Intertidal Reef Assessment on the Fleurieu Peninsula, S.A.

REPORT TO THE S.A. DEPARTMENT OF ENVIRONMENT AND HERITAGE

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Summary

Biodiversity and habitat surveys of the physical environment were conducted at 17 intertidal sites along the Fleurieu Peninsula S.A. Species inventories revealed 112 species of molluscs, 29 echinoderms and 49 marine plants across all sites. A hotspot for molluscan diversity was located at Kings Beach at the tip of the Peninsula, whereas a hotspot for echinoderms occurred at Myponga and for algae at Hallett Cove within the Gulf of St Vincent. Sites within the Aquatic reserves at Port Noarlunga and Aldinga Reef were found to have a significantly lower mean species richness for invertebrates (p value = 0.015) compared to sites outside the reserves. This could be partly related to rock type, as all sites within the reserves was composed of soft limestone, whereas significantly higher species richness was found on the harder crystalline, igneous and metamorphic rock types (invertebrates p = 0.007, flora p = 0.031). Multivariate analyses revealed significantly different molluscan communities occur on the two rock types (p value = 0.004). Species richness of invertebrates and algae were found to be significantly correlated (p = 0.028), but there were no significant correlations between species richness and the number of habitats, habitat complexity or percent cover of sessile organisms found. Consequently, habitat data can not be used as a surrogate for prioritizing sites for biodiversity conservation. However, adequate protection for hard intertidal rocky reefs, such as the invertebrate hotspots, should be considered for future marine planning in this region.

Introduction

Intertidal reefs (rocky shores) are important ecosystems along the coastline of the Fleurieu Peninsula, S.A. They support complex communities of algae and invertebrates, which have adapted to survive the harsh extremes of the constantly changing physical environment. Southern Australian temperate marine flora and fauna is well known for high biodiversity and a large proportion of endemic species (Zann 2000). Nevertheless, the communities occurring on intertidal reefs in South Australia have been more or less neglected since Womersley and Thomas's (1976) account in the original volume of "The Natural History of the Adelaide Region" (adapted from Womersley and Edmonds, 1958 study), with the exception of several unpublished student theses (e.g. Williams 1996; Pocklington 2003; Cantin 2005; Dutton 2007; Liversage 2007).

In the “No Species Loss” biodiversity policy, the S.A. Government (2006) has recognized the need to identify and fill gaps in the scientific knowledge and understanding of our biodiversity. Under Strategic Area III, Target 21 identifies the need for systematic surveys of marine plants and animals. Species inventory data provides the foundation for conservation and management of marine habitats (Benkendorff and Davis 2002; Gladstone 2002). It provides baseline data for characterizing and monitoring the state of the environment. Strategic area III of the No Species Loss Policy (S.A. Government 2006) further recognizes the need to identify priority areas of high conservation value for biodiversity planning. Species inventory data collected using rapid biodiversity assessment (1hr timed search surveys) has been validated for prioritising intertidal reefs for their biodiversity (Benkendorff, 2003) and can facilitate the identification of biodiversity hotspots (e.g. Benkendorff 2005). Benkendorff and Davis (2002), define biodiversity hotspots as sites with more than two standard deviations above the mean species richness for a region. These sites may be considered a priority for efficient protection of a broad range of species. Multivariate analyses of species occurrence data can also be used to identify distinct ecological communities (e.g. Benkendorff 2005) and thus facilitate the process of ensuring representativeness within a network of marine reserves.

Ecological communities on intertidal reefs can be influenced by a range of different biotic and abiotic interactions. The *Habitat Diversity Hypothesis* (Connor and McCoy, 1979), predicts that a greater diversity of species will occur where a greater diversity of habitats exist. Consequently, habitat diversity has been used as a surrogate for intertidal reef biodiversity in NSW (NSW Fisheries 2001). Other features that could influence the diversity of species found include rock type (e.g. Cattaneo-Vietti *et al*., 2002; Guidetti *et al*. 2004) and habitat complexity (e.g. McGuinness and Underwood 1986; Benkendorff 2005). For example, the presence of complex boulder fields in shallow pools provides good habitat for many sessile invertebrates and the deposition of molluscan egg masses (Benkendorff *et al*., 2005). However, it is currently unclear if these abiotic measures will be useful for characterization of S.A. intertidal reefs.

The principle aim of this project was to provide a preliminary assessment of intertidal reefs along the Fleurieu Peninsula, S.A. Specifically, the abiotic characteristics of 17 intertidal reefs were assessed, including substrate type, rock type and substrate complexity. Information on percent cover of sessile organisms was also collected. Baseline species inventory data was collected for algae, molluscs and echinoderms from all selected sites. Molluscs have previously been established as good indicators for other invertebrates on temperate intertidal reefs in Australia (Gladstone 2002). They are also the most dominant and conspicuous intertidal organisms, they represent the full range of tropic niches and they can be relatively easily identified compared to other invertebrates

(Benkendorff and Davis 2002). However, molluscan diversity has been shown not to correlate with algal diversity (Gladstone 2002; Cantin 2003) and consequently independent surveys are required for these primary producers on intertidal reefs. Furthermore, preliminary surveys have found no correlation between echinoderms and molluscs on South Australian reefs (Cantin 2003; Benkendorff 2005).

These surveys have been used to provide a preliminary assessment of the physical environment and relative species richness found at different intertidal reefs around the Fleurieu Peninsula. However, the species inventories should not be taken as a comprehensive species list for the area, due to the limited time frame of the project. Intertidal community composition has been compared across the different sites, with a preliminary assessment of relationships to abiotic habitat characteristics. This later point has been followed up in more detail, particularly with respect to rock type, for a subset of sites in the Honours thesis by Dutton (2007).

Methods

In total 17 sites were selected for surveys along the Fleurieu Penninsula, S.A. (Figure 1). Due to the size of the intertidal reef within the Aquatic reserve at Aldinga, two sites were located on this reef over 100m apart. At each site a 20 x 20 m plot was established using tape measures and corner markers. Due to the relatively small patches of rock found near Port Noarlunga Jetty, two small reefs with a total length of 20m were combined for the survey at this location. A GPS location was taken from approximately the middle of each plot. A summary of the survey dates, weather and tidal conditions and the exact locations for each survey site is provided in Table 1. All surveys were undertaken between November 2006 to early March 2007 during low tide (<0.3m). At each site basic observational data was collected on the rock type and type of habitats present.

Substrate Transect Sampling

Five randomly-spaced 20 m shore-normal line transects were located within each study site using a 50 m fiberglass tape. Substrate types and percent coverage of sessile organisms occurring in patches greater than 5 cm in length were visually observed along the transects using the line intercept method. The extent of each substrate was recorded in centimeters, then summed and divided by the total length (20m) to obtain the percent cover. The following classifications were used for substrates and sessile organisms:

Substrates:

- exposed rock
- exposed boulders
- exposed pebbles
- exposed sand
- submerged rock
- submerged boulders
- submerged pebbles
- submerged sand

- boulders were classed as larger than fist-sized

- where boulders exceeded approximately 1 m along their longest axis they were classed as rock
- submerged substrates were covered with at least 5 cm of seawater at low tide

Sessile Organisms:

- foliose algae
- turfing algae
- encrusting algae/lichen
- seagrass
- mussels
- galeolaria crust
- mixed community
- barnacles

- encrusting algae and lichen were classed together.
- mixed communities consisted of high-density mussel concentrations on mats of turfing algae where the species ratio was visually observed to approach approximately 20/80 percent in either direction.

Complexity

Substrate complexity was determined by aligning a 10 m chain (link size = 23mm) along each transect and pushing it into all cracks and crevices to closely contour the vertical profile of the substrate. The horizontal distance reached by the chain was recorded and used to calculate substrate complexity by the ratio of the substrate contour length (X < 10m) to total linear length (10m). Ratios approaching 1 are almost flat, whereas those closer to zero are highly rugose.

Species Inventories

At each site a 1hr timed-search survey was conducted for molluscs and echinoderms. Species were recorded within 10 minute time intervals to enable construction of species accumulation curves. All available habitats were thoroughly searched within each 20 x 20m plot. At the completion of each survey each species was assigned a semi-quantitative abundance ranking whereby; rare < 5, uncommon = 6-20, common = 21-100 and abundant >100 individuals per site. The species were identified in the field where possible and voucher specimens or photographs were used for further confirmation. Molluscs were identified according to Lamprell & Healy (1998), Lamprell & Whitehead (1992), Wilson (1993), Edgar (1997), Jansen (2000) and Coleman (2003). Higher taxonomic groupings of the Mollusca have been assigned according to the classification outlined in Beesley *et al*. (1998). Echinoderms were identified according to Edgar (1997) and Shepherd and Thomas (1989).

At the end of each invertebrate survey, algal surveys were undertaken by collecting representative specimens from each morphologically distinct alga. These samples were transported back to the laboratory and fixed in 10% formalin in seawater for two days, then rinsed and pressed dry between tissue paper. Identification was based on Edgar (1997), Huisman (2000) and Womersley (1984). In some cases unidentified species were assigned as recognizable taxonomic units and cross checked between all sites for consistency in their records of occurrence.

Data Presentation & Analysis

Histograms have been prepared to compare mean percent substrate composition across sites by adding the data for each habitat type from the five transects within sites and then dividing by the total cover (*100). The cover of sessile organisms is provided as a mean (± s.e.) per transect. Histograms are also provided for the total species richness of each phyla across sites. Species richness has also been compared for sites inside and outside aquatic reserves, as well as for soft (limestone, aeolinite, calcarenite) and hard (basalt, gneiss, migmatite, schist and granite) using independent t-tests (SPSS version 14). The assumptions of normality were checked by visually by frequency distribution curves and equal variances using the Levenes test in SPSS. Correlation analyses were performed to test the relationships between 1) species richness of intertidal flora and fauna, 2) the number of habitats and species richness of fauna and flora and 3) complexity and species richness of fauna and flora across all sites. For comparison of species composition across sites, nMDS ordination plots were generated using the PRIMER software package from the Bray-Curtis similarity matrix generated from combined mollusc and echinoderm abundance rankings. Species observed just outside the study sites were included in the species list at that site for these analyses for a more comprehensive of the communities. Algal data was independently analyzed using presence/absence data.

Results

Overall 9 of the survey sites were characterized as soft (limestone type) reefs and 8 were composed of hard reefs of crystalline igneous, volcanic and metamorphic rocks (Table 1). The number of habitat types observed at the different study sites ranged from five to ten (out of a possible 11, Table 2). The average substrate composition varied greatly between all sites (Figure 2). A substantial amount of horizontal rock platform (exposed and submerged rock, Figure 2a) occurred at all sites except Kings Beach, where the study site occurred within a large boulder field. A large area of submerged and exposed boulders also occurred at Myponga, Carrackalinga, the Bluff and Blanche Point. Some smaller pebbles occurred at Myponga, Second Valley and Marino Rocks. Patches of sandy habitat occurred at nine of the sites (Figure 2a). At some sites such as Myponga, sand was recorded under pebbles and boulders (Table 2), but does not appear as sandy substrate in the substrate composition transects (Figure 2a). The mean habitat complexity based on a rugosity index (RI) varied from almost flat (RI = 0.91) at Lady Bay and the Aldinga North site to highly complex (RI = 0.6) at Hallett Cove (Figure 3).

The mean percent cover of sessile organisms ranges from less than 10% at Marino Rocks, to over 100% at Christies Beach (Figure 2b). Turfing and foliose algae were the dominant types of sessile organisms occurring across all reefs. Substantial mussel beds were recorded at Port Noarlunga, Christies Beach and Aldinga Reef. Communities of the tube worms occurred in large encrusting beds at seven of the study sites (Figure 2b). Large patches of sea grass habitat were only recorded within the study sites at Blanche Point and Carrackalinga. It should be noted that substantial areas of seagrass habitat also occur in a shallow lagoon in the middle of Aldinga Reef, although not towards the reef edge where the study sites were located.

In total 112 molluscs and 24 echinoderms were recorded across all intertidal reefs along the Fleurieu Peninsula. The total number of algal species tentatively identified in the surveys include 19 Phaeophyta (brown algae), 9 Rhodophyta (red alga) and 18 Chlorophyta (green algae). In addition, 3 species of Magnoliophyta (sea grasses) were recorded. Species lists for each site are provided in Appendix 1. The mean number of molluscan species found on intertidal reefs in the Fleurieu peninsula was 30.3 (± 7.8 st. dev.). The highest molluscan species richness was recorded at Kings Beach (Figure 4a) with more than two standard deviations above the mean (46 species), suggesting this site is a hotspot for molluscan diversity. On the other hand only 12 molluscan species were on the relatively small patches of rocky reef near the Port Noarlunga Jetty. This site also had no echinoderm species present (Figure 4a) and the lowest species richness of primary producers (Figure 4b). Overall, echinoderms were only recorded at 11/17 sites, with a mean species richness of 1.6 (± 2.3). A hotspot of echinoderms was recorded at Myponga (Figure 4a) with a total of nine species (>3 standard deviations above the mean). The mean number of primary producers was 12.4 (± 4.4) species. The highest number of algal species was recorded at Hallett Cove (21, Figure 4b), with nearly 2 standard deviations above the mean for all primary producers, despite the absence of any sea grass (Magnoliophyta). Sea grasses were more common around the Southern tip of the Fleurieu Peninsula (Figure 4b). Within the Port Noarlunga aquatic reserve, both Southport and Port Noarlunga had a noticeable absence of brown algae (Phaeophyta) and Magnoliophyta. Overall, there was a significant positive correlation between the species richness of the fauna and flora ($r^2 = 0.284$, $p = 0.028$) surveyed across all reefs in this study (Figure 5).

The species accumulation curves for invertebrate species numbers started leveling off within the last 20min of surveying at most sites (Appendix 2) suggesting the survey time was generally adequate to accurately represent the species richness. However, reasonable increases in the species richness were recorded in the last 10 minutes at Aldinga, Blanche Point, Hallett Cove and Myponga, suggesting these sites could be somewhat under represented. No further species were recorded after the first 30 minutes of survey at Port Noarlunga (Appendix 2).

On average a high number of species were found on sites outside Aquatic reserves compared to the mean number found at sites inside the Port Noarlunga and Aldinga Aquatic reserves (Figure 6a). The number of species was significantly lower inside reserves for both the fauna (molluscs and echinoderms; d.f. 15; t =2.75, p value = 0.015), but no significant difference was found for the primary producers (d.f. 15; t = 1.91; p = 0.076). All of the reefs inside Aquatic reserves are soft limestone type reefs and the mean number of species on soft rocks was found to be significantly lower than the mean number found on hard rocky reefs (Figure 6b; fauna d.f. 15; t = 3.09 , p value = 0.007; primary producers d.f. 15; t =2.39; p value = 0.031). There were no significant correlations between species richness and number of habitats (Figure 7a; fauna r^2 = 0.056, p= 0.361; flora r^2 = 0.071, p = 0.301) or habitat complexity (Figure 7b fauna r^2 = 0.112, p = 0.19; flora r^2 = 0.077, p = 0.28) or the percent of cover by sessile organisms (Figure 7c fauna r^2 = 0.018, p = 0.611; flora r^2 = 0.001, p = 0.924).

nMDS ordination plots from the semi-quantitative abundance rankings for invertebrates revealed broad separation in the community composition from different intertidal reefs along the Fleurieu Peninsula (Figure 8). In particular, the two sites within the Aldinga Aquatic reserve were quite distinct from any other site and two sites within the Port Noarlunga Aquatic reserve also grouped separately from all other sites (Figure 8a). There was also a clear separation in the community composition according to rock type (Figure 8b). ANOSIM revealed a significant difference in invertebrate communities on reefs of different rock type (Global R = 0.299, p value = 0.004). SIMPER analysis revealed 56% dissimilarity in the communities on hard and soft reefs, with over 70 species contributing to the differences (Appendix 3). Multivariate analyses on the presence/absence of primary producers revealed substantially more overlap between sites (Figure 9a), with no clear separation between hard and soft rocky reefs (Figure 9b). ANOSIM found no significant difference in the algal and plant communities between soft and hard reefs (Global R = -0.009; p value = 0.533).

Discussion

Overall this study revealed great diversity in the physical structure and biological communities occurring on intertidal reefs along the Fleurieu Peninsula. A relatively high diversity of molluscs, echinoderms and algae on intertidal reefs were found, with records for 185 species in total. The number of species recorded compare favorably to previous biodiversity assessments along the temperate Australian coastline (e.g. Benkendorff and Davis 2002; Gladstone 2002; Benkendorff 2003, 2005). The number of echinoderm species (24) found was substantially higher than in recent surveys that have been conducted by the same research in S.A. Along the Yorke Peninsula Benkendorff (2005) only recorded 9 echinoderms, whereas on Kangaroo Island Benkendorff *et al*., (2007) recorded 12 species. But noticeably many of the echinoderms in this study were only recorded at one site, indicating their patchy spatial distribution on South Australian Reefs. The number of molluscan species recorded in the current study also exceeds that found in the previous S.A. studies, but this could be in part related to the higher survey effort i.e. 17 sites were surveyed here compared to

10 on Yorke Peninsula (Benkendorff 2005) and only 5 on Kangaroo Island (Benkendorff *et al*., 2007). Nevertheless, more algal species were recorded in the limited surveys on Kangaroo Island (55 species compared to 46 in this study).

A number of species rich hotspots (defined as two standard deviations above the mean across all sites) were recorded in this study. These were found to occur at different sites for molluscs, echinoderms and algae (Figure 4), despite an overall significant correlation in species richness between the invertebrates and flora surveyed (Figure 5). The remote boulder field at Kings Beach supports an unusually large diversity of molluscan species, whereas the complex boulder field at Myponga was a hotspot for echinoderms. This reef at Myponga also supported a higher diversity of molluscs and should be considered a priority for conservation based on the presence of a large number of brittle stars which occurred at no other site (Appendix 1). Since these fragile organisms live under boulders, it is possible that the high level of recreational use prevents their persistence at some other apparently suitable sites. Hallett Cove was found to be a hotspot for algal diversity (Figure 4b), which was surprising given the relatively low percent cover of sessile organisms, including algae (Figure 2b). The large reef at Aldinga and several other sites around the tip of Fleurieu Peninsula appear to support a good mix of algae and seagrass (Figure 4b).

As a consequence of the limited species inventory data, the application of systematic reserve selection procedures is typically very limited in the marine environment (Pressey and McNeill 1996; Gladstone 2002). Along the Fleurieu Peninsula, two Aquatic reserves have been designated: Aldinga Reef and Port Noarlunga Aquatic reserves (PIRSA Fisheries 2007). In terms of biodiversity conservation, the current aquatic reserves along the Fleurieu Peninsula do not appear to be protecting particularly high numbers of species. In fact, comparison of the mean number of species occurring on reefs inside and outside aquatic reserves revealed significantly lower numbers of species in the reserves for both the invertebrates and flora (Figure 6a). This may be in part influenced by the fact that sites within the reserves are all soft limestone type reefs, whereas a higher diversity of species was recorded on the harder rocky reefs surveyed in this study (Figure 6b). Nevertheless, Williams (1996) also reported a significantly higher diversity and taxa richness on similar limestone reefs outside these two reserves compared to locations within the Aquatic reserves.

Aldinga Reef is designated as a biodiversity reserve to protect aquatic plants and animals associated with the very tertiary limestone platform (PIRSA Fisheries 2007). The size of this reef makes it difficult to adequately represent in our 20 x 20m plots used for rapid biodiversity assessment. Nevertheless, it is surprising that the two survey sites at on this reef did not record a particularly high number of molluscan species. Unusually high densities of the predatory crab *Ozius truncatus* were observed at this site and previous studies by Chilton & Bull (1984, 1986) have shown that *Ozius* can affect the size distribution of gastropods at Aldinga reef. This, in addition to high recreational activity, such as reef walking

(Wiliams 1996) and overturning boulders may be influence the diversity of species on this aquatic reserve.

The Port Noarlunga aquatic reserve is designated for the protection of reef organisms from exploitation and encompasses intertidal reefs near the Jetty, at Christies Beach and on the edge of Onkaparinga Head (South Port). The rocky reefs at Port Noarlunga beside the jetty were highly diminished in all taxa compared to the other locations. This is likely to be due to high recreational activity (Williams 1996). There was also a noticeable amount of pollution from recreational boating fuel and oil in the water at the time of this survey, which could have negative impacts on the local marine organisms (e.g. Piller, 1998). Some very common gastropods such as *Nerita atramentosa*, *Austrocochlea* spp. and *Bembicium nanum* were absent or rare within the Port Noarlunga Aquatic reserve sites, but present at all other locations along the coast (Appendix 1).

In terms of ensuring an adequate representation of intertidal reefs in Marine Parks with in the Fleurieu Peninsula Bioregions, it will be necessary to expand the current reserve system. In particular, hard reefs comprised of igneous and metamorphic rock should be represented to compliment the current limestone reefs, as these were found to support distinct ecological communities for the invertebrate taxa surveyed (Figure 8). The proposed Encounter Marine Park (S.A. DEH Coast and Marine, 2007) should help facilitate a more comprehensive representation of a range of different intertidal substrates and habitats (see Tables 1 & 2). Further survey work, including species inventories will need to be undertaken in other S.A. bioregions. Based on this data from the Fleurieu Peninsula, it appears that habitat data, such as number of habitats, habitat complexity and percent of cover by sessile organisms can not be used as a surrogate for intertidal biodiversity assessment (Figure 7).

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Table 1: The location of 17 study sites, dates surveyed, tidal and weather conditions for intertidal surveys along the Fleurieu Peninsula, S.A. The orientation of the reef is provided for the principle direction looking out to sea. Rock type is classified as soft for limestone, calcaranite and aeolinite reefs, whereas hard reefs were composed of basalt, gneiss, migmatite, schist or granite.

Site	**Latitude**	**Longitude**	**Date surveyed**	**Tidal height**	**Weather**	**Orientation**	**Rock type**
Marino	S35.04445	E138.50838	23.11.06	0.2	sunny	W	hard
Hallett Cove	S35.07425	E138.49518	3.1.07	0.27	sunny	W	hard
Christies Beach	S38.08587	E138.28017	2.3.07	0.27	sunny	W	soft
Port Noarlunga	S35.08925	E138.28015	2.3.07	0.27	sunny	W	soft
South Port	S35.16528	E138.46773	5.1.07	0.24	light rain	W	soft
Blanche Point	S 35.24669	E138.46127	24.11.06	0.27	sunny	NW	soft
Aldinga North	S35.26863	E138.44135	21.12.06	0.15	cloudy	W	soft
Aldinga South	S35.2750	E138.43979	20.12.06	0.19	cloudy	W	soft
Myponga	S35.37132	E138.38272	9.1.07	0.25	sunny	NE	hard
Carrackalinga	S35.41961	E138.32304	6.1.07	0.24	cloudy	NW	soft
Lady Bay	S35.47256	E138.28733	22.12.06	0.15	light rain	W	soft
Second Valley	S35.51084	E138.21484	4.1.07	0.25	sunny	SWW	hard
Fishery Beach	S35.63328	E138.11530	24.1.06	0.29	windy	SW	hard
Kings Beach	S35.60323	E138.58235	24.1.06	0.25	sunny	NEE	hard
The Bluff	S35.58624	E138.59976	22.12.06	0.15	windy	NE	hard
Yilki	S35.57985	E138.59818	20.12.06	0.19	breeze	SEE	soft
Middleton	S35.51635	E138.70493	17.1.07	0.25	windy	SE	hard

Table 2: The present of different habitats observed within the 17 intertidal study sites along the Fleurieu Peninsula, S.A.

Boulder fields and sand are only recorded as present if there was a patch of more than $2m^2$ within the study site.

Site	Bare Rock	Boulder Field	Sand	Crevices	Rock Pools	Supra littoral	Mussel Beds	Foliose Algae	Turfing Algae	Sea grass	Galeolaria Crust	Total habitats
Marino	y	n	y	y	y	y	y	y	n	n	y	8
Hallett Cove	y	y	y	y	y	y	y	y	y	n	y	10
Christies Beach	y	n	y	y	y	n	y	y	y	n	n	7
Port Noarlunga	y	n	y	n	n	n	y	y	y	n	n	5
South Port	y	n	y	y	y	n	y	y	y	n	y	8
Blanche Point	y	y	y	y	y	n	y	y	y	y	n	9
Aldinga North	y	n	n	y	y	n	y	y	y	n	n	6
Aldinga South	y	y	y	n	y	n	y	y	y	y	n	8
Myponga	y	y	y	y	y	n	n	y	y	n	n	7
Carrackalinga	y	y	n	y	y	y	y	y	y	y	y	10
Lady Bay	y	y	y	y	y	n	y	y	y	y	n	9
Second Valley	y	y	n	y	y	y	y	y	y	n	y	9
Fishery Beach	y	y	n	y	y	y	n	y	y	n	y	8
Kings Beach	y	y	n	y	y	n	n	y	y	n	y	7
The Bluff	y	y	y	n	y	y	n	y	n	n	n	6
Yilki	y	y	y	y	y	n	n	y	y	n	y	8
Middleton	y	n	n	y	y	y	y	y	y	n	y	8

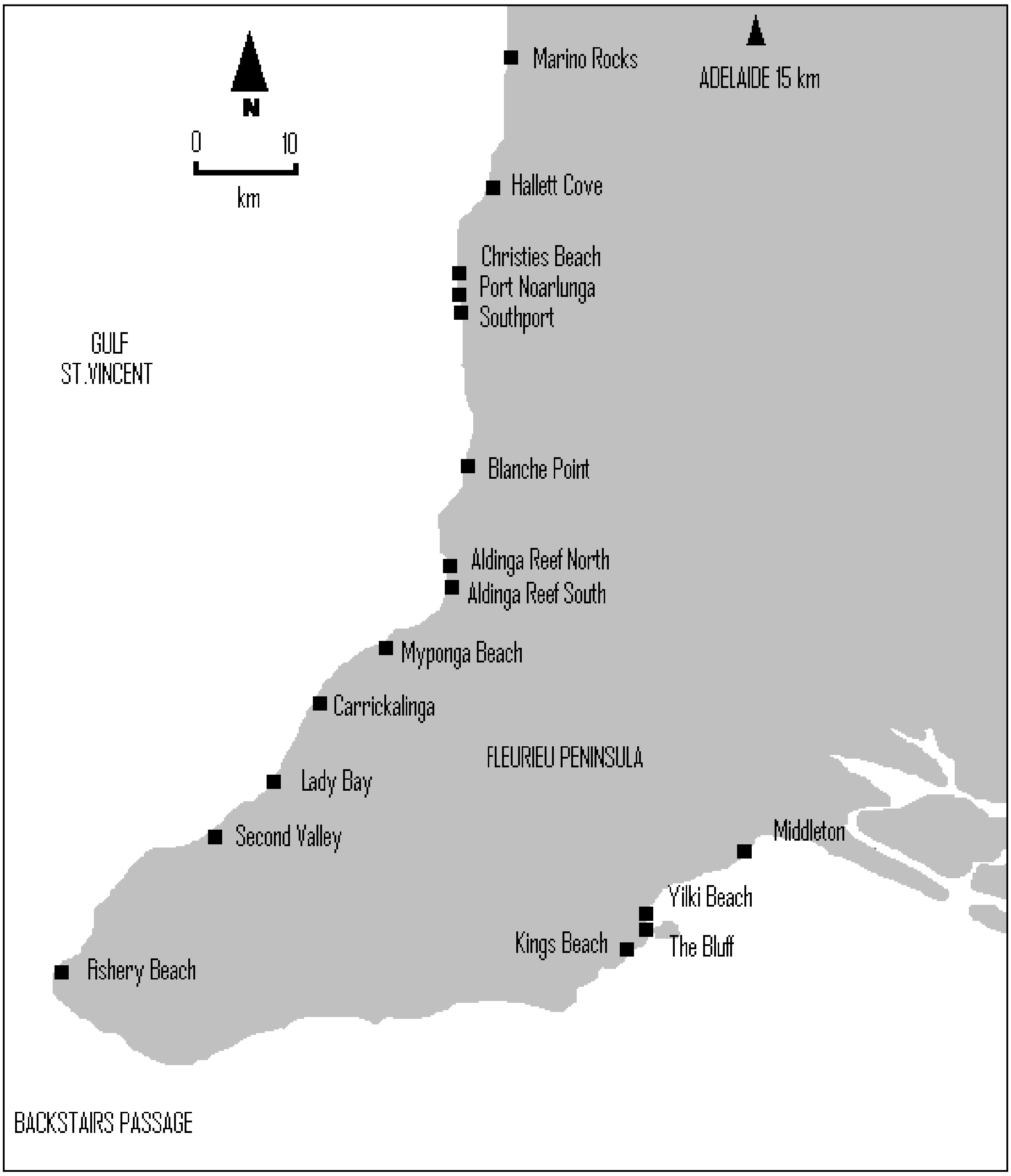


Figure 1: The location of 17 study sites sampled for intertidal reef habitat and biodiversity along the Fleurieu Peninsula, S.A.

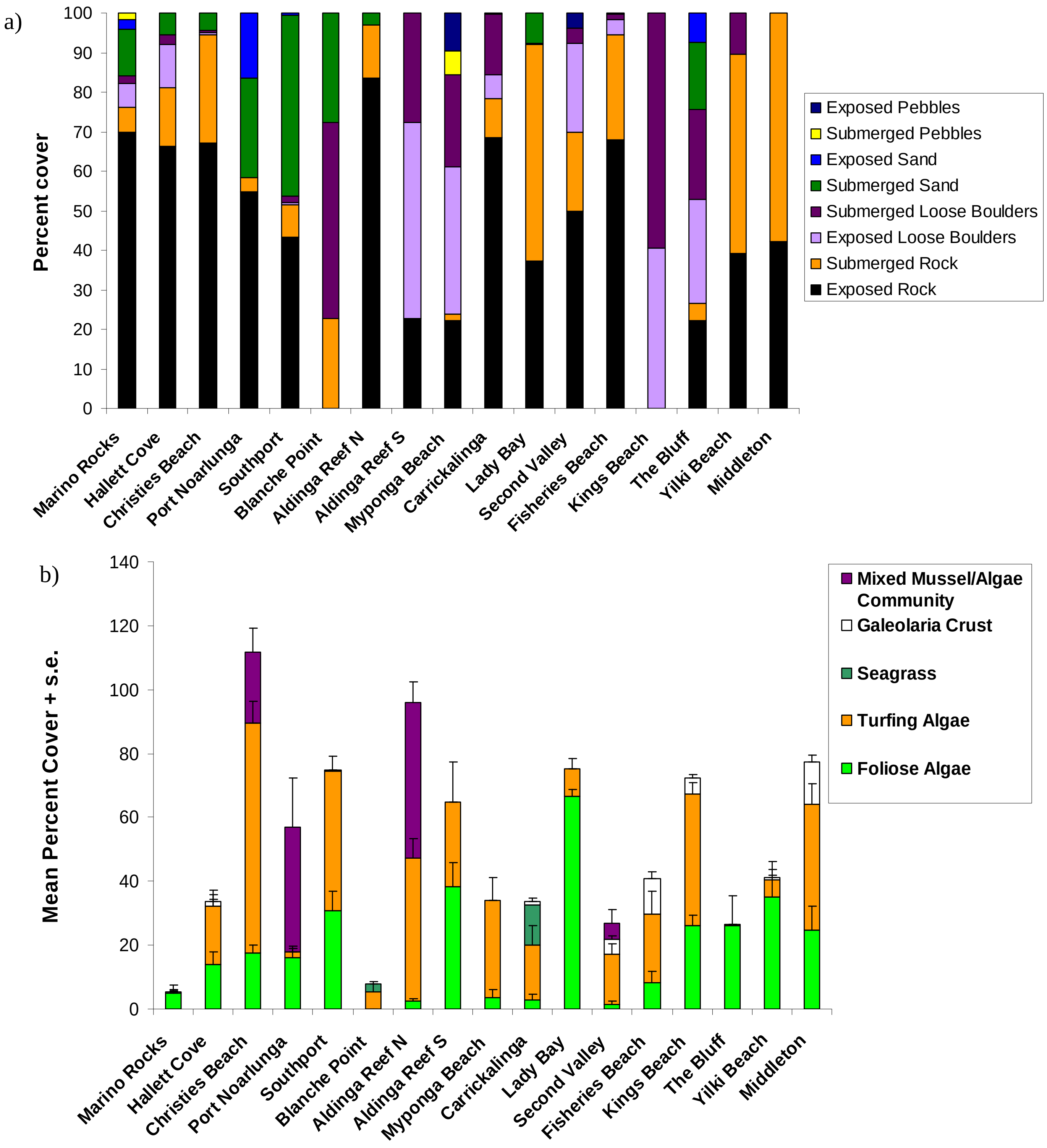


Figure 2: Mean percent cover of substrate for a) abiotic habitat and b) sessile organisms at 17 intertidal reefs along the Fleurieu Peninsula, S.A.

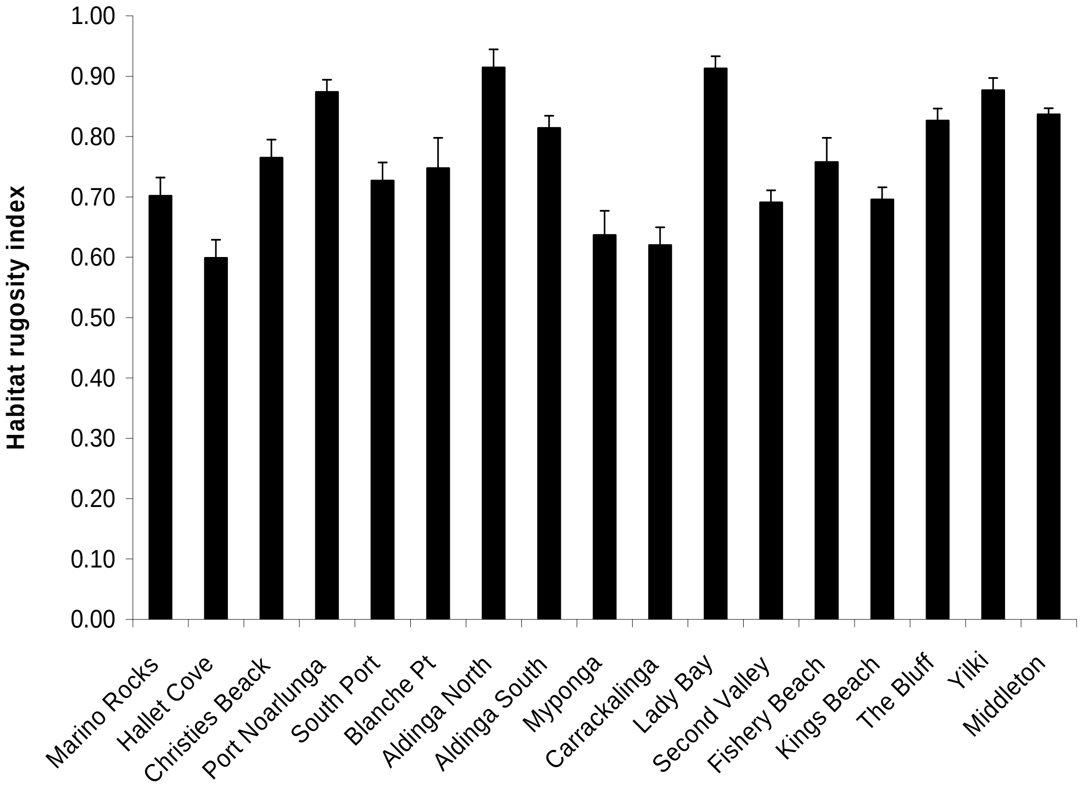


Figure 3: Habitat complexity at 17 intertidal rocky reef sites along the Fleurieu Peninsula, S.A Complexity is based on a rugosity index whereby values closer to one are more flat and those closer to zero are highly complex.

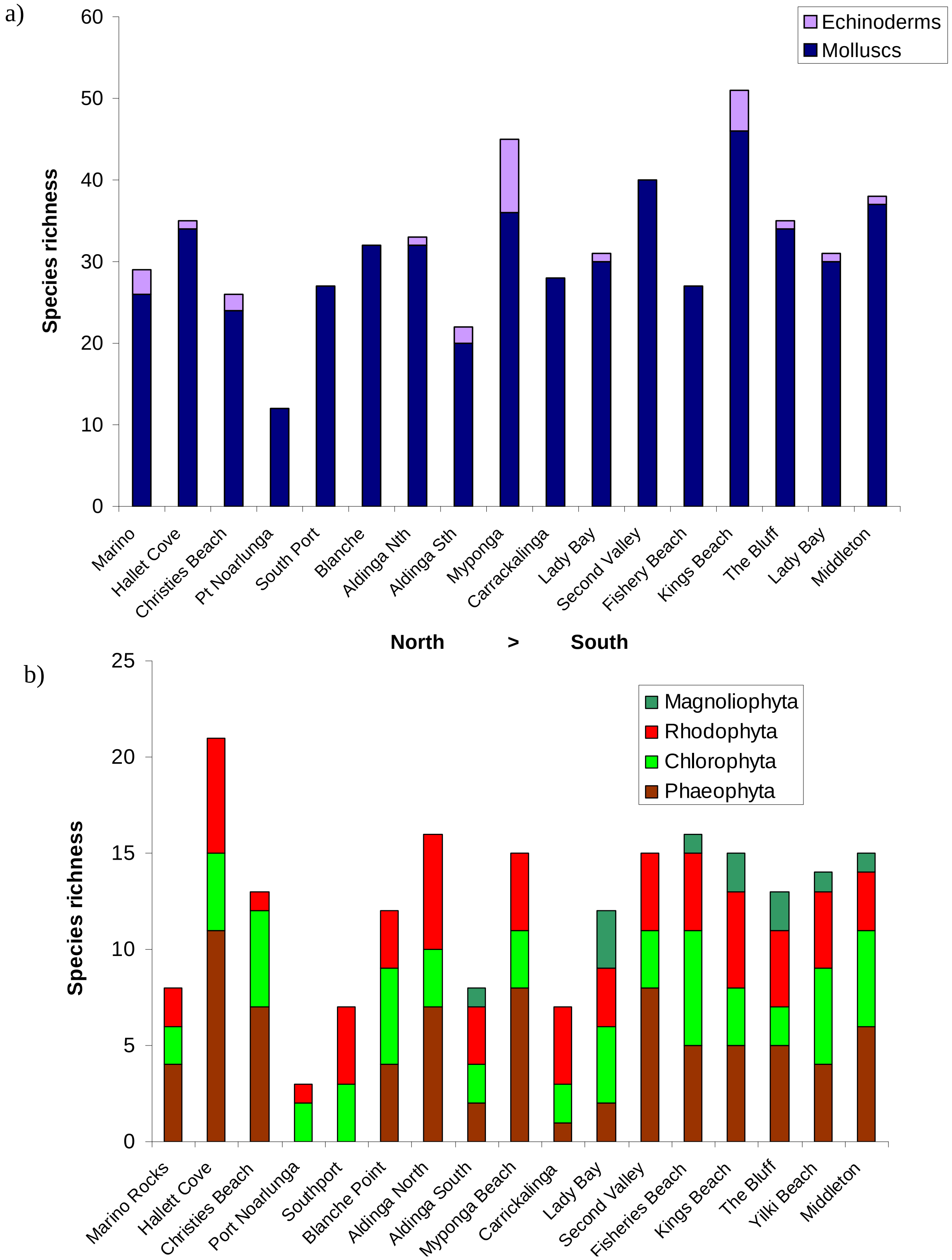


Figure 4: The number of species of a) molluscs and echinoderms and b) primary producers recorded during 1hr timed search surveys at 17 sites on intertidal rocky reefs along the Fleurieu Peninsula S.A.

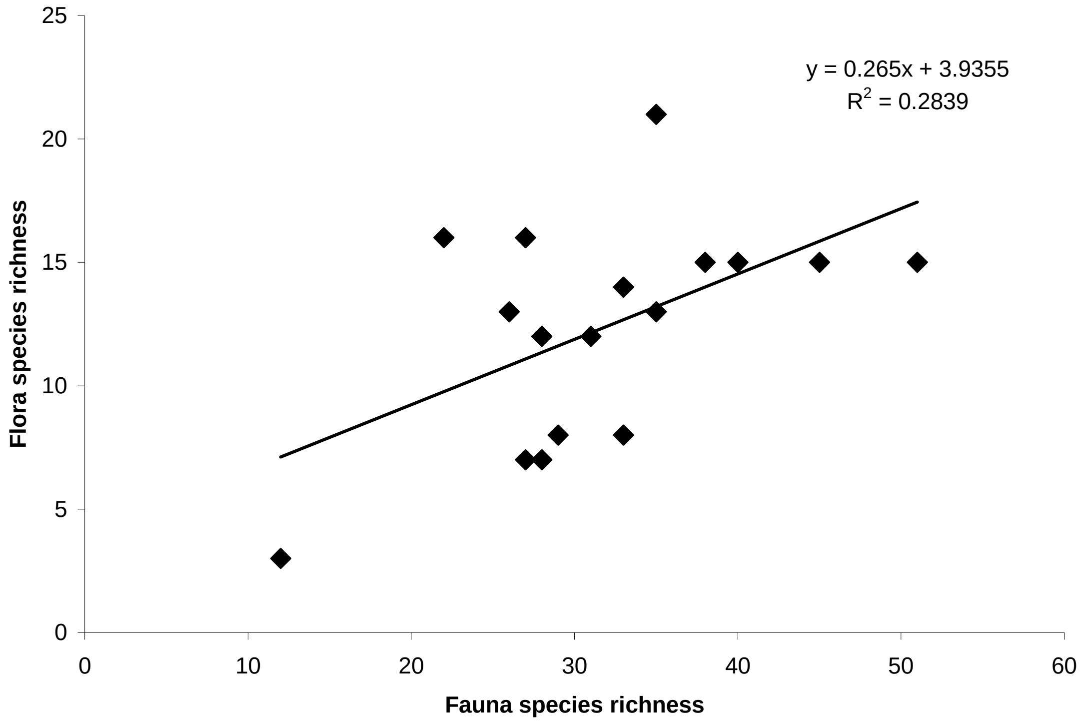


Figure 5: Correlation between the number of fauna (molluscs and echinoderms) and the number of flora (algae and seagrasses) found on 17 intertidal reefs along the Fleurieu Peninsula, S.A.

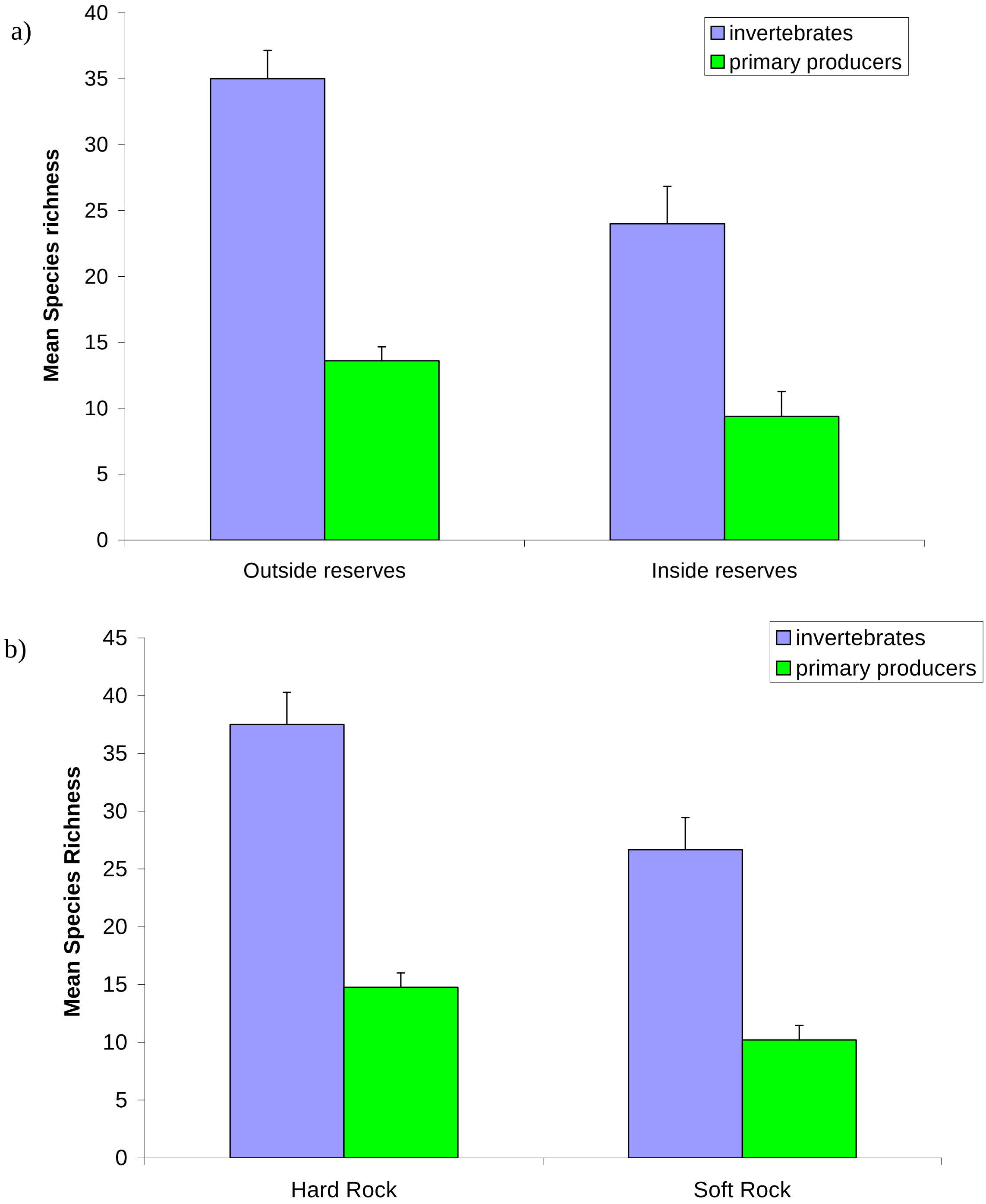


Figure 6: The mean number of invertebrates (molluscs and echinoderms) and primary producers (algae, seagrass and lichen) found on rocky reef along the Fleurieu Peninsula S.A. grouped according to a) Aquatic reserve status and b) rock type. Error bars represent standard error of the mean.

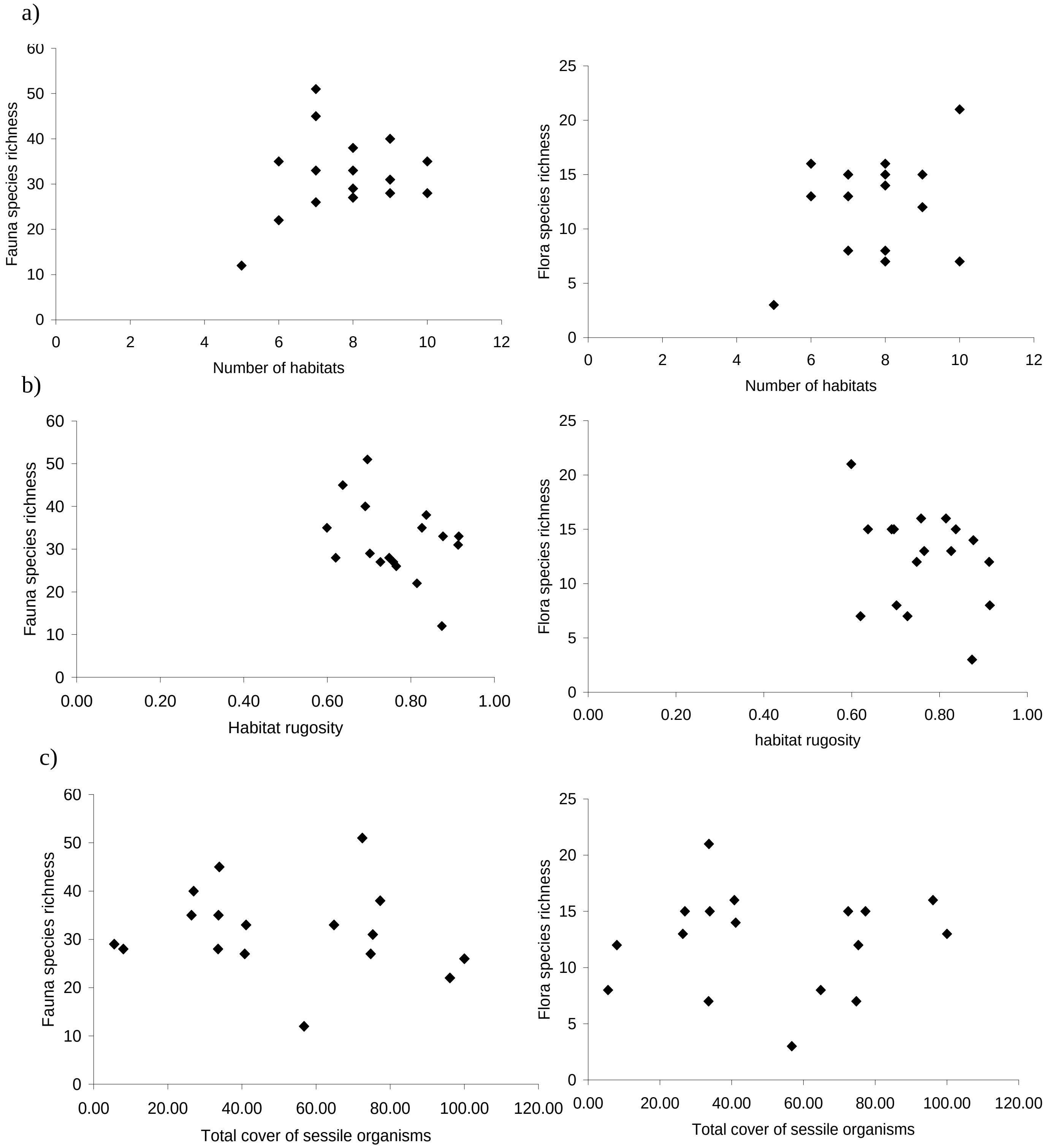
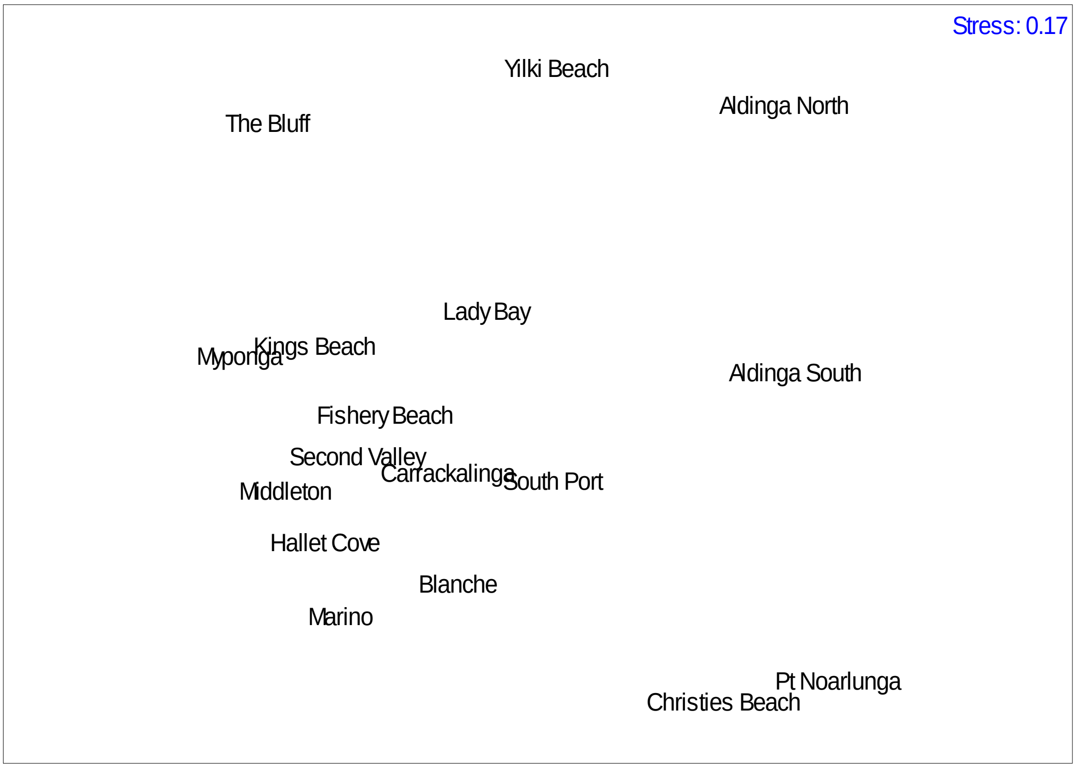


Figure 7: The relationship between species richness and a) number of intertidal habitats, b) habitat rugosity and c) cover of sessile organisms at 17 intertidal reefs. Left panels represent species richness of fauna (molluscs and echinoderms), whereas right panels represent species richness of flora (algae and seagrasses).

a)



b)

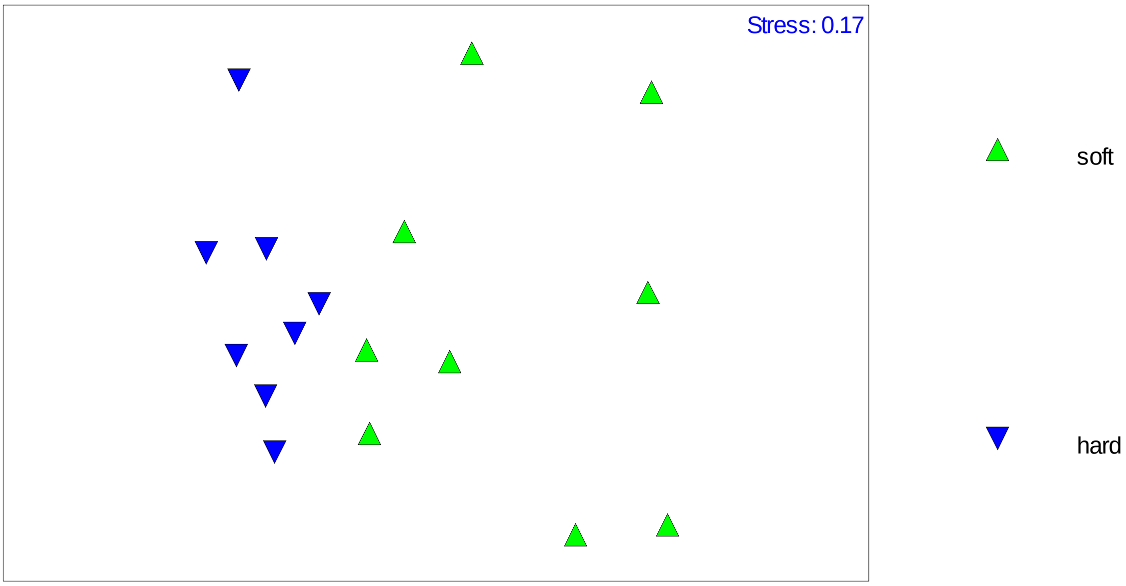
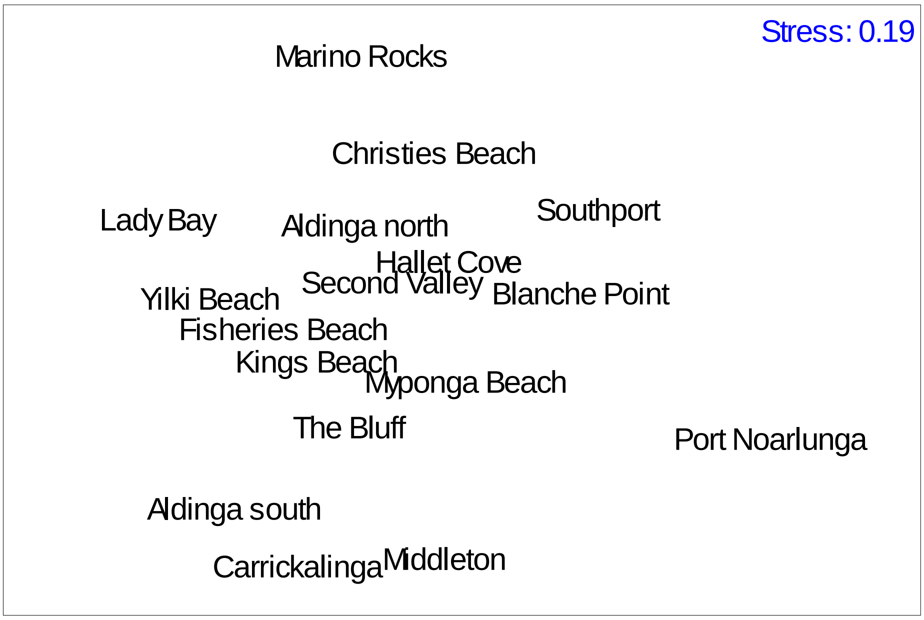


Figure 8: nMDS ordinations for mollusc and echinoderm community composition showing the differences between a) 17 sites and b) sites grouped according to rock type.

a)



b)

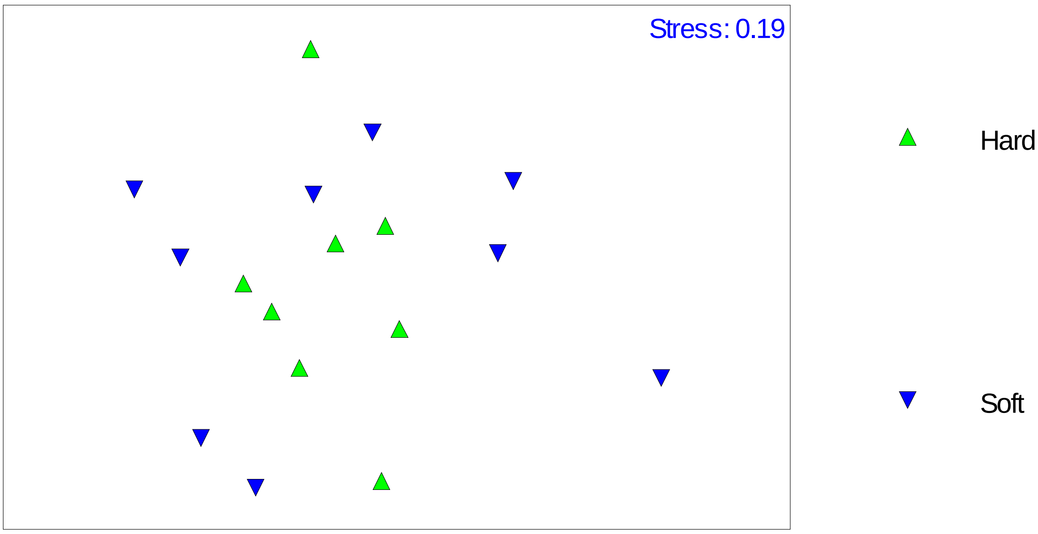


Figure 9: nMDS ordinations for algal and plant community composition showing the differences between a) 17 sites and b) sites grouped according to rock type.

Appendix 1

Appendix 1: Species occurrence for a) macromolluscs, b) echinoderms and c) marine flora recorded on 17 intertidal reefs in South Australia; MR = Mario Rocks, HC = Hallett Cove, CB = Christies Beach , PN = Port Noarlunga, SP = South Port, BP = Blanche Point, AN = Aldinga North, AS= Aldinga South, My = Myponga, Ca = Carrackalinga, LB = Lady Bay, SV = Second Valley, FB = Fishery Beach, KB = Kings Beach, TB = The Bluff, YB = Yilki Beach, Mi = Middleton. Semi-quantitative abundance ranking are used for the invertebrates, whereby R = rare < 5 individuals; U = Uncommon 6-20 individuals; C = Common 21-100 individuals; A = Abundant >100 individuals. For the marine plants 1 = present and 0 = absent. Extra notes are made in the mollusc table for the presence of egg masses (egg) and shells (She), as well as records where species were recorded outside the 20x 20 m plot on the same reef (out).

a) MOLLUSCA

Class/ Subclass Family	Species	MR	HC	CB	PN	SP	BP	AN	AS	My	Ca	LB	SV	FB	KB	TB	YB	Mi
Eogastropoda																		
Patellidae	*Patella peronii*	0	U	0	0	0	R	R	0	R	0	0	0	R	C	0	0	0
Nacellidae	*Cellana tramoserica*	C	A	R	0	U	C	0	0	C	U	A	A	C	U	0	0	U
	Cellana solida	A	A	C	0	C	C	0	0	C	C	R	A	A	A	C	R	C
Lottidae	*Collisella mixta*	0	U	0	0	U	0	0	0	R	0	0	U	0	0	0	0	R
	Notoacmea mayi	0	C	0	0	C	U	0	0	0	0	0	C	0	U	0	R	C
	Notoacmea petterdi	A	A	U	A	A	A	U	C	A	C	A	C	A	C	C	C	A
	Notoacmea flammea	0	R	0	0	0	R	A	0	0	0	0	C	C	0	C	0	0
	Patelloida cf. *insignia*	0	R	0	0	R	0	C	0	C	0	0	U	0	U	0	0	0
	Patelloida alticostata	R	U	R	0	0	R	U	0	U	U	0	C	C	A	0	0	U
	Patelloida profunda calamus	C	0	0	0	U	0	0	0	0	R	C	U	C	C	0	R	R
	Patelloida latistrigata	A	U	0	0	0	0	U	0	C	C	C	A	0	C	0	0	A
Neritopsidae	*Nerita atramentosa*	A	A	0	0	0	out	0	out	A + egg	A + egg	A	A + egg	A	C	C	0	U
Orthogastropoda																		
Haliotidae	*Haliotis rubra*	0	R	R	0	0	U	R	0	R	0	0	0	0	R	0	0	0

	Haliotis laevigata	0	0	0	0	0	U	0	0	0	0	0	0	0	0	0	0	0
	Haliotis sp.	0	0	0	0	0	0	0	0	R	0	0	0	0	0	0	0	0
Fisurellidae	*Clypidina rugosa*	R	0	0	0	R	0	U	R	R	0	C	0	U	0	R	U	0
	Amblychilepas javanicensis	0	0	0	0	0	0	0	0	0	0	0	0	0	R	0	0	C
	Cosmetalepas cancatenatus	R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Scutus antipodes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R	0	0
Trochidae	*Austrocochlea concamerata*	0	0	0	0	U	0	0	out	A	U	U	C	C	U	A	0	C
	Austrocochlea odontis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	she	0
	Austrocochlea adelaidae	R	C	0	0	R	0	0	0	0	0	0	0	U	A	0	0	A
	Austrocochlea porcata	0	C	0	0	A	0	0	0	0	A	0	A	A	U	A	0	0
	Austrochoclea constricta	U	out	0	0	A	out	0	0	0	C	U	A	C	C	A	A	A
	Notogibbula preissiana	R	U	0	0	0	0	R	0	U	0	R	R	R	C	0	0	0
	Clanculus consobrinus	0	0	0	0	0	0	0	0	0	0	0	R	0	C	0	R	C
	Clanculus cf limbatus	0	0	0	0	0	0	0	0	0	0	0	0	0	U	0	U	0
	Clanculus c.f. undatum	0	0	0	0	0	0	0	0	0	0	0	0	0	U	0	0	0
	Granata imbricata	0	0	0	0	0	0	0	0	U	R	0	0	0	0	U	U	0
	Euchelus profunior	R	0	0	0	0	R	0	U	C	0	0	R	0	0	0	0	R
	Canthrindella picturata	0	U	0	R	U	0	0	U	U	0	R	U	0	U	R	0	0
	Herpetoma pumilo	0	R	0	0	0	0	U	0	0	R	0	R	0	R	R	U	0
	Thalotia chlorostoma	0	U	out	0	0	0	R	0	0	0	0	0	R	R	0	R	0
	Thalotia conica	R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Cantharidus (Thalotia) pullcherrimus	0	0	0	U	0	0	R	0	0	0	0	R	0	0	0	0	0
	Cantharidus (Thalotia) lehmanni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R
	Phasianotrochus juvenlies?	0	0	U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Minolia cf cincta	0	0	0	0	0	0	0	0	0	0	0	0	0	C	0	0	0
	Astele (Calliostoma) monile	0	0	0	0	0	0	R	0	0	0	0	0	0	0	0	0	0

	unid black ridged	0	0	0	0	0	0	0	0	0	R	0	0	0	0	0	0	0
	Unidentified juveniles	R	0	0	0	C	0	0	0	0	0	0	U	0	0	0	0	0
Turbinidae	*Turbo undulatus*	U	C	C	C	A	0	C	0	0	0	U	C	A	C	0	C	U
	Austroliotia australis	0	0	0	0	0	0	0	0	R	0	0	0	0	0	0	0	0
	Australium cf squamiferum	0	0	0	0	0	0	out	0	0	0	0	0	0	0	0	0	0
	Phasianella australis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R
	Phasianella ventricosa	0	0	U	R	0	0	0	0	0	0	0	0	0	U	0	0	0
Cererthidae	*Bittium granarium*	0	0	0	0	0	C	C	U	A	U	U	0	0	C	U	C	R
	Bittium c.f. icarus	0	0	0	0	0	0	0	0	C	0	R	0	0	0	0	0	0
	unidentified	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	U	0
Batillariidae	*Zeacumantus diemenensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	A	R	0
	Batllaria estuarina	0	0	0	0	0	0	C	R	0	0	0	0	0	0	0	0	0
Littorinidae	*Bembicium nanum*	A	C	R	0	A	out	0	out	U	R	C	C	C	U	0	0	A
	Littorina acutispira	C	C	0	out	0	0	0	0	out	C	0	0	A	C	0	0	A
	Littorina unifasciata	A	A	0	out	0	U	0	0	out	A	0	A	A	A	A	0	A
	Nodilittorina praetermissa	C	C	0	0	0		0	0	0	0	0	C	0	0	U	0	C
	Rissoina crassa	0	0	U	U	0	C	C	R	0	R	0	U	R	0	0	0	0
	Rissoina sp.	0	0	0	0	0	0	0	0	C	0	0	0	0	0	R	0	0
Cypraea	*Cypraea compti*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hipponicidae	*Hipponix australis*	0	0	0	0	0	0	R	0	0	0	0	0	0	0	0	R	0
Naticidae	*Sinum scf zonale*	0	0	0	0	0	0	0	0	R	0	0	0	0	0	0	0	0
Calyptraeidae	*Crepidula aculeata*	0	0	0	0	0	0	0	0	0	0	R	0	0	0	0	0	0
Buccinidae	*Cominella lineolata*	0	0	0	0	0	0	0	she	0	C	she	0	R	U	R	U	0
	Cominella eburnea	0	0	0	0	0	0	0	she	0	0	she	0	0	0	R	0	0
Naticidae	*Polinices* sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R egg	she
Columbellidae	*Mitrella pulla*	0	0	0	0	0	0	R	0	R	0	0	0	0	0	R	0	R
Muricidae	*Lepsiella vinosa*	0	0	0	0	0	0	0	0	U	0	C	C	C	0	0	U	U

	Dicathais orbita	C	C	0	0	0	U	out	0	R	0	R	C	U	U	0	R	C
	Lepsiella flindersii	0	0	0	0	0	0	0	0	0	0	she	C	0	R + egg	C	0	0
	Lepsiella reticulata	0	0	0	0	0	0	0	0	0	0	0	0	0	R	0	0	0
Nassaridae	*Nassarius pyrrhus*	0	0	0	0	0	0	0	0	0	0	she	0	0	0	0	0	0
Conidae	*Conus anemone*	0	0	0	0	0	0	0	0	0	0	she	0	0	0	R	R + egg	0
Epitoniidae	*Epitonium* sp	0	0	0	0	R	0	0	0	0	0	0	0	0	0	0	0	0
Siphonariidae	*Siphonaria zelandica*	0	0	A	A	out	0	U	C	A	U	A	U	C	A	C + egg	A	U
	Siphonaria diemenensis	A	A	A	A	A	A	C	A	A	A	A	A	A	A	A + egg	A	U
	Siphonaria sp.	C	A	C	0	A	C	0	0	U	C	A	A	A	A	U	A	A
Tylodinidae	*Tylodina* sp.	0	0	0	0	0	0	R	0	0	0	0	0	0	0	0	0	0
Dorididae	*Discodoris sp.*	0	0	0	0	0	0	0	R	0	0	0	0	0	0	0	0	0
	Rostanga c.f. *calumus*	0	0	0	0	0	0	0	0	0	0	0	0	0	R + egg	0	0	0
	Hoplodoris nodulosa	0	0	R	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dendodorididae	*Doriopsilla* sp.	0	0	0	0	0	0	0	0	0	0	U + egg	0	0	0	0	0	0
Chromodoridae	*Verconia verconis*	0	out	0	0	0	R	0	0	0	0	0	0	0	0	0	0	0
	Dendrodoris nigra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R + egg	0
	Hypselodoris obscura	0	0	R	0	0	R	0	R + egg	0	0	0	0	0	0	0	0	0
	Chromodoris sp.	0	0	R	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Facelinidae	*Austraeolis ornata*	0	R	0	0	0	0	0	R	0	0	0	0	0	0	R	0	0
Madrellidae	*Mandrella sanguinea*	0	R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
unidentified	*egg ribbons*	0	0	0	0	0	0	R	0	0	0	0	0	0	0	0	0	0
Polyplacophora																		
Ischnochitonidae	*Ischnochiton elongatus*	R	C	U	R	R	C	U	U	C	U	A	U	C	C	A	C	A

	Ischnochiton virgatus	0	0	0	0	0	0	0	0	0	0	0	U	0	0	U	U	U
	Ischnochiton australis	0	C	0	0	0	U	0	0	R	0	0	U	0	C	C	0	A
	Ischnochiton lineolatus	0	0	0	0	0	0	0	0	U	0	U	R	0	R	R	0	0
	Ischnochiton tori	0	0	0	0	0	R	R	0	R	R	0	R	0	0	U	0	U
	Ischnochiton cariosus	R	0	R	0	0	0	U	0	0	R	0	0	0	0	0	U	0
	Ischnochiton smaragdinus	R	R	R	0	0	R	0	0	R	0	0	R	0	0	0	0	R
	Ischnochiton resplendens	0	0	0	0	0	0	R	0	U	0	R	0	0	R	0	0	0
	Ischnochiton variegatus	0	0	0	0	R	0	0	0	0	0	R	0	0	0	U	0	0
Acanthochitonidae	*Acanthochiton sp.*	0	0	0	0	0	R	0	0	0	0	0	0	0	R	0	0	0
Mopalidae	*Plaxiphora albida*	0	U	0	0	0	0	0	0	0	0	0	0	0	R	0	0	R
Bivalvia																		
Galeommatidae	*Lasea australis*	R	R	U	0	C	R	R	U	R	U	0	0	0	0	R	0	U
Solemyidae	*Barbatia* sp.	0	0	0	0	0	0	R	U	0	0	R	0	0	R	R	U	0
Mytilidae	*Brachidontes erosa*	0	0	0	0	C	R	U	U	0	0	R	0	0	0	0	U	0
	Xenostrobus pulex	A	A	A	A	A	A	A	C	out	A	A	A	0	U	0	U	A
	Mytilus sp.	0	0	R	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Trichomya hirsuta	0	0	0	R	0	0	0	R	0	0	R	0	0	0	0	0	0
	Musculus sp.	0	U	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ostreidae	*Ostrea angasi*	0	U	R	0	C	U	U	C	0	C	0	U	0	0	0	0	0
	Saccostrea glomerata	0		U	U	0	0	0	0		0	0	0	0	0	0	0	0
Pteriidae	*Pinctada* sp.	0	0	0	0	0	0	0	R	0	0	0	0	0	0	0	0	0
Malleidae	*Malleus* c.f. *meridianis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Veneridae	*Katelysia peronii*	0	0	0	0	0	0	0	0	0	0	R	0	0	0	0	0	0
Lucinidae	*Codakia rugifera*	0	0	0	0	R	0	0	0	0	0	0	0	0	0	0	0	0
Cephalopoda																		
Decapoda	*Sepioteuthis australis*	R + egg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	**26**	**34**	**24**	**12**	**27**	**28**	**32**	**20**	**36**	**28**	**30**	**40**	**27**	**46**	**34**	**31**	**37**

b) ECHINODERMATA

Class/ Subclass Family	**Species**	**MR**	**HC**	**CB**	**PN**	**SP**	**BP**	**AN**	**AS**	**My**	**Ca**	**LB**	**SV**	**FB**	**KB**	**TB**	**YB**	**Mi**
Asteriidae	*Patiriella calcar*	0	0	0	0	0	0	0	0	0	0	0	0	0	C	0	0	C
	Patirella exigua	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Patiriella sp.	0	0	0	0	0	0	0	0	R	0	0	0	0	R	0	0	0
	Patiriella brevispina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Coscinasterias muricata	R	R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Smilasterias sp.	0	0	0	0	0	0	0	0	R	0	0	0	0	0	0	0	0
Goniasteridae	*Allostichaster polyplax*	0	0	0	0	0	0	0	0	U	0	0	0	0	U	0	0	0
Oreasteridae	*Tosia australis*	out	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Nectria ocellata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Unidentified species	out	0	0	0	0	0	R	0	0	0	0	0	0	0	0	0	0
Ophionereididae	*Ophionereis schayeri*	0	0	0	0	0	0	0	0	C	0	0	0	0	0	0	R	0
Ophiactidae	*Ophiactis resiliens*	0	0	0	0	0	0	0	0	R	0	U	0	0	R	C	U	0
	Unidentifed species	0	0	0	0	0	0	0	0	R	0	0	0	0	0	0	0	0
Temnopleuridae	*Clarkoma pulchra*	0	0	0		0	0	0	0	R	0	0	0	0	0	0	0	0
	Ophiarachnella ramsayi	0	0	0	0	0	0	0	0	R	0	0	0	0	0	0	0	0
Echinometridae	*Holopneustes inflatus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Centrostephanus tenuispinus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Heliocidaris erythrogramma	R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Phyllacanthus irregularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Comasteridae	*Comatula sp.*	0	0	R	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stichopodidae	*Stichopus mollis*	0	0	R	0	0	0	0	0	0	0	0	0	0	R	0	0	0
	purple cucumber	R	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	grey cucumber	0	0	0	0	0	0	0	R	0	0	0	0	0	0	0	0	0
	transparant cucumber	0	0	0	0	0	0	0	R	R	0	0	0	0	0	0	0	0
	TOTAL	**3**	**1**	**2**	**0**	**0**	**0**	**1**	**2**	**9**	**0**	**1**	**0**	**0**	**5**	**1**	**2**	**1**

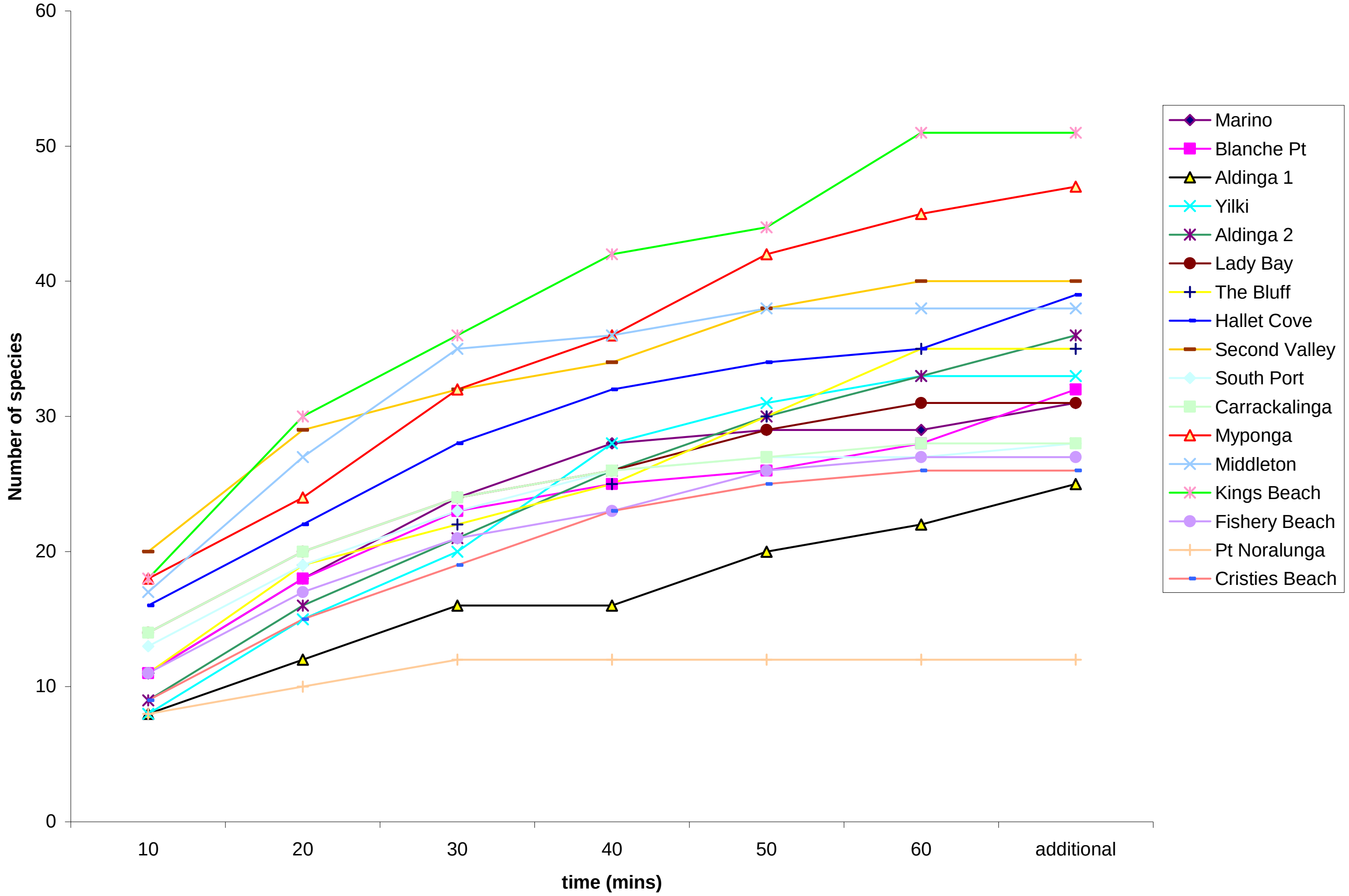
b) MARINE PLANTS

DIVISION Class	**Species**	**MR**	**HC**	**CB**	**PN**	**SP**	**BP**	**AN**	**AS**	**My**	**Ca**	**LB**	**SV**	**FB**	**KB**	**TB**	**YB**	**Mi**
CHLOROPHYTA	*Avrainvillea clavatiramea*	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
	Caulerpa brownii	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	1
	Caulerpa longifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	Chaetomorpha sp.	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	1
	Codium fragile	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	Codium lucasii	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
	Codium pomoides	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0
	Colpomenia sp	1	1	0	0	0	0	1	0	0	0	0	1	1	1	0	0	0
	Enteromorpha compressa	1	1	1	0	1	1	1	0	0	0	1	1	1	0	0	1	0
	Rhipiliopsis cf. *peltata*	0	1	0	1	1	1	0	0	1	0	0	0	0	0	1	0	0
	Ulva australis	0	1	1	0	1	1	0	1	0	0	0	0	0	1	1	0	1
	Ulva taeniata	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	Unid green filamentous alga 1	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	1	0
	Unid green foliose alga 1	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0
	Unid green foliose alga 2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
	Unid green foliose alga 3	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	Unid green turfing alga 1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
	Unid green turfing alga 2	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Total		2	4	5	6	3	5	3	2	2	2	4	3	6	3	2	4	5
HETEROKONTOPHYTA																		
Phaeophyta	*Cladostephus spongiosus*	0	1	0	0	0	1	0	1	1	0	0	0	0	0	1	0	0
	Cystophora grevillei	0	0	1	1	0	1	1	0	1	0	0	1	1	0	0	0	0
	Cystophora intermedia	0	1	1	0	0	0	0	0	0	0	1	1	1	1	1	1	0
	Cystophora moniliformis	1	1	1	0	0	0	1	0	1	0	0	1	1	1	0	0	1

	Cystophora subfarcinata	1	1	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0
	Dictyopteris muelleri	0	1	1	0	0	1	1	0	1	0	0	0	0	0	0	0	1
	Ecklonia radiata	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	Hormosira banksii	0	0	0	0	0	0	0	1	1	0	0	0	1	1	1	1	1
	Lobophora variegata	1	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0
	Myriodesma sp.	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	Sphacelaria sp.	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
	Unid brown filamentous alga 1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
	Unid brown filamentous alga 2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	Unid brown foliose alga 1	1	1	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0
	Unid brown foliose alga 2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Unid brown foliose alga 3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Unid brown turfing alga	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
	Zonaria spiralis	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	Zonaria turneriana	0	0	0	1	0	0	1	0	1	0	0	1	1	1	0	0	0
	Total	**4**	**11**	**7**	**0**	**0**	**4**	**7**	**2**	**8**	**1**	**2**	**8**	**5**	**5**	**5**	**4**	**6**
RHODOPHYTA	*Callophyllis* sp	1	1	0	0	1	1	1	0	1	1	1	1	1	1	1	1	0
	Haptilon roseum	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	1	1
	Jania micrarthrodia	1	0	0	0	0	0	1	1	1	1	0	1	1	0	1	1	0
	Lithophyllum sp. cf *frondosum*	0	1	0	0	0	0	1	1	0	1	0	1	1	1	0	0	1
	Metagoniolithon cf. *radiatum*	0	1	0	0	1	0	1	0	1	0	0	1	0	1	1	1	0
	Rhodopeltis australis	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	Stylonema sp.	0	1	1	0	0	0	1	1	1	1	1	0	0	1	1	0	0
	Unid red filamentous alga 2	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	Unid red foliose alga 1	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
	Total	2	6	1	1	4	3	6	3	4	4	3	4	4	5	4	4	3

MAGNOLIOPHYTA																		
Liliospida	*Amphibolis griffithi*	0	0	0	0	0	0	0	1	0	0	1	0	1	1	1	0	0
	Heterozostera tasmanica	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	1
	Posidonia sp.	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**3**	**0**	**1**	**2**	**2**	**1**	**1**
	ALL MARINE PLANTS	**8**	**21**	**13**	**3**	**7**	**12**	**16**	**8**	**15**	**7**	**12**	**15**	**16**	15	**13**	**14**	**15**

Appendix 2



Appendix 2: Species accumulation curves for molluscs and echinoderms recorded within 10 minute intervals in 1 hr timed-search surveys at 17 intertidal reefs along the Fleurieu Peninsula

Appendix 3: SIMPER results for the difference in molluscan communities on soft and hard rocky reefs along the Fleurieu Peninsula, S.A. The Bray Curtis dissimilarity measure is based on a categorized rarity matrix with 999 permutations and several repeated computations.

	soft	hard reefs				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Littorina unifasciata	1.11	4.00	1.89	1.68	3.37	3.37
Littorina acutispira	0.78	2.63	1.53	1.38	2.73	6.10
Nerita atramentosa	1.67	3.50	1.49	1.29	2.65	8.75
Cellana solida	1.56	3.63	1.40	1.35	2.51	11.25
Patelloida latistrigata	0.89	2.50	1.40	1.32	2.50	13.75
Austrocochlea porcata	0.89	2.13	1.39	1.11	2.47	16.22
Austrocochlea concamerata	1.00	2.38	1.27	1.32	2.27	18.49
Austrochoclea constricta	1.78	2.75	1.27	1.26	2.26	20.76
Cellana tramoserica	1.33	2.63	1.27	1.40	2.26	23.01
Bembicium nanum	1.89	2.63	1.25	1.33	2.23	25.24
Ischnochiton australis	0.22	2.00	1.24	1.35	2.20	27.44
Nodilittorina praetermissa	0.00	1.75	1.18	1.24	2.11	29.56
Dicathais orbita	0.56	2.13	1.17	1.59	2.08	31.64
Siphonaria sp.	2.33	3.38	1.12	1.08	1.99	33.63
Austrocochlea adelaidae	0.11	1.75	1.11	1.12	1.98	35.61
Patelloida alticostata	0.67	2.13	1.09	1.49	1.94	37.55
Siphonaria zelandica	2.89	2.25	1.07	1.14	1.91	39.46
Bittium granarium	1.67	1.25	1.04	1.30	1.85	41.32
Turbo undulatus	2.00	2.13	1.03	1.15	1.84	43.15
Notoacmea flammea	0.56	1.25	0.96	0.98	1.71	44.87
Patelloida profunda calamus	0.78	1.50	0.95	1.15	1.70	46.57
Ostrea angasi	1.56	0.50	0.95	1.21	1.70	48.27
Xenostrobus pulex	3.67	2.75	0.92	0.81	1.65	49.92
Notoacmea mayi	0.67	1.38	0.90	1.07	1.61	51.53
Lepsiella vinosa	0.56	1.25	0.86	1.00	1.53	53.06
Rissoina crassa	1.33	0.38	0.85	1.18	1.52	54.58
Ischnochiton elongatus	2.22	2.88	0.80	1.30	1.43	56.01
Brachidontes erosa	1.22	0.00	0.79	1.17	1.40	57.41
Notogibbula preissiana	0.22	1.25	0.73	1.28	1.30	58.71
Patelloida cf. insignia	0.44	1.00	0.70	0.97	1.25	59.96
Lasea australis	1.22	0.75	0.68	1.28	1.21	61.16
Canthrindella picturata	0.67	1.13	0.66	1.21	1.17	62.34
Clypidina rugosa	1.00	0.63	0.64	1.16	1.15	63.49
Lepsiella flindersii	0.00	0.88	0.57	0.66	1.02	64.51
Ophiactis resiliens	0.44	0.63	0.56	0.79	1.00	65.51
Clanculus consobrinus	0.11	0.88	0.55	0.74	0.99	66.49

Patella peronii	0.22	0.88	0.55	0.93	0.98	67.48
Euchelus profunior	0.33	0.75	0.55	0.91	0.97	68.45
Cominella lineolata	0.56	0.50	0.54	0.87	0.96	69.41
Ischnochiton virgatus	0.22	0.75	0.53	0.81	0.95	70.36
Collisella mixta	0.22	0.75	0.51	0.94	0.92	71.28
Ischnochiton tori	0.33	0.75	0.50	0.99	0.89	72.17
Notoacmea petterdi	3.22	3.63	0.49	1.03	0.88	73.05
Herpetoma pumilo	0.56	0.50	0.47	1.08	0.84	73.89
Barbatia sp.	0.67	0.25	0.46	0.91	0.82	74.71
Patiriella calcar	0.00	0.75	0.45	0.57	0.81	75.52
Ischnochiton lineolatus	0.22	0.63	0.45	0.95	0.80	76.32
Ischnochiton cariosus	0.67	0.13	0.45	0.88	0.80	77.12
Granata imbricata	0.33	0.50	0.44	0.74	0.79	77.90
Zeacumantus diemenensis	0.11	0.50	0.41	0.44	0.74	78.64
Unidentified juveniles	0.33	0.38	0.40	0.64	0.72	79.36
Thalotia chlorostoma	0.33	0.50	0.38	0.90	0.69	80.05
Ischnochiton smaragdinus	0.22	0.63	0.38	1.12	0.67	80.72
Haliotis rubra	0.44	0.38	0.37	0.89	0.66	81.38
Phasianella ventricosa	0.33	0.25	0.34	0.63	0.60	81.98
Saccostrea glomerata	0.44	0.00	0.33	0.53	0.59	82.57
Rissoina sp.	0.00	0.50	0.32	0.51	0.57	83.14
Plaxiphora albida	0.00	0.50	0.31	0.69	0.56	83.70
Amblychilepas javanicensis	0.00	0.50	0.31	0.48	0.56	84.26
Ischnochiton resplendens	0.22	0.38	0.30	0.72	0.54	84.80
Allostichaster polyplax	0.00	0.50	0.30	0.57	0.53	85.33
Batllaria estuarina	0.44	0.00	0.29	0.47	0.52	85.85
Cantharidus (Thalotia) pullcherrimus	0.33	0.13	0.29	0.57	0.51	86.36
Ophionereis schayeri	0.11	0.38	0.29	0.47	0.51	86.87
Bittium c.f. icarus	0.11	0.38	0.28	0.47	0.50	87.38
Ischnochiton variegatus	0.22	0.25	0.28	0.59	0.50	87.88
Mitrella pulla	0.11	0.38	0.27	0.81	0.47	88.35
Clanculus cf limbatus	0.22	0.25	0.25	0.51	0.45	88.81
Trichomya hirsuta	0.33	0.00	0.23	0.69	0.41	89.22
Hypselodoris obscura	0.33	0.00	0.23	0.70	0.41	89.63
Siphonaria diemenensis	3.89	3.75	0.21	0.50	0.38	90.01