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Victorian Subtidal Reef Monitoring Program

The Reef Biota at Port Phillip Bay Marine Sanctuaries

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**Victorian Subtidal Reef Monitoring
Program :**

**The Reef Biota at Port Phillip Bay Marine
Sanctuaries**

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Executive Summary

Shallow reef habitats cover extensive areas along the Victorian coast and are dominated by seaweeds, mobile invertebrates and fishes. These reefs are known for their high biological complexity, species diversity and productivity. They also have significant economic value through commercial and recreational fishing, diving and other tourism activities. In order to effectively manage and conserve these important and biologically rich habitats, the Victorian Government has established a long-term Subtidal Reef Monitoring Program (SRMP). Over time the SRMP will provide information on the status of Victorian reef flora and fauna and determine the nature and magnitude of trends in species populations and species diversity through time.

The monitoring program in, and around, the Port Phillip Bay marine sanctuaries began in 2003. The Point Cooke, Jawbone and Ricketts Point Marine Sanctuaries are all included in the monitoring program. Six monitoring sites have been established, three inside and three outside the marine sanctuaries. The monitoring involves standardised underwater visual census methods to a depth of between 2 and 4 m. This report aims to:

- provide general descriptions of the biological communities and species populations at each monitoring site in March-April 2003;
- identify any unusual biological phenomena such as interesting or unique communities or species; and
- identify any introduced species at the monitoring locations.

The surveys were done along a 200 m transect line. Each transect was surveyed for:

1. abundance and size structure of large fishes;
2. abundance of cryptic fishes and benthic invertebrates;
3. percentage cover of macroalgae; and
4. density of dominant kelp species.

To date over 100 different species have been observed during the monitoring program in, and around, the marine sanctuaries of northern Port Phillip Bay. Algal assemblages tended to be dominated at most sites by small green, brown and red algal species. The algal species richness was variable among all sites and there were relatively large differences in richness between paired sanctuary and monitoring sites. Invertebrate assemblage structure tended to be more similar between selected sites compared with different locations in the bay. The

invertebrate species richness ranged from between 9 and 18 species, but was generally similar at most sites. Small fish, particularly southern hulafish, were dominant at all sites, however there were few clear trends in fish assemblage structure. Fish species richness was generally lowest at sites in the north and northwest of the bay and highest at sites in the northeast of the bay (*i.e.*, at Ricketts Point and Halfmoon Bay).

The results in this report present a snapshot in time for community structure and species population trends, which operate over long time scales. This was the first survey in the Subtidal Reef Monitoring Program for these sites. As monitoring continues and longer-term datasets are accumulated (over multiple years to decades) the program will be able to more adequately reflect any trends in community or population structure or any specific ecological patterns occurring in the system.

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1.0 Introduction

1.1 SUBTIDAL REEF ECOSYSTEMS OF NORTHERN PORT PHILLIP BAY

Rocky reefs in Port Phillip Bay are generally restricted to the near-shore regions of headlands and points. Reefs in the northwest of the bay, along the Geelong Arm, are predominantly near Point Liliias, Point Wilson and Kirks Point. These reefs occur in short coastal strips from the intertidal zone to 2-4 m depth, joining bare sediment and seagrass habitats a short distance from shore (10s of metres). Occasional small patches of reef, 10-50 m across, are present further offshore, particularly between Point Wilson and Kirks Point. These patch reefs are mostly 1-3 m deep.

Along the northern shore of the bay, small patches of shallow reef, interspersed by silty sands, are also present in the vicinity of Point Cooke, western beach (north of Point Cooke), Altona, Jawbone (Williamstown Rifle Range), Point Gellibrand and Point Ormond. These reefs are generally no deeper than 4 m. More extensive reef habitat is present from Sandringham to Ricketts Point, extending from the shore 50-100 m and to a depth of approximately 6 m.

In general the reefs in the northern half of the bay are quite sheltered from the prevailing northwesterly to southwesterly weather and are not subject to large waves, strong currents or swell. One exception is Ricketts Point which can be subject to steep, short-period waves during southwesterly storms. These reefs are, at times, in estuarine conditions and are subject to lower salinities from coastal runoff, rivers and drains, as well as considerable temperature ranges (as low as 8° C in winter and as high as 23° C in summer). The northern reefs are also frequently subject to turbid conditions from phytoplankton blooms and disturbance of adjacent, moderate to fine sediments.

Reefs on the northeastern side of the bay, particularly between Halfmoon Bay and Ricketts Point, are exposed to the prevailing westerly weather across a relatively long stretch of water. Consequently, these reefs are occasionally subject to turbulent wind-driven waves. These northeastern reefs are also influenced, to some extent, by the Yarra River plume and east-coast drainages.

Reef habitats in the north of Port Phillip Bay are different from the predominant reef habitats in Victoria, which occur on exposed open coasts. While there are similar species inhabiting both sheltered reefs in the north of the bay and reefs on more exposed coasts, there are substantial and important differences in community structure between the two reef environments. Seaweeds are the predominant biological habitat providers in both locations

however the importance of large canopy forming species such as crayweed *Phyllospora comosa* and common kelp *Ecklonia radiata* is much reduced on reefs in the bay. Smaller species of brown algae (10–30 cm high) such as *Sargassum* spp. and *Dictyota dichotoma* and green algae, particularly in the genus *Caulerpa*, are often the dominant habitat providers on reefs in the bay (Figure 1.1). Species of *Caulerpa* can form large mixed species assemblages creating meadow-like habitat in some locations. Grazed algal turfs and hard encrusting layers of coralline algae are also important species growing directly over the rocky substratum.



Green algae *Caulerpa brownii*



Species of thallose red algae with green algae *Caulerpa* spp. and *Cladophora* spp.

Figure 1.1 Examples of macroalgae found on subtidal reefs in northern Port Phillip Bay

Grazing and predatory mobile invertebrates are prominent animal inhabitants of the reef (Figure 1.2). Large grazing species such as the urchin *Heliocidaris erythrogramma* and blacklip abalone *Haliotis rubra* can occur in very high densities and are enormously productive components of the bay's reef communities. These species can significantly influence the growth and survival of habitat forming algal species and so are important structuring components of reef communities. Filter feeding species feed on phytoplankton and detritus and can be important for transferring nutrients and energy from the water column to other species directly inhabiting reefs. Filter feeding species on reefs in the north of the bay include aggregations of mussels *Mytilus edulis planulatus*, ascidians such as *Herdmania momus* and the introduced European fanworm *Sabella spallanzanii*. Other filter feeders are colonial species including sponges, bryozoans and soft corals such as

Erythropodium hicksoni. Important predatory invertebrates include octopus such as *Octopus berrima* and seastars including *Coscinasterias muricata* and *Uniophora granifera*. Predatory gastropod molluscs (shellfish) include the dogwhelk *Dicathais orbita* and *Pleuroploca australasia*.



Sea urchin *Heliocidaris erythrogramma*



Blacklip abalone *Haliotis rubra*



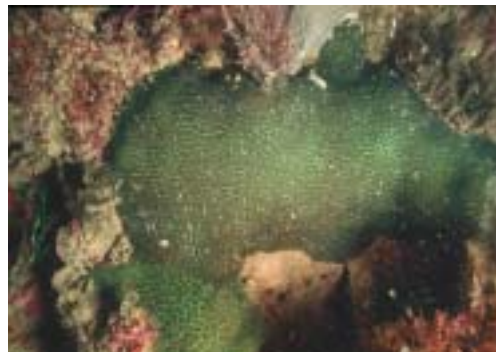
Eleven armed seastar *Coscinasterias muricata*



Seastar *Uniophora granifera*



Biscuit star *Tosia australis* with filamentous green and brown algae



Stony coral *Plesiastrea versipora*

Figure 1.2 Examples of species of invertebrates found on subtidal reefs in northern Port Phillip Bay.

Fish are also dominant components of reef ecosystems both in terms of biomass and ecological function. Reef fish assemblages include predators such as snapper *Crysophrys auratus*, omnivores including zebrafish *Girella zebra*, planktivores such as the southern hulafish *Trachinops caudimaculatus* and picker-feeders such as horseshoe leatherjacket *Meuschenia hippocrepis*. Schools of small baitfish, particularly herrings, sardines, pilchards and sprats are common over reef habitats in the north of the bay. Reefs also provide important habitat and source of food for juveniles of many fish species including snapper *Crysophrys auratus* on reefs in the north and east of the bay. Many fish species play a substantial ecological role in the functioning and structuring of reef ecosystems. Reef fish assemblages in the north of Port Phillip Bay are different to those in exposed coastal which tend to have higher abundances of wrasses (labrids), cales (odacids) and leatherjackets (monacanthids).



Southern hulafish *Trachinops caudimaculatus*



Globefish *Diodon nichthemerus*

Figure 1.3 Examples of fish species found on subtidal reefs in northern Port Phillip Bay.

Although shallow reef ecosystems in Victoria are dominated, in terms of biomass and production, by seaweeds, mobile invertebrates and fishes, there are many other important biological components to the reef ecosystem. These include small species of crustaceans and molluscs from 0.1 to 10 mm in size (mesoinvertebrates), occupying various ecological roles as grazers, predators and detritivores. At the microscopic level, films of microalgae and bacteria on the reef surface are also important.

Victoria's shallow reefs are a very important component of the marine environment due to their high biological complexity, species diversity and productivity. Subtidal reef habitats have important social and cultural values, which incorporate aesthetic, recreational, commercial and historical aspects. Shallow subtidal reefs also have significant economic value, through commercial fishing of reef species such as abalone and sea urchins, as well as recreational

fishing, diving and other tourism activities. Reefs in the north of Port Phillip Bay are highly accessible components of the marine environment because of their proximity to the large population centres of Melbourne and surrounding suburbs. Consequently, these reefs are subject to pressures due to human activities.

1.2 SUBTIDAL REEF MONITORING PROGRAM

1.2.1 Objectives

An important aspect of the management and conservation of Victorian marine natural resources and assets is assessing the condition of the ecosystem and how this changes over time. Combined with an understanding of ecosystem processes, this information can be used to manage any threats or pressures on the environment to ensure ecosystem sustainability.

Consequently, the Victorian Government has established a long-term Subtidal Reef Monitoring Program (SRMP). The primary objective of the SRMP is to provide information on the status of Victorian reef flora and fauna (focussing on macroalgae, macroinvertebrates and fish). This includes monitoring the nature and magnitude of trends in species abundances, species diversity and community structure. This is achieved through regular surveys at locations throughout Victoria, encompassing both representative and unique habitats and communities.

Information from the SRMP allows managers to better understand and interpret long-term changes in the population and community dynamics of Victoria's reef flora and fauna. As a longer time series of data is collected, the SRMP will allow managers to:

- compare changes in the status of species populations and biological communities between highly protected marine national parks and marine sanctuaries and other Victorian reef areas (e.g. Edgar and Barrett 1997, 1999);
- determine associations between species and between species and environmental parameters (e.g. depth, exposure, reef topography) and assess how these associations vary through space and time (e.g. Edgar *et al.* 1997; Dayton *et al.* 1998; Edmunds, Roob & Ferns 2000);
- provide benchmarks for assessing the effectiveness of management actions, in accordance with international best practice for quality environmental management systems (Holling 1978; Meredith 1997); and
- determine the responses of species and communities to unforeseen and unpredictable events such as marine pest invasions, mass mortality events, oil spills, severe storm

events and climate change (e.g. Ebeling *et al.* 1985; Edgar 1998; Roob *et al.* 2000; Sweatman *et al.* 2000).

A monitoring survey gives an estimate of population abundance and community structure at a small window in time. Patterns seen in data from periodic surveys are unlikely to exactly match changes in the real populations over time or definitively predict the size and nature of future variation. Plots of changes over time are unlikely to match the changes in real populations because changes over shorter time periods and actual minima and maxima may not be adequately sampled (Figure 1.4). Furthermore, because the nature and magnitude of environmental variation is different over different time scales, variation over long periods may not be adequately predicted from shorter-term data. Sources of environmental variation can operate at the scale of months (e.g. seasonal variation), years (e.g. el Niño), decades (e.g. extreme storm events) or even centuries (e.g. global warming). Other studies indicate this monitoring program will begin to adequately reflect average trends and patterns as the surveys continue over longer periods (multiple years to decades). Results always need to be interpreted within the context of the time scale over which they have been measured.

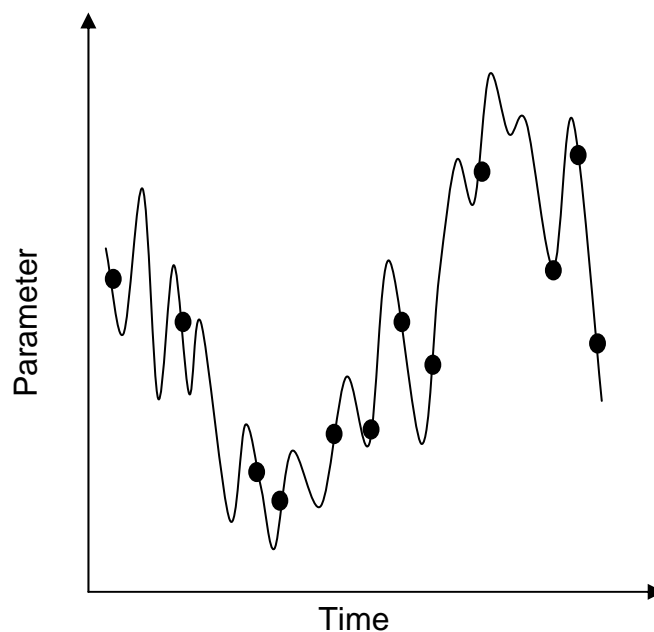


Figure 1.4 An example plot depicting change in an environmental, population or community variable over time (days, months or years). The black circles denote examples of monitoring times. Note how data from these times may not necessarily reflect patterns over shorter time periods, or true maxima or minima over longer time periods. Note further how data from any window of 2 or 3 consecutive monitoring times fails to adequately estimate the patterns or variation over the longer time period.

1.2.2 Monitoring Protocols and Locations

The SRMP uses standardised underwater visual census methods based on an approach developed and applied in Tasmania by Edgar and Barrett (1997). Details of standard operational procedures and quality control protocols for Victoria's SRMP are described in Edmunds and Hart (2003).

The SRMP was initiated in May 1998 with 15 sites established on subtidal reef habitats in the vicinity of Port Phillip Heads Marine National Park. In 1999 the SRMP was expanded to reefs in the vicinity of the Bunurong Marine National Park (12 sites), Phillip Island (6 sites), and Wilsons Promontory Marine National Park (20 sites).

In 2003, the Subtidal Reef Monitoring Program was expanded to include a further seven Marine National Parks and Marine Sanctuaries: Point Cooke, Jawbone and Ricketts Point, Merri, Marengo Reef and Eagle Rock Marine Sanctuaries and Point Addis Marine National Park.

1.2.3 Monitoring in Port Phillip Bay Marine Sanctuaries

This report describes the subtidal reef monitoring program and the results from the first survey of subtidal reefs in northern Port Phillip Bay, including at Point Cooke, Jawbone and Ricketts Point Marine Sanctuaries. The objectives of this report were to:

1. provide an overview of the methods used for the SRMP;
2. provide general descriptions of the biological communities and species populations at each monitoring site in March-April 2003;
3. identify any unusual biological phenomena such as interesting or unique communities or species; and
4. identify any introduced species at the monitoring locations.

2.0 Methods

2.1 SITE SELECTION AND SURVEY TIMES

Six monitoring sites were established on northern Port Phillip Bay subtidal reefs in March-April 2003 (Figure 2.1; Table 2.1). One monitoring site was located in, and one site near, each marine sanctuary. All monitoring sites were located on representative subtidal reef habitat

Point Cooke Marine Sanctuary

Point Cooke Marine Sanctuary is close to Werribee on the northwestern shore of the bay. The subtidal reef at Point Cooke consists of low-relief, textured basalt reef interspersed with patches of sand and mud. The Point Cooke monitoring site (Site 1) was positioned along the 3-4 m depth contour over the reef and patches of sand.

A monitoring site (RAAF Base; Site 2) was located offshore from RAAF Base Williams at Laverton, approximately 3 km southwest of Point Cooke Marine Sanctuary. The reef at RAAF Base is similar to Point Cooke. It consists mostly of low-relief, textured basalt reef but with less extensive patches of sand and mud. The RAAF Base monitoring site (Site 2) was positioned along the 3-4 m depth contour.

Jawbone Marine Sanctuary

Jawbone Marine Sanctuary is close to Williamstown in the north of the bay. The subtidal reef at Jawbone Marine Sanctuary is in shallow water (< 5 m) and consists of large basalt boulders interspersed with patches of sediment. The Jawbone monitoring site (Site 3) is close to shore and runs over the boulders along the 3 m depth contour.

A monitoring site (Point Gellibrand; Site 4) was located approximately 2 km east of Jawbone Marine Sanctuary at Point Gellibrand, Williamstown. Reef structure at this site was similar to the Jawbone reef, consisting predominantly of large basalt boulders, but with less sand. The monitoring site at Point Gellibrand (Site 4) was located along the 2 m depth contour.

Ricketts Point Marine Sanctuary

Ricketts Point Marine Sanctuary is near Beaumaris on the northeastern shore of the bay. The reef at Ricketts Point is low to medium relief sandstone reef. The Ricketts Point monitoring site traversed the sandstone reef along the 3 m depth contour, approximately 70 m offshore from the intertidal rock platform

A monitoring site (Halfmoon Bay; Site 6) was located approximately 3 km north of Ricketts Point at Halfmoon Bay. The reef at Halfmoon Bay is low to medium relief reef with occasional ledges and overhangs. The site (Site 6) was positioned along the 3 m depth contour.

The reef habitats at Ricketts Point Marine Sanctuary and Half Moon Bay have less estuarine influence than the other northern Port Phillip Bay reefs.

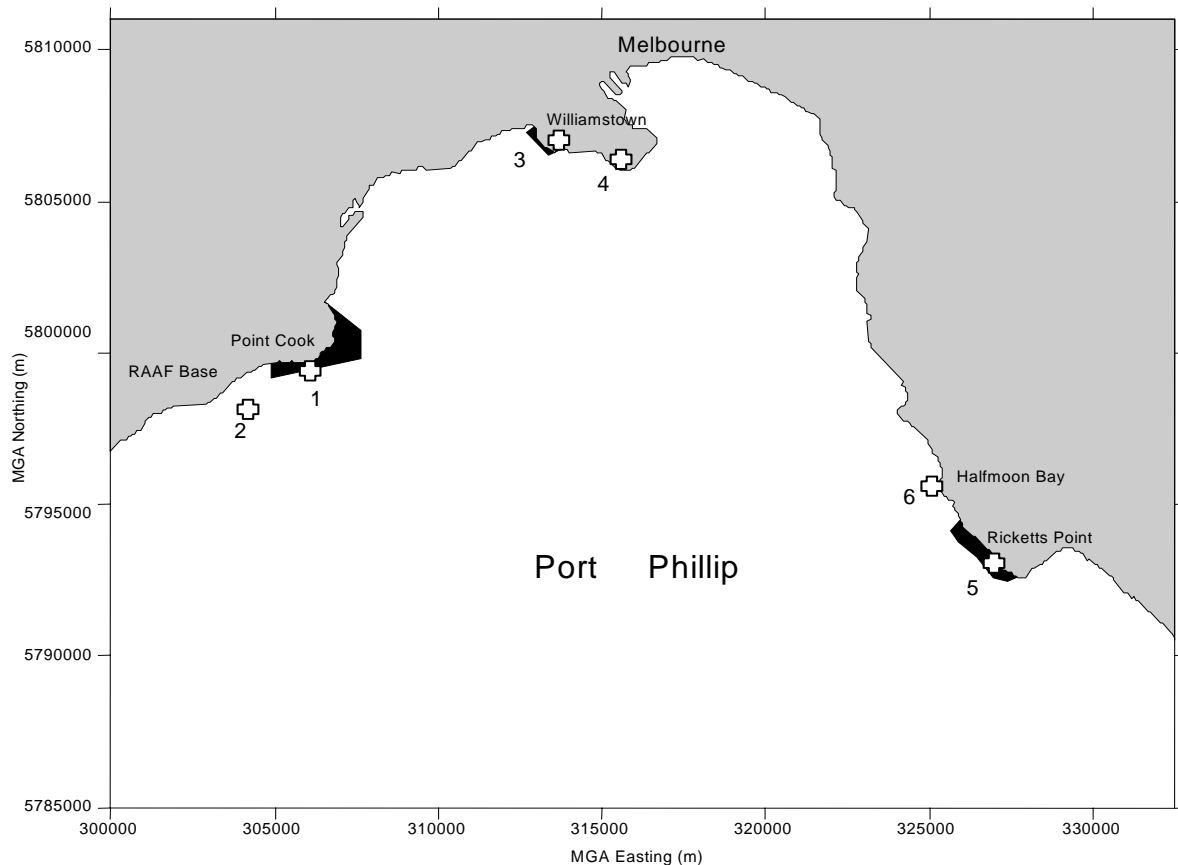


Figure 2.1. Approximate location of monitoring sites in northern Port Phillip Bay. Marine Sanctuaries are indicated in black.

Table 2.1. Subtidal reef monitoring sites in northern Port Phillip Bay

Site No.	Site Name	Depth (m)
1	Point Cooke	3
2	RAAF Base	4
3	Jawbone	3
4	Point Gellibrand	2
5	Ricketts Point	3
6	Half Moon Bay	3

2.2 CENSUS METHOD

2.2.1 Transect Layout

The visual census methods of Edgar and Barrett (Edgar & Barrett 1997, 1999; Edgar *et al.* 1997) are used for this monitoring program as they are non-destructive and provide quantitative data on a large number of species, and the structure of the reef communities. The Edgar-Barrett method is also used in Tasmania, New South Wales and Western Australia. The adoption of this method in Victoria provides a systematic and comparable approach to monitoring reefs in southern Australia. The surveys in Victoria are in accordance with a standard operational procedure to ensure long-term integrity and quality of the data. (Edmunds and Hart 2003).

At most monitoring locations in Victoria, surveying along the 5 m depth contour is considered optimal because diving times are not limited by decompression schedules and these reefs are of interest to natural resource managers. However, the actual depth that can be surveyed varies with reef extent, geomorphology and exposure. Monitoring sites in northern Port Phillip Bay are between 2 and 4 m deep because suitable reef does not extend to greater depths.

Each site is located using differential GPS and marked with a buoy or the boat anchor. A 100 m numbered and weighted transect line is run along the appropriate depth contour either side of the central marker. The resulting 200 m of line is divided into four contiguous 50 m sections of transects (T1 to T4). The orientation of transect is the same for each survey, with T1 generally toward the north or east (*i.e.* anticlockwise along the coast).

For each transect, three different census methods were used to obtain adequate descriptive information on reef communities at different spatial scales. These involved the census of: (1) the abundance and size structure of large fishes; (2) the abundance of cryptic fishes and benthic invertebrates; and (3) the percent cover of macroalgae and sessile invertebrates. Over 100 species were observed during the monitoring program in northern Port Phillip Bay (Table 2.3). The depth, horizontal visibility, sea state and cloud cover are recorded for each site. Horizontal visibility is gauged by the distance along the transect line to detect a 100 mm long fish. All field observations are recorded on underwater paper.

2.2.2 Method 1 – Mobile Fishes and Cephalopods

The densities of mobile large fishes and cephalopods are estimated by a diver swimming up one side of a 50 m section of the transect, and then back along the other. The diver records the number and estimated size-class of fish, within 5 m of each side of the line. The size-classes for fish are 25, 50, 75, 100, 125, 150, 200, 250, 300, 350, 375, 400, 500, 625, 750, 875 and 1000+ mm. Each diver has size-marks on their underwater slate to enable

calibration of their size estimates. A total of four 10 x 50 m sections of the 200m transect are censused for mobile fish at each site. The data for easily sexed species are recorded separately for males and female/juveniles. Such species include the blue-throated wrasse *Notolabrus tetricus*, herring cale *Odax cyanomelas*, barber perch *Caesioperca rasor*, rosy wrasse *Pseudolabrus psittaculus* and some leatherjackets.

2.2.3 Method 2 – Invertebrates and Cryptic Fishes

Cryptic fishes and megafaunal invertebrates (non-sessile: e.g. large molluscs, echinoderms, crustaceans) are counted along the transect lines used for the fish survey. A diver counts animals within 1 m of one side of the line (a total of four 1 x 50 m sections of the 200 m transect). A pole carried by the diver is used to standardise the 1 m distance. The maximum length of abalone is measured *in situ* using vernier callipers whenever possible. Selected specimens are collected for identification and preservation in a reference collection.

2.2.4 Method 3 – Macroalgae and Sessile Invertebrates

The area covered by macroalgal and sessile invertebrate species is quantified by placing a 0.25 m² quadrat at 10 m intervals along the transect line and determining the percent cover of the all plant species. The quadrat is divided into a grid of 7 x 7 perpendicular wires, giving 50 points (including one corner). Cover is estimated by counting the number of times each species occurs directly under the 50 positions on the quadrat (1.25 m² for each of the 50 m sections of the transect line). Selected specimens are collected for identification and preservation in a reference collection.

2.2.5 Method 4 – Macrocystis

In addition to macroalgal cover, the density of *Macrocystis angustifolia* plants is estimated. While swimming along the 200 m transect line, a diver counts all observable plants within 5 m either side of the line, for each 10 m section of the transect (giving counts for 100 m² sections of the transect). This survey component commenced during spring 1999.

Table 2.3. Macroalgae (Method 3), invertebrates and cryptic fish (Method 2) and mobile cephalopods and fish (Method 1) censused in northern Port Phillip Bay

Method 3	Method 2	Method 1
Chlorophyta (green)	Polychaete	Mobile Bony Fishes
<i>Ulva</i> spp	<i>Sabella spallanzani</i>	<i>Trygonorrhina fasciata</i>
<i>Cladophora prolifera</i>	Crustacea	<i>Atherinid</i> sp.
<i>Cladophora</i> spp	<i>Strigopagurus strigimanus</i>	<i>Neosebastes scorpaenoides</i>
<i>Caulerpa remotifolia</i>	Pagurid unidentified	<i>Platycephalus bassensis</i>
<i>Caulerpa longifolia</i>	<i>Nectocarcinus tuberculatus</i>	<i>Caesioperca rasor</i>

Method 3	Method 2	Method 1
Chlorophyta (green) cont.	Mollusca	Mobile Bony Fishes
<i>Caulerpa brownii</i>	<i>Plagusia chabrui</i>	<i>Trachinops caudimaculatus</i>
<i>Caulerpa flexilis</i>	<i>Haliotis rubra</i>	<i>Arripis trutta</i>
<i>Caulerpa geminata</i>	<i>Diodora lineata</i>	<i>Chrysophrys auratus</i>
<i>Caulerpa simpliciuscula</i>	<i>Dicathais orbita</i>	<i>Upeneichthys vlaminghii</i>
<i>Codium</i> spp	<i>Pleuroploca australasia</i>	<i>Pempheris multiradiata</i>
Filamentous greens	<i>Ceratosoma brevicaudatum</i>	<i>Girella zebra</i>
Phaeophyta (brown)	<i>Ostrea angasi</i>	<i>Scorpius aequipinnis</i>
<i>Leathesia difformis</i>	Echinodermata	<i>Tilodon sexfasciatus</i>
<i>Splachnidium rugosum</i>	<i>Tosia australis</i>	<i>Enoplosus armatus</i>
<i>Dictyota dichotoma</i>	<i>Tosia magnifica</i>	<i>Parma victoriae</i>
<i>Dilophus marginatus</i>	<i>Petricia vernicina</i>	<i>Cheilodactylus nigripes</i>
<i>Lobospira bicuspidata</i>	<i>Patiriella exigua</i>	<i>Dactylophora nigricans</i>
<i>Distromium flabellatum</i>	<i>Patiriella calcar</i>	<i>Neoodax balteatus</i>
<i>Zonaria turneriana</i>	<i>Patiriella brevispina</i>	<i>Nesogobius</i> sp.
<i>Colpomenia peregrina</i>	<i>Coscinasterias muricata</i>	<i>Acanthaluteres vittiger</i>
<i>Ecklonia radiata</i>	<i>Asterias amurensis</i>	<i>Meuschenia flavolineata</i>
<i>Caulocystis cephalornithos</i>	<i>Uniophora granifera</i>	<i>Meuschenia freycineti</i>
<i>Acrocarpia paniculata</i>	<i>Amblypneustes leucoglobus</i>	<i>Meuschenia hippocrepis</i>
<i>Cystophora moniliformis</i>	<i>Amblypneustes</i> sp.	<i>Aracana ornata</i>
<i>Cystophora retroflexa</i>	<i>Helicoidaris erythrogramma</i>	<i>Tetractenos glaber</i>
<i>Cystophora subfarcinata</i>	Ascidacea	<i>Diodon nichthemerus</i>
<i>Sargassum linearifolium</i>	<i>Pyura stolonifera</i>	
<i>Sargassum spinuligerum</i>	Cryptic Fish	
<i>Sargassum</i> spp	<i>Aetapcus maculatus</i>	
Rhodophyta (red algae)	<i>Vincentia conspersa</i>	
<i>Haliptilon roseum</i>	<i>Pempheris multiradiata</i>	
Encrusting corallines	<i>Bovichtus angustifrons</i>	
<i>Gigartina</i> sp.	<i>Parablennius tasmanianus</i>	
<i>Callophyllis rangiferina</i>	<i>Norfolkia clarkei</i>	
<i>Plocamium angustum</i>	<i>Heteroclinus perspicillatus</i>	
<i>Dictymenia harveyana</i>	<i>Nesogobius</i> sp.	
<i>Laurencia filiformis</i>	<i>Brachaluteres jacksonianus</i>	
<i>Laurencia tumida</i>		
Sessile Invertebrates		
Other sponges		
<i>Plesiastrea versipora</i>		
<i>Amathia</i> sp.		
Unidentified colonial ascidian		

2.3 DATA ANALYSIS

2.3.1 Community Structure

Community structure is a multivariate function of both the species present and the abundance of each species. The community structure between pairs of samples was compared using the Bray-Curtis dissimilarity coefficient. This index compares the abundance of each species between two samples to give a single value of the difference between the samples, expressed as a percentage (Faith *et al.* 1987; Clarke 1993).

Prior to analysis, the data were log transformed to weight down the influence of highly abundant species in describing community structure, giving a more even weighting between abundant and rarer species (following abundance transformations by Sweatman *et al.* 2000).

The Bray-Curtis dissimilarity index was calculated for all possible combinations of sites. This resulted in a matrix of pair-wise comparisons known as a dissimilarity matrix. The dissimilarity matrix is also termed a distance matrix as it effectively represents distances between samples in hyper-dimensional space. The dissimilarity matrix was used for all analyses of community structure in this study.

2.3.2 Depiction of Community Differences

The hyper-dimensional information in the dissimilarity matrix was simplified and depicted using non-metric multidimensional scaling (MDS; Clarke 1993). This ordination method finds the representation in fewer dimensions that best depicts the actual patterns in the hyper-dimensional data (i.e. reduces the number of dimensions while depicting the salient relationships between the samples). The MDS results were then depicted graphically to show differences between the replicates at each location. The distance between points on the MDS plot is representative of the relative difference in community structure.

Kruskall stress is an indicator statistic calculated during the ordination process and indicates the degree of disparity between the reduced dimensional data set and the original hyper-dimensional data set. A guide to interpreting the Kruskal stress indicator is given by Clarke (1993): (< 0.1) a good ordination with no real risk of drawing false inferences; (< 0.2) can lead to a usable picture, although for values at the upper end of this range there is potential to mislead; and (> 0.2) likely to yield plots which can be dangerous to interpret. These guidelines are simplistic and increasing stress is correlated with increasing numbers of samples. Where high stress was encountered with a two-dimensional data set, three-dimensional solutions were sought to ensure an adequate representation of the higher-dimensional patterns.

2.3.3 Trends in Community Structure

Trends cannot be examined in this report since only one survey has been completed in northern Port Phillip Bay. Trends in community structure will be examined statistically when further surveys have been completed at each location.

2.3.4 Species Diversity

Species diversity involves the consideration of two components: species richness and evenness. Species richness is the number of species present in the community while evenness is the degree of similarity of abundances between species. If all species in a community have similar abundances, then the community has a high degree of evenness. If a community has most of the individuals belonging to one species, it has low evenness. Species diversity is a combination of species richness and the relative abundance of each species, and is often referred to as species heterogeneity. Measures of diversity give an indication of the likelihood that two individuals selected at random from a community are different species.

Species richness (S) was enumerated by the total species count per site. This value was used for calculation of evenness and heterogeneity statistics. Species diversity (*i.e.* heterogeneity among species) was described using the reciprocal of Simpson's index ($1/D_{\text{Simpson}} = \text{Hill's } N_2$). This index provides more weighting for common species, in contrast to indices such as the Shannon-Weiner Index (Krebs 1999), which weights the rarer species. The weighting of common species was considered more appropriate for this study because the sampling regime is designed to target the more common species.

Simpson's index of evenness ($E_{1/D}$) was used to describe the equitability of abundances between species. This index is relatively unaffected by rare species in the sample (Krebs 1999).

Trends in species richness and diversity over time will be assessed when additional monitoring surveys have been completed.

2.3.5 Species Populations

The abundance of each species was summarised by calculating total counts of fish and invertebrates and total percentage cover of macroalgae, for each site. Trends in species abundances over time will be examined when additional monitoring surveys have been completed. Except for small species (*e.g.* *Trachinops caudimaculatus*), fish abundances were generally low at sites in northern Port Phillip Bay. This prevented useful assessments of the population size structure of important species.

The population size structure for blacklip abalone *Haliotis rubra* was assessed by calculating mean lengths and size frequency curves.



Figure 2.3. Biologist-diver with transect reel, Lonsdale Back Beach.

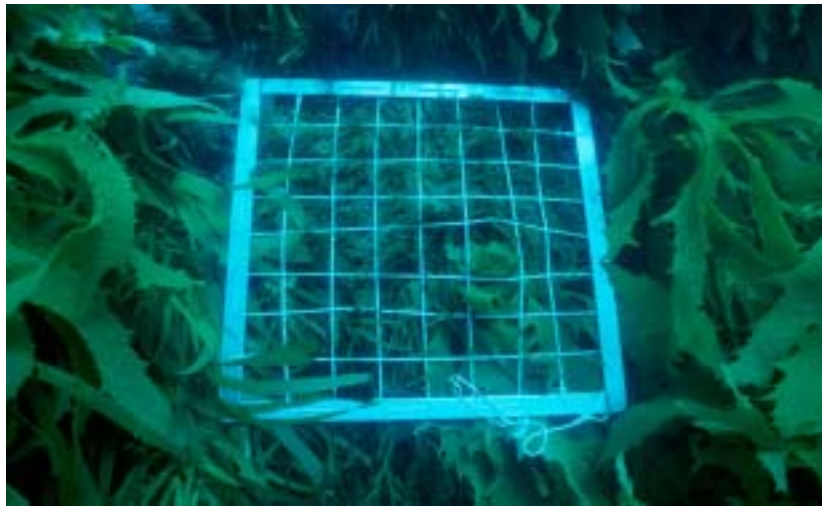


Figure 2.4. The cover of macrophytes is measured by the number of points intersecting each species on the quadrat grid.

3.0 Macroalgae and Sessile Invertebrates

3.1 SPECIES RICHNESS AND DIVERSITY

Algal species richness was variable among all sites and there were relatively large differences in richness between paired sanctuary and monitoring sites (Table 3.1). Highest species richness occurred at Ricketts Point (Site 5) and RAAF Base (Site 2). This was because of a relatively large number of small brown algal species at Ricketts Point and green algal species, particularly in the genus *Caulerpa*, at RAAF Base. There was intermediate species richness at Point Gellibrand and Halfmoon Bay. Lowest species richness occurred at Point Cooke and Jawbone, both of which also had lower total abundance of algae.

Evenness was lowest at Jawbone (Site 3) principally because of the very high cover of low-growing filamentous brown algae to the exclusion of other species. High evenness occurred at Point Cooke (Site 1) and Halfmoon Bay (Site 6).

Lowest species diversity occurred at the northern Port Phillip Bay sites, Jawbone (Site 3) and Point Gellibrand (Site 4). This was because of the low number of species and the dominance of filamentous brown algae at these sites. Higher and similar species diversity was recorded at Point Cooke (Site 1) and RAAF Base (Site 2) and at Ricketts Point (Site 5) and Halfmoon Bay (Site 6).

Table 3.1. Diversity statistics for algae in northern Port Phillip Bay: pooled values for number of species, heterogeneity and evenness for each site.

Site	Species S	Heterogeneity $1/D=N_2$	Evenness $E_{1/D}$
1	10	4.86	0.49
2	18	4.47	0.25
3	10	1.57	0.16
4	15	3.23	0.22
5	22	5.27	0.24
6	15	5.5	0.37

3.2 COMMUNITY STRUCTURE

Unlike in many exposed open coastal environments, large canopy forming species did not tend to be dominant components of the algal assemblages in the north of Port Phillip Bay. Common kelp *Ecklonia radiata*, did provide some canopy cover at all sites, however, smaller green, brown and red species tended to be the dominant components of the algal assemblages. Fleshy brown algal turfs and/or encrusting coralline algae were also important

at most sites. There were substantial differences between the algal assemblages at all monitoring sites (Figure 3.1).

The reef at Point Cooke (Site 1) was patchy and was interspersed with large areas of bare sediment. Consequently, the distribution and cover of algae was also patchy at this site. The dominant species was common kelp *Ecklonia radiata*, but this occurred in low abundance. Smaller species in low abundance included the green algae *Ulva* sp., *Caulerpa remotifolia*, brown alga *Dilophus marginatus* and thallose red alga *Gigartina* sp. In contrast, RAAF Base (Site 2) was predominantly a *Caulerpa* bed assemblage dominated by *Caulerpa flexilis*, but also including *C. longifolia*, *C. brownii*, *C. remotifolia*, and *C. simpliciuscula*. Species common to both sites included common kelp *Ecklonia radiata*, green alga *Caulerpa remotifolia*, the small brown alga *Dictyota dichotoma* and thallose red alga *Callophyllis rangiferina*. There was a higher total cover of algae at RAAF Base than at Point Cooke.

The algal assemblages at Jawbone (Site 3) and Point Gellibrand (Site 4) were characterised by low abundance of large algal species and were instead dominated by low turfs of the filamentous brown algae *Ectocarpales* spp. Filamentous brown algae had a cover of 42 % and 24 % at Jawbone and Point Gellibrand respectively. Other small brown algal species such as *Dictyota dichotoma* and *Sargassum* spp. were generally more common at these sites than green or red algal species, but were typically in low abundance. The temperate stony coral *Plesiastrea versipora* covered more than 6 % of the substratum at Jawbone. There was a higher cover of the green algae *Ulva* spp. at Point Gellibrand compared with all other sites in the bay. The cover of encrusting coralline algae was also relatively high at this site. The algal community structure at Jawbone and Point Gellibrand probably reflects the large estuarine influence at these sites. In particular, the high abundance of *Ectocarpales* spp. is often an indicator of high nutrient concentrations.

Ricketts Point (Site 5) and Halfmoon Bay (Site 6) were predominantly *Caulerpa* bed assemblages. At Ricketts Point *Caulerpa geminata* was the dominant species. *Ecklonia radiata* provided some algal canopy on small patches on the reef. Smaller species included the green alga *Ulva* sp., the thallose red alga *Laurencia filiformis* as well as a suite of smaller brown species including *Splanchnidium rugosum*, *Distromium flabellatum*, *Zonaria turneriana* and *Sargassum* spp. Encrusting coralline algae occurred in relatively low abundance. At Halfmoon Bay the number of species and total cover of *Caulerpa* were much higher than at Ricketts Point. *Caulerpa geminata* and *Caulerpa brownii* were the dominant species and other species included *Caulerpa remotifolia* and *C. longifolia*. *Ecklonia radiata* was more widely distributed on this reef than at Ricketts Point but provided relatively little algal cover. The thallose red alga *Laurencia filiformis* was another prominent species at this site.

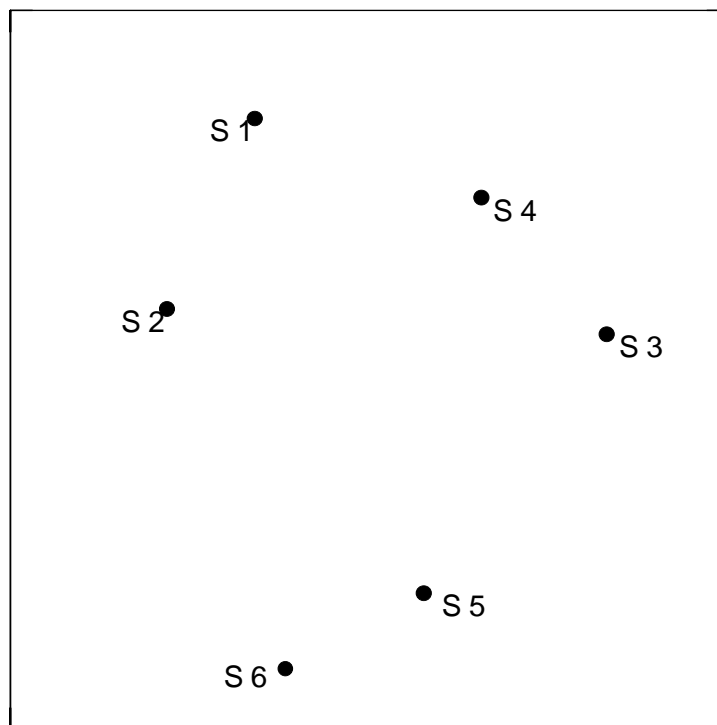


Figure 3.1. MDS plot of algal assemblage structure in northern Port Phillip Bay. The numbers on each plot denote the survey site. Kruskal stress = 0.01.

Table 3.2. Macroalgal abundance per site (percent cover), in northern Port Phillip Bay March-April 2003.

Species	Site					
	4101	4102	4103	4104	4105	4106
Chlorophyta – Green Algae						
<i>Ulva</i> spp	4	2	0.2	14.3	4.5	0.4
<i>Cladophora prolifera</i>		0.9				0.7
<i>Cladophora</i> spp	0.1	0.3				
<i>Caulerpa remotifolia</i>	2	2.6			0.6	8.7
<i>Caulerpa longifolia</i>		6.5				9.5
<i>Caulerpa brownii</i>		4.8				21.3
<i>Caulerpa flexilis</i>		25				
<i>Caulerpa geminata</i>					25.4	26.8
<i>Caulerpa simpliciuscula</i>		0.4				
<i>Codium</i> spp			0.4	1.1		
Filamentous greens			0.1	0.7	1.1	
Phaeophyta – Brown Algae						
<i>Leathesia difformis</i>					0.3	
<i>Splachnidium rugosum</i>					1.2	

Species	Site					
	4101	4102	4103	4104	4105	4106
<i>Dictyota dichotoma</i>	0.8	0.6	0.3	0.3		
<i>Dilophus marginatus</i>	1.1			0.6		
<i>Lobospira bicuspidata</i>						1.1
<i>Distromium flabellatum</i>					1.4	0.2
<i>Zonaria turneriana</i>				0.2	2.2	
<i>Colpomenia peregrina</i>				1		
<i>Ecklonia radiata</i>	9.3	13.7	0.5	1.9	14.3	7.4
<i>Caulocystis cephalornithos</i>					0.6	
<i>Acrocarpia paniculata</i>					0.9	
<i>Cystophora moniliformis</i>					0.7	
<i>Cystophora retroflexa</i>					0.3	
<i>Cystophora subfarcinata</i>				0.9		
<i>Sargassum linearifolium</i>		0.9				
<i>Sargassum spinuligerum</i>				3.2		1.1
<i>Sargassum</i> spp		0.4	0.6	1.2	3.2	0.4
Filamentous browns (<i>Ectocarpales</i>)		41.9	24.1	3.2		
Brown algae unidentified		0.7				
Rhodophyta – Red Algae						
<i>Haliptilon roseum</i>					0.1	
<i>Encrusting corallines</i>	5.9	7.1	0.8	11.2	5.9	0.4
<i>Gigartina</i> sp	1.5					
<i>Callophyllis rangiferina</i>	0.6	0.6				
<i>Plocamium angustum</i>					0.1	
<i>Dictymenia harveyana</i>		0.4				
<i>Laurencia filiformis</i>					5	8
<i>Laurencia tumida</i>				0.3		
Filamentous red algae	3.2	1.8			0.6	
Other thallose red alga	2.1	0.8		1.1	1.7	3.7
Sessile Encrusting Animals						
Sponges			2.1		1.3	0.5
<i>Plesiastrea versipora</i> (hard coral)			6.2	0.1	1.5	0.2

4.0 Invertebrates and cryptic fishes

4.1 SPECIES RICHNESS AND DIVERSITY

Invertebrate species richness ranged between 9 and 18 species, but was generally similar at most sites. Highest species richness occurred in the northwest at Point Cooke (Site 1) and RAAF Base (Site 2; Table 4.1). The relatively high species richness at Point Cooke was principally due to the large number of species of echinoderms, particularly seastars, at this site (Table 4.2).

Invertebrate species evenness was relatively low (Table 4.1). This was because two species, *Helicoidaris erythrogramma* and blacklip abalone *Haliotis rubra*, were highly abundant and were the numerically dominant species at all sites. All other species were generally in low or very low abundance.

Species diversity was highest at Point Cooke (Site 1) and was lowest at Ricketts Point (Site 5) and Halfmoon Bay (Site 6).

Table 4.1. Species richness and diversity of invertebrates in northern Port Phillip Bay.

Site	Individuals <i>N</i>	Species <i>S</i>	Heterogeneity $1/D=N2$	Evenness $E_{1/D}$
1	1102	18	1.75	0.24
2	1525	13	1.15	0.20
3	281	11	1.46	0.30
4	497	11	1.19	0.24
5	1118	9	0.51	0.16
6	621	9	0.46	0.15

Table 4.2. Abundance of megfaunal invertebrates and cryptic fishes (200 m²) at sites in Northern Port Phillip Bay, March-April 2003.

Species	Site					
	4101	4102	4103	4104	4105	4106
Invertebrates						
<i>Sabella spallanzani</i>	9	72	13	4		1
<i>Strigopagurus strigimanus</i>	1					
Pagurid unidentified				1		
<i>Nectocarcinus tuberculatus</i>		12		3	1	6
<i>Plagusia chabrus</i>		4				
<i>Haliotis rubra</i>	376	212	9	11	126	48
<i>Dicathais orbita</i>	6				5	

Species	Site					
	4101	4102	4103	4104	4105	4106
<i>Pleuroploca australasia</i>		1				
<i>Diodora lineata</i>	1					1
<i>Ceratosoma brevicaudatum</i>		1	2		3	
<i>Ostrea angasi</i>	1		1			
<i>Tosia australis</i>	47	51	9	8	10	5
<i>Tosia magnifica</i>	1	11				
<i>Petricia vernicina</i>	7	9	1	1	3	4
<i>Patiriella brevispina</i>	105	60	52	30		
<i>Patiriella exigua</i>	2					
<i>Patiriella calcar</i>	72		39	66		
<i>Coscinasterias muricata</i>	9	14	3	39	6	1
<i>Uniophora granifera</i>	7	25		4	1	1
<i>Asterias amurensis</i>			3			
<i>Amblypneustes</i> spp	3					
<i>Heliocidaris erythrogramma</i>	309	1053	149	330	963	554
Cryptic Fishes						
<i>Aetapcus maculatus</i>			1			
<i>Vincentia conspersa</i>						5
<i>Bovichtus angustifrons</i>					1	
<i>Parablennius tasmanianus</i>			1	3		
<i>Norfolkia clarkei</i>					1	
<i>Heteroclinus perspicillatus</i>		4	3	1	1	
<i>Nesogobius</i> sp.		5	3			
<i>Brachaluteres jacksonianus</i>			2		1	

4.2 ASSEMBLAGE STRUCTURE

Invertebrate assemblage structure tended to be most similar between selected monitoring sites compared with different locations in the bay (Figure 4.1). The largest difference in assemblage structure were between Point Cooke (Site 1) and Ricketts Point (Site 2). The main differences between these two sites appeared to be because of differences in the abundance of the urchin *Heliocidaris erythrogramma*, as well as the species composition and abundance of seastars, particularly *Patiriella calcar* and *Patiriella brevispina* (Table 4.2). There were also high numbers of the introduced European fanworm *Sabella spallanzanii* at RAAF Base, but not at Point Cooke. The large grazing herbivores, the sea urchin *Heliocidaris erythrogramma* and/or blacklip abalone *Haliotis rubra*, were the dominant invertebrate species at all monitoring sites in northern Port Phillip Bay (Table 4.2).

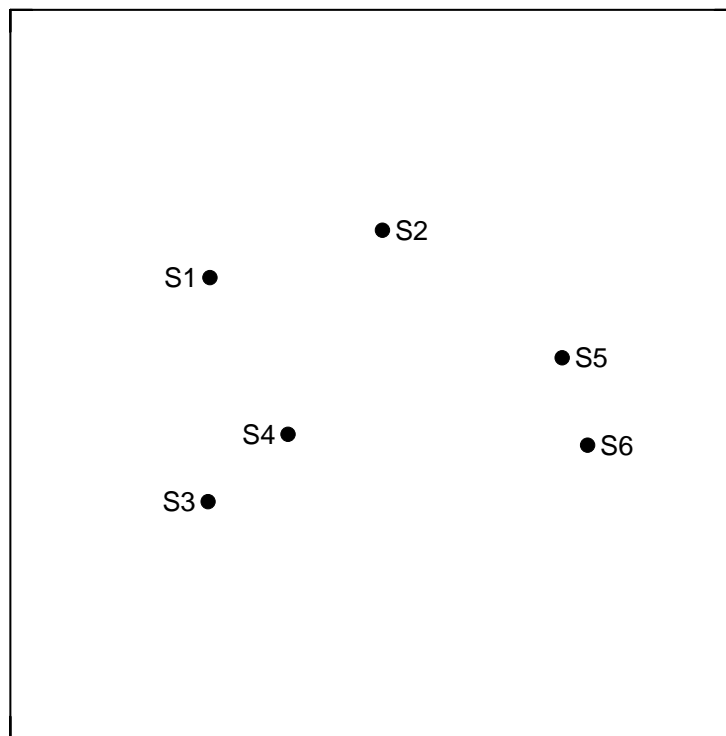


Figure 4.1. MDS plot of invertebrate assemblage structure in northern Port Phillip Bay, March-April 2003. The labels next to each point denote the survey site. Kruskal stress = 0.01

The invertebrate assemblage at Point Cooke was dominated by echinoderms. *Heliocidaris erythrogramma* was highly abundant, and another urchin *Amblypneustes* spp. was also present. The seastars *Patiriella brevispina*, *Patiriella calcar* and *Tosia australis* were more abundant at Point Cooke than at other monitoring sites. Other species of seastar included *Petricia vernicina*, eleven-armed seastar *Coscinasterias muricata* and *Uniophora granifera*. Blacklip abalone *Haliotis rubra* occurred in roughly equivalent numbers to *Heliocidaris erythrogramma* at Point Cooke. Other gastropod molluscs were rare (Table 4.2). RAAF Base (Site 2) was dominated by *Heliocidaris erythrogramma* which was exceptionally abundant at this site ($> 5 \text{ m}^{-2}$). Other abundant echinoderms were the seastars *Tosia australis*, *Patiriella brevispina* and *Uniophora granifera*. Blacklip abalone *H. rubra* was highly abundant, but less so than at Point Cooke. The crabs *Nectocarcinus tuberculatus* and *Plagusia chabrus* also occurred at RAAF Base (Table 4.2).

There were low abundances of invertebrates at Jawbone (Site 3). The assemblage was dominated by *Heliocidaris erythrogramma*, but abundances there were lower than at all other sites. The seastars *Patiriella calcar* and *P. brevispina* were the only other abundant species at Jawbone (Table 4.2). The assemblage at Point Gellibrand (Site 4) was characterised by

relatively high abundances of *H. erythrogramma* and the seastars *Patiriella calcar* and *P. brevispina*. The large predatory eleven armed seastar *Coscinasterias muricata* was very abundant at this site (Table 4.2).

There were relatively few invertebrate species at Ricketts Point (Site 5) and the assemblage was dominated by very high ($> 4.5 \text{ m}^{-2}$) abundances of *H. erythrogramma* and lower abundances of blacklip abalone *H. rubra*. There was low or very low abundance of seastars such as *Tosia australis* and *Coscinasterias muricata* and also low abundance of the predatory gastropod mollusc *Dicathais orbita*. The invertebrate assemblage at Halfmoon Bay (Site 6) was very similar to Ricketts Point in terms of species composition but abundances of most species were generally lower at Halfmoon Bay. Halfmoon Bay was dominated by *Heliocidaris erythrogramma*, with lower abundances of *H. rubra* (Table 4.2).

4.3 POPULATION ABUNDANCES AND SIZES

Echinoderms tended to be the most abundant invertebrates at most survey sites (Table 4.2). The urchin *Heliocidaris erythrogramma* was the most abundant invertebrate at all sites except Point Cooke. Densities *Heliocidaris erythrogramma* were exceptionally high at RAAF base (Site 2) and Ricketts Point (Site 5), which had 1053 and 963 individuals per 200 m^2 , respectively. The lowest density recorded during the current survey was at Jawbone (Site 3), which had 149 individuals per 200 m^2 (Figure 4.2). Other abundant echinoderms were the seastars *Patiriella calcar*, *Patiriella brevispina*, *Tosia australis* and *Coscinasterias muricata* (Figure 4.2)

There were high densities of blacklip abalone *Haliotis rubra* at three monitoring sites within the bay. Densities were very high at Point Cooke (Site 1), which had 376 individuals per 200 m^2 . More than 100 and 200 individuals per 200 m^2 occurred at Ricketts Point (Site 5) and RAAF Base (Site 2), respectively (Figure 4.2)

The mean size of blacklip abalone at monitoring sites within the bay ranged between 83 and 88 mm. Sizes within the bay were smaller than in open coastal locations (e.g. Edmunds *et al.* 2003). Sizes were fairly similar between sites but abalone may be slightly larger on the eastern shore of the bay at Ricketts Point and Halfmoon Bay than on the northern shore (Figure 4.3).

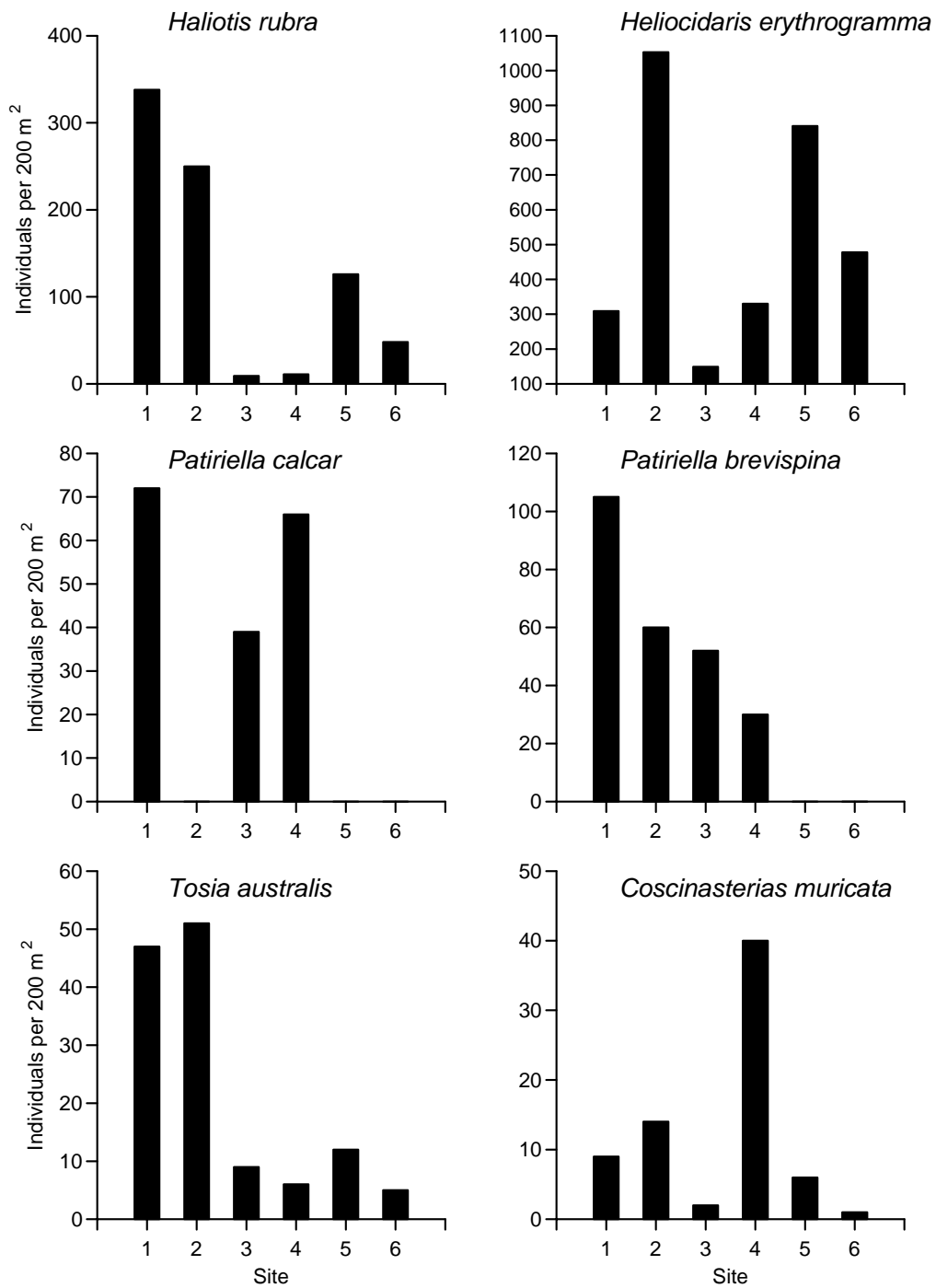


Figure 4.2 Abundance of common invertebrates on subtidal reefs in northern Port Phillip Bay.

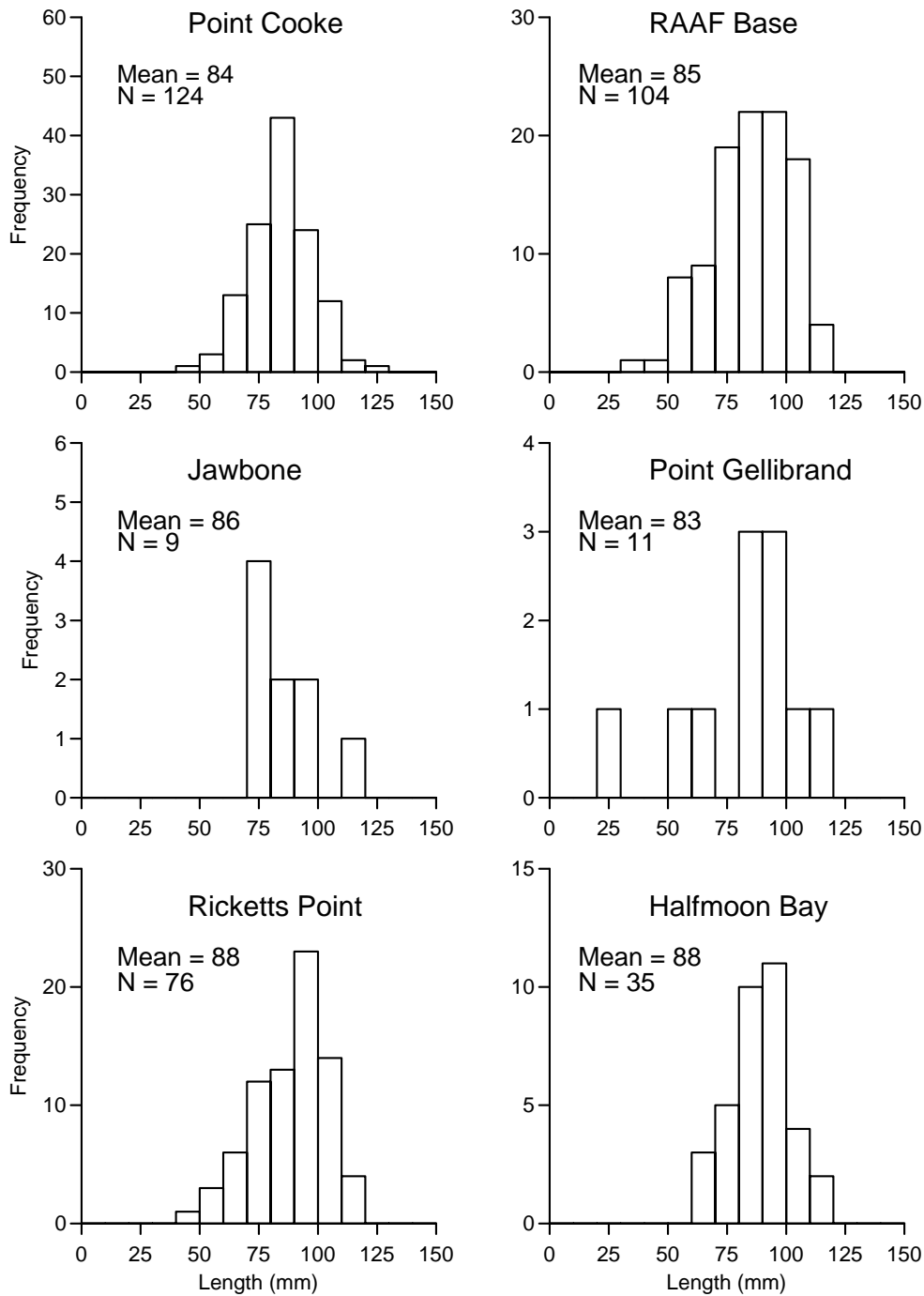


Figure 4.3. Size frequency distributions for *Haliotis rubra* at monitoring sites in northern Port Phillip Bay.

5.0 Fish

5.1 SPECIES RICHNESS AND DIVERSITY

Fish species richness was generally lowest in the north and northwest of the bay and highest in the northeast of the bay at Ricketts Point (Site 5) and Halfmoon Bay (Site 6; Table 5.1). There were seven species of fish at Point Cooke and eleven species at nearby RAAF Base. Lower species richness occurred at Jawbone and Point Gellibrand with only 6 and 4 species recorded at these sites, respectively. Highest species richness occurred at Ricketts Point, which had 19 species and there were 14 species at nearby Halfmoon Bay (Table 5.1).

Species evenness was relatively low at all sites principally because of very large numbers of one or two species at most sites and consistently lower abundances of most other species (Tables 5.1; 5.2). Fish species diversity was also low at all sites. Diversity was particularly low at Jawbone because of the very low species richness at this site combined with the very high abundance of southern hulafish *Trachinops caudimaculatus* (Table 5.2). Highest species diversity occurred at Halfmoon Bay. Species diversity was consistently higher at reference monitoring sites than at sanctuary sites (Table 5.1).

Table 5.1. Fish species richness and diversity in northern Port Phillip Bay.

Site	Individuals <i>N</i>	Species <i>S</i>	Heterogeneity $1/D=N2$	Evenness $E_{1/D}$
1	152	7	1.18	0.17
2	716	11	2.84	0.26
3	2203	6	1.01	0.17
4	27	4	1.36	0.34
5	712	19	1.39	0.07
6	90	14	3.20	0.23

5.2 COMMUNITY STRUCTURE

There were few clear patterns in fish assemblage structure at monitoring sites within the bay and there was no clear separation of paired reference and monitoring sites indicated by MDS (Figure 5.1). Small fish, particularly southern hulafish *Trachinops caudimaculatus*, were numerically dominant at all sites (Table 5.2).

Southern hulafish *Trachinops caudimaculatus* was the most abundant fish at Jawbone (Site 1), but was only present in moderate numbers at this site compared with other sites (Table 5.2). *T. caudimaculatus* occurred sheltering in depressions between small reef outcrops.

There were low abundances of larger species of fish including zebra fish *Girella zebra* and moonlighter *Tilodon sexfasciatus*. The banjo ray *Trygonorrhina fasciata* also occurred at this site (Table 5.2). There were higher densities of *Trachinops caudimaculatus* at RAAF Base (Site 2). Schools of smaller fish such as hardyheads (atherinids) also occurred at this site. The relatively large numbers of these small schooling fish at this site probably resulted in the large differences in community structure between RAAF Base and Point Cooke identified in MDS. Larger fish were in low abundance and included little rock whiting *Neoodax balteatus*, toothbrush leatherjacket *Acanthaluteres vittiger* and globefish *Diodon nichthemerus* (Table 5.2).

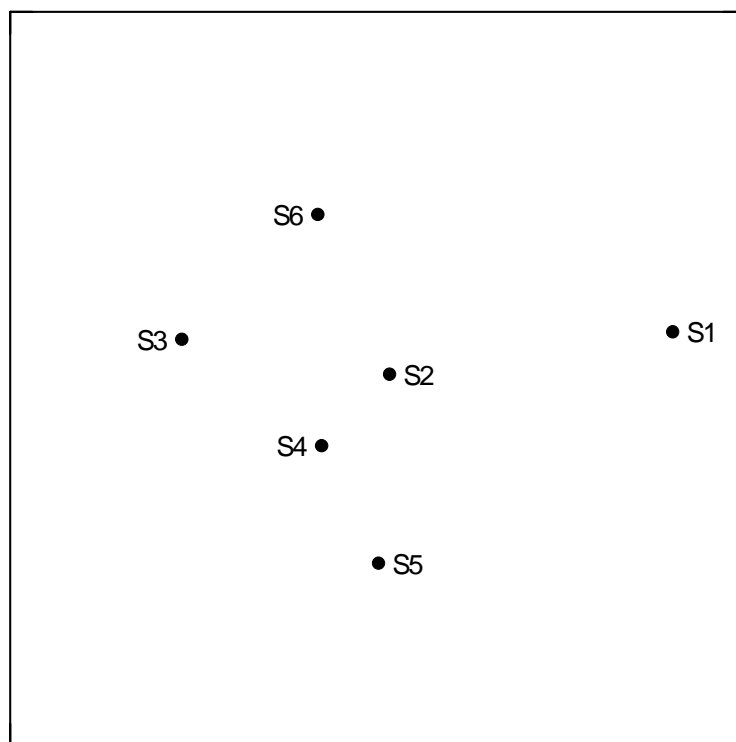


Figure 5.1. MDS plot of fish assemblage structure in northern Port Phillip Bay, March-April 2003. The labels next to each point denote the survey site. Kruskal stress = 0.05

At Jawbone (Site 3), very large numbers of southern hulafish *Trachinops caudimaculatus* resulted in the very high total densities of fish (Table 5.2). The other prominent species at this site was dusky morwong *Dactylophora nigricans*. Juveniles and subadults of this species appeared to be sunning themselves in shallow water. A female barber perch *Caesioperca rasor* was an unusual species to be recorded at this site. Fish were not a prominent component of the subtidal community at Point Gellibrand (Site 4). The few species at this site included low abundances of southern hulafish *Trachinops caudimaculatus*, moonlighter *Tilodon sexfasciatus* and common gurnard perch *Neosebastes scorpaenoides* (Table 5.2).

Fish assemblages were more diverse, and larger species were more abundant, at Ricketts Point (Site 5) and Halfmoon Bay (Site 6) than at other sites in the bay. The Ricketts Point assemblage included a school of Australian salmon *Arripis trutta* as well as several subadult male snapper *Chrysophrys auratus*. This species normally avoids divers and is rarely observed underwater in Port Phillip Bay. Other prominent large species of fish included zebra fish *Girella zebra*, horseshoe leatherjacket *Meuschenia hippocrepis* and moonlighter *Tilodon sexfasciatus*. Species of leatherjacket included toothbrush leatherjacket *Acanthaluteres vittiger*, yellow tailed leatherjacket *Meuschenia flavolineata* and six spined leatherjacket *Meuschenia freycineti*. There were lower abundances of fish at Halfmoon Bay than at Ricketts Point, although the assemblage was composed of similar species. Species at this site included snapper *Crysophrys auratus*, zebra fish *Girella zebra*, moonlighter *Tilodon sexfasciatus*, toothbrush leatherjacket *Acanthaluteres vittiger* and horseshoe leatherjacket *Meuschenia hippocrepis*.

Table 5.2. Fish abundance (2000 m⁻²) at monitoring sites in northern Port Phillip Bay, March-April 2003.

Species	Site					
	411	412	413	414	415	416
<i>Trygonorrhina fasciata</i>	2				1	
Atherinid sp		137				
<i>Neosebastes scorpaenoides</i>				1		
<i>Platycephalus bassensis</i>					1	
<i>Caesioperca rasor</i>			1			
<i>Trachinops caudimaculatus</i>	14	248	2195	23	63	47
<i>Arripis trutta</i>					3	
<i>Chrysophrys auratus</i>					7	2
<i>Upeneichthys vlaminghii</i>		1			7	2
<i>Pempheris multiradiata</i>						3
<i>Girella zebra</i>	3		1		18	2
<i>Scorpius aequipinnis</i>					4	1
<i>Tilodon sexfasciatus</i>	4	1		2	12	3
<i>Enoplosus armatus</i>					1	1
<i>Parma victoriae</i>					2	3
<i>Cheilodactylus nigripes</i>					1	
<i>Dactylophora nigricans</i>	1		4		1	1
<i>Neoodax balteatus</i>		4			6	1
<i>Nesogobius</i> sp		1				

Species	Site					
	411	412	413	414	415	416
<i>Acanthaluteres vittiger</i>		3			1	14
<i>Meuschenia flavolineata</i>					4	
<i>Meuschenia freycineti</i>			1		2	1
<i>Meuschenia hippocrepis</i>	1	1			1	9
<i>Aracana ornata</i>		1				
<i>Tetractenos glaber</i>				1		
<i>Diodon nichthemerus</i>	1	2	1		1	
Small schooling fish		317				

6.0 Introduced Species

Introduced marine species pose a significant threat to the integrity of subtidal reef habitats and communities in Port Phillip Bay. Two introduced species, *Sabella spallanzanii* and *Asterias amurensis* were recorded from sites in the north of Port Phillip Bay during this survey (Figure 6.1). Both of these species are listed as a noxious marine species under the *Fisheries Act 1995* and have been identified as causing threats to native biota under the *Flora and Fauna Guarantee Act 1998*.

The European fanworm *Sabella spallanzanii* is a tube building polychaete worm that inhabits subtidal sediment and hard substratum habitats in Port Phillip Bay. *Sabella* is a native of the Mediterranean and the Atlantic coast of Europe where it is an epifaunal species inhabiting depths to 30 m. The species was first positively identified in the bay during trawl surveys in Corio Bay in 1990 and 1992 (Carey and Watson 1992; Parry *et al.* 1996).

Sabella spallanzanii was found at all monitoring sites in the north of the bay except Ricketts Point (Site 5). *Sabella spallanzanii* was most abundant at RAAF Base where there were 70 individuals per 200 m² (Figure 6.2). *Sabella* was recorded at Jawbone and Point Cooke Marine Sanctuaries but was not an important component of the invertebrate assemblage at these sites.

The northern Pacific seastar *Asterias amurensis* is native to the coasts of Japan and southeastern Russia (Ward and Andrew 1995). *Asterias amurensis* was first recorded in Port Phillip Bay in 1995. The population of *Asterias amurensis* expanded rapidly between 1997 to 2000 and this species is now an established component of the epibenthic fauna in Port Phillip Bay. During this survey, *Asterias amurensis* occurred in very low densities at Jawbone Marine Sanctuary, but was not recorded from other sites (Table 4.2).

Japanese kelp *Undaria pinnatifida* is an introduced species of large brown algae that is sometimes referred to as the “blackberries of the sea”. *Undaria pinnatifida* can cause substantial alterations to subtidal reef habitat structure and will often out compete native species. *Undaria pinnatifida* was not recorded during late summer, in March-April 2003. The species was unlikely to be detected during this time because the visible plants die off during summer and the alga generally exists only as a microscopic gametophyte stage during autumn and winter. However, *Undaria pinnatifida* is known to occur in the vicinity of the northern (Jawbone and Point Gellibrand) and northwestern (Point Cooke and RAAF Base) monitoring sites, sometimes in high abundance.



Figure 6.1. Introduced invertebrates in Port Phillip Bay: European fanworm *Sabella spallanzanii* (left) and *Asterias amurensis* (right).

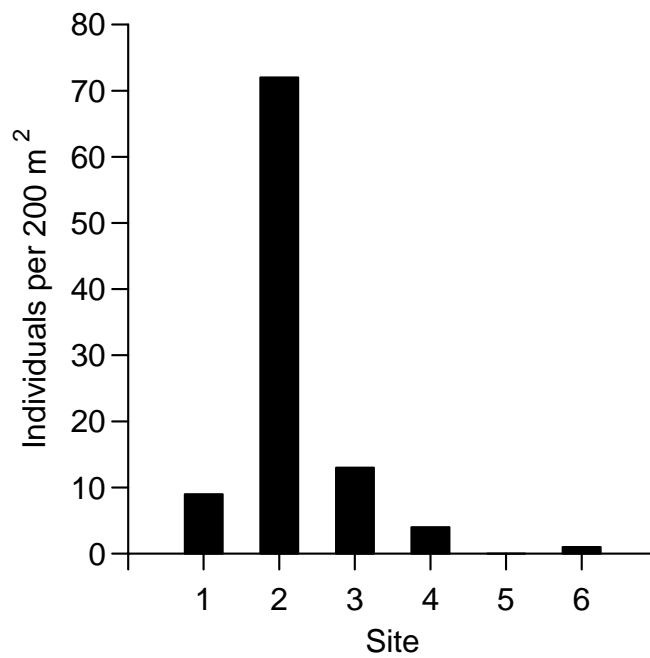


Figure 6.2 Abundance of the introduced European fanworm *Sabella spallanzanii* at monitoring sites in Port Phillip Bay.

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