

Kāpiti and Mana Island Rocky Shore Survey

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for

Greater Wellington Regional Council

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CONTENTS

1. INTRODUCTION	3
2. METHODS.	5
2.1 Background	5
2.2 Sampling sites and survey	5
2.3 Field sampling methods	5
2.4 Species identifications	8
2.5 Data recording, QA/QC and analysis.	8
3. RESULTS AND DISCUSSION	9
3.1. General site features	9
3.2 Substratum cover	12
3.3 Species richness patterns	13
3.4 Species composition and abundance patterns	15
4. SYNTHESIS OF FINDINGS	21
5. FUTURE MONITORING	22
5.1 Utility of existing sites for ongoing monitoring	22
5.2 Utility of existing methods for ongoing monitoring	22
5.3 Broader considerations.	23
6. CONCLUSIONS AND RECOMMENDATIONS	24
7. REFERENCES CITED	25
Appendix 1. Site location information and field recording sheets	26
Appendix 2. List of 83 species and higher taxa, their functional group, main taxonomic group and common name	31
Appendix 3. Quadrat physical data and taxa information for each replicate within each shore height and site	33
Appendix 4. Transect point count data for each shore height and site	37
Appendix 5. SACFOR assessment data for each shore height and site	38
Appendix 6. Mean and standard error of key response variables measured in replicate (n=10) quadrats	40

TABLES

Table 1. SACFOR ratings used to assess site-scale abundance or percent cover.	8
Table 2. Total number of species recorded at each of the four sites.	14
Table 3. SACFOR ratings for the most regularly encountered species at each of the four sites.	17

FIGURES

Fig. 1. Kāpiti and Mana Islands, showing locations of the four rocky shore survey sites.	4
Fig. 2. Illustration of the three methods used to sample the four rocky shore sites	6
Fig. 3 Schematic illustrating the shore cross-sectional profile and general characteristics of the sites	10
Fig. 4. Substratum composition for each of the four survey sites and intertidal shore heights.	12
Fig. 5. Percent cover of bare rock and groups of sessile organisms for each of the four survey sites	13
Fig. 6. Taxon richness for each shore height and site, derived from each of the three data types.	14
Fig. 7. Densities of mobile invertebrates (mean \pm SE, n=10) for some of the main gastropod groups.	15
Fig. 8. Kite diagrams showing the relative SACFOR abundance and distribution of main species groups.	16
Fig. 9. Photos of some of the species referred to in the text that characterised the different shore zones.	18
Fig. 10. Ordination biplot (nMDS) depicting the grouping of shore heights among rocky shore sites.	19
Fig. 11. Frequency of occurrence of each SACFOR rating for the four sites and four zones.	20

EXECUTIVE SUMMARY

This report describes a baseline assessment and characterisation of four rocky shore sites undertaken in January 2019: three sites on Kāpiti Island (one inside the marine reserve) and one site on Mana Island. The work was funded by Greater Wellington Regional Council (GWRC) but logistical support was provided by the Department of Conservation (DOC) due to their interest in Kāpiti Island as one of several priority sites to be included in a national Marine Sentinel Site programme. Sampling methods involved a semi-quantitative 'SACFOR' assessment to inventory the species present and document their relative prevalence, and quantitative sampling that used random quadrat and transect methods.

All sites appeared to be moderately wave-exposed at times, and consist of gently-sloping shores of mainly boulder and cobble over outcrops of bedrock. These substrata provided physically complex habitats that supported reasonably diverse intertidal assemblages whose main species were similar among locations. The results revealed a species-poor supra-tidal zone, a high shore dominated by barnacles and periwinkles, transitioning to increasingly diverse assemblages toward the low tide mark, where macroalgae were conspicuous and diverse around the lower shore fringes. These are expected trends that reflect a progression from very harsh conditions in the highest parts of the shore (e.g. long periods of air exposure) that are tolerated by only a few specialised species, to relatively benign lower shore conditions that are suitable for a far greater diversity of organisms.

Overall, the range of species and higher taxa recorded was typical of 'healthy' New Zealand rocky shores. A total of 83 species and higher taxa were recorded, which is more extensive than that described for previous GWRC surveys. This difference reflects that there was a suite of taxa present that were relatively uncommon at any given site but greatly contributed to overall species richness. The main species and cross-shore patterns of change among sites broadly match the description from a qualitative survey undertaken in 1968 at Kāpiti Island, which appears to be the only previous comprehensive rocky shore sampling undertaken there. Although the survey was not intended as an assessment of the effect of marine reserve protection, there was no evidence that the rocky shore assemblage from the site inside the Kāpiti marine reserve was appreciably different biologically to the other sites sampled, noting that there is restricted public access to all of the sites.

Approaches to future rocky shore monitoring are discussed in the report. Assuming that GWRC continue a rocky shore programme in some form, we recommend the following:

1. Kāpiti and/or Mana Island sites provide valuable reference locations against which to compare mainland sites subject to greater anthropogenic pressure. We suggest that repeat surveys, conducted at an interval of 5-years, would be sufficient to capture long term trends.
2. GWRC should consider developing a formalised approach to rocky shore monitoring that aims to: (i) characterise a regionally 'representative' selection of the rocky habitats present (i.e. based on physical habitat types and/or key areas of high ecological value); and (ii) address the effect of local and broad scale pressures on rocky shore habitats through selection of 'at risk' monitoring sites, complemented by a comparable network of reference locations.
3. The methods described in this report and previous GWRC studies are all appropriate for long term monitoring. The most 'fit for purpose' methods for GWRC need to be able to characterise a site to a sufficient level of detail to enable regional rocky shores to be compared against each other (e.g. 'impact' vs reference sites), and to be tracked over time. For this purpose, we consider future monitoring should combine the SACFOR and transect sampling approach described in this report, with quadrat sampling based on fixed rather than random quadrats. This type of survey provides a good return for a modest effort (e.g. a 2-3 person field team).

1. INTRODUCTION

Developing an understanding of the state of coastal habitats is critical to the management of biological resources. A report produced for Greater Wellington Regional Council (GWRC) by Robertson and Stevens (2007) identified the nature and extent of risk from a range of stressors to coastal habitats in the Wellington region. Since that report was produced, GWRC have implemented a programme of coastal habitat mapping, baseline assessment and ongoing monitoring of representative estuaries, beaches and rocky shores. For rocky shores, Robertson and Stevens (2007) recommended baseline assessment and long-term monitoring of the abundance and diversity of plants and animals at regionally representative high diversity sites, using rapid survey methods to broadly characterise ecological condition.

Rocky habitats are a dominant and visually dramatic element of parts of the Wellington region's coastline. Intertidal rocky shores are physically complex, with rock pools, gullies, crevices and boulders providing a diverse range of habitats that can support a high diversity of species. The harsh and variable physical conditions, including degree of wave-exposure and large shifts in temperature, as well as aspect and substratum type, together with biotic interactions, lead to the development of a characteristic zonation of species in stable rocky habitats. These zones include supra-tidal (i.e. wave-splash) and high shore areas dominated by lichens, periwinkles, and barnacles, with a transition to lower shore zones that are typically characterised by an increasing diversity of species. The lowest shore is often visually dominated by seaweeds, in particular canopy-forming brown algae, which are a dominant biogenic habitat along temperate rocky shores worldwide (Tomanek & Helmuth 2002).

Rocky shore habitats can be degraded by a variety of anthropogenic stressors. These include habitat loss or modification due to over-harvesting of resources, the introduction of invasive species, coastal armouring, eutrophication from nutrient enrichment, and smothering or turbidity effects from fine sediments (Stevens 2018). As well as these ongoing sources of disturbance, infrequent but potentially significant events (e.g. oil spills, harmful algal blooms) can also have catastrophic consequences. Monitoring of representative rocky shore sites enables the influence of these types of stressors to be characterised, and provides a benchmark for assessing longer-term changes that occur across broad spatial scales, such as sea temperature and sea level rise, changes in freshwater input and wave-climate (e.g. due to

altered storm frequency or intensity), and ocean acidification (Schiel 2011).

To date, baseline rocky shore assessments in the Wellington region have been undertaken for GWRC at Flat Point on the Wairarapa coast (Stevens & O'Neill-Stevens 2017), in Wellington Harbour (Scorching Bay), and at Makara and Baring Head (Stevens 2018). To provide a further characterisation of the condition of some of the region's rocky shores, Salt Ecology was contracted by GWRC in late 2018 to undertake synoptic baseline assessments of Kāpiti and Mana Islands (Fig. 1), as part of a joint project with the Department of Conservation (DOC). For both agencies, the Kāpiti/Mana area is of interest as a marine environment where major sea currents converge, leading to an overlap of species that are typically only found further south or further north.

The relative remoteness of Kāpiti and Mana Islands is expected to make them useful as reference sites against which GWRC monitoring sites along the mainland coast can be compared. Although subtidal surveys have been conducted around Kāpiti Island since a marine reserve was established in 1992 (<https://www.doc.govt.nz/nature/habitats/marine/type-1-marine-protected-areas-marine-reserves/marine-reserve-report-cards/Kapiti-marine-reserve/research-and-monitoring/>), the intertidal zone has received little attention, with the last assessment we are aware of being a qualitative inventory of a few sites described by McCoy et al. (1968). Furthermore, for DOC specifically, Kāpiti Marine Reserve has been identified as one of several priority sites to be included in a Marine Sentinel Site programme that the Department is developing in partnership with Air New Zealand (<https://www.doc.govt.nz/nature/habitats/marine/type-1-marine-protected-areas-marine-reserves/marine-sentinel-site-programme/>). In that programme, a network of 'marine sentinel sites' will be established around the country, to gather in-depth data that is intended to broaden knowledge of New Zealand's marine environment and inform policies and management decisions.



Fig. 1. Kapiti and Mana Islands, showing locations of the four rocky shore survey sites.
 Numbers refer to start and end points of each shore transect. See Appendix 1 for site coordinates.

2. METHODS

2.1 BACKGROUND

Previous GWRC assessments have involved a rapid survey approach that is intended to characterise the general condition of rocky shore habitats with relatively little effort (typically a 2-person survey team). For this purpose, past methods have been based on semi-quantitative 'SACFOR' approaches (see below), combined with the installation of fixed quadrats from which photographs are taken and archived. In the context of the Marine Sentinel Site programme, DOC were interested not only in the findings of the survey, but also in the application of quantitative transect-based and quadrat-based random sampling methods. As such, the work we describe in this report expands on the typical approach used in GWRC projects. Due to time constraints, and because the types of habitats and their accessibility for sampling were unknown prior to the survey, a decision was made that fixed quadrats would not be installed. It was nonetheless recognised that the survey findings would provide a basis for determining whether it would be feasible and useful to install fixed quadrats at a later date.

2.2 SAMPLING SITES AND SURVEY

The field survey was conducted during low spring tides from 22-24 January 2019. Reported tidal ranges for these dates differ widely depending on the reference station used. Based on the NIWA tide prediction model (<https://www.niwa.co.nz/services/online-services/tide-forecaster>) for Kāpiti Island at Waiorua Bay, the tidal range was ~1.93-2.06m over the survey period. This reflects some of the largest predicted tides for the area (i.e. spring tides). By comparison the minimum range (during neap tides) in the month either side was ~0.59m. As such, the tidal conditions enabled sampling into the very lowest part of the intertidal zone, which would be uncovered on only a few days every month.

The survey team comprised four scientists (two each from Salt Ecology and GWRC), which enabled a site to be surveyed in single low tide and meant that in the time allocated for the work, four sites could be surveyed in total (see locations in Fig. 1), consisting of three sites on Kāpiti Island (Kap1, Kap2, Kap3) and a single site on Mana Island (Mana). Kāpiti Island site Kap2 was in the marine reserve, just to the north of Rangitira Point. The survey team was supported by a DOC skipper (Dave Wrightson), whose local knowledge of the area was invaluable in selecting stable rock sampling sites that could be safely accessed by foot or boat under most weather

conditions. This limited the choice of suitable and comparable sites to a few locations, mainly along the eastern side of each island, although sea conditions at the time of sampling enabled us to access one site (Kap1) with a more southerly aspect. The chosen sites had gentle to moderate slope profiles and consisted of a mix of boulder and cobble with greywacke bedrock outcrops in parts. Much of the island habitat outside the chosen sites consists of either steep difficult-to-access (and highly wave-exposed) bedrock or relatively mobile cobble, both of which are unsuitable for monitoring.

2.3 FIELD SAMPLING METHODS

2.3.1 General

Monitoring focused on the true intertidal zone, extending from the rarely inundated spring high water tide line, to the almost-always inundated spring low tide line. In this zone the shore was stratified into high, mid and low shore sampling zones. In addition, a cursory semi-quantitative assessment was made within the supra-tidal zone (the highest shore zone, which is regularly splashed but not submerged by seawater), as has been conducted in previous GWRC surveys. Hence, four shore zones in were surveyed in total, but only the three intertidal zones were assessed using quantitative transect and quadrat sampling methods.

Sites were defined by a 50m length of shore across these zones. At each site, video and still photographs were taken, and general site features described and categorised according to the template in Appendix 1. The information recorded included site aspect, wave-exposure, shore width, topographic features, and substratum rugosity (i.e. 'roughness'). All site information and sampling data were recorded on pre-prepared water-proof sheets. The assessment approach used three different sampling methods (Fig. 2), which were intended to characterise the most conspicuous species at each site, rather than provide a complete biological inventory. Note that the following were not included: (i) rocks were not turned over in boulder and cobble habitats, hence the assemblage of 'under boulder' fauna was not assessed; (ii) rock pools were not sampled; (iii) crabs and other highly mobile species were not recorded; and (iv) infauna associated with gravels and beach wrack biota were not assessed.

2.3.2 Transect sampling

Transect sampling provided a rapid method for quantitatively characterising the rock type and dominant biota in the three intertidal zones at each

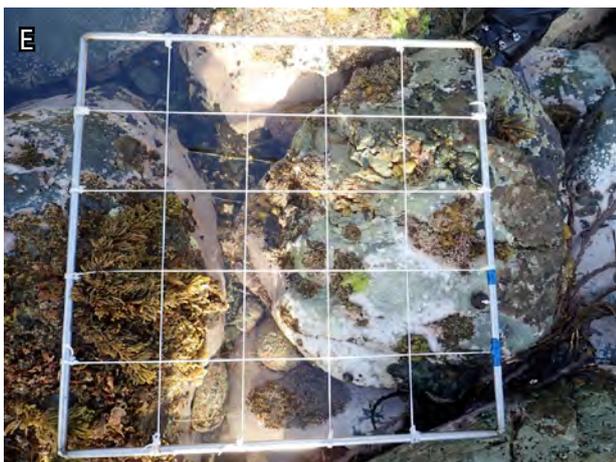


Fig. 2. Three methods were used to sample the four rocky shore sites:

- a) searches to describe the conspicuous species present and their relative abundance (A & B);**
- b) point sampling along a 50m transect line to assess percent cover of the dominant sessile biota and substratum features (C & D), and**
- c) sampling inside define 0.25m² quadrats, including point counts of sessile biota at grid intercepts (E & F).**

site, with the approach used based on a method described by Forrest and Taylor (2002). A lead-cored transect line (50m long in 2 x 25m sections) was laid out in each of the three intertidal zones, and the GPS position of the start and end was recorded. Beneath each of 80 random points (pre-marked) along the 50m length, the following was undertaken:

- The type of substratum was recorded as bedrock, boulder (>256mm), cobble (64mm to < 256mm) or gravel (2mm to < 64mm). Size designations for the latter three rock types followed the standard Wentworth scale (FGDC 2012), although in the field the size classes were estimated rather than measured.
- The sessile organisms (i.e. those attached to a fixed position on the rock) beneath each point, or bare rock where no visible organisms were present, were recorded.

Note that in the low shore (mainly), where there was a primary layer (i.e. algal canopy) masking other biota or bare space in the understory beneath, both the primary and understory layer were recorded for that point.

2.3.3 Quadrat sampling

Stainless steel quadrats 0.5 x 0.5m (0.25m² area) were used to quantitatively sample the biota within each of the three intertidal zones at a finer scale than provided for by the SACFOR (see below) or transect approaches. Although a larger quadrat size (1m²) was considered, a decision was made to keep consistency with previous GWRC surveys, which have also used the smaller 0.25m² quadrat. The rationale for the smaller size is that due to the relatively small tidal height range in the Wellington region (~0.59 during neap tides, as noted above for Kāpiti), 1m² is too big to sample across three shore zones at sites with near-vertical faces.

A total of ten replicate quadrats were placed in each of the three intertidal zones, so that within-site variability could be assessed. The position of each quadrat in each shore zone was determined by pre-selecting a random subset of the points used for the transect sampling. Once in position, each quadrat was labelled and photographed, after which three types of species data were collected, as follows:

- One quadrat was gridded with string to create 36 evenly spaced intercept points (see Fig. 2). At each point, the biota present, or occurrence of bare rock, were recorded as described above for the transect sampling. Due to time constraints imposed by the tides, in low shore situations where a primary layer and understory were present, the field time was used to characterise

the understory, with the primary layer later assessed from the photographs.

- Once the intercept counts were completed, the gridded quadrat was removed and the abundances of mobile invertebrates and selected sessile species were counted.
- Finally, any additional species observed in the quadrat that were not detected as part of the point intercepts or counts were recorded as being present, in order to more comprehensively characterise species richness (Forrest & Taylor 2002).

In addition, for each quadrat an assessment was made of: (i) the dominant rock type, using the same classifications as for transects; (ii) quadrat slope (from flat to steep); (iii) aspect (magnetic degrees); and (iv) substratum rugosity (Appendix 1).

2.3.4 SACFOR assessment

As in previous GWRC surveys a semi-quantitative assessment was undertaken to develop a checklist of the main species present and assess their relative prevalence between the supra-tidal and low shore zone. For this purpose, bare rock, invertebrates and plants (macroalgae and lichens) within the four zones (supratidal plus three intertidal) were scored according to the 'SACFOR' ratings shown in Table 1. The approach involves assigning abundance (density per m²) or surface cover (%) estimates in the following categories: super abundant (S), abundant (A), common (C), frequent (F), occasional (O), or rare (R).

The ratings in Table 1 represent a scoring scheme simplified from methods used in previous GWRC surveys, which were developed from monitoring methods that have been implemented by the United Kingdom's Joint Nature Conservation Committee (JNCC) since 1990 (MNCR 1990; Hiscock 1998; Blyth-Skyrme et al. 2008). The SACFOR method is ideally suited for characterising conspicuous (nominally >5mm body size) or patchy intertidal epibiota. In this instance it was also useful as a means of characterising the supra-tidal zone. In most instances this zone was quite steep, and not particularly amenable to sampling by the quantitative methods described above.

Table 1. SACFOR ratings used to assess site-scale abundance or percent cover of invertebrates, macroalgae, lichens and bare rock.

Category	Code	Density m ⁻²	Percent cover
Super abundant	S	> 1000	> 50
Abundant	A	100 - 999	20 - 50
Common	C	10 - 99	10 - 19
Frequent	F	5 - 9	5 - 9
Occasional	O	1 - 4	1 - 4
Rare	R	< 1	< 1

The SACFOR method when applied to the biota present is intended to characterise only the most conspicuous species, being those that are readily apparent to the naked eye (typically organisms exceeding 5mm in size).

2.4 SPECIES IDENTIFICATIONS

Where necessary, unidentified organisms were assigned field 'placeholder' names to foster their consistent classification during the survey, with voucher specimens collected for later taxonomic identification. Where such identifications could not be made from fresh specimens, samples were preserved in 10% formalin, and fresh macroalgae were also pressed. Most identifications were made by the authors, with the main taxonomic references used being: general (Morton & Miller 1973; Carson & Morris 2017), invertebrates (Cook 2012), and macroalgae (Adams 1994; Nelson 2013). For a selection of the macroalgae, provisional names were assigned by Dr Wendy Nelson (NIWA) based on photographs, for which a subset was then verified by examination of pressed or preserved samples. However, recognising that the intent was not to produce a biodiversity inventory, a small number of the identifications remain provisional (noted as such where necessary), and some are assigned an unidentified status. Note that the term 'species' as used in this report, can also refer to morphologically similar organisms that cannot reliably or easily be separated into different true species, most notably some of the macroalgae (e.g. brown crusts, coralline paint). In the case of the brown macroalgae within the morphologically plastic *Cystophora* genus, we assigned three species names. Of these, two 'species' (*C. scalaris* and *C. retroflexa*) have intermediate morphotypes with other closely related (*C. distenta* and *C. congesta*, respectively) species (Buchanan & Zuccarello 2018).

2.5 DATA RECORDING, QA/QC AND ANALYSIS

Site information and sampling data were entered into Microsoft Excel, with ~50% of entries cross-checked for transcription errors. To minimise the risk of subsequent data manipulation errors, Excel sheets for the different data types were imported into the software R 3.6.0 (R Core Team 2019). All summaries and analyses of univariate responses were produced using R code. To derive percent cover estimates for bare rock, substratum classes, or sessile species prevalence, as described below, point or intercept data from each transect and quadrat were converted to a percentage based on the total number of records for each sampling unit.

The prevalence of bare rock, and substratum composition classes, were derived from the transect and quadrat point/intercept data. Whereas for transects the substratum composition data show relative percentages, for quadrats the result represents the relative frequency of occurrence (from 10 replicate samples) of the dominant rock class in each quadrat. The univariate biological responses considered were richness, counts and percent cover, by species, or by higher taxonomic or functional groupings. For the latter, the functional groups used were lichens (supra-tidal SACFOR only), macroalgae, sessile invertebrates and mobile invertebrates.

Note that the primary aim of the analysis presented is to illustrate broad trends and assess rocky shore condition for GWRC purposes. As such, the quadrat data for most analyses of univariate responses is aggregated within each site and shore height to foster comparison with the transect and SACFOR data. There is clearly considerable scope to drill deeper into the data, for example to compare the methods in greater detail, and to examine the within-site variability recorded by the replicated quadrat sampling. While we touch on these considerations as part of a discussion of future monitoring approaches for GWRC, a detailed analysis was beyond our present scope.

As the SACFOR dataset includes the full complement of species recorded, it was used to examine some of the broad distributional patterns of main taxonomic groups and as the basis for a multivariate analysis of compositional similarity across sites and shore heights. To create a numerical data set, the SACFOR ratings from the semi-quantitative survey were converted into ranked dominance scores, simply by recoding categories from rare to super abundant as values from 1 to 6, respectively.

Using the ranked SACFOR data, kite diagrams were constructed using custom developed R code,

in order to visually illustrate relative patterns of dominance among the four shore heights (i.e. supratidal included) and sites. For this purpose, species composition data were aggregated to ten higher taxa, facilitating a high-level comparison of shore height and location differences. Aggregation was undertaken by averaging SACFOR scores across species within each group, and hence provides only a crude representation of the changing dominance patterns among sites and across tidal zones.

To explore similarities among shore heights and sites in terms of relative dominance at the species level, multivariate analysis was undertaken using the software package Primer v7.0.13 (Clarke et al. 2014). For this analysis the SACFOR supratidal data were excluded. Patterns in site and intertidal shore height similarity as a function of macrofauna composition and relative dominance were evaluated using a non-metric multidimensional scaling (nMDS) ordination, constructed from pairwise Bray-Curtis similarity index scores. A square root transformation was applied in order to scale the data so that the rare (R) SACFOR species exerted an influence on the ordination pattern. The similarity percentages procedure (SIMPER) was used to explore the main groups that characterised the nMDS site clusters, or discriminated clusters from each other. Overlay plots were used to explore relationships between multivariate biological patterns and substratum type. An examination of the frequency of occurrence of the different SACFOR classes was used to assist in the interpretation of site and shore height differences.



Example of rocky shore species in a creviced refuge area. Such assemblages are readily assessed using the SACFOR methodology

3. RESULTS AND DISCUSSION

Raw data from the survey are provided in the attached appendices. Appendix 2 contains a full list of species recorded and their associated functional group, main taxonomic group and common name (if available). Appendices 3, 4 and 5 contain the raw data for quadrats, transects and the SACFOR assessment, respectively.

3.1. GENERAL SITE FEATURES

The general features of each site in terms of cross-sectional profile and substratum type are shown schematically in Fig. 3, with substratum composition as determined from transect and quadrat sampling shown in Fig. 4.

Sites ranged in width from ~15 to 30m between the high and low spring tide water line. The dominant substrata were bedrock and small boulders, with the latter being particularly prevalent at Kap2 and in the low shore zone at Kap3. In fact, there was no bedrock recorded from either the mid or low shore of Kap2 and Kap3. The differences in rock type between quadrats and transects in Fig. 4 can be attributed to the different methods used to derive the composition data. Transects provide a more realistic representation in that the data show relative percent cover from 80 random points sampled along the 50m line, meaning that the less common rock types like gravel are detected. For quadrats, the data show the frequency of occurrence of the dominant rock type recorded for each of 10 replicates per shore height; as such, less common rock types like gravel are not represented.

Typically, the supratidal zone at each site was relatively steep, often characterised by bedrock or large boulders and, in places, interspersed among eroding soil banks. Across the shore profile, the steep supratidal gave way to an intertidal slope that became progressively gentler down the shore (see Fig. 3). The lowest part of the tide zone at all sites had a relatively flat profile, which was most extensive at Kap3 and Mana. The shortest and slightly steeper beach profile was at Kap2, immediately north of Rangitira Point, suggesting perhaps that the cobble and boulder habitat is less stable and more strongly shaped by the wave regime than the profile at other sites. Evidence of physical disturbance at Kap2 was present in the form of coralline-encrusted rocks that had been cast ashore by wave action. McCoy et al. (1968) also reported evidence of recent storm-related stranding of rocky shore and subtidal biota in the vicinity of Rangitira Point.

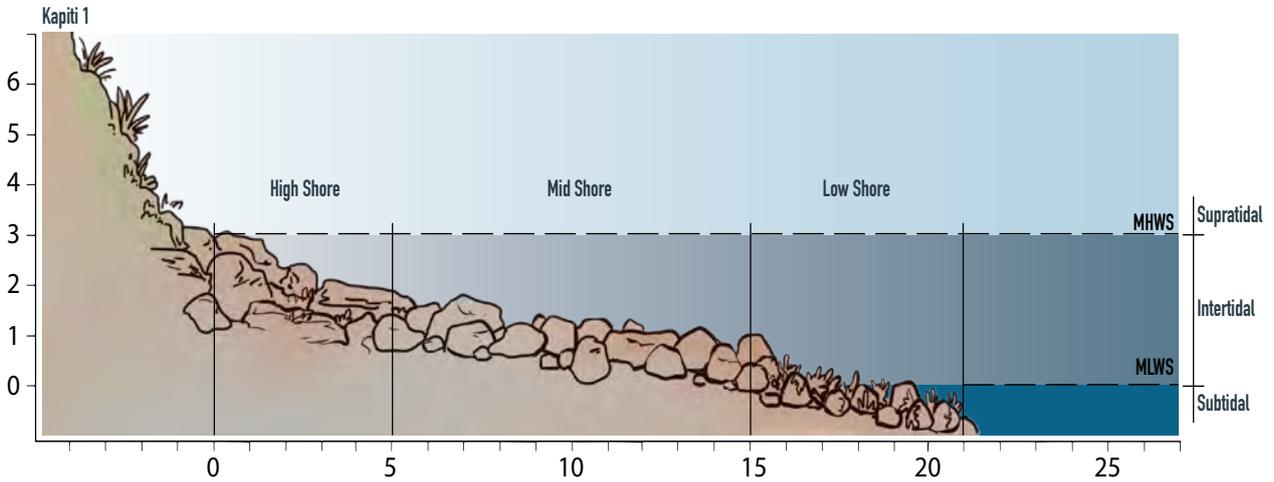


Fig. 3a Schematic illustrating the shore cross-sectional profile and general characteristics of Kap1.

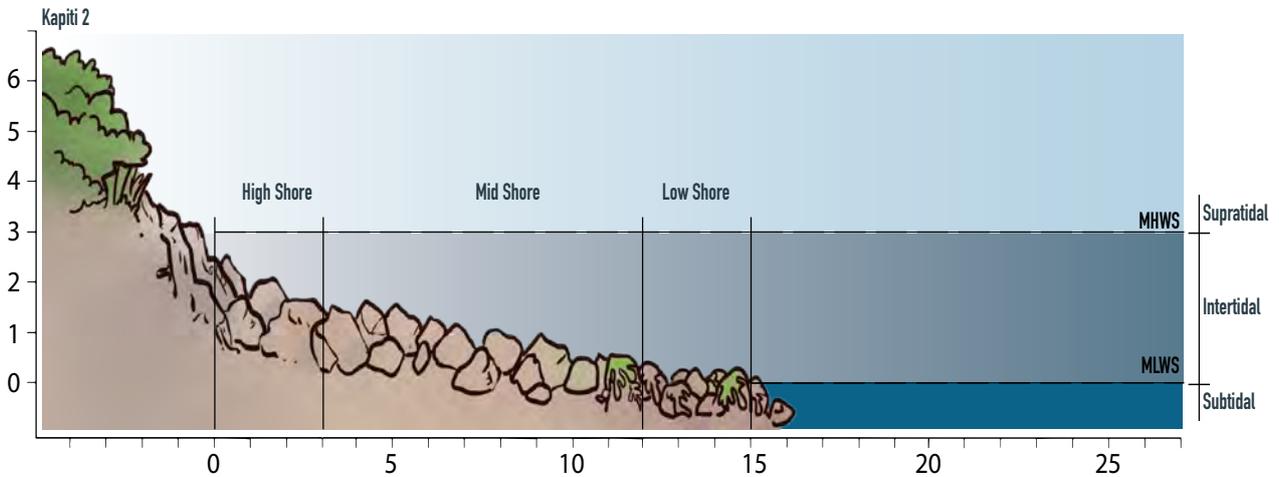


Fig. 3b Schematic illustrating the shore cross-sectional profile and general characteristics of Kap2.

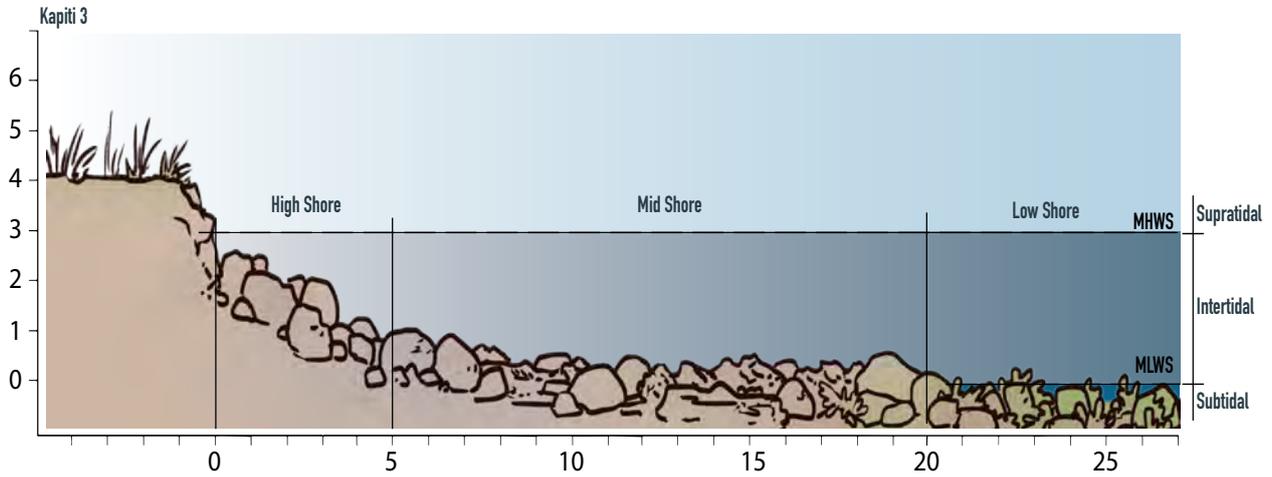


Fig. 3c Schematic illustrating the shore cross-sectional profile and general characteristics of Kap3.

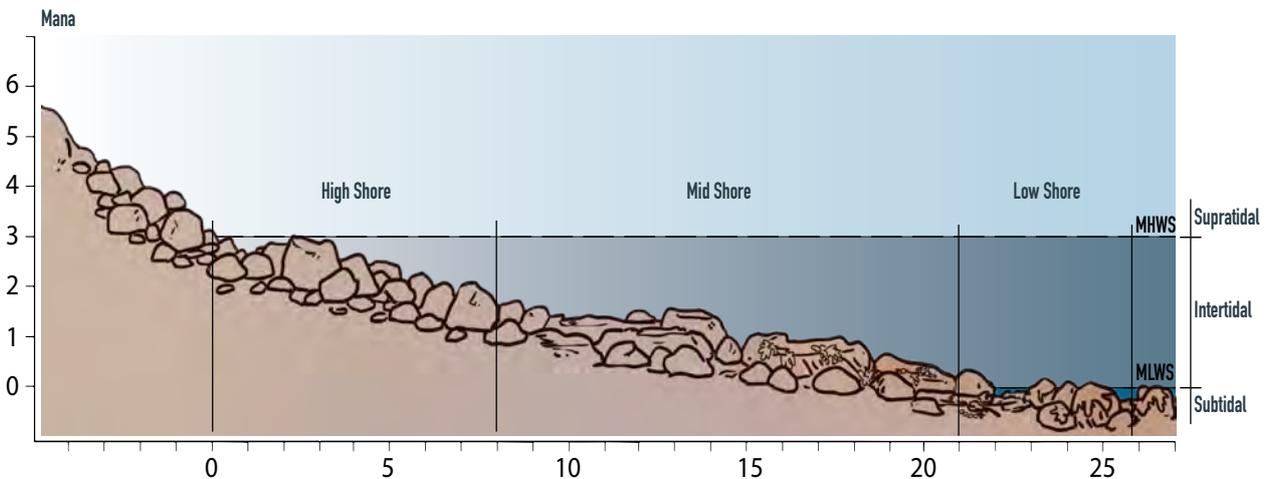


Fig. 3d Schematic illustrating the shore cross-sectional profile and general characteristics of Mana.

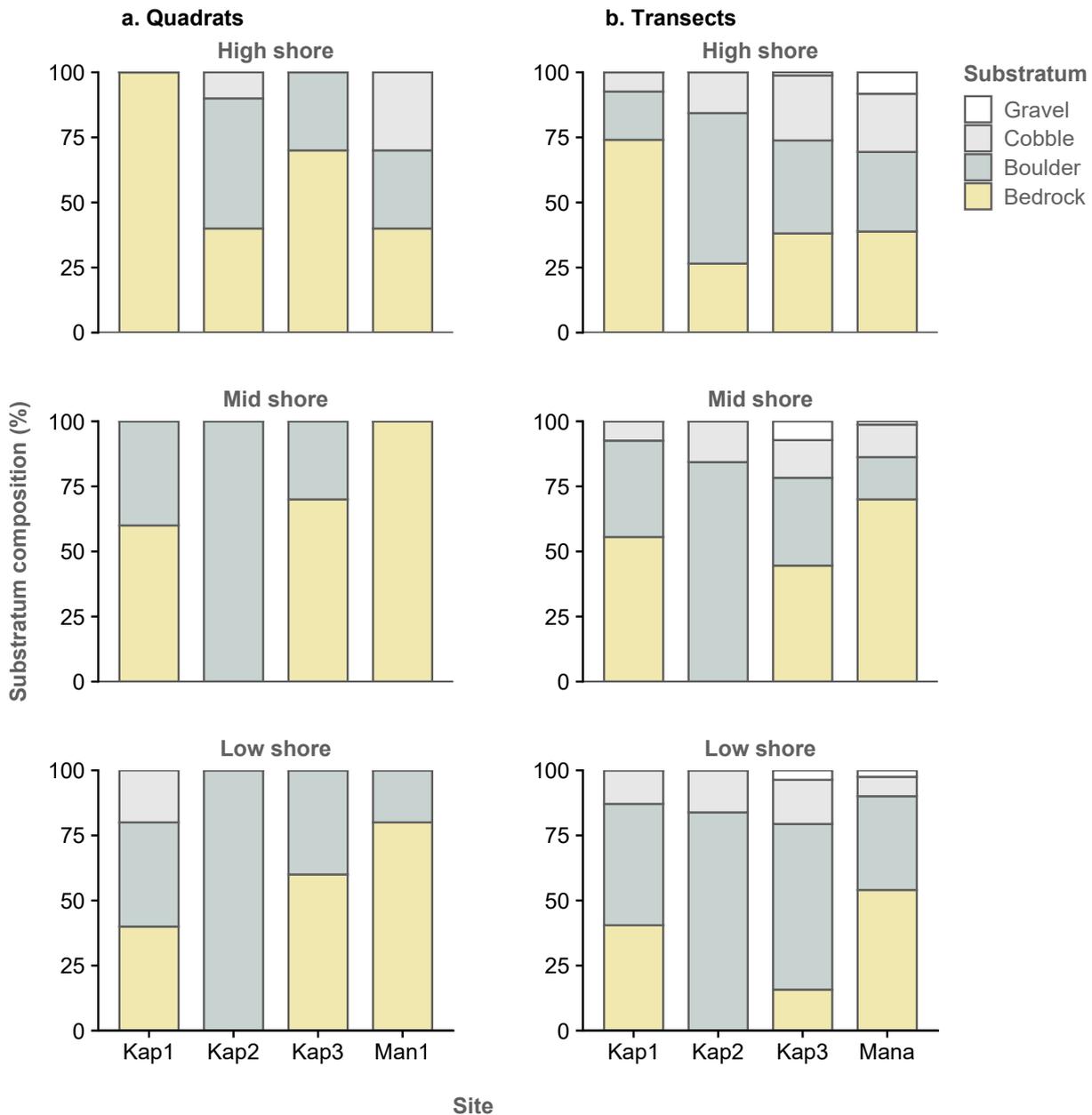


Fig. 4. Substratum composition for each of the four survey sites and intertidal shore heights, showing: a) Quadrats, for which composition is based on the frequency of occurrence of the dominant rock type recorded across 10 replicates; b) Transects, for which composition reflects percentage cover based on point counts.

3.2 SUBSTRATUM COVER

Along with the photographs in Fig. 3, a plot of the percent cover of bare rock and functional groups of sessile biota from quadrats and transects illustrates the prevalence of bare space in the high and mid-shore zones, and visual dominance of macroalgae in the low shore Fig. 5. In the low shore the greatest amount of bare space was recorded at Kap3. Of interest in the mid and high shore was the absence of an extensive cover of barnacles. By contrast, barnacle cover was relatively extensive in wave-exposed areas near the survey sites, especially those with near-vertical rock bedrock faces



High shore rock encrusted with barnacles at Mana

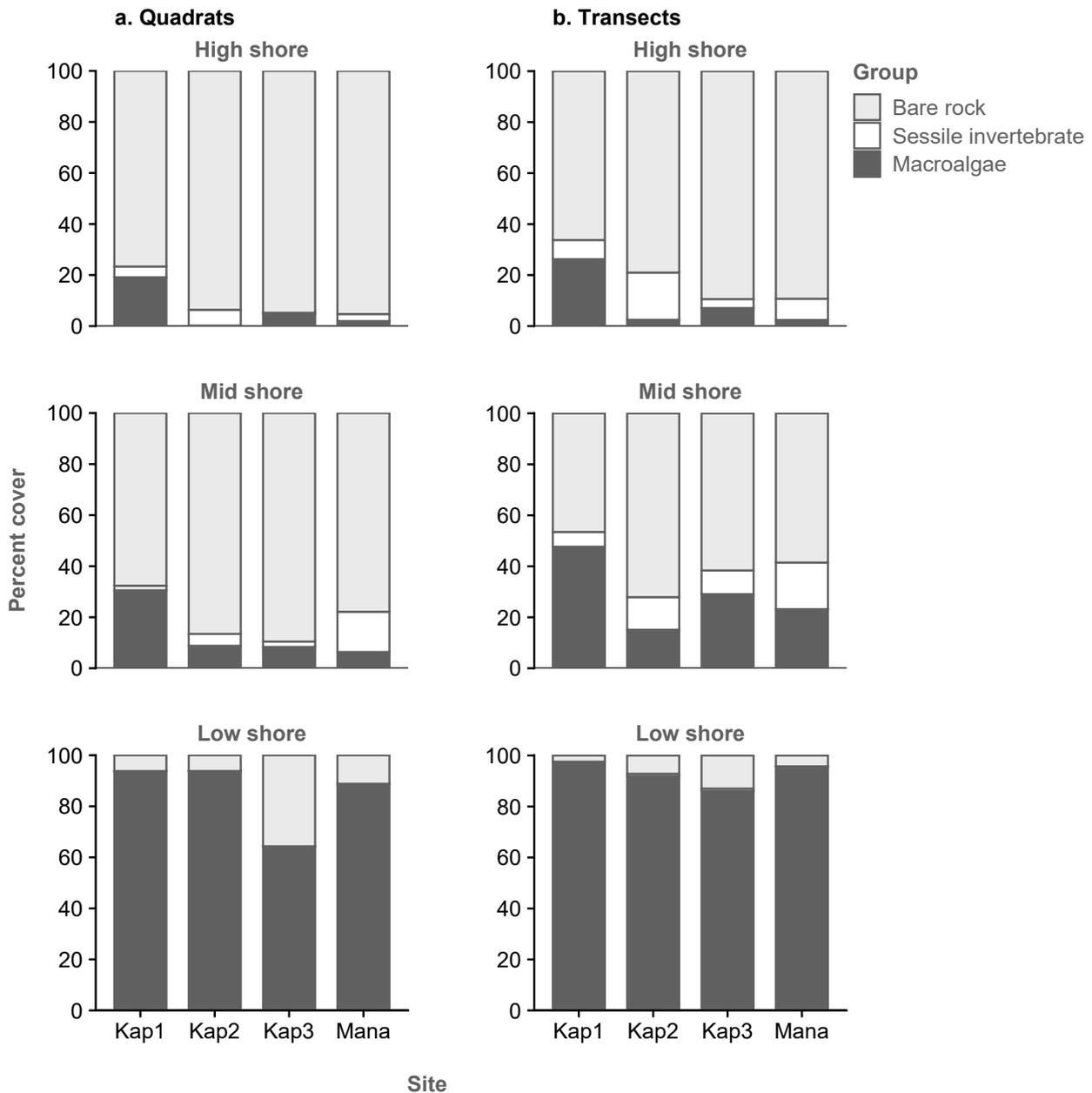


Fig. 5. Percent cover of bare rock and two functional groups of sessile organisms for each of the four survey sites and intertidal shore heights.

3.3 SPECIES RICHNESS PATTERNS

The rocky substrata at all sites provided physically complex habitats that supported reasonably diverse intertidal assemblages. In total, 83 species and higher taxa were recorded (Appendix 2), with the breakdown of total species per site shown for each survey method in Table 2. Within each method, species richness across sites was reasonably similar, but the methods themselves differed in terms of species detection. The SACFOR assessment provides the most complete species inventory, as it reflects the combined species detected by transect and quadrat

sampling, as well as additional species detected by neither of these two quantitative methods (see Appendices 3-5). The most species detected at any one site by the SACFOR assessment was 64 at Mana. The transect method detected the least species, which is not unexpected given that: (i) it includes only sessile biota; i.e. it does not include the richness of mobile invertebrates; and (ii) its purpose is to rapidly characterise the percent cover of dominant sessile species at the broad site scale. Quadrats detected an intermediate complement of species, with those not detected being almost exclusively the taxa

that were rated as rare (R) by the SACFOR method. An examination of within-site variability from the quadrat data shows similar mean values across sites, with a relatively small variance (Appendix 6).

Table 2. Total number of species recorded at each of the four sites.

Site	Quadrat	Transect	SACFOR
Kap1	36	20	59
Kap2	31	21	49
Kap3	35	22	48
Mana	44	24	64

Note that the transect method targets the dominant sessile biota, hence does not include the richness of mobile invertebrates

The general methodological differences are reinforced by Fig. 6, in which richness is shown for each intertidal height and site, partitioned into three different functional groups. As expected, species richness increased markedly down the shore, concomitant with the decrease in bare space depicted in Fig. 5. The relatively low richness of the high shore reflects the harsh physical environment in that zone, to which few marine species are adapted. Such species must be able to withstand extremes of heat and severe desiccation, amongst other stressors. Low shore richness was greatest at Mana, where the more extensive spring low tide zone provides a topographically complex and stable habitat across which a particularly extensive cover of brown canopy-forming macroalgae was evident. Despite the visual dominance of macroalgae in this low shore zone, many other taxa were present,

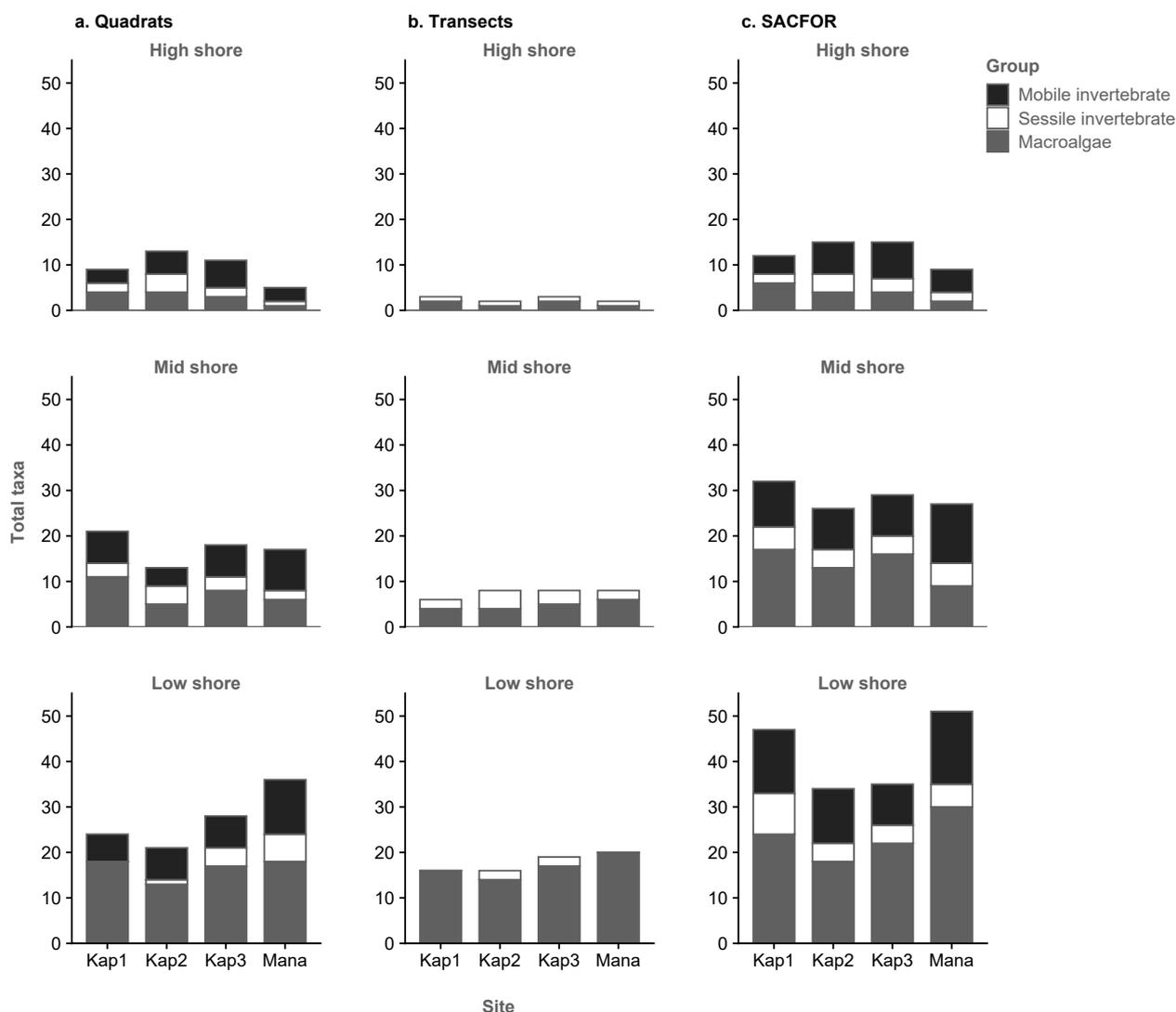


Fig. 6. Taxon richness for each shore height and site, derived for broad functional groups from each of the three data types.

with the combined SACFOR richness of sessile and mobile invertebrates being around one third to one half that of macroalgae in the low shore (Fig. 6). Compared with the intertidal zone, far fewer species were present in the supratidal. Between two and four superficially distinct lichen were present at all sites, with two species of periwinkle present in the supratidal at all sites except Mana (Appendix 5).

3.4 SPECIES COMPOSITION AND ABUNDANCE PATTERNS

Trends from supratidal to low shore

Patterns in the relative distribution and abundance of species from the supratidal to low shore zone are illustrated for mobile invertebrates in Fig 7, and the 10 main species groups in Fig. 8. Within these groups, the SACFOR ratings for the most common

or commonly occurring species are given in Table 3, with raw data in Appendix 5. Photographs of some of the more common species referred to in the text below are in Fig. 9.

Fig. 8 shows the prevalence of lichens in the supratidal as noted above, of which the most conspicuous species was the white pore lichen *Pertusaria* sp., which was rated as common (C) to super abundant (S). Periwinkles were numerically dominant in the high shore, in particular the small blue banded periwinkle *Austrolittorina antipodum*, which extended into the mid shore at the Mana site. These small top shells, while highly tolerant of air exposure, tend to aggregate in cracks and fissures in the rock that provide protection from the elements during the day. Barnacles were also present in the high shore zone but, as noted above, were not particularly abundant compared to some

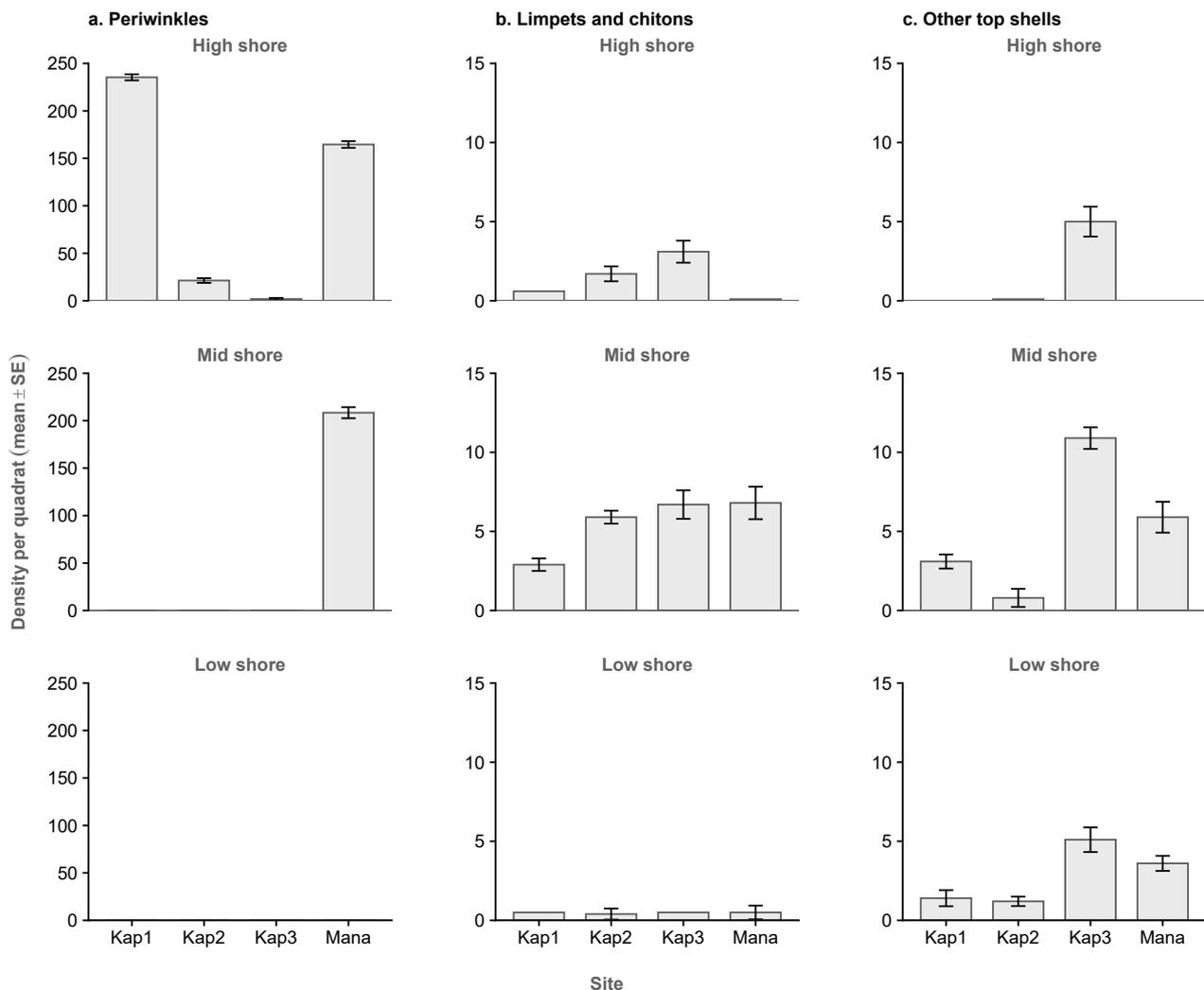


Fig. 7. Densities of mobile invertebrates (mean ± SE, n=10) for some of the main gastropod (marine snail) groups, based on counts within 0.25m² quadrats. Note the different density scale for periwinkles, and the complete absence of this group from the low shore and from the mid shore at three sites.

of the habitats outside the site boundaries. The most dominant was the brown surf barnacle *Chamaesipho brunnea*. It was uncommon to find algae on the high shore, but the lower parts of that zone were characterised by the occasional conspicuous wiry tuft of *Capreolia implexa* and the rosette-shaped red seaweed, referred to here as *Pyropia* but often generically referred to as *Porphyra* or Karengo (an edible species).

Most conspicuous across the entire mid-shore were a range of limpets, chitons and other top shells. Most commonly occurring were several *Diloma* species, in particular *Diloma aethiops*, and several limpet species, notably the denticulate limpet *Cellana denticulata*. Among the sessile invertebrates, brown surf barnacles occurred also in the mid shore, and occasional patches of the calcareous tube worm *Spirobranchus cariniferus* were present across all shore zones. The macroalgae *Capreolia implexa* and *Pyropia* were also present in the mid shore, but the most conspicuous seaweed on the lower part of this zone and extending into neap low tide was the brown alga *Hormosira banksii* (Neptune's necklace).

In the low mid to neap low shore zone, two species of green algae were co-occurrent with *Hormosira*, namely the bright green sea lettuce *Ulva* sp. (in particular at Kap2 and Kap3) and the green velvet weed *Codium convolutum*. Large brown algae visually dominated the low shore, with pink crustose coralline algae ('pink paint') common beneath the brown algae canopy. Among the browns the most abundant was the flapjack *Carpophyllum maschalocarpum*, three different *Cystophora* species (mainly *C. torulosa*), the strap-like *Dictyota kunthii* and fan-shaped *Zonaria aureomarginata* (see examples in Fig. 9). Small red algae were not a visually conspicuous part of the low shore assemblage, despite comprising around one third to one half of low shore species richness.

Densities of mobile invertebrates were quite variable among sites (Fig. 7). Periwinkles were by far the most abundant taxon, being particularly abundant in the high shore at Kap1 and Mana and also in the Mana mid shore. This pattern most likely relates to relative habitat stability and rugosity. Periwinkles were particularly abundant where bedrock was prevalent (i.e. see Kap1 high & Mana mid in Fig. 8) and/or

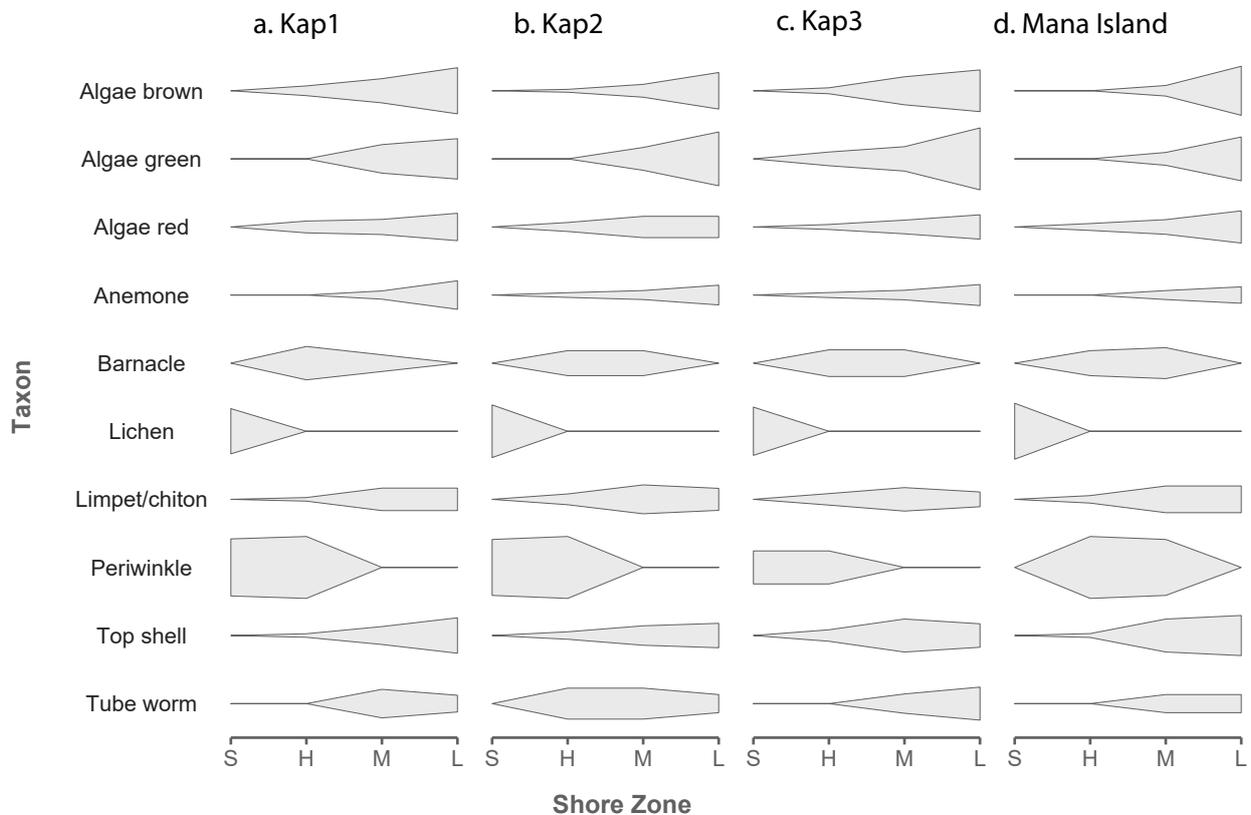


Fig. 8. Kite diagrams showing the relative SACFOR abundance and distribution of main species groups across four shore zones at the four sites. Shores zones are coded as: S = supratidal, H = high shore, M = Mid shore, L = low shore.

Table 3. SACFOR ratings for the most regularly encountered species at each of the four sites.

Shore zones coded as: S = supratidal, H = high shore, M = Mid shore, L = low shore

SACFOR ratings coded as S=Superabundant, A=Abundant, C=Common, F=Frequent, O=Occasional, R=Rare (see Table 1)

Main group	Taxon	Kap1				Kap2				Kap3				Mana			
		S	H	M	L	S	H	M	L	S	H	M	L	S	H	M	L
Bare rock	Bare rock	A	S	A	O	A	S	S	F	S	S	S	C	S	S	S	O
Algae brown	Brown crust	-	O	O	O	-	R	O	R	-	O	R	O	-	-	R	F
	<i>Carpophyllum maschalocarpum</i>	-	-	-	C	-	-	-	A	-	-	R	A	-	-	-	C
	<i>Colpomenia</i> spp.	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	F
	<i>Cystophora retroflexa</i>	-	-	-	F	-	-	-	-	-	-	-	-	-	-	-	-
	<i>Cystophora scalaris</i>	-	-	-	R	-	-	-	R	-	-	R	R	-	-	-	R
	<i>Cystophora torulosa</i>	-	-	R	C	-	-	-	O	-	-	R	O	-	-	-	C
	<i>Dictyota kunthii</i>	-	-	-	O	-	-	-	O	-	-	-	O	-	-	-	O
	<i>Ecklonia radiata</i>	-	-	-	F	-	-	-	F	-	-	-	O	-	-	-	R
	<i>Halopteris funicularis</i>	-	-	R	O	-	-	-	R	-	-	-	R	-	-	-	R
	<i>Hormosira banksii</i>	-	R	C	O	-	-	R	R	-	-	A	R	-	-	O	C
	<i>Leathesia marina</i>	-	-	R	O	-	-	-	-	-	-	R	R	-	-	-	R
	<i>Scytothamnus australis</i>	-	R	R	-	-	-	-	-	-	-	-	R	-	-	R	R
	<i>Splachnidium rugosum</i>	-	-	R	R	-	-	R	R	-	-	R	R	-	-	-	R
	<i>Zonaria aureomarginata</i>	-	-	R	C	-	-	R	O	-	-	R	R	-	-	-	F
	Algae green	<i>Codium convolutum</i>	-	-	R	F	-	-	R	F	-	-	R	C	-	-	-
<i>Ulva</i> sp.		-	-	O	R	-	-	R	C	-	R	R	C	-	-	R	O
Algae red	<i>Capreolia implexa</i>	-	O	R	-	-	R	F	-	-	R	R	-	-	R	O	-
	<i>Caulacanthus ustulatus</i>	-	R	R	O	-	R	O	R	-	-	R	R	-	-	R	O
	<i>Champia novaezelandiae</i>	-	-	R	-	-	-	R	-	-	-	R	R	-	-	-	R
	Coralline paint	-	-	O	A	-	-	R	A	-	-	R	A	-	-	R	C
	Coralline turf	-	-	R	C	-	-	-	O	-	-	R	R	-	-	R	O
	<i>Pterocladia</i> sp.	-	-	-	R	-	-	-	R	-	-	-	R	-	-	-	R
	<i>Pteroclatiella capillacea</i>	-	-	R	O	-	-	-	-	-	-	-	O	-	-	-	R
	<i>Pyropia</i>	-	F	R	-	-	O	O	-	-	R	R	-	-	O	O	-
	<i>Sarcothalia decipiens</i>	-	-	-	R	-	-	R	R	-	-	-	-	-	-	-	R
	<i>Sarcothalia livida</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	O
Anemone	<i>Actinia tenebrosa</i>	-	-	R	O	-	R	O	R	-	R	O	O	-	-	R	R
	<i>Corynactis australis</i>	-	-	-	R	-	-	-	F	-	-	-	-	-	-	-	
	<i>Habrosanthus bathamae</i>	-	-	-	-	-	-	-	-	-	-	-	F	-	-	-	
	<i>Oulactis mucosa</i>	-	-	-	O	-	-	-	-	-	-	-	-	-	-	-	R
Barnacle	<i>Chamaesipho brunnea</i>	-	F	R	-	-	F	O	-	-	O	O	-	-	O	F	-
	<i>Chamaesipho columna</i>	-	O	R	-	-	-	R	-	-	-	-	-	-	-	-	
Lichen	Lichen unident sp. 1	-	-	-	-	R	-	-	-	-	-	-	-	O	-	-	
	<i>Pertusaria</i> sp.	S	-	-	-	S	-	-	-	C	-	-	-	C	-	-	
	<i>Xanthoria parietina</i>	O	-	-	-	R	-	-	-	F	-	-	-	C	-	-	
Limpet/chiton	<i>Cellana denticulata</i>	-	R	C	R	-	R	C	R	-	R	C	R	-	R	O	O
	<i>Cellana ornata</i>	-	-	R	-	-	-	R	R	-	R	R	R	-	R	F	R
	<i>Cellana radians</i>	-	-	R	F	-	R	O	R	-	R	R	R	-	-	R	O
	<i>Siphonaria zelandica</i>	-	-	R	R	-	-	R	R	-	-	-	-	-	-	R	R
	<i>Sypharochiton pelliserpentis</i>	-	-	R	R	-	-	R	R	-	-	R	-	-	-	R	R
	Periwinkle	<i>Austrolittorina antipodum</i>	C	A	-	-	C	A	-	-	R	R	-	-	-	A	C
<i>Austrolittorina cincta</i>		O	O	-	-	R	R	-	-	R	R	-	-	-	R	R	-
Top shell	<i>Diloma aethiops</i>	-	-	O	O	-	R	C	F	-	R	C	C	-	R	F	F
	<i>Diloma bicanaliculatum</i>	-	-	R	-	-	-	-	-	-	-	R	-	-	-	F	-
	<i>Diloma nigerrimum</i>	-	-	-	-	-	R	-	-	-	R	C	R	-	-	F	-
	<i>Diloma zelandicum</i>	-	R	R	C	-	-	-	-	-	-	-	-	-	-	-	-
	<i>Haliotis iris</i>	-	-	-	F	-	-	-	R	-	-	-	R	-	-	-	C
	<i>Haustrum haustorium</i>	-	-	R	R	-	-	R	O	-	-	R	R	-	-	R	O
	<i>Haustrum scobina</i>	-	-	-	-	-	-	R	-	-	-	R	-	-	-	O	F
	<i>Lunella smaragda</i>	-	-	R	F	-	-	-	R	-	-	-	-	-	-	-	O
	Tube worm	<i>Spirobranchus cariniferus</i>	-	-	O	R	-	R	O	R	-	-	R	R	-	-	R



Lichens - *Pertusaria* and *Xanthoria*, Mana supratidal zone



Brown and blue banded periwinkles on the high shore



Capreolia from the mid shore, Kap3



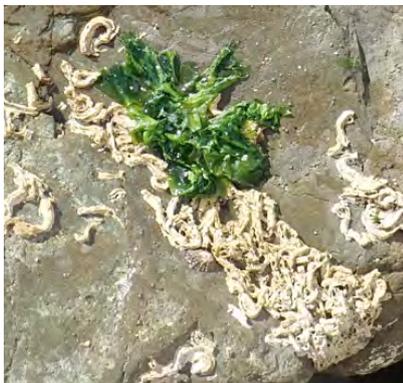
Tuft of *Pyropia*, mid shore, Kap3



Surf barnacles *Chamaesipho brunnea* and limpets *Cellana denticulata*



Hormosira banksii (Neptune's necklace) and topshell *Diloma aethiops*, Kap1



Calcareous tubeworm *Spirobranchus cariniferus* and green sea lettuce (*Ulva*)



Carpophyllum maschalocarpum, *Ulva* and coralline paint, Kap2 low shore



Carpophyllum maschalocarpum and *Cystophora torulosa*, Mana low shore



Zonaria auroemarginata, Mana low shore



Mixed low shore algae at Mana including bright green *Sarcothalia livida*



Paua among mixed brown algae, Mana low shore

Fig. 9. Photos of some of the species referred to in the text that characterised the different shore zones.

rugosity was high, with the latter reflecting cracks and fissures that provide a refuge from desiccation (notably Mana mid, see Appendix 1).

Limpets and chitons were most abundant in the mid shore zone, but least abundant at Kap1, which may be related to a greater wave-exposure in that location given its southerly aspect. Density of other top shells (i.e. whelks and herbivorous snails) were similarly variable across sites, but across all shore heights were most abundant at the relatively sheltered north-western Kap3 site.

Species assemblage patterns across intertidal shore zones and sites

In order to further explore the differences and similarities in the macrofaunal assemblage among sites and shore heights, the nMDS ordination in Fig. 10 places sites and shore heights of similar composition close to each other in a 2-dimensional biplot, with less similar samples being further apart. In this instance

the low 'stress' value of the ordination (i.e. 0.05) can be interpreted to mean that a 2-dimensional plot provides a reliable representation. The clustering pattern in Fig. 10 reinforces the fundamental differences in species composition among shore heights that were described above, reflecting the strong physical gradient that exists across the intertidal zone. Within each shore site, there is a relatively high similarity in assemblage composition, with most sites having a pairwise similarity (i.e. as measured by the Bray-Curtis index) of at least 65%. The one exception was Kap1 in the high shore, which separated out from the cluster formed by the other three sites, due mainly to a greater prevalence of brown algal crusts and co-occurrence of the column barnacle *Chamaesipho columna* with *C. brunnea*. At a 70% Bray-Curtis similarity threshold, there was a greater segregation of sites. None of the sites on the high shore grouped together, and Kap1 and Mana formed a low shore cluster that was distinct from a grouping of Kap2 and Kap3.

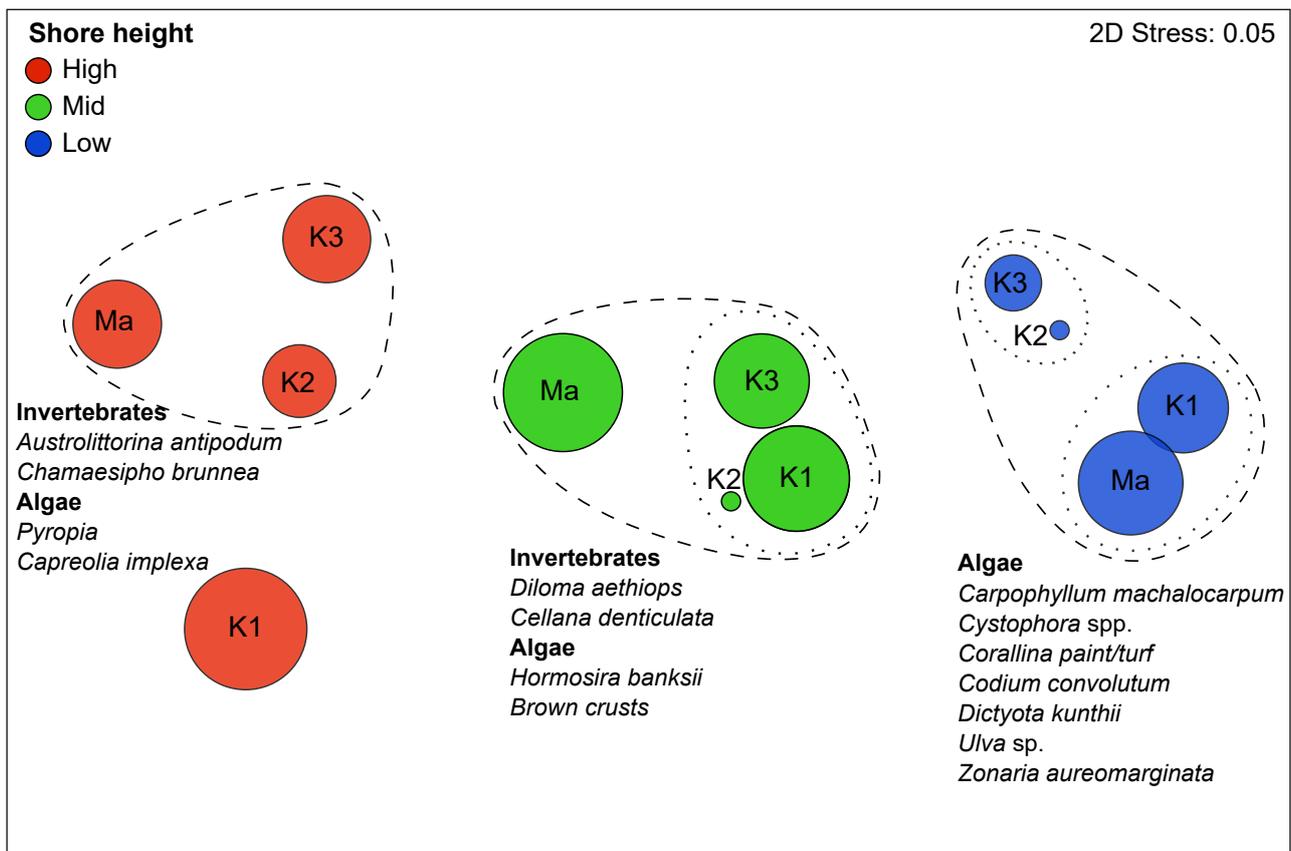


Fig. 10. Ordination biplot (nMDS) depicting the grouping of shore heights among rocky shore sites according to their taxon composition and ranked abundances derived from SACFOR ratings.

The colour circles for each site are scaled to the prevalence of stable bedrock habitat. Sites encircled with dotted lines grouped at > 70% Bray-Curtis similarity, while dashed lines encircle sites grouping at > 65% similarity. The key species characterising each main site group are shown.

The dissimilarity was driven by changes in relative abundances of the common taxa, and also by compositional differences in the less abundant or widespread species (e.g. SACFOR species rated R). For example, among the common low shore species, the algal assemblage at Kap2 and Kap3 was dominated by *Carpophyllum maschalocarpum* and *Ulva* sp., whereas at Kap1 and Mana there was a greater relative prevalence of *Cystophora* spp., *Hormosira banksii* and *Zonaria aureomarginata* (see Table 3). The latter two sites also had a greater relative abundance of certain invertebrates. As well as periwinkles as shown in Fig. 7, specific species included black foot pāua (*Haliotis iris*), cats eyes (*Lunella smaragda*) and radiate limpets (*Cellana radians*). Simultaneously, each site had its own small subgroup of species that were not recorded at other sites. For the most part, these were species with a SACFOR rating of rare (R). Fig. 11 shows that such species comprised ~50-75% of the assemblage present at low and mid shore heights. As such, the fine-scale differences among locations may simply reflect chance sampling variation rather than true site-to-site differences in the rocky shore assemblage.

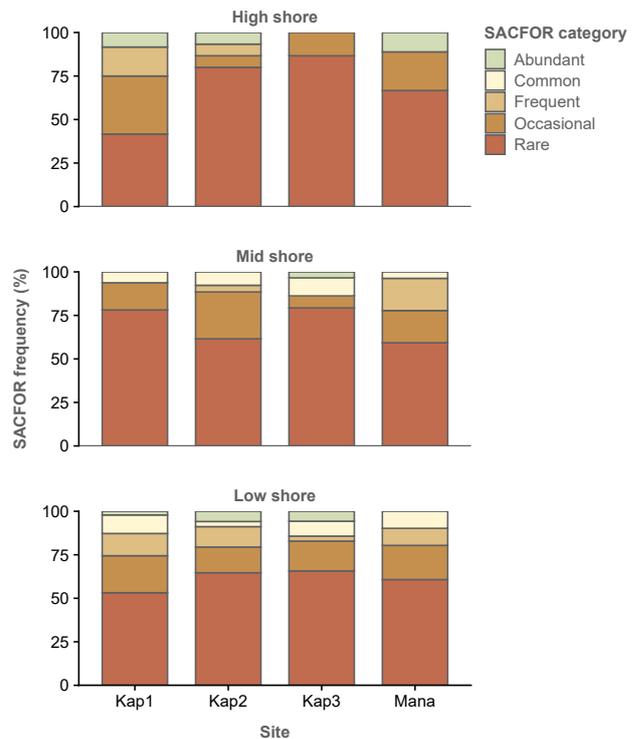


Fig. 11. Frequency of occurrence of each SACFOR rating for the four sites and four zones.

The figure illustrates that the majority of the species characterising the intertidal zone were relatively uncommon, with only a few species rated as being common or abundant.



Low tide sampling at Kap 3

4. SYNTHESIS OF FINDINGS

The present survey has provided an overview of baseline conditions at four rocky shore sites on Kāpiti and Mana Islands off Wellington's west coast, adding to the regional picture provided by previous synoptic studies conducted elsewhere in the region, in particular surveys for GWRC at Flat Point on the Wairarapa coast, in Wellington Harbour, and on the south coast. All four Kāpiti and Mana locations surveyed in 2019 provided physically complex habitats that supported reasonably diverse intertidal assemblages. The results revealed a species-poor supra-tidal zone, a high shore dominated by barnacles and periwinkles, transitioning to increasingly diverse assemblages with progression toward the low tide mark, where macroalgae were conspicuous and diverse around the lower shore fringes. These are expected trends that reflect a progression from very harsh conditions in the highest parts of the shore (e.g. long periods of air exposure) that are tolerated by only a few specialised species, to relatively benign lower shore conditions that are suitable for a far greater diversity of organisms (Schiel 2011).

Overall, the range of species and higher taxa recorded is typical of 'healthy' New Zealand rocky shores across the spectrum of wave exposures likely experienced at the four sites (Morton & Miller 1973; Nelson 2013; Carson & Morris 2017). The list of 83 species and higher taxa in Appendix 2 is more extensive than that described for previous GWRC surveys that have used the SACFOR approach. At Flat Point, 28 species were described over two surveys (Stevens & O'Neill-Stevens 2017), with 61 species described collectively from Scorching Bay, Makara and Baring Head in 2018 (Stevens 2018).

The Kāpiti Island study by McCoy et al. (1968) does not report a total species count, but the list reported from the various habitats surveyed is quite extensive. It appears to include a slightly greater range of invertebrates but fewer macroalgae than we describe, which will in part be attributable to method differences. The 1968 study involved a qualitative assessment of five sites with different habitats. These ranged from a steep bedrock site on the wave-exposed northern side of the island to four relatively sheltered boulder or cobble habitats positioned between the Kap2 and Kap3 sites described in the present report. Furthermore, the earlier study included under-boulder fauna, mobile species such as crabs and other crustaceans, searches of the strand line and beach wrack (near Kap2), and the report makes references to diving checks around the extreme low water spring tide elevation. Despite

the different sites and methods, and accounting for name changes, the description provided by McCoy et al. (1968) refers to a similar suite of common benthic taxa to that described in the most recent survey.

Of interest is that despite the marine reserve having been in place for almost three decades, there appeared to be no major differences between Kap2 (inside the marine reserve) and the other sites sampled in 2019 (outside the marine reserve), or between Kap2 and nearby sites sampled in 1968 (i.e. pre-reserve). Restricted public access to the sites may contribute to the similarity between sites inside and outside of the marine reserve. Also of interest in the latest survey is that no bivalves were found. The McCoy et al. survey described *Modiolus neozelandicus* (now *Xenostrobus neozelanicus*) from four of the five sites surveyed, with green-lipped and ribbed mussels recorded from 'cliff' habitat at two sites between our Kap2 and Kap3. However, the McCoy report does not provide the impression that the latter two species were particularly abundant. In our boat reconnaissance to find suitable sites (i.e. involving looking towards the shore from the water) we did not note any bands of mussels across the shore, which in many parts of the New Zealand coast can be quite conspicuous. Elsewhere along the Cook Strait coast of Wellington, bivalves are known to be uncommon or absent, compared to inner Wellington Harbour where the above three species, as well as blue mussels (*Mytilus galloprovincialis*), can be abundant (Gardner 2000; Stevens 2018). The general absence of mussels was hypothesised by Gardner (2000) to be attributable to insufficient food resources along the Cook Strait coast.



The relatively sheltered eastern site of Mana Island, with Kapiti Island in the background

5. FUTURE MONITORING

5.1 UTILITY OF EXISTING SITES FOR ONGOING MONITORING

The reasonable uniformity of the Kāpiti and Mana Island sites surveyed (with respect to their physical habitats and main species assemblages), combined with the high richness of species present, makes them good candidate sites for long term monitoring. A common approach with baseline monitoring is to undertake several surveys initially (e.g. annually at the same time of year, or even seasonally) to establish natural temporal variability. Given the broad similarities in dominant species when comparing present survey findings with the historic Kāpiti survey and other studies in the region, repeat surveys in close succession would arguably be of little benefit for GWRC. Except perhaps when major disturbance events occur (e.g. an oil spill or introduction of an invasive species), significant year-to-year changes are unlikely over short time scales, evident in the results for Flat Point where there was little change over two surveys conducted in consecutive summers.

Notwithstanding the above comments, if GWRC intend to continue a rocky shore programme in some form, there is certainly a benefit in continued monitoring at Kāpiti and/or Mana Island as reference locations against which to compare mainland sites subject to greater anthropogenic pressure. We suggest that repeat surveys conducted at an interval of 5-years would be sufficient to capture long term trends. Of course, outside of the chosen monitoring sites used in 2019, the islands have different habitat types (e.g. steeper bedrock, higher wave-exposure) that could be considered for synoptic surveys as part of a broader regional characterisation of rocky shore types (see Section 5.3).

5.2 UTILITY OF EXISTING METHODS FOR ONGOING MONITORING

The methods used in the 2019 survey all have value in the context of long term monitoring, and the choice of approach really depends on the ecological features of interest and the resources and expertise available. Some key pros and cons are described below.

SACFOR

The SACFOR approach is ideal for obtaining a reasonably comprehensive inventory of all biota (sessile and mobile) across all shore zones, as well as a site's physical characteristics. Being semi-quantitative, SACFOR is sufficient for the purpose of measuring gross changes in percent cover and

abundance. It can be particularly useful in low shore areas subject to wave-swash as the habitat can be assessed between wave sets. It is also useful in the supratidal, or on shores that are too steep to easily sample quantitatively. We found the simplified SACFOR rating system that we have developed to be far easier to implement than the United Kingdom's JNCC method that has previously been used for GWRC projects.

Transects

The transect method was very effective for rapidly characterising and quantifying the physical characteristics and sessile biota across the intertidal zone. It performed well in capturing the main sessile biota, considering that only 80 random points were sampled. With the lead core inside, the transect line remained in place during moderate wave swash, and slight movement is irrelevant anyway as the sampling points are random. To provide a basic level of replication, it would be relatively straightforward to run two transects across each shore height.

Quadrats

Random quadrat sampling provided a method for fully quantifying both the percent cover and densities of target species or groups, and for gaining a sense of within-site variability (which we have not explored in this report; see Appendix 6 for means and errors associated with key response variables). In terms of practicality, quadrats are difficult to sample in wave-swash as the quadrat frame is easily moved (so has to be firmly held in place). The question of how well quadrats capture the biota at a site depends on the response variable of interest, and the nature of the site itself (e.g. species patchiness). For example, the replicated (n=10) randomly-placed 0.25m² quadrats that we used here did not fully capture the diversity of species present at any one shore height or site, with species missed being those rated as rare (R) by the SACFOR method (i.e. < 1 individual/m² or <1% cover). A more detailed analysis, beyond our present scope, would be required to evaluate quadrat sampling sufficiency (e.g. to estimate the number of quadrats required to sample a given response to a specified level of confidence). Software packages like R (e.g. the multSE function) and Primer (e.g. species-accumulation plots and richness estimators) have routines for investigating such questions.

Other method considerations

Irrespective of the unanswered questions regarding quadrat sampling sufficiency, the practical reality for the present study was that two people (1 to assess, 1 to record) only just managed to sample 10 x 0.25m²

quadrats in the time available. To take more point intercepts, use a larger quadrat size, or include more replicates, would have required either an extra tide for sampling or a larger survey team. Both come at greater cost, with increasing the size of the survey team introducing an increased risk of taxonomic inconsistency, unless only the dominant easily recognisable species are targeted.

Another consideration for quadrat sampling is to install fixed quadrats, such as used at some of the other GWRC rocky shore sites. Fixed quadrats have particular appeal for long term monitoring as they can be deliberately positioned in areas with particular species or groups of interest, and whose change (in density or cover) can be measured accurately. For example, fixed quadrats attached to rocky faces can be used to track changes in vertical zonation patterns of sessile taxa like barnacles in response to factors such as climate change. Fixed quadrat areas can be photographed (reducing field time) and quantitative analysis can be conducted at any time thereafter; for example, if a significant change was obvious from archived photographs.

5.3 BROADER CONSIDERATIONS

The GWRC programme is gradually building up a picture of the condition of the region's rocky shores. If the intent is to continue such monitoring, it might be timely to develop a structured approach for moving forward, building on the earlier 2007 risk assessment (Robertson & Stevens 2007). Considerations include:

- Identifying any additional locations that should be included as part of the synoptic baseline survey programme, with the goal being to eventually characterise a regionally 'representative' selection of the rocky habitats present (i.e. representing the range of physical habitat types and/or key areas of high ecological value).
- Monitoring for the explicit purpose of identifying the effect of local scale anthropogenic pressures on rocky shore habitats, as well as long term and broad scale trends (e.g. due to climate change), noting that such an approach would require:
 - Careful selection of 'at risk' monitoring sites, which may be enhanced by alignment of rocky shore monitoring with other monitoring activities, including extending and linking catchment and estuary monitoring to adjacent rocky habitats.
 - Development of a network of reference locations against which the condition of 'at risk' locations, as well as long term trends, could be evaluated. For example, in

the same way that Kāpiti and Mana Island have value as reference sites for similar mainland habitats, the rocky shores of islands such as exist in Wellington Harbour would have value as references for more accessible parts of the main harbour coastline.

6. CONCLUSIONS AND RECOMMENDATIONS

The four rocky shore sites surveyed on Kāpiti and Mana Island supported diverse and healthy intertidal assemblages. The list of species and higher taxa recorded is more extensive than that described for previous GWRC surveys, much of which reflects a suite of taxa that were relatively uncommon at any given site. The main species and cross-shore patterns of change are similar among sites, and broadly match the description from a survey undertaken in 1968. Although the survey was not intended as an assessment of the effect of marine reserve protection, there is no evidence that the rocky shore assemblage from the site inside the Kāpiti marine reserve is appreciably different biologically to the other sites sampled, noting that there is restricted public access to all of the sites. Assuming that GWRC intend to continue a rocky shore programme in some form, we recommend the following:

1. Kāpiti and/or Mana Island sites provide valuable reference locations against which to compare mainland sites subject to greater anthropogenic pressure. We suggest that repeat surveys, conducted at an interval of 5-years, would be sufficient to capture long term trends.
2. GWRC should consider developing a formalised approach to rocky shore monitoring that aims to: (i) characterise a regionally 'representative' selection of the rocky habitats present (i.e. based on physical habitat types and/or key areas of high ecological value); and (ii) address the effect of local and broad scale pressures on rocky shore habitats through selection of 'at risk' monitoring sites, complemented by a comparable network of reference locations.
3. The methods described in this report and previous GWRC studies are all appropriate for long term monitoring. The most 'fit for purpose' methods for GWRC need to be able to characterise a site to a sufficient level of detail to enable regional rocky shores to be compared against each other (e.g. 'impact' vs reference sites), and to be tracked over time. For this purpose, we consider future monitoring should combine the SACFOR and transect sampling approach described in this report, with quadrat sampling based on fixed rather than random quadrats. This type of survey provides a good return for a modest effort (e.g. a 2-3 person field team).

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APPENDIX 1. SITE LOCATION INFORMATION AND FIELD RECORDING SHEETS

Site	Transect	Position	NZTMEast	NZTMNorth
Kap1	1	start	1758793	5471914
Kap1	1	end	1758801	5471879
Kap1	2	start	1758782	5471910
Kap1	2	end	1758796	5471875
Kap1	3	start	1758776	5471907
Kap1	3	end	1758788	5471871
Kap2	1	start	1763060	5476295
Kap2	1	end	1763090	5476321
Kap2	2	start	1763066	5476291
Kap2	2	end	1763098	5476320
Kap2	3	start	1763068	5476288
Kap2	3	end	1763098	5476322
Kap3	1	start	1763907	5477875
Kap3	1	end	1763894	5477832
Kap3	2	start	1763907	5477880
Kap3	2	end	1763902	5477831
Kap3	3	start	1763920	5477869
Kap3	3	end	1763904	5477823
Mana	1	start	1750304	5450593
Mana	1	end	1750285	5450556
Mana	2	start	1750312	5450587
Mana	2	end	1750289	5450547
Mana	3	start	1750318	5450593
Mana	3	end	1750299	5450556

ROCKY SHORE SITE SHEET (p1of2)

LOCATION

Site name
 Survey area
 Region

POSITION

NZTM East

NZTM North

Centre of site

Transect position

T1 (high) Start
 End

T2 (mid) Start
 End

T3 (low) Start
 End

SURVEY DETAILS

Date (dd:mm:yy)
 Time at start (h:m)
 Time at end (h:m)
 MHWS (h)
 MLWS (h)
 Tidal range (m)
 Wave Height (m)
 Weather:

Photos taken?

Surveyor name

Organisation

1
 2
 3
 4

Quadrat size (m²)
 (when facing land, position bottom left on transect marker)

Transect length (m)
 Orientation (cross shore or perpendicular)

SURVEY TYPE

- Inventory/map (biotope types only)
- Intermediate in situ (habitat / main spp.)
- Intermediate remote (habitat / main spp.)
- Detailed (habitat / all spp.)
- Other (state)

SURVEY QUALITY (self assessment)

Flora	Fauna	
<input type="checkbox"/>	<input type="checkbox"/>	Thorough
<input type="checkbox"/>	<input type="checkbox"/>	Adequate
<input type="checkbox"/>	<input type="checkbox"/>	Incomplete

SITE MAP AND DESCRIPTION (include plan view and cross shore profile)

.....

Scale

North arrow

ROCKY SHORE SITE SHEET (p2of2)

<table border="0"> <tr><td><input type="checkbox"/></td><td>Overhangs</td></tr> <tr><td><input type="checkbox"/></td><td>Vertical faces (80-100°)</td></tr> <tr><td><input type="checkbox"/></td><td>Very steep faces (40-80°)</td></tr> <tr><td><input type="checkbox"/></td><td>Upper faces (0-40°)</td></tr> <tr><td><input type="checkbox"/></td><td>Underboulders</td></tr> <tr><td><input type="checkbox"/></td><td>100% Total</td></tr> </table>	<input type="checkbox"/>	Overhangs	<input type="checkbox"/>	Vertical faces (80-100°)	<input type="checkbox"/>	Very steep faces (40-80°)	<input type="checkbox"/>	Upper faces (0-40°)	<input type="checkbox"/>	Underboulders	<input type="checkbox"/>	100% Total	<table border="0"> <tr><td><input type="checkbox"/></td><td>Hard (e.g. basalt)</td></tr> <tr><td><input type="checkbox"/></td><td>Mod. hard (e.g. limestone)</td></tr> <tr><td><input type="checkbox"/></td><td>Friable (e.g. shale)</td></tr> <tr><td><input type="checkbox"/></td><td>Soft (e.g. mudstone)</td></tr> <tr><td><input type="checkbox"/></td><td>Very soft (e.g. Clay)</td></tr> </table>	<input type="checkbox"/>	Hard (e.g. basalt)	<input type="checkbox"/>	Mod. hard (e.g. limestone)	<input type="checkbox"/>	Friable (e.g. shale)	<input type="checkbox"/>	Soft (e.g. mudstone)	<input type="checkbox"/>	Very soft (e.g. Clay)	<table border="0"> <tr><td><input type="checkbox"/></td><td>Surface relief (even-rugged)</td></tr> <tr><td><input type="checkbox"/></td><td>Texture (smooth-pitted)</td></tr> <tr><td><input type="checkbox"/></td><td>Stability (stable-mobile)</td></tr> <tr><td><input type="checkbox"/></td><td>Scour (none-scoured)</td></tr> <tr><td><input type="checkbox"/></td><td>Silt (none-silted)</td></tr> <tr><td><input type="checkbox"/></td><td>Fissures >10mm (none-many)</td></tr> <tr><td><input type="checkbox"/></td><td>Crevices <10mm (none-many)</td></tr> <tr><td><input type="checkbox"/></td><td>Rockpools (none-all)</td></tr> <tr><td><input type="checkbox"/></td><td>Boulder/cobble/pebble shape (rounded-angular)</td></tr> </table>	<input type="checkbox"/>	Surface relief (even-rugged)	<input type="checkbox"/>	Texture (smooth-pitted)	<input type="checkbox"/>	Stability (stable-mobile)	<input type="checkbox"/>	Scour (none-scoured)	<input type="checkbox"/>	Silt (none-silted)	<input type="checkbox"/>	Fissures >10mm (none-many)	<input type="checkbox"/>	Crevices <10mm (none-many)	<input type="checkbox"/>	Rockpools (none-all)	<input type="checkbox"/>	Boulder/cobble/pebble shape (rounded-angular)
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<input type="checkbox"/>	Boulder/cobble/pebble shape (rounded-angular)																																									

LITTORAL ASPECT (e.g. N, NW)

CONSERVATION ASSESSMENT

<input type="checkbox"/>	Unspoilt / natural
<input type="checkbox"/>	Representative (for sector)
<input type="checkbox"/>	Rare / unusual biotopes
<input type="checkbox"/>	Rare species
<input type="checkbox"/>	High species richness
<input type="checkbox"/>	High biotope richness
<input type="checkbox"/>	Fragile species present
<input type="checkbox"/>	Fragile biotopes present
<input type="checkbox"/>	Intrinsic appeal
<input type="checkbox"/>	Ornithological interest
<input type="checkbox"/>	Seal haul out
<input type="checkbox"/>	Other:

LITTORAL WIDTH

m

TIDAL STREAMS

<input type="checkbox"/>	Very strong (>6 kn.)
<input type="checkbox"/>	Strong (3-6 kn.)
<input type="checkbox"/>	Moderately strong (1-3 kn.)
<input type="checkbox"/>	Weak (<1 kn.)
<input type="checkbox"/>	Very weak (negligible)
<input type="checkbox"/>	Unknown

Tick

<input type="checkbox"/>	Gully
<input type="checkbox"/>	Cave
<input type="checkbox"/>	Boulder/cobble - on rock
<input type="checkbox"/>	Boulder/cobble - on sediment
<input type="checkbox"/>	Boulder holes
<input type="checkbox"/>	Sediment on rock

WAVE EXPOSURE

<input type="checkbox"/>	Very exposed (prevailing wind and swell onshore)
<input type="checkbox"/>	Exposed (prevailing wind onshore, offshore shallows / obstructions)
<input type="checkbox"/>	Moderately exposed (prevailing wind offshore onshore wind frequent)
<input type="checkbox"/>	Sheltered (restricted [<20 km] fetch, offshore shallows / obstructions)
<input type="checkbox"/>	Very sheltered (fetch <20 km in any direction and <3 km to prevailing wind)
<input type="checkbox"/>	Extremely sheltered (fully enclosed, fetch <3 km)
<input type="checkbox"/>	Ultra sheltered (fetch of few 10s or at most 100s m)

* Apply to site as a whole; local variations can be noted on individual habitat forms

APPENDIX 2. LIST OF 83 SPECIES AND HIGHER TAXA RECORDED DURING THE SURVEY AND THEIR ASSOCIATED FUNCTIONAL GROUP, MAIN TAXONOMIC GROUP AND COMMON NAME (IF AVAILABLE)

Provisional place-holder taxon names are marked with an asterisk

Functional group	Main group	Taxon	Common name	SACFOR	Quadrat	Transect
Lichen	Lichen	Lichen unident sp. 1*	Green lichen	x	-	-
		Lichen unident sp. 2*	Grey lichen	x	-	-
		<i>Pertusaria</i> sp.	White pore lichen	x	-	-
		<i>Xanthoria parietina</i> *	Yellow/orange lichen	x	-	-
Macroalgae	Algae brown	Brown crust*	Brown crust	x	x	x
		<i>Carpophyllum flexuosum</i>	Flapjack	x	x	-
		<i>Carpophyllum maschalocarpum</i>	Flapjack	x	x	x
		<i>Colpomenia</i> spp.	Oyster thief	x	-	x
		<i>Cystophora retroflexa</i>	Slender zig-zag weed	x	x	x
		<i>Cystophora scalaris</i>	Ladder zigzag seaweed	x	x	x
		<i>Cystophora torulosa</i>	Knobbed zigzag seaweed	x	x	x
		<i>Dictyota kunthii</i>	Dictyota	x	x	x
		<i>Ecklonia radiata</i>	Paddle weed	x	x	x
		<i>Halopteris funicularis</i>	Halopteris	x	x	x
		<i>Hormosira banksii</i>	Neptune's necklace	x	x	x
		<i>Leathesia marina</i>	Leathesia	x	x	x
		<i>Scytothamnus australis</i>	Scytothamnus	x	-	-
		<i>Splachnidium rugosum</i>	Gummy weed	x	-	x
		<i>Zonaria aureomarginata</i>	Zonaria	x	x	x
		Algae green	<i>Caulerpa geminata</i>	Sea grapes	x	x
	<i>Codium convolutum</i>		Velvet weed	x	x	x
	<i>Ulva</i> sp.		Sea lettuce	x	x	x
	Algae red		<i>Anotrichium crinitum</i>	Anotrichium	x	-
		<i>Capreolia implexa</i>	Capreolia	x	x	x
		<i>Caulacanthus ustulatus</i>	Caulacanthus	x	x	x
		<i>Champia novaezelandiae</i>	Champia	x	x	x
		Coralline paint	Pink paint	x	x	x
		Coralline turf	Pink turf	x	x	x
		<i>Euptilota formosissima</i>	Euptilota	x	-	-
		<i>Gymnogrongus furcatus</i> *	Gymnogrongus	x	-	-
		<i>Laurencia thyrsoifera</i>	Laurencia	x	-	x
		<i>Lophurella caespitosa</i> *	Lophurella	x	-	-
		<i>Pachymenia laciniata</i> *	Pachymenia	x	-	-
		<i>Pachymenia lusoria</i>	Pachymenia	x	-	-
		<i>Plocamium</i> spp.	Plocamium	x	-	-
		<i>Pterocladia</i> sp.	Agar weed	x	-	x
<i>Pteroclatiella capillacea</i>		Small agar weed	x	x	x	
<i>Pyropia</i> *		Porphyra, Karengo, Nori	x	x	x	
<i>Sarcothalia decipiens</i> *	Sarcothalia	x	x	x		
<i>Sarcothalia livida</i>	Sarcothalia	x	x	x		
Mobile invertebrate	Other	<i>Patiriella regularis</i>	Cushion star	x	x	-
		<i>Phlyctenactis tuberculosa</i>	Wandering anemone	x	x	-
		<i>Stegnaster inflatus</i>	Ambush star	x	-	-
	Top shell	<i>Atalacmea fragilis</i>	Fragile limpet	x	-	-
		<i>Austrolittorina antipodum</i>	Blue banded periwinkle	x	x	-
		<i>Austrolittorina cincta</i>	Brown periwinkle	x	x	-
		<i>Cellana denticulata</i>	Denticulate limpet	x	x	-
		<i>Cellana ornata</i>	Ornate limpet	x	x	-
		<i>Cellana radians</i>	Radiate limpet	x	x	-
		<i>Chiton glaucus</i>	Green chiton	x	x	-
		<i>Dicathais orbita</i>	Ridged whelk	x	x	-
		<i>Diloma aethiops</i>	Grooved topshell	x	x	-
		<i>Diloma bicanaliculatum</i>	Knobbed top shell	x	x	-
		<i>Diloma nigerrimum</i>	Bluish top shell	x	x	-
		<i>Diloma zelandicum</i>	Green-banded black top shell	x	x	-
		<i>Eudoxochiton nobilis</i>	Noble chiton	x	x	-
		<i>Haliotis iris</i>	Paua	x	x	-
		<i>Haustrum haustorium</i>	Dark rock whelk	x	x	-
		<i>Haustrum scobina</i>	Oyster borer	x	x	-

Functional group	Main group	Taxon	Common name	SACFOR	Quadrat	Transect	
Mobile invertebrate	Top shell	<i>Ischnochiton maorianus</i>	Brown chiton	x	-	-	
		<i>Lunella smaragda</i>	Cats eye	x	x	-	
		<i>Nerita melanotragus</i>	Top shell	x	x	-	
		<i>Notoacmea pileopsis</i>	Limpet	x	-	-	
		<i>Notoplax violacea</i>	Violet chiton	x	-	-	
		<i>Siphonaria zelandica</i>	Siphon limpet	x	x	-	
		<i>Sypharochiton pelliserpentis</i>	Snakeskin chiton	x	x	-	
		<i>Trochus viridis</i>	Trochid	x	x	-	
Sessile invertebrate	Anemone	<i>Actinia tenebrosa</i>	Red waratah	x	x	x	
		<i>Anthopleura rosea</i>	Rose anemone	x	-	-	
		<i>Anthothoe albocincta</i>	White-striped anemone	x	x	-	
		<i>Corynactis australis</i>	Jewel anemone	x	x	x	
		<i>Epiactis thompsoni</i>	Red striped anemone	x	-	x	
		<i>Habrosanthus bathamae*</i>	Apricot anemone	x	x	x	
		<i>Isactinia olivacea</i>	Olive anemone	x	x	-	
		<i>Oulactis mucosa</i>	Sand anemone	x	x	-	
		Barnacle	<i>Calantica spinosa</i>	Spiny gooseneck barnacle	x	-	-
			<i>Chamaesipho brunnea</i>	Brown surf barnacle	x	x	x
	<i>Chamaesipho columna</i>		Column barnacle	x	x	x	
	<i>Epopella plicata</i>		Plicate barnacle	x	-	-	
	Other	Hydroid thecate unident sp. 1*	Hydroid	x	x	-	
		Sponge unident sp. 1*	Sponge	x	-	-	
	Tube worm	Spirobidae	Spiroid worm	x	x	-	
		<i>Spirobranchus cariniferus</i>	Blue tubeworm	x	x	x	

APPENDIX 3. QUADRAT PHYSICAL DATA AND TAXA INFORMATION (PERCENT COVER AND COUNT) FOR EACH REPLICATE WITHIN EACH SHORE HEIGHT AND SITE

* Quadrat physical information recorded as described in Appendix 1.

Component	Unit	Kap1HQ01	Kap1HQ02	Kap1HQ03	Kap1HQ04	Kap1HQ05	Kap1HQ06	Kap1HQ07	Kap1HQ08	Kap1HQ09	Kap1HQ10	Kap1MQ01	Kap1MQ02	Kap1MQ03	Kap1MQ04	Kap1MQ05	Kap1MQ06	Kap1MQ07	Kap1MQ08	Kap1MQ09	Kap1MQ10
Physical features																					
Dominant substratum	see *																				
Slope	see *																				
Aspect	degrees	270	150	163	192	194	350	275	235	228	162	170	176	215	242	205	205	205	310	240	222
Rugosity	see *	5	5	5	4	4	5	6	5	6	4	3	3	6	3	3	3	3	3	3	3
Bar rock	percent	75.9	71.6	99.2	83.6	85.6	82.4	38.1	77.3	69.9	82.9	52.5	33.1	74.0	97.0	93.7	88.4	88.6	63.5	58.0	27.5
Taxon																					
Brown crust	percent	23.6	25.1	0.3	15.5	14.1	16.8	15.0	0.6	24.2	16.6	0.3	3.0	0.5	3.0	5.5	11.0	3.0	0.3	41.4	8.3
<i>Caprella implexa</i>	percent	-	2.8	0.3	0.3	0.3	-	2.9	2.8	0.3	-	-	-	-	-	-	-	-	-	-	0.3
<i>Carpophyllum flexuosum</i>	percent	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Carpophyllum maschalocarpum</i>	percent	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Caulacanthus ustulatus</i>	percent	-	-	-	-	-	-	-	-	-	-	-	-	0.3	-	0.3	-	-	-	-	-
<i>Caulerpa geminata</i>	percent	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Charaxesipho brunnica</i>	percent	0.3	0.3	-	-	-	0.3	23.5	16.6	0.3	0.3	-	-	-	-	0.3	-	-	-	-	-
<i>Charaxesipho columna</i>	percent	-	-	-	0.3	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3
<i>Champia novaezelandiae</i>	percent	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Codium convolvutum</i>	percent	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coralline paint	percent	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.3	-	-
Coralline turf	percent	-	-	-	-	-	-	-	-	-	-	0.3	0.3	0.3	-	-	0.3	-	5.5	-	19.3
<i>Cystophora retroflexa</i>	percent	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Cystophora scalaris</i>	percent	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Cystophora torulosa</i>	percent	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19.3
<i>Dicryota kunthii</i>	percent	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Ecklonia radiata</i>	percent	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Halopteris funicularis</i>	percent	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Hormosira banksii</i>	percent	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Leathesia marina</i>	percent	-	0.3	-	-	-	-	-	-	-	-	47.0	63.5	24.7	-	-	-	-	8.3	0.3	24.8
<i>Pterodictella capillacea</i>	percent	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3	-	-
<i>Pyropia</i>	percent	0.3	-	0.3	0.3	-	0.3	20.5	2.8	5.4	0.3	-	-	-	-	-	-	-	5.5	-	-
<i>Sarcophthalma decipiens</i>	percent	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Sarcophthalma livida</i>	percent	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spirobridae	percent	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Spirobranchus carmillerus</i>	percent	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Ulva</i> sp.	percent	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Zonaria aureomarginata</i>	percent	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Actinia tenethosa</i>	count	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	7	11	-	-	0.3
<i>Anthothoe albocincta</i>	count	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Australitarina antipodum</i>	count	305	35	345	435	380	325	35	170	35	285	-	-	-	-	-	-	-	-	-	-
<i>Australitarina cincta</i>	count	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Cellana denticulata</i>	count	-	5	-	-	-	-	-	1	-	-	3	1	2	2	3	6	1	5	2	-
<i>Gellana ornata</i>	count	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Gellana radians</i>	count	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Chiton glaucus</i>	count	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Corynactis australis</i>	count	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Dicathais orbifera</i>	count	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Diloma aethiops</i>	count	-	-	-	-	-	-	-	-	-	-	2	8	6	-	-	1	1	1	1	-
<i>Diloma bicanaliculatum</i>	count	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
<i>Diloma nigrinum</i>	count	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Diloma zelandicum</i>	count	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2	2	5	-	-
<i>Eudoxochiton nobilis</i>	count	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Habrosanthis bathymae</i>	count	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Haliotis iris</i>	count	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Haustrum haustrorum</i>	count	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Haustrum scabina</i>	count	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Hydrobia thecates unident.sp.1</i>	count	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Lacertina olivacea</i>	count	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Lunella smaragda</i>	count	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
<i>Nerita melanotragus</i>	count	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Oulactis mucosa</i>	count	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Patirella regularis</i>	count	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Phycenactis tuberculosa</i>	count	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Siphonaria zelandica</i>	count	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Siphonochiton pelliserpentis</i>	count	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-
<i>Trachus viridis</i>	count	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Component	Kap1LQ01	Kap1LQ02	Kap1LQ03	Kap1LQ04	Kap1LQ05	Kap1LQ06	Kap1LQ07	Kap1LQ08	Kap1LQ09	Kap1LQ10	Kap2HQ01	Kap2HQ02	Kap2HQ03	Kap2HQ04	Kap2HQ05	Kap2HQ06	Kap2HQ07	Kap2HQ08	Kap2HQ09	Kap2HQ10		
Physical features																						
Dominant substratum																						
Slope																						
Aspect	165	230	212	BF/GF	Gentle	228	230	208	RF	Gentle	225	230	208	BF	Gentle	228	230	208	RF	Gentle	225	230
Rugosity	3	2	3	3	3	4	4	5	5	5	4	3	4	3	3	3	4	4	7	7	7	7
Bare rock	-	22.3	1.4	13.2	1.4	2.7	1.5	7.2	12.1	-	97.0	99.4	99.7	94.2	99.7	93.9	88.9	88.6	83.3	91.2		
Taxon																						
Brown crust																						
<i>Caprella implexa</i>																						
<i>Carpophyllum flexuosum</i>																						
<i>Carpophyllum maxichalocarpum</i>																						
<i>Caulacanthus ustulatus</i>																						
<i>Caulerpa geminata</i>																						
<i>Chamaesipho brunnea</i>																						
<i>Chamaesipho columna</i>																						
<i>Champia novaezelandiae</i>																						
<i>Codium convolutum</i>																						
Coralline paint	4.7	14.5	2.8	19.1	2.8	1.4	1.5	11.5	2.7	2.8												
Coralline turf	31.2	13.1	40.7	13.2	49.7	47.7	43.7	24.5	28.3	51.3												
<i>Cystophora retroflexa</i>	6.2	9.2	-	7.3	14.2	0.1	15.1	14.4	-	0.1												
<i>Cystophora scalaris</i>	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1												
<i>Cystophora torulosa</i>	45.2	10.5	37.9	36.7	0.1	19.1	22.6	11.5	28.3	18.0												
<i>Dicystra kuntzii</i>	4.7	17.1	-	1.5	5.7	20.4	15.1	8.7	12.1	15.3												
<i>Ecklonia radiata</i>	1.6	-	-	2.9	-	-	-	-	-	-												
<i>Halopteris lunicularis</i>	1.6	1.3	-	-	0.1	-	-	0.1	16.2	-												
<i>Hormosira banksii</i>	-	-	-	-	-	-	-	-	-	-												
<i>Leathesia marina</i>	-	-	-	-	-	-	-	-	-	-												
<i>Peucedaniella capillacea</i>	-	-	-	-	-	0.1	0.1	0.2	-	-												
<i>Pyropia</i>	-	-	-	-	-	-	-	-	-	-												
<i>Sarcothalia decipiens</i>	-	-	-	-	-	-	-	-	-	-												
<i>Sarcothalia livida</i>	-	-	-	-	-	-	-	-	-	-												
<i>Spirobidia</i>	-	-	-	-	-	-	-	-	-	-												
<i>Spirobranchus cariniferus</i>	-	-	-	-	-	-	-	-	-	-												
<i>Ulva</i> sp.	-	-	-	-	-	-	-	-	-	-												
<i>Zonaria aureomarginata</i>	4.7	1.3	4.2	4.4	1.4	0.1	0.2	1.4	0.1	2.8												
<i>Actinia tenebrosa</i>	-	-	-	-	-	-	-	-	-	-												
<i>Anthothoe albocincta</i>	-	-	-	-	-	-	-	-	-	-												
<i>Australitorina antipodum</i>	-	-	-	-	-	-	-	-	-	-												
<i>Australitorina circa</i>	-	-	-	-	-	-	-	-	-	-												
<i>Cellana denticulata</i>	-	-	-	-	-	1	-	-	-	1												
<i>Cellana ornata</i>	-	-	-	-	-	-	-	-	-	-												
<i>Cellana radians</i>	-	-	-	-	-	-	-	-	3	-												
<i>Chiton glaucus</i>	-	-	-	-	-	-	-	-	-	-												
<i>Corynactis australis</i>	-	-	-	-	-	-	-	-	-	-												
<i>Dicathais orbita</i>	-	-	-	-	-	-	-	-	-	-												
<i>Diloma aethiops</i>	-	-	-	1	1	-	-	-	-	1												
<i>Diloma bicanaliculatum</i>	-	-	-	-	-	-	-	-	-	-												
<i>Diloma nigerimum</i>	-	-	-	-	-	-	-	-	-	-												
<i>Diloma zelandicum</i>	-	-	-	-	-	-	-	-	-	-												
<i>Eudoxochiton nobilis</i>	-	-	-	-	-	-	-	-	-	-												
<i>Habrosanthus bathymae</i>	-	-	-	-	-	-	-	-	-	-												
<i>Haliotis iris</i>	-	-	-	-	-	-	-	6	-	-												
<i>Haustrum haustrorum</i>	-	-	-	-	-	-	-	-	-	-												
<i>Haustrum scobina</i>	-	-	-	-	-	-	-	-	-	-												
Hydroid thecae unident sp. 1	-	-	-	-	-	-	-	-	-	-												
<i>Isactinia olivacea</i>	-	-	-	-	-	-	-	-	-	-												
<i>Nerita melanotragus</i>	-	-	-	-	-	1	-	-	-	2												
<i>Onizotis mucosa</i>	-	-	-	-	-	-	-	-	-	-												
<i>Patriella regularis</i>	-	-	-	-	-	-	-	-	-	-												
<i>Phlyctenacis tuberculosa</i>	-	-	-	-	-	-	-	-	-	-												
<i>Siphonaria zelandica</i>	-	-	-	-	-	-	-	-	-	-												
<i>Siphonochiton pelliserpentis</i>	-	-	-	-	-	-	-	-	1	-												
<i>Trochus viridis</i>	-	-	-	-	-	-	-	-	-	-												

Component	Kap2MQ01	Kap2MQ02	Kap2MQ03	Kap2MQ04	Kap2MQ05	Kap2MQ06	Kap2MQ07	Kap2MQ08	Kap2MQ09	Kap2MQ10	Kap2LQ01	Kap2LQ02	Kap2LQ03	Kap2LQ04	Kap2LQ05	Kap2LQ06	Kap2LQ07	Kap2LQ08	Kap2LQ09	Kap2LQ10
Physical features																				
Dominant substratum	BF Gentle 112	BF Gentle 115	BF Gentle 92	BF Vertical 148	BF Gentle 112	BF Gentle 116	BF Steep 96	BF Moderate 108	BF Gentle 120	BF Flat 112	BF Gentle 110	BF Flat 109	BF Flat 140	BF Gentle 106	BF Gentle 108	BF Gentle 116	BF Gentle 105	BF Gentle 108	BF Flat 100	BF Gentle 112
Slope	3	3	3	3	3	3	3	4	3	3	2	2	2	2	2	3	2	2	2	2
Rugosity	96.5	96.9	93.9	52.2	93.9	78.2	90.9	77.6	99.7	85.6	-	1.4	1.4	2.6	1.31	-	11.2	15.1	12.6	4.2
Bare rock																				
Taxon																				
Brown crust	-	-	-	-	3.0	-	0.3	2.8	-	-	4.1	0.3	0.1	10.5	4.5	-	0.1	1.4	0.3	-
<i>Caprella implexa</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Carpophyllum flexuosum</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Carpophyllum maschalocarpum</i>	-	-	-	-	-	-	-	-	-	-	4.0	12.8	32.3	10.5	23.4	8.4	8.4	1.4	1.4	16.9
<i>Caulacanthus ustulatus</i>	2.7	2.6	5.5	46.7	-	5.4	5.5	8.3	-	2.8	6.6	-	-	-	0.1	-	-	-	-	-
<i>Caulerpa geminata</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Chamaespho brunnea</i>	0.3	-	0.3	0.3	2.8	16.2	2.8	11.1	-	0.3	-	-	-	-	-	-	-	-	-	-
<i>Chamaespho columna</i>	-	-	-	-	0.3	0.3	0.3	0.3	-	-	-	-	-	-	-	-	-	-	-	-
<i>Champia novaezealandiae</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Codium convolutum</i>	-	-	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Coraline</i> sp.	-	-	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Coralineturf</i>	-	-	-	-	-	-	-	-	-	-	19.9	36.9	42.1	39.5	24.8	42.1	49.2	30.1	11.2	1.4
<i>Cystophora retroflexa</i>	-	-	-	-	-	-	-	-	-	34.6	11.8	8.4	11.8	11.8	16.1	15.4	9.8	8.2	11.2	11.3
<i>Cystophora scalaris</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Cystophora torulosa</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	3.9	0.1	0.1	1.4	-	-	-
<i>Dicysta kunthii</i>	-	-	-	-	-	-	-	-	-	-	6.6	2.8	-	3.9	1.5	5.6	0.1	8.2	-	1.4
<i>Ecklonia radiata</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.8	1.4	-	-	-	-
<i>Halopteris lunicularis</i>	-	-	-	-	-	-	-	-	-	-	-	9.8	-	5.3	-	-	-	-	-	-
<i>Homosira banksii</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-	-	-	-
<i>Leathesia marina</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Preocladia capillacea</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Pyropia</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Sarcothalia decipiens</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Sarcothalia livida</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Spirobidae</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Spirobranchus cariniferus</i>	0.3	0.3	0.3	-	-	-	-	-	-	11.0	-	-	-	-	-	-	-	-	-	-
<i>Ulva</i> sp.	0.3	0.3	0.3	0.3	-	-	0.3	-	0.3	0.3	23.9	19.9	5.6	11.8	10.2	26.7	19.7	12.3	30.9	15.5
<i>Zonaria aureomarginata</i>	-	-	-	-	-	-	-	-	-	-	0.1	0.1	0.1	-	0.1	0.1	-	-	-	0.1
<i>Actinia tenebrosa</i>	-	-	7	-	6	-	15	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Anothoe albocincta</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Australarina antipodum</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Australarina cincta</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Cellana denticulata</i>	4	4	3	7	-	1	5	5	1	2	-	1	-	-	-	-	-	-	-	-
<i>Cellana ornata</i>	-	-	-	-	-	1	4	4	1	-	-	-	-	-	-	-	-	-	-	-
<i>Cellana radians</i>	5	2	3	1	1	3	2	2	4	1	-	-	-	-	-	-	-	-	-	1
<i>Chiton glaucus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Corynactis australis</i>	-	-	-	-	-	-	-	-	-	-	15	55	80	80	215	80	20	115	190	50
<i>Dicathais orbita</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Diloma aethiops</i>	2	5	-	1	-	-	-	-	-	-	2	2	-	-	-	2	-	1	-	-
<i>Diloma bicanaliculatum</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Diloma nigerrimum</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Diloma zelandicum</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Eudoxochiton nobilis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
<i>Halosiphonia bathymae</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Halolithis</i>	-	-	-	-	-	-	-	-	-	-	2	1	1	1	-	-	-	1	-	-
<i>Haustrum haustrorum</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Haustrum scobina</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Hydrodictyon thecate unident. sp. 1</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Isactinia olivacea</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Lunella smaragda</i>	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
<i>Nerita melanostragus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Oulactis mucosa</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Patirella regularis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Phlyctenacis tuberculosa</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Siphonaria zelandica</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Siphonochiton pelliserpentis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Trachusa viridis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Component	Kap3HQ01	Kap3HQ02	Kap3HQ03	Kap3HQ04	Kap3HQ05	Kap3HQ06	Kap3HQ07	Kap3HQ08	Kap3HQ09	Kap3HQ10	Kap3MO01	Kap3MO02	Kap3MO03	Kap3MO04	Kap3MO05	Kap3MO06	Kap3MO07	Kap3MO08	Kap3MO09	Kap3MO10	
Physical features	BF/CF	BF/CF	RF	RF	RF	BF	RF	RF	RF	RF	BF	RF	RF	RF/BE	RF	RF	BF	RF	RF	RF	
	Flat	Flat	Flat	Flat	Gentle	Flat	Flat	Flat	Flat	Flat	Flat	Vertical	Vertical	Flat	Flat	Flat	Gentle	Gentle	Flat	Gentle	
Dominant substratum																					
Slope																					
Aspect	64	72	68	70	58	88	82	98	90	84	52	90	80	42	84	72	80	80	90	72	100
Rugosity	3	4	3	6	6	4	8	7	8	7	3	5	4	3	6	7	4	3	7	6	6
Barerock	99.7	91.7	92.1	83.3	85.5	97.0	99.4	99.7	99.4	100.0	90.9	90.9	90.9	99.4	93.9	79.5	88.2	93.0	98.9	88.6	88.6
Taxon																					
Brown crust	0.3	8.3	7.9	16.7	14.3	0.3	0.3	-	0.3	-	5.5	27.7	2.8	-	2.8	0.3	-	0.3	0.3	-	-
<i>Caprella implexa</i>	-	-	-	-	-	-	-	-	-	-	0.3	-	0.3	0.3	-	11.0	8.3	5.8	-	-	-
<i>Carpophyllum flexuosum</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Carpophyllum moschalo-carpum</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Caulacanthus ustulatus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Caulerpa geminata</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Chamaesipho brunnea</i>	-	-	-	-	-	-	-	-	-	-	0.3	-	0.3	-	-	-	-	-	-	-	-
<i>Chamaesipho columna</i>	-	-	-	-	2.8	-	-	-	0.3	-	-	-	-	-	-	-	-	-	-	0.3	11.1
<i>Champia novezealandiae</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Codium convolutum</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coralline-paint	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coralline-turf	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Cystophora retroflexa</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.8	5.5	2.8	0.3	-	-	-
<i>Cystophora scalaris</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3	0.3	-	-	-	-
<i>Cystophora torulosa</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Dicentra kunthii</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Ecklonia radlata</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Halipteris funicularis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Hormosira banksii</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Leathesia marina</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Pterocladia capillacea</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Pyropia</i>	-	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Sarcothalia decipiens</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Sarcothalia livida</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spirabidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Spirabranchus cariniferus</i>	-	-	-	-	-	-	-	-	-	-	2.8	0.3	5.5	-	-	-	-	-	-	-	-
<i>Ulva</i> sp.	-	-	-	-	-	-	-	0.3	-	-	0.3	0.3	0.3	-	0.3	0.3	0.3	0.3	-	-	0.3
<i>Zonaria aureomarginata</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Actinia tenebrosa</i>	2	2	-	-	-	-	-	3	-	19	8	9	19	8	-	-	-	15	2	-	-
<i>Anithothoe albocincta</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Austrolittorina antipodum</i>	-	-	-	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Austrolittorina cincta</i>	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
<i>Cellana denticulata</i>	-	-	-	-	1	5	2	8	1	5	21	12	1	1	3	2	3	4	1	2	2
<i>Cellana ornata</i>	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	2	6	6
<i>Cellana radlans</i>	-	-	-	-	-	2	2	2	-	2	-	4	-	-	-	-	-	-	3	-	-
<i>Chiton glaucus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Corynactis australis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Dicathais orbita</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Diloma aethiops</i>	-	1	-	-	10	1	19	13	1	4	-	9	18	17	13	12	1	14	2	2	2
<i>Diloma bicanaliculatum</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Diloma nigerrimum</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Diloma zelandicum</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Eudowichion nobilis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Habrosanthus bathymae</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Haliotis lilis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Haustrum haustorium</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Haustrum scobina</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
<i>Hydroid thecate unident sp. 1</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Isactinia olivacea</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Lunella smaragda</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Nerita melanotragus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Oulactis mucosa</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Patriella regularis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Phycenacis tuberculosa</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Siphonaria zelandica</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Siphonochiton pelliserpentis</i>	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
<i>Trochus viridis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

APPENDIX 4. TRANSECT POINT COUNT DATA FOR EACH SHORE HEIGHT AND SITE

Main group	Taxon/substrate	Kap1			Kap2			Kap3			Mana		
		H	M	L	H	M	L	H	M	L	H	M	L
Bare rock	Bare rock	66.3	46.5	2.4	79.0	72.1	7.1	89.4	61.6	13.0	89.3	58.5	4.2
Substrate composition													
	Bedrock	74.1	55.6	40.5	26.5	0.0	0.0	38.1	44.6	15.8	38.8	70.0	54.0
	Boulder	18.5	37.0	46.6	57.8	84.3	83.9	35.7	33.7	63.6	30.6	16.3	36.0
	Cobble	7.4	7.4	12.9	15.7	15.7	16.1	25.0	14.5	17.0	22.4	12.5	7.5
	Gravel	0.0	0.0	0.0	0.0	0.0	0.0	1.2	7.2	3.6	8.2	1.3	2.5
Taxonomic group													
Algae brown	Brown crust	18.8	17.4	1.9	-	2.3	1.3	5.9	3.5	2.8	-	3.7	7.5
	<i>Carpophyllum maschalocarpum</i>	-	-	5.8	-	-	15.2	-	-	13.0	-	-	7.0
	<i>Colpomenia</i> spp.	-	-	-	-	-	-	-	-	-	-	-	1.4
	<i>Cystophora retroflexa</i>	-	-	4.8	-	-	-	-	-	-	-	-	-
	<i>Cystophora scalaris</i>	-	-	1.9	-	-	0.9	-	-	1.4	-	-	2.3
	<i>Cystophora torulosa</i>	-	-	10.6	-	-	2.2	-	-	6.9	-	-	13.6
	<i>Dictyota kunthii</i>	-	-	1.0	-	-	1.8	-	-	0.9	-	-	2.3
	<i>Ecklonia radiata</i>	-	-	4.3	-	-	3.6	-	-	2.3	-	-	1.4
	<i>Halopteris funicularis</i>	-	-	2.4	-	-	-	-	-	1.4	-	-	-
	<i>Hormosira banksii</i>	-	18.6	3.9	-	-	-	-	14.0	6.0	-	2.4	4.2
	<i>Leathesia marina</i>	-	-	1.4	-	-	-	-	-	-	-	-	0.5
	<i>Splachnidium rugosum</i>	-	-	-	-	-	-	-	-	0.5	-	-	-
	<i>Zonaria aureomarginata</i>	-	-	10.1	-	-	3.6	-	-	7.4	-	-	8.5
Algae green	<i>Caulerpa geminata</i>	-	-	-	-	-	-	-	-	-	-	-	0.5
	<i>Codium convolutum</i>	-	3.5	4.3	-	-	6.3	-	2.3	6.9	-	-	2.3
	<i>Ulva</i> sp.	-	-	-	-	2.3	17.0	-	1.2	6.0	-	-	2.3
Algae red	<i>Capreolia implexa</i>	-	-	-	-	8.1	0.9	-	-	-	-	7.3	-
	<i>Caulacanthus ustulatus</i>	-	-	3.4	-	-	0.4	-	-	0.9	-	-	1.9
	<i>Champia novaezelandiae</i>	-	-	-	-	-	-	-	-	-	-	-	1.4
	Coralline paint	-	8.1	24.6	-	2.3	37.1	-	8.1	25.5	-	4.9	29.6
	Coralline turf	-	-	14.0	-	-	1.3	-	-	0.9	-	1.2	6.6
	<i>Laurencia thyrifera</i>	-	-	-	-	-	0.4	-	-	-	-	-	-
	<i>Pterocladia</i> sp.	-	-	-	-	-	-	-	-	1.4	-	-	0.5
	<i>Pterocladia capillacea</i>	-	-	2.9	-	-	-	-	-	1.9	-	-	-
	<i>Pyropia</i>	7.5	-	-	2.5	-	-	1.2	-	-	2.4	3.7	-
	<i>Sarcothalia decipiens</i>	-	-	-	-	-	-	-	-	-	-	-	0.5
	<i>Sarcothalia livida</i>	-	-	-	-	-	-	-	-	-	-	-	1.4
Anemone	<i>Actinia tenebrosa</i>	-	-	-	-	3.5	-	-	4.7	0.5	-	-	-
	<i>Corynactis australis</i>	-	-	-	-	-	0.4	-	-	-	-	-	-
	<i>Epiactis thompsoni</i>	-	-	-	-	-	0.4	-	-	-	-	-	-
	<i>Habrosanthus bathamae</i>	-	-	-	-	-	-	-	-	0.5	-	-	-
Barnacle	<i>Chamaesipho brunnea</i>	7.5	-	-	18.5	3.5	-	3.5	3.5	-	8.3	17.1	-
	<i>Chamaesipho columna</i>	-	2.3	-	-	1.2	-	-	-	-	-	-	-
Tube worm	<i>Spirobranchus cariniferus</i>	-	3.5	-	-	4.7	-	-	1.2	-	-	1.2	-

APPENDIX 5. SACFOR ASSESSMENT DATA FOR EACH SHORE HEIGHT AND SITE

Main group	Taxon	Kap1				Kap2				Kap3				Mana				
		S	H	M	L	S	H	M	L	S	H	M	L	S	H	M	L	
Bare rock	Bare rock	A	S	A	O	A	S	S	F	S	S	S	C	S	S	S	O	
Algae brown	Brown crust	-	F	F	O	-	R	O	R	-	O	R	O	-	-	R	F	
	<i>Carpophyllum flexuosum</i>	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	R	
	<i>Carpophyllum maschalocarpum</i>	-	-	-	C	-	-	-	A	-	-	R	A	-	-	-	C	
	<i>Colpomenia</i> spp.	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	F	
	<i>Cystophora retroflexa</i>	-	-	-	F	-	-	-	-	-	-	-	-	-	-	-	-	
	<i>Cystophora scalaris</i>	-	-	-	R	-	-	-	R	-	-	R	R	-	-	-	R	
	<i>Cystophora torulosa</i>	-	-	R	C	-	-	-	O	-	-	R	O	-	-	-	C	
	<i>Dictyota kunthii</i>	-	-	-	O	-	-	-	O	-	-	-	O	-	-	-	O	
	<i>Ecklonia radiata</i>	-	-	-	F	-	-	-	F	-	-	-	O	-	-	-	R	
	<i>Halopteris funicularis</i>	-	-	R	O	-	-	-	R	-	-	-	R	-	-	-	R	
	<i>Hormosira banksii</i>	-	R	C	O	-	-	R	R	-	-	A	R	-	-	O	C	
	<i>Leathesia marina</i>	-	-	R	O	-	-	-	-	-	-	R	R	-	-	-	R	
	<i>Scytothamnus australis</i>	-	R	R	-	-	-	-	-	-	-	-	R	-	-	R	R	
	<i>Splachnidium rugosum</i>	-	-	R	R	-	-	R	R	-	-	R	R	-	-	-	R	
	<i>Zonaria aureomarginata</i>	-	-	R	C	-	-	R	O	-	-	R	R	-	-	-	F	
	Algae green	<i>Caulerpa geminata</i>	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	R
		<i>Codium convolutum</i>	-	-	R	F	-	-	R	F	-	-	R	C	-	-	-	O
<i>Ulva</i> sp.		-	-	O	R	-	-	R	C	-	R	R	C	-	-	R	O	
Algae red	<i>Anotrichium crinitum</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	
	<i>Capreolia implexa</i>	-	O	R	-	-	R	F	-	-	R	R	-	-	R	O	-	
	<i>Caulacanthus ustulatus</i>	-	R	R	O	-	R	O	R	-	-	R	R	-	-	R	O	
	<i>Champia novaezealandiae</i>	-	-	R	-	-	-	R	-	-	-	R	R	-	-	-	R	
	Coralline paint	-	-	O	A	-	-	R	A	-	-	R	A	-	-	R	C	
	Coralline turf	-	-	R	C	-	-	-	O	-	-	R	R	-	-	R	O	
	<i>Euptilota formosissima</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	
	<i>Gymnogrongus furcatus</i>	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	
	<i>Laurencia thyrsoifera</i>	-	-	-	-	-	-	R	R	-	-	-	-	-	-	-	-	
	<i>Lophurella caespitosa</i>	-	-	-	R	-	-	-	-	-	-	-	R	-	-	-	-	
	<i>Pachymenia laciniata</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	
	<i>Pachymenia lusoria</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	
	<i>Plocamium</i> spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	
	<i>Pterocladia</i> sp.	-	-	-	R	-	-	-	R	-	-	-	R	-	-	-	R	
	<i>Pteroclatiella capillacea</i>	-	-	R	O	-	-	-	-	-	-	-	O	-	-	-	R	
	<i>Pyropia</i>	-	F	R	-	-	-	O	O	-	-	R	R	-	-	O	O	
	<i>Sarcothalia decipiens</i>	-	-	-	R	-	-	R	R	-	-	-	-	-	-	-	R	
	<i>Sarcothalia livida</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	O	
	Anemone	<i>Actinia tenebrosa</i>	-	-	R	O	-	R	O	R	-	R	O	O	-	-	R	R
		<i>Anthopleura rosea</i>	-	-	-	R	-	-	-	-	-	-	-	-	-	-	R	-
<i>Anthothoe albocincta</i>		-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Corynactis australis</i>		-	-	-	R	-	-	-	F	-	-	-	-	-	-	-	-	
<i>Epiactis thompsoni</i>		-	-	-	R	-	-	-	R	-	-	-	-	-	-	-	-	
<i>Habrosanthus bathamae</i>		-	-	-	-	-	-	-	-	-	-	-	F	-	-	-	-	
<i>Isactinia olivacea</i>		-	-	R	R	-	-	-	-	-	-	-	-	-	-	-	R	
<i>Oulactis mucosa</i>		-	-	-	O	-	-	-	-	-	-	-	-	-	-	-	R	
<i>Phlyctenactis tuberculosa</i>		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	
Barnacle		<i>Calantica spinosa</i>	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-
	<i>Chamaesipho brunnea</i>	-	F	R	-	-	F	O	-	-	O	O	-	-	O	F	-	
	<i>Chamaesipho columna</i>	-	O	R	-	-	-	R	-	-	-	-	-	-	-	-	-	
	<i>Epopella plicata</i>	-	-	-	-	-	-	-	-	-	R	-	-	-	R	R	-	
Lichen	Lichen unident sp. 1	-	-	-	-	R	-	-	-	-	-	-	-	O	-	-	-	
	Lichen unident sp. 2	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	
	<i>Pertusaria</i> sp.	S	-	-	-	S	-	-	-	C	-	-	-	C	-	-	-	
	<i>Xanthoria parietina</i>	O	-	-	-	R	-	-	-	F	-	-	-	C	-	-	-	
Limpet/chiton	<i>Atalacmea fragilis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	
	<i>Cellana denticulata</i>	-	R	C	R	-	R	C	R	-	R	C	R	-	R	O	O	
	<i>Cellana ornata</i>	-	-	R	-	-	-	R	R	-	R	R	R	-	R	F	R	
	<i>Cellana radicans</i>	-	-	R	F	-	R	O	R	-	R	R	R	-	R	R	O	
	<i>Chiton glaucus</i>	-	-	-	R	-	-	-	-	-	-	-	R	-	-	-	R	

Main group	Taxon	Kap1				Kap2				Kap3				Mana			
		S	H	M	L	S	H	M	L	S	H	M	L	S	H	M	L
Limpet/chiton	<i>Eudoxochiton nobilis</i>	-	-	-	R	-	-	R	R	-	-	-	-	-	-	-	-
	<i>Ischnochiton maorianus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R
	<i>Notoacmea pileopsis</i>	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-
	<i>Notoplax violacea</i>	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-
	<i>Siphonaria zelandica</i>	-	-	R	R	-	-	R	R	-	-	-	-	-	-	R	R
	<i>Sypharochiton pelliserpentis</i>	-	-	R	R	-	-	R	R	-	-	R	-	-	-	R	R
Other	Hydroid thecate unident sp. 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R
	<i>Patiriella regularis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R
	Sponge unident sp. 1	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-
	<i>Stegnaster inflatus</i>	-	-	-	R	-	-	-	-	-	-	-	R	-	-	-	-
Periwinkle	<i>Austrolittorina antipodum</i>	C	A	-	-	C	A	-	-	R	R	-	-	A	C	-	-
	<i>Austrolittorina cincta</i>	O	O	-	-	R	R	-	-	R	R	-	-	R	R	-	-
Top shell	<i>Dicathais orbita</i>	-	-	-	R	-	-	-	R	-	-	-	-	-	-	-	R
	<i>Diloma aethiops</i>	-	-	O	O	R	C	F	-	R	C	C	-	R	F	F	-
	<i>Diloma bicanaliculatum</i>	-	-	R	-	-	-	-	-	-	R	-	-	-	F	-	-
	<i>Diloma nigerrimum</i>	-	-	-	-	R	-	-	-	R	C	R	-	-	F	-	-
	<i>Diloma zelandicum</i>	-	R	R	C	-	-	-	-	-	-	-	-	-	-	-	-
	<i>Haliotis iris</i>	-	-	-	F	-	-	-	R	-	-	-	R	-	-	-	C
	<i>Haustrum haustorium</i>	-	-	R	R	-	-	R	O	-	-	R	R	-	-	R	O
	<i>Haustrum scobina</i>	-	-	-	-	-	-	R	-	-	-	R	-	-	-	O	F
	<i>Lunella smaragda</i>	-	-	R	F	-	-	-	R	-	-	-	-	-	-	-	O
	<i>Nerita melanotragus</i>	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-
	<i>Trochus viridis</i>	-	-	-	R	-	-	-	-	-	-	-	R	-	-	-	R
Tube worm	Spirobidae	-	-	-	-	R	-	-	-	-	-	-	R	-	-	-	-
	<i>Spirobranchus cariniferus</i>	-	-	O	R	R	O	R	-	-	-	R	R	-	-	R	R

APPENDIX 6. MEAN AND STANDARD ERROR OF KEY RESPONSE VARIABLES MEASURED IN REPLICATE (N=10) QUADRATS

Response variable	Site Shore height	Kap1 High	Kap1 Mid	Kap1 Low	Kap2 High	Kap2 Mid	Kap2 Low	Kap3 High	Kap3 Mid	Kap3 Low	Mana High	Mana Mid	Mana Low
Bare rock cover	Mean %	76.7	67.6	6.2	93.6	86.5	6.2	94.8	89.5	35.7	95.3	77.8	11.2
	SE	0.6	1.0	0.9	0.2	0.5	0.8	0.2	0.3	1.6	0.3	0.6	0.7
Macroalgal cover	Mean %	19.1	30.6	93.8	0.2	8.8	93.8	4.9	8.4	64.3	1.9	6.4	88.8
	SE	0.8	1.5	0.2	0.2	1.5	0.2	0.9	1.0	1.2	1.4	0.5	0.3
Sessile invertebrate cover	Mean %	4.2	1.8	0.0	6.2	4.7	0.0	0.3	2.1	0.0	2.8	15.8	0.0
	SE	1.3	0.8	-	0.7	0.9	-	0.5	0.8	0.1	1.3	1.3	0.1
Total richness	Mean #	5.5	6.8	10.4	3.9	6.3	10.4	3.7	7.5	10.0	1.6	6.5	10.6
	SE	0.4	0.4	0.6	0.4	0.4	0.4	0.4	0.7	1.0	0.2	0.7	1.0
Limpet & chiton count	Mean #	0.6	2.9	0.5	1.7	5.9	0.4	3.1	6.7	0.5	0.1	6.8	0.5
	SE	0.6	0.4	0.6	0.5	0.4	0.3	0.7	0.9	0.6	0.3	1.0	0.4
Periwinkle count	Mean #	235.3	0.0	0.0	21.3	0.0	0.0	1.8	0.0	0.0	164.6	208.4	0.0
	SE	3.2	-	-	2.5	-	-	1.2	-	-	3.6	5.9	-
Other top shell count	Mean #	0.0	3.1	1.4	0.1	0.8	1.2	5.0	10.9	5.1	0.0	5.9	3.6
	SE	-	0.4	0.5	0.3	0.6	0.3	0.9	0.7	0.8	-	1.0	0.5

