CHAPTER 6

MARINE BIOGEOGRAPHY OF CENTRAL VICTORIA AND FLINDERS BIOREGIONS – A PRELIMINARY ANALYSIS OF REEF FLORA AND FAUNA

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6.1 Introduction

This chapter presents the results from the first quantitative classification of biological communities for macrophytes, invertebrates and fish associated with shallow water rocky reefs within the Central Victoria and Flinders bioregions. The study delineates biological communities, termed *Marine Ecological Communities* (MECs), derived from non-parametric and descriptive statistical analyses. MECs form a basis towards understanding and describing biodiversity representativeness of rocky reefs within a bioregional context.

6.1.1 Biogeography and Classification for Management

Biogeography is now recognised as an important framework for describing patterns of biodiversity. A critical requirement for the management of biodiversity assets is an understanding of the nature and distribution of species, communities and habitats as components of larger ecosystems (Interim Marine and Coastal Areaalisation of Australia Technical Group, 1998).

In Victoria there has been considerable progress in mapping and classifying components of marine ecosystems at various spatial scales. This work led to the development of *Marine Habitat Classes* (MHCs) which are based predominantly on qualitative descriptions of the physical structure and dominant biota that characterise benthic habitats such as subtidal reefs and seagrass beds (Chapter 1). During the development of MHCs, systematic and quantitative studies of Victorian biological communities on rocky reefs were conducted by Edmunds *et al* (Chapter 4). This work demonstrated that biological communities varied in structure across a longitudinal gradient (west to east) from Phillip Island to Wilsons Promontory, and that these communities could be described in detail using numerical classification techniques.

During 1999, four areas were surveyed within the Central Victoria and Flinders bioregions. The data was analysed to develop a standardised classification system for marine communities associated with shallow subtidal rocky reefs. The objectives of this study were to:

- develop a standardised classification system for marine biological communities associated with reefs using quantitative numerical analyses, termed *Marine Ecological Communities* (MECs); and
- examine the biogeographic relationships of reef MECs across the Central Victoria and Flinders bioregions.

This study employed standard, non-parametric multivariate analyses, as outlined by Clarke (1993) to provide a preliminary overview of biogeographic trends. The multivariate analyses were used to identify representative MECs and their distribution, including an assessment of biogeographic boundaries at the local (10s km) and areaal (100s km) scales.

6.1.2 A Brief Review of Victorian Marine Biogeography

Earlier studies on the distribution and occurrence of marine species identified three marine biogeographic provinces along the southern coast of Australia (Bennett and Pope 1952; Knox 1963; Edgar 1984; Womersley 1990). These provinces are: the western warm-temperate Flindersian Province; the eastern warm-temperate Peronian Province; and the southern cool-temperate Maugean Province

The coast of Victoria is situated at the confluence of these provinces, the biological communities having an interesting mixture of typically western, eastern and southern species (Figure 6.1a). Typical western (Flindersian) species on Victorian reefs include the algae: *Caulerpa brownii*, *Zonaria turneriana*, *Seirococcus axillaris*, *Carpoglossum confluens*, *Cystophora monilifera*, *Sargassum decipiens*, *Sargassum varians*, *Sonderopelta coriacea* and *Melanthalia obtusata* (Bennett and Pope 1952; Womersley 1984, 1987; Edgar 1984, 1997). Animals include the sea urchins *Holopneustes porossisimus* and *Holopneustes inflatus*, the abalone *Haliotis laevigata* and *Haliotis scalaris*, and the fish *Meuschenia hippocrepis*, *Meuschenia flavolineata* and *Parma victoriae* (Bennett and Pope 1952; Edgar 1984, 1997).

Typical eastern (Peronian) species include the sea urchins *Centrostephanus rodgersii* and *Holopneustes purpurascens*, the sea squirt *Pyura stolonifera* and the fishes *Trachinops taeniolatus*, *Scorpis lineolatus*, *Girella elevata*, *Parma microlepis* and *Atypichthys strigatus* (Bennett and Pope 1952; Edgar 1984, 1997).

Prominent southern (Maugean) species include the string kelp *Macrocystis angustifolia*, bull kelp *Durvillaea potatorum*, the algae *Splachnidium rugosum*, *Zonaria angustata* and *Cystophora torulosa*. Animals include the sea stars *Patiriella brevispina*, *Nectria ocellata* and *Fromia polypora*, as well as the fish *Trachinops caudimaculatus* and *Aplodactylus arctidens* (Bennett and Pope 1952; Womersley 1987, 1990; Edgar 1984, 1997).

In addition to these provincial influences, Victorian communities are also composed of species distributed throughout southern Australia. These species include the common sea urchin *Heliocidaris erythrogramma*, eleven armed sea star *Coscinasterias muricata*, the common kelp *Ecklonia radiata*, many species of the *Sargassum* and *Cystophora* genera, *Pterocladia capillacea*, *Phacelocarpus peperocarpus* and *Haliptilon roseum* (Bennett and Pope 1952; Womersley 1987; Edgar 1997).

There is considerable overlap of the provincial influences, particularly in the area of central Victoria (Figure 6.1a). The Flindersian components are particularly dominant west of Cape Otway, but extend as far east as Cape Liptrap and Waratah Bay (just west of Wilsons Promontory). The Peronian components are dominant east of Wilsons Promontory, but extend as far west as Cape Otway. The Maugean components are prevalent in the central and western areas of Victoria, west of Wilsons Promontory, but are also present in eastern Victoria (see reviews by Bennett and Pope 1952; Knox 1963; Edgar 1984; Womersley 1990).

A limitation of early biogeographic studies was their reliance on qualitative assessments of species distributions and differences in communities between provinces (except for Edgar 1984). However, the composition of species distributions was recently assessed semi-quantitatively using presence-absence data by O'Hara (Chapter 3). This study used museum records for echinoderm and crustacean species distributions within 62 spatial units between Western Australia and northern New South Wales. The results of this study were consistent with previous biogeographical classifications: Perth to South Australian Gulfs (Flindersian influence); South Australian Gulfs to central Victoria and Tasmania (Flindersian and Maugean influence); and Wilsons Promontory to Sydney (Peronian influence). Importantly, a high turnover of species was identified in the central Victorian area, this being consistent with a biogeographic boundary between the Peronian and Flindersian/Maugean provinces (Chapter 3).

More recently, the Victorian marine environment has been classified into five bioregions as part of the Interim Marine and Coastal Areaalisation for Australia, commonly referred to as "IMCRA" (Interim Marine and Coastal Areaalisation Technical Group 1998) (Figure 6.1b). This biogeographic areaalisation was largely based on physical variables to act as surrogates of biological variability. Physical variables included bathymetry, coastal geomorphology, sediments, currents, tides, water chemistry and water temperature (Victorian Institute of Marine Science *et al* 1994; Hamilton 1994). The resulting IMCRA bioregions derived for Victoria (Figure 6.1b) were: Otway (west of Cape Otway to South Australia); Central Victoria (Cape Otway to Cape Liptrap); Victorian Embayments (Port Phillip Bay, Westernport, Corner Inlet, Gippsland Lakes); Flinders (Wilsons Promontory and eastern Bass Strait Islands); and Twofold Shelf (east of Wilsons Promontory to New South Wales).

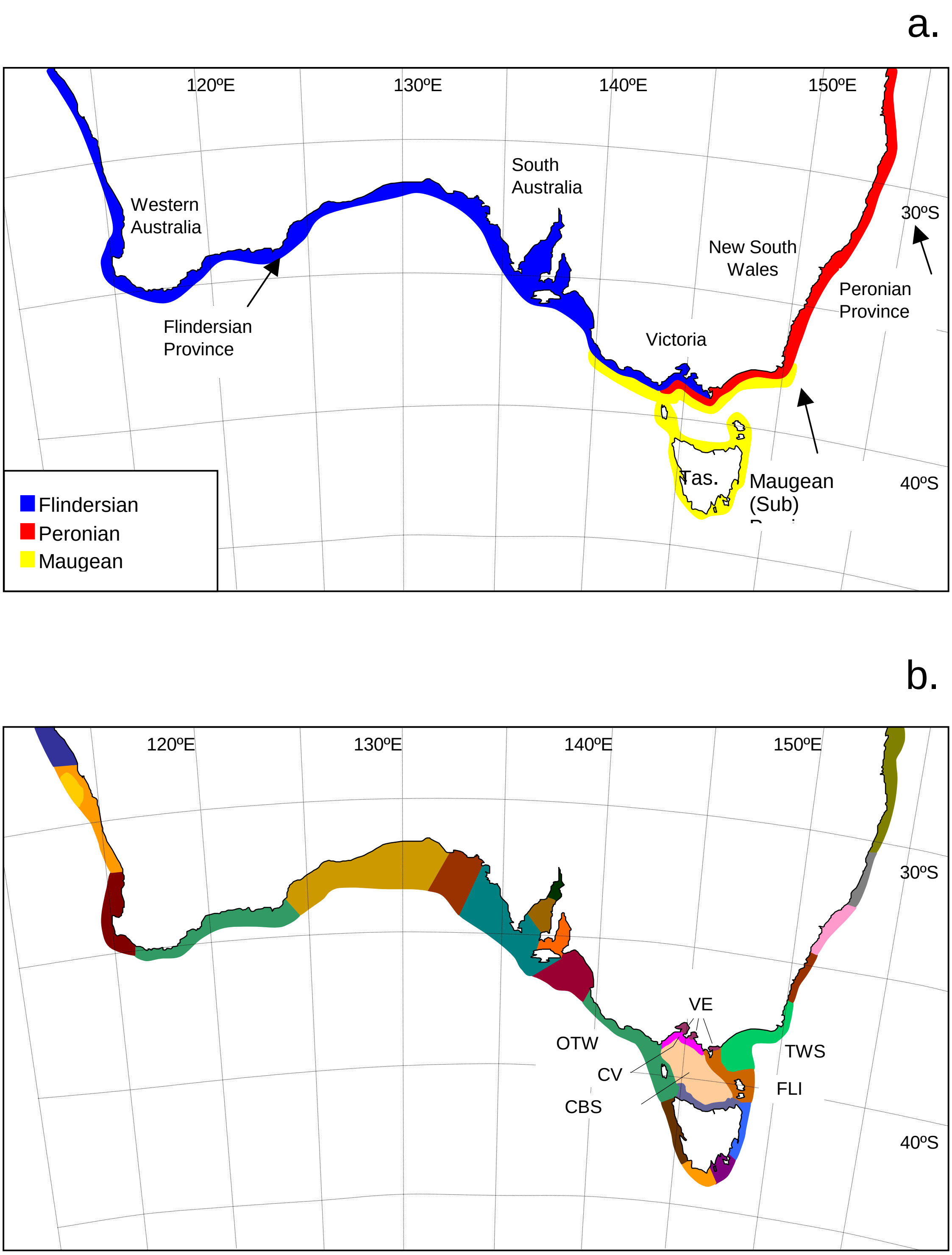


Figure 6.1 Marine biogeography of southern Australia, showing: (a) biogeographical provinces (after Bennett and Pope 1953); and (b) Interim Marine and Coastal Areaalisation for Australia (Interim Marine and Coastal Areaalisation for Australia Technical Group 1998). Only IMCRA bioregions within Victoria have been labelled: OTW = Otway; CV = Central Victoria; CBS = Central Bass Strait; VE = Victorian Embayments; TWS = Twofold Shelf; FLI = Flinders.

6.2 Methods

6.2.1 Survey Methodology

Between July and December 1999, reef flora and fauna were surveyed at four areas in the Central Victoria and Flinders bioregions. For the Central Victoria bioarea, surveys were conducted at Bunurong, Port Phillip Heads, Phillip Island areas; for the Flinders bioarea, surveys were conducted in the Wilsons Promontory area (Table 6.1; Figure 6.2). The visual census methods of Edgar-Barrett (Edgar and Barrett 1997, 1999; Edgar *et al* 1997) were used as they are non-destructive and provide quantitative data on a large number of species, and the structure of the reef communities.

The target survey depth was along the 5 m (± 1 m) depth contour, to minimise depth variability between sites surveyed in the four areas. The depth of 5 m is considered logistically optimal for monitoring because diving times are not limited by decompression schedules. However, sampling at many sites had to be deeper or shallower, depending on the available habitat and exposure to wave action (with sites ranging between 2 and 10 m deep).

Each site was located using differential GPS and marked with a buoy, or the boat anchor. One 'fixed' 200 m transect was established for each site. Transects were constructed by running a 100 m numbered and weighted transect line along an appropriate depth contour either side of a central marker. The resulting 200 m of line was divided into four contiguous 50 m transects (T1 to T4). The orientation of transects was the same for each survey, with T1 generally toward the north or east (ie anticlockwise along the open coast).

The depth, horizontal visibility, sea state and cloud cover was also recorded for each site. Horizontal visibility was gauged by the distance along the transect line to detect a fish with a length of 100 mm. For each transect, four different census methods were used to obtain adequate descriptive information on reef communities. These involved the census of:

- the abundance and size structure of large fishes;
- the abundance of cryptic fishes and larger benthic invertebrates;
- the percent cover of macrophytes; and
- the density of string-kelp *Macrocystis* plants.

The densities of mobile fishes and cephalopods were estimated by a diver swimming up one side of the 50 m transect, and then back along the other. The diver records the number, estimated size-class and sex (if possible) of fish, within 5 m of each side of the line. The sex and size information was not used in this analysis. A total of four 10 x 50 m transects were sampled for mobile fish at each site.

Benthic macroinvertebrates (eg non-sessile molluscs, echinoderms and crustaceans) were counted along the transect lines used for the fish survey. The census method does not include cryptic species or attempt to look under rocks. A diver counted all visible animals within 1 m of one side of the line (ie a total of four 1 x 50 m transects). A pole carried by the diver was used to standardise the 1 m distance.

The area covered by macrophyte species was quantified by placing a 0.25 m^2 quadrat at 10 m intervals along the transect line and determining the percent cover of the all plant species. The quadrat was divided into a grid of 7 x 7 perpendicular wires, giving 50 points (including one corner). Cover was estimated by counting the number of times each species occurs directly under the 50 positions on the quadrat (1.25 m^2 for each of the 50 m sections of transect line). The density of encrusting corallines and the string kelp *Macrocystis angustifolia* was also measured, but the data were not used for this analysis.

Area	Site	Site Name	Depth (m)	Latitude	Longitude
Port Phillip Heads	2801	Point Franklin	2	38° 19.128	144° 42.955
	2804	South Channel Fort	2	38° 18.505	144° 47.982
	2812	Annulus (Popes Eye)	5	38° 16.692	144° 41.777
	2802	Nepean Offshore	2	38° 18.215	144° 39.441
	2803	Nepean Inner West	2	38° 18.337	144° 39.271
	2808	Nepean Inner East	2	38° 18.345	144° 39.458
	2805	Shortland Bluff	5	38° 16.607	144° 39.250
	2806	Victory Shoal	5	38° 16.900	144° 37.424
	2807	Merlan Inner	5	38° 17.330	144° 37.120
	2810	Merlan Outer	5	38° 17.497	144° 37.275
	2809	Lonsdale Kelp Outer	7	38° 17.272	144° 37.698
	2811	Lonsdale Kelp Inner	7	38° 17.212	144° 37.570
	2813	Lonsdale Point	7	38° 17.890	144° 36.700
	2814	Lonsdale Back Beach	5	38° 17.502	144° 35.250
	2815	Lonsdale Pt SW	7	38° 17.734	144° 35.816
Phillip Island	2901	Nobbies North	6	38° 31.143	145° 06.515
	2902	Pyramid Rock West	6	38° 31.622	145° 12.639
	2903	Pyramid Rock North	4	38° 31.817	145° 13.287
	2904	Cape Woolamai West	6	38° 33.617	145° 20.370
	2905	Cape Woolamai Mid	6	38° 34.115	145° 21.437
	2906	Cape Woolamai East	4	38° 33.994	145° 21.622
Bunurong	3001	Cape Patterson	4	38° 40.911	145° 36.499
	3002	Cape Patterson Boat Ramp	6	38° 40.732	145° 36.938
	3003	Oaks East	6	38° 40.707	145° 38.740
	3004	Twin Reefs	6	38° 40.827	145° 39.172
	3005	Shack Bay West	5	38° 40.691	145° 39.442
	3006	Shack Bay Middle	6	38° 40.397	145° 39.796
	3007	The Caves	6	38° 39.948	145° 40.907
	3008	Petrel Rock East	5	38° 39.389	145° 41.629
Wilsons Promontory	3101	North Shellback Is	10	38° 58.065	146° 13.642
	3102	North Tongue Pt	10	38° 59.571	146° 15.244
	3103	Northwest Norman Is	10	39° 08.382	146° 19.065
	3104	West Norman Is	10	39° 01.560	146° 14.428
	3105	Leonard Pt	10	39° 01.507	146° 16.954
	3106	Pillar Pt	10	39° 02.467	146° 18.202
	3107	South Norman Pt	10	39° 03.329	146° 19.157
	3108	Oberon Pt	10	39° 04.671	146° 19.402
	3109	East Glennie Is	10	39° 05.123	146° 14.001
	3110	West Glennie Is	10	39° 05.464	146° 13.853
	3111	North of Sea Eagle Bay	10	39° 06.232	146° 19.948
	3112	Sea Eagle Bay	10	39° 06.804	146° 20.509
	3113	North Anser Is	10	39° 08.361	146° 19.067
	3114	South Pt	10	39° 08.139	146° 22.161
	3115	Roaring Meg Bight	10	39° 07.892	146° 22.854
	3116	West of West Landing	10	39° 07.858	146° 24.384
	3117	East landing	10	39° 07.537	146° 25.353
	3118	Fenwick Pt	10	39° 06.876	146° 25.741
	3119	Waterloo Pt	10	39° 05.354	146° 26.364
	3120	Central Waterloo Bay	10	39° 03.802	146° 26.600
	3121	North Waterloo Bay	10	39° 03.943	146° 28.081
	3122	North Cape Wellington	10	39° 03.439	146° 28.716
	3123	Bareback Bay	10	39° 03.220	146° 28.444
	3124	South Refuge	10	39° 02.831	146° 28.614
	3125	North Refuge	10	39° 02.257	146° 28.148
	3126	Horn Bay	10	39° 01.812	146° 27.942
	3127	North Horn Pt	10	39° 01.585	146° 28.202
	3128	The Hat	10	38° 59.923	146° 26.764

Table 6.1 Sites used for the biogeographical analysis and classification of MECs.

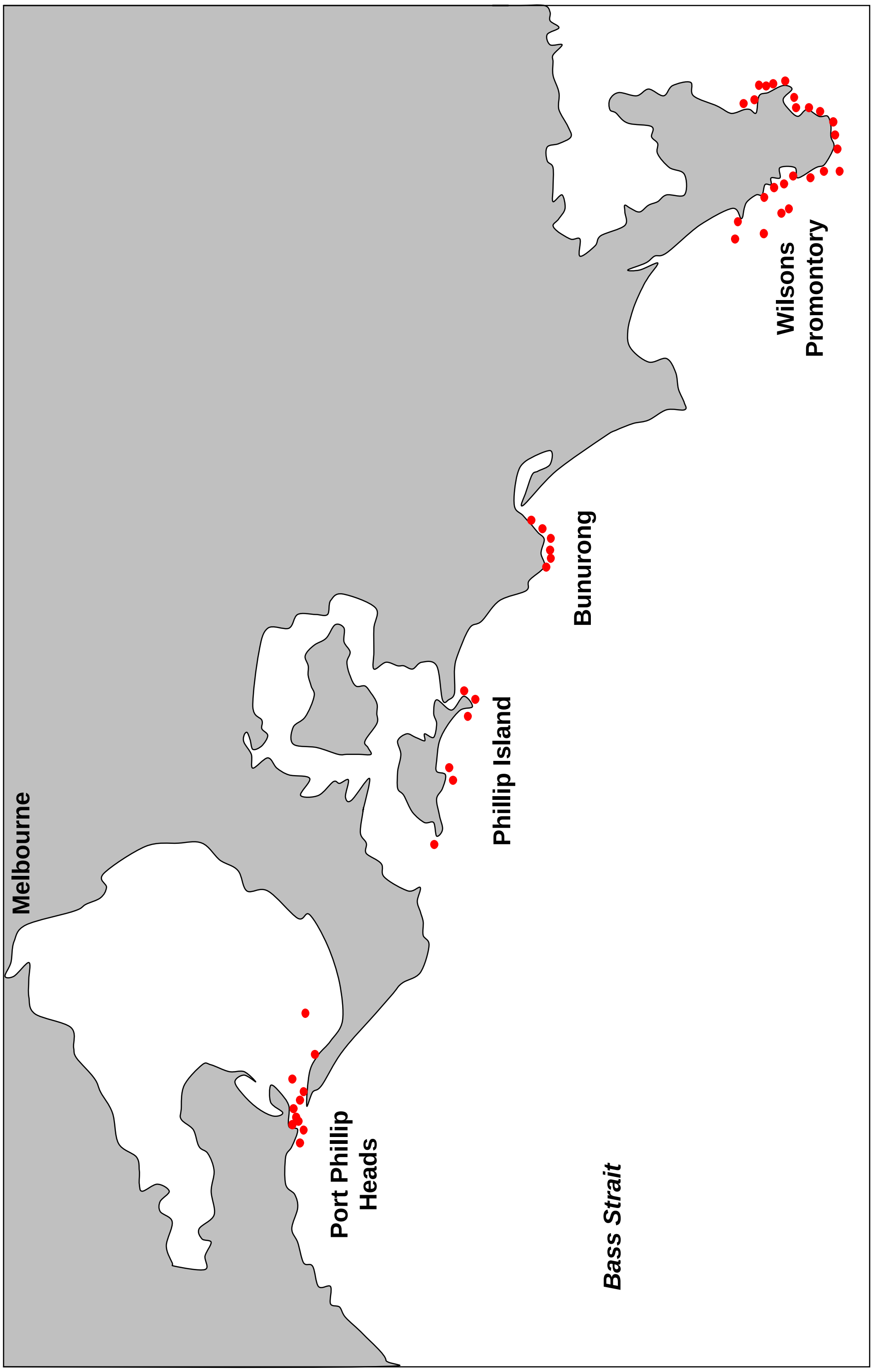


Figure 6.2 General location of sites surveyed for each of the four areas.

6.2.2 Statistical Analysis

Differences in community structures between samples and sites were compared using non-parametric multivariate methods described by Clarke (1993).

The Bray-Curtis dissimilarity coefficient index was used to compare the community structure between pairs of sites. All community data was square-root transformed prior to calculation of the coefficient index. This index uses the difference in abundance of each species between two sites to give a single value of difference in community structure, expressed as a percentage (Faith *et al* 1987; Clarke 1993). The Bray-Curtis dissimilarity index was calculated for all combinations of sample/site pairs, resulting in a matrix of pair-wise comparisons. The dissimilarity index is also termed a distance matrix, as it effectively represents differences between sites in hyper-dimensional space.

Non-metric multidimensional scaling (MDS) was then used to depict the differences between sites expressed in the dissimilarity matrix. This ordination method finds the representation in fewer dimensions that best depicts the actual patterns in the hyper-dimensional data (*ie.* reduces the number of dimensions while depicting the salient relationships between the sites). The MDS results were depicted graphically to show differences between the samples or sites, with the distance between points on the plot 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.

Group analysis was used to better identify groups of sites with similar community structures. The same Bray-Curtis dissimilarity matrix was ranked and agglomeratively grouped (UPGMA, following the methods of Sneath and Sokal 1973 and Clarke 1993). This method links pairs of sites and groups at increasing levels of dissimilarity, to produce a dendrogram (tree diagram).

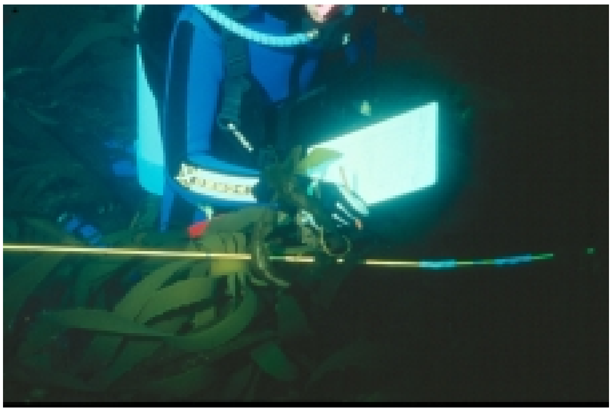
The species responsible for major groupings identified from the group analysis were determined using similarity/dissimilarity percent breakdowns (SIMPER, Clarke 1993). The discrimination of each species was indicated by the average species contribution to between group dissimilarity ($\overline{\delta}_i$). The typically of species within a group was indexed by the average similarity within a group, $\overline{S}_i$, and the mean-to-SD ratio, $\overline{S}_i/\mathrm{SD}(S_i)$. A species typifies a group if it is found at a consistent abundance throughout the samples, so the standard deviation is low and mean-to-SD ratio is high (Clarke 1993).

6.2.3 Species Diversity

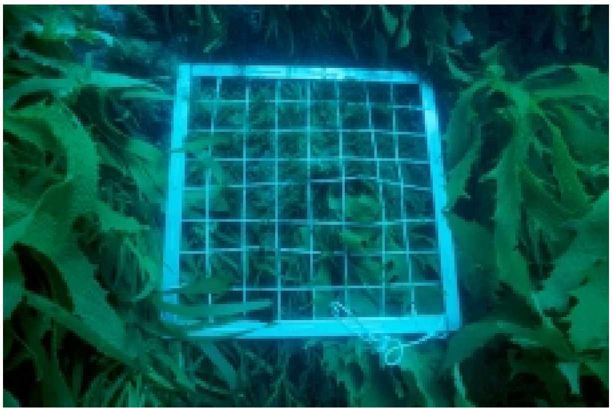
Species diversity involves the consideration of two components: species richness and evenness. Species richness is the number of species present in the community while evenness is the degree of similarity of abundances between species. If all species in a community have similar abundances, then the community 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 (*ie.* heterogeneity among species) was described using the reciprocal of Simpson's index ($1/D_{\mathrm{Simpson}}$ = Hill's N_2). This index provides more weighting for common species, as opposed to the weighting of rarer species such as by the Shannon-Weiner Index (Krebs 1999). The weighting of common species was considered more appropriate for this study, the sampling being directed more towards the enumeration of common species rather than rarer ones. Camargo's index of evenness (*E′*) was used to describe the equitability of abundances between species. This index is independent of species richness and relatively unaffected by the rare species in the sample (Krebs 1999).

Biologist-diver with transect reel, Lonsdale Back Beach.



Divers record species counts on underwater paper attached to a slate.



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

6.3 Introduction to Victorian Reef Flora and Fauna

6.3.1 Community Components

Victorian shallow reefs are typically covered by large brown algal species such as kelps. These larger plants often form a canopy 1 - 3 m above the reef surface. Smaller green, brown and red algal species are usually present as an understorey. Filter feeding sessile invertebrates are also found beneath the canopy, with the remaining reef surface covered by pink encrusting coralline algae. Living amongst the algae and within cracks and crevices of the rock surface are large mobile invertebrates, such as sea urchins, sea stars, abalone and lobsters. The algal thalli are inhabited by small cryptic species such as amphipods, molluscs and brittle stars, which also live in crevices in the rock surface and between sessile invertebrates. Various fish species inhabit the water column above the algal canopy, within the canopy or in caves and crevices. Other biological components on Victorian reefs include algal turfs and seagrass beds.

The species composition of these biological components, and hence community structure, differs substantially according to an array of environmental and biological influences. Such influences include depth, wave exposure, substratum morphology and geographic locality (Edmunds *et al* 1999). This study examined the spatial variation in species forming the macrophyte (plant), large invertebrate and fish communities (presented in Sections 6.4, 6.5 and 6.6).

Descriptions and of common species found within these communities are given below.

6.3.2 Macrophytes

The canopy of macrophyte communities in Victoria are often dominated (in terms of biomass) by the large brown species *Ecklonia radiata*, *Macrocystis angustifolia*, *Durvillaea potatorum*, *Phyllospora comosa* and *Seirococcus axillaris*. Smaller brown species, particularly *Acrocarpia paniculata*, *Cystophora* spp and *Sargassum* spp, are also abundant, particularly where the larger species are absent.

Ecklonia radiata (common kelp) has a much branched and intertwined (root-like) holdfast with a long stipe to a large flat frond with numerous blades along the side. This plant is up to 2 m long, and can form dense stands with an open space beneath the canopy. A diverse understorey community of small red, green and brown algal species is often present beneath the canopy.

Macrocystis angustifolia (string kelp) is a close relative of the giant kelp, *M. pyrifera*. *Macrocystis angustifolia* has a large root-like holdfast with rope-like stipes connecting fronds with gas-filled vesicles (floats). The plants often extend from depths of 10 m to the surface to form a floating canopy. Stands of *M. angustifolia* can be quite dense, providing substantial vertical habitat and reducing light conditions on the reef below. However, *M. angustifolia* does not form stands over large areas, as with *Ecklonia* or *Phyllospora*, tending to occur in isolated patches (although there is evidence that it has done in the past).

Durvillaea potatorum (bull kelp) has a large conical holdfast, a robust smooth stipe and a large, flat leathery frond. The thallus is very smooth and extremely heavy. This species only inhabits exposed and turbulent waters – usually in the intertidal and shallow subtidal zone. This species occurs in deeper waters on more exposed coasts, and can grow up to 8 m long (but is usually 1-3 m long). Few organisms (apart from encrusting species) live beneath the canopy because of scouring by the heavy fronds).

Phyllospora comosa (cray weed) has numerous strap-like fronds and spindle-shaped floats arising from a flat central axis, attached to a small conical holdfast. This species commonly forms a dense canopy over large areas of reef. It can be quite open beneath the canopy, however erect sessile organisms are not usually prolific in the understorey because of scouring by the *Phyllospora* fronds. The canopy is usually 1 - 2 m above the reef, with individual plants up to 3 m long.

Seirococcus axillaris is similar in form to *Phyllospora*, having large flattened strap-like fronds. However, this species is smaller (0.5 - 2 m long) and does not form large monospecific stands.

Cystophora species are generally intermediate in size (0.5 - 2 m long) and, although quite variable in form, tend to be more finely branched than the larger macroalgae. Common species in Victoria include *C. moniliformis*, *C. retorta*, *C. retroflexa*, *C. platylobium*, *C. monilifera* and *C. subfarcinata*.

Acrocarpia paniculata is a finely branched, but robust species up to 1 m long.

Sargassum species are intermediate to small in size (0.2 - 1 m), occur in a variety of forms and generally finely branched. For many species, the reproductive fronds are produced seasonally, with senescence back to vegetative lower fronds during the colder months.

Amphibolis antarctica is a seagrass abundant on Victorian reefs. *Amphibolis* has woody, branched stems arising from root-like rhizomes, and groups of small leaves at the end of the stems. This species can occupy reefs among algae or form monospecific stands, often trapping sand on the reef surface.

Smaller algal species are usually present as either an understorey beneath the canopy of larger brown species, or in the form of a turfing mat. These species include pink corallines, fleshy thallose reds, small browns and green species. Typical erect coralline species include *Haliptilon roseum*, *Amphiroa anceps*, *Cheilosporum* sp and *Metagoniolithon* sp. Typical thallose red species include *Phacelocarpus peperocarpus*, *Ballia callitricha*, *Melanthalia obtusata*, *Pterocladia lucida*, *Areschougia* sp and *Plocamium* species. Common small brown species include *Halopteris* spp and *Carpomitra costata* while common green algae include *Caulerpa* and *Codium* species.

6.3.3 Mobile Invertebrates

The southern rock lobster *Jasus edwardsii* is one of the largest invertebrates found on Victorian rocky reefs, growing to a maximum carapace length of 230 mm. The body is orange-red in colour and consists of a rigid carapace with long antennae, eyes and walking legs and a segmented, recurvable abdomen (tail). *Jasus edwardsii* shelter under rocky ledges during the day and emerge at night to feed on sea urchins, molluscs and crabs. Anecdotal evidence suggests this species extremely common on inshore rocky reefs prior to modern harvesting pressures.

The red bait crab *Plagusia chabrus* is a large (up to 70mm carapace width), reddish purple coloured crab, distinctively flattened (dorso-ventrally). This crab also shelters in rocky crevices and feeds on small molluscs, other crustaceans and sponges.

Abalone (ear shells) are the most common large gastropods on Victorian reefs, with the black lip *Haliotis rubra* being the most abundant. The green lip *H. laevigata* tends to occur on reefs near sandy patches while the tiger-lipped *H. scalaris* is smaller and less common. Abalone are grazing herbivores, but will also feed on drift algae trapped beneath the foot. They tend to occur in aggregations, particularly within cracks and crevices in the reef. Other prominent gastropods include the herbivorous periwinkle *Turbo undulatus*, and the predatory dog whelk *Dicathais orbita*.

The common feather star (or crinoid) *Cenolia trichoptera* is a large echinoderm with ten arms, each arm having many sticky pinnae. *Cenolia* inhabits crevices, but protrudes its arms to filter feed on plankton and particulate matter. The common sea urchin *Heliocidaris erythrogramma* also occupies crevices and grazes small to microscopic algae on the reef. Both *Cenolia* and *Heliocidaris* can be present in high abundances on the reef

A large variety of sea stars are present on the reef surface, including *Pentagonaster dubeni*, *Nectria ocellata*, green tipped star *Nectria macrobrachia*, velvet star *Petricia vernicina*, many-dotted star *Fromia polypora*, biscuit star *Tosia australis* and mosaic star *Plectaster decanus*.

6.3.4 Fishes

The fish communities in Victoria have a strong component of wrasse (Labridae), morwong (Cheilodactylidae) and leatherjacket (Monacanthidae) species. The wrasses include blue throated wrasse *Notolabrus tetricus*, purple wrasse *Notolabrus fucicola*, and senator wrasse *Pictilabrus laticlavius*. These species are roaming predatory species, feeding on small molluscs and crustaceans.

Common morwong species include the magpie morwong *Cheilodactylus nigripes*, banded morwong *Cheilodactylus spectabilis* and dusky morwong *Dactylophora nigricans*. The *Cheilodactylus* species use long rays on its pectoral fins to disturb prey from algal and invertebrate habitats and are usually associated with cracks and caverns in the reef (where they will flee to if disturbed). *Dactylophora* is an herbivore. Both *C. spectabilis* and *D. nigricans* can grow to over a metre long (where fishing pressures are minimal).

The leatherjackets are generally omnivorous or carnivorous picker-type fishes, roaming within or beneath the algal canopy. These fishes, as their name suggests have a leathery skin, as well being laterally flattened, and generally swim slowly by undulations of their dorsal and anal fins. Common species include the six-spined leatherjacket *Meuschenia freycinetti*, horseshoe leatherjacket *M. hippocrepis*, yellow-tailed leatherjacket *M. flavolineata* and toothbrush leatherjacket *Acanthaluteres vittiger*.

Other common species include the spiny globefish *Diodon nichthemerus*, old wife *Enoplosus armatus*, sea sweep *Scorpis aequipinnis*, herring cale *Odax cyanomelas*, scalyfin *Parma victoriae* and zebra fish *Girella zebra*. Both *Odax cyanomelas* and *Girella zebra* consume algae and small invertebrates. The grazing effects of *O. cyanomelas* is known to modify the habitat, particularly in creating gaps within the algal canopy. *Parma victoriae* is also a habitat modifying species as it maintains algal turfing areas for breeding.

6.4 Macrophyte Communities

6.4.1 Community Groups

The multivariate analysis identified three main groups of macrophyte communities (Figure 6.3 and 6.4) within the geographic range sampled. These consisted of predominantly from: inside Port Heads (group ABCD, Figure 6.4); sites at Phillip Island and Bunurong (Group EFGHI, Figure 6.4); and sites at Lonsdale Bay (Port Phillip Heads) and Wilsons Promontory (group JKLMNO, Figure 6.4).

The Port Phillip Heads group (ABCD, Figure 6.4; lower left of MDS plot in Figure 6.3) consisted of sites well within the Heads (Point Franklin, South Channel Fort, Popes Eye and Shortland Bluff), as well as Victory Shoal (within Lonsdale Bay) and Nepean Bay (inside the eastern side of the Heads). This group was differentiated from other communities in having relatively low abundances of the brown algae *Phyllospora comosa* and *Acrocarpia paniculata* and the red understorey species *Phacelocarpus peperocarpus.* This group of sites had relatively high abundances of *Ecklonia radiata*, *Cladophora rugulosa* and *Cystophora moniliformis* (Table 6.2). Within this group, four community types were apparent, each represented by only 1-3 sites. The Nepean Bay community (Group D; Figure 6.4) was quite distinctive in having a high cover of the seagrass *Amphibolis antarctica*.

The Phillip Island and Bunurong group (EFGHI, Figure 6.4; upper left of MDS plot in Figure 6.3) encompassed all sites at Phillip Island except the highly exposed western Cape Woolamai (Site 2904); all sites surveyed at Bunurong and sites at Lonsdale Point and Lonsdale Back Beach (Sites 2813 and 2814) outside Port Phillip Heads. This group was differentiated from other groups in having intermediate abundances of *Phyllospora comosa*, relatively low abundances of *Ecklonia radiata* and high abundances of *Acrocarpia paniculata*, *Cystophora retorta*, *Seirococcus axillaris* and *Haliptilon roseum* (Table 6.2).

Five community types were apparent within the Phillip Island-Bunurong group. These communities were clearly separated according to the sampling location along the coast of Point Lonsdale at Port Phillip Heads, Phillip Island and Bunurong. These three locations had similar levels of dissimilarity to one another (40-50%, Figure 6.4). Differences were also apparent between east Pyramid Rock (Site 2903) and other sites at Phillip Island (Groups E and F), as well as between southern Bunurong (Group H) and eastern Bunurong (Group I; Figure 6.4). The Phillip Island communities were differentiated from the Bunurong and Lonsdale Point communities in having higher densities of *Phyllospora comosa*, *Amphiroa anceps*, *Cystophora moniliformis* and *Caulerpa flexilis*. The Bunurong and Lonsdale communities had higher abundances of *Cystophora retorta*, *Cystophora platylobium*, *Seirococcus axillaris, Acrocarpia paniculata* and *Amphibolis antarctica*.

The Wilsons Promontory group (JKLMNO, Figure 6.3; mid-right of MDS plot Figure 6.3) included all sites surveyed at Wilsons Promontory, Lonsdale Bay (near the entrance to Port Phillip Bay) and Cape Woolamai on Phillip Island. This group was differentiated from other locations in having high abundances of *Phyllospora comosa*, *Ecklonia radiata* and *Phacelocarpus peperocarpus*, but lower abundances of *Acrocarpia paniculata*, *Cystophora retorta*, *Cystophora moniliformis* and *Seirococcus axillaris* (Table 6.2).

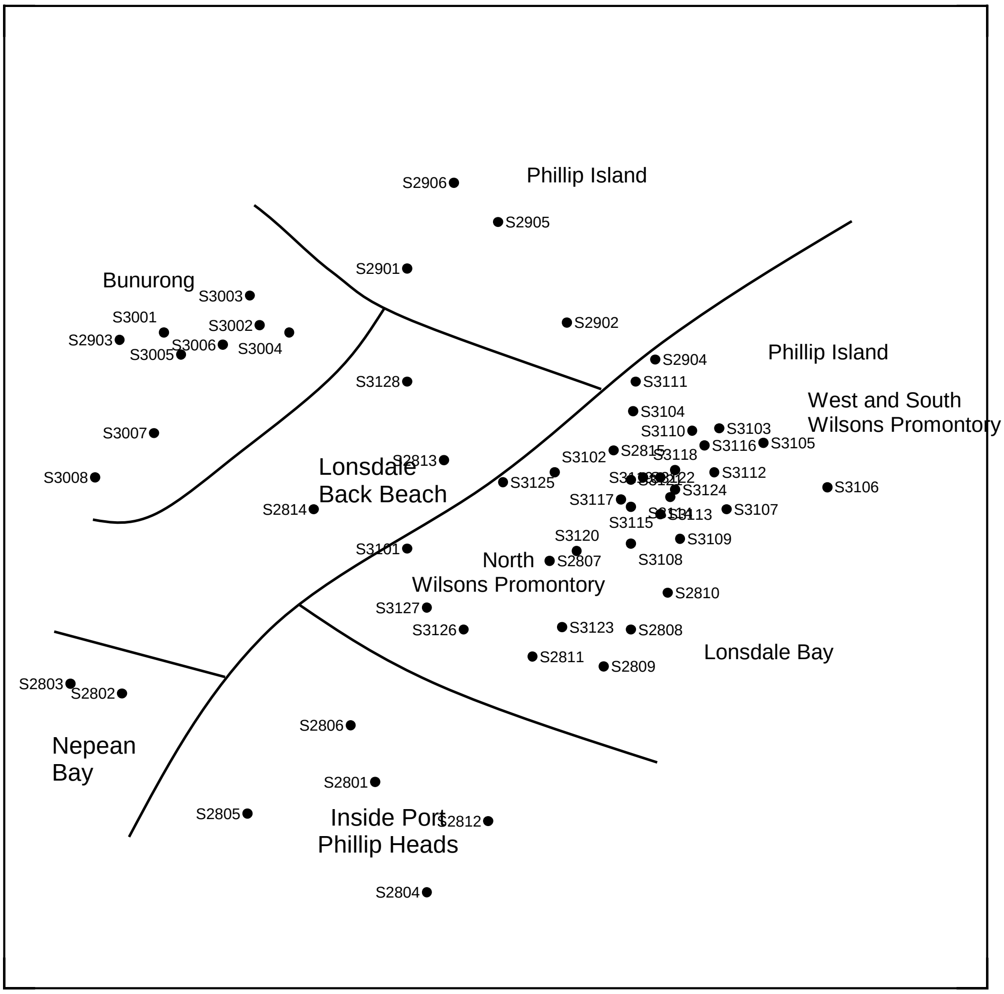


Figure 6.3 Two dimensional MDS ordination for macrophyte community structures in Central Victoria and Flinders bioregions. Site names locations are given in Table 6.1. Kruskal stress = 0.18.

Six separate groups (corresponding to six communities) were identified from the Wilsons Promontory group. These being reasonably well defined according to location: Lonsdale Bay (M); northeast Wilsons Promontory (groups K and L); west to southeast Wilsons Promontory (group NO); and far northeast Wilsons Promontory (group J, The Hat, Site 3128). The north Wilsons Promontory communities (KL) differed from other Wilsons Promontory communities in having lower abundances of *Phyllospora comosa*, but higher abundances of *Seirococcus axillaris*, *Sargassum sonderi*, *Ecklonia radiata* and red algal understorey species (Table 6.2). The Lonsdale Bay community (M) differed from the southern Wilsons Promontory community in having higher abundances of *Ecklonia radiata*, *Cladophora rugulosa*, *Pterocladia lucida*, *Areschougia* sp and lower abundances of *Phacelocarpus peperocarpus* and *Melanthalia obtusata* (Table 6.2). However, the community groups within the Wilsons Promontory group were not distinctly separated, the MDS plot suggesting a gradient of community structures from west and south Wilsons Promontory (group NO) to north Wilsons Promontory (groups J, K and L) and Lonsdale Bay (group M; Figure 6.3).

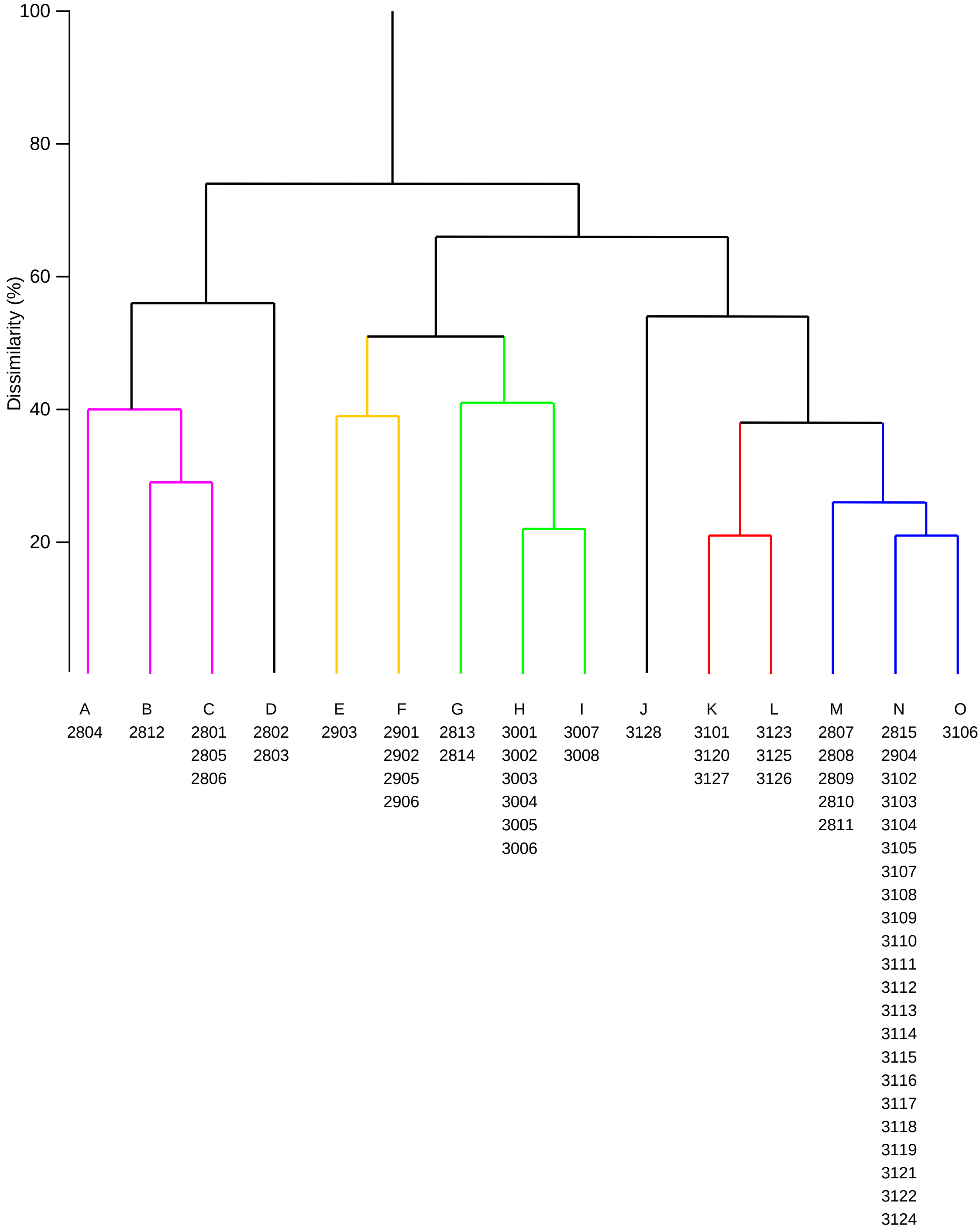


Figure 6.4 Dendrogram of macrophyte community structure. Linkages below 20% dissimilarity are not shown. Site locations are given in Table 6.1.

Comparison/species	$\overline{y}_{iA}$	$\overline{y}_{iB}$	$\overline{\delta}_i$	SD($\overline{\delta}_i$)	$\overline{\delta}_i$/SD	$\overline{\delta}_i$%
Inside Port Phillip Heads (ABCD) v Other Areas						
Phyllospora comosa	0.38	5.18	7.23	4.95	1.46	9.50
Ecklonia radiata	4.55	3.38	4.34	3.05	1.43	15.21
Cladophora rugulosa	3.21	0.16	4.19	2.20	1.91	20.71
Amphibolis antarctica	2.64	0.44	3.49	3.16	1.10	25.30
Acrocarpia paniculata	0.00	1.84	2.37	2.43	0.97	28.41
Phacelocarpus peperocarpus	0.00	1.48	2.06	1.60	1.29	31.11
Cystophora moniliformis	1.51	0.90	1.91	1.61	1.19	33.63
Cystophora retorta	0.97	0.97	1.89	1.99	0.95	36.11
Sargassum spinuligerum	1.45	0.05	1.88	1.00	1.88	38.58
Haliptilon roseum	0.31	1.58	1.88	1.30	1.44	41.05
Seirococcus axillaris	0.62	1.42	1.87	1.76	1.06	43.51
Caulerpa flexilis	1.36	0.37	1.77	1.58	1.12	45.84
Other thallose red algae	2.27	1.56	1.77	1.19	1.49	48.16
Caulerpa brownii	1.29	0.37	1.64	1.45	1.13	50.32
Phillip Island and Bunurong (EFGHI) v Other Areas						
Phyllospora comosa	2.05	5.50	5.88	4.13	1.42	8.12
Ecklonia radiata	0.74	4.51	5.01	2.67	1.88	15.05
Acrocarpia paniculata	4.09	0.73	4.50	2.55	1.76	21.27
Cystophora retorta	3.14	0.19	3.82	2.55	1.50	26.55
Seirococcus axillaris	1.91	1.11	2.46	2.15	1.15	29.95
Haliptilon roseum	2.60	1.01	2.14	1.46	1.47	32.91
Cystophora moniliformis	1.97	0.63	2.13	1.75	1.22	35.85
Amphibolis antarctica	1.21	0.54	1.84	2.46	0.75	38.39
Cystophora platylobium	1.38	0.10	1.67	1.33	1.26	40.70
Phacelocarpus peperocarpus	0.93	1.43	1.62	1.24	1.31	42.94
Metagoniolithon sp	1.30	0.10	1.61	0.99	1.64	45.16
Other thallose red algae	1.49	1.70	1.46	1.07	1.36	47.18
Cystophora subfarcinata	1.12	0.12	1.41	1.31	1.07	49.12
Wilsons Promontory and Lonsdale Bay (JKLMNO) v Other Areas						
Phyllospora comosa	6.52	1.52	7.34	4.20	1.75	10.05
Ecklonia radiata	4.50	1.95	4.65	2.58	1.80	16.41
Acrocarpia paniculata	0.88	2.79	3.37	2.67	1.27	21.02
Cystophora retorta	0.04	2.45	3.12	2.60	1.20	25.29
Seirococcus axillaris	1.20	1.50	2.24	2.00	1.12	28.35
Amphibolis antarctica	0.12	1.66	2.24	2.86	0.78	31.40
Cystophora moniliformis	0.45	1.82	2.09	1.74	1.20	34.26
Phacelocarpus peperocarpus	1.71	0.63	1.95	1.41	1.38	36.92
Haliptilon roseum	1.15	1.87	1.82	1.35	1.35	39.42
Cladophora rugulosa	0.20	1.07	1.59	2.36	0.67	41.59
Other thallose red algae	1.59	1.74	1.56	1.17	1.34	43.73
Ballia callitricha	1.29	0.41	1.36	0.99	1.37	45.59
Sargassum fallax	0.45	1.08	1.35	1.09	1.23	47.44
Melanthalia obtusata	1.02	0.20	1.29	0.96	1.35	49.21
Plocamium angustum	1.38	0.74	1.28	0.91	1.41	50.95

Table 6.2 Macrophyte species with the highest contribution to differences between groups (SIMPER breakdowns). Statistics are: (y_{iA}) mean abundance (square-root transformed values) for group A; (y_{iB}) mean abundance for group B; ($\overline{\delta}_i$) the average species contribution to differences between sites; standard deviation SD; discrimination ratio; and ($\overline{\delta}_i$%) the cumulative percent discrimination.

Comparison/species	$\bar{y}_{iA}$	$\bar{y}_{iB}$	$\bar{\delta}_i$	SD(δ_i)	$\bar{\delta}_i$/SD	$\bar{\delta}_i$%
Phillip Island (EF) v Bunurong and Lonsdale Back Beach (GHI)						
Phyllospora comosa	5.13	0.51	5.65	3.15	1.79	8.83
Cystophora retorta	1.47	3.97	3.36	2.22	1.51	14.08
Seirococcus axillaris	0.20	2.77	3.13	2.33	1.35	18.98
Amphiroa anceps	2.52	0.25	2.68	1.82	1.47	23.17
Acrocarpia paniculata	3.97	4.15	2.44	1.67	1.46	26.99
Cystophora moniliformis	2.15	1.88	2.13	1.56	1.37	30.32
Amphibolis antarctica	0.00	1.81	2.11	2.37	0.89	33.62
Macrocystis angustifolia	1.63	0.55	1.95	1.85	1.05	36.67
Cystophora platylobium	0.59	1.78	1.64	1.15	1.43	39.24
Caulerpa flexilis	1.50	0.28	1.63	1.05	1.56	41.78
Carpoglossum confluens	0.00	1.42	1.61	1.03	1.56	44.30
Sargassum fallax	0.45	1.58	1.50	0.99	1.51	46.65
Areschougia spp	0.00	1.30	1.49	0.86	1.73	48.98
Cystophora subfarcinata	0.82	1.27	1.43	1.11	1.28	51.21
North Wilsons Promontory (KL) v Lonsdale Bay and Wilsons Promontory (MNO)						
Phyllospora comosa	2.83	7.55	6.19	2.76	2.25	10.88
Seirococcus axillaris	2.84	0.90	2.76	1.56	1.77	15.73
Sargassum sonderi	1.94	0.11	2.51	1.73	1.46	20.14
Ecklonia radiata	4.91	4.50	2.21	1.65	1.34	24.02
Other thallose red algae	2.24	1.43	1.71	1.24	1.38	27.02
Callophyllis rangiferinus	1.54	0.26	1.69	0.86	1.96	29.98
Acrocarpia paniculata	1.62	0.69	1.68	1.18	1.43	32.94
Plocamium angustum	2.35	1.17	1.64	1.10	1.48	35.81
Pterocladia lucida	1.47	0.80	1.58	1.18	1.33	38.58
Cystophora retroflexa	1.19	0.05	1.56	1.31	1.19	41.31
Sargassum decipiens	1.13	0.00	1.44	1.10	1.30	43.83
Phacelocarpus peperocarpus	1.74	1.68	1.41	0.84	1.69	46.32
Ballia callitricha	0.47	1.50	1.38	0.93	1.49	48.75
Haliptilon roseum	0.45	1.34	1.38	0.90	1.53	51.17
Lonsdale Bay (M) v South Wilsons Promontory (NO)						
Ecklonia radiata	5.29	4.33	2.73	2.24	1.22	5.47
Phacelocarpus peperocarpus	0.24	1.99	2.68	1.54	1.75	10.86
Other thallose red algae	2.40	1.22	2.61	1.34	1.95	16.11
Cladophora rugulosa	1.40	0.00	2.18	1.35	1.61	20.48
Phyllospora comosa	7.07	7.65	1.74	1.12	1.56	23.97
Plocamium angustum	0.30	1.35	1.64	0.90	1.82	27.27
Melanthalia obtusata	0.26	1.23	1.55	0.95	1.62	30.37
Seirococcus axillaris	0.62	0.96	1.52	1.35	1.12	33.43
Pterocladia lucida	0.90	0.78	1.45	1.20	1.20	36.33
Areschougia spp	0.94	0.00	1.36	0.89	1.53	39.07
Haliptilon roseum	1.41	1.32	1.24	0.90	1.38	41.55
Zonaria turneriana	1.06	0.51	1.22	0.62	1.97	44.00
Amphibolis antarctica	0.82	0.00	1.16	1.99	0.58	46.33
Sargassum fallax	0.74	0.13	1.11	1.03	1.07	48.55

Table 6.2 (continued). Macrophyte species with the highest contribution to differences between groups (SIMPER breakdowns). Statistics are: (y_{iA}) mean abundance (square-root transformed values) for group A; (y_{iB}) mean abundance for group B; ($\bar{\delta}_i$) the average species contribution to differences between sites; standard deviation SD; discrimination ratio; and ($\bar{\delta}_i$%) the cumulative percent discrimination.

6.4.2 Community Structures

The macrophyte communities at the surveyed sites were largely structured such that there was a canopy of larger brown species (0.5 - 3 m above the reef), an understorey of smaller thallose species (50 - 300 mm high) and a rock covering of encrusting coralline species. A turf of typically understorey species was usually present where there were breaks in the canopy cover. The predominant algal community types were typified by both canopy and understorey species. Delineation of communities corresponds to arrangement of alphabetic group codes outlined in Figure 6.4.

Both Lonsdale Bay (group M) and south Wilsons Promontory (group NO) were typified by a canopy dominated by *Phyllospora comosa*, with *Ecklonia radiata* also an abundant component. However, the understorey at Lonsdale Bay was quite different. Typical understorey species included *Haliptilon roseum*, *Zonaria turneriana*, *Areschougia* sp, *Ballia callitricha* and *Pterocladia lucida* (Table 6.3). The green filamentous *Cladophora rugulosa* was also a distinctive understorey component, as well as forming turf patches where the canopy was absent. This species is thought to be introduced from South Africa, and has only been observed in Port Phillip Bay.

The Phillip Island (group EF) canopy was generally dominated by *Phyllospora comosa* and *Acrocarpia paniculata*. The understorey was typically composed of erect, pink coralline species such as *Haliptilon roseum*, *Amphiroa anceps*, *Metagoniolithon* sp and *Cheilosporum* spp. The green *Caulerpa* species, particularly *C. brownii* and *C. flexilis*, were also characteristic understorey species (Table 6.3).

The Bunurong canopy (group GHI) consisted of many brown algal species, but was typified by *Acrocarpia paniculata*, *Seirococcus axillaris*, *Cystophora moniliformis*, *C. retorta* and *C. platylobium*. Typical understorey species included the fleshy red species *Plocamium angustum*, *Areschougia* sp and *Phacelocarpus peperocarpus*, the small brown species *Chlanidophora microphylla* and *Halopteris* sp and the coralline *Metagoniolithon* (Table 6.3). The Bunurong algal communities were interspersed by patches of the seagrass *Amphibolis antarctica*.

North Wilsons Promontory (group KL) was dominated by a canopy of *Ecklonia radiata*, *Seirococcus axillaris* and *Phyllospora comosa*. However, this canopy structure was often broken by patches of smaller browns such as *Sargassum sonderi Sargassum fallax*, *Acrocarpia paniculata* and *Perithalia cordata*. Understorey species typically include *Phacelocarpus peperocarpus*, *Melanthalia obtusata*, *Pterocladia lucida*, *Callophyllis rangiferinus* and *Zonaria turneriana* (Table 6.3).

South Wilsons Promontory (group NO) was typified by a canopy dominated by *Phyllospora comosa*, but *Ecklonia radiata* was also an abundant canopy component. The understorey was sparse, with low abundances of *Phacelocarpus peperocarpus*, *Ballia callitricha*, *Plocamium angustum*, *Melanthalia obtusata* and *Haliptilon roseum* (Table 6.3). Much of the reef beneath the canopy was covered by pink encrusting coralline algae.

Comparison/species	$\bar{y}_i$	$\bar{S}_i$	SD($\bar{S}_i$)	$\bar{S}_i$/SD(S_i)	$\Sigma\bar{S}_i$%
Phillip Island (EF)					
Phyllospora comosa	5.13	10.33	7.11	1.45	15.59
Acrocarpia paniculata	3.97	8.06	3.30	2.44	27.75
Haliptilon roseum	3.17	7.01	1.65	4.25	38.33
Amphiroa anceps	2.52	4.26	3.56	1.20	44.76
Metagoniolithon sp	1.83	3.84	1.18	3.27	50.55
Halopteris spp	1.69	3.29	2.57	1.28	55.51
Caulerpa brownii	1.50	2.92	1.05	2.77	59.92
Caulerpa flexilis	1.50	2.62	2.27	1.15	63.88
Cystophora moniliformis	2.15	2.45	4.03	0.61	67.57
Sargassum spp	1.07	2.14	0.74	2.90	70.80
Cystophora retorta	1.47	2.05	3.02	0.68	73.90
Macrocystis angustifolia	1.63	1.84	3.78	0.49	76.67
Cheilosporum spp	0.90	1.81	1.45	1.25	79.41
Bunurong (GHI)					
Cystophora retorta	3.97	6.81	3.34	2.04	11.38
Acrocarpia paniculata	4.15	6.80	4.39	1.55	22.75
Haliptilon roseum	2.31	4.21	1.15	3.65	29.79
Seirococcus axillaris	2.77	3.56	3.89	0.91	35.73
Cystophora moniliformis	1.88	3.35	1.30	2.59	41.34
Other thallose red algae	1.88	2.99	1.19	2.50	46.33
Cystophora platylobium	1.78	2.61	1.82	1.43	50.69
Sargassum fallax	1.58	2.37	1.85	1.28	54.64
Carpoglossum confluens	1.42	2.01	1.41	1.43	58.00
Plocamium angustum	1.20	1.99	1.11	1.80	61.33
Areschougia spp	1.30	1.91	1.51	1.26	64.53
Cystophora subfarcinata	1.27	1.68	1.91	0.88	67.34
Amphibolis antarctica	1.81	1.67	3.13	0.53	70.14
Metagoniolithon sp	1.03	1.63	1.28	1.27	72.87
Phacelocarpus peperocarpus	1.10	1.40	1.62	0.86	75.20
Chlanidophora microphylla	0.77	1.23	0.73	1.69	77.27
Halopteris spp	0.83	1.11	1.00	1.10	79.12
Perithalia cordata	0.89	1.02	1.28	0.79	80.81

Table 6.3 Macrophyte species with the highest contribution to average similarity within groups (SIMPER breakdowns). Statistics are: (y_i) mean abundance (square-root transformed values) within group; (S_i) the average similarity within the group; standard deviation SD; typification ratio; and the cumulative percent similarity.

Comparison/species	$\bar{y}_i$	$\bar{S}_i$	SD($\bar{S}_i$)	$\bar{S}_i$/SD(S_i)	$\Sigma\bar{S}_i$%
North Wilsons Promontory (KL)					
Ecklonia radiata	4.91	9.61	1.26	7.65	14.42
Seirococcus axillaris	2.84	5.74	1.31	4.38	23.04
Plocamium angustum	2.35	4.66	1.39	3.35	30.04
Phyllospora comosa	2.83	4.46	3.95	1.13	36.74
Other thallose red algae	2.24	4.13	1.39	2.97	42.94
Phacelocarpus peperocarpus	1.74	3.45	1.04	3.31	48.12
Sargassum sonderi	1.94	3.24	2.25	1.44	52.98
Callophyllis rangiferinus	1.54	2.91	1.00	2.93	57.36
Acrocarpia paniculata	1.62	2.26	2.06	1.10	60.76
Pterocladia lucida	1.47	2.07	1.74	1.19	63.87
Cystophora retroflexa	1.19	1.74	2.03	0.86	66.48
Sargassum decipiens	1.13	1.61	1.77	0.91	68.90
Melanthalia obtusata	0.99	1.33	1.43	0.93	70.90
Sargassum fallax	1.05	1.31	1.47	0.89	72.87
Zonaria turneriana	0.77	1.25	1.05	1.18	74.74
Perithalia cordata	0.99	1.20	1.99	0.60	76.54
Cystophora moniliformis	0.88	1.14	1.41	0.81	78.25
Lonsdale Bay (M)					
Phyllospora comosa	7.07	19.47	2.72	7.15	28.13
Ecklonia radiata	5.29	14.30	2.54	5.63	48.79
Other thallose red algae	2.40	5.11	4.03	1.27	56.17
Haliptalon roseum	1.41	3.10	1.42	2.19	60.65
Cladophora rugulosa	1.40	2.96	2.58	1.15	64.93
Zonaria turneriana	1.06	2.62	0.32	8.25	68.71
Ballia callitricha	0.96	2.30	0.75	3.08	72.04
Areschougia spp	0.94	1.57	1.44	1.09	74.31
Sargassum fallax	0.74	1.37	1.84	0.75	76.29
Pterocladia lucida	0.90	1.37	2.12	0.64	78.27
Seirococcus axillaris	0.62	1.05	1.32	0.80	79.78
South Wilsons Promontory (NO)					
Phyllospora comosa	7.65	23.42	5.97	3.93	35.92
Ecklonia radiata	4.33	10.58	5.31	1.99	52.15
Phacelocarpus peperocarpus	1.99	4.48	3.20	1.40	59.02
Ballia callitricha	1.61	4.36	1.03	4.23	65.71
Plocamium angustum	1.35	3.40	1.61	2.12	70.93
Haliptilon roseum	1.32	3.00	2.18	1.37	75.53
Melanthalia obtusata	1.23	2.95	1.77	1.66	80.05

Table 6.3 (continued). Macrophyte species with the highest contribution to average similarity within groups (SIMPER breakdowns). Statistics are: (y_i) mean abundance (square-root transformed values) within group; (S_i) the average similarity within the group; standard deviation SD; typification ratio; and the cumulative percent similarity.

6.4.3 Species Diversity

Areas of high macrophyte species diversity were Lonsdale Back Beach (group G), eastern Bunurong (group I) and northern Wilsons Promontory (group KL). These areas also had high species richness (Table 6.4). South Bunurong (group H) also had high species richness, however a dominance of *Acrocarpia*, *Seirococcus* and *Cystophora retorta* meant the diversity (distribution of individuals among species) was similar to most other areas in Victoria (Table 6.4).

Areas of particularly low diversity were Popes Eye (group B) and Lonsdale Bay (group M) at Port Phillip Heads, as well as southern Wilsons Promontory (group NO; Table 6.4). This low diversity was predominantly because of a dense canopy comprised of only one to three species (*Phyllospora*, *Ecklonia* and *Seirococcus*) and a sparse understorey.

Area	Community (Group code)	*S*	N_2	*E′*
South Channel Fort	A	14	4.3	0.37
Popes Eye	B	20	2.6	0.19
Inside Port Phillip Heads	C	31	5.6	0.29
Nepean Bay at Port Phillip Heads	D	27	5.5	0.32
Northeast of Pyramid Rock	E	24	7.5	0.37
Phillip Island	F	19	5.7	0.36
Lonsdale Back Beach	G	35	10.4	0.36
South and West Bunurong	H	30	6.0	0.29
East Bunurong	I	33	8.8	0.34
Northeast Wilsons Promontory	J	17	9.1	0.49
Northeast and northwest Wilsons Promontory	K	29	8.6	0.43
Northeast and northwest Wilsons Promontory	L	28	9.0	0.36
Port Phillip Heads	M	25	3.8	0.21
Lonsdale Back Beach, Cape Woolamai, Wilsons Prom.	N	19	2.9	0.22
Pillar Point at Wilsons Promontory	O	8	1.4	0.20

Table 6.4 Diversity statistics for macrophyte communities in Central Victoria and Flinders bioregions: average species richness (*S*), diversity (Hills N_2) and evenness (Camargo's index of evenness, *E′*). Communities groups are from the group analysis (Figure 6.4).

6.5 Invertebrate Communities

6.5.1 Community Groups

Invertebrate community structures were divided into three major groups: sites from the Port Phillip Heads area (group ABCD); sites predominantly from the Wilsons Promontory area (group FGHIJ); and sites from the Port Phillip Heads, Phillip Island and Bunurong areas (group KLMNOP; Figures 6.5 and 6.6).

Six sites within the Port Phillip heads area had communities that were quite distinct from any other sites, distinctly separated to the lower left of the MDS plot (Figure 6.5). These sites were located at South channel Fort, Point Franklin, Popes Eye, Lonsdale Bay and Nepean Bay, and were quite different to other sites in the area, including sites only a few hundred metres away (*eg.* sites 2802 and 2803 in Nepean Bay). Compared to other sites, these sites were depauperate in abundances of most invertebrate species, including *Haliotis rubra*, *Heliocidaris erythrogramma*, *Turbo undulatus* and *Nectria ocellata*. However, these sites averaged higher abundances of the feather star *Cenolia trichoptera* and the sea stars *Nectria multispina* and *Uniophora granifera* (Table 6.5).

Most other Port Phillip Heads sites had similarities in community structure with sites from Phillip Island and Bunurong (upper right of Figure 6.5; group KLMNOP, Figure 6.6). This large group of central Victorian sites differed from the Wilsons Promontory sites in having higher abundances of the gastropods *Turbo undulatus*, *Dicathais orbita* and *Haliotis laevigata* (Table 6.5). The Wilsons Promontory communities averaged higher abundances of the sea urchin *Heliocidaris erythrogramma*, abalone *Haliotis rubra*, feather star *Cenolia trichoptera* and most sea stars, including *Patiriella brevispina*, *Nectria ocellata*, *Nectria macrobrachia* and *Plectaster decanus* (Table 6.5).

The group KLMNOP was divided into two prominent community groups: sites at Port Phillip Heads and Bunurong (NOP, Figure 6.6) having a higher abundances of *Patiriella brevispina*, *Haliotis laevigata* and *Heliocidaris erythrogramma*; and sites at Phillip Island, Bunurong and Port Phillip Heads (KLM) with a higher abundance of *Haliotis rubra* and *Turbo undulatus* (Table 6.6). Communities at Phillip Island (K and L) were distinguished from communities at Port Phillip Heads (M) in having much higher abundances of *Turbo undulatus*, *Haliotis rubra* and *Patiriella brevispina* (Table 6.5).

The group EFGHIJ was divided into community groups from Port Phillip Heads (E), The Hat at northeast Wilsons Promontory (F), south and eastern Wilsons Promontory (G and H), northwest Wilsons Promontory (I) and a mixture of sites at Phillip Island and Wilsons Promontory (J; Figure 6.6). The sites in the south and eastern Wilsons Promontory had higher abundances of *Heliocidaris erythrogramma* and *Nectria macrobrachia*, while the northwestern community had higher abundances of *Haliotis rubra*, *Turbo undulatus*, *Nectria ocellata*, *Patiriella brevispina* and *Cenolia trichoptera* (Table 6.5).

6.5.2 Community Structures

Invertebrate communities were largely composed of abalone, other gastropod snails, sea urchins and sea stars. Characteristic species of the predominant communities described above are given in Table 6.6. The blacklip abalone *Haliotis rubra* was a prominent component of most communities, but was particularly dominant in the northwest Wilsons Promontory (group I) and Phillip Island-Bunurong communities (group KL; Table 6.6).

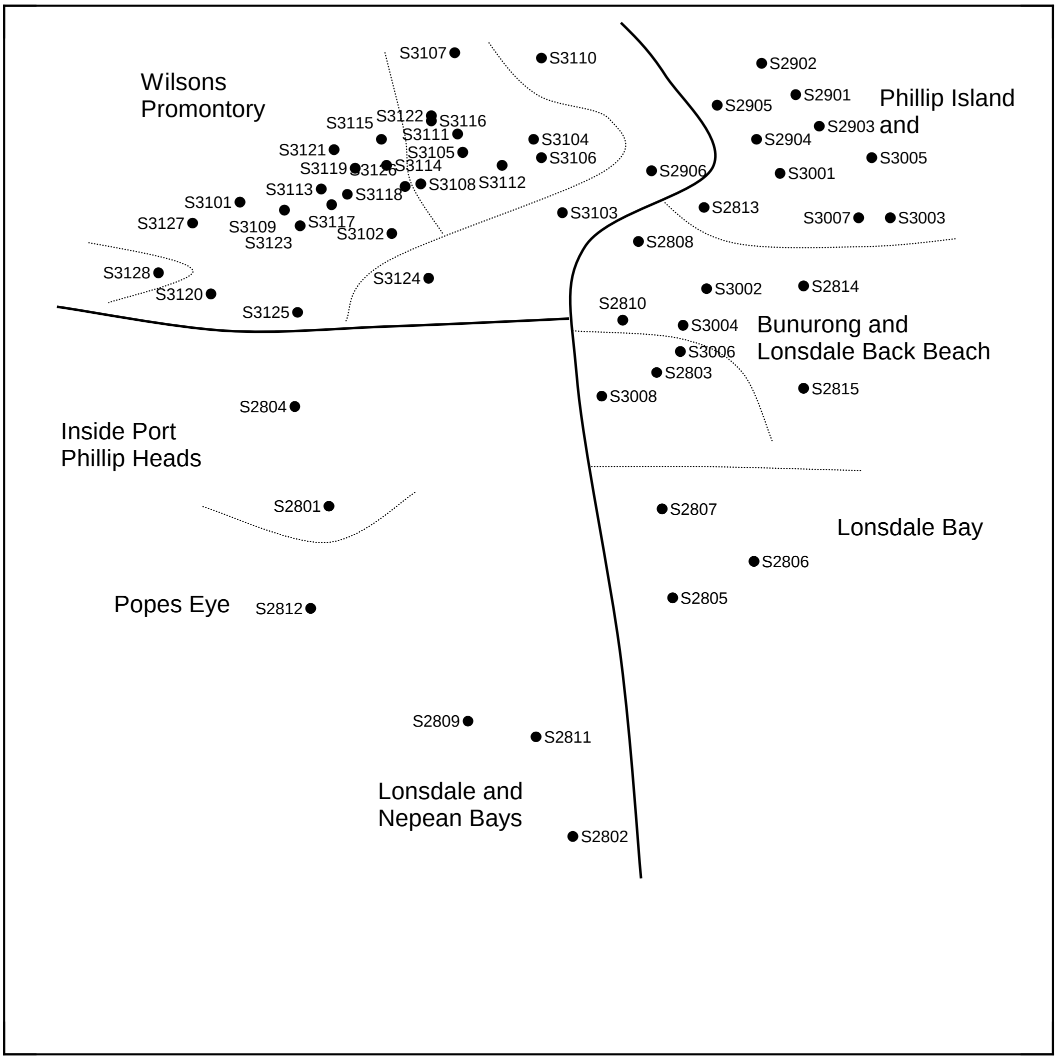


Figure 6.5 Two dimensional MDS ordination for invertebrate community structures in Central Victoria and Flinders bioregions. Site locations are given in Table 6.1. Kruskal stress = 0.17.

In addition to *Haliotis rubra*, *Cenolia trichoptera*, *Nectria ocellata* and *Heliocidaris erythrogramma* were characteristic components of both the south to east Wilsons Promontory (GH) and northwest Wilsons Promontory (I) communities. *Nectria macrobrachia* was a typical component of the south to east (GH) community while *Patiriella brevispina* and *Petricia vernicina* was typical in the northwest community (I; Table 6.6).

The Phillip Island/Bunurong community (KL) was dominated by *Haliotis rubra* and the periwinkle *Turbo undulatus*. Other species were considerable low in abundance, but included the dogwhelk *Dicathais orbita*, red bait crab *Plagusia chabrus* and sea star *Patiriella brevispina* (Table 6.6).

The Port Phillip Heads/Bunurong community (M) also had a dominance of *Haliotis rubra* and *Turbo undulatus*, but also included greater abundances of the green lip abalone *Haliotis laevigata* and sea stars *Tosia australis* and *Nectria ocellata*.

Other Port Phillip Heads and Bunurong communities (NOP) were typified by *Haliotis rubra and H. laevigata*, *Heliocidaris erythrogramma* and *Patiriella brevispina* (Table 6.6).

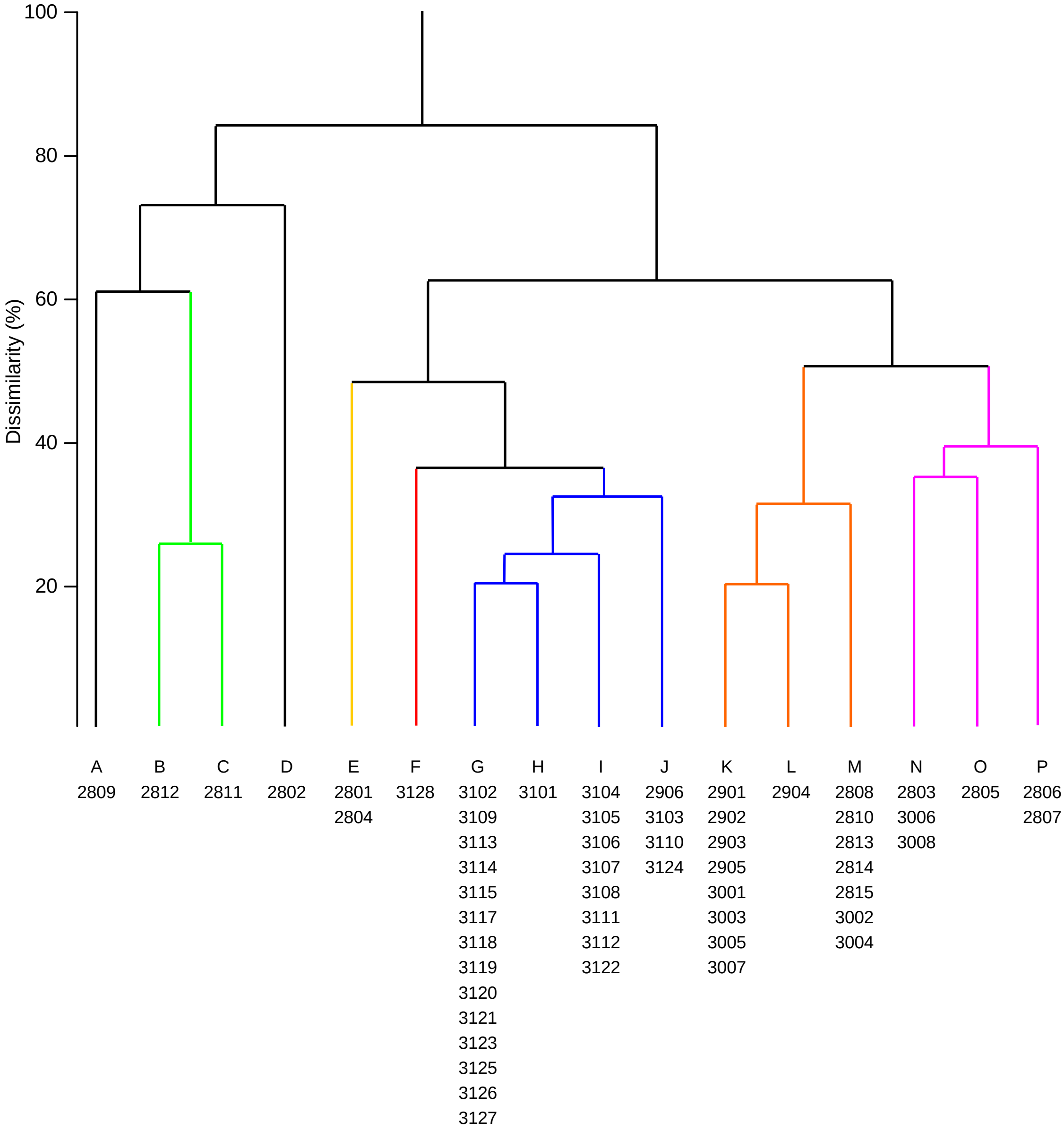


Figure 6.6 Dendrogram of invertebrate community structure. Linkages below 20% dissimilarity are not shown. Site locations are given in Table 6.1.

Comparison/species	$\bar{y}_{iA}$	$\bar{y}_{iB}$	$\bar{\delta}_i$	SD(δ_i)	$\bar{\delta}_i$/SD	$\bar{\delta}_i$%
Port Phillip Heads Group (ABCD) v Other Areas						
Haliotis rubra	0.81	9.28	16.43	7.94	2.07	21.11
Heliocidaris erythrogramma	0.35	6.60	11.18	9.22	1.21	35.47
Cenolia trichoptera	3.40	3.27	5.92	4.60	1.29	43.08
Turbo undulatus	0.35	2.53	5.57	7.56	0.74	50.24
Patiriella brevispina	0.25	2.16	3.99	4.97	0.80	55.37
Tosia australis	2.04	1.17	2.73	2.24	1.22	58.88
Haliotis laevigata	0.61	0.78	2.53	3.63	0.70	62.12
Nectria ocellata	1.29	1.65	2.44	1.73	1.41	65.26
Nectria macrobrachia	0.00	1.18	2.06	2.53	0.82	67.91
Nectria multispina	1.04	0.08	2.03	1.46	1.39	70.52
Dicathais orbita	0.25	0.95	1.93	1.93	1.00	72.99
Uniophora granifera	0.75	0.09	1.54	1.71	0.90	74.97
Plectaster decanus	0.00	0.90	1.54	1.61	0.95	76.95
Plagusia chabrus	0.00	0.77	1.44	1.54	0.93	78.79
Nepanthia troughtoni	0.00	0.75	1.38	1.55	0.89	80.57
Wilsons Promontory Group (EFGHIJ) v Phillip Island and Bunurong Group (KLNOP)						
Heliocidaris erythrogramma	10.38	1.27	12.54	6.61	1.90	19.40
Haliotis rubra	9.51	8.95	7.15	5.11	1.40	30.46
Turbo undulatus	0.67	5.16	6.61	5.12	1.29	40.69
Cenolia trichoptera	4.95	0.91	5.74	3.95	1.45	49.56
Patiriella brevispina	2.17	2.14	3.77	3.59	1.05	55.40
Haliotis laevigata	0.03	1.84	2.67	2.67	1.00	59.53
Nectria ocellata	2.35	0.68	2.50	1.50	1.67	63.39
Nectria macrobrachia	1.86	0.22	2.46	2.08	1.18	67.20
Plectaster decanus	1.48	0.09	1.94	1.15	1.68	70.19
Dicathais orbita	0.67	1.35	1.64	1.28	1.28	72.73
Tosia australis	1.19	1.14	1.62	1.44	1.13	75.24
Petricia vernicina	1.09	0.11	1.49	1.12	1.33	77.54
Pentagonaster dubeni	0.94	0.05	1.24	1.17	1.06	79.46
Inner Port Phillip Heads and The Hat (EF) v Wilsons Promontory (GHIJ)						
Haliotis rubra	1.80	10.34	10.92	5.27	2.07	19.77
Heliocidaris erythrogramma	8.73	10.56	6.20	4.14	1.50	31.00
Cenolia trichoptera	4.31	5.02	3.66	3.00	1.22	37.62
Nectria ocellata	0.75	2.52	2.62	1.59	1.65	42.38
Patiriella brevispina	1.00	2.30	2.59	2.37	1.09	47.07
Nectria macrobrachia	0.94	1.96	2.39	1.90	1.26	51.40
Tosia australis	2.61	1.04	2.34	1.86	1.26	55.62
Coscinasterias muricata	1.46	0.05	1.82	1.39	1.31	58.92
Plagusia chabrus	1.05	0.96	1.77	1.30	1.36	62.12
Plectaster decanus	0.58	1.57	1.69	1.10	1.53	65.18
Trizopagurus strigimanus	0.82	0.81	1.40	1.05	1.33	67.72
Dicathais orbita	0.82	0.66	1.37	1.23	1.11	70.19
Petricia vernicina	0.47	1.16	1.32	1.05	1.25	72.58
Nepanthia troughtoni	0.00	1.02	1.28	1.14	1.13	74.90

Table 6.5 Invertebrate species with the highest contribution to differences between groups (SIMPER breakdowns). Statistics are: (y_{iA}) mean abundance (square-root transformed values) for group A; (y_{iB}) mean abundance for group B; ($\bar{\delta}_i$) the average species contribution to differences between sites; standard deviation SD; discrimination ratio; and ($\bar{\delta}_i$%) the cumulative percent discrimination.

Comparison/species	$\overline{y}_{iA}$	$\overline{y}_{iB}$	$\overline{\delta}_i$	SD(δ_i)	$\overline{\delta}_i$ /SD	$\overline{\delta}_i$ %
South and East Wilsons Prom (GH) v Northwest Wilsons Prom (I)						
Heliocidaris erythrogramma	14.07	6.80	7.52	3.49	2.16	17.59
Haliotis rubra	8.17	15.31	7.45	4.24	1.76	35.02
Patiriella brevispina	1.69	4.48	3.42	2.32	1.47	43.02
Cenolia trichoptera	5.69	5.75	3.30	2.47	1.33	50.73
Nectria macrobrachia	2.63	0.53	2.16	1.39	1.55	55.77
Turbo undulatus	0.06	1.51	1.48	1.34	1.11	59.24
Nectria ocellata	2.44	3.05	1.28	0.94	1.36	62.23
Pentagonaster dubeni	1.43	0.43	1.15	0.83	1.38	64.91
Tosia australis	1.33	0.63	1.10	0.70	1.57	67.47
Nepanthia troughtoni	1.25	1.08	1.03	0.74	1.39	69.87
Fromia polypora	0.69	1.26	0.97	0.79	1.23	72.15
Plagusia chabrus	0.86	1.46	0.96	0.79	1.21	74.39
Plectaster decanus	1.65	1.40	0.90	0.68	1.32	76.50
Dicathais orbita	0.38	1.09	0.90	0.62	1.44	78.60
Phillip Island, Bunurong and Port Phillip Heads: Group KLM v NOP						
Haliotis rubra	10.55	4.66	10.77	5.90	1.83	18.34
Turbo undulatus	6.47	1.65	9.73	6.51	1.50	34.90
Patiriella brevispina	1.50	3.86	6.96	6.38	1.09	46.76
Haliotis laevigata	1.33	3.18	5.00	3.87	1.29	55.27
Heliocidaris erythrogramma	0.65	2.94	4.48	2.39	1.87	62.90
Cenolia trichoptera	0.82	1.17	2.37	2.04	1.16	66.94
Dicathais orbita	1.42	1.15	2.21	1.28	1.73	70.70
Tosia australis	1.14	1.14	2.02	1.49	1.36	74.14
Nectria ocellata	0.81	0.33	1.52	1.42	1.07	76.73
Phillip Island and Bunurong Group KL v Bunurong and Port Phillip Heads Group M						
Turbo undulatus	9.27	2.88	11.84	5.15	2.30	24.37
Haliotis rubra	11.95	8.76	7.94	5.64	1.41	40.71
Patiriella brevispina	2.05	0.80	3.71	3.96	0.94	48.36
Cenolia trichoptera	0.11	1.73	2.89	2.56	1.13	54.30
Dicathais orbita	1.79	0.96	2.62	1.92	1.36	59.69
Haliotis laevigata	0.96	1.81	2.55	1.54	1.65	64.93
Tosia australis	0.76	1.64	2.51	1.88	1.33	70.10
Nectria ocellata	0.49	1.21	1.85	1.25	1.48	73.91
Heliocidaris erythrogramma	0.46	0.89	1.59	1.40	1.14	77.19
Nepanthia troughtoni	0.22	0.94	1.54	1.21	1.27	80.36

Table 6.5 (continued). Invertebrate species with the highest contribution to differences between groups (SIMPER breakdowns). Statistics are: (y_{iA}) mean abundance (square-root transformed values) for group A; (y_{iB}) mean abundance for group B; ($\overline{\delta}_i$) the average species contribution to differences between sites; standard deviation SD; discrimination ratio; and ($\overline{\delta}_i$ %) the cumulative percent discrimination.

Comparison/species	$\bar{y}_i$	$\bar{S}_i$	SD($\bar{S}_i$)	$\bar{S}_i$/SD(S_i)	$\Sigma\bar{S}_i$%
South and East Wilsons Prom (GH)					
Heliocidaris erythrogramma	14.07	25.28	6.98	3.62	35.85
Haliotis rubra	8.17	12.80	4.89	2.62	54.01
Cenolia trichoptera	5.69	8.15	4.09	1.99	65.57
Nectria macrobrachia	2.63	3.88	1.89	2.06	71.07
Nectria ocellata	2.44	3.63	1.97	1.84	76.22
Plectaster decanus	1.65	2.39	1.45	1.65	79.61
Pentagonaster dubeni	1.43	1.99	1.34	1.48	82.44
Northwest Wilsons Prom (I)					
Haliotis rubra	15.31	26.31	4.56	5.77	34.22
Heliocidaris erythrogramma	6.80	11.75	2.40	4.89	49.50
Cenolia trichoptera	5.75	8.80	4.44	1.98	60.95
Patiriella brevispina	4.48	6.41	3.57	1.80	69.29
Nectria ocellata	3.05	5.22	1.61	3.24	76.08
Petricia vernicina	1.43	2.54	0.58	4.40	79.37
Plagusia chabrus	1.46	2.01	1.50	1.34	81.99
Plectaster decanus	1.40	2.01	1.30	1.55	84.60
Phillip Island and Bunurong (KL)					
Haliotis rubra	11.95	31.61	8.00	3.95	44.46
Turbo undulatus	9.27	25.69	8.35	3.08	80.59
Dicathais orbita	1.79	3.92	3.24	1.21	86.10
Patiriella brevispina	2.05	2.05	3.87	0.53	88.98
Plagusia chabrus	0.68	1.20	1.72	0.70	90.67
Port Phillip Heads and Bunurong (M)					
Haliotis rubra	8.76	32.91	6.09	5.41	47.02
Turbo undulatus	2.88	8.92	4.29	2.08	59.75
Haliotis laevigata	1.81	6.65	2.07	3.20	69.25
Tosia australis	1.64	4.48	4.80	0.93	75.65
Nectria ocellata	1.21	3.93	2.66	1.48	81.26
Cenolia trichoptera	1.73	3.71	4.21	0.88	86.56
Nepanthia troughtoni	0.94	2.50	2.80	0.89	90.14
Port Phillip Heads and Bunurong (NOP)					
Haliotis rubra	4.66	18.35	3.00	6.12	28.54
Heliocidaris erythrogramma	2.94	9.39	3.90	2.41	43.14
Haliotis laevigata	3.18	9.35	9.67	0.97	57.68
Patiriella brevispina	3.86	7.23	10.88	0.66	68.91
Dicathais orbita	1.15	3.68	2.73	1.35	74.63
Tosia australis	1.14	3.68	2.98	1.24	80.35

Table 6.6 Invertebrate species with the highest contribution to average similarity within clusters (SIMPER breakdowns). Statistics are: (y_i) mean abundance (square-root transformed values) within group; (S_i) the average similarity within the group; standard deviation SD; typification ratio; and the cumulative percent similarity.

6.5.3 Species Diversity

The diversity statistics indicated that the Phillip Island/Bunurong and Bunurong/Lonsdale community types had relatively low species richness (*S*), low diversity (N_2) and moderate evenness in the distribution of individuals among species (*E′*; groups K and M, Table 6.7). In contrast, the Bunurong/Nepean community had a moderate level of species richness and relatively high diversity and evenness (Sites 6 and 8; Figure 6.6, Group N, Table 6.7). Communities with the highest species richness were located at Wilsons Promontory, while communities with highest diversity tended to be in the Port Phillip Heads area (Table 6.7).

Area	Community	*S*	N_2	*E′*
Port Phillip Heads	A	8.0	5.25	0.63
Port Phillip Heads	B	8.0	3.52	0.48
Port Phillip Heads	C	7.0	2.06	0.33
Port Phillip Heads	D	11.0	8.70	0.74
Port Phillip Heads	E	10.5	2.44	0.29
Northeast Wilsons Promontory	F	14.0	3.66	0.36
South Wilsons Promontory	G	15.6	2.46	0.20
Northwest Wilsons Promontory	H	13.0	2.98	0.24
East and west Wilsons Promontory	I	16.4	2.51	0.21
Philip Island - Wilsons Promontory	J	10.5	2.39	0.29
Phillip Island - Bunurong	K	8.6	2.11	0.26
Phillip Island - Bunurong	L	11.0	1.88	0.23
Bunurong - Lonsdale	M	9.14	2.14	0.30
Bunurong - Nepean	N	12.6	4.81	0.41
Lonsdale Bay	O	6.0	2.18	0.40
Lonsdale Bay	P	9.5	2.95	0.37

Table 6.7 Diversity statistics for invertebrate community groups in the Central Victoria and Flinders bioregions: average species richness (*S*), diversity (Hills N_2) and evenness (Camargo's index of evenness, *E′*). Communities groups are from the group analysis (Figure 6.6).

6.6 Fish Communities

6.6.1 Community Groups

The multivariate analysis divided the survey sites into two predominant groups according to fish community structure. These were a central Victorian group including Port Phillip Heads, Phillip Island and Bunurong (left of MDS plot, Figure 6.7; FGHI in Figure 6.8) and a Wilsons Promontory Group (right side of MDS plot, Figure 6.7, JK in Figure 6.8). Five sites (2805, 2801, 2812, 2804 and 3008) had communities distinctly different from any other site (groups A to E, Figure 6.8).

The Wilsons Promontory group was differentiated from the central Victorian group in having higher abundances of most fish species, but particularly higher abundances of barber perch *Caesioperca rasor*, long finned pike *Dinolestes lewini*, silver sweep *Scorpis lineolata*, old wife *Enoplosus armatus* and pygmy weed whiting *Siphonognathus beddomei* (Table 6.7).

The central Victorian group was divided into communities generally only found at each sampling location: Port Phillip Heads (I); Phillip Island (G); and Bunurong (H). This group also included an community type present at sites at central Phillip Island and south eastern Bunurong (F; Figure 6.8). These communities differences were not as apparent on the MDS plot. However, the Kruskal stress was high (0.21), indicating a poor two-dimensional representation of the multivariate data.

The Port Phillip Heads community (I) differed from the other central Victorian locations (EFGH) in having lower abundances of sea sweep *Scorpis aequipinnis*, purple wrasse *Notolabrus fucicola* and blue throated wrasse *N. tetricus*, as well as higher abundances of herring cale *Odax cyanomelas*, horseshoe leatherjacket *Meuschenia hippocrepis*, scalyfin *Parma victoriae* and zebrafish *Girella zebra* (Table 6.8). The Phillip Island (G) and Bunurong (H) communities had similar species compositions. However, abundances were higher at Phillip Island for most species, except *N. tetricus* and senator wrasse *Pictilabrus laticlavius* (Table 6.8).

The Wilsons Promontory group (JK) was clearly divided into a western (J) and eastern (K) community. These two communities were quite similar, being close together on the MDS plot, and linked at a high level of similarity on the dendrogram (Figures 6.7 and 6.8). There was very little overlap in community structure between the eastern and western sites, although two western sites (3106 and 3107) appeared to be intermediate in structure between the two groups (Figure 6.7). The western community had higher abundances of *Dinolestes lewini*, *Notolabrus fucicola*, *Odax cyanomelas* and southern hulafish *Trachinops caudimaculatus*. The eastern community had higher abundances of *Scorpis lineolata*, *S. aequipinnis*, *Caesioperca rasor*, *N. tetricus*, *Enoplosus armatus* and mado *Atypichthys strigatus* (Table 6.8).

6.6.2 Community Structures

The Port Phillip Heads community (I) was characterised by a dominance of *Notolabrus tetricus*, intermediate abundances of *Parma victoriae*, *Odax cyanomelas* and *Meuschenia hippocrepis*, and lower abundances of *Pictilabrus laticlavius*, *N. fucicola* and yellow striped leatherjacket *M. flavolineata* (Table 6.9).

The Phillip Island community (G) was dominated by a greater number of species, including *Notolabrus tetricus*, *Odax cyanomelas*, *N. fucicola*, *Scorpis aequipinnis* and magpie morwong *Cheilodactylus nigripes*. As with Port Phillip Heads, *Parma victoriae* and *Meuschenia hippocrepis* were present in intermediate abundances (Table 6.9).

The Bunurong fish community (H) typified by high abundances of *Notolabrus tetricus*, and intermediate to low abundances of *Pictilabrus laticlavius*, *Scorpis aequipinnis*, *N. fucicola* and *Cheilodactylus nigripes* (Table 6.9).

The western Wilsons Promontory community (J) had high abundances of *Caesioperca rasor*, *Notolabrus tetricus*, *N. fucicola*, *Dinolestes Lewini* and *Odax cyanomelas*. The toothbrush leatherjacket *Acanthaluteres vittiger*, *Enoplosus armatus*, *Cheilodactylus nigripes* and *Scorpis aequipinnis* were also typical species.

The eastern Wilsons Promontory community (K) was also dominated by *Caesioperca rasor*, *Notolabrus tetricus* and *Dinolestes lewini*, but had a higher dominance of *Cheilodactylus nigripes* and *Scorpis lineolata* compared with the western community. The eastern community was also typified by *Atypichthys strigatus* and bastard trumpeter *Latridopsis forsteri* (Table 6.9).

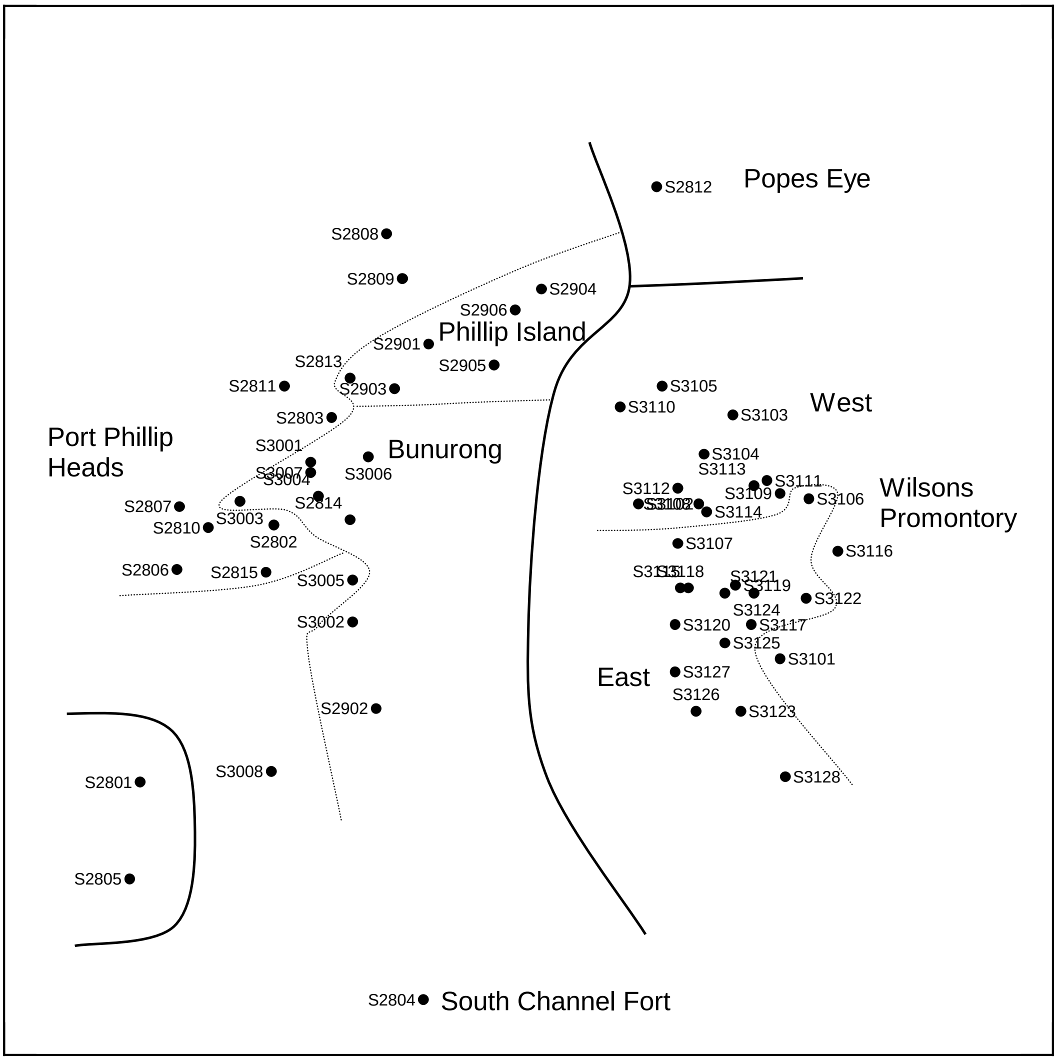


Figure 6.7 Two dimensional MDS ordination for fish community structures in Central Victoria and Flinders bioregions. Site locations are given in Table 6.1. Kruskal stress = 0.21.

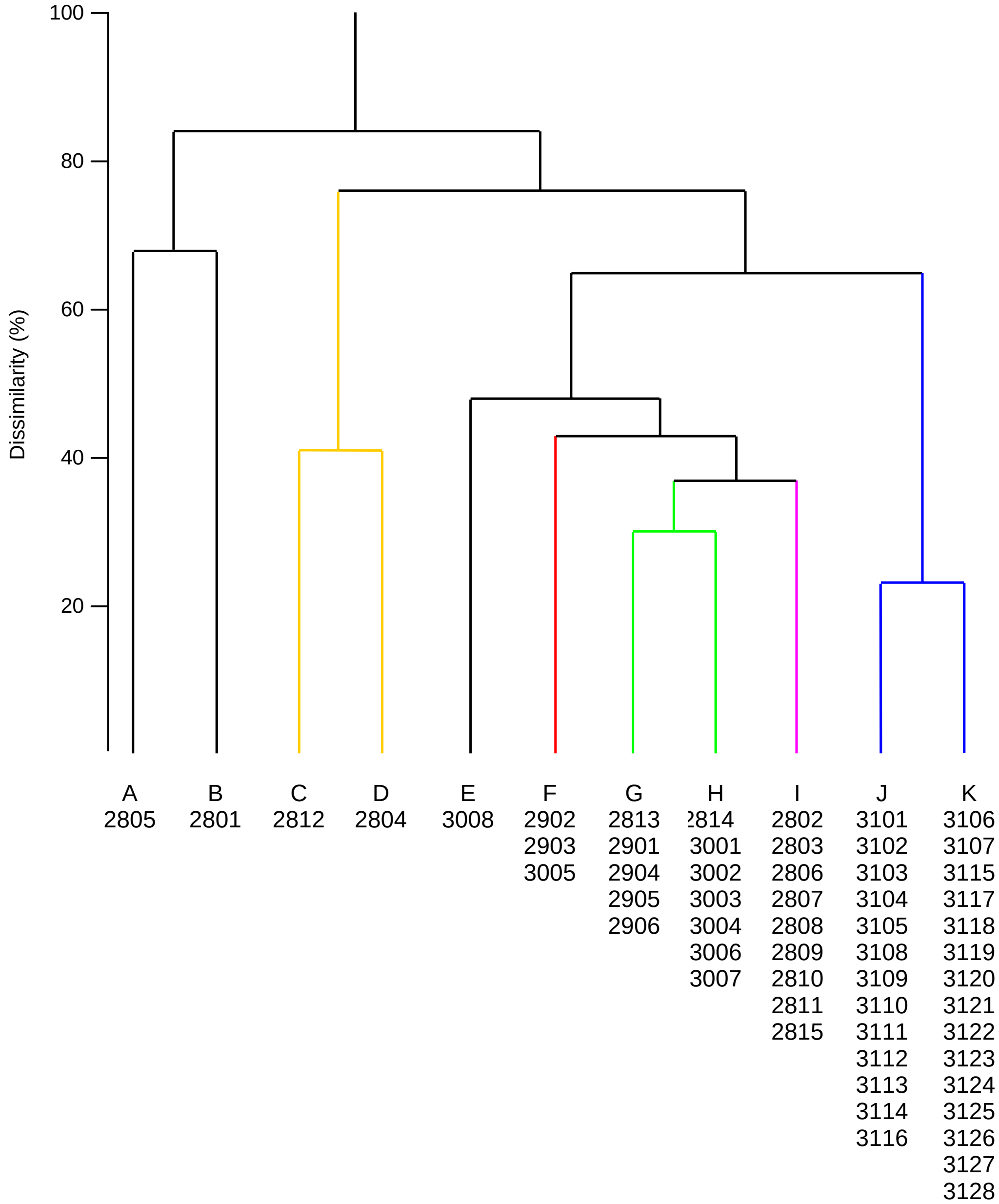


Figure 6.8 Dendrogram of fish community structure. Linkages below 20% dissimilarity are not shown. Site locations are given in Table 6.1.

Comparison/species	$\overline{y}_{iA}$	$\overline{y}_{iB}$	$\overline{\delta}_i$	SD(δ_i)	$\overline{\delta}_i$/SD	$\overline{\delta}_i$%
Inside Port Phillip Heads (ABCD) v Other Areas (EFGHIJK)						
Trachinops caudimaculatus	8.66	0.75	7.77	7.67	1.01	10.70
Caesioperca rasor	0.25	5.59	5.92	6.65	0.89	18.86
Engraulis australis	4.33	0.00	4.62	8.25	0.56	25.21
Notolabrus tetricus	3.92	5.96	4.26	3.29	1.30	31.09
Notolabrus fucicola	1.77	3.01	3.64	3.16	1.15	36.10
Scorpis aequipinnis	1.75	1.96	3.28	3.00	1.09	40.62
Dinolestes lewini	0.00	2.83	3.27	4.13	0.79	45.12
Odax cyanomelas	1.01	2.75	3.10	2.87	1.08	49.39
Parma victoriae	2.34	1.63	2.97	2.40	1.23	53.48
Acanthaluteres vittiger	1.71	1.32	2.50	2.96	0.84	56.92
Cheilodactylus nigripes	1.63	1.78	2.04	1.57	1.30	59.74
Enoplosus armatus	0.96	1.70	1.91	1.60	1.19	62.37
Scorpis lineolata	0.00	1.78	1.88	3.41	0.55	64.96
Meuschenia hippocrepis	1.32	0.70	1.86	2.39	0.78	67.52
Meuschenia freycineti	1.93	0.54	1.82	1.98	0.92	70.02
Port Phillip Heads, Phillip Island and Bunurong (EFGHI) v Wilsons Promontory (JK)						
Caesioperca rasor	0.00	10.59	12.47	4.33	2.88	18.97
Dinolestes lewini	0.68	4.75	5.14	3.92	1.31	26.79
Scorpis lineolata	0.04	3.34	3.90	4.17	0.94	32.72
Notolabrus fucicola	2.00	3.91	3.32	2.54	1.31	37.77
Odax cyanomelas	2.20	3.24	2.94	1.91	1.54	42.24
Enoplosus armatus	0.39	2.87	2.93	1.46	2.00	46.70
Scorpis aequipinnis	1.74	2.16	2.37	1.78	1.33	50.30
Cheilodactylus nigripes	0.88	2.58	2.30	1.36	1.69	53.80
Acanthaluteres vittiger	0.54	2.02	1.97	1.34	1.48	56.80
Notolabrus tetricus	5.62	6.27	1.96	1.49	1.31	59.79
Siphonognathus beddomei	0.00	1.68	1.92	1.28	1.50	62.71
Atypichthys strigatus	0.36	1.35	1.76	2.35	0.75	65.38
Parma victoriae	1.78	1.49	1.62	1.22	1.32	67.85
Phillip Island and Bunurong (EF) v Port Phillip Heads, Phillip Island and Bunurong (GHI)						
Dinolestes lewini	3.03	0.24	6.51	5.01	1.30	11.71
Odax cyanomelas	1.00	2.43	4.35	3.32	1.31	19.53
Scorpis aequipinnis	1.56	1.77	4.05	2.89	1.40	26.81
Parma victoriae	0.68	1.99	3.48	2.37	1.47	33.07
Atypichthys strigatus	1.44	0.15	3.32	5.47	0.61	39.05
Notolabrus tetricus	5.30	5.68	3.31	2.32	1.43	45.00
Notolabrus fucicola	1.30	2.14	3.22	2.56	1.26	50.79
Meuschenia hippocrepis	0.00	1.45	3.07	2.93	1.05	56.30
Girella zebra	0.00	1.28	2.64	2.63	1.00	61.04
Pictilabrus laticlavius	1.97	1.37	2.54	1.93	1.32	65.62
Cheilodactylus nigripes	0.00	1.04	2.17	2.12	1.02	69.52
Meuschenia flavolineata	0.50	0.72	1.59	1.45	1.10	72.37

Table 6.8 Fish species with the highest contribution to differences between groups (SIMPER breakdowns). Statistics are: ($\overline{y}_{iA}$) mean abundance (square-root transformed values) for group A; ($\overline{y}_{iB}$) mean abundance for group B; ($\overline{\delta}_i$) the average species contribution to differences between sites; standard deviation SD; discrimination ratio; and ($\overline{\delta}_i$%) the cumulative percent discrimination.

Comparison/species	$\overline{y}_{iA}$	$\overline{y}_{iB}$	$\overline{\delta}_i$	SD($\overline{\delta}_i$)	$\overline{\delta}_i$/SD	$\overline{\delta}_i$%
Port Phillip Heads (I) v Phillip Island and Bunurong (GH)						
Scorpis aequipinnis	0.00	3.10	6.15	3.90	1.58	11.54
Odax cyanomelas	2.92	2.07	5.00	3.27	1.53	20.93
Notolabrus fucicola	1.03	2.97	4.06	2.98	1.36	28.55
Meuschenia hippocrepis	1.93	1.09	3.37	2.60	1.29	34.88
Parma victoriae	2.34	1.72	3.09	1.96	1.58	40.68
Notolabrus tetricus	5.01	6.18	3.06	2.24	1.37	46.41
Girella zebra	1.33	1.24	2.83	2.28	1.24	51.72
Cheilodactylus nigripes	0.38	1.54	2.58	2.02	1.28	56.56
Pictilabrus laticlavius	1.40	1.34	2.25	1.65	1.36	60.78
Meuschenia flavolineata	1.25	0.31	2.18	1.56	1.40	64.88
Upeneichthys vlaminghii	0.97	0.00	2.01	1.65	1.22	68.66
Aplodactylus arctidens	0.38	0.96	1.67	1.35	1.24	71.79
Acanthaluteres vittiger	0.76	0.47	1.60	1.58	1.01	74.79
Phillip Island (G) and Bunurong (H)						
Odax cyanomelas	4.48	0.34	7.73	2.36	3.28	15.54
Scorpis aequipinnis	3.81	2.59	4.85	3.42	1.42	25.30
Notolabrus fucicola	4.30	2.02	4.42	2.28	1.94	34.20
Pictilabrus laticlavius	0.20	2.15	3.74	1.35	2.76	41.71
Parma victoriae	1.82	1.65	3.41	2.30	1.48	48.57
Cheilodactylus nigripes	2.34	0.98	3.28	1.59	2.06	55.16
Girella zebra	1.67	0.94	3.12	2.76	1.13	61.44
Meuschenia hippocrepis	1.59	0.74	3.02	2.06	1.46	67.51
Notolabrus tetricus	5.60	6.60	2.72	1.81	1.50	72.99
Aplodactylus arctidens	1.08	0.88	1.34	1.14	1.18	75.68
Cheilodactylus spectabilis	0.57	0.40	1.24	1.39	0.90	78.19
Western Wilsons Prom (J) v Eastern Wilsons Prom (K)						
Scorpis lineolata	0.46	5.83	4.59	2.65	1.73	9.99
Caesioperca rasor	10.23	10.90	3.72	2.51	1.48	18.10
Dinolestes lewini	4.95	4.57	3.09	2.60	1.19	24.83
Notolabrus fucicola	5.71	2.36	3.03	1.68	1.80	31.43
Trachinops caudimaculatus	2.72	0.31	2.10	3.01	0.70	36.02
Atypichthys strigatus	0.22	2.34	1.90	1.68	1.13	40.15
Odax cyanomelas	3.80	2.76	1.73	1.20	1.44	43.92
Notolabrus tetricus	5.92	6.58	1.42	1.30	1.09	47.02
Scorpis aequipinnis	1.85	2.43	1.42	0.96	1.48	50.10
Acanthaluteres vittiger	2.65	1.47	1.33	0.91	1.47	53.01
Enoplosus armatus	2.71	3.01	1.21	0.89	1.37	55.65
Pictilabrus laticlavius	1.32	1.34	1.18	0.95	1.24	58.22
Cheilodactylus nigripes	2.06	3.03	1.18	0.90	1.30	60.78
Siphonognathus beddomei	1.69	1.67	1.10	0.83	1.33	63.18
Girella zebra	1.16	0.82	1.07	1.10	0.97	65.50
Parma victoriae	1.60	1.40	0.98	0.75	1.31	67.63
Meuschenia freycineti	1.29	0.32	0.96	0.76	1.27	69.73
Upeneichthys vlaminghii	0.58	1.02	0.92	0.82	1.13	71.74

Table 6.8 (continued). Fish species with the highest contribution to differences between groups (SIMPER breakdowns). Statistics are: ($\overline{y}_{iA}$) mean abundance (square-root transformed values) for group A; ($\overline{y}_{iB}$) mean abundance for group B; ($\overline{\delta}_i$) the average species contribution to differences between sites; standard deviation SD; discrimination ratio; and ($\overline{\delta}_i$%) the cumulative percent discrimination.

Comparison/species	$\bar{y}_i$	$\bar{S}_i$	**SD($\bar{S}_i$)**	**$\bar{S}_i$/SD(S_i)**	**Σ$\bar{S}_i$%**
Port Phillip Heads (I)					
Notolabrus tetricus	5.01	19.74	6.88	2.87	30.70
Parma victoriae	2.34	8.31	2.59	3.21	43.63
Odax cyanomelas	2.92	7.13	3.95	1.81	54.72
Meuschenia hippocrepis	1.93	5.23	5.45	0.96	62.85
Pictilabrus laticlavius	1.40	4.35	3.15	1.38	69.61
Meuschenia flavolineata	1.25	3.38	2.81	1.20	74.87
Notolabrus fucicola	1.03	2.87	2.54	1.13	79.34
Upeneichthys vlaminghii	0.97	2.80	3.39	0.82	83.69
Girella zebra	1.33	2.67	3.22	0.83	87.85
Enoplosus armatus	0.80	1.57	2.44	0.64	90.29
Phillip Island (G)					
Notolabrus tetricus	5.60	17.05	3.72	4.59	23.64
Odax cyanomelas	4.48	12.36	3.10	3.98	40.76
Notolabrus fucicola	4.30	12.23	2.72	4.50	57.71
Scorpis aequipinnis	3.81	7.81	7.11	1.10	68.53
Cheilodactylus nigripes	2.34	5.08	4.00	1.27	75.57
Parma victoriae	1.82	4.40	5.32	0.83	81.66
Meuschenia hippocrepis	1.59	3.64	3.49	1.04	86.70
Aplodactylus arctidens	1.08	2.79	1.96	1.42	90.57
Girella zebra	1.67	2.51	4.65	0.54	94.05
Bunurong (H)					
Notolabrus tetricus	6.60	27.51	3.92	7.02	39.87
Pictilabrus laticlavius	2.15	8.70	2.36	3.68	52.47
Scorpis aequipinnis	2.59	8.19	4.65	1.76	64.33
Notolabrus fucicola	2.02	7.15	3.79	1.89	74.70
Cheilodactylus nigripes	0.98	3.45	2.35	1.47	79.70
Parma victoriae	1.65	3.38	4.01	0.84	84.60
Aplodactylus arctidens	0.88	2.43	2.62	0.93	88.12
Girella zebra	0.94	1.84	3.07	0.60	90.78
Acanthaluteres vittiger	0.61	1.34	2.64	0.51	92.72
Meuschenia hippocrepis	0.74	0.81	2.52	0.32	93.89
Odax cyanomelas	0.34	0.69	2.08	0.33	94.89

Table 6.9 Fish species with the highest contribution to average similarity within groups (SIMPER breakdowns). Statistics are: (y_i) mean abundance (square-root transformed values) within group; (S_i) the average similarity within the group; standard deviation SD; typification ratio; and the cumulative percent similarity.

Comparison/species	$\bar{y}_i$	$\bar{S}_i$	SD($\bar{S}_i$)	$\bar{S}_i$/SD(S_i)	$\Sigma\bar{S}_i$%
West Wilsons Promontory (J)					
Caesioperca rasor	10.23	12.87	6.14	2.10	19.84
Notolabrus fucicola	5.71	8.39	3.85	2.18	32.77
Notolabrus tetricus	5.92	8.36	2.32	3.61	45.65
Dinolestes lewini	4.95	5.87	4.74	1.24	54.70
Odax cyanomelas	3.80	5.68	1.85	3.07	63.46
Acanthaluteres vittiger	2.65	3.21	1.80	1.78	68.40
Enoplosus armatus	2.71	3.16	1.40	2.25	73.26
Cheilodactylus nigripes	2.06	2.33	1.33	1.75	76.86
Scorpis aequipinnis	1.85	2.28	1.72	1.33	80.38
Siphonognathus beddomei	1.69	1.70	1.64	1.04	83.00
Parma victoriae	1.60	1.62	1.33	1.22	85.50
Meuschenia freycineti	1.29	1.40	1.34	1.04	87.66
Trachinops caudimaculatus	2.72	1.06	2.49	0.42	89.29
Girella zebra	1.16	0.82	1.22	0.67	90.56
East Wilsons Promontory (K)					
Caesioperca rasor	10.90	16.13	3.71	4.35	24.08
Notolabrus tetricus	6.58	9.70	1.63	5.94	38.57
Scorpis lineolata	5.83	6.98	4.44	1.57	48.98
Cheilodactylus nigripes	3.03	4.35	1.14	3.82	55.47
Dinolestes lewini	4.57	4.21	3.62	1.16	61.76
Enoplosus armatus	3.01	4.19	0.97	4.32	68.01
Odax cyanomelas	2.76	2.60	2.39	1.09	71.88
Notolabrus fucicola	2.36	2.51	1.87	1.34	75.63
Scorpis aequipinnis	2.43	2.36	2.30	1.02	79.15
Atypichthys strigatus	2.34	1.99	2.79	0.71	82.13
Siphonognathus beddomei	1.67	1.69	1.37	1.24	84.66
Acanthaluteres vittiger	1.47	1.53	1.34	1.15	86.95
Parma victoriae	1.40	1.48	1.50	0.99	89.16
Pictilabrus laticlavius	1.34	1.24	1.32	0.94	91.01
Upeneichthys vlaminghii	1.02	0.81	1.15	0.70	92.22
Latridopsis forsteri	0.83	0.59	0.98	0.60	93.09

Table 6.9 (continued). Fish species with the highest contribution to average similarity within groups (SIMPER breakdowns). Statistics are: (y_i) mean abundance (square-root transformed values) within group; (S_i) the average similarity within the group; standard deviation SD; typification ratio; and the cumulative percent similarity.

6.6.3 Species Diversity

Fish communities of Central Victoria and Flinders bioregions had reasonably similar species richness, ranging from 7 to 12 species per site. Two exceptions were Popes Eye and South Channel Fort at Port Phillip Heads (communities C and D respectively), which had relatively high numbers of species. The Wilsons Promontory communities (J and K) also had relatively high species richness (Table 6.10). The Wilsons Promontory communities had high diversity indices (Hills N_2), along with the Phillip Island community (G). The Bunurong (H) and South Channel Fort (D) communities had the lowest diversity (Table 6.10).

Area	Community	S	N_2	E'
Port Phillip Heads (one site)	A	7.0	3.86	0.59
Port Phillip Heads (one site)	B	10.0	3.66	0.45
Port Phillip Heads (one site)	C	22.0	3.00	0.24
Port Phillip Heads (one site)	D	16.0	2.26	0.17
Bunurong East (one site)	E	8.0	3.09	0.38
Bunurong/Phillip Island	F	10.3	3.09	0.37
Phillip Island	G	10.4	4.95	0.47
Bunurong South and West	H	10.0	2.89	0.35
Port Phillip Heads	I	12.3	3.83	0.40
Wilsons Promontory	J	19.5	4.59	0.30
Wilsons Promontory	K	19.7	4.84	0.30

Table 6.10 Diversity statistics for fish community groups in Central Victoria and Flinders bioregions: average species richness (S), diversity (Hills N_2) and evenness (Camargo's index of evenness, E'). Communities groups are from the group analysis in Figure 6.8.

6.7 Ecological Boundaries

6.7.1 Combined Community Data

The abundance data for macrophytes, invertebrates and fishes were combined to examine overall spatial trends in reef community structure. Before these datasets were combined, the abundances within each species by site matrix were transformed into percentage ranks (with the highest abundance having the highest rank, zeros were ignored). This transformation down-weighted the influence of species with high abundances and standardised the data ranges so the datasets could be combined. To examine differences in community structure between sites, the combined dataset was analysed using the multivariate methods described in Section 6.2.2 (except the percent-rank data was not square-root transformed).

Both the MDS ordination and the group analysis dendrogram indicated the Wilsons Promontory community structure was quite distinct from all other locations (Figures 6.9 and 6.10, group QRS). The sites within the Wilsons Promontory location were grouped tightly together, indicating the community structure was reasonably similar over relatively large distances along the Promontory coastline.

Sites at Bunurong (DEF), Phillip Island (C) and outside Port Phillip Heads (Lonsdale Point and Lonsdale Back Beach, AB) were grouped together with little overlap with sites from neighbouring locations – indicating these locations also had distinctive community structures. However, the differences between these locations were much smaller than the differences with Wilsons Promontory.

There were large differences in community structure between sites inside Port Phillip Heads, these points being scattered over a large area of the MDS plot (Figure 6.9). These differences within the Port Phillip Heads location were as great, or greater, than community differences observed outside the Heads, from Point Lonsdale to eastern Wilsons Promontory (Figures 6.9 and 6.10). While the differences inside Port Phillip Heads were large, they were generally correlated with the spatial location of sites: sites at Nepean Bay, Lonsdale Bay and further inside the Heads were grouped loosely together.

6.7.2 Biogeographical Patterns and Boundaries

To identify areas that were relatively homogeneous in community structure, the group analysis in Section 6.7.1 was repeated, but with spatial constraints. The spatially constrained grouping followed the methods of Legendre and Legendre (1998), where groups were forced to be composed of contiguous sites. A connection network of site contiguity was first constructed using a Gabriel graph, and the resulting site connections were transformed into a contiguity matrix containing 1's for connected sites and 0's elsewhere (Legendre and Legendre 1998). The product of the contiguity and community dissimilarity matrix was computed (Hadamard product), with the subsequent matrix used for the grouping procedure. Both the dissimilarity and contiguity matrices were updated before each grouping iteration.

The dendrogram of constrained groups identified Bunurong (group A), Phillip Island (group BCDE), Lonsdale Point (group OPQ) and Wilsons Promontory (group RSTU) as separate areas that are relatively homogeneous in community structure (Figure 6.11). In contrast, sites within Port Phillip Heads were relatively heterogeneous in community structure, but distinct in structure from communities outside the Heads.

Biogeographical boundaries were also examined using a modification of the moving split-window method (Whittaker 1960; Webster and Wong 1969; Johnston *et al* 1992).

Essentially, the data were arranged such that each site was positioned in rank spatial order along the coast (*ie.* at equi-distant intervals). A split-window was laid over a portion of the sites and the dissimilarity in community structure between each window half was compared. In this case, Clarke's ANOSIM *R* statistic (Clarke 1993) was used to compare the window-halves. This statistic is the non-parametric equivalent of Mahalonobis' Distance (as recommended by Legendre and Legendre 1998), and can be readily computed from the Bray-Curtis dissimilarity matrix rather than using the raw data. The split-window was then moved sequentially along the transect of sites, calculating differences in window halves for the length of the coast. The *R*-values were then plotted against the rank-order of sites. Boundary locations occur at peaks in the *R*-value, indicating the rate of community structure change is at a maximum. More abrupt boundaries can be differentiated from the less distinct boundaries as peaks with higher *R*-values and peaks that persist with increased window sizes.

The constrained grouping results were supported by the split-window analysis. Strong discontinuities in community structure were apparent between the Port Phillip Heads, Phillip Island, Bunurong and Wilsons Promontory areas (Figure 6.12). In addition to these major boundaries, weaker discontinuities were apparent between inside and outside Port Phillip Heads, as well as in the vicinity of Glennie Island, South Point and Cape Wellington on Wilsons Promontory (Figure 6.12). These weaker Wilsons Promontory boundaries correspond with the north-south differences in macrophytes, and east-west differences in invertebrates and fish.

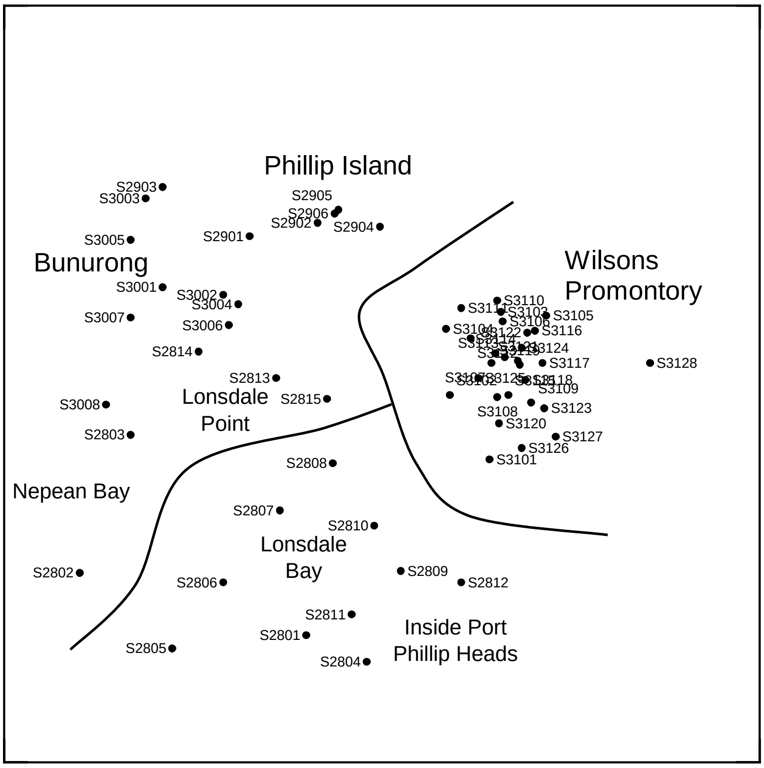


Figure 6.9 Two dimensional MDS ordination for reef community in the Central Victoria and Flinders bioregions. Site locations are listed in Table 6.1. Kruskal stress = 0.16

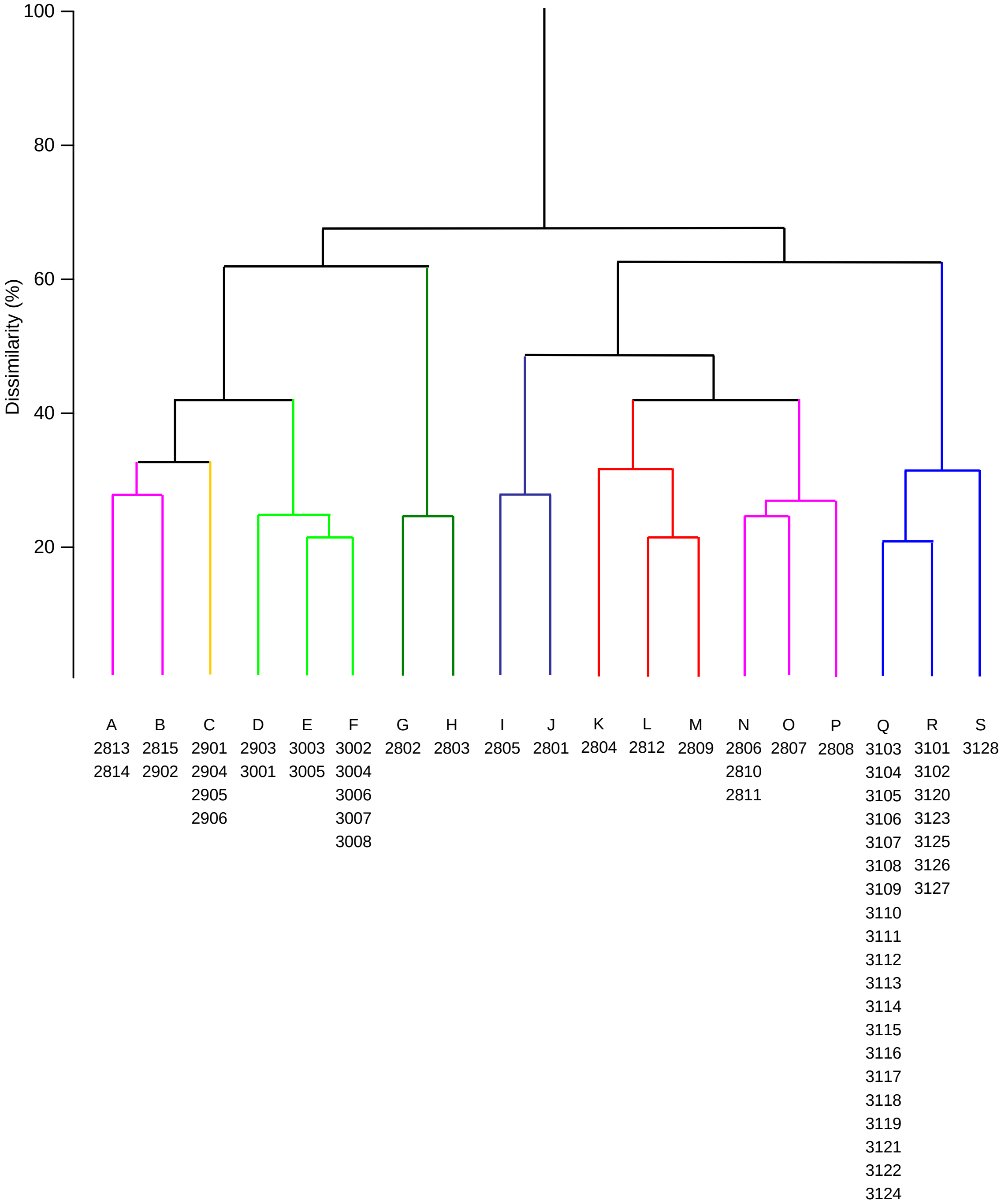


Figure 6.10 Dendrogram of community structure using combined data for macrophytes, invertebrates and fish (grouping was unconstrained). Linkages below 20% dissimilarity are not shown. Site locations are given in Table 6.1.

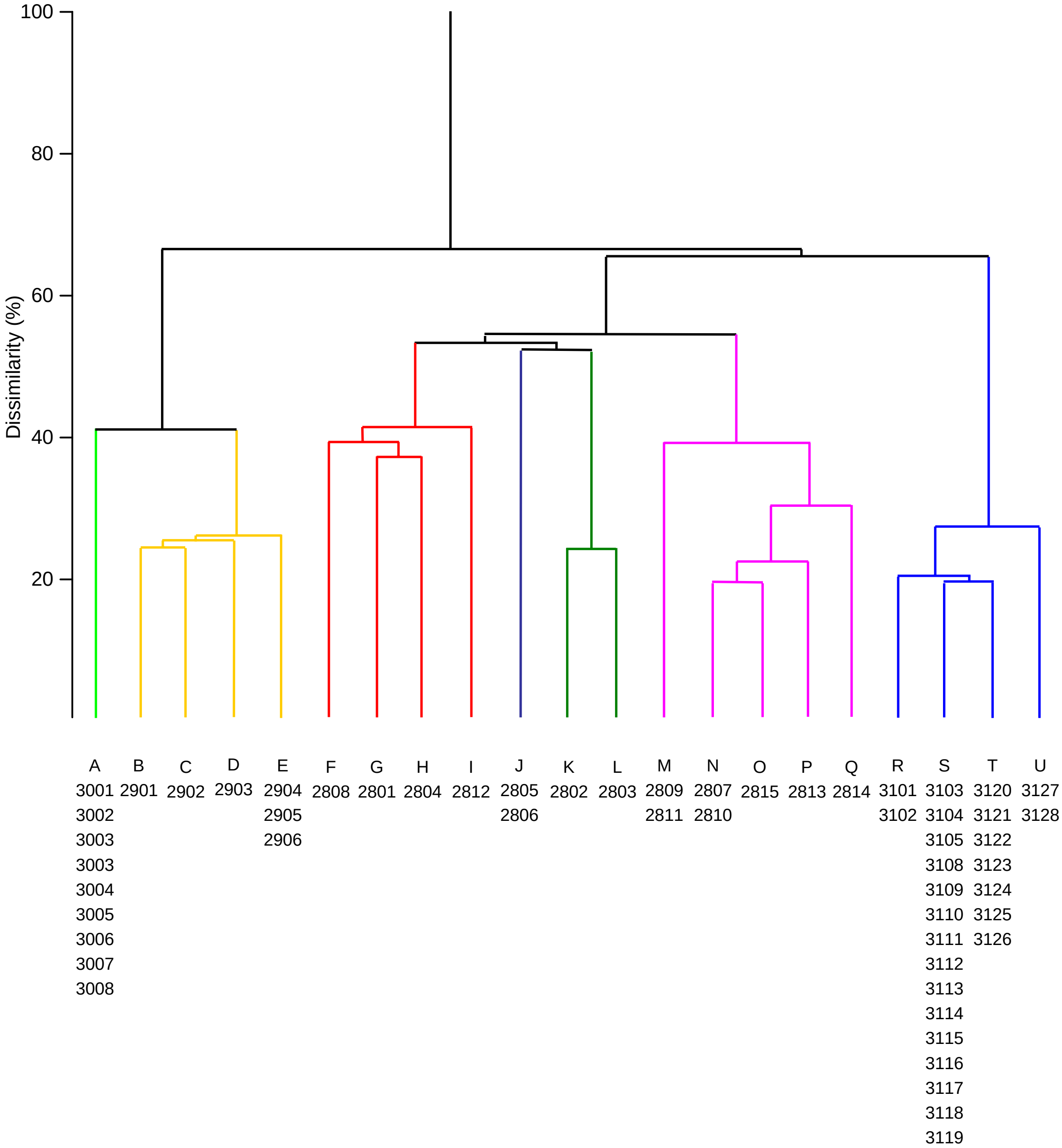


Figure 6.11 Spatially constrained dendrogram of community structure. Linkages below 20% dissimilarity are not shown. Site locations are given in Table 6.1.

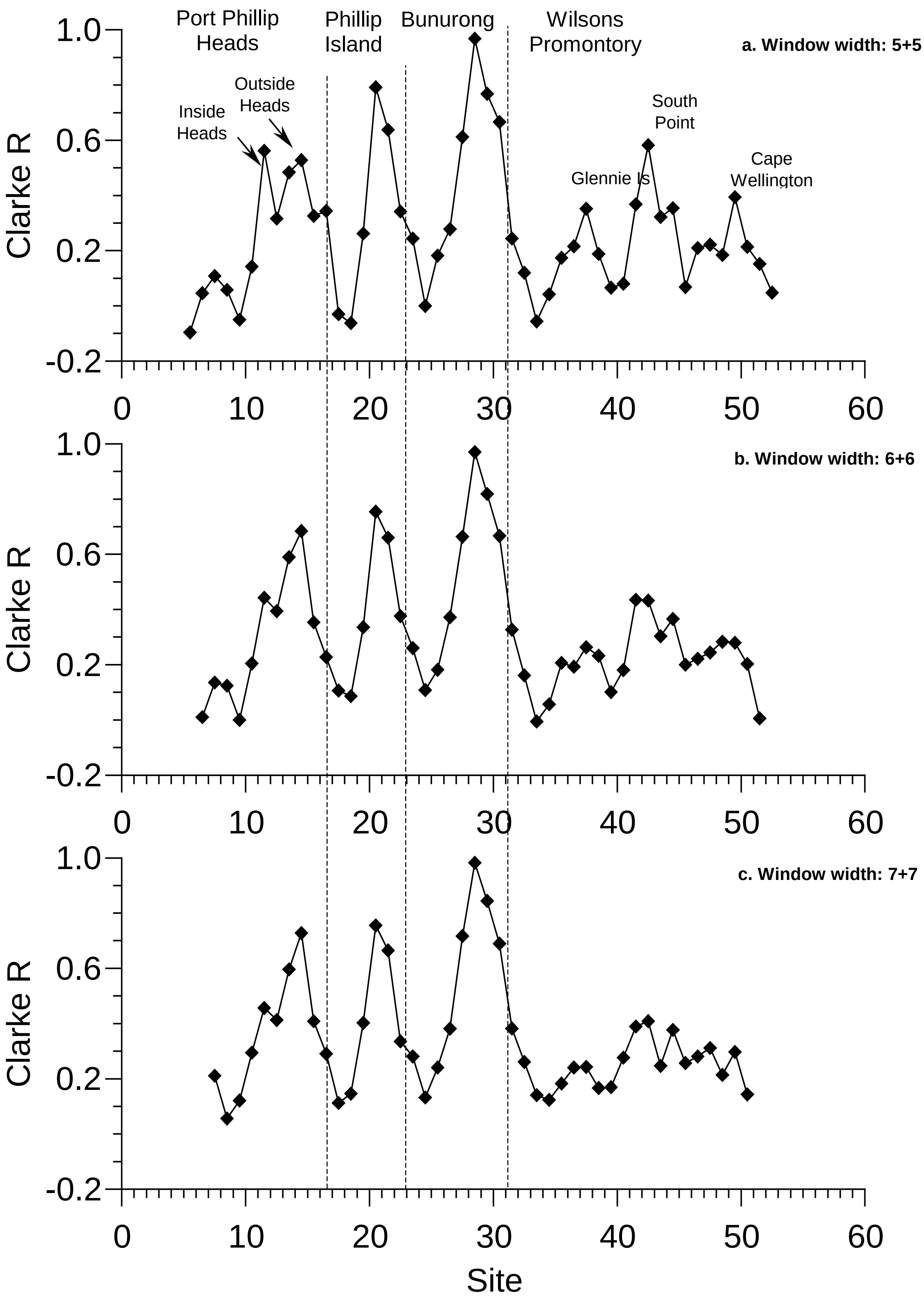


Figure 6.12 Boundary analysis results using Webster's moving split window. The sites are in order from west to east, with dashed lines delineating the Port Phillip Heads, Phillip Island, Bunurong and Wilsons Promontory areas. The peaks indicate rapid changes in community structure (quantified by Clarke's ANOSIM *R*).

6.8 Delineation of Marine Ecological Communities (MECs)

Multivariate data for macrophyte communities (Figures 6.3 and 6.4), invertebrate communities (Figures 6.5 and 6.6) and fish communities (Figures 6.7 and 6.8) were used to classify recurrent MECs for macrophyte, invertebrate and fish communities (Tables 6.11, 6.13 and 6.15 below respectively). MECs form a basis for classifying and representing patterns in community structure using quantitative numerical analysis. The process of delineation involved integrated analysis of the following ecological data sets:

- similarities in community structure (MDS, dendrogram);
- relative abundances (mean numbers / percent cover of characteristic species);
- relative species diversity (numbers of species, evenness); and
- site-specific spatial patterns in species distribution (ie characteristic mosaic patches of species along a transect).

The first step in the delineation was to identify distinctive site groupings on dendrograms below 33% dissimilarity (Figures 6.4, 6.6 and 6.8). These site groupings were then compared with their relative spatial arrangements on MDS ordinations (Figures 6.3, 6.5 and 6.7).

The second step in the delineation was to compare the relative abundance and species diversity statistics for among sites within each distinct site grouping. In this way dominant species, understorey and other characteristic species could be confidently identified and described for each site grouping.

For some site groupings it was also necessary to consider the actual spatial arrangement of species, particularly where communities are characterised by alternating mosaic patches of dominant species over small spatial areas (eg inside Port Phillip Heads). This data is derived from analysis of species data across individual transects.

Descriptions and distribution of all macrophyte (Tables 6.11 and 6.12), invertebrate (Tables 6.13 and 6.14) and fish (Tables 6.15 and 6.16) MECs are listed below. Note that invertebrate MECs coded “A”, “BC”, “D”, “E” and “F” assigned in Table 6.14 and Fish MECs coded “A”, “B”, “D” and “E “ assigned in Table 6.16 are not yet formally described due to very low abundances of species, and lack of replicate sites to enable confident descriptions. Further sampling will eventually elucidate their status. For a small number of sites MECs have been assigned on the basis of qualitative data. For these sites MECs can be delineated confidently without quantitative measures.

Group Codes	MEC Description
HI	Mixed browns dominated by *Acrocarpia paniculata*, *Cystophora retorta*, *Seirococcus axillaris* and the seagrass *Amphibolis antarctica*. *Phyllospora* absent, *Ecklonia radiata* uncommon. *Macrocystis angustifolia* present in small patches. Erect coralline algae abundant. Locality: south and east Bunurong
E	Mixed browns dominated by *Cystophora moniliformis*, *Cystophora retroflexa*, *Cystophora retorta*, *Acrocarpia paniculata* and *Macrocystis angustifolia*. Erect coralline algae abundant. Fleshy red algae not abundant. Locality: east Pyramid Rock, Phillip Island.
F	*Phyllospora comosa* dominated community. *Acrocarpia paniculata*, *Macrocystis angustifolia*, *Cystophora* spp and other browns also abundant. Understorey and open turfs of erect coralline algae and fleshy red algae, including *Haliptilon*, *Amphiroa* and *Phacellocarpus*. *Ecklonia* uncommon. Locality: Phillip Island.
G	*Phyllospora-Ecklonia-Cystophora retorta* dominated community. *Acrocarpia paniculata*, *Carpoglossum confluens* and *Cystophora platylobium* abundant. Understorey of fleshy red algae including *Pterocladia lucida*, *Melanthalia obtusata*, *Plocamium* spp, *Phacelocarpus peperocarpus*. Locality: Lonsdale Back Beach.
PR	*Ecklonia* dominated community. Fleshy red algal species abundant, similar species to Category G. *Phyllospora* absent. Locality: Rye Back Beach to Cape Shanck
A	*Ecklonia* dominated community with patches dominated by *Caulerpa brownii* and *Cladophora rugulosa.* Mixture of other browns, reds and green algae in low abundance. Locality: South Channel Fort.
B	*Ecklonia* dominated community with occasional patches of *Cladophora rugulosa*, some sites dominated by *Macrcystis angustifolia*. Understorey sparse cover of thallose red algae. Other brown algae in very low abundance. Locality: Popes Eye.
C	*Ecklonia* and mixed *Cystophora* and *Sargassum* species dominate, occasional patches dominated by *Amphibolis antarctica* or mixtures of *Cladophora rugulosa*, *Sargassum* and red algae. Locality: Inside Port Phillip Heads (Victory Shoal, Shortland Bluff, Point Franklin).
KL	*Ecklonia-Phyllospora* dominated community. *Seirococcus axillaris*, *Carpoglossum confluens*, *Sargassum* species abundant and fleshy red algal species abundant. Locality: northwest (Shellback Is) and northeast Wilsons Promontory (from north Waterloo Bay).
MNO	*Phyllospora* dominated community. *Ecklonia* abundant. Understorey of fleshy and coralline red algae common but in low abundance. High cover of encrusting coralline algae. Other browns present but in very low abundance. *Durvillaea* may be present in the shallow sub-littoral zone. Locality: Lonsdale Bay; Nepean Bay; Cape Woolamai; midwest, south to mid-eastern Wilsons Promontory.
D	*Amphibolis antarctica* dominated community. Occasional patches of *Ecklonia* and other brown algae such as *Cystophora*. Understorey mainly *Caulerpa* species and other red algae in low abundance. Locality: Nepean Bay
Q	*Phyllospora* and *Durvillaea* community, *Durvillaea* occurring to considerable depth (>3 m). Understorey algae generally absent. High cover of encrusting coralline algae. Locality: Cape Schanck; Cape Otway.
S	Low to medium cover of large brown algal species, either mixed or monospecific (generally less than 50% cover). Sparse to patchy stands of *Phyllospora*, *Macrocystis*, *Ecklonia* and *Acrocarpia*. High cover of encrusting and erect coralline algae, including *Haliptilon*, *Metagoniolithon* and *Cheilosporum*. *Halopteris*, *Caulerpa flexilis*, *Caulerpa obscura* and *Sonderopelta* common. Locality: Flinders to Cape Schanck.

Table 6.11 Macrophyte MECs for shallow water rocky reef s of Central Victoria and Flinders Bioregions.

Site Code	Site Name	Depth (m)	MEC	Reference	Ref. Type
Cape Otway					
D69	Further West of Cape Otway	15	MNO	R. Roob, unpub obs.	2
D74	West of Cape Otway	12	Q	R. Roob, unpub obs.	2
D68	Cape Otway	11	Q	R. Roob, unpub obs.	2
D67	South of Blanket Bay	9	Q	R. Roob, unpub obs.	2
Western Coast					
D66	Cape Morengo	10	MNO	R. Roob, unpub obs.	2
D65	Morengo	5	MNO	R. Roob, unpub obs.	2
D64	South Cape Patton	10	MNO	R. Roob, unpub obs.	2
	Point Addis	10	MNO		2
	Barwon Heads		MNO	M. Callan, pers. comm.	3
S2814	Lonsdale Backbeach	5	G	Edmunds *et al*, this study	1
S2815	Point Lonsdale Southwest	7	MNO	Edmunds *et al*, this study	1
S2813	Point Lonsdale	7	G	Edmunds *et al*, this study	1
Port Phillip Heads					
S2807	Merlan Inner	5	MNO	Edmunds *et al*, this study	1
S2810	Merlan Outer	5	MNO	Edmunds *et al*, this study	1
S2811	Lonsdale Kelp Inner	7	MNO	Edmunds *et al*, this study	1
S2809	Lonsdale Kelp Outer	7	MNO	Edmunds *et al*, this study	1
S2808	Nepean Bay	2	MNO	Edmunds *et al*, this study	1
S2802	Nepean Bay	2	D	Edmunds *et al*, this study	1
S2803	Nepean Bay	2	D	Edmunds *et al*, this study	1
S2806	Victory Shoal	5	C	Edmunds *et al*, this study	1
S2805	Shortland Bluff	5	C	Edmunds *et al*, this study	1
S2801	Point Franklin	3	C	Edmunds *et al*, this study	1
S2812	Popes Eye	5	B	Edmunds *et al*, this study	1
S2804	South Channel Fort	2	A	Edmunds *et al*, this study	1
Mornington Peninsula					
D59	Sorrento Backbeach	10	PR	R. Roob, unpub obs.	2
	Rye Backbeach	11	PR	M. Edmunds, personal obs.	3
G0.9-4.1	Gunnumatta and to south	14	PR	Chidgey *et al* 1998	1
A	Cape Schanck	14	PR	Edmunds *et al* 1999	1
A36	Northwest Cape Schanck	8	S	M. Edmunds, unpub obs.	2
A35	Pulpit Rock	10	S	M. Edmunds, unpub obs.	2
A213	Pulpit Rock South	8	PR	M. Edmunds, unpub obs.	2
B	Cape Schanck	14	PR	Edmunds *et al* 1999	1
A212	Cape Schanck East	10	S	M. Edmunds, unpub obs.	2
A34	Bushrangers Bay	7	S	M. Edmunds, unpub obs.	2
A211	Bushrangers Bay South	13	S	M. Edmunds, unpub obs.	2
A118	Limestone Caves	8	S	M. Edmunds, unpub obs.	2
A214	Bushrangers Bay Inside	10	S	M. Edmunds, unpub obs.	2
A227	Picnic Point Bay	8	Q	M. Edmunds, unpub obs.	2
A212	Picnic Point Cliff	12	S	M. Edmunds, unpub obs.	2
A33	Picnic Point	8	S	M. Edmunds, unpub obs.	2

Table 6.12 Distribution of macrophyte MECs in the Central Victorian and Flinders bioregions, based on available information. MEC codes are described in Table 6.11. The reference type (Ref. Type) refers to whether the classification was from: (1) quantitative data; (2) formal qualitative survey data; or (3) informal qualitative description.

Site Code	Site Name	Depth (m)	MEC	Reference	Ref. Type
Mornington Peninsula (continued)					
A216	The Arch	12	S	M. Edmunds, unpub obs.	2
A217	The Arch Gully	11	S	M. Edmunds, unpub obs.	2
A212	Simmons Bay West	7	S	M. Edmunds, unpub obs.	2
A221	Glensira Point 3	13	S	M. Edmunds, unpub obs.	2
A220	Glensira Point 2	7	S	M. Edmunds, unpub obs.	2
A222	Blowhole West	9	S	M. Edmunds, unpub obs.	2
A31	The Pinnacles	7	S	M. Edmunds, unpub obs.	2
A226	Flinders Backbeach West	7	S	M. Edmunds, unpub obs.	2
A30	Flinders Backbeach	7	S	M. Edmunds, unpub obs.	2
A29	West Head Reef	7	S	M. Edmunds, unpub obs.	2
Phillip Island					
S2901	North of Nobbies	6	F	Edmunds *et al*, this study	1
D49	Seal Rocks	8	F	R. Roob, unpub obs.	2
D48	East of Summerland	8	F	R. Roob, unpub obs.	2
C	Red Bluff	14	F	Edmunds *et al* 1999	1
S2902	Red Bluff	6	F	Edmunds *et al*, this study	1
D47	Pyramid Rock	10	F	R. Roob, unpub obs.	2
S2903	North of Pyramid Rock	4	E	Edmunds *et al*, this study	1
D	Cape Woolamai west	14	MNO	Edmunds *et al* 1999	1
S2904	Cape Woolamai west	6	MNO	Edmunds *et al*, this study	1
D46	Cape Woolamai	8	MNO	R. Roob, unpub obs.	2
S2905	Cape Woolamai Central	6	F	Edmunds *et al*, this study	1
S2906	Cape Woolamai East	4	F	Edmunds *et al*, this study	1
Kilcunda					
	Kilcunda		F	L. Thorbecke, pers. comm.	3
Bunurong					
CPA17	Coal Point	10	F	Wilson *et al* 1983	2
CPA16	Coal Point	9	F	Wilson *et al* 1983	2
CPA15	Harmers Haven	5	HI	Wilson *et al* 1983	2
CPA14	Harmers Haven	11	HI	Wilson *et al* 1983	2
S3001	Cape Paterson	4	HI	Edmunds *et al*, this study	1
S3002	Cape Paterson Boatramp	6	HI	Edmunds *et al*, this study	1
S3003	The Oaks East	6	HI	Edmunds *et al*, this study	1
S3004	Twin Reefs	6	HI	Edmunds *et al*, this study	1
S3005	Shack Bay West	5	HI	Edmunds *et al*, this study	1
S3006	Shack Bay Central	6	HI	Edmunds *et al*, this study	1
S3007	The Caves	6	HI	Edmunds *et al*, this study	1
S3008	Petrel Rock East	5	HI	Edmunds *et al*, this study	1
Cape Liptrap					
	Cape Liptrap		HI	L. Thorbecke, pers. comm.	3

Table 6.12 (continued). Distribution of macrophyte MECs in the Central Victoria and Flinders bioregions, based on available information. MEC codes are described in Table 6.11. The reference type (Ref. Type) refers to whether the classification was from: (1) quantitative data; (2) formal qualitative survey data; or (3) informal qualitative description.

Site Code	Site Name	Depth (m)	MEC	Reference	Ref. Type
Wilsons Promontory					
S3101	North Shellback Island	10	KL	Edmunds *et al*, this study	1
S3102	North Tongue Pt	10	MNO	Edmunds *et al*, this study	1
S3103	Northwest Norman Is	10	MNO	Edmunds *et al*, this study	1
S3104	West Norman Is	10	MNO	Edmunds *et al*, this study	1
S3105	Leonard Pt	10	MNO	Edmunds *et al*, this study	1
S3106	Pillar Pt	10	MNO	Edmunds *et al*, this study	1
S3107	South Norman Pt	10	MNO	Edmunds *et al*, this study	1
S3108	Oberon Pt	10	MNO	Edmunds *et al*, this study	1
S3109	East Glennie Is	10	MNO	Edmunds *et al*, this study	1
S3110	West Glennie Is	10	MNO	Edmunds *et al*, this study	1
S3111	North of Sea Eagle Bay	10	MNO	Edmunds *et al*, this study	1
S3112	Sea Eagle Bay	10	MNO	Edmunds *et al*, this study	1
S3113	North Anser Is	10	MNO	Edmunds *et al*, this study	1
S3114	South Pt	10	MNO	Edmunds *et al*, this study	1
S3115	Roaring Meg Bight	10	MNO	Edmunds *et al*, this study	1
S3116	West of West Landing	10	MNO	Edmunds *et al*, this study	1
S3117	East landing	10	MNO	Edmunds *et al*, this study	1
S3118	Fenwick Pt	10	MNO	Edmunds *et al*, this study	1
S3119	Waterloo Pt	10	MNO	Edmunds *et al*, this study	1
S3120	Central Waterloo Bay	10	KL	Edmunds *et al*, this study	1
S3121	North Waterloo Bay	10	MNO	Edmunds *et al*, this study	1
S3122	North Cape Wellington	10	MNO	Edmunds *et al*, this study	1
S3123	Bareback Bay	10	KL	Edmunds *et al*, this study	1
S3124	South Refuge	10	MNO	Edmunds *et al*, this study	1
S3125	North Refuge	10	KL	Edmunds *et al*, this study	1
S3126	Horn Bay	10	KL	Edmunds *et al*, this study	1
S3127	North Horn Pt	10	KL	Edmunds *et al*, this study	1
S3128	The Hat	10	J	Edmunds *et al*, this study	1

Table 6.12 (continued). Distribution of macrophyte MECs in the Central Victoria and Flinders bioregions, based on available information. MEC codes are described in Table 6.11. The reference type (Ref. Type) refers to whether the classification was from: (1) quantitative data; (2) formal qualitative survey data; or (3) informal qualitative description.

Group* Codes	MEC Description
GHIJ	*Heliocidaris erythrogramma*, *Haliotis rubra* and *Cenolia trichoptera* very abundant. High diversity of sea star species with characteristic species including *Nectria ocellata*, *Nectria macrobrachia*, *Patiriella brevispina*, and *Petricia vernicina*. Location: Wilsons Promontory.
KLM	*Haliotis rubra* and *Turbo undulatus* the most abundant species. *Dicathais orbita*, *Plagusia chabrus* and *Patiriella brevispina* also common. *Heliocidaris erythrogramma* not abundant. Locations: Lonsdale Bay, Lonsdale Back Beach, Phillip Island and Bunurong.
NOP	*Haliotis rubra*, *Haliotis laevigata*, *Heliocidaris erythrogramma* and *Patiriella brevispina* the most abundant species. Locations: Port Phillip Heads and Bunurong.
Q	All species low in abundance. *Haliotis rubra* the most abundant. Other characteristic species: *Nectria ocellata*, *Nectria macrobrachia*, *Fromia polypora* and *Tosia australis*. Location: from Gunnamatta to Cape Schanck.
R	*Cenolia trichoptera* abundant, all other species relatively low in abundance, including *Haliotis rubra*. Location: south of Waratah Bay.

Table 6.13 Invertebrate MECs for shallow water rocky reef s of Central Victoria and Flinders Bioregions. (***Note Invertebrate MECs A, BC, D, E and F are not yet described due to very low abundances of invertebrate species and lack of replicate sites to enable confident descriptions. Further sampling will eventually confirm their status).**

Site Code	Site Name	Depth (m)	MEC	Reference	Ref. Type
West Coast					
S2814	Lonsdale Backbeach	5	KLM	Edmunds *et al*, this study	1
S2815	Point Lonsdale Southwest	7	KLM	Edmunds *et al*, this study	1
S2813	Point Lonsdale	7	KLM	Edmunds *et al*, this study	1
Port Phillip Heads					
S2807	Merlan Inner	5	NOP	Edmunds *et al*, this study	1
S2810	Merlan Outer	5	KLM	Edmunds *et al*, this study	1
S2811	Lonsdale Kelp Inner	7	BC	Edmunds *et al*, this study	1
S2809	Lonsdale Kelp Outer	7	A	Edmunds *et al*, this study	1
S2808	Nepean Bay	2	KLM	Edmunds *et al*, this study	1
S2802	Nepean Bay	2	D	Edmunds *et al*, this study	1
S2803	Nepean Bay	2	NOP	Edmunds *et al*, this study	1
S2806	Victory Shoal	5	NOP	Edmunds *et al*, this study	1
S2805	Shortland Bluff	5	NOP	Edmunds *et al*, this study	1
S2801	Point Franklin	3	E	Edmunds *et al*, this study	1
S2812	Popes Eye	5	BC	Edmunds *et al*, this study	1
S2804	South Channel Fort	2	E	Edmunds *et al*, this study	1

Table 6.14 Distribution of invertebrate MECs in the Central Victoria and Flinders bioregions, based on available information. MEC codes are described in Table 6.13. The reference type (Ref. Type) refers to whether the classification was from: (1) quantitative data; (2) formal qualitative survey data; or (3) informal qualitative description.

Site Code	Site Name	Depth (m)	MEC	Reference	Ref. Type
Mornington Peninsula					
G0.9-4.1	Gunnumatta and to south	14	Q	Chidgey *et al* 1998	1
A	Cape Schanck	14	Q	Edmunds *et al* 1999	1
A36	Northwest Cape Schanck	8	KLM	M. Edmunds, unpub obs.	2
A35	Pulpit Rock	10	KLM	M. Edmunds, unpub obs.	2
A213	Pulpit Rock South	8	KLM	M. Edmunds, unpub obs.	2
B	Cape Schanck	14	KLM	Edmunds *et al* 1999	1
A212	Cape Schanck East	10	KLM	M. Edmunds, unpub obs.	2
A34	Bushrangers Bay	7	KLM	M. Edmunds, unpub obs.	2
A227	Picnic Point Bay	8	KLM	M. Edmunds, unpub obs.	2
Phillip Island					
S2901	North of Nobbies	6	KLM	Edmunds *et al*, this study	1
C	Red Bluff	14	KLM	Edmunds *et al* 1999	1
S2902	Red Bluff	6	KLM	Edmunds *et al*, this study	1
S2903	North of Pyramid Rock	4	KLM	Edmunds *et al*, this study	1
D	Cape Woolamai west	14	KLM	Edmunds *et al* 1999	1
S2904	Cape Woolamai west	6	KLM	Edmunds *et al*, this study	1
S2905	Cape Woolamai Central	6	KLM	Edmunds *et al*, this study	1
S2906	Cape Woolamai East	4	GHIJ	Edmunds *et al*, this study	1
Bunurong					
S3001	Cape Paterson	4	KLM	Edmunds *et al*, this study	1
S3002	Cape Paterson Boatramp	6	KLM	Edmunds *et al*, this study	1
S3003	The Oaks East	6	KLM	Edmunds *et al*, this study	1
S3004	Twin Reefs	6	KLM	Edmunds *et al*, this study	1
S3005	Shack Bay West	5	KLM	Edmunds *et al*, this study	1
S3006	Shack Bay Central	6	NOP	Edmunds *et al*, this study	1
S3007	The Caves	6	KLM	Edmunds *et al*, this study	1
S3008	Petrel Rock East	5	NOP	Edmunds *et al*, this study	1

Table 6.14 (continued). Distribution of invertebrate MECs in the Central Victoria and Flinders bioregions, based on available information. MEC codes are described in Table 6.13. The reference type (Ref. Type) refers to whether the classification was from: (1) quantitative data; (2) formal qualitative survey data; or (3) informal qualitative description.

Site Code	Site Name	Depth (m)	MEC	Reference	Ref. Type
Wilsons Promontory					
E	South of Waratah Bay	12	R	Edmunds *et al* 1999	1
F	North Shellback Island	10	GHIJ	Edmunds *et al* 1999	1
S3101	North Shellback Island	10	GHIJ	Edmunds *et al*, this study	1
S3102	North Tongue Pt	10	GHIJ	Edmunds *et al*, this study	1
S3103	Northwest Norman Is	10	GHIJ	Edmunds *et al*, this study	1
S3104	West Norman Is	10	GHIJ	Edmunds *et al*, this study	1
S3105	Leonard Pt	10	GHIJ	Edmunds *et al*, this study	1
S3106	Pillar Pt	10	GHIJ	Edmunds *et al*, this study	1
S3107	South Norman Pt	10	GHIJ	Edmunds *et al*, this study	1
S3108	Oberon Pt	10	GHIJ	Edmunds *et al*, this study	1
S3109	East Glennie Is	10	GHIJ	Edmunds *et al*, this study	1
S3110	West Glennie Is	10	GHIJ	Edmunds *et al*, this study	1
S3111	North of Sea Eagle Bay	10	GHIJ	Edmunds *et al*, this study	1
S3112	Sea Eagle Bay	10	GHIJ	Edmunds *et al*, this study	1
S3113	North Anser Is	10	GHIJ	Edmunds *et al*, this study	1
S3114	South Pt	10	GHIJ	Edmunds *et al*, this study	1
S3115	Roaring Meg Bight	10	GHIJ	Edmunds *et al*, this study	1
S3116	West of West Landing	10	GHIJ	Edmunds *et al*, this study	1
S3117	East landing	10	GHIJ	Edmunds *et al*, this study	1
S3118	Fenwick Pt	10	GHIJ	Edmunds *et al*, this study	1
S3119	Waterloo Pt	10	GHIJ	Edmunds *et al*, this study	1
S3120	Central Waterloo Bay	10	GHIJ	Edmunds *et al*, this study	1
S3121	North Waterloo Bay	10	GHIJ	Edmunds *et al*, this study	1
S3122	North Cape Wellington	10	GHIJ	Edmunds *et al*, this study	1
S3123	Bareback Bay	10	GHIJ	Edmunds *et al*, this study	1
S3124	South Refuge	10	GHIJ	Edmunds *et al*, this study	1
S3125	North Refuge	10	GHIJ	Edmunds *et al*, this study	1
S3126	Horn Bay	10	GHIJ	Edmunds *et al*, this study	1
S3127	North Horn Pt	10	GHIJ	Edmunds *et al*, this study	1
S3128	The Hat	10	F	Edmunds *et al*, this study	1

Table 6.14 (continued). Distribution of invertebrate MECs in the Central Victoria and Flinders bioregions, based on available information. MEC codes are described in Table 6.13. The reference type (Ref. Type) refers to whether the classification was from: (1) quantitative data; (2) formal qualitative survey data; or (3) informal qualitative description.

Group* Codes	MEC Description
C	Dominant species *Trachinops caudimaculatus* in very high abundance, other species in high abundance *Scorpis aequipinnis*, *Notolabrus tetricus*, *Notolabrus fucicola*, *Meuschenia freycineti* and *Parma victoriae*. Location: Popes Eye.
D	Dominant species *Trachinops caudimaculatus* in high abundance. Other species *Notolabrus tetricus* characteristic. Location: South Channel Fort.
F	Dominant species *Notolabrus fucicola, Odax cyanomelas* and *Scorpis aequipinnis* in low abundance. Locations: Phillip Island (Red Bluff, north of Pyramid Rock).
GH	Dominant species are *Notolabrus tetricus*, *Odax cyanomelas*, *Scorpis aequipinnis*, *Notolabrus fucicola* and *Cheilodactylus nigripes*. Other characteristic species include *Parma victoriae*, *Pictilabrus laticlavius*, *Meuschenia hippocrepis* and *Aplodactylus arctidens*. Locations: Lonsdale Back Beach, Phillip Island and Bunurong.
I	Dominant species are *Notolabrus tetricus*, *Odax cyanomelas*, *Parma victoriae* and *Cheilodactylus nigripes*. *Scorpis aequipinnis* and *Notolabrus fucicola* are generally low in abundance. Other characteristic species include *Pictilabrus laticlavius*, *Upeneichthys vlamingii*, *Meuschenia hippocrepis* and *Meuschenia flavolineata*. Location: Port Phillip Heads.
J	Dominant species are *Caesioperca rasor*, *Notolabrus tetricus*, *Notolabrus fucicola*, *Dinolestes lewini* and *Odax cyanomelas*. Other characteristic species are: *Acanthaluteres vittiger*, *Enoplosus armatus*, *Cheilodactylus nigripes*, *Scorpis aequipinnis* and *Trachinops caudimaculatus*. Location: western Wilsons Promontory.
K	Dominant species are *Caesioperca rasor*, *Notolabrus tetricus* and *Dinolestes lewini*. Other characteristic species are: *Cheilodactylus nigripes*, *Scorpis aequipinnis*, *Scorpis lineolata*, *Atypichthys strigatus* and *Latridopsis forsteri*. Location: eastern Wilsons Promontory.

Table 6.15. Fish MECs for shallow water rocky reefs of Central Victoria and Flinders Bioregions. (*Note Fish MECs A, B, D and E not yet described due to very low abundances of fish species and lack of replicate sites to enable confident descriptions. Further sampling will eventually confirm their status).

Site Code	Site Name	Depth (m)	MEC	Reference	Ref. Type
West Coast					
S2814	Lonsdale Backbeach	5	GH	Edmunds *et al*, this study	1
S2815	Point Lonsdale Southwest	7	I	Edmunds *et al*, this study	1
S2813	Point Lonsdale	7	GH	Edmunds *et al*, this study	1
Port Phillip Heads					
S2807	Merlan Inner	5	GH	Edmunds *et al*, this study	1
S2810	Merlan Outer	5	GH	Edmunds *et al*, this study	1
S2811	Lonsdale Kelp Inner	7	GH	Edmunds *et al*, this study	1
S2809	Lonsdale Kelp Outer	7	GH	Edmunds *et al*, this study	1
S2808	Nepean Bay	2	GH	Edmunds *et al*, this study	1
S2802	Nepean Bay	2	I	Edmunds *et al*, this study	1
S2803	Nepean Bay	2	I	Edmunds *et al*, this study	1
S2806	Victory Shoal	5	I	Edmunds *et al*, this study	1
S2805	Shortland Bluff	5	A	Edmunds *et al*, this study	1
S2801	Point Franklin	3	B	Edmunds *et al*, this study	1
S2812	Popes Eye	5	C	Edmunds *et al*, this study	1
S2804	South Channel Fort	2	D	Edmunds *et al*, this study	1
Phillip Island					
S2901	North of Nobbies	6	GH	Edmunds *et al*, this study	1
S2902	Red Bluff	6	F	Edmunds *et al*, this study	1
S2903	North of Pyramid Rock	4	F	Edmunds *et al*, this study	1
S2904	Cape Woolamai west	6	GH	Edmunds *et al*, this study	1
S2905	Cape Woolamai Central	6	GH	Edmunds *et al*, this study	1
S2906	Cape Woolamai East	4	GH	Edmunds *et al*, this study	1
Bunurong					
S3001	Cape Paterson	4	GH	Edmunds *et al*, this study	1
S3002	Cape Paterson Boatramp	6	GH	Edmunds *et al*, this study	1
S3003	The Oaks East	6	GH	Edmunds *et al*, this study	1
S3004	Twin Reefs	6	GH	Edmunds *et al*, this study	1
S3005	Shack Bay West	5	GH	Edmunds *et al*, this study	1
S3006	Shack Bay Central	6	GH	Edmunds *et al*, this study	1
S3007	The Caves	6	GH	Edmunds *et al*, this study	1
S3008	Petrel Rock East	5	E	Edmunds *et al*, this study	1

Table 6.16. Distribution of fish MECs in the Central Victoria and Flinders bioregions, based on available information. MEC codes are described in Table 6.15. The reference type (Ref. Type) refers to whether the classification was from: (1) quantitative data; (2) formal qualitative survey data; or (3) informal qualitative description.

Site Code	Site Name	Depth (m)	MEC	Reference	Ref. Type
Wilsons Promontory					
S3101	North Shellback Island	10	J	Edmunds *et al*, this study	1
S3102	North Tongue Pt	10	J	Edmunds *et al*, this study	1
S3103	Northwest Norman Is	10	J	Edmunds *et al*, this study	1
S3104	West Norman Is	10	J	Edmunds *et al*, this study	1
S3105	Leonard Pt	10	J	Edmunds *et al*, this study	1
S3106	Pillar Pt	10	K	Edmunds *et al*, this study	1
S3107	South Norman Pt	10	K	Edmunds *et al*, this study	1
S3108	Oberon Pt	10	J	Edmunds *et al*, this study	1
S3109	East Glennie Is	10	J	Edmunds *et al*, this study	1
S3110	West Glennie Is	10	J	Edmunds *et al*, this study	1
S3111	North of Sea Eagle Bay	10	J	Edmunds *et al*, this study	1
S3112	Sea Eagle Bay	10	J	Edmunds *et al*, this study	1
S3113	North Anser Is	10	J	Edmunds *et al*, this study	1
S3114	South Pt	10	J	Edmunds *et al*, this study	1
S3115	Roaring Meg Bight	10	K	Edmunds *et al*, this study	1
S3116	West of West Landing	10	J	Edmunds *et al*, this study	1
S3117	East landing	10	K	Edmunds *et al*, this study	1
S3118	Fenwick Pt	10	K	Edmunds *et al*, this study	1
S3119	Waterloo Pt	10	K	Edmunds *et al*, this study	1
S3120	Central Waterloo Bay	10	K	Edmunds *et al*, this study	1
S3121	North Waterloo Bay	10	K	Edmunds *et al*, this study	1
S3122	North Cape Wellington	10	K	Edmunds *et al*, this study	1
S3123	Bareback Bay	10	K	Edmunds *et al*, this study	1
S3124	South Refuge	10	K	Edmunds *et al*, this study	1
S3125	North Refuge	10	K	Edmunds *et al*, this study	1
S3126	Horn Bay	10	K	Edmunds *et al*, this study	1
S3127	North Horn Pt	10	K	Edmunds *et al*, this study	1
S3128	The Hat	10	K	Edmunds *et al*, this study	1

Table 6.16 (continued). Distribution of fish MECs in the Central Victoria and Flinders bioregions, based on available information. MEC codes are described in Table 6.15. The reference type (Ref. Type) refers to whether the classification was from: (1) quantitative data; (2) formal qualitative survey data; or (3) informal qualitative description.

6.9 Discussion

This study found substantial differences in reef communities within the Central Victoria and Flinders bioregions. Although not every available reef habitat was sampled in these bioregions, spatial trends occur at both the broader areaal (100s km) and local (10s km) scale. At the bioregional scale, the Wilsons Promontory area (Flinders bioregion) was well differentiated from the more western Port Phillip Heads to Bunurong area (Central Victoria bioregion) in terms of overall macrophyte, invertebrate and fish community composition.

At the Wilsons Promontory area, northern and southern differences were apparent in the macrophyte communities, while east-west differences were apparent in the invertebrate and fish communities. Localised differences were also observed for macrophyte and fish communities within the Port Phillip Heads to Bunurong area. These components were generally differentiated into communities that were characteristic of the Port Phillip Heads, Phillip Island or Bunurong sampling locations. Distinct invertebrate community types were also identified within the Port Phillip Heads to Bunurong area, but these community types were present at more than one location (eg at Bunurong and Phillip Island or at Bunurong and Port Phillip Heads).

Most observed species were present throughout the sampled areas, from Port Phillip Heads to eastern Wilsons Promontory. Consequently, differences in community structure were generally because of shifts in species abundances rather than the presence or absence of species. In addition, the differentiation (or characterisation) of each community type was usually based on a suite of many species. Consequently, the observed communities cannot be easily identified or defined by just a few dominant species. Prominent community types were described in detail in the preceding sections (Sections 6.4, 6.5 and 6.6).

Distinct boundaries in community structure were identified, separating the Port Phillip Heads, Phillip Island, Bunurong and Wilsons Promontory areas. The community structure within the Phillip Island, Bunurong and Wilsons Promontory areas was considered reasonably homogeneous between sites. However, There was considerable variability in community composition between the Port Phillip Heads sites.

The reef biota changed considerably across the Central Victoria bioregion. This is consistent with the findings of O’Hara (Chapter 3) that this bioregion is an area of rapid turnover in species. The observed pattern was also consistent with this area having overlapping influences of species from the Flindersian and Peronian biogeographic provinces (Figure 6.1a). The influence of Flindersian species is expected to decrease from west to east, with a corresponding increase in the influence of Peronian species.

Although specific species distributions were not analysed in detail, the data show an extension to the known ranges of many common species. Based on previous descriptions by Womersley (1987) and Edgar (1997), these include increased eastern extents of: *Zonaria turneriana* and *Melanthalia obtusata* from Port Phillip Heads to eastern Wilsons Promontory; and *Seirococcus axillaris, Sonderopelta coriacea* and *Callophyllus lambertii* from Walkerville to northeastern Wilsons Promontory. Such observations will be subject to confirmation through the submission of samples to the National Herbarium of Victoria.

6.10 Acknowledgments

This report was prepared with funding from the Victorian Department of Natural Resources and Environment, Australian Marine Safety Authority, Australian Marine Ecology Pty Ltd. We wish to thank Dr Jeremy Austin for his substantial and invaluable assistance in preparation of text and figures, as well as editorial comment.

6.11 References

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