian IUCN Reserve Management Categories and Principles, which describe how each IUCN category reserve is to be managed (Department of the Environment, Water, Heritage and the Arts, 2010).

The use to date of the listing of key threatening processes under the *EPBC Act* has been very limited when it comes to protecting Australia's ocean life, but it could be useful if threatening processes such as overfishing, beach netting for sharks, seabed trawling, land-based pollution, invasive marine pests, habitat conversion and nearshore reclamation were listed. The same can be said of the need for an expansion of the lists for threatened species and ecological communities, but currently there are only two marine ecological communities listed as threatened, and the list of species does not include any marine invertebrates or commercial fish species (Australian Conservation Foundation and National Environmental Law Association, 2006).

As a result of the limited coverage of NES, processes for referral of actions for assessment and approval under the *EPBC Act* have had limited value for oceans protection and are unlikely to capture many future proposals in state waters. (Australian Conservation Foundation and National Environmental Law Association, 2006).

It is a statutory requirement that the Act be independently reviewed every 10 years. The first review was commissioned by the Commonwealth Government in 2008. The results were released in a comprehensive report in 2009 and include recommendations for significant changes to the Act's operation and administration. The Hawke Report makes 71 primary recommendations as well as numerous conclusions and findings of an advisory nature. These recommendations are currently being reviewed by the Commonwealth Government and include:

- Redraft the Act to better reflect the Australian Government's role, streamline its arrangements and rename it the *Australian Environment Act*;

- Establish an independent Environment Commission to advise the government on project approvals, strategic assessments, bioregional plans and other statutory decisions;
- Invest in the building blocks of a better regulatory system such as national environmental accounts, skills development, policy guidance, and acquisition of critical spatial information;
- Streamline approvals through earlier engagement in planning processes and provide for more effective use and greater reliance on strategic assessments, bioregional planning and approvals bilateral agreements;
- Set up an Environment Reparation Fund and national 'biobanking' scheme;
- Provide for environmental performance audits and inquiries by the Environment Commission;
- Create a new matter of national environmental significance for 'ecosystems of national significance' and introducing an interim greenhouse trigger;
- Improve transparency in decision making and provide greater access to the courts for public interest litigation; and
- Mandate the development of foresight reports to help government manage emerging environmental threats (Department of the Environment, Water, Heritage and the Arts, 2009).

National Strategy for the Conservation of Australia's Biological Diversity (1996)

The main goals of the National Strategy for the Conservation of Australia's Biological Diversity are to protect biological diversity and to maintain ecological processes and systems. The Strategy states that central to the conservation of Australia's biological diversity are the principles that:

- Biological diversity is best conserved in-situ.
- Lack of full knowledge should not be an excuse for postponing action to conserve biological diversity.
- Central to the conservation of Australia's biological diversity is the establishment of a comprehensive, representative and adequate system of ecologically viable protected areas integrated with the sympathetic management of all other areas, including agricultural and other resource production systems.

The objectives of the Strategy include:

- Identifying important biological diversity components and threatening processes.
- Managing biological diversity on a regional basis, using natural boundaries to facilitate the integration of conservation and production-oriented management.

- Improving the standards of management and protection of Australia's biological diversity by encouraging the implementation of integrated management techniques.
- Establishing and manage a comprehensive, adequate and representative system of protected areas covering Australia's biological diversity.
- Strengthening off-reserve conservation of biological diversity.
- Ensuring that the potential impacts of any projects, programs and policies on biological diversity are assessed and reflected in planning processes, with a view to minimising or avoiding such impacts.
- Providing the knowledge and understanding of Australia's biological diversity essential for its effective conservation and management.

The Strategy also provides for the development and implementation of a marine conservation and management strategy for Australian coastal waters (including estuaries and the Australian Fishing Zone), including mechanisms (eg. zoning) for minimising the adverse impacts of such activities as coastal development, land-based discharge of pollutants, shipping, and the harvesting of marine resources.

This Strategy is currently under review and the draft *Australia's Biodiversity Conservation Strategy 2010-2020* was released for public comment in March, 2009. The consultation draft has been developed to replace the *National Strategy for the Conservation of Australia's Biological Diversity*. The draft strategy is an important national policy document that will guide how governments, the community, industry and scientists manage and protect Australia's plants, animals and ecosystems over the next ten years (Department of Environment, Water, Heritage and the Arts, 2006).

Australia's Biodiversity Conservation Strategy 2010-2020

Australia's Biodiversity Conservation Strategy 2010-2020 aims to ensure Australia's biodiversity is healthy, resilient to climate change and valued for its essential contribution to our existence. It recognizes that despite efforts to manage threats, biodiversity in Australia continues to decline. The strategy outlines the short and long term activities required to maintain biodiversity with a minimum 10 year outlook.

The Strategy outlines six 'priorities for change' that are urgently to achieve the strategy's vision. These are: building ecosystem resilience, mainstreaming biodiversity, knowledge for all, getting results, involving Indigenous peoples and measuring success.

Each priority for change is linked to objectives, actions and results which will guide the development of biodiversity conservation approaches for national, state, territory and local governments, and for businesses, non-government organisations and community groups. The listed results are the expected 'onground' consequences of successful

implementation of the actions (National Biodiversity Strategy Review Task Group, 2009). The final Strategy is expected to be released early in 2010.

Victoria's System of Marine National Parks and Marine Sanctuaries Management Strategy 2003–2010

Victoria's System of Marine National Parks and Marine Sanctuaries Management Strategy was prepared to guide the management of Victoria's highly protected system of 13 Marine National Parks and 11 Marine Sanctuaries until 2010. It describes the vision for Victoria's Marine National Parks and Marine Sanctuaries as 'a world-class system that conserves the diversity of Victoria's marine environments, protected and enjoyed by Victorians and visitors, forever' (Parks Victoria, 2003). The Strategy provides a consistent, state-wide approach for the management of Victoria's Marine National Parks and Marine Sanctuaries. It requires that management plans be prepared for each of the 13 Marine National Parks and 11 Marine Sanctuaries. Community participation and involvement in the development of these plans is a key focus (Commissioner for Environmental Sustainability Victoria, 2008).

The body of the Strategy is arranged under five major themes, with key performance areas under each theme outlining the management framework, objectives, desired outcomes, strategies and implementation actions. The five major themes are:

- Protecting Natural Values
- Protecting and Recognising Cultural Values
- Community Engagement
- Recreation, Tourism and Visitor Management
- Environmental Research and Monitoring.

The Strategy also outlines the way in which management performance will be evaluated and reported upon.

Flora and Fauna Guarantee Act 1988

The *Flora and Fauna Guarantee Act* is the main legal framework for the protection of Victoria's biodiversity, native plants and animals, and ecological communities on land and in water (including marine species and communities). The primary objectives are to conserve listed endangered or threatened species and to ensure that genetic diversity of flora and fauna is maintained (Australian Conservation Foundation, 2005).

The objectives of the Act include: ensuring that our native flora and fauna can survive, flourish and retain their potential for evolutionary development in the wild; ensuring that any use of flora or fauna by humans is sustainable; and encouraging the

conservation of flora and fauna through co-operative community endeavours. The Act can also allow for the protection of a sensitive species when the rest of the community may be coping well with impacts.

The framework provides for a listing process where any taxon or community of flora and fauna that satisfies the criteria can be listed in the Schedule of the Act and be protected. Threatening processes, such as habitat fragmentation, are also listed under the Act. After listing, a Flora and Fauna Guarantee Strategy must be prepared to outline how conservation and management objectives will be achieved. The objects are to be considered when preparing the Strategy including proposals for the survival, abundance and evolutionary development in the wild of all taxa and communities of flora and fauna.

Action Statements must be prepared to describe the threatened species, biological communities and potentially threatening processes listed under the Act, which set out management prescriptions and actions to conserve listed features. Critical habitats can be declared by the Secretary if an area is critical to the survival of a taxon or community (Australian Conservation Foundation, 2005). In preparing Action Statements the Secretary must consider any relevant nature conservation, social and economic matters. There are currently no Action Statements for listed marine invertebrates as they take years to implement after listing. Aside from Humpback and Blue whales, existing statements also lack targets and monitoring of management success.

However the effectiveness of the Act is limited in a number of ways:

- The Act does not provide for groups of adjacent communities to be listed to allow for the protection of a significant ecosystem unit.
- The Act generally lacks timeframes for making decisions and taking actions to implement the Act.
- No form of Environmental Impact Assessment is required for activities which may affect listed species or communities, or before threatening processes are undertaken.
- There are no provisions for protection of listed fauna in the Act. Offences in relation to fauna are contained in a separate piece of legislation the *Wildlife Act 1975 (VIC).*
- Third parties are unable to bring an action under the Act.
- There is a lack of accountability for adhering to requirements for making and implementing Action Statements. Action Statements are not reviewed on a regular basis and there is no system to allow for public contribution to the revision or implementation of them.
- The public cannot make nominations for critical habitat to be recognized (Australian Conservation Foundation, 2005).

Victoria's Biodiversity Strategy (1997)

Victoria's strategy for the conservation of biodiversity was released in 1997, and included marine, coastal and estuarine environments. The preparation of such a strategy is a requirement under the *Flora and Fauna Guarantee Act 1988* and forms a key step in achieving the Act's objectives of conserving native species, communities and gene pools, preventing threats and encouraging community involvement. The Victorian Biodiversity Strategy aimed to clarify the concepts underpinning biodiversity. It also had a mandate to express the intent of the *Flora and Fauna Guarantee Act (1988)* in practical goals to enable planning and measurement of effectiveness (Clear Horizons, 1997).

The environmental goals in the Strategy were:

- The reversal, across the entire landscape, of the long-term decline in the extent and quality of native vegetation, leading to a net gain
- Maintenance and restoration of the ecological processes and the biodiversity dependent upon terrestrial, freshwater and marine
- Maintain of improve the present diversity of species and ecological communities and their viability across each bioregion.
- There is no further preventable decline in the viability of any rare species or of any rare ecological community.
- There is an increase in the viability of threatened species and in the extent and quality of threatened ecological communities (Clear Horizons, 1997).

The strategy emphasized:

- Systemic prevention or reduction of the causes of biodiversity loss
- Ecologically sustainable management of public lands and waters by government agencies in association with resource based industries
- Cooperative management of biodiversity on private land, in partnership with landholders, the community, catchment management authorities and local government
- Every community and bioregion forming an integral part of our living wealth
- A reporting framework for monitoring progress (Environment Conservation Council, 2000).

An independent review in 2007 revealed a number of shortfalls with the current Strategy, including that the environmental targets have not been achieved and there is insufficient data to accurately report on trends; the Strategy lacks SMART targets, indicators and ways of assessing progress; and that the goals are essentially 'aspirational' and require more realistic timeframes. This may have resulted becaus

additional money was not put forward in 1997 for Strategy implementation and follow through. Additionally, the Strategy does not provide sufficient guidance on implementation and responsible authorities. Marine biodiversity is not adequately addressed by the Strategy (Clear Horizons, 1997).

The Strategy is being renewed during 2008-10 as a separate document to the *Land and Biodiversity at a Time of Climate Change White Paper*, and will provide strategic directions for biodiversity management across Victoria. The draft Biodiversity Strategy was be released for public comment in 2009.

International listings of important conservation areas:

Australia can receive international recognition for its conservation values in three ways: under the World Heritage Convention, the Convention on Wetlands of International Importance (the Ramsar Convention), and the UNESCO Biosphere Reserves Program. These designations do not have a legal foundation, but act as 'overlays' for areas with a range of land tenures, some of which may not be recognized as protected areas (Environment Conservation Council, 2000).

World Heritage Areas

UNESCO's World Heritage Convention seeks to encourage the identification, protection and preservation of cultural and natural heritage around the world considered to be of outstanding value to humanity. It aims to: ensure the protection of States' natural and cultural heritage; encourage parties to establish management plans and set up reporting systems on the state of conservation of their World Heritage sites; encourage participation of the local population in the preservation of their cultural and natural heritage; and encourage international cooperation in the conservation of our world's cultural and natural heritage. The Royal Exhibition Building and Carlton Gardens is currently the only World Heritage Area in Victoria (Environment Conservation Council, 2000).

Wetlands of International Importance

The Ramsar Convention aims to promote the conservation of wetlands and waterfowl, to establish nature reserves on wetlands, to provide adequately for their protection and management and to train personnel competent in the fields of wetland research and management. Four coastal marine areas in Victoria are designated as Wetlands of International Importance under the Ramsar Convention:

- Port Phillip Bay (western shoreline) and Bellarine Peninsula
- Western Port
- Corner Inlet (includes the Nooramunga area)

- Gippsland Lakes

Two other international agreements that act to protect migratory birds are the Japan-Australia migratory Birds Agreement (JAMBA) and the China-Australia Migratory Birds Agreement (CAMBA). The agreements recognize that certain species of birds migrate between the two countries and that both countries will conserve the habitats of these species.

Biosphere Reserves

Biosphere Reserves are areas nominated by a UNESCO member state which, because of their characteristic plants and animals and the way they are used by humans, have been given international recognition by the Man and the Biosphere Programme of UNESCO. A Biosphere Reserve contains gradations of areas which have been modified by human activity, with a core area or areas devoted to long-term protection, and one or more surrounding buffer zones in which activities compatible with the conservation objectives may be carried out. Three coastal and marine areas in Victoria have been designated as Biosphere Reserves by UNESCO:

- Croajingolong National Park
- Wilson's Promontory National Park
- Mornington Peninsula and Westernport

Appendix 3: Commonwealth and State Marine Conservation Policy Context

Offshore Constitutional Settlement

In 1979 the Commonwealth and the states entered into the Offshore Constitutional Settlement (OCS). It allows for arrangements to be made between the States and the Commonwealth on resource and conservation matters for marine waters (except bays, inlets and estuaries). Under the OCS the Commonwealth delegated a significant portion of its responsibility to the states (Australian Conservation Foundation and National Environmental Law Association, 2006).

To implement the OCS, the states passed legislation requesting the Commonwealth parliament to enact laws giving states powers with respect to the territorial sea. The Commonwealth passed 14 pieces of legislation which form the framework of marine management that is now in place. The two most significant pieces of legislation passed by the Commonwealth are the *Coastal Waters (State Powers) Act 1980* (Cth) and the *Coastal Waters (State Title) Act 1980* (Cth).

The OCS established arrangements between the Commonwealth and the states under which fisheries could be managed by either the Commonwealth, by a state given responsibility to the edge of the Australian Fishing Zone, by retaining the status-quo with state and Commonwealth legislation, or through a 'joint authority' to manage fisheries that crossed jurisdictional boundaries (Australian Conservation Foundation and National Environmental Law Association 2006). For the purposes of fisheries management this gives the Commonwealth jurisdiction for specified fishing areas within Victorian territorial waters, and vice versa. For example, Victoria manages some Commonwealth waters with respect to abalone, and the Commonwealth manages some Victorian waters with respect to royal red prawns (Environment Conservation Council, 2000).

According to the ACF, '*While designed to ensure cooperation with state interests, the Offshore Constitutional Settlement has, in the absence of any overarching Commonwealth control, resulted in divided, sector-based and insular management focused on the exploitation of marine resources within jurisdictional boundaries, not ecological or resource boundaries' (*Smyth, C., Prideaux, M., Davey, K. and Grady, M. 2003, p.22*).*

The jurisdictional allocation of responsibilities under the Offshore Constitutional Settlement does not facilitate effective management of the maritime environment. It undermines uniform regulation and consistent resource management in Australian

marine waters (Australian Conservation Foundation and National Environmental Law Association, 2006; Smyth, C., Prideaux, M., Davey, K. and Grady, M., 2003).

Fisheries Management Act 1991

The *Fisheries Management Act 1991* is the primary legislation governing Commonwealth fisheries in Australia. Under the Act, a "fishery" can be defined by a type of fish, an area of sea, a class of boats, a purpose of activities, a class of person or a method of fishing. The Act can apply in both State and Commonwealth waters if an arrangement is made between State and Commonwealth. Either State or Commonwealth manages a particular "fishery" and management by "Joint Authority" can also occur. The Act prohibits certain fishing practices (eg driftnet fishing, fishing for prescribed species) and grants the Australian Fisheries Management Authority (AMFA) discretion to require a fishery to have a Plan of Management, to grant or revoke statutory fishing rights, and to grant or revoke fishing permits. The Act can be administered by the Australian Fisheries Management Authority or by joint authorities (between the State and Commonwealth).

The Act includes the following objectives:

- Implementing efficient and cost-effective fisheries management on behalf of the Commonwealth
- Ensuring that the exploitation of fisheries resources and the carrying on of any related activities are conducted in a manner consistent with the principles of ecologically sustainable development and the exercise of the precautionary principle, in particular the need to have regard to the impact of fishing activities on non-target species and the long term sustainability of the marine environment
- Maximising economic efficiency in the exploitation of fisheries resources

These objectives must be pursued by the Minister in the administration of the Act and by AFMA in the performance of its functions The Minister, AFMA and Joint Authorities are also to have regard to the objectives of:

- Ensuring, through proper conservation and management measures, that the living resources of the AFZ are not endangered by over-exploitation
- Achieving the optimum utilisation of the living resources of the AFZ
- Ensuring that conservation and management measures in the AFZ and the high seas implement Australia's obligations under international agreements that deal with fish stocks

The Act includes power to regulate fishing methods and equipment for the purposes of conserving the environment, and includes the development and adoption of

management plans for fisheries to achieve "ecosystem integrity, intergenerational equity and intra-generational equity." However the focus of the Act is on commercial target species, rather than on ecosystems. Fisheries boundaries can be based around fishing methods, boat types, a class of persons or a purpose of activities rather than ecosystems boundaries. The Act does not regulate recreational fishing unless it takes place in management zones.

Issues also arise as a result of the involvement of a variety of agencies with no legislative linkage in applying the Act, including AFMA, the Department of Environment, Water, Heritage and the Arts, and the Department of Agriculture, Fisheries and Forestry. There is no provision for cross sector input into management plans or the granting of fishing rights. The Act does require advertising to invite interested people to be included in a register, through which they receive notification of new or amended plans of management and can make submissions. Management Plans are not mandatory under the Act and are only required at the discretion of AFMA (Australian Conservation Foundation, 2005).

National System for the Prevention and Management of Marine Pest Incursions

The *National System for the Prevention and Management of Marine Pest Incursions* is a suite of measures aimed at:

- preventing marine pests from arriving in Australian waters or spreading to new areas
- providing a coordinated emergency response should a new pest arrive in Australian waters
- Eradicate new marine pests wherever possible
- Controlling and managing marine pests already here, where eradication is not feasible.
- Improve knowledge of the impacts of marine pests
- Effectively co-ordinate control activities

The National System focuses on prevention, emergency management and ongoing management and control. This is achieved through the implementation of various legislation, regulations and policies for various sectors, including commercial and recreational fishing, shipping, boating and aquaculture. The system is supported through an ongoing national program to detect new pest species early; industry and community awareness and education programs; targeted research and the development of policy and management measures; and ongoing evaluation and review of the system.

The measures and arrangements under the National System are being implemented by the National Introduced Marine Pests Coordination Group (NIMPCG). NIMPCG

comprises representatives of each of the government, industry and environmental partners of the National System. The implementation of the National System is overseen by the National System Implementation Group comprising higher level representation from each jurisdiction (Commonwealth of Australia, 2009).

Victoria's arrangements for the management of marine pests are consistent with the national approach and are outlined in the *Action Statement: Introduction of exotic marine organisms into Victorian marine waters*.

National Policy for the Translocation of Live Aquatic Organisms

In 1999 the Ministerial Council on Forestry, Fisheries and Agriculture published the National Policy for the Translocation of live Aquatic Organisms: Issues, Principles and Guidelines for Implementation, acknowledging the need for a national approach to managing the risks associated with translocations. The Guidelines provide a policy framework and a risk assessment process against which translocation proposals can be assessed (Ministerial Council on Forestry, Fisheries and Agriculture, 1999).

To meet the intentions of that policy, all Australian states and territories are required to develop translocation guidelines for their jurisdiction that achieve:

- Consistency in the consideration of translocations within Australia
- Effective coordination of administrative arrangements within jurisdictions appropriate supporting legislation
- Acceptable levels of compliance
- A nationally accepted, explicit and transparent risk assessment process
- Regular assessment and continuous improvement of risk management strategies including the adequacy of risk assessment, decision-making and enforcement processes
- Increased community and industry awareness of the potential risks associated with the translocation of live organisms.

Coastal Management Act 1995 (Vic)

The *Coastal Management Act 1995* aims to provide a co-ordinated approach to strategic planning and management of the Victorian coast to protect environmental features, control future use and facilitate sustainable development and use (Commissioner for Environmental Sustainability Victoria, 2008). The Act defines coastal Crown land, and its use and development for consent under the Act. The Minister can determine the areas of Victoria which are coastal regions and define their boundaries. Under the Act, any use or development on coastal Crown land requires written consent from the minister

and ensures that the broader public interest for public land use is maintained (Australian Conservation Foundation, 2005).

The Act establishes the Victorian Coastal Council as the peak body for achieving the objectives of the Act, primarily through the development and implementation of the Victorian Coastal Strategy, which must "ensure the protection of significant environmental features of the coast…identify suitable development areas…and ensure the sustainable use of natural coastal resources". There is a clear duty to consider these factors in the regional plans (Australian Conservation Foundation, 2005).

The Act also establishes three Regional Coastal Boards: the Western, Central and Gippsland Coastal Boards. The implementation of the strategy is specific to each region. A key function of the Boards is to develop regional Coastal Action Plans (CAPs), which establish objectives for use and development of the area as well as detailed planning for the region, and are to be consistent with the Coastal Strategy. CAPs are not mandatory unless the Minister or Victorian Coastal Council directs one to be prepared (Australian Conservation Foundation, 2005).

The Council is required to submit annual reports to the Minister to monitor the effectiveness of the Act. The Victorian Coastal Strategy and CAPs must be approved by the Minister and reviewed after 5 years. However without clear indicators to measure successful coastal and marine management, it is difficult to determine whether these actions are effective. Management plans for any area of coastal Crown land can be prepared under the Act and must be consistent with the Victorian Coastal Strategy and any CAP for the area (Commissioner for Environmental Sustainability Victoria, 2008).

Although land based activities have significant impacts on marine and coastal health, many inland areas regulated by other legislation and plans. The Act does not specify that ecosystem based management (EBM) principles should be the main determinants of regional boundaries instead of economic or political factors. The Act does not prioritize issues but leaves it up to the Victorian Coastal Council to decide which issues it is going to give most importance. It does not provide for the precautionary principle to be applied in the Strategy or plans. The Act also does not provide for assessment of cumulative impacts of different regions (Australian Conservation Foundation, 2005).

The Land and Biodiversity at a Time of Climate Change White Paper calls for review and reform of the *Coastal Management Act 1995 (Vic)* and provides for substantial restructuring of governance arrangements.

Victorian Coastal Strategy (2008)

The *Victorian Coastal Strategy* (VCS) is the long-term vision for sustainable development of Victoria's coast. The Victorian Coastal Council was appointed under the *Coastal Management Act 1995* (Vic) as the peak body for strategic planning and to provide advice to the Minister. The Act directs the VCC to develop the Victorian Coastal Strategy which provides for long-term planning of the Victorian coast for at least the next 100 years. The *Victorian Coastal Strategy 2008*, the third iteration of the VCS, sets a long term vision for the coast and provides policies and actions to guide decisions about its management over the next five years. The VCS provides a framework to ensure the following outcomes for Victoria's coast:

- Provide for the protection of significant environmental and cultural values.
- Undertake integrated planning and provide clear direction for the future.
- Ensure the sustainable use of natural coastal resources.
- Ensure development on the coast is located within existing modified and resilient environments where the demand for development is evident and the impact can be managed.

The VCS is an important management response to coastal modification pressures, as it sets out actions for appropriately managing the coastal and marine environment into the future. It recognises important principles of ecologically sustainable development, identifies significant coastal issues (e.g. marine ecological integrity) and encourages implementation through regional and local plans. It is also a material consideration under the State Planning Policy Framework. However implementation of the actions arising from the Victorian Coastal Strategy has often lacked co-ordination and accountability. The VCS will have minimal effect if the actions lack support from the management bodies or are not implemented. (Commissioner for Environmental Sustainability Victoria, 2008).

The VCS identifies the need to develop key indicators and targets to provide a measure of successful coastal management. While the need for indicators has been identified, little work has yet been done to develop the indicators, limiting the ability to make strong assessments of the efficacy of coastal management actions (Commissioner for Environmental Sustainability Victoria, 2008). Although the policy purports to provide a "comprehensive integrated management framework" for the coast of Victoria, it is limited to visions of planning, management and use. Its benefit cannot be realised given lack of information to support assessment of significance and value of marine ecological components. Poor evaluation of significance in decisions that affect the environment is a serious shortfall of environmental assessment processes. Further, the lack of any biodiversity offsets mechanism, such as the terrestrial equivalent Victorian Native

Vegetation Management Framework, means there is no way to manage human-induced change and maintain or improve marine ecological integrity.

Securing Our Natural Future: A White Paper for Land and Biodiversity at a Time of Climate Change

Released in 2009, *Securing Our Natural Future: A white paper for land and biodiversity at a time of climate change* (the White Paper) provides a long-term, strategic framework which aims to secure the health of Victoria's land, water and biodiversity in the face of ongoing pressures and a changing climate. The White Paper was an action in *Our Environment, Our Future: Sustainability Action Statement*, was an election commitment, and is the product of a three phase process that began in 2006. It is aligned with national strategies including *The National Biodiversity and Climate Change Action Plan (2007)*; *Australia's Biodiversity Conservation Strategy 2009*; and *Australia's Strategy for the National Reserve System 2008-2030* (Department of Sustainability and Environment, 2009a).

The strategy sets the direction for Victorian Government policy and investment priorities in natural resource management, land health, and biodiversity for the next 20-50 years. The goals of the White Paper are to reform and realign Victorian Government processes and institutions which manage Victoria's land, water and biodiversity; to increase market demand for land, water and biodiversity outcomes; to encourage Victorians to work together as stewards of land, water and biodiversity, and; to restore ecological processes and resilience that underpin the health of Victoria's land, water and biodiversity.

The White Paper requires the Victorian Government to prepare a Victorian Natural Resource Management Plan (NRM Plan) to prioritise management goals, standards, processes and approaches for the State. The White Paper also provides for the development of a Victorian Marine plan to consistently guide management across the state, and establishes a research program to further develop understanding of marine and coastal ecosystem and function. The aims of the Marine plan are to:

- Give effect to the directions in the *Victorian Coastal Strategy (2008).*
- Guide integrated conservation and resource development decisions across sectors.
- Increase certainty for management of development and resource use.
- Streamline and consolidate referral and approval requirements consistent with government policy to reduce regulatory burden.
- Guide development and implementation of coastal and marine related plans, such as park management plans and regional catchment strategies.

- Recognise that all activities currently managed exclusively under the *Fisheries Act 1995* and key earth resources legislation will continue to be managed exclusively under these pieces of legislation and their associated policies and consultative arrangements.
- Enable decisions to be made based on a sound scientific understanding of estuarine and coastal ecosystem functions and the risks and opportunities resulting from climate change and other land and water use practices (Department of Sustainability and Environment, 2009a).

The White Paper calls for reform of the *Coastal Management Act 1995* and sets out a strategy to streamline and integrate regional and local coastal and marine planning and management arrangements. The reform agenda comprises structural reform of natural resource management organizations, focusing on Catchment Management Authorities (CMAs) and Regional Coastal Boards (RCBs); the establishment of a new peak body, the Victorian Natural Resource & Catchment Council that will encompass the roles and responsibilities of the Victorian Catchment Management Council (VCMC), the Victorian Coastal Council (VCC), and the Victorian Environmental Assessment Council (VEAC); administrative and enabling reforms, including changes to rules, systems and processes, governance arrangements, organizational culture and capacity-building; and the establishment of new Natural Resource & Catchment Authorities by the end of June 2011 (Department of Sustainability and Environment, 2009a). This reform agenda is disturbing, stating that "amendments will be made to legislation to enable the Minister to appoint specific advisory panels to advise on appropriate land use and land tenure of public land on a case-by-case basis". The new policy would essentially abolish the independent VEAC and VCC, replacing them with some vague advisory boards appointed at the whim of government.

Fisheries Act 1995 (Vic)

The Fisheries Act applies to Victoria's fisheries, aquatic habitats aquaculture industries and associated aquatic biological resources; and to Victorian waters and protected waters, including marine waters. The Act is administered by the Minister for Agriculture - Department of Primary Industries (Vic) (Australian Conservation Foundation, 2005).

The Act contains provisions complementary to the *Commonwealth Fisheries Management Act 1991* and equivalent legislation in other States, and interplays with provisions of the Commonwealth Act. The purpose of this is to facilitate cooperation in matters such as research, adjustment schemes and enforcement. The Act allows for State-to-Commonwealth and State-to-State interaction and also provides a jurisdictional extension of fishing restrictions (Australian Conservation Foundation, 2005). Among the purposes of the Act are:

- To promote sustainable commercial fishing and viable aquaculture industries and quality recreational fishing opportunities for the benefit of present and future generations;
- To facilitate access to fisheries resources for commercial, recreational, traditional and non-consumptive uses;
- To promote the welfare of persons engaged in the commercial fishing industry and to facilitate the rationalisation and restructuring of the industry; and
- To encourage the participation of resource users and the community in fisheries management.
- To protect and conserve fisheries resources, habitats and ecosystems including the maintenance of aquatic ecological processes and genetic diversity;
- To provide for the management, development and use of Victoria's fisheries, aquaculture industries and associated aquatic biological resources in an efficient, effective and *ecologically sustainable* manner;
- The intended effects of the Act include comprehensive protection of Victoria's fisheries resources and aquatic ecosystems; and creation of a framework for fisheries management. Emphasis is placed on the use of 'management plans', on voluntary codes of practice and on greater co-operation between the Minister and relevant stakeholders (Australian Conservation Foundation, 2005).

Under the Act the Minister has the power to create fishery management plans, the purpose of which is to specify policies and strategies for the management of the fishery on an ecologically sustainable basis. Such Plans must be consistent with the objectives of the Act (Australian Conservation Foundation, 2005).

However, the fisheries management plans are based around preservation of particular species which are the targets of commercial fishing, rather than preservation of ecosystems for their own sake. The very slow response to the issue of overfishing in Australia's oceans also suggests that individual sectors struggle to resolve fundamental management issues under the existing administrative and legislative arrangements (Australian Conservation Foundation and National Environmental Law Association, 2006).

Victorian Aquaculture Strategy 2008

The purpose of this strategy, released in 2008, is to grow the value of the Victorian aquaculture industry from $22m to $60m by 2015 in a sustainable manner. The Victorian Aquaculture Strategy aims to provide a framework for the development of the Victorian aquaculture industry by:

- Identifying and promoting investment and development of Victoria's natural advantages for aquaculture.

- Developing and implementing whole-of-government best practice management and regulation.
- Improving market-led development, including efficient supply chains, product integrity, market access and branding.
- Improving productivity and reducing the environmental impact of production systems.
- Increasing public awareness about the benefits of sustainable aquaculture and its products.
- Increasing self reliance and capability of aquaculture industry sectors.

Planning and Environment Act 1987 (Vic)

The purpose of the Planning and Environment Act is to establish a framework for planning the use, development and protection of land in Victoria in the present and long term interests of Victorians, and provides for the consideration of environmental matters for planning schemes, amendments to schemes, and planning permits (Environment Assessment Review Advisory Committee, 2002). The Act sets out the aims of planning in Victoria, which include to provide for the fair, orderly, economic and sustainable use, and development of land; to provide for the protection of natural and man-made resources and the maintenance of ecological processes and genetic diversity; and to facilitate development in accordance with the objectives of the Act.

The objectives of the planning framework established by the Act include:

- To enable land use and development planning and policy to be easily integrated with environmental, social, economic, conservation and resource management policies at State, regional and municipal levels;
- To ensure that the effects on the environment are considered and provide for explicit consideration of social and economic effects when decisions are made about the use and development of land.

The Planning and Environment Act establishes the Victorian Planning provisions, Planning Schemes and a system of amendments. It establishes the Growth Areas Authority and sets out its role and responsibilities. Provisions for other responsible authorities are also detailed.

The Act outlines regional development strategies and requirements, including permits required by planning schemes and the process for review of these permits. It establishes compliance, compensation and enforcement requirements. It also provides a framework for projects of state significance. Finally, the Act details the process for appointing Advisory Committees and Panels, and provides Hearings directions.

The Act sets out an explicit requirement that every amendment to a planning scheme must take into account environmental effects and may take into account social and economic effects. Ministerial Directions have been issued at times to assist in dealing with such considerations. A similar set of provisions applies when a responsible authority is considering a planning permit application (Environment Assessment Review Advisory Committee, 2002).

Notwithstanding Ministerial discretion and over-ride of decisions, Victoria has a very strong framework for environmental protection. Yet it appears to fail to consider biodiversity properly in planning decisions. There are three main reasons for this:

1. Lack of overall knowledge about the marine environment;
2. Arbitrary division of terrestrial and marine issues in decision-making, both as a result of lack of expertise and policy constraints; and
3. Lack of appropriate standards and expectations for ecological assessment within the environmental assessment domain.

The first problem has been discussed at length in this document. Some of these problems can be overcome by implementing better standards of expectation for ecological assessment.

In summary there is a legislative requirement for Councils, as planning authorities and as responsible authorities, to consider environmental, social and economic effects. The requirements of the *Planning and Environment Act* for a full consideration of environmental, social and economic matters are still unevenly implemented. The system continues to be heavily reliant upon local governments which have varying capacity and capability (Environment Assessment Review Advisory Committee, 2002). The Government is currently reviewing the *Planning and Environment Act (1987)* to modernise the Act and enhance the operation of Victoria's planning system.

Environmental Effects Act 1978

Environmental assessment, even for terrestrial projects in Victoria, has significant connotations for the marine environment. There are several avenues for assessment, each of which has both strengths and weaknesses but for reasons explained here, the sum result is poor in terms of biodiversity management. Statutory environmental assessment is triggered either at the Commonwealth level through the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) or the *Environmental Effects Act 1978* (Vic) (EES Act).

Statutory environmental assessment is triggered at the Commonwealth level through the EPBC Act by levels of significance. In brief, any project where there is the slightest

chance of an important or notable impact on any Commonwealth protected matter (*e.g.* threatened species, community, Ramsar site etc) should require an assessment. Important and notable is defined in terms of the context related to the protected matter and the intensity of the effect. Removing habitat for instance, would be more intensive than human disturbance. Nevertheless, the latter could trigger an assessment if the protected matter had considerable local relevance. Where the Commonwealth EPBC Act triggers an assessment, it is common for the EES legislation to be applied because that process can be accredited. Victoria is currently in the process of formalising this arrangement in a bilateral agreement with the Commonwealth.

The *Environmental Effects Act 1978* applies to public works in Victoria and enables the Minister for Planning to require an Environmental Effect Statement (EES) for any works requiring approval under Victorian law. The Act requires the environmental effects of certain works to be assessed by the Minister, which could include impact on the marine environment (Australian Conservation Foundation, 2005). The Act does not contain any statement of its purpose or objectives, and it does not define the environment. A more specific statement of the aims of the EES process is provided in the EES Guidelines, including:

- To ensure that decisions are taken following timely and sound environmental advice
- To encourage and provide opportunities for public participation in environmental aspects of proposals before decisions are taken
- To facilitate environmentally sound proposals by minimising adverse impacts and maximising benefits to the environment (Environment Assessment Review Advisory Committee, 2002).

Application of the Victorian legislation is by Ministerial decree so relatively few projects are statutorily assessed. A decision to trigger a requirement for an EES depends on a formal request for the Minister's advice being made by a decision maker. The Minister must only require an EES if the works could be considered to have or to be capable of having a significant effect on the environment (Australian Conservation Foundation, 2005). Neither a consultative committee nor a consultation strategy is a formal requirement under the Act (Environment Assessment Review Advisory Committee, 2002). The benefit of the EES process is that terms of reference can be applied and subject to a planning panel hearing. However, in recent times, the advice from planning panel hearings has been over-turned by the Minister and it is presently unclear to what extent evidence about environmental impacts would be considered in the process.

Decisions that affect the environment are to a very large degree dependent on sound scientific advice, tailored to the case in hand. The Ecology Group of the Environment

Institute of Australia and New Zealand has recently published a draft consultation document on Ecological Impact Assessment (EcIA), which considers these issues: Ecological impact assessment (EcIA) is an independent, stand-alone and specific scientific discipline that usually forms an integral part of Environmental Impact Assessment (EIA). Treweek (1999) defines EcIA as *the process of identifying, quantifying and evaluating the potential impacts of defined actions on ecosystems or their components; and providing a scientifically defensible approach to ecosystem management. Impact assessment is defined by the International Association for Impact Assessment (IAIA) as the process of identifying the future consequences of a current or proposed action. It is used to ensure that policies, plans, programmes and projects are economically viable, socially equitable and environmentally sustainable*.

As described in Ecological Impact Assessment (Treweek, 1999): "*EcIA is firmly rooted in ecological science, drawing on traditional techniques of survey, monitoring, functional analysis and predictive modelling. In addition however, EcIA requires evaluation of the implications of any predicted outcomes. It is this aspect of evaluation which distinguishes EcIA from the pure science of ecology and which has created demand for new approaches to the ways in which ecological information is handled...Ecological outcomes must therefore be translated into a common language or scale for comparison with other findings, whether these are of a social, economic or political nature. In short, EcIA should provide a scientifically defensible rationale for decision making and for environmental management*".

EIANZ recognises that professional consulting standards, in all sectors from Universities to private companies and individuals, are necessary for environmental protection. A survey of ecological members of EIANZ concluded that better recognition and implementation of standards for EcIA was a necessary underpinning for biodiversity management. However, no definition of either ‘environment’ or ‘significant effect’ is provided under the Act. The EES Guidelines do not provide clear guidance on works that may require an EES (Environment Assessment Review Advisory Committee, 2002). There is a wide degree of discretion as to when the Act applies, and it is usually triggered because of the large scale of a project and the high risk to the environment. If required by the Minister, the proponent must prepare an Environment Effects Statement (EES) and submit it to the Minister for assessment of the environmental effects of the works (Australian Conservation Foundation, 2005).

There are numerous common failings of environmental assessment that need to be addressed at this level if appropriate decisions are to be made. EcIA is about producing and disseminating material suited to decision-making that both acknowledges and deals with uncertainty. Some of the more common problems include:

- Lack of forward scoping, meaning the extent of consideration is too limited;

- Lack of broad public consultation to establish baseline knowledge and understand the likely scope of investigations – or worse, an adversarial context for public consultation, when public knowledge is widely viewed as the key to unlocking good EIA process;
- Lack of field data to support assessment, resulting in over-dependence on (potentially biased) expert 'opinion' instead of more robust evidence-based approaches;
- Lack of appropriate methods for assessing 'impacts', meaning potential problems that cannot be statistically proven are all too often put in too-hard-basket; lack of commitment to follow up monitoring, especially when inappropriate statistical thresholds (*e.g.* 95 % criteria) are used in power calculations (thresholds for ecological change use a range of approaches and often lower thresholds); and
- Lack of a mechanism or commitment to a no-net-loss outcome. In the latter case, there is scope for investigating the application of biodiversity offsets to the marine environment. Biodiversity Offsets are **measurable conservation outcomes** resulting from actions designed to compensate for residual adverse biodiversity impacts arising from project development and persisting after appropriate prevention and mitigation measures have been implemented.

In Victoria the *Native Vegetation Management Framework* is the existing statutory mechanism for creating offsets in the terrestrial environment and the relevant metrics for measuring biodiversity loss / gain already exist. There is no equivalent for the marine environment. Suitable alternative methods are available in the form of manuals produced by the Business Biodiversity Offsets Program (BBOP). BBOP is about to embark on consultation for marine offset manuals and 90 % of the process of establishing offsets can be done as part of a normal but rigorous EIA process. The consideration of biodiversity offsets requires a considerable level of ecological understanding and knowledge to be confident that planned actions would have the desired outcomes. A key gap is there is presently no basic ecological knowledge to support such considerations – requiring any proponent to implement basic ecological research alongside any specific impact and offset assessment studies.

Under the current system it is therefore difficult to match the assessment process to the level of environmental risk presented by the proposal. The Act does not specify general matters an EES should include, or procedures for determining specific matters to be addressed by a particular EES. Neither the Act nor the EES Guidelines stipulate any specific requirements for the type of information to be provided by a proponent. There is also no statutory power to evaluate strategic plans and proposals (Environment Assessment Review Advisory Committee, 2002).

There are no organisations or authorities established to implement the Act. The EES process does not result in any direct statutory approvals under the Act, but informs decisions under Acts such as the *Environment Protection Act 1970* and the *Planning and Environment Act 1996*. The Department of Sustainability and Environment make recommendations to the Minister of Planning in relation to Environment Effects Statements, who then makes recommendations to the authority who decides whether and how a project will go ahead. The recommendations of the Minister must be considered, but not adhered to, by the decision makers (Environment Assessment Review Advisory Committee 2002, Australian Conservation Foundation 2005).

The Act does not provide a framework for integrating the actual statutory results of decision making. The result can be a number of assessments being conducted in parallel or sequentially, and this can have negative impacts on the efficiency of the process and for the public in terms of understanding the difference between, and the requirements of, multiple processes. The system also gives rise to the formation of a number of different groups under different legislation to monitor implementation of the project once approved (Environment Assessment Review Advisory Committee, 2002).

For projects that do not require this level of statutory consent, environmental assessment may still be required through Victorian planning policy. Local councils can request information to inform a decision about developments and there is a right of appeal for members of the public, councils and proponents through the Victorian Civil Administrative Tribunal (VCAT), although this happens in a minority of cases. Therefore, most planning decisions in Victoria are influenced by the Victorian Planning Provisions (VPP) and the State Planning Policy Framework (SPPF). This sets out the terms for particular developments. If projects appear in VCAT, the tribunal is generally rigorous in its consideration of environmental policy requirements.

In summary, ecologically sustainable development principles are not incorporated and ecosystem based management is not provided for in the Act. There is no cross-referral to other sectors or agencies before granting approvals or permits. The Act does not specify any principles to be taken into account in the assessment of works, and the recommendations by the Department and Minister are very subjective (Australian Conservation Foundation, 2005).

State Planning Policy Framework and Victorian Planning Provisions (EES Act Eval)

The introduction of the Victoria Planning Provisions (VPP) into the *Planning and Environment Act* in 1996 consolidated the requirement to follow an integrated approach for the consideration of planning scheme amendments and planning permit applications (Environment Assessment Review Advisory Committee, 2002).

The purpose of the VPP is to implement the State Planning Policy Framework (SPPF) and the Local Planning Policy Framework. The State Framework is common to all planning schemes and amendments to planning schemes and permits must be consistent with and implement the State policies. The relevant Council develops each Local Framework, each of which must be consistent with the State Framework. A planning scheme must include a Municipal Strategic Statement. Planning schemes can also include overlays that reflect and highlight a complex range of environmental constraints and attributes that must be considered in regard to development applications and planning scheme amendments (Environment Assessment Review Advisory Committee, 2002).

Major directions for coastal planning are set out in *Clause 15.08 Coastal Areas* which sets out strategies that aim to provide integrated management, manage coastal hazards and the coastal impacts of climate change, plan for population growth and sustainable development, and ensure sustainable use, protection and management of significant environmental and cultural values. It also sets out strategies specifically for planning in the Great Ocean Road Region.

The objectives of Clause 15.08 of the SPFF are:

- To protect and enhance the natural ecosystems and landscapes of the coastal and estuarine environment
- To ensure sustainable use of natural coastal resources
- To achieve development that provides an environmental, social and economic balance
- To recognize and enhance the community's value of the coast
- To plan for and manage the potential impacts of climate change.

Clause 15.08 of the SPFF identifies that land use and development planning should be coordinated with the requirements of the *Coastal Management Act 1995,* and that decision-making by planning authorities and responsible authorities should apply the hierarchy of principles for coastal planning and management as set out in the *Victorian Coastal Strategy 2008* (VCS). It also specifies that decision making by planning and responsible authorities should be consistent with a range of other State and Regional policies and legislation.

To strengthen statutory tools to manage urban growth and the impacts of climate change, the SPPF has been updated to support implementation of the VCS. Clause 15.08 of the SPPF states that in order to plan and manage coastal hazards and the coastal impacts responsible authorities should:

- Plan for sea level rise of not less than 0.8 metres by 2100, and allow for the combined effects of tides, storm surges, coastal processes and local conditions such as topography and geology when assessing risks and coastal impacts associated with climate change
- Apply the precautionary principle to planning and management decision-making when considering the risks associated with climate change
- Ensure that new development is located and designed to take account of the impacts of climate change on coastal hazards such as the combined effects of storm tides, river flooding, coastal erosion and sand drift
- Identify and appropriately manage land subject to coastal hazards to ensure that future development is not at risk
- Avoid development in identified coastal hazard areas susceptible to inundation (both river and coastal), erosion, landslip/landslide, acid sulfate soils, wildfire and geotechnical risk.

Concurrently, the Minister for Planning has issued Direction No. 13 – Managing Coastal Hazards and the Coastal Impacts of Climate Change. This requires planning authorities to review the impacts of projected coastal hazards associated with climate change when making decisions about re-zoning non-urban land for urban use or development.

However the division of land and sea in the planning process remains a substantial problem because it means that the consideration of effects on the marine environment, irrespective of coastal policy, is most often limited to above mean high water. Most decisions about coastal development are made by local councils, whose jurisdiction is to above the mean high water mark. Victorian planning policy, despite being 'policy' is often defined quite strictly by a history of Victorian Civil Administrative Tribunal (VCAT) cases. Further, in the absence of a specific mechanism for realising requirements of the SPPF, there is no requirement on a proponent. For example, the need to protect biodiversity is realised entirely through the Native Vegetation Management Framework. Because this framework does not extend to the marine environment, local councils are not, in the strictest sense, empowered to deny approval on such grounds.

The other option is to refer the case to VCAT which would be required to consider issues to the 3 nautical mile state limit. The VCAT are more likely to consider the issues but are equally constrained by the lack of policy, so local councils may not see fit to appeal. The other possible avenue is to refer direct to the Commonwealth, in cases where a protected matter may be involved. However, this is unlikely to happen because mostly local councils deal with development applications and there is no statutory obligation to the Commonwealth. Local councils are not constitutionally recognised and

have no authorisation from the State, to contact the Commonwealth Department of Environment, Water, Heritage and the Arts.

In a quasi-hypothetical example concerning housing development on the northern shores of Western Port, impacts occur to Western Port's mudflats, due to changes in the hydrology of creeks and inlets. This is caused by erosion and vegetation loss along creeks at a housing development, run-off from gardens, roads and roofing. Sedimentation and soil loss from the development releases nutrients from previously enriched agricultural land and this affects nutrient processes on the coastal mudflats. The area directly offshore is where more than 1 % of Western Port's Curlew Sandpipers feed. Western Port and Curlew Sandpipers are both protected matters under the EPBC Act. Curlew Sandpiper is in sharp decline internationally and dependent on the Victorian bays and inlets. As with most shorebird, it feeds most actively on the falling tide and relatively near the coast.

In this case, developments occurring even a few hundred metres inland could have significant impacts on Commonwealth protected matters. However, the coastal policy may not be considered relevant given the geographic separation between the development and Western Port. Although the EPBC Act would require "all relevant matters" including direct and indirect effects to be considered, State planning policies do not have the same expectation. Hence, it is unlikely that it will be considered relevant. If the development does not end up challenged in VCAT, the local council are obliged to proceed without reference to the Commonwealth requirements, hence the marine flow-on effects are not considered.

Wildlife Act 1975 (Vic)

The Wildlife Act provides the Governor in Council with the power to declare an area (including inland and coastal waters) a wildlife sanctuary, and provides for the protection of whales. The Act creates and regulates State Wildlife Reserves, State Nature Reserves, Wildlife Management Cooperative Areas and Prohibited Areas which may encompass coastal areas (Australian Conservation Foundation, 2005).

The Act makes it an offence to take or destroy wildlife in a sanctuary, and to hunt or wilfully disturb wildlife in a sanctuary without the authority of the Secretary. A range of offences are established for hunting, taking or destroying particular categories of wildlife (eg endangered and protected wildlife) without a license. A regime is established to protect whales, creating offences for killing or taking whales, approaching whales beyond a certain distance, and conducting swim tours without a permit. The Secretary has the power to grant whale sightseeing and whale swim tour permits. Authorised officers have search and inspection powers, and may stop and

search a boat if they reasonably believe it is being used by persons to commit an offence (Australian Conservation Foundation, 2005).

The purposes of the Act include:

- To establish procedures in order to promote--
- The protection and conservation of wildlife; and
- The prevention of taxa of wildlife from becoming extinct; and
- The sustainable use of and access to wildlife; and
- To prohibit and regulate the conduct of persons engaged in activities concerning or related to wildlife.

Environmental Protection Act 1970 (Vic)

The Environmental Protection Act applies to the territorial seas adjacent to the coasts of Victoria and to the discharge of waste into the River Murray from any premises situated in Victoria. The Act provides the legal framework by which environmental objectives, goals and regulations are established throughout Victoria for industry, commerce and the general public. The Act is outcome orientated, with a basic philosophy of preventing pollution and environmental damage by setting environment quality objectives and establishing programs to meet them (Australian Conservation Foundation, 2005).

The Act establishes the powers, duties and functions of the Environment Protection Authority. These include the administration of the Act and any regulations and Orders made pursuant to it, recommending State environment protection policies and industrial waste management policies, issuing works approvals, licences, permits, pollution abatement notices and implementing National Environment Protection Measures. The Act also establishes an Environment Protection Board (Australian Conservation Foundation, 2005).

The aims of the Act include sustainable use and holistic management of the environment, ensuring consultative processes are adopted so that community input is a key driver of environment protection goals and programs, and encouraging a co-operative approach to environment protection. The Act reflects the following key principles: the precautionary principle, the protection of intergenerational equity, the polluter pays principle, and the protection of biodiversity. The emphasis is on shifting to market mechanisms, collaboration and co-regulation to achieve environmental performance (Australian Conservation Foundation, 2005).

Most of the policies created under the Act are unlikely to incorporate ecosystem based management. However the EPA may declare an environment protection policy to be observed with respect to the environment generally, in any portion of Victoria, or with

respect to any element or segment of the environment. The Act does not encourage ecosystem based management principles to be considered when assessing when licences and notices specific to smaller sites should be issued. The Act also does not provide for assessment of cumulative impacts of different regions (Australian Conservation Foundation, 2005).

State Environment Protection Policies (SEPPs)

SEPPs are important statutory instruments in Victoria for the protection of environmental quality. They are developed with extensive community and stakeholder consultation and provide a statutory framework for the protection of identified beneficial uses, objectives and indicators. They also provide for a program of plans, works and activities to protect beneficial uses. Any activities which have the potential to affect the environment must be planned and undertaken according to SEPP provisions (Environment Conservation Council, 2000).

SEPP (Waters of Victoria) (2003) is the overarching policy for Victoria's fresh and marine waters, and provides the framework for the protection and monitoring of Victoria's marine waters. The policy provides for the control of diffuse and point source pollution, application of catchment management principles, monitoring, development of codes of practice, research and public education and participation (Environment Conservation Council 2000). It establishes a series of targets to maintain the health of marine water quality and sets the standards for other water quality programs (e.g. Beach Report program). There is scope for tightening water quality objectives and for a greater level of monitoring in some cases (Commissioner for Environmental Sustainability Victoria 2008).

Water Act 1989 (VIC)

The Water Act was established to regulate and manage water resources in Victoria. It applies mainly to catchment areas (and does not apply to oceans), but is relevant when considering catchment regulation and commercial fishing. The Act is supervised by the Minister for Water through approved corporate plans and express directions. The Act establishes the Melbourne Water Corporation and offences for the pollution of water where property is damaged. The Act's application mainly to fresh water catchments without consideration of oceans policy represents a fragmented approach to regulating water (Australian Conservation Foundation, 2005).

The Minister plays a major role in enforcement of the Act, and also has a role in assessing water resources and collecting information concerning in-stream uses of water. The Minister can declare a water supply protection area and investigate water resources. Management plans in relation to a protection area must be approved and can

be enforced. The Minister can also require an Authority to develop a water resources management plan for an area (Australian Conservation Foundation, 2005).

While the Act incorporates principles of sustainability, there is significant discretion on what constitutes sustainability and its implementation. Generally, the aim of the Act is to promote conservation and proper management of water resources for sustainable, equitable and efficient use for the benefit of all Victorians. However the focus is primarily on managing water as a finite economic resource and facilitating water use, rather than on ecosystem based management (Australian Conservation Foundation, 2005).

Action Statement: Introduction of exotic marine organisms into Victorian marine waters

The Victorian Government's policy for managing exotic marine organism introductions is outlined in the Action Statement 'Introduction of Exotic Organisms into Victorian Marine Waters'. The Action Statement is prepared under the *Flora and Fauna Guarantee Act 1988*.

The policy objectives are to minimise further introductions of exotic organisms into Victorian marine waters; and to develop and implement, where possible, practical measures to manage the spread and minimise the adverse effects of current and future incursions of exotic organisms in Victorian marine waters. On-going minimisation of exotic organism introductions is prioritized above attempts to eradicate or manage exotic organisms once they have arrived. A risk-based approach is adopted as the basis for decision making.

Major actions outlined in the Action Statement include:

- Victorian Ballast Water Management System
- Industrial Waste Management Policy for Ballast Water and Hull Fouling
- Disposal of Biological Waste from Land-based facilities
- Codes of Practice or other Effective Measures to Minimise the Risk of Introduction and Spread of Exotic Organisms via Aquaculture, Fishing Activities and Boating
- Interim Victorian Protocol for Managing Exotic Marine Organisms Incursions

Responsibility for the implementation of these strategies is shared by several agencies, industries, organisations and individuals. These include government agencies, the port, shipping and fishing industries, recreational organisations and the community. Key implementation responsibilities within Government are as follows: the EPA is responsible for developing and managing the Victorian Ballast Water Management

System; the Department of Sustainability and the Environment is responsible for manging the *Interim Victorian Protocol for Managing Exotic Marine Organism Incursions*; and the Department of Primary Industries is responsible for developing and managing Victoria's Invasive Plants and Animals Strategy and is also responsible for the development of measures to minimize risks of introduction and spread of exotic organisms by fishing, aquaculture and boating.

Interim Victorian Protocol for Managing Exotic Marine Organism Incursions

The implementation of the *Interim Victorian Protocol for Managing Exotic Marine Organism Incursions* is intended to minimise the adverse impacts of exotic marine organism incursions in Victorian marine waters. Its aim is to ensure that Victoria has appropriate measures in place to minimise the adverse effects of future incursions of exotic marine organisms, and to minimise the adverse effects of current exotic marine organism incursions (Department of Natural Resources and Environment, 1999).

The objectives of the protocol include:

- Identifying the roles and responsibilities of personnel responding to an exotic organism incursion
- Outlining operational procedures and plans to evaluate and co-ordinate the response
- Ensuring rapid and effective decision making on what specific actions should be taken to manage an incursion
- Identifying the strategies and actions to be adopted in the event of an incursion
- Ensuring integration and co-operation between the Protocol and other national and state plans and strategies
- Providing appropriate public information and education

Arrangements to manage the impacts caused by marine pests include identifying distributions; preventing the spread of marine pests; emergency response to new pests; ongoing control; and improving management through research. However, detection of and response to invasive marine organisms in Victorian waters is currently poorly coordinated and as a result management actions continue to be reactive and inadequate (Department of Natural Resources and Environment, 1999).

Invasive marine organisms were not considered in the first module of the Department of Primary Industry's *Invasive Plants and Animals Strategy* released in 2009, and it remains unclear when, or even whether, a comprehensive strategy for the prevention and management of invasive species will be developed and implemented for Victorian marine waters. Overall, management of marine pest species is seriously lacking in

Victoria, with no comprehensive strategy in place to guide management actions (Department of Natural Resources and Environment, 1999).

Guidelines for Assessing Translocations of Live Aquatic Organisms in Victoria

Victoria met the National requirements for translocation of live aquatic organisms with the development of the *Guidelines for Assessing Translocations of Live Aquatic Organisms in Victoria,* released in 2003 and updated in 2009. These Guidelines provide a structured approach to managing the risks associated with deliberate translocations of aquatic biota in Victoria to public and private waters managed under the *Fisheries Act 1995*. The Guidelines establish a transparent basis by which Victoria will meet the requirements of the *National Policy for the Translocation of Live Aquatic Organisms (1999) and* describe a risk management and decision-making process for assessing translocation applications. The Guidelines are not used to manage the translocation risks that may arise incidentally to other processes such as the discharge of ship's ballast water.

To support the implementation of the Guidelines, DPI has developed Protocols for the most common types of translocation. A Protocol identifies the most common translocation activities within a translocation type and includes control measures to achieve effective risk management for those translocation activities. Protocols allow individual translocations, which conform to the protocol, to be considered and approved without the need for a full risk assessment.

The Guidelines and protocols also establish a system of controls intended to minimize the risks posed by deliberate translocation of live aquatic organisms. Examples of controls include the number of organisms that are being translocated, requirements for stock health certificates and/or other certifications and other biosecurity controls and must include a period of time that the approval is valid.

Coastal Action Plans and management plans

These plans are prepared under the *Coastal Management Act* 1995. They identify strategies and objectives to promote recreational use and tourism, and provide for protection and enhancement of significant regional coastal features (Environment Conservation Council, 2000).

Planning schemes

Planning schemes are developed by the local council or the Minister for Planning under the *Planning and Environment Act* 1987. They set out state and local policies and

provisions for the use, development and protection of land (Environment Conservation Council, 2000).

Regional Catchment Strategies

These strategies are prepared under the *Catchment and Land Protection Act* 1994 and outline the natural assets of the region, how they are interrelated, and what needs to be done to manage and use them in a sustainable way (Environment Conservation Council, 2000).

Appendix 4: ECC Recommended Special Management Zones

Area	Bioregion	Values
Cape Bridgewater	Otway	23 ha area west of Portland includes the waters around one of only two mainland Australian fur seal colonies. Reports of breeding seals make it only mainland breeding colony in Australia. A small number of New Zealand fur seals are also reported to come ashore here. Viewing platform, diving and snorkeling excursions with local operators, charter boat operators
Lawrence Rocks	Otway	24 ha area near Portland consists of waters around the islands of volcanic rock which make up Lawrence Rocks. A kelp forest up to 12m high is intermittently found in waters on the northern side of Lawrence Rocks. The rocks are of State geological and geomorphological significance and are the highest offshore point of a largely submerged volcanic caldera beneath Nelson Bay. Wildlife reserve with high values as breeding colonies for several species of seabirds. Species utilizing the area include the little penguin, fairy prion, common diving petrel and the largest colony of gannets in Australia. Western side of Lawrence Rocks offers diving and snorkeling within a natural harbour noted for calm conditions and abundant marine life.
Portland Bay	Otway	2,675ha area situated about 1km offshore near Portland, contains the most extensive known beds of *Amphibolis Antarctica* seagrass on the open coast in Victoria. The highly productive seagrass ecosystem supports a diverse invertebrate community and is a nursery ground for juvenile fish such as king George whiting, and occasionally snapper and shark. The site is also one of the very few locations where the rare brown algae *Cystophora cymodocea* occurs, growing attached to the seagrass. Low and high profile rocky reefs at this site also provide habitats for a range of reef species. This site is visually attractive for diving and snorkeling and is popular with recreational fishers.
Deen Maar (Lady Julia Percy Island)	Otway	The local Gunditjmara people have a spiritual, traditional physical and contemporary connection to Deen Maar. The adjoining mainland and wetlands are also of great spiritual significance. The island is home to one of Victoria's two largest Australian fur seal breeding colonies, and is also a breeding ground for numerous species of birds some of which are threatened (fairy prion, common diving petrel, white-bellied sea eagle). It is of national geological and geomorphological importance and recent habitat mapping undertaken by DSE and Deakin University have identified the existence of unique pinnacles in the waters surrounding the island. The island is a wildlife reserve. The sharply sloping reefs of the southern and eastern sides of the island are covered by a dense kelp canopy, which provides habitat for other marine life,

Area	Bioregion	Values
		while at the northern end the island drops into a sandy seabed. The subtidal area around Deen Maar is considered to be some of the most spectacular underwater environments in Victoria. The endangered great white shark frequents this area.
Logans Beach	Otway	This area near Warnambool is a calving and nursery ground for the southern right whale. This whale is listed as an endangered species both at a national and a state level. It was listed under Victoria's *Flora and Fauna Guarantee Act* 1998 in 1990. The whales congregate in the general area every year from about May to October and breed approximately every three years. The exact boundaries of the breeding ground are not known, but whales with their young are often seen at Logan's Beach. The whales move along the shore between a point 2km east of Warnambool (south of Lake Gillear) and Point Fairy, up to 1.5km offshore.
Dinosaur Cove	Otway	The area contains spectacular underwater scenery with sheer underwater cliffs, massive boulders and a unique feature for this part of the coast, a large bommie, 'Innamincka Rock'. The complexity of the seabed is enriched with large rock ledges, gutters and shallow sand/reef. Surveys have shown that areas as small as two square metres include 15 species of sponges, 10 ascidians, 27 bryozoans, and 4 hydroids (O'Hara 2000 in ECC). The coastline offers spectacular views of the ocean, steep cliffs, sea caves and magnificent rock platforms. The site has major palaeontological significance with the reknowned dig site, Dinosaur Cove.
Clifton Springs	Victorian Embayments	This area contains some of the best examples of intertidal and subtidal seagrass (Heterozostera tasmanica, Zostera muelleri) in the Geelong arm of Port Phillip Bay and is an important area for settlement of larval fish, including King George whiting and shark. The seagrass at Clifton Springs are part of a larger seagrass meadow extending westwards from Point Richards to Point Henry.
Werribee River estuary	Victorian Embayments	This area is situated adjacent to the suburb of Werribee South, and includes the lower estuarine waters of the Werribee River. Melbourne Water's Western Treatment plant is located on the western side of the river. The Werribee River estuary has a number of recognized environmental and recreational values, including important habitat for waterbirds, geological and geomorphological significance, value for recreational fishing and boating, and potential value for nature-based tourism
Capel Sound	Victorian Embayments	This area lies offshore from Rosebud, and encompasses the wreck of the Hurricane and a hard coral reef. The area lies about 400m west of the end of the jetty, extending west for 2.3km and north for 1-3km. The area surrounding the Hurricane is noted particularly for an unusually extensive bed of pink sea pens, and numerous reef fish. The reef, which emerges from the sea floor at 9m depth and rises to about 6m, has a colourful understory, dominated by an extensive covering of hard coral, which are relatively uncommon in Victoria.

Area	Bioregion	Values
Honeysuckle Reef	Victorian Embayments	This area is home to diverse intertidal reef communities. It is predominantly flat and shallow, within a relatively sheltered bay area. Honeysuckle Reef has a shallow pool area used extensively by schools of young fish. The site includes mainly intertidal reefs and some subtidal reefs. Part of the adjacent beach is used as a high tide roost for migratory waders.
Crawfish Rock	Victorian Embayments	This area is an unusual intertidal/subtidal reef located in the north-west of Western Port. Crawfish Rock is significant because it supports a benthic fauna with apparent affinities with deep water communities in Bass Strait. Due to high water turbitdity around Crawfish Rock reducing light penetration, many deep-water species of algae, hydroids and sponges occur at unusually shallow depth. Overall there are believed to be more than 500 species present here. High numbers of species have been recorded for some groups – for example, 150 species of sponges, 123 hydroids and 34 ascidians. Crawfish Rock also has a number of distinct communities characterized by differing combinations of light, current energy and substrate types.
Bass River delta	Victorian Embayments	This area in eastern Westernport has significant ecological values as a fish nursery, bird roost, and for its diversity of habitats including intertidal flats and subtidal areas. The shallow waters of the bass River delta support diverse fish life, and the area is a nursery for various species of shark and whiting. The intertidal flats are foraging areas for waders associated with the adjoining high-tide roost at Reef Island. The delat complex is of geomorphological significance and supports significant-mangrove saltmarsh habitat, extensive intertidal and subtidal flats of bare sand, dense algal beds and seagrass.
San Remo	Victorian Embayments	This site contains one of only two marine communities listed under the *Flora and Fauna Guarantee Act* 1988. It is the only known example of its kind, comprising an extremely rich opistobranch (sea slug) and bryozoan (sea moss) community. 125 species of opistobranchs have been recorded at San Remo of which eight are known only from this site. The diversity of substrate types including patches of sand, mud, boulders and vesicular, weathered basalt; the north-facing aspect; and the low wave energy and proximity to a fast-flowing tidal channel, are some of the factors that contribute to the existence of this apparently rare community. The site includes the edge of a deep and fast-flowing tidal channel, which is the most diverse part of the community.
Rhyll	Victorian Embayments	This area is within a primary foraging area for 32 species of migratory waders. Rhyll wetlands (including Rhyll and Rowell wetlands, Rhyll Inlet and Conservation Hill) have international significance as bird habitat and fall within the Westernport Ramsar area. The rhyll wetlands area is recognized as a major high tide roost, and the mudflats further south are important feeding areas for red-necked stints, curlew sandpipers, eastern curlews, and double-banded plovers. As well as abundant bird life, the

Area	Bioregion	Values
		low profile basalt reef, mangroves, saltmars, soft sediments and dynamic sand spit, with a complex array of active and relict geomorphological features, are of high conservation value.
Summerland Peninsula (Phillip Island)	Central	The Summerland Peninsula is home to the famous colony of little penguins and significant numbers of short-tailed shearwaters. Seal Rocks is one of Victoria's two largest breeding colonies of Australian fur seals. It is also the only Victorian breeding site for the sooty oyster catcher. Seal Rocks are exposed basalt rock, and the surrounding waters are rich in marine life, including the endangered great white shark.
The Skerries	Twofold Shelf	This area includes waters for 200m offshore from the Skerries, one of four breeding sites in Victoria of the Australian fur seal. The Skerries are a granite outcrop located opposite Wingham Inlet in East Gippsland, and are part of the Croajingolong National Park. The Skerries are also known as a significant breeding site for the crested tern and as a roosting site for the black-faced shag.
Mallacoota Inlet	Victorian Embayments	This area includes the tidal delta area at the entrance to the inlet, and the Goodwin Sands. Mallacoota Inlet is the largest estuarine lagoon system in south-eastern Australia, and provides habitat for a wide range of flora and fauna. Three species of seagrass were recorded in Mallacoota Inlet, *Zostera muelleri*, *Heterozostera tasmanica* and a species of *Ruppia*. *Zostera muelleri* is the dominant subtidal vegetation in Mallacoota Inlet with the largest area in the tidal delta. *Ruppia* beds are restricted to the Bottom Lake and are most dense around the Goodwin Sands area. A wide variety of birds depend on the inlet, including Caspian, little, fairy and crested terns, all of which breed on Goodwin Sands. Some of these birds are listed under the bilateral Japan Australia Migratory Birds Agreement. Both the tidal delta and Goodwin Sands are of regional geological and geomorphological significance.
Gabo Island harbour	Twofold Shelf	This area in far East Gippsland has important nature-based tourism values. These values include the largest colony of little penguins in Victoria, and temperate reef communities surrounding both natural reef and a shipwreck within the Gabo Island harbour. These reef communities include reef fish such as morwong, wrasse and leatherjacket species.

(Environment Conservation Council, 2000).

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