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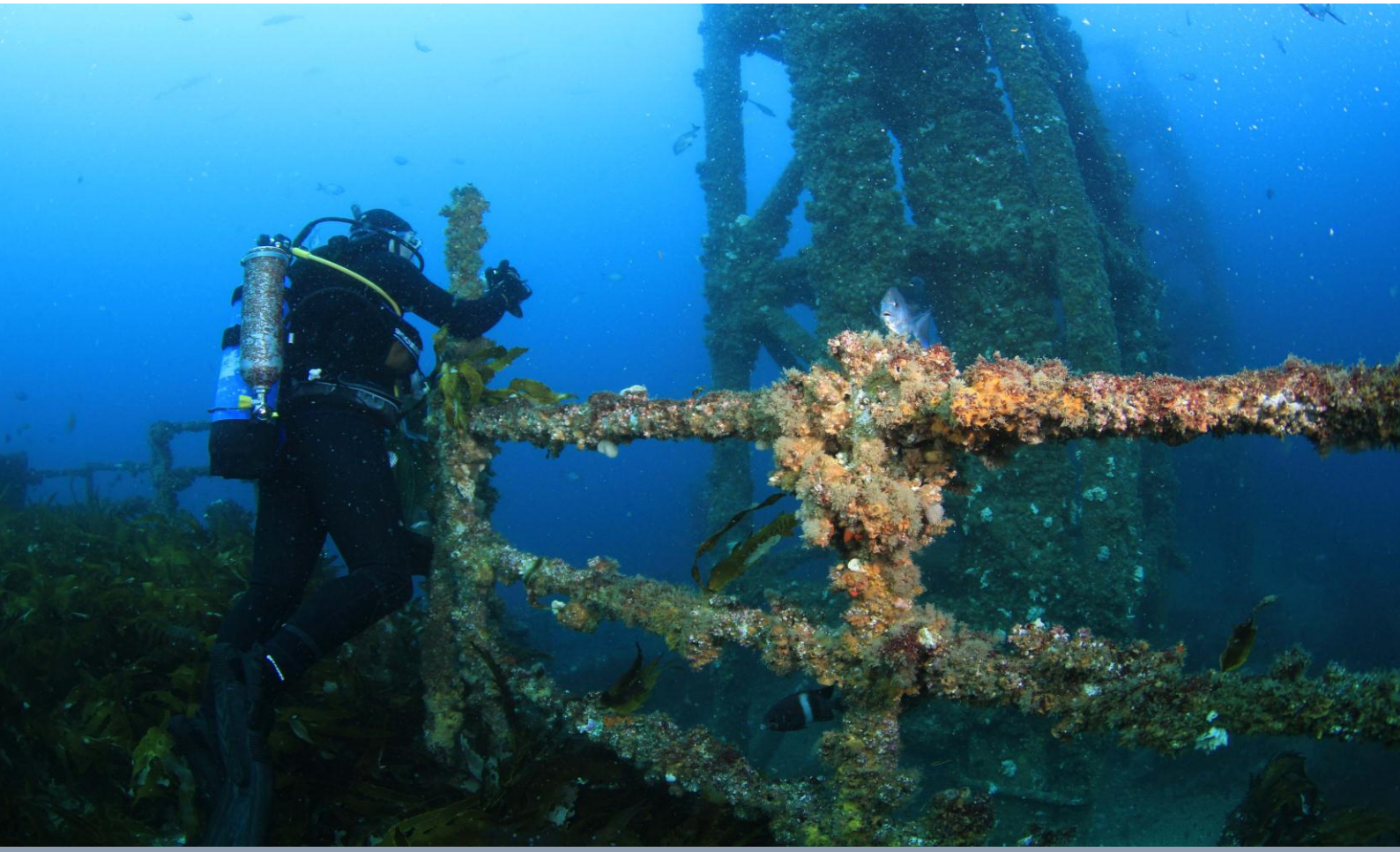

Ex-HMAS Adelaide Artificial Reef

Reef Community Monitoring

Survey 6

Job Number: EL1112024 I

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Cover Image: Main mast of the Ex-HMAS Adelaide, January 2013. Photographer, Chris Roberts (Cardno Ecology Lab).

Document Control

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Executive Summary

Cardno (NSW/ACT) trading as Cardno Ecology Lab Pty Ltd was commissioned by the Department of Primary Industries – Catchments and Lands, to undertake the post-scuttling environmental monitoring for the Ex-HMAS Adelaide artificial reef and dive site.

A comprehensive environmental assessment has been undertaken for the project in accordance with state and federal environmental legislation. This included approval under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) and obtaining an Artificial Reef (or Sea Dumping) Permit issued under the *Environment Protection (Sea Dumping) Act 1981* from the federal Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC). A condition of the Permit is that the Department of Primary Industries – Catchments and Lands must implement the proposed Long Term Monitoring and Management Plan (LTMMP) prepared in March 2011.

This Progress Report outlines the methodology and findings of Reef Community Monitoring Survey 6 (**Table ES 1**), the sixth of eight reef community surveys required as part of the LTMMP. These surveys are carried out on a quarterly basis. The aims of the reef community survey as outlined in the LTMMP were to gain an understanding of:

- Types of flora and fauna assemblages present;
- Rate of development of fouling assemblages and how they change over time;
- Variation in the rates at which assemblages develop on different surfaces of the vessel; and
- Presence of introduced or pest species.

Field surveys were carried out on 16 and 17 January 2013. Survey methods involved using divers to take photoquadrats and under water video transects on different parts of the ship. Photoquadrats were analysed for percentage cover of encrusting biota using Coral Point Count with Excel extensions (CPCe) and compared with the previous Monitoring Surveys. Underwater video footage was reviewed and also used to describe the encrusting reef assemblage and fish species present.

Analysis of photoquadrats taken from different parts of the ship showed that the number of individual taxa or groups of taxa (36 recorded in total) had decreased slightly since the previous survey (Survey 5), although the assemblage has become less variable and more uniform over the ship as a whole.

In general, similar taxa to that observed in the previous survey were recorded in Survey 6, with the serpulid, barnacle and encrusting algal matrix being numerically abundant, although there appeared to have been noticeable increase in the percent cover of an encrusting orange bryozoan and white papillate sponge. Other taxa/groupings that were well represented during the survey (and have been abundant in previous surveys) included the ascidian *Herdmania momus,* the common kelp *Ecklonia radiata* and large barnacles, covered in sediment and brown filamentous algae. Several taxa/groupings not previously documented on the ship, but which were recorded during Monitoring Survey 6, included white tubular sponges, unidentified globular ascidians and dead barnacles.

Analysis of spatial differences and comparison through time indicated that the assemblage recorded on the ship 21 months post-scuttling was significantly different to that in previous surveys, although there were similarities in some of the spatial patterns. Orientation continued to be an important factor in structuring the reef assemblage, with horizontal deck and vertical hull surfaces being consistently different from one another for both Surveys 5 and 6. Depth was also found to be a major driver in the differences seen on various parts of the ship, with the deeper hull sections being consistently different from the shallower vertical surfaces of the superstructure. Reef assemblages on different sections of the deck also varied consistently for both Surveys 5 and 6, with position (bow, midships or stern) continuing to be a key aspect in structuring the reef assemblage associated with the ship.

Inspection of the fixed photos indicated that the thick encrusting layer that had become established on certain parts of the ship, such as ladders and railings, has remained, although some small patches appeared to have been dislodged between Surveys 5 and 6. There also appeared to have been an increase in a light coloured sponge or encrusting bryozoan, mainly on the more vertical surfaces of the hull and superstructure. All surfaces are now covered with an encrusting assemblage of barnacles, ascidians, bryozoans, sponges, and algae.

Fish abundance and species richness observed around the Ex-HMAS Adelaide has generally increased over the past year, although the number of species recorded during the current survey (19) was slightly lower than that recorded in Survey 5 (23) despite the occurrence of a new species of leatherjacket (*Eubalichthys mosaicus*). These reef associated species are common to coastal reef habitats and may have become resident to the ship as the epifaunal assemblage has developed over time. No introduced marine pests were observed during the survey.

Table ES1: Summary of Reef Community Sampling Carried Out To-Date

Survey	Sampling Dates	Timeframe
Baseline	18 April and 30 May 2011	1 week post-scuttling
Monitoring Survey 1	11 and 13 October 2011	6 months post-scuttling
Monitoring Survey 2	14 and 16 February 2012	10 months post-scuttling
Monitoring Survey 3	3 and 4 May 2012	1 year post scuttling
Monitoring Survey 4	27 July 2012	15 months post scuttling
Monitoring Survey 5	31 October and 01 November 2012	18 months post scuttling
Monitoring Survey 6	16 and 17 January 2013	21 months post scuttling

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Glossary

Artificial Reef	A structure or formation placed on the seabed for the purpose of increasing or concentrating populations of marine plants and animals or for the purpose of being used in human recreational activities.
CPCe	Coral Point Count with Excel Extensions. A software package used to analyse cover of encrusting organisms and corals.
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EP&A Act	Environmental Planning & Assessment Act 1979
Epifauna	Animals that live on the surface of the seabed
Epiphytic	Growing on the surface of.
Introduced Marine Pest	Introduced marine pests are species moved to an area outside their natural range, generally by human activities, and that threaten the environment, human health or economic values.
Macroinvertebrate	Organisms associated with sediment and retained in a sieve of 0.5 to 1.0 mm
LAT	Lowest Astronomical Tide
LTMMP	Long Term Monitoring and Management Plan
PCoA	Principle Coordinates Analyses
PERMANOVA	Permutational Analysis of Variance. A statistical routine run in Primer-E.
SIMPER	Similarity Percentage. A statistical routine run in Primer-E.

1 Introduction

1.1 Background and Aims

Cardno (NSW/ACT) trading as Cardno Ecology Lab Pty Ltd was commissioned by the Department of Primary Industries – Catchments and Lands to undertake the post-scuttling environmental monitoring for the Ex-HMAS Adelaide artificial reef and dive site.

The Ex-HMAS Adelaide was gifted from the Australian to the NSW Government for the specific purpose of scuttling the ship as an artificial reef off the Central Coast of NSW. A comprehensive environmental assessment was undertaken for the project in accordance with state and federal environmental legislation. This included approval under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) and obtaining an Artificial Reef (or Sea Dumping) Permit issued under the *Environment Protection (Sea Dumping) Act 1981* from the federal Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC).

Sea Dumping Permits ensure that appropriate sites are selected, materials are suitable and appropriately prepared, that there are no significant adverse impacts on the marine environment and that the reef does not pose a danger to marine users. A condition of the Permit is that the Department of Primary Industries – Catchments and Lands must implement the proposed Long Term Monitoring and Management Plan (LTMMP) which was prepared in March 2011.

The LTMMP covers environmental and structural monitoring for the first five years post-scuttling and forms the basis for ongoing monitoring and maintenance over the operational life of the vessel as a dive site, which is estimated to be 40 years. The frequency of monitoring and the methodologies used will be reviewed periodically during the life of the Plan. The scope of work to be carried out by Cardno Ecology Lab is for a two year period post-scuttling, which follows on from initial baseline investigations carried out by Worley Parsons in April/May 2011. It includes the following environmental monitoring components:

- Reef communities;
- Sediment quality; and
- Bioaccumulation studies.

This Progress Report outlines the methodology and findings for the sixth of eight reef community surveys. These surveys are to be carried out on a quarterly basis.

The aims of the reef community monitoring survey, as outlined in the LTMMP, is to gain an understanding of:

- Types of flora and fauna assemblages present;
- Rate of development of fouling assemblages and how they change over time;
- Variation in the rates at which assemblages develop on different surfaces of the vessel; and
- Presence of introduced or pest species.

This progress report outlines the following:

- Description of sampling dates, times, weather conditions and tidal height;
- Description of the methods used including the position of the fixed transects and photoquadrats;
- Results including interpretation of video footage, fixed point photographs and CPCe analyses;
- Statistical analyses of photoquadrats over time and spatially;
- Identification of fish, threatened or protected species and any introduced or marine pest species observed during the survey;
- Discussion of findings; and
- Reports of any condition or occurrence that may influence results of the study.

1.2 Study Site and Vessel

The Ex-HMAS Adelaide artificial reef and dive site is located within Bulbaring Bay, approximately 1.87 km offshore from Avoca Beach. The ship lies at a depth of approximately 32 m to 34 m of water at Lowest Astronomical Tide (LAT) and is embedded 1 m – 2 m into the flat, sandy, seabed.

There is a minimum of 6 m of sand overlying bedrock. The vessel is orientated with the bow facing into the prevailing ESE swell direction (**Figure 1**). Approximate depths to various levels on the ship from Lowest Astronomical Tide (LAT) are shown in Figure 2.

The ship is 138.1 m in length, with a beam of 14.3 m and an original displacement of 4,200 tonnes. The hull is made of steel and the superstructure of aluminium alloy. Heights from the keel are approximately 12 m to the main deck, 18 m to the bridge, 24 m to the top of the foremast (the mast closest to the bow), and 39 m to the top of the mainmast (NSW Government 2011).

Preparation for scuttling involved the removal of the main mast structures for safety and navigation reasons and stripping of machinery, hatches and any items that could pose a risk to divers or the environment. Potential contaminants such as fuels, oils, heavy metals, batteries and electrical items containing polychlorinated biphenols (PCBs) were removed. Diver access holes were cut into the sides of the hull, floors and ceilings to allow extra vertical access between decks and also to allow light to penetrate. Further holes were also made to allow air to escape during the scuttling process (NSW Government 2011).

The Ex-HMAS Adelaide was prepared to meet DSEWPaC standards which were specified during the months of preparation prior to scuttling. DSEWPaC had conducted a series of inspections to confirm that its detailed requirements were achieved. The original clean-up process included removing loose or flaking paint in accordance with DSEWPaC's requirements.

1.3 Previous Surveys

1.3.1 Baseline Survey

The Ex-HMAS Adelaide was scuttled on the 13 April 2011. A baseline investigation of reef communities was carried out between the 18 April and 30 May 2011 (Worley Parsons 2011), immediately post-scuttling. In accordance with the methodology outlined in the LTMMP, underwater video and still photography was taken along horizontal and vertical transects of the ship using divers. These were sampled as follows:

- Horizontal Hull = 6 transects in total (3 x 100 m transects along the starboard and port planes).
- Vertical Hull = 4 transects in total (2 x starboard (stern and bow), 2 x port (stern and bow)).
- Horizontal Deck = 6 transects in total (2 x 50 m transects at the bow, mid ship and stern).

Qualitative surveys of the superstructure were also undertaken.

As expected, marine growth on the vessel was minimal, consisting of green foliose algae and calcareous casings of serpulid polychaete worms, although these were thought to have colonised the lower part of the vessel's hull while docked for preparation prior to scuttling. A light covering of algae and bryozoans was noted on the horizontal (deck) surface of the vessel approximately two weeks post-scuttling, otherwise the superstructure was bare. Three species of juvenile fish including blennies (Blenniidae), goatfish (Mullidae) and bannerfish (Chaetodontidae) were recorded around the vessel although their abundance was not reported.

As for the current study, SCUBA divers were limited to working to a maximum depth of 30 m (as per Australian Standard AS 2815: Training and Certification of Occupational Divers) and as the lowest point of the vessel sits at approximately 33.9 m (LAT), samples could not be collected from the bottom section of the hull. Horizontal transects along the hull were within 1 m of each other and did not provide the vertical spread across the hull as intended. Furthermore, in adverse weather conditions, horizontal surveys of the hull proved difficult due to surges and time restrictions. An alternative design to that specified within the LTMMP was therefore recommended whereby six additional transects (50 m length) were taken on the deck of the ship which is at approximately 28 m LAT, and can therefore be sampled at all tides. In summary, the following recommendations were made for future monitoring surveys:

- Horizontal Hull transects be limited to a single 100 m transect along the horizontal plane on either side of the vessel; and
- Additional vertical transects be taken on either side of the super structure.

Adjustments to the sampling methodology from that outlined in the LTMMP were therefore made to subsequent monitoring surveys. Additional transects were added to the superstructure to provide a greater vertical range, while some of the deeper horizontal transects were not surveyed. The sampling design was modified to allow for more robust statistical analyses to be undertaken.

1.3.2 Monitoring Survey 1

Following the baseline survey, the first monitoring survey was carried out over a two-day period on 11 and 13 October 2011. Analysis of photoquadrats taken from different parts of the ship indicated that at approximately six months post-scuttling, spatial differences in community assemblages were evident. This was particularly apparent among transects sampled from the deck (horizontally orientated) and hull (vertically orientated) surfaces, which were significantly different from each other, mainly due to differences in abundance of serpulid and serpulid/barnacle matrices. Visual comparison of photoquadrats between the baseline and monitoring survey 1 showed that the majority of the ship's surface had changed from being virtually bare to completely covered in encrusting organisms including serpulid polychaetes, barnacles, ascidians, encrusting algae, bryozoans and hydroids.

Fish abundance and diversity observed around the Ex-HMAS Adelaide had also increased substantially. A total of three species; from three families were initially observed in the baseline survey. A total of 19 species from 16 families were observed during the first monitoring survey. The most common species of fish were eastern fortesque (*Centropogon australis*) and yellowtail scad (*Trachurus novaezelandiae*), but also observed were a mixture of resident reef-associated species and transient visitors which are typical of temperate natural reef habitats. No introduced marine pests or species that are protected under conservation legislation were observed during the first survey.

1.3.3 Monitoring Survey 2

Approximately 10 months post-scuttling, there was a small increase in the number of individual taxa or groups of taxa, including red and brown algae, anemones and sponges not previously recorded. Throughout the ship a matrix of barnacles, sediment and brown filamentous algae provided the greatest cover, followed by a matrix of serpulid tubes covered with trapped sediment and turfing brown algae. Large barnacles, sediment, brown filamentous algae and the brown macroalgae *Ecklonia radiata*, had the next greatest percentage cover. Analysis of spatial differences and comparison through time indicated that the assemblage recorded on the ship in February 2012 was significantly different to that in October 2011, although the effect of time was not consistent among parts on the ship. Fish abundance and species richness observed around the Ex-HMAS Adelaide did not appear to have increased since the previous survey, although several new species including tarwhine (*Rhabosargus sarba*), girdled scalyfin (*Parma unifasciata*) and yellowtail kingfish (*Seriola lalandi*) were recorded, some of which were likely to be seasonally abundant at the time of survey.

1.3.4 Monitoring Survey 3

The colonisation of the Ex-HMAS Adelaide, approximately one year post- scuttling, was substantial and the assemblage that had formed was consistent with observations on similar artificial structures on the east coast of Australia and abroad. Analysis of photoquadrats taken from different parts of the ship showed that the number of individual taxa or groups of taxa (32 recorded) was similar to that of previous surveys, although several taxa not previously recorded were observed in the current survey. The most abundant group throughout the survey was the serpulid polychaete, barnacle and encrusting algal matrix. Several new taxa/groups were also recorded. Analysis of spatial differences and comparison through time indicated that the assemblage recorded on the ship was significantly different to that in previous surveys, although the effect of time was not consistent among parts of the ship. The encrusting layer had become notably thicker on certain parts of the ship since the previous survey. Kelp (*Ecklonia radiata*) and red branching algae has continued to grow substantially on parts of the ship (particularly the mid deck) since the previous survey. Fish abundance and species richness observed around the Ex-HMAS Adelaide had not increased substantially since the previous survey, although several new species were recorded.

1.3.5 Monitoring Survey 4

Fifteen months post-scuttling the entire ship was covered with an encrusting layer of serpulid polychaete tubes, barnacles, encrusting bryozoans, sponges and ascidians among other groups. Taxa/groupings that were well represented during the fourth survey included the ascidian *Herdmania momus,* large barnacle, sediment and brown filamentous algae matrix and turfing brown algae, sediment and serpulid matrix. New taxa included an orange colonial ascidian (likely to be *Botryloides leachi*) and a purple sponge, although these groups were present in low abundances. Overall, there appeared to be a transition from an assemblage numerically

dominated by an encrusting serpulid matrix to that dominated by barnacles and ascidians. Analysis of spatial differences and comparison through time indicated that the assemblage recorded on the ship was significantly different to that in previous surveys, although there were similarities in some of the spatial patterns with orientation continuing to be an important factor in structuring the reef assemblage. Inspection of the fixed photos indicated that the encrusting layer had become marginally thicker on certain parts of the ship such as ladders and railings, but not on others. Fish abundance and species richness decreased in comparison with the earlier monitoring survey although two new species (batfish (*Platax* sp.) and dusky flathead (*Platycephalus fuscus*)) were recorded in survey 4.

1.3.6 Monitoring Survey 5

Survey 5 showed that the number of individual taxa or groups of taxa of sessile benthic biota had increased since previous surveys, although the assemblage was becoming less variable and more uniform over the ship as a whole. Similar taxa to those observed in the previous survey were recorded, with the serpulid, barnacle and encrusting algal matrix being numerically abundant, although there appeared to have been an increase in the percent cover of *Ecklonia radiata*, large barnacles and the bryozoan *Biflustra perfragilis*. Several taxa/groupings not previously documented on the ship included two new categories of colonial ascidians and a polyplacophoran (chiton). Analysis of spatial differences and comparison through time indicated that the assemblage recorded on the ship 18 months post-scuttling was significantly different to that in previous surveys, although there were similarities in some of the spatial patterns. Orientation continued to be an important factor in structuring the reef assemblage, with deck and hull surfaces being consistently different. Reef assemblages on the deck surfaces of the ship also varied consistently through time, with position (bow, midships or stern) being an important factor, although this was also dependent on whether transects were on the port of starboard side of the ship. Fish abundance and species richness has generally increased over the past year and several new species not previously recorded were observed. These included eastern hula fish (*Trachinops taeniatus*), schooling bannerfish (*Heniochus diphreutes*), blotched hawkfish (*Cirritichthys aprinus*), eastern kelpfish (*Chironemus marmoratus*), rock cale, (*Crinodus lophodon*), comb wrasse (*Coris picta*) and six spined leatherjacket (*Meuschenia freycineti*). A pair of eastern blue groper (*Archoerodus viridis*) (protected under the NSW *Fisheries Management Act 1994*) were also observed in this survey.

A summary of sampling dates and surveys carried out to date is provided in **Table 1** below:

Table 1: Summary of Reef Community Sampling Carried Out To-Date

Survey	Sampling Dates	Timeframe
Baseline	18 April and 30 May 2011	1 week post-scuttling
Monitoring Survey 1	11 and 13 October 2011	6 months post-scuttling
Monitoring Survey 2	14 and 16 February 2012	10 months post-scuttling
Monitoring Survey 3	3 and 4 May 2012	1 year post scuttling
Monitoring Survey 4	27 July 2012	15 months post scuttling
Monitoring Survey 5	31 October and 01 November 2012	18 months post scuttling
Monitoring Survey 6	16 and 17 January 2013	21 months post scuttling

Boundary of Dive Site	Easting (MGA 94)	Northing (MGA 94)
A	356428.713	6296117.693
B	356538.438	6296341.142
C	356850.615	6296188.618
D	356742.410	6295963.310

Figure 1: Location of Ex-HMAS Adelaide Artificial Reef and Dive Site. The approximate location and orientation of the ship is indicated by the yellow line.

2 Study Methods

2.1 Field Methods

2.1.1 Photoquadrats

Line transects were demarcated along vertical and horizontal planes of the ship on the hull, superstructure and deck. These transects were based on those used for the previous monitoring survey. Cable ties used in the baseline survey to mark transects were located to ensure the same transects were sampled. Fluorescent pink flagging tape was also added to help locate the same transects in future surveys where needed. Within each line transect, replicate photoquadrats (50 x 50 cm) were taken to sample reef assemblages colonising different parts of the ship. In total, 82 photoquadrats and 16 line transects were sampled. These included:

Horizontal Hull

- x 2 transects in total: (1 x 100 m transects along the starboard and port planes).
- x 12 photoquadrats in total (x 6 photoquadrats along each side).

Vertical Hull

- x 4 transects in total: (portside stern x 1), (portside bow x 1), (starboard stern x 1), (starboard bow x 1),
- x 20 photoquadrats in total (x 5 photoquadrats along each vertical transect).

Vertical Superstructure

- x 4 transects in total: (portside stern x 1), (portside bow x 1), (starboard stern x 1), (starboard bow x 1),
- x 20 photoquadrats in total (x 5 photoquadrats along each vertical transect).

Deck

- x 6 transects in total (2 x 50 m transects at the bow, 2 x mid ship and 2 x stern).
- x 30 photoquadrats in total (x 5 per transect).

The approximate locations of all transects are indicated on **Figure 2**.

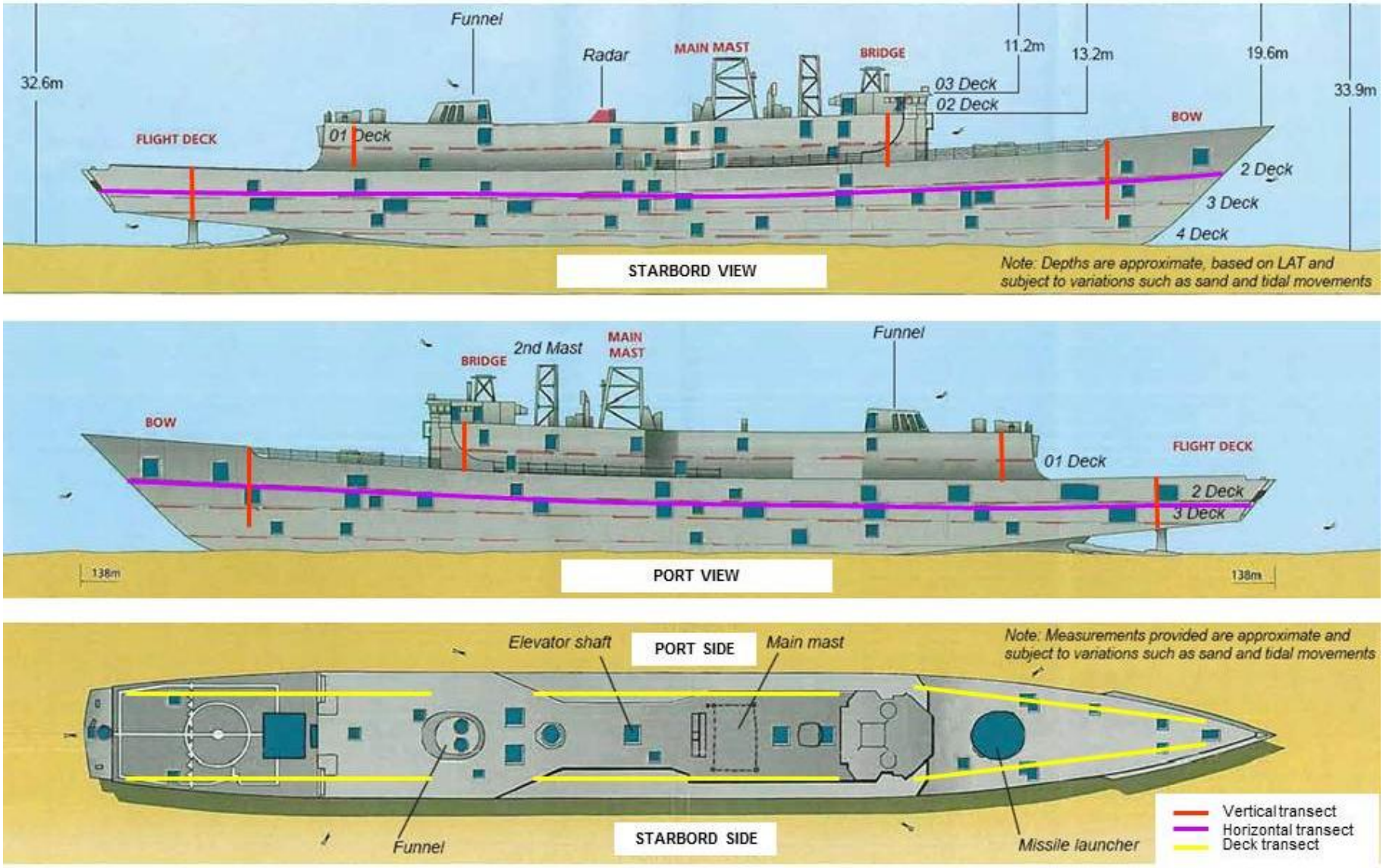

Figure 2: Plans of the Ex-HMAS Adelaide and Positions of the Reef Community Survey Sampling Transects.

Photoquadrats were acquired at regular intervals along each transect. For the vertical transects this was approximately every 0.5 metres. This was originally every metre, however, the 30 m depth limit for divers meant the number of replicate photoquadrats was restricted, therefore photoquadrats were taken every 0.5 metres.

For horizontal hull transects this was approximately every 6 m and for the deck and superstructure every 10 m (consistent with earlier surveys). Photographs were taken with a Canon G12 digital still camera which provides high quality (10MP) photographs. Photographs of individual taxa were taken to aid in identification and the interpretation of the video transects and photoquadrats. Fish species encountered were also photographed where possible.

2.1.2 Fixed Point Photographs

Photographs were taken at 10 fixed point locations. This was to provide a qualitative record of changes to reef assemblages over time. Notes were taken on the exact location, distance from the structure or reference point and depth at which the photographs were taken (**Appendix A**).

2.1.3 Video Transects

Video footage covered the same transects used for the photoquadrat survey. Divers used underwater scooters, enabling them to maintain a constant slow speed and depth while filming along the proposed transects. Video was taken on Canon G12 still cameras set to HD video mode or a Sony miniDV HD camcorder. The video footage was taken at approximately 1 – 2 m from the vessel and angled at approximately 45° towards the vessel. This allowed the benthic community to be seen clearly in the foreground of the footage, while also capturing fish swimming in the background.

2.2 Analysis

2.2.1 Photoquadrats

Photographs were reviewed immediately after collection to ensure they were of suitable quality to meet the long term outcomes of the study. Where necessary, photographs were colour-corrected using Adobe Photoshop which helped filter out the green light and bring out natural colours.

Photoquadrats were analysed for percentage cover of encrusting biota (algae, bryozoans, sponges, sessile invertebrates, etc.) using Coral Point Count with Excel extensions (CPCe) (Kohler and Gill 2006). A 'virtual' photoquadrat scaled to 50 x 50 cm was digitally overlaid on each of the 82 frames (**Figure 3**). Within each photoquadrat, 100 points were placed on a 10 x 10 grid and the taxon, matrix or substratum under each point was identified visually. The total number of each was used as an estimate of percentage cover. Still photographs of different taxa were then compiled to prepare a project-specific Biota Identification Manual and project coral code file for use with CPCe. Identifications were made to the highest taxonomic level practical, although it should be recognised that species level identification of many encrusting organisms such as sponges, bryozoans and ascidians may not be feasible without further laboratory identification. In many instances, groups were described as an encrusting 'matrix' or were based on morphological characteristics such as colour or growth form. Examples of the matrix categories assigned included:

- Serpulid matrix = serpulid tubes, sediment and fine brown filamentous algae;
- Barnacle matrix = *Balanus* spp. sediment and fine brown filamentous algae;
- Large barnacle matrix = large barnacles, sediment and brown filamentous algae; and
- Serpulid/barnacle matrix = Mixture of serpulid tubes and barnacles with a layer of encrusting red algae.

QA/QC checks of CPCe files and identifications were made to minimise the potential for user bias in visual identification and to ensure the accuracy and repeatability of methods.

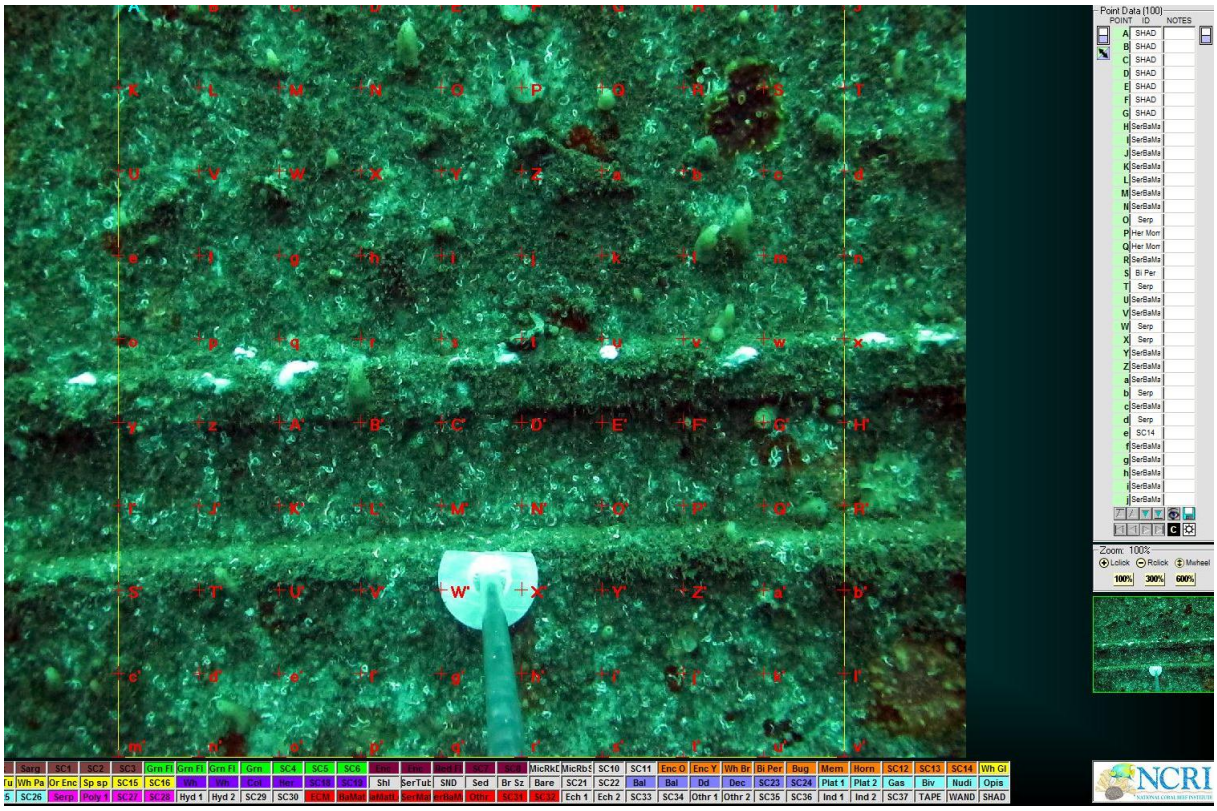

Figure 3: Screenshot of the CPCe Photoquadrat Analyses Frame with a Virtual 10 x 10 Grid Overlayed.

Analyses carried out included:

1. General findings;
2. Analysis of spatial variation in reef communities; and
3. Analyses of temporal variation in reef communities using a qualitative approach.

General Findings

General findings included a list of species, taxa or groups identified, a description of the groups identified and general trends in total percentage cover.

Spatial and Temporal Analyses

Variation in reef assemblages on different parts of the ship and over time were analysed using multivariate and univariate statistical techniques as appropriate. Due to the existing design of the sampling program (pre-determined by the LTMMP and the baseline survey) this was separated into different analyses. As data for the baseline survey was limited, no time comparisons were made between the baseline and Monitoring Survey 1. Time was added as a factor in the current analyses to investigate both spatial and temporal trends between Monitoring surveys 5 and 6. The four null hypotheses tested were:

1. No significant differences in reef assemblage structure between deep and shallow vertical transects or among times.

2. No significant differences in reef assemblage structure between port and starboard vertical transects or among times.

The design to test these hypotheses was as follows:

- Time (Survey 5/Survey 6): fixed, orthogonal;
- Depth (shallow/deep): fixed, orthogonal;
- Aspect (port/starboard): fixed, orthogonal;
- Transect: nested (depth x aspect), random.

This design compared vertical transects among the superstructure (i.e. port bow, port stern, starboard bow and starboard stern) and vertical hull at the same positions at two times.

3. No significant differences in reef assemblage structure between horizontally orientated (i.e. deck) surfaces and vertically orientated (hull) surfaces or among times.

The design to test these hypotheses was as follows:

- Time (Survey 5/Survey 6): fixed, orthogonal;
- Orientation (deck/hull): fixed, orthogonal;
- Aspect: (port/starboard): fixed, orthogonal.

This design compared transects from the deck (stern and mid, port and starboard) with the two horizontal transects along the ship's hull at the two previous times.

4. No significant differences in reef assemblage structure among positions (deck surface only) or among times.

The design to test these hypotheses was as follows:

- Time (Survey 5/Survey 6): fixed, orthogonal;
- Position (bow, mid-ships, stern): fixed, orthogonal;
- Aspect (port/starboard): fixed, orthogonal.

This design compared all transects sampled along the deck surfaces of the ship at two times.

Statistical analysis of photoquadrat data was done using PERMANOVA+ (based on Bray-Curtis similarity matrices) in PRIMER v6. This is a permutational approach to analysis of variance (ANOVA) that is superior to traditional methods (Anderson *et al.* 2008) in that there is no assumption of normality in the data and designs can be unbalanced (e.g. different numbers of replicate samples at different places or times) if necessary. The approach yields exact tests for each level of an experimental design and is robust to differences among variances. As transformation of data to achieve normality was unnecessary, percentage data were not transformed. This also avoids problems with the transformation commonly applied to percentage data that have been recently identified (Warton and Hui 2011).

Multivariate data were represented graphically using Principle Coordinates Analysis (PCoA), a generalised form of Principal Components Analysis which complements the permutational ANOVA procedure (Anderson et al. 2008). Similarity Percentage Analysis (SIMPER) was used to identify those taxa, or groups of taxa contributing most to dissimilarities between assemblages.

Differences in the dispersion of data between surveys were examined using the PERMDISP routine in Permanova+. This routine is used to separate the effects of differences in dispersion of points within clusters from differences in the relative positions of the clusters (Anderson *et al*. 2008).

Where appropriate, further univariate analyses were done using PERMANOVA+ (based on Euclidian distance) to investigate the abundance of species or taxa contributing the most to the spatial variability of samples.

2.2.2 Fixed Point Photographs

Fixed point photographs were qualitatively evaluated and compared to photos taken in similar locations during the baseline survey. It is noted, however, that due to difficulty in finding many of the original fixed points, direct comparisons were not made. Direct comparisons at the exact fixed points will be used for comparison in future surveys.

2.2.3 Video Transects

Video footage was reviewed and used to describe the encrusting reef community colonising the hull, deck and superstructure. Categories included: sessile invertebrates, mobile invertebrates, aquatic vegetation and fish. Identifications were done to the highest taxonomic level practical.

Fish observed were identified and added to the master species list for all surveys to date. Notes were made on the abundance of fish observed but no quantitative assessment of the fish assemblage associated with the ship was made in this survey.

Species of particular interest, i.e. that were observed in abundance or that were possible pests/introduced species were identified for further investigation. In future reef community surveys specimens will be brought back to the laboratory for identification.

3 Results

3.1 Photoquadrats

3.1.1 General Findings

In total, 36 categories were identified from the 82 quadrats that were sampled. Similar to previous surveys, an encrusting matrix of serpulid polychaete worms, barnacles and turfing algae was, by far, the most abundant category across the survey. Common kelp (*Ecklonia radiata*) and the ascidian *Herdmania momus*, were the next most abundant categories recorded during the survey.

Other taxa/groupings that were well represented (and have been abundant in previous surveys) included an encrusting orange bryozoan, a matrix of large barnacles, covered in sediment and brown filamentous algae, the bryozoan *Biflustra perfragilis*, white globular sponge and encrusting red algae. Several taxa/groupings not previously documented on the ship, but which were recorded during Monitoring Survey 6, included white tubular sponge, unidentified globular ascidians and dead barnacles. In general, similar taxa to that observed in the previous survey were recorded in Survey 6, although there was an increase in the percent cover of various encrusting organisms such as orange bryozoan and white papillate sponge. Categories that decreased markedly from Monitoring Survey 5 were white globular sponge and turfing brown algae.

A summary of all taxa and groups of taxa identified in the analyses of photoquadrats for the current survey is given in **Appendix B**.

Comparisons of photoquadrats among the baseline, Monitoring Surveys 1, 2, 3, 4, 5 and 6 are presented in **Plates 1 – 16**.

3.1.2 Spatial and Temporal Variation in Reef Communities

Overall, the reef assemblage sampled during Survey 6 was significantly different to those sampled during Surveys 1, 2, 3, 4 and 5 (**Appendix C**), although this was not obvious within the PCoA (**Figure 4**). Although approximately 63% of the total variation among samples appeared to be explained by the two axes within the PCoA, differences among surveys were not clear, especially samples from Surveys 5 and 6 (**Figure 4**). Pair wise tests (**Appendix D**), indicated that reef assemblages sampled during all surveys were different from each other, including those sampled in Surveys 5 and 6. PERMDISP indicated that the variability among photoquadrats analysed during Survey 5 was similar to Survey 6. This is evident in **Figure 4** which shows a similar spread of data points in both surveys (**Appendix F**). This suggests that the differences detected within the PERMANOVA test were in fact a result of differences among surveys and not from the variability (or spread) among replicate samples.

The taxa/groupings that best described the differences in assemblage structure between Survey 6 and the previous survey included serpulid, barnacle and encrusting algal matrix, which increased from 68% cover in Survey 5 to 73% cover in Survey 6, a slight increase in the percent cover of common kelp *Ecklonia radiata* from 4.8% to 4.9% and a decrease in the percent cover of large barnacle, sediment and brown filamentous algae matrix (6.2% to 3.2%) (**Appendix E**).

Orientation

The reef assemblage sampled from the hull and deck varied significantly regardless of the survey and whether they were port or starboard facing (**Appendix C**). This difference was generally due to a greater cover of serpulid, barnacle and encrusting algal matrix residing on the vertical hull surfaces and a greater cover of *Ecklonia radiata* on the horizontal deck surfaces (**Appendix E**). This is illustrated in the corresponding PCoA, which shows that approximately 76% of the total variation among samples was explained by the ordination, and that the majority of this variation (approx. 65%) was due to differences in reef assemblages between the deck and hull surfaces (**Figure 5**). Other categories/taxa that were well represented on the vertical hull surfaces included large barnacles, sediment and brown filamentous algae and the presence of the ascidian *Herdmania momus* (both of which were not recorded on any horizontally orientated surfaces). Along with the serpulid, barnacle and encrusting algal matrix, horizontally orientated surfaces (i.e. deck) were generally more characterised by red encrusting algae and common kelp *Ecklonia radiata*. Various sponges and bryozoans also contributed to differences in assemblages between the deck and hull, although representative groups of both categories could

be found on both vertically and horizontally orientated surfaces. PERMDISP indicated that the variation among samples was similar for Surveys 5 and 6 (**Appendix F**).

Depth and Aspect

In relation to the vertical transects on the hull and superstructure, significant differences in reef assemblages were detected between surveys 5 and 6, although these differences were dependent upon the individual transect (**Appendix C**). For example, the reef assemblages along transects situated at the Deep Port Stern, Shallow Port Bow, Shallow Port Stern and the Shallow Starboard Stern all showed differences between surveys 5 and 6 (**Appendix D**). In addition, significant differences in reef assemblages between both depths sampled were detected by PERMANOVA, regardless of the survey and whether the assemblages were situated on the port or starboard side of the ship (**Figure 4**, **Appendix C**). The non-significance of the PERMDISP test for depth indicates the differences in reef assemblages between depths were actual locational differences and not as a result of the variability (spread) among replicate samples taken at each depth (**Appendix F**).

The differences in reef assemblages between depths were generally as a result of a greater percent cover of serpulid, barnacle and encrusting algae matrix, and large barnacle, sediment and brown filamentous algae matrix at the deeper depth strata (**Appendix E**). In comparison, the bryozoan *Biflustra perfragilis* and the ascidian *Herdmania momus* were generally found with a greater cover at the shallower depth strata on the superstructure (**Appendix E**).

Deck Position (Bow, Midships, Stern)

Significant differences in reef assemblages among the various positions on the ship's deck surface (i.e. bow, midships or stern) were detected, and these spatial patterns were similar for both surveys and irrespective of whether the assemblages were situated on the port or starboard side of the ship (**Figure 7**, **Appendix D**). This is illustrated in the corresponding PCoA which shows that approximately 87% of the total variation among samples could be explained by the two axes in the ordination (**Figure 7**). PERMDISP indicated that the variation among samples taken from the three positions on the ship's deck were all significantly different from one another (**Appendix F, Figure 7**).

SIMPER analyses (**Appendix E**) indicated that the positional differences in reef assemblages on the ship's deck were generally due to differences in the percent cover of serpulid, barnacle and encrusting algae matrix, and common kelp *Ecklonia radiata*. When comparing the percent cover of various species between the three positions on the ship, a much greater cover of *Ecklonia radiata* (40%) was evident on the midships compared to both the bow and stern, where no cover was recorded for this species (**Appendix E**). Generally, a greater cover of serpulid, barnacle and encrusting algae matrix was found on the bow and stern of the ship (82% and 94%, respectively) compared to the midships (46%). Other taxa/groupings that contributed to the differences in reef assemblages on the deck were encrusting red algae and turfing brown algae (**Appendix E**).

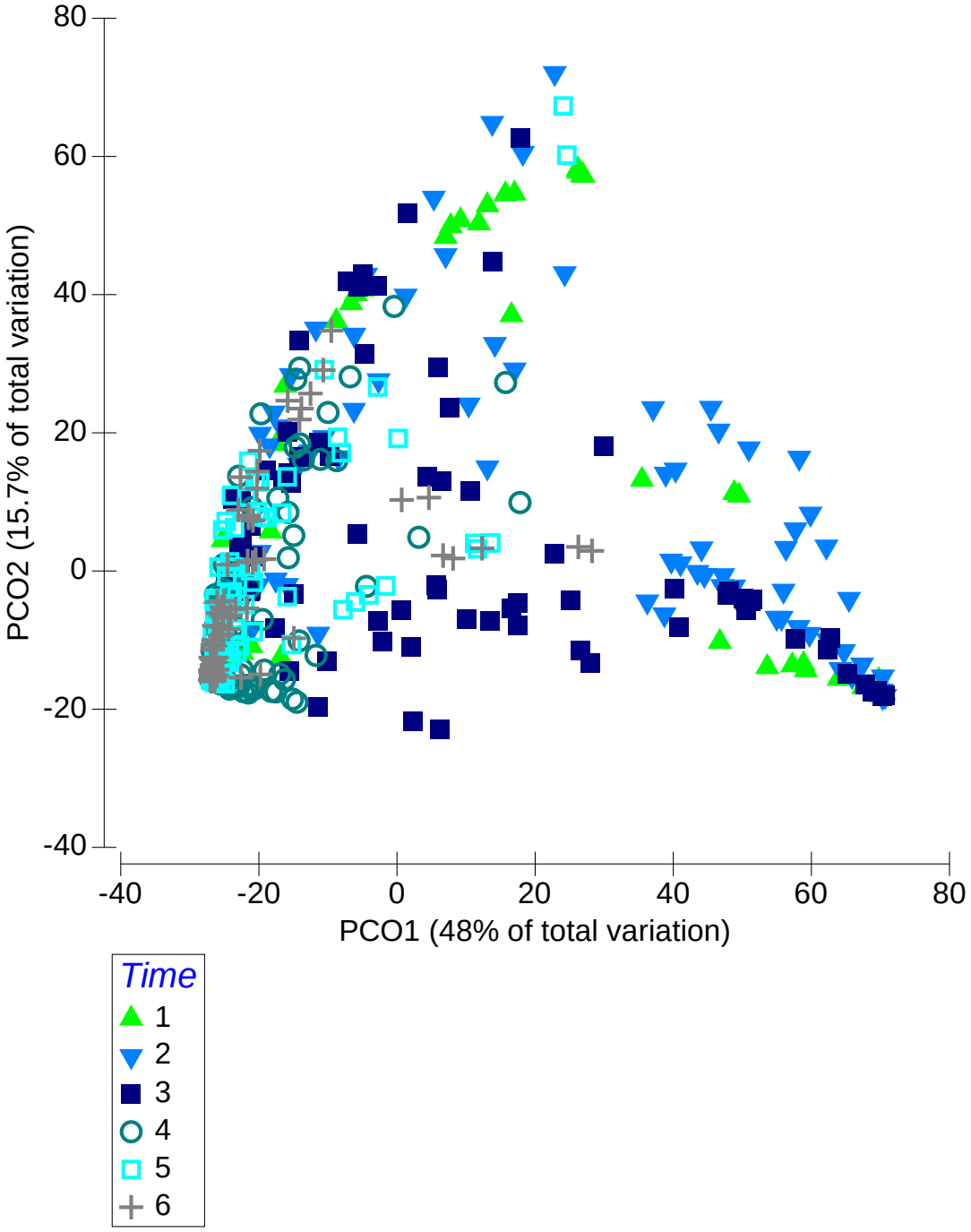

Figure 4: Principal Coordinates Analyses (PCoA) of Percent Cover of Encrusting Assemblages from Transects Taken at all Positions on the Ex-HMAS Adelaide for Surveys 1, 2, 3, 4, 5 and 6.

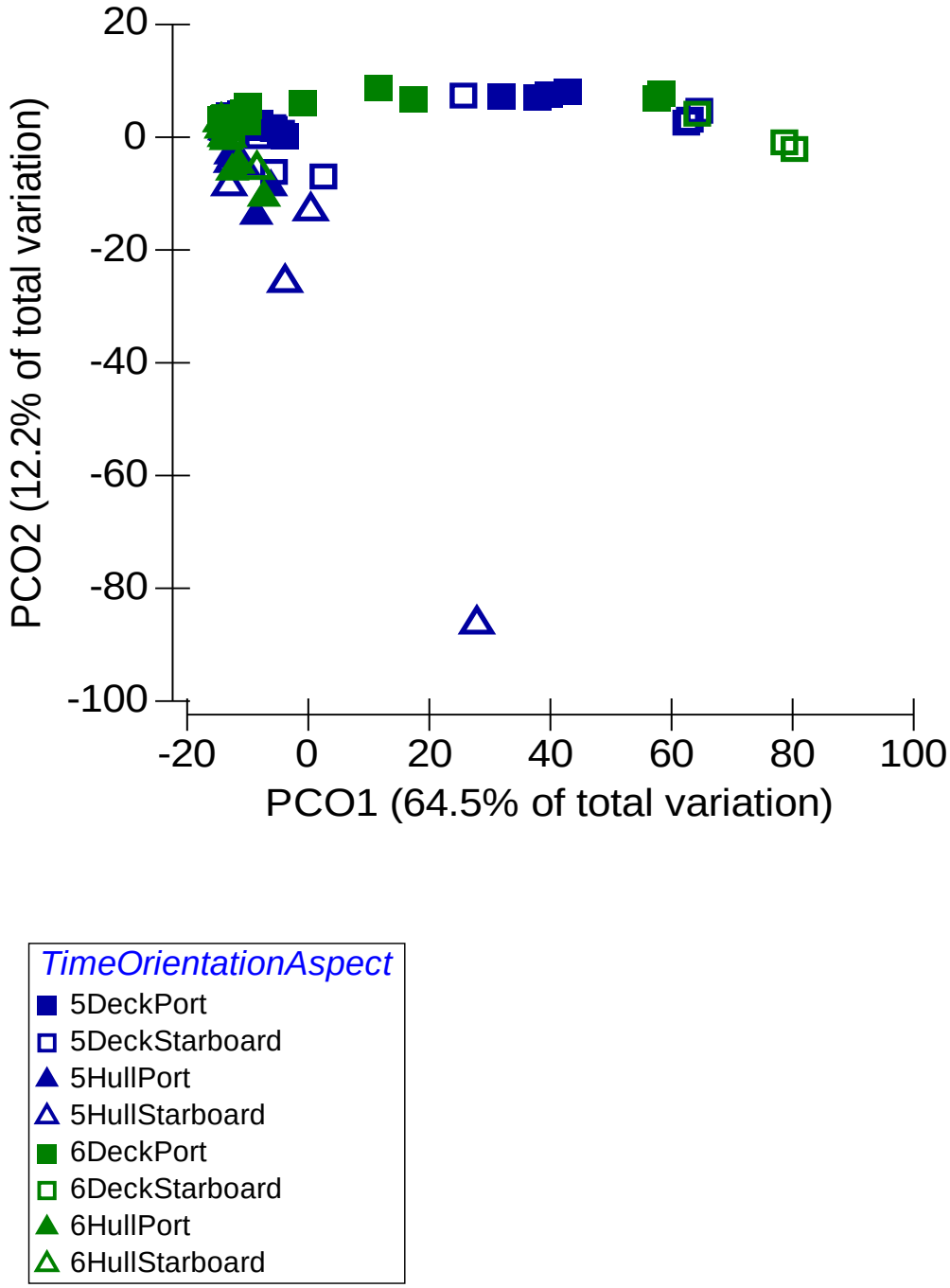

Figure 5: Principal Coordinates Analyses (PCoA) of Percent Cover of Encrusting Assemblages from Transects Taken on Hull and Deck Surfaces of the Ex-HMAS Adelaide for Surveys 5 and 6.

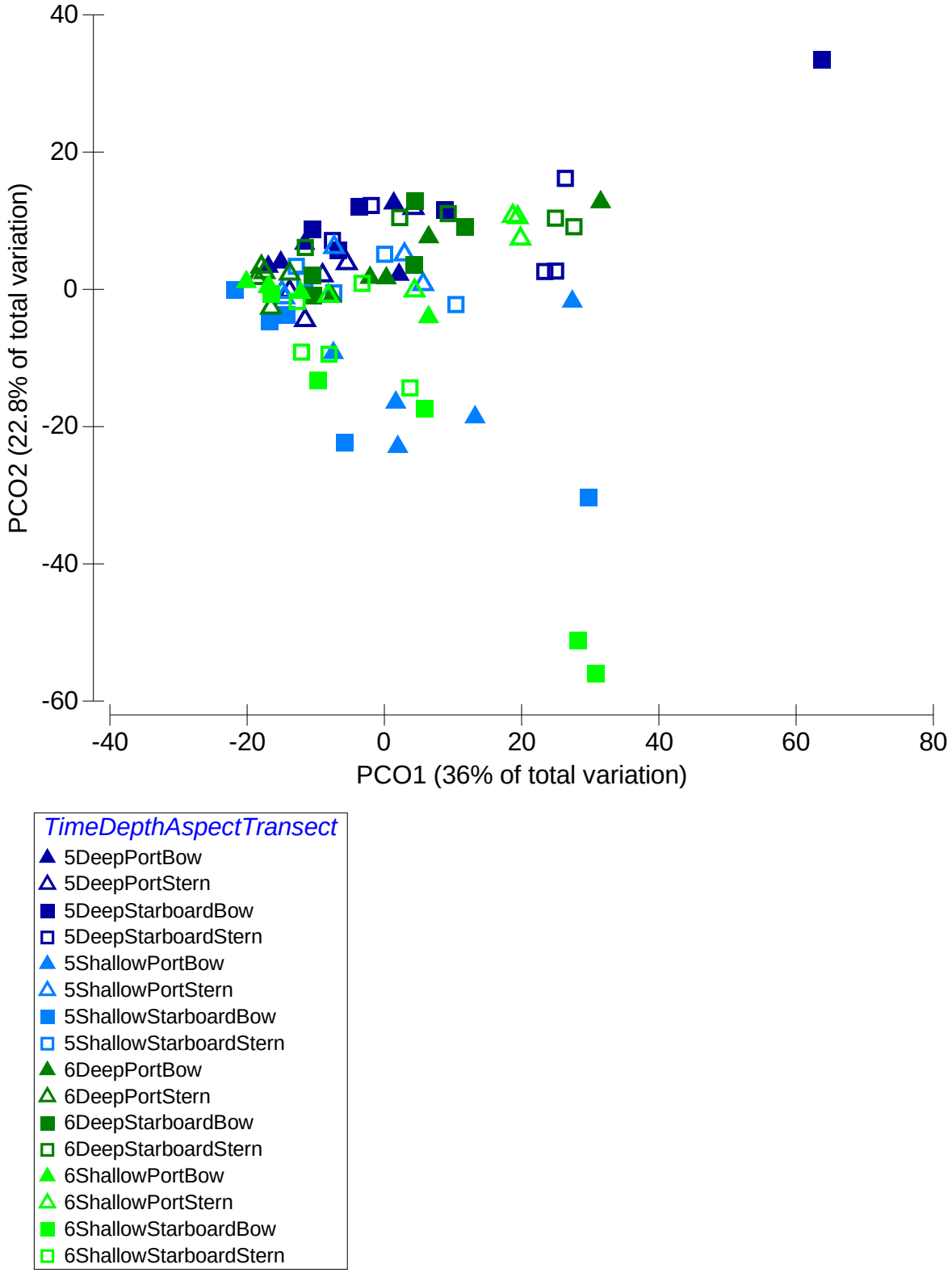

Figure 6: Principal Coordinates Analyses (PCoA) of Percent Cover of Encrusting Assemblages from Transects at Different Depths and Aspect on the Ex-HMAS Adelaide for Surveys 5 and 6.

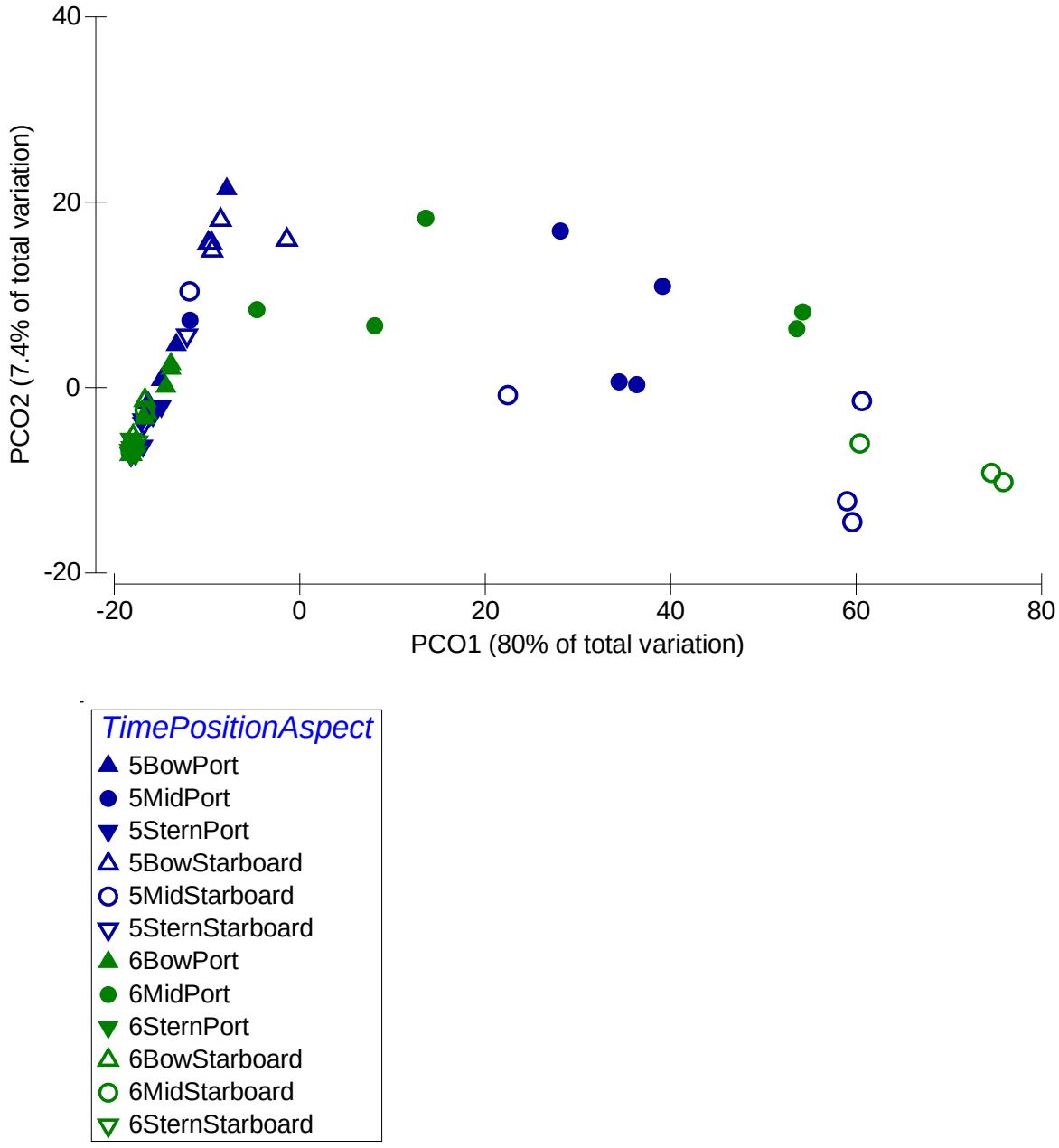

Figure 7: Principal Coordinates Analyses (PCoA) of Percent Cover of Encrusting Assemblages from Transects Taken at Different Positions on the Deck Ex-HMAS Adelaide for Surveys 5 and 6.

3.2 Fixed Photographs

Photographs taken from fixed locations are presented in **Appendix A.** Inspection of the fixed photos indicates that the thick encrusting layer that was noticeable during Survey 5 on certain parts of the ship such as ladders, railings and mast structures (e.g. fixed photographs 4, 5, 9 and 10) is still present, although some small patches showed lower cover, possibly being dislodged at some time between the last two surveys (e.g. fixed photographs 4, 5, 9, and 10). Other flat, less complex surfaces of the ship e.g. fixed photographs 1, 7 and 8 showed little change in the coverage of sessile biota between surveys 5 and 6. There appears to also have been an increase in cover of, what looks like, a light coloured sponge or encrusting bryozoan on some areas of the ship (e.g. fixed photographs 1, 2, 4, 6 and 10).

3.3 Video Transects

The results of observations made from video transects are summarised in **Table 2** below. A list of all fish observed during previous surveys and the current monitoring survey (Survey 6) are listed in **Table 3**. Species of recreational, commercial or conservation value are also indicated. One new species of fish was recorded during Survey 6 yielding a total of 19 taxa for the current survey. The new species of fish recorded was the mosaic leatherjacket (*Eubalichthys mosaicus*).

Table 2: Summary of Observations of Attached Encrusting and Fish Assemblages Observed from Video Footage of the Ex-HMAS Adelaide in January 2013 (Survey 6).

Position	Description of Assemblage
Deck Port Bow	The deck surface is heavily encrusted with growth of barnacles, encrusting algae, hydroids and fine filamentous algae. Occasional patches of bright yellow and orange encrusting and white papillate sponges can also be seen on the flat of the deck. Tarwhine (*Rhabdosargus sarba*) were abundant in schools and observed feeding. Other species of fish in this area included juvenile snapper (*Pagrus auratus*) and yellow finned leatherjacket (*Meuschenia trachylepis*).
Deck Port Mid	Kelp (*Ecklonia radiata*) fronds have continued to grow following the previous survey, particularly along the edges of the midships. An unknown bright white encrusting substance (observed in previous survey) remained present and additionally, small branching red filamentous algae was observed attached to the deck. The majority of the deck is otherwise heavily encrusted with barnacles, encrusting algae, hydroids and fine filamentous algae. The superstructure and areas of railing have become heavily colonised with ascidians, occasional branching and papillate bryozoans and sponges. Tarwhine (*Rhabdosargus sarba*) were observed feeding on the deck, with silver sweep (*Scorpis lineolata*), eastern blue groper (*Achoerodus viridis*) and crimson banded wrasse (*Notolabrus gymnogenis*) also observed.
Deck Port Stern	The deck was predominantly covered in serpulid tubes, barnacles, encrusting algae, hydroids and fine filamentous algae. Some sand and occasional patches of orange encrusting sponge and red encrusting algae were also observed along with small, but distinct clumps of green filamentous algae (although this was not evident from the photoquadrats) and white sponges. Tarwhine (*Rhabdosargus sarba*) was again abundant in schools along with juvenile snapper (*Pagrus auratus*) and a single blue morwong (*Nemadactylus douglasii*).
Deck Starboard Bow	Encrusting growth of barnacles, algae and hydroids was abundant on the flat surfaces of the deck with patches of encrusting sponges similar to previous surveys. Small, but distinct clumps of green filamentous algae (not sampled in any of the photoquadrats, or previously observed on the ship) were observed on the deck. Kelp (*Ecklonia radiata*) fronds can be seen along the internal side of the bow. Silver sweep (*Scorpis lineolata*), juvenile snapper (*Pagrus auratus*) and yellow finned leatherjacket (*Meuschenia trachylepis*) were present in small numbers.
Deck Starboard Mid	Kelp (*Ecklonia radiata*) fronds have continued to grow following the previous survey particularly along the edges of the midships. An unknown bright white encrusting substance (observed in previous survey) remained present. The majority of the deck is

	otherwise heavily encrusted with barnacles, encrusting algae, hydroids and fine filamentous algae. Additionally, small branching red filamentous algae and small branching hard corals were observed. The superstructure and areas of railing had become heavily colonised with ascidians and the occasional branching and papillate white bryozoans and sponges. Tarwhine (*Rhabdosargus sarba*) were abundant in schools and observed feeding on the deck, and in mixed schools alongside juvenile trevally (*Pseudocaranx dentex*). Silver sweep (*Scorpis lineolata*) were observed in small numbers. Several black-spot goatfish (*Parupenseus signatus*), a single eastern blue groper (*Achoerodus viridis*), rock cale (*Crinodus lophodon*), crimson banded wrasse (*Notolabrus gymnogenis*) and blue morwong (*Nemadactylus douglasii*) were also observed.
Deck Starboard Stern	Encrusting growth of predominantly serpulid worm tubes, small barnacles, encrusting algae, hydroids and fine filamentous algae covered the flat areas of the deck similar to other surveys. Patches of white sponges were also observed. Schools of tarwhine (*Rhabdoglosus sarba*) and snapper (*Pagrus auratus*) and various species of leather jacket were also observed.
Horizontal Hull Port and Starboard	The hull has become heavily colonised by sessile invertebrates on both the port and starboard sides of the ship. These included ascidians (predominantly *Herdmania momus,* but also *Botryloides magnicoecum*), large barnacles, yellow, orange and white encrusting sponges and bryozoans such as *Tryphyllozoan* sp. A white sponge has also become heavily colonised along the sides of the ship. The growth appears thickest around the gunwale, and around the edges of holes in the hull. The hull is otherwise encrusted with a layer of serpulid worm tubes covered with small barnacles, encrusting algae, hydroids and fine filamentous algae. Some bare patches were noted where the encrusting layer had broken off. Tarwhine (*Rhabdosargus sarba*), rock cale (*Crinodus lophodon*), yellow finned leatherjacket (*Meuschenia trachylepis*), girdled scalyfin (*Parma unifasciata*) and a single sergeant baker (*Aulopus purpurissatus*) laying on the deck of the ship were observed during the current survey.
Vertical Hull Bow	Similar to previous surveys, ascidians and large barnacles were generally more prevalent on the hull of the ship, in comparison to the deck surfaces, while barnacles, various encrusting and papillate sponges were also observed. Established small branching white bryozoans were infrequently observed. The vertical plane of the hull is otherwise encrusted with a layer of serpulid worm tubes covered with small barnacles, encrusting algae, hydroids and fine filamentous algae.
Vertical Hull Stern	As with previous surveys, ascidians and large barnacles were again more prevalent on the hull of the ship, in comparison to the deck surfaces, while bryozoans, sponges and clumps of small branching white bryozoans were also observed. The vertical plane of the hull was otherwise encrusted with a layer of serpulid worm tubes covered with barnacles, encrusting algae, hydroids and fine filamentous algae.
Vertical Hull Superstructure	The superstructure, including the main mast and funnel, consisted of a combination of solitary ascidians, occasional encrusting and papillate bryozoans and layer of serpulid worm tubes covered with barnacles, encrusting algae, hydroids and fine filamentous algae. Clumps of small white branching bryozoans were observed attached to the superstructure. A number of juvenile snapper (*Pagrus auratus*) were also observed in association with this structure.

Table 3: Species of Fish Observed in Association with the Ex-HMAS Adelaide Artificial Reef between April/May 2011 and January 2013. (*) = recreationally important species, (+) = commercially important species, (#) = species of conservation significance.

Family	Species Name	Common Name	Species Number (Hutchins & Swainston)	Baseline Survey (April/May 2011)	Survey 1 (October 2011)	Survey 2 (February 2012)	Survey 3 (May 2012)	Survey 4 (August 2012)	Survey 5 (October 2012)	Survey 6 (January 2013)
Aulopodidae	*Aulopus purpurrissatus*	Sergeant baker	83		●	●	●		●	●
Scorpaenidae	*Centropogon australis*	Eastern fortesque	166		●	●	●			
Scorpaenidae	*Scorpaena cardinalis*	Eastern red scorpioncod	176		●	●			●	
Platycephalidae	*Platycephalus fuscus*	Dusky flathead*+	203					●		
Serranidae	*Hypoplectrodes maccullochi*	Half-banded sea perch	225				●	●		
Plesiopidae	*Trachinops taeniatus*	Eastern hulafish	246						●	●
Dinolestidae	*Dinolestes lewini*	Longfinned pike	263		●			●		
Carangidae	*Pseudocaranx dentex*	Silver trevally	292				●	●	●	
Carangidae	*Trachurus novaezelandiae*	Yellowtail scad+	294		●			●		
Carangidae	*Seriola lalandi*	Yellowtail kingfish*#	298			●	●		●	●
Sparidae	*Pagrus auratus*	Snapper (juv)*+	310		●	●	●		●	●
Sparidae	*Rhabdosargus sarba*	Tarwhine*	311			●	●	●	●	●
Mullidae	*Parupeneus spilurus*	Blackspot goatfish	323	●					●	●
Kyphosidae	*Kyphosus sydneyanus*	Silver drummer*	346				●			
Scorpididae	*Atypicthys strigatus*	Mado	349		●	●	●	●		
Scorpididae	*Microcanthus strigatus*	Stripey	350		●	●	●			
Scorpididae	*Scorpis lineolatus*	Silver sweep*	353		●	●	●			●
Ephippidae	*Platax sp.*	Batfish	355					●		
Chaetodontidae	*Heniochus diphreutes*	Schooling bannerfish	372	●	●				●	
Enoplosidae	*Enoplosus armatus*	Old wife	376				●	●		
Pomacentridae	*Parma microlepis*	White ear	388		●			●	●	●
Pomacentridae	*Parma unifasciata*	Girdled scalyfin	393			●			●	●
Cirritidae	*Cirritichthys aprinus*	Blotched hawkfish	406						●	●
Chironemidae	*Chironemus marmoratus*	Eastern kelpfish	411						●	
Aplodactylidae	*Crinodus lophodon*	Rock cale	415						●	
Cheilodactylidae	*Cheilodactylus fuscus*	Red morwong*	416		●	●	●	●	●	●
Cheilodactylidae	*Nemadactylus douglasii*	Blue morwong*	424		●	●				●
Latridiidae	*Latridopsis forsteri*	Bastard trumpeter	427		●				●	●
Labridae	*Achoerodus viridis*	Eastern blue groper#	438		●	●	●	●	●	●
Labridae	*Coris picta*	Comb wrasse	446						●	
Labridae	*Notolabrus gymnogenis*	Crimson banded wrasse	481				●		●	●
Labridae	*Notolabrus parilus*	Brown spotted wrasse	483				●			
Blenniidae	*Petroscirtes lupus*	Brown sabretooth blenny	532	●						●
Blenniidae	*Parablennius intermedius*	Horned blenny	?							
Monacanthidae	*Monacanthus chinensis*	Fan belly leatherjacket*	636						●	
Monacanthidae	*Meuschenia freycineti*	Six-spined leatherjacket*	643						●	
Monacanthidae	*Meuschenia trachylepis*	Yellow-finned leatherjacket*	646				●		●	●
Monacanthidae	*Nelusetta ayraudi*	Chinaman leather jacket*+	648		●	●	●			
Monacanthidae	*Eubalichthys mosaicus*	Mosiac leatherjacket*	652							●
Monacanthidae	*Meuschenia spp.*	Unidentified leatherjackets	?				●	●	●	
Tetraodonitdae	*Dicotlichthys punctulatus*	Three-bar porcupinefish	682		●				●	●
Total Number of Taxa				**3**	**17**	**14**	**19**	**13**	**23**	**19**

4 Discussion

4.1 Encrusting Biota

Overall, the reef assemblage associated with the ship during Survey 6 (carried out approximately 21 months post-scuttling) was different to that sampled during earlier surveys. Fewer categories/taxa were recorded during the current survey (36) compared to that recorded during Survey 5 (41). As with previous surveys, however, results of Survey 6 show that although new categories have been recorded since the previous survey, differences among surveys were attributed to changes in percent cover of existing taxa rather than the colonisation of new taxa, which were present in low abundance. Change in percent cover of existing taxa may be a result of several biotic, density dependant interactions (such as predation and competition) and/or changes to physical conditions (e.g. from storms or seasonal fluctuations in sea temperature and current patterns). Following on from the results of Survey 5, the variability among samples remained stable and showed little difference in the spread of replicates within the current survey compared with that of the previous survey (Survey 5). This indicates that the variability among replicate samples on the ship as a whole, has become more uniform over time, which has help to alleviate any dispersion effects in the data, which may complicate the interpretation of results pertaining to temporal changes. This stabilised variability among samples within a particular survey is attributed to the succession of the underlying encrusting matrix which has become progressively colonised by barnacles and encrusting algae over the majority of the vessel.

As with previous surveys, the large majority of coverage throughout the ships surface was a matrix of serpulid worms, barnacles and encrusting algae. Other taxa/groupings that were again well represented but in lower proportions included a matrix of large barnacles, sediment and brown filamentous algae, followed by kelp (*Ecklonia radiata)* and the ascidian *Herdmania momus*. The heterogenous structure created by these organisms is likely to provide habitat for a range of invertebrates such as polychaetes, amphipod crustaceans and bivalves among others. Close up photographs and video footage showed that mobile macroinvertebrates such as gastropod molluscs, crabs and small cryptic fish (such as blennies) also inhabit the more heavily developed encrusted structures of the ship.

Analysis of photoquadrats in the current and previous surveys has shown a strong and recurrent pattern of assemblages occurring on horizontally orientated (deck) surfaces being different in composition from the vertically orientated (hull) assemblage. In the current survey, both the deck and hull surfaces were dominated by a serpulid worm, barnacle and encrusting algal matrix, although other categories/taxa that favoured vertical surfaces were large barnacles, sediment and brown filamentous algae and the presence of the ascidian *Herdmania momus*, whereas other taxa that were more likely to be found on the horizontally orientated surfaces were red encrusting algae and common kelp *Ecklonia radiata*. As discussed in previous monitoring surveys, it is possible that ascidians and large barnacles tend to proliferate on more shaded portions of the ship or possibly where there is more current to improve feeding efficiency, whereas *Ecklonia* and red encrusting algae occur where light availability is optimal.

In contrast to the previous survey (Survey 5), both depth and position on the ship (i.e. bow, midships or stern) appeared to influence the structure of the ship's reef assemblage. Taxa/groupings that were prevalent in the deeper vertical surfaces of the ship's hull included large barnacles, sediment and brown filamentous algae and encrusting orange bryozoan, whereas taxa such as the bryozoan *Biflustra perfragilis* and the ascidian *Herdmania momus* were more abundant in shallower environments such as those on the vertical surfaces of the superstructure. Deck position also showed differences in reef assemblages, although this factor is confounded by depth, as the midships deck position is situated on top of the superstructure, whereas the bow and stern deck positions are situated at the level of the flight deck in slightly deeper water. Notwithstanding this, spatial differences were evident as bow and stern reef assemblages were also found to be different with both deck positions occurring at very similar depths. By nature of the ships design and its partial burial within the seabed, there may be subtle depth differences on various sections of the deck that may influence shading on these parts of the ship, ultimately affecting the benthic assemblages residing in these areas. Differences may otherwise have been a result of changing currents and chance settlement patterns of propagules at the time of scuttling.

4.2 Fish and Macroinvertebrates

Fish abundance and species richness observed around the Ex-HMAS Adelaide has generally increased over the past year, although the number of species recorded during the current survey (19) was slightly lower than that recorded in Survey 5 (23) despite the occurrence of a new species of leatherjacket (*Eubalichthys mosaicus*). Survey 5 has still recorded the most diverse fish assemblage to date. The mosaic leatherjacket (*Eubalichthys mosaicus*) is generally reef associated and common to coastal reef habitats, suggesting that the development of the reef habitat over time may be influencing the fish assemblage in and around the ship.

It is important to note that observations of fish carried out as part of this survey were not quantitative and should be treated as indicative only. It is possible that the increased number of species observed was due to the development of the reef assemblage over time or seasonal differences, but may also be due to variation in sampling effort.

5 Acknowledgements

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7 Plates

Deck, Port Bow

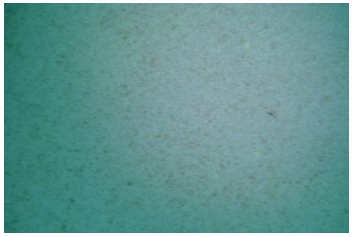
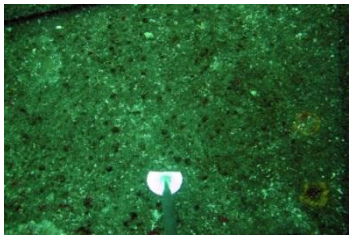
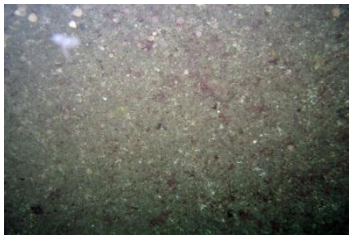
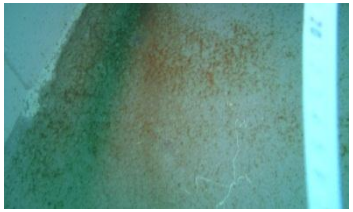
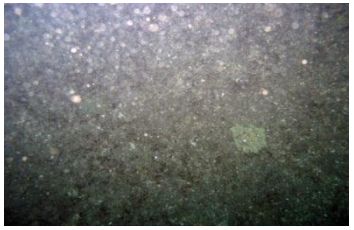
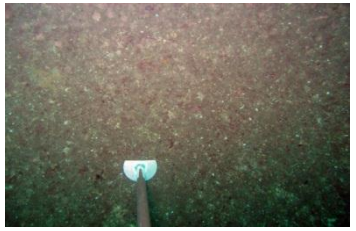
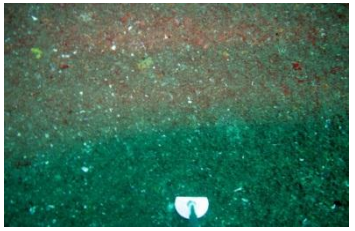
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 1: Deck port bow

Deck, Port Bow

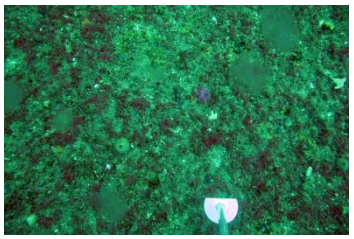
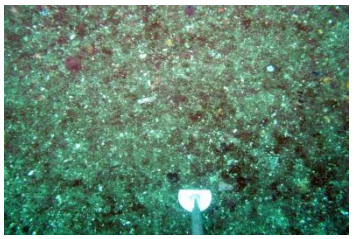
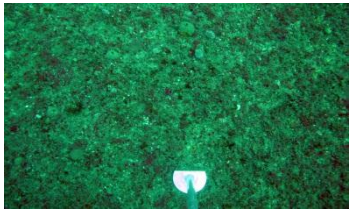
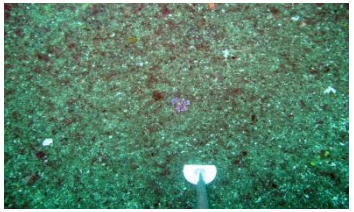
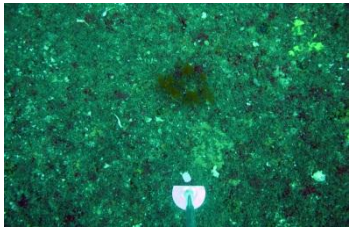
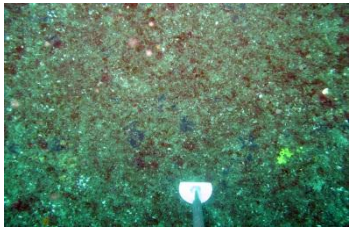
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)
	
	
	

Plate 1: Deck port bow

Deck, Port Mid

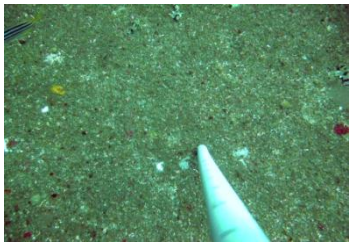
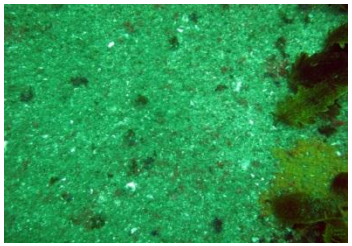
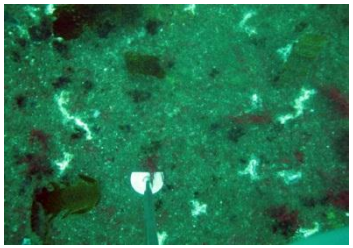
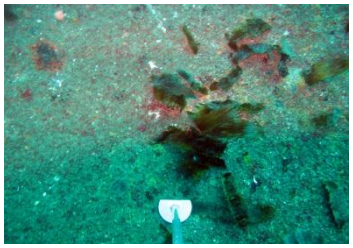
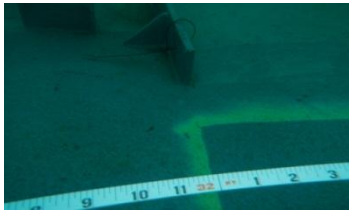
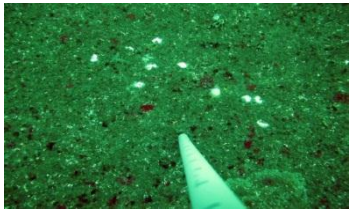
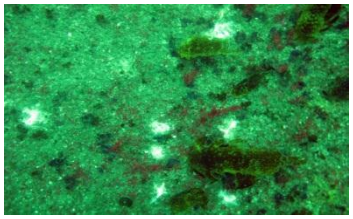
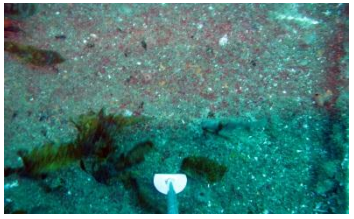
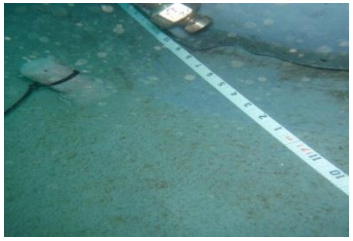
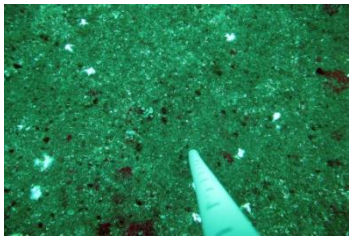
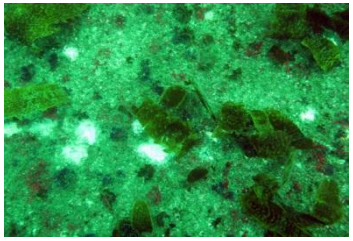
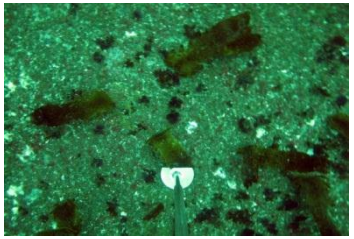
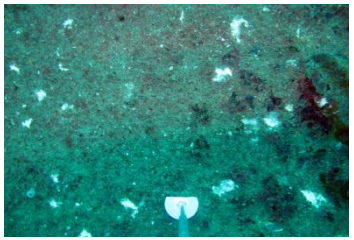
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 2: Deck Port Mid

Deck, Port Mid

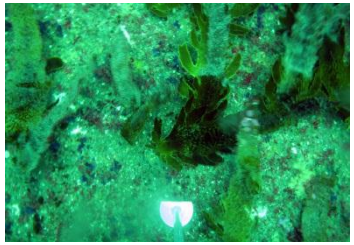
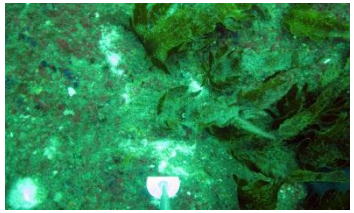
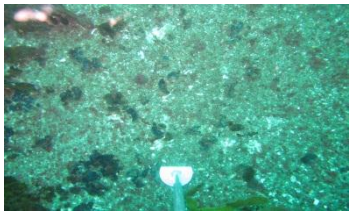
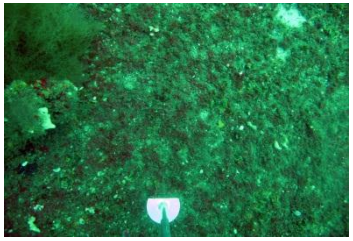
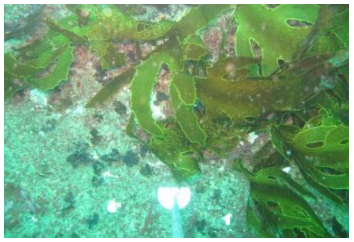
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)
	
	
	

Plate 2: Deck Port Mid

Deck, Port , Stern

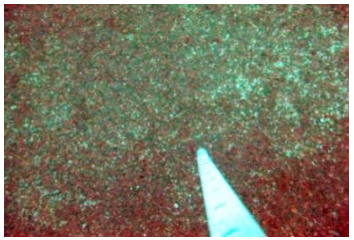
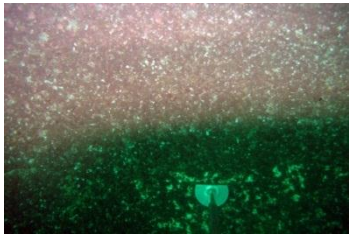
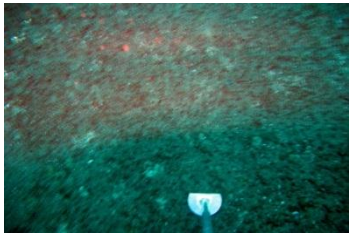
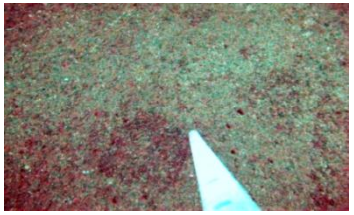
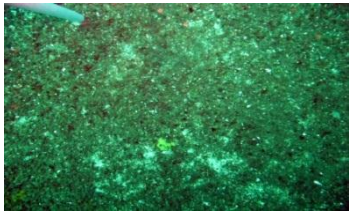
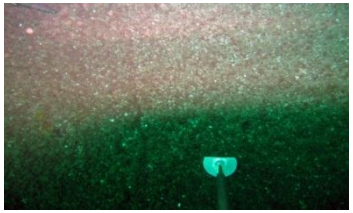
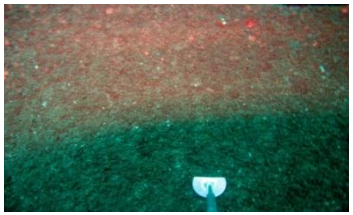
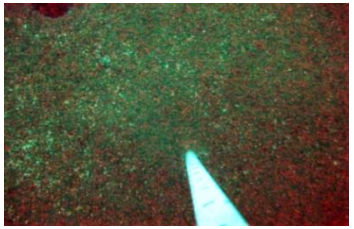
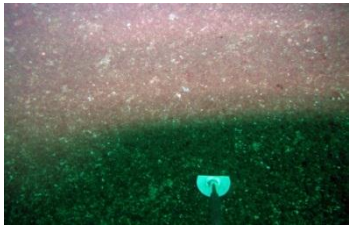
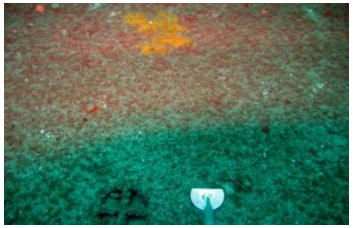
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 3: Deck Port Stern

Deck, Port, Stern

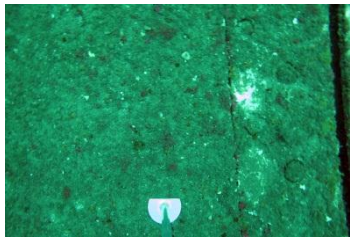
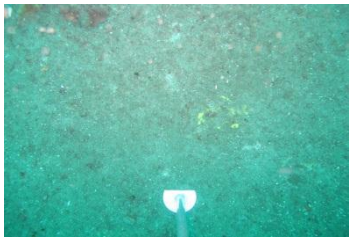
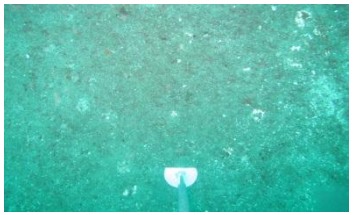
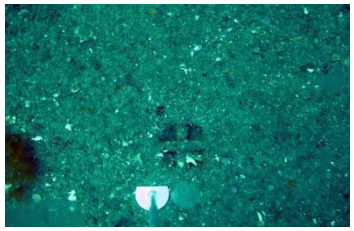
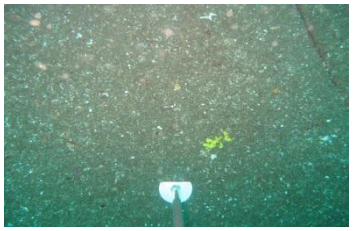
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)
	
	
	

Plate 3: Deck Port Stern

Deck, Starbord, Bow

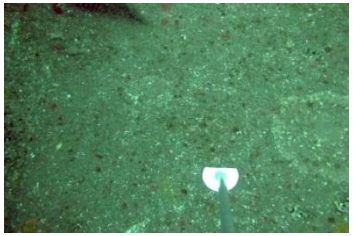
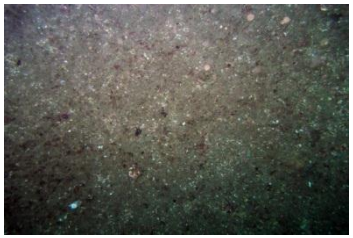
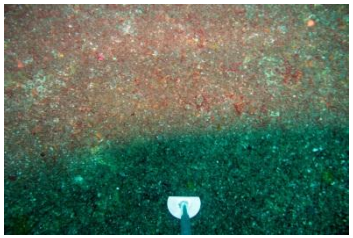
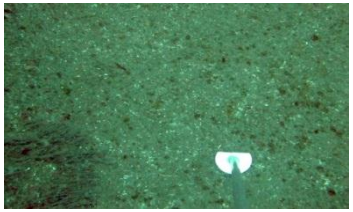
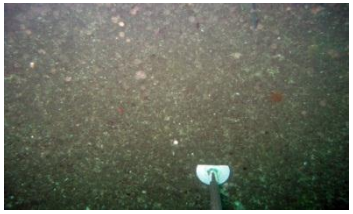
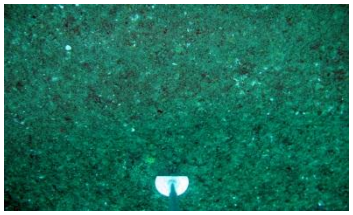
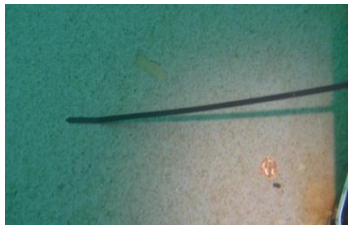
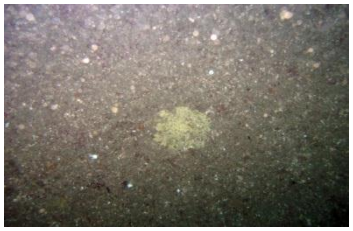
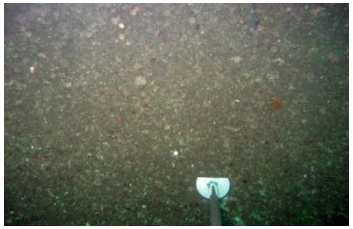
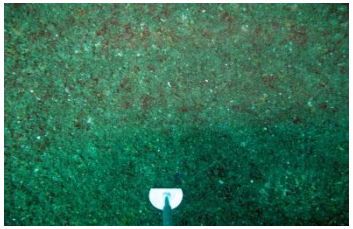
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 4: Deck Starbord Bow

Deck, Starbord, Bow

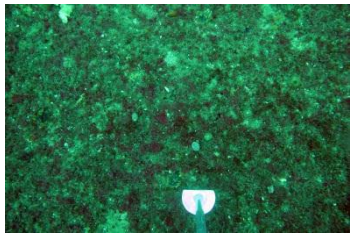
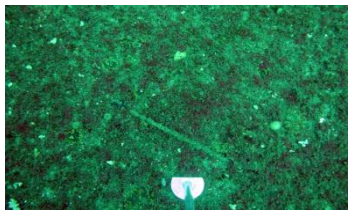
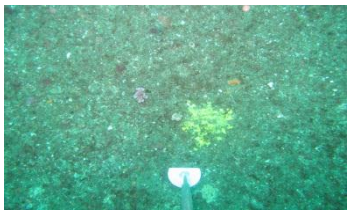
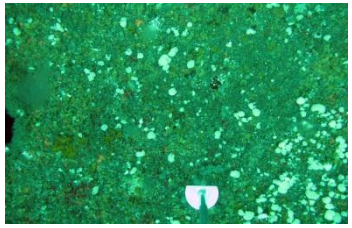
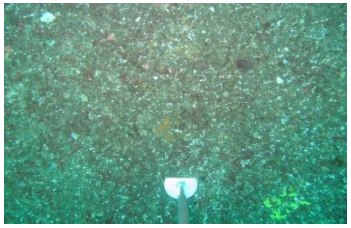
Monitoring Survey 5(October/November 2012)	Monitoring Survey 6 (January 2013)
	
	
	

Plate 4: Deck Starbord Bow

Deck, Starbord, Mid

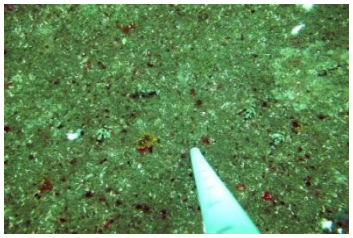
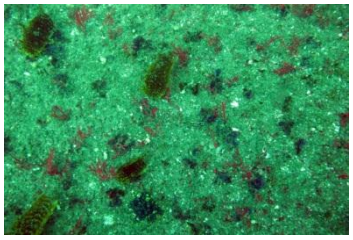
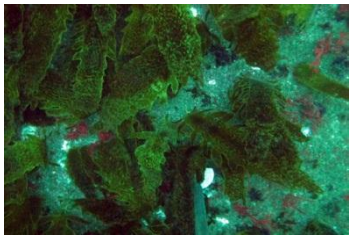
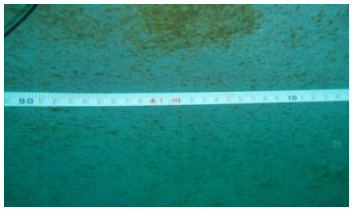
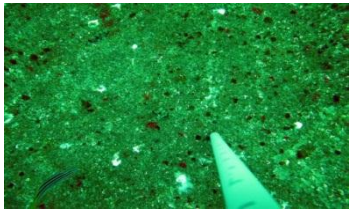
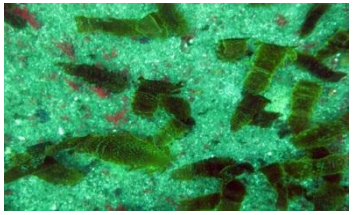
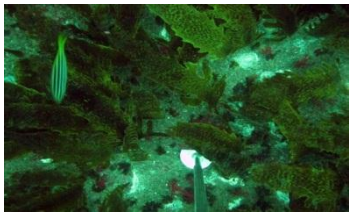
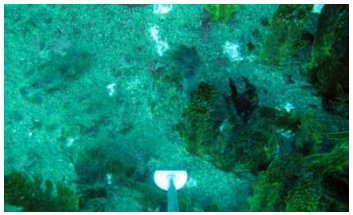
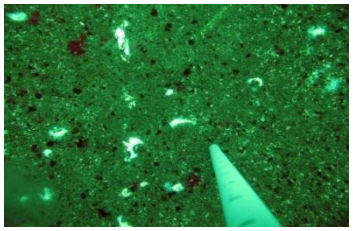
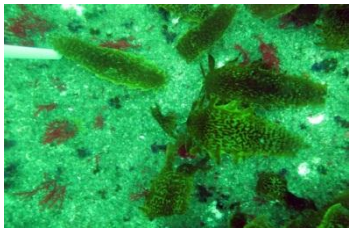
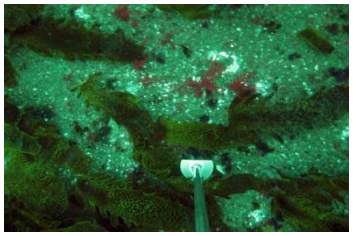
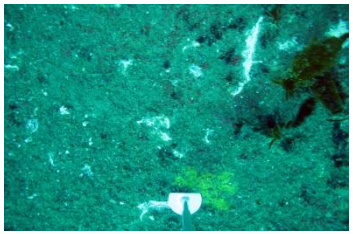
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 5: Deck Starbord Mid

Deck, Starbord, Mid

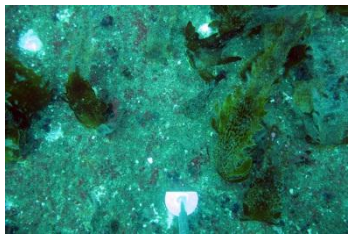
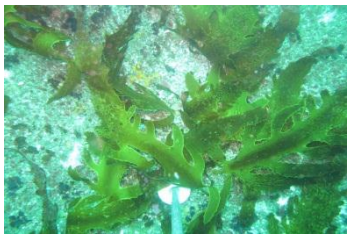
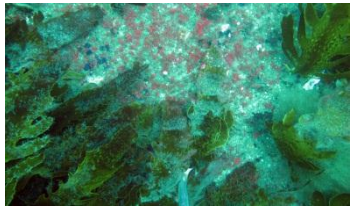
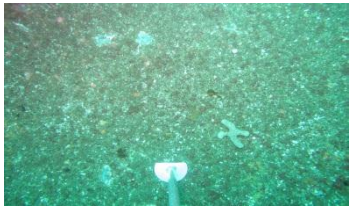
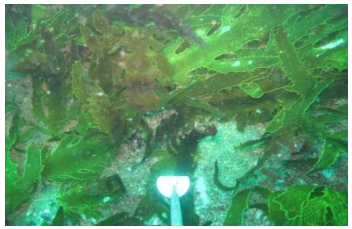
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)
	
	
	

Plate 5: Deck Starbord Mid

Deck, Starbord, Stern

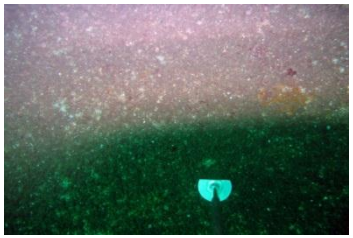
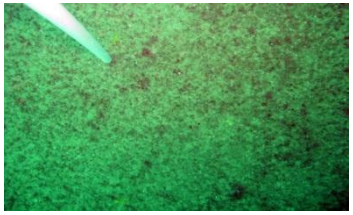
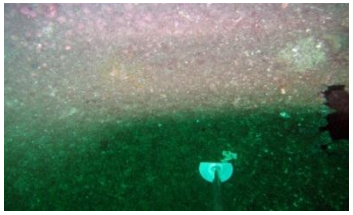
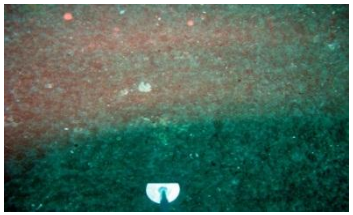
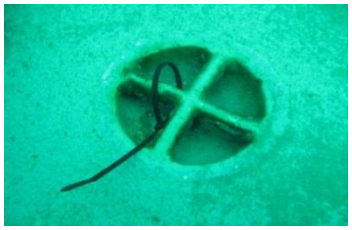
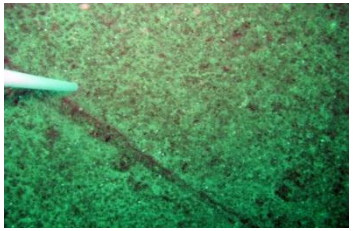
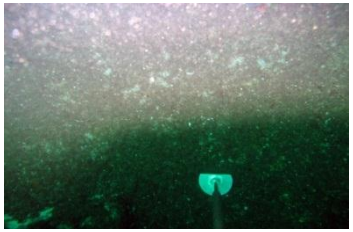
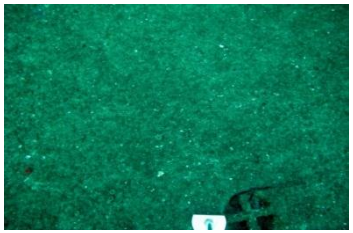
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 6: Deck Starbord Stern

Deck, Starbord, Stern

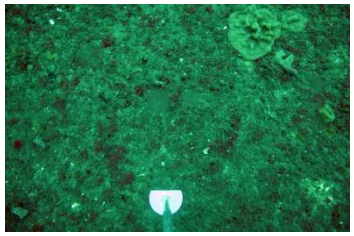
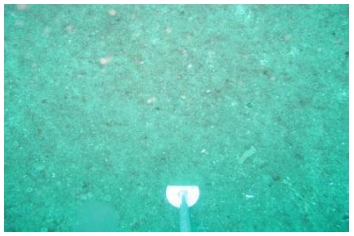
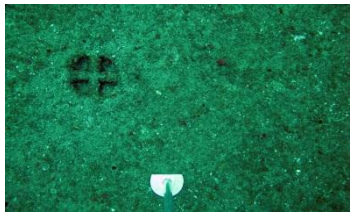
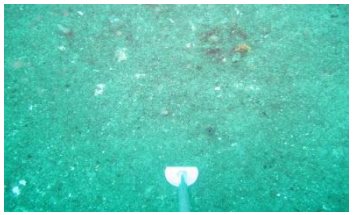
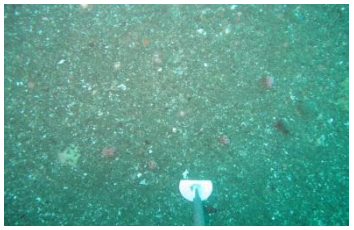
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2012)
	
	
	

Plate 6: Deck Starbord Stern

Horizontal Hull Port

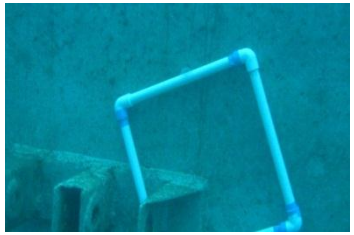
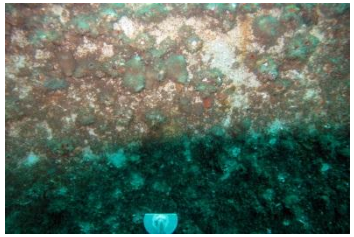
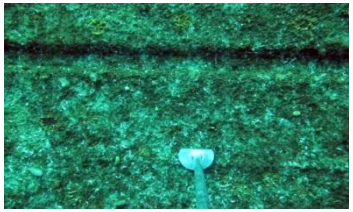
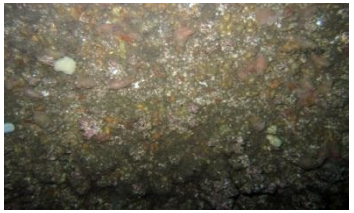
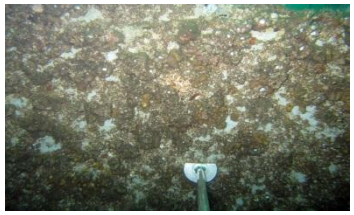
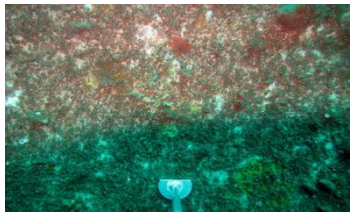
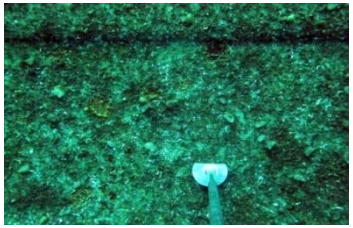
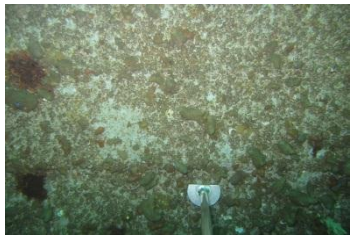
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 7: Horizontal Hull Port

Horizontal Hull Port

Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)

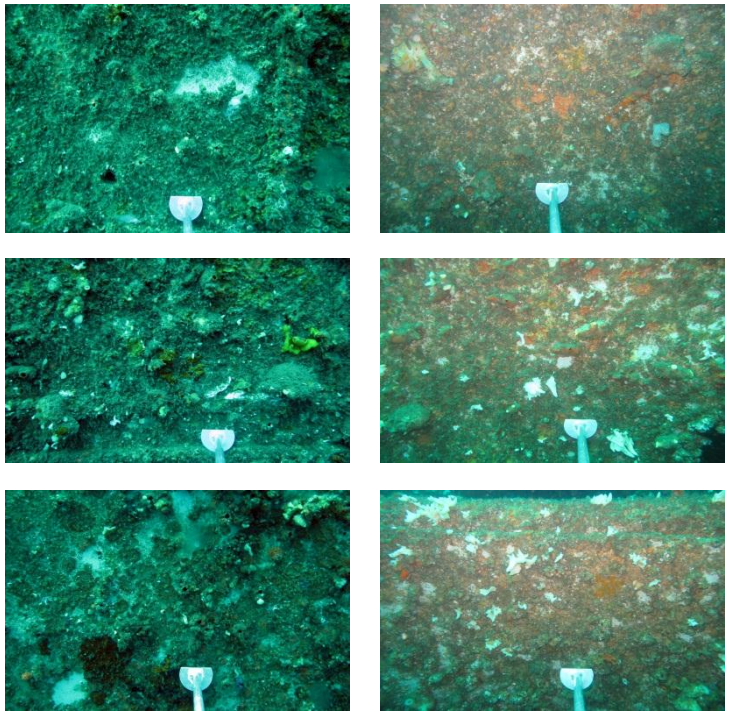


Plate 7: Horizontal Hull Port

Horizontal Hull Starbord

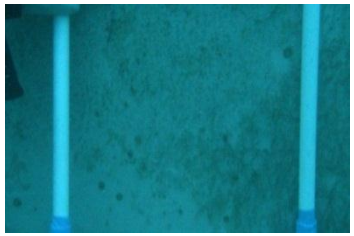
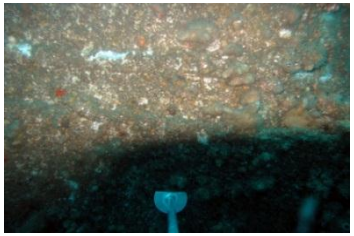
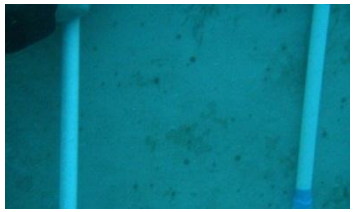
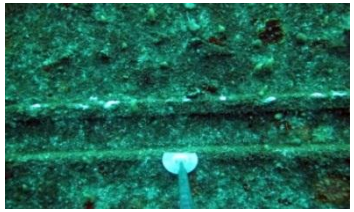
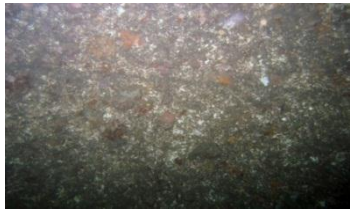
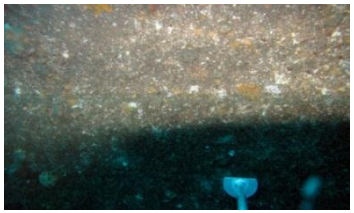
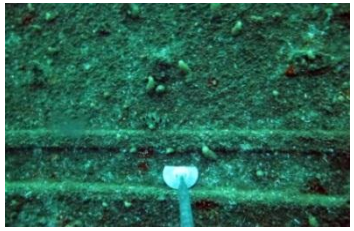
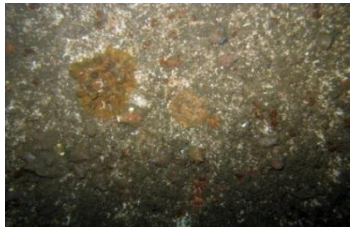
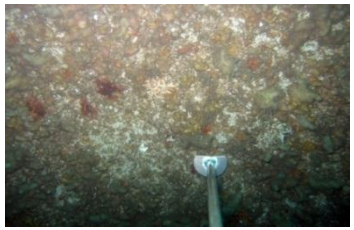
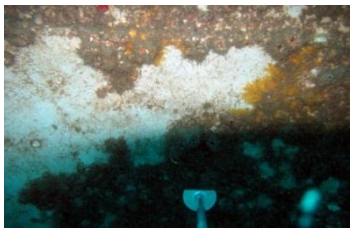
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 8: Horizontal Hull Starbord

Horizontal Hull Starbord

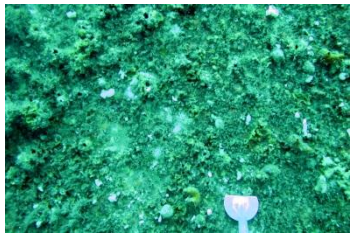
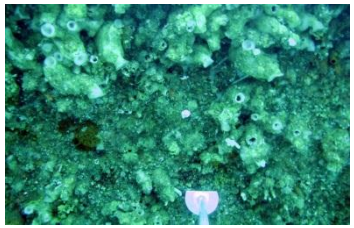
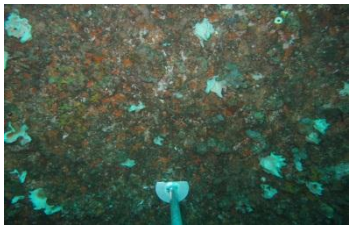
Monitoirng Survey 5 (October/November 2012)	Monitoring Survey 5 (October/November 2012)
	
	
	

Plate 8: Horizontal Hull Starbord

Vertical Hull Port Bow

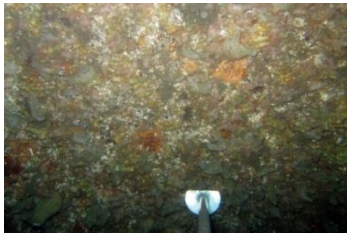
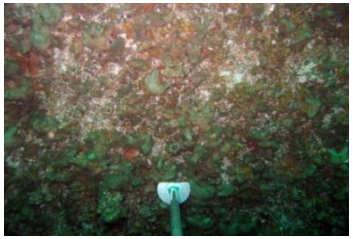
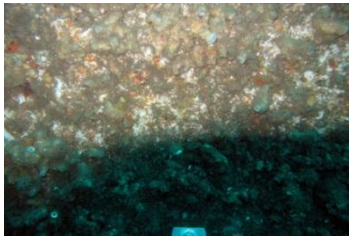
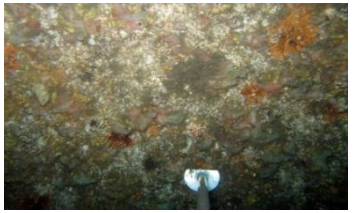
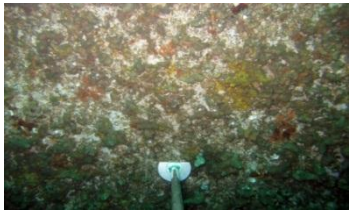
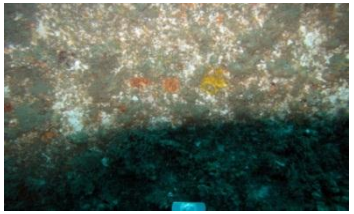
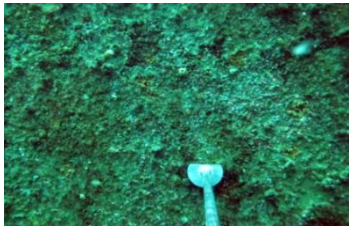
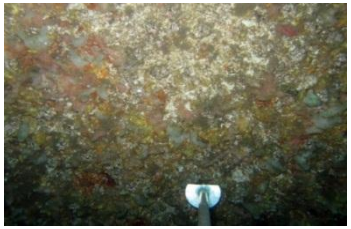
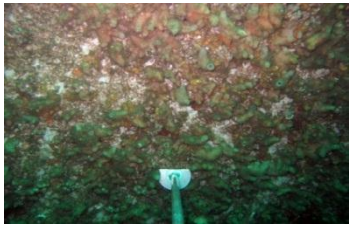
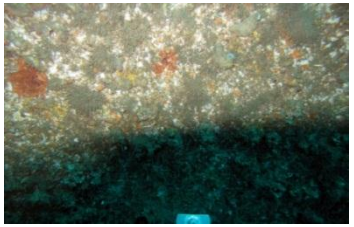
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 9: Vertical Hull Port Bow

Vertical Hull Port Bow

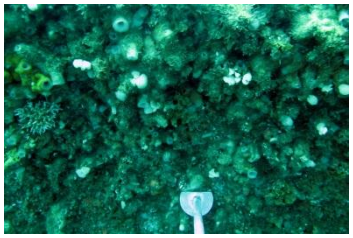
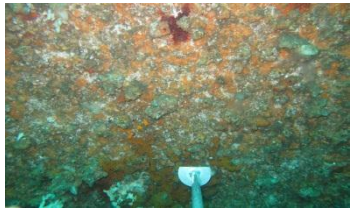
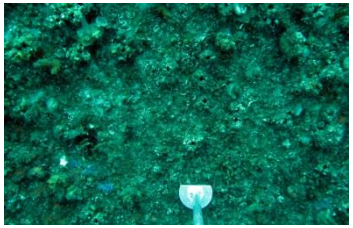
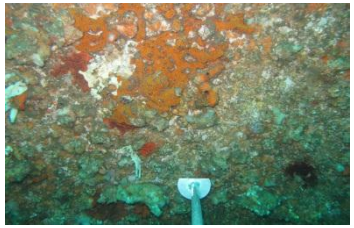
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)
	
	
	

Plate 9: Vertical Hull Port Bow

Vertical Hull Port Stern

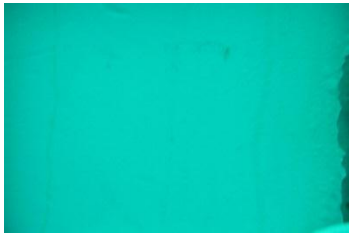
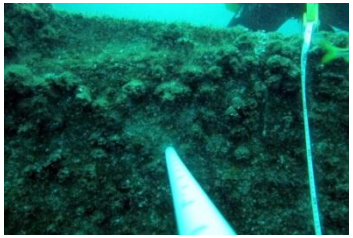
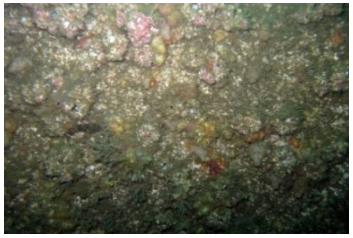
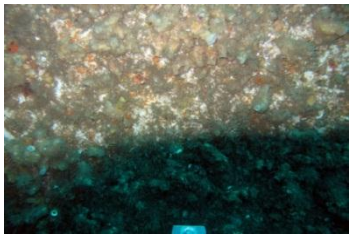
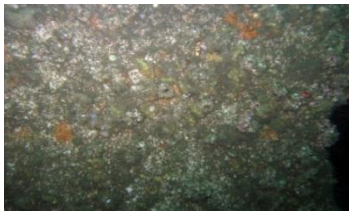
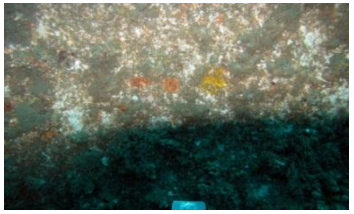
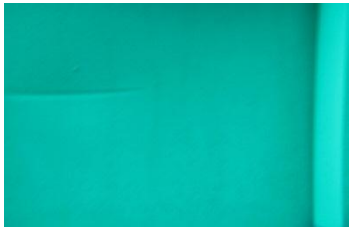
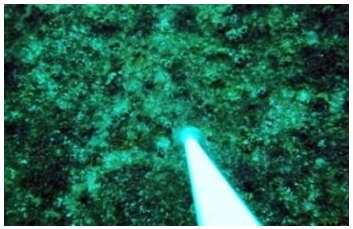
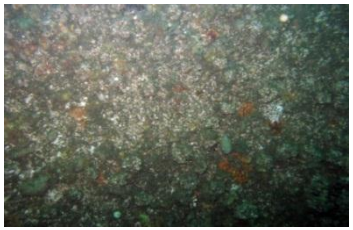
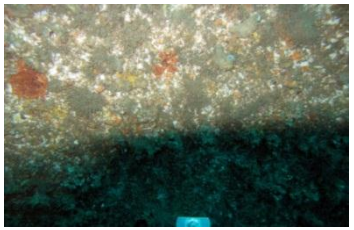
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 10: Vertical Hull Port Stern

Vertical Hull Port Stern

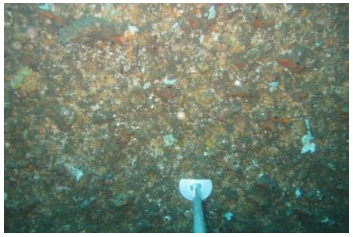
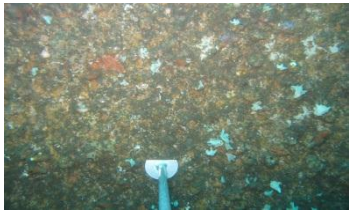
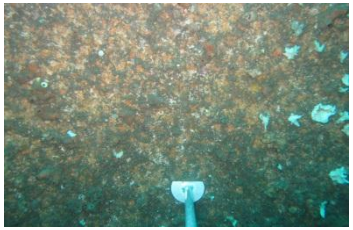
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)
	
	
	

Plate 10: Vertical Hull Port Stern

Vertical Hull Starbord Bow

Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)

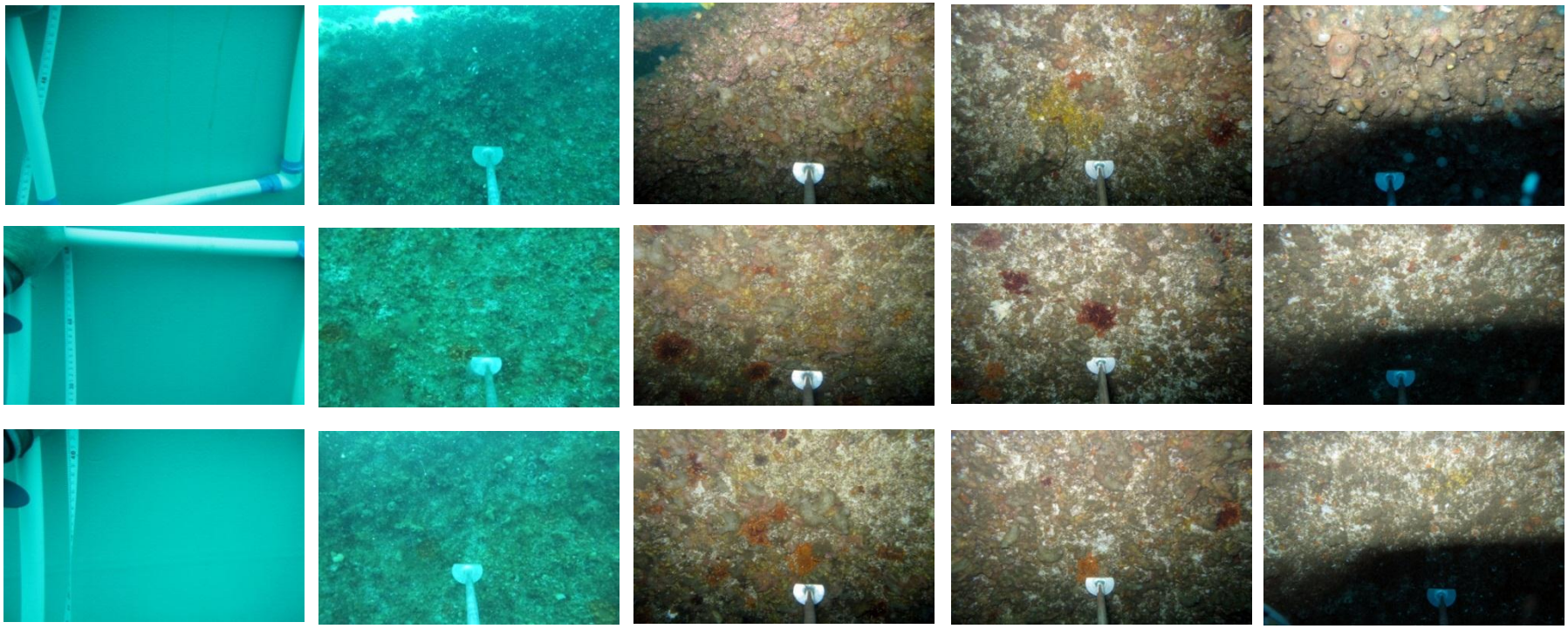


Plate 11: Vertical Hull Starbord Bow

Vertical Hull Starboard Bow

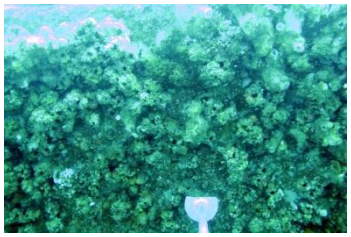
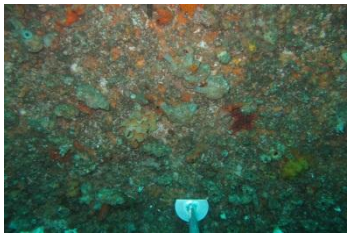
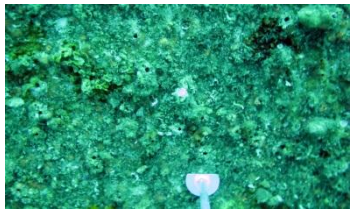
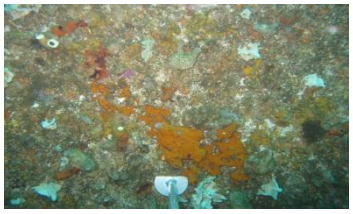
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)
	
	
	

Plate 11: Vertical Hull Starboard Bow

Vertical Hull Starboard Stern

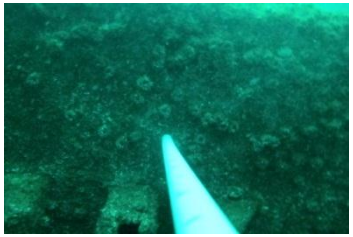
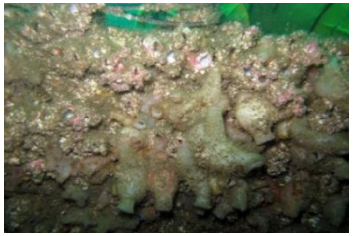
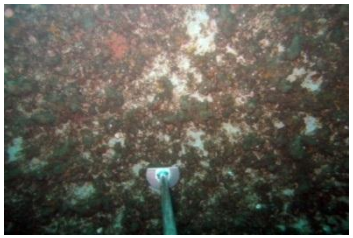
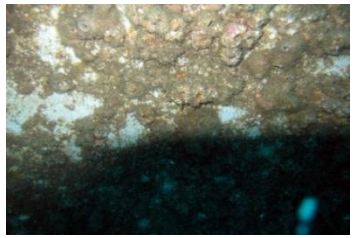
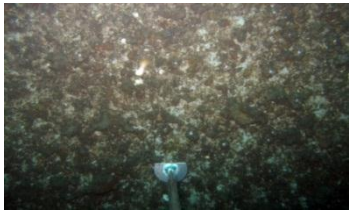
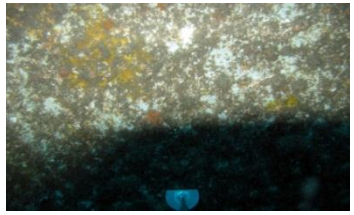
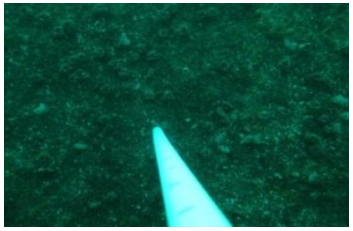
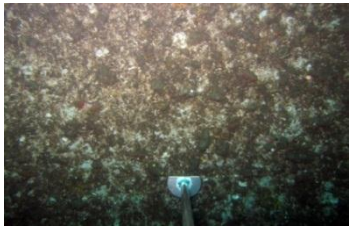
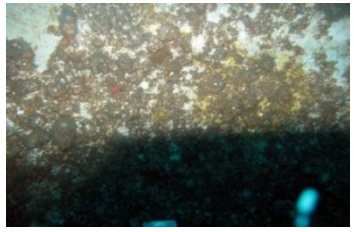
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 12: Vertical Hull Starboard Stern

Vertical Hull Starboard Stern

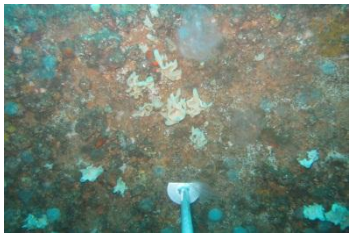
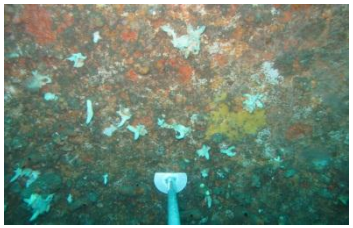
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)
	
	
	

Plate 12: Vertical Hull Starboard Stern

Vertical Superstructure Port Bow

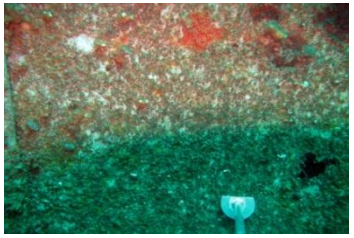
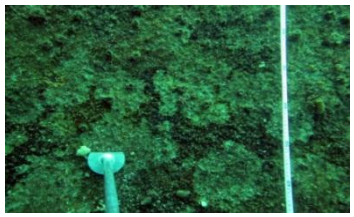
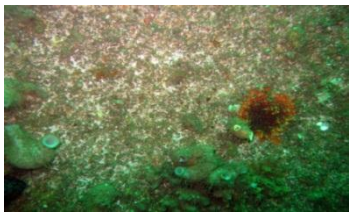
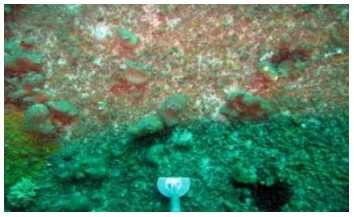
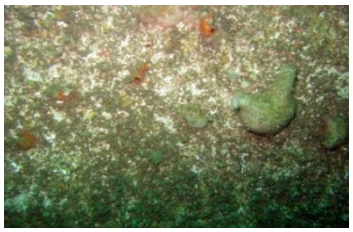
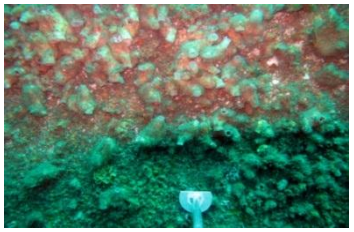
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
Not Sampled				
Not Sampled				
Not Sampled				

Plate 13: Vertical Superstructure Port Bow

Vertical Superstructure Port Bow

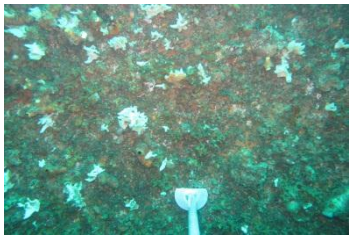
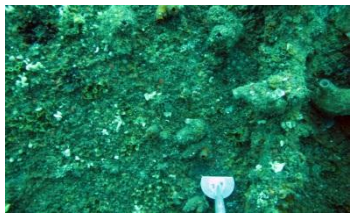
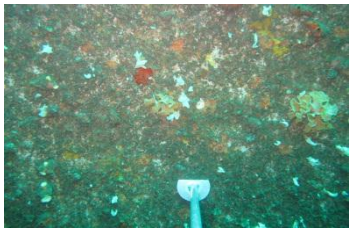
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)
	
	
	

Plate 13: Vertical Superstructure Port Bow

Vertical Superstructure Port Stern

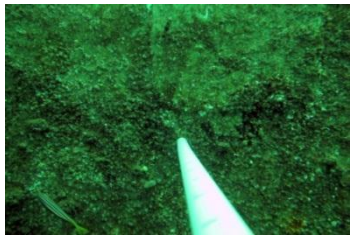
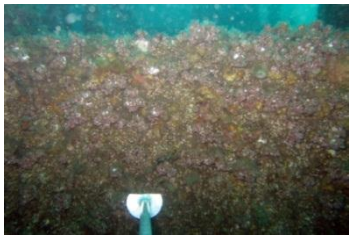
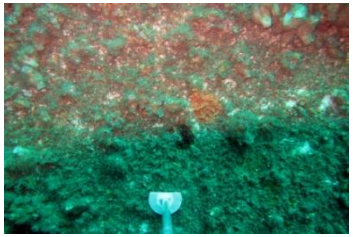
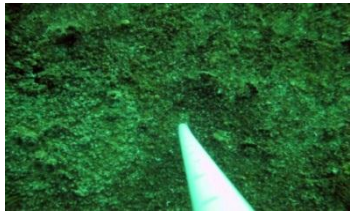
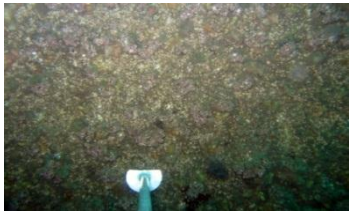
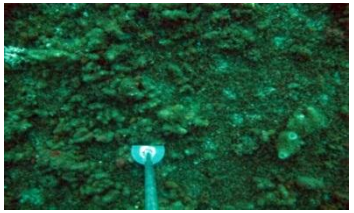
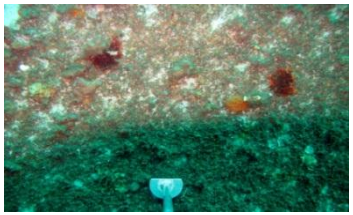
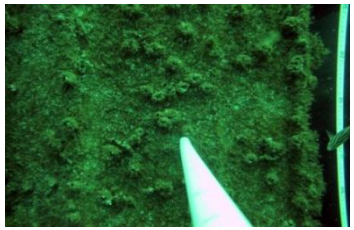
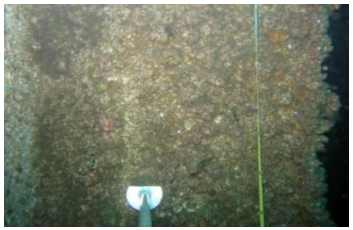
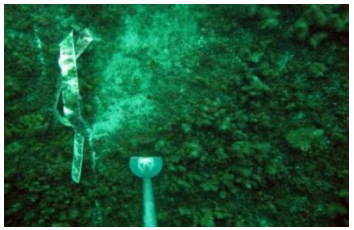
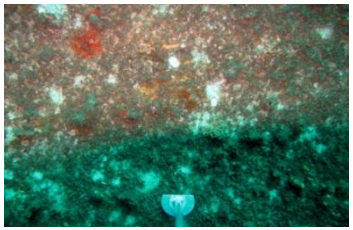
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
Not Sampled				
Not Sampled				
Not Sampled				

Plate 14: Vertical Superstructure Port Stern

Vertical Superstructure Port Stern

Survey 5 (October/November 2012)

Survey 6 (January 2013)

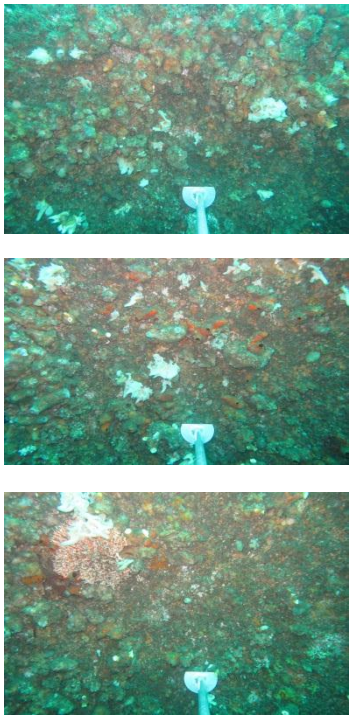


Plate 14: Vertical Superstructure Port Stern

Vertical Superstructure Starboard Bow

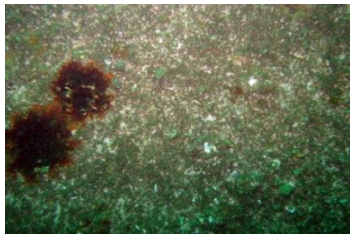
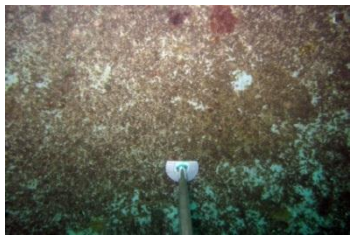
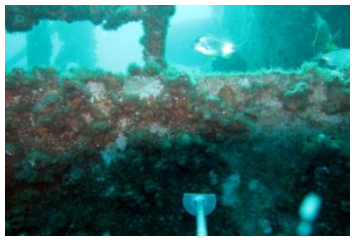
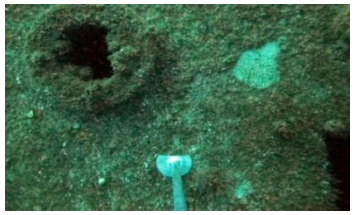
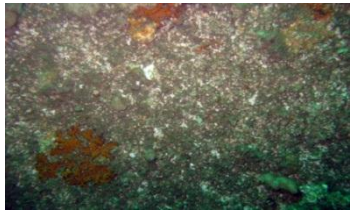
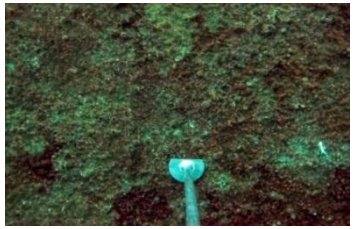
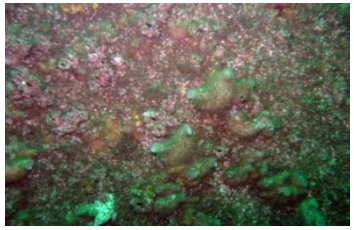
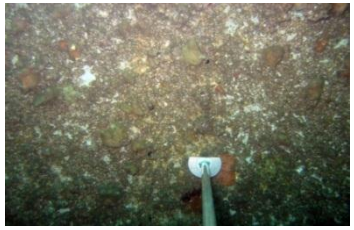
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
Not Sampled				
Not Sampled				
Not Sampled				

Plate 15: Vertical Superstructure Starboard Bow

Vertical Superstructure Starboard Bow

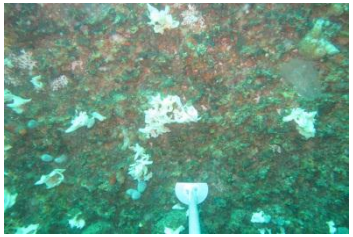
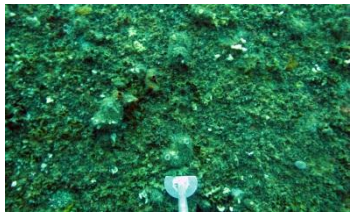
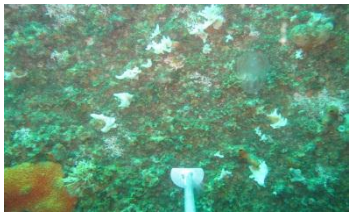
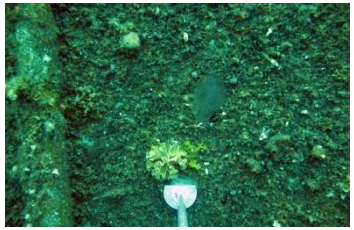
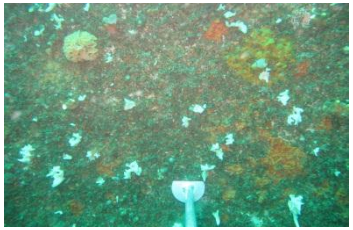
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)
	
	
	

Plate 15: Vertical Superstructure Starboard Bow

Vertical Superstructure Starboard Stern

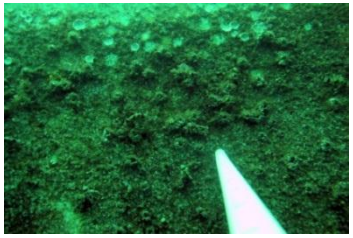
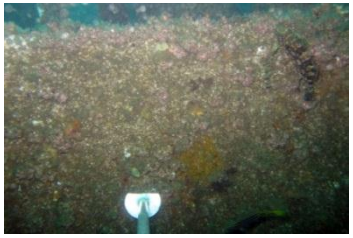
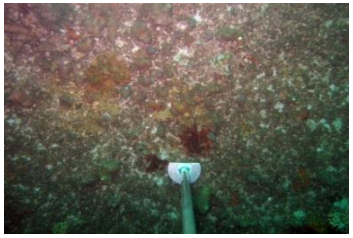
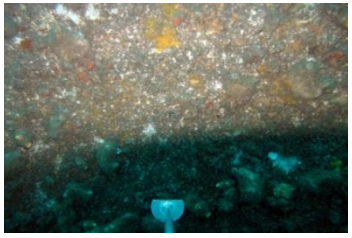
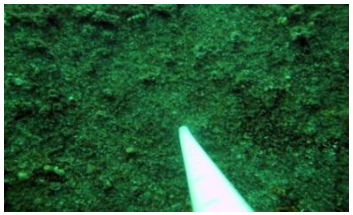
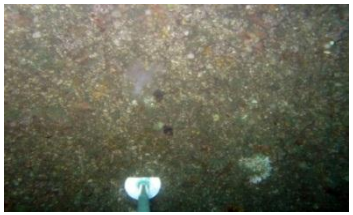
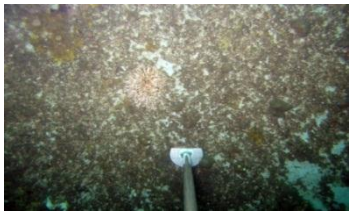
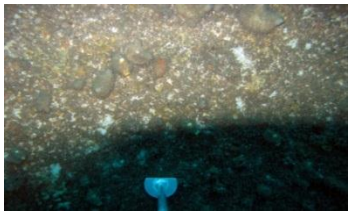
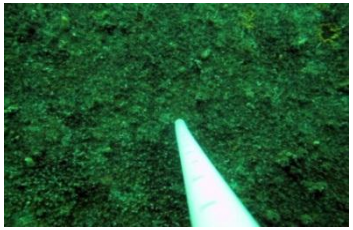
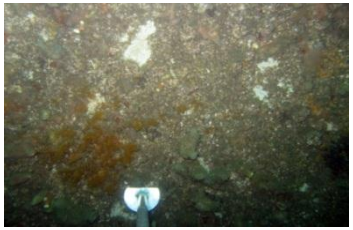
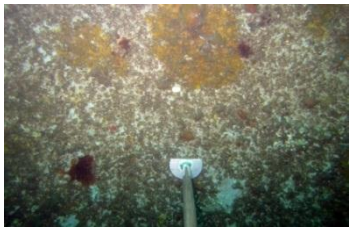
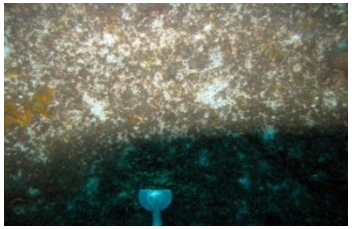
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
Not Sampled				
Not Sampled				
Not Sampled				

Plate 16: Vertical Superstructure Starboard Stern

Vertical Superstructure Starboard Stern

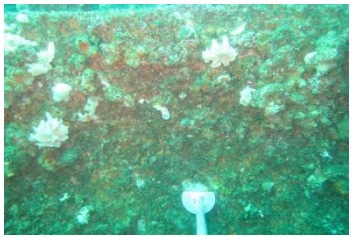
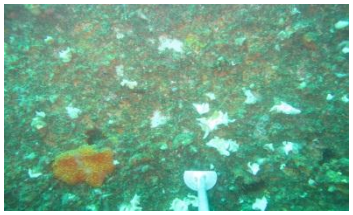
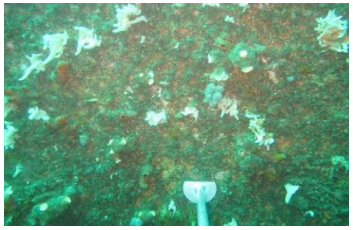
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)
	
	
	

Plate 16: Vertical Superstructure Starboard Stern

8 Appendices

Appendix A: Fixed Photograph Locations.
Appendix B: Mean Percentage Cover (± Standard Error) of Reef Communities.
Appendix C: PERMANOVA of Reef Assemblages.
Appendix D: Pair-wise t-tests.
Appendix E: SIMPER Analyses
Appendix F: PERMDISP Analyses

Appendix A: Fixed Photo Locations and Descriptions

Fixed Photo: 1

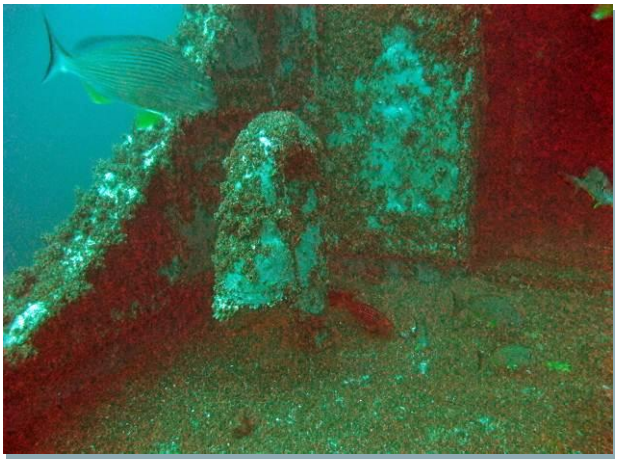
Location: Flight deck port side between the hanger and hull. Photo taken standing 2 m towards the stern from the pipe.

Depth: Approximately 27 m

Survey 1

Survey 2

Survey 3



Survey 4

Survey 5

Survey 6

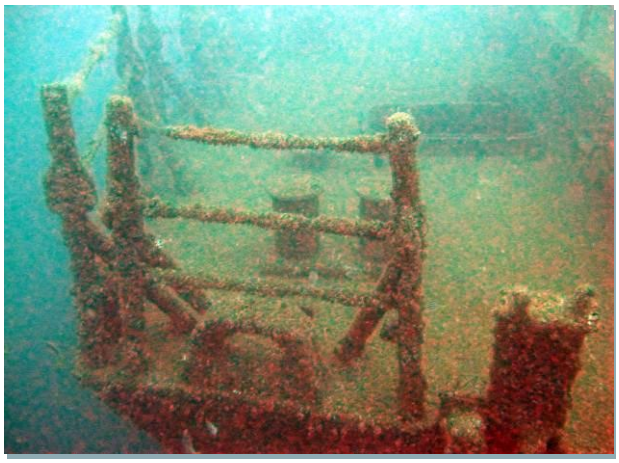
Appendix A: (Continued).

Fixed Photo: 2

Location: Back of the flight deck, starbord side. Photo taken swimming 2 m off and above the deck.

Depth: Approximately 27 m

Survey 1



Survey 2

Survey 3

No Data

Survey 4

Survey 5

No Data

Survey 6

Appendix A: (Continued).

Fixed Photo: 3

Location: Middle of the stern end of the top deck. Photo taken standing 2 m towards the bow from the pillar.

Depth: Approximately 23 m

Survey 1

Survey 2

Survey 3

Survey 4

Survey 5

Survey 6

Appendix A: (Continued).

Fixed Photo: 4

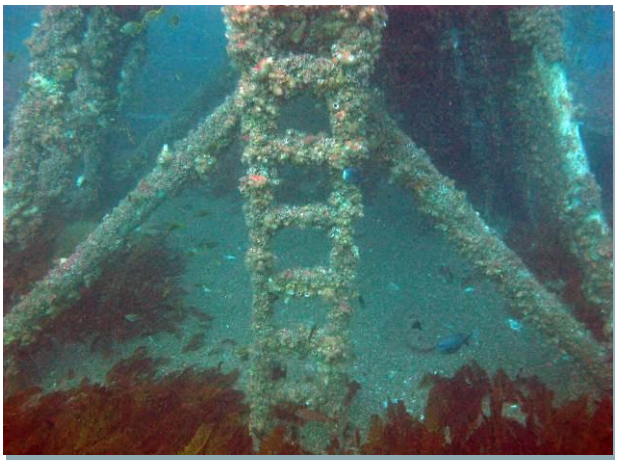
Location: Middle of the top deck. Photo taken standing 2 m towards the stern from the main mast.

Depth: Approximately 23 m

Survey 1

Survey 2

Survey 3



Survey 4

Survey 5

Survey 6

Appendix A: (Continued).

Fixed Photo: 5

Location: Front of the main mast. Photo taken standing on top of the bridge facing the main mast.

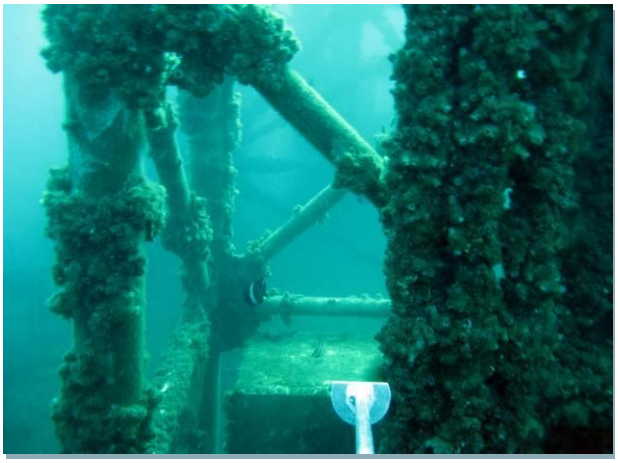
Depth: Approximately 18 m

Survey 1

Survey 2

Survey 3

Survey 4



Survey 5

Survey 6

Appendix A: (Continued).

Fixed Photo: 6

Location: Port bollard between the bow and mid-ship on the front deck. Photo taken standing 2 m towards bridge facing the bow.

Depth: Approximately 26 m

Survey 1

Survey 2

Survey 3

Survey 4

Survey 5

Survey 6

Appendix A: (Continued).

Fixed Photo: 7

Location: Starbord vent on the bow deck. Photo was taken standing 2 m towards the centre of the deck.

Depth: Approximately 25 m.

Survey 1

Survey 2

Survey 3

Survey 4

Survey 5

Survey 6

Appendix A: (Continued).

Fixed Photo: 8

Location: Inside of bow. Photo was taken standing behind the cut out in the deck.

Depth: Approximately 25 m.

Survey 1

Survey 2

Survey 3

Survey 4

Survey 5

Survey 6

Appendix A: (Continued).

Fixed Photo: 9

Location: Wall below the bridge on the starboard side. Photo was taken standing on the front deck 2 m in front of the ladder.

Depth: Approximately 26 m.

Survey 1

Survey 2

Survey 3

Survey 4

Survey 5

Survey 5

Appendix A: (Continued).

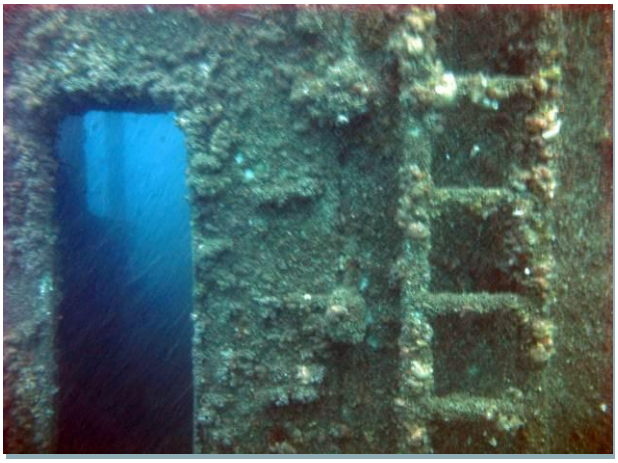
Fixed Photo: 10

Location: Wall below the bridge on the port side. Photo was taken standing on the front deck 2 m in front of the ladder.

Depth: Approximately 26 m.

Survey 1

Survey 2

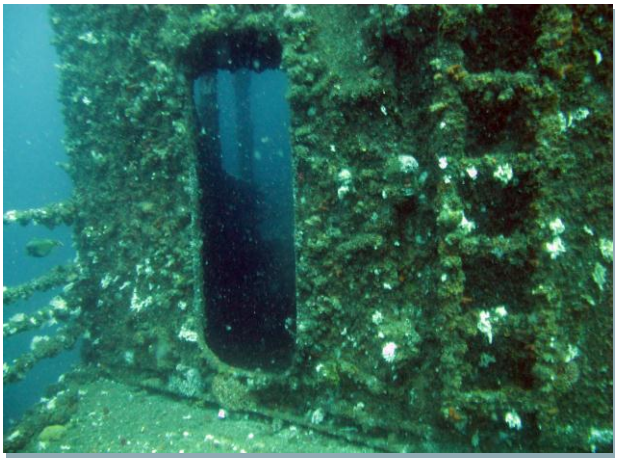


Survey 3

Survey 4

Survey 5

Survey 6



Appendix B: Mean percentage cover (± standard error) of reef communities for each transect analysed during Survey 6.

	Deck Port Bow		Deck Port Mid		Deck Port Stern	
Categories	Mean	S.E.	Mean	S.E.	Mean	S.E.
PHAEOPHYTA						
Ecklonia radiata	0.00	0.00	31.67	11.25	0.00	0.00
Lobed Brown Algae	0.00	0.00	6.23	2.36	0.00	0.00
Sargassum Indeterminate	0.00	0.00	0.00	0.00	0.00	0.00
Brown Filamentous Algae	0.81	0.81	0.00	0.00	0.00	0.00
Orange Filamentous Algae	0.00	0.00	0.00	0.00	1.00	1.00
Turfing Brown Algae	0.00	0.00	0.00	0.00	0.00	0.00
RHODOPHYTA						
Encrusting Red Algae	3.87	1.64	8.49	1.25	0.00	0.00
Encrusting Coralline	0.00	0.00	0.22	0.22	0.00	0.00
Red Branching Algae	0.00	0.00	0.00	0.00	0.00	0.00
Red Filamentous	0.20	0.20	1.60	0.93	0.00	0.00
BRYOZOA						
Biflustra perfragilis	0.00	0.00	0.00	0.00	0.00	0.00
Encrusting Orange Broyozoan	0.00	0.00	0.00	0.00	0.00	0.00
Membranipora membranacea	0.00	0.00	0.00	0.00	0.00	0.00
Triphyllozoan sp	0.00	0.00	0.00	0.00	0.00	0.00
SPONGE						
Orange Encrusting Sponge	0.00	0.00	0.00	0.00	0.00	0.00
Purple Sponge	0.81	0.81	0.00	0.00	0.00	0.00
Yellow Encrusting Sponge	4.22	2.59	0.00	0.00	0.60	0.40
White Encrusting Sponge	0.20	0.20	0.00	0.00	0.40	0.24
White Globular Sponge	0.60	0.25	0.00	0.00	0.00	0.00
White Papillate Sponge	0.20	0.20	0.00	0.00	0.00	0.00
White Tubular Sponge	0.00	0.00	0.00	0.00	0.00	0.00
ASCIDIAN						
Colonial Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
Herdmania momus	0.00	0.00	0.00	0.00	0.00	0.00
Botryloides magnicoecum	0.00	0.00	0.00	0.00	0.00	0.00
White Encrusting Solitary Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
White Tubular Solitary Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
Unidentified Globular Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
ABIOTIC						
Bare Ships Surface	0.00	0.00	0.00	0.00	0.00	0.00
CRUSTACEAN						
Dead Barnacle	0.00	0.00	0.00	0.00	0.00	0.00
POLYCHAETE						
Filograna implexa	0.00	0.00	0.00	0.00	0.00	0.00
CNIDARIAN						
Spare Category 21	0.00	0.00	0.00	0.00	0.00	0.00
MATRIX						
Large Barnacle,sediment,brown fil	0.00	0.00	0.00	0.00	0.00	0.00
Serpulid Barnacle and Encrusting Algae Matrix	89.09	2.63	50.98	10.42	98.00	1.05
Serpulid Matrix	0.00	0.00	0.00	0.00	0.00	0.00
FISH MOBILE						
Fish Mobile	0.00	0.00	0.00	0.00	0.00	0.00
INDETERMINATE						
Indeterminate	0.00	0.00	0.82	0.38	0.00	0.00
TAPE, WAND, SHADOW						
Shadow	0.00	0.00	0.81	0.81	0.20	0.20
Wand	0.40	0.25	0.40	0.40	0.00	0.00

Appendix B: (Continued).

	Deck Starbord Bow		Deck Starbord Mid		Deck Starbord Stern	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
PHAEOPHYTA						
Ecklonia radiata	0.00	0.00	49.15	20.29	0.00	0.00
Lobed Brown Algae	0.00	0.00	0.80	0.49	0.00	0.00
Sargassum Indeterminate	0.00	0.00	0.00	0.00	0.00	0.00
Brown Filamentous Algae	0.00	0.00	0.00	0.00	0.00	0.00
Orange Filamentous Algae	0.00	0.00	0.00	0.00	0.00	0.00
Turfing Brown Algae	5.09	2.35	1.20	1.20	0.00	0.00
RHODOPHYTA						
Encrusting Red Algae	0.20	0.20	2.82	0.98	0.20	0.20
Encrusting Coralline	0.20	0.20	0.00	0.00	0.00	0.00
Red Branching Algae	0.00	0.00	0.20	0.20	0.00	0.00
Red Filamentous	0.00	0.00	0.00	0.00	0.00	0.00
BRYOZOA						
Biflustra perfragilis	0.00	0.00	0.00	0.00	0.20	0.20
Encrusting Orange Broyozoan	0.40	0.40	0.20	0.20	0.20	0.20
Membranipora membranacea	0.00	0.00	0.00	0.00	0.00	0.00
Triphyllozoan sp	0.00	0.00	0.00	0.00	0.00	0.00
SPONGE						
Orange Encrusting Sponge	0.20	0.20	0.40	0.40	0.00	0.00
Purple Sponge	0.00	0.00	0.00	0.00	0.00	0.00
Yellow Encrusting Sponge	0.61	0.41	0.40	0.25	0.00	0.00
White Encrusting Sponge	0.20	0.20	0.20	0.20	0.41	0.25
White Globular Sponge	0.00	0.00	0.20	0.20	0.00	0.00
White Papillate Sponge	0.00	0.00	0.00	0.00	0.20	0.20
White Tubular Sponge	0.00	0.00	0.00	0.00	0.00	0.00
ASCIDIAN						
Colonial Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
Herdmania momus	0.00	0.00	0.00	0.00	0.00	0.00
Botryloides magnicoecum	0.00	0.00	0.00	0.00	0.00	0.00
White Encrusting Solitary Ascidian	0.41	0.25	0.00	0.00	0.00	0.00
White Tubular Solitary Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
Unidentified Globular Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
ABIOTIC						
Bare Ships Surface	0.00	0.00	1.00	1.00	0.00	0.00
CRUSTACEAN						
Dead Barnacle	0.00	0.00	0.00	0.00	0.00	0.00
POLYCHAETE						
Filograna implexa	0.00	0.00	0.00	0.00	0.00	0.00
CNIDARIAN						
Spare Category 21	0.00	0.00	0.40	0.40	0.00	0.00
MATRIX						
Large Barnacle,sediment,brown fil	0.00	0.00	0.00	0.00	0.00	0.00
Serpulid Barnacle and Encrusting Algae Matrix	92.47	2.66	42.82	20.16	97.97	0.64
Serpulid Matrix	0.00	0.00	0.00	0.00	0.00	0.00
FISH MOBILE						
Fish Mobile	0.00	0.00	0.00	0.00	0.61	0.61
INDETERMINATE						
Indeterminate	0.20	0.20	0.20	0.20	0.20	0.20
TAPE, WAND, SHADOW						
Shadow	0.00	0.00	0.00	0.00	0.00	0.00
Wand	1.60	0.24	0.40	0.22	1.40	0.24

Appendix B: (Continued).

	Horizontal Hull Port		Horizontal Hull Starbord		Vertical Hull Port Bow	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
PHAEOPHYTA						
Ecklonia radiata	0.00	0.00	0.00	0.00	0.00	0.00
Lobed Brown Algae	0.00	0.00	0.00	0.00	0.00	0.00
Sargassum Indeterminate	0.00	0.00	0.17	0.17	0.00	0.00
Brown Filamentous Algae	0.19	0.19	0.17	0.17	0.00	0.00
Orange Filamentous Algae	0.00	0.00	0.00	0.00	0.00	0.00
Turfing Brown Algae	3.00	2.24	0.00	0.00	0.00	0.00
RHODOPHYTA						
Encrusting Red Algae	0.00	0.00	0.17	0.17	0.41	0.41
Encrusting Coralline	0.00	0.00	0.00	0.00	0.00	0.00
Red Branching Algae	0.00	0.00	0.00	0.00	0.00	0.00
Red Filamentous	0.00	0.00	0.00	0.00	0.00	0.00
BRYOZOA						
Biflustra perfragilis	0.00	0.00	0.34	0.21	1.01	0.55
Encrusting Orange Broyozoan	6.17	1.53	4.65	1.55	10.02	4.15
Membranipora membranacea	0.00	0.00	0.34	0.34	0.21	0.21
Triphyllozoan sp	0.33	0.21	0.88	0.43	0.60	0.60
SPONGE						
Orange Encrusting Sponge	0.34	0.34	0.69	0.50	0.21	0.21
Purple Sponge	0.00	0.00	0.00	0.00	0.00	0.00
Yellow Encrusting Sponge	0.00	0.00	0.37	0.37	0.00	0.00
White Encrusting Sponge	0.36	0.23	0.34	0.21	0.00	0.00
White Globular Sponge	0.00	0.00	0.00	0.00	0.20	0.20
White Papillate Sponge	3.07	0.78	4.44	1.44	3.46	1.23
White Tubular Sponge	0.00	0.00	0.00	0.00	0.00	0.00
ASCIDIAN						
Colonial Ascidian	0.50	0.22	0.00	0.00	4.46	3.01
Herdmania momus	3.21	1.34	1.03	0.64	11.59	4.47
Botryloides magnicoecum	0.17	0.17	0.36	0.23	0.00	0.00
White Encrusting Solitary Ascidian	0.34	0.21	0.00	0.00	0.00	0.00
White Tubular Solitary Ascidian	0.00	0.00	0.00	0.00	0.21	0.21
Unidentified Globular Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
ABIOTIC						
Bare Ships Surface	0.67	0.49	0.86	0.31	1.02	0.65
CRUSTACEAN						
Dead Barnacle	0.00	0.00	0.00	0.00	0.00	0.00
POLYCHAETE						
Filograna implexa	0.34	0.34	0.00	0.00	0.21	0.21
CNIDARIAN						
Spare Category 21	0.00	0.00	0.00	0.00	0.00	0.00
MATRIX						
Large Barnacle,sediment,brown fil	0.75	0.75	0.00	0.00	8.37	4.26
Serpulid Barnacle and Encrusting Algae Matrix	80.40	4.07	85.19	3.55	57.59	4.45
Serpulid Matrix	0.17	0.17	0.00	0.00	0.44	0.27
FISH MOBILE						
Fish Mobile	0.00	0.00	0.00	0.00	0.00	0.00
INDETERMINATE						
Indeterminate	0.00	0.00	0.00	0.00	0.00	0.00
TAPE, WAND, SHADOW						
Shadow	1.83	1.64	1.67	1.67	2.60	2.60
Wand	0.33	0.21	1.50	0.34	1.40	0.40

Appendix B: (Continued).

	Vertical Hull Port Stern		Vertical Hull Starbord Bow		Vertical Hull Starbord Stern	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
PHAEOPHYTA						
Ecklonia radiata	0.00	0.00	0.00	0.00	0.00	0.00
Lobed Brown Algae	0.00	0.00	0.00	0.00	0.00	0.00
Sargassum Indeterminate	0.00	0.00	0.00	0.00	0.00	0.00
Brown Filamentous Algae	0.00	0.00	0.00	0.00	0.00	0.00
Orange Filamentous Algae	0.00	0.00	0.00	0.00	0.00	0.00
Turfing Brown Algae	0.00	0.00	0.00	0.00	0.20	0.20
RHODOPHYTA						
Encrusting Red Algae	0.00	0.00	0.20	0.20	0.00	0.00
Encrusting Coralline	0.00	0.00	0.00	0.00	0.00	0.00
Red Branching Algae	0.00	0.00	0.00	0.00	0.00	0.00
Red Filamentous	0.00	0.00	0.00	0.00	0.00	0.00
BRYOZOA						
Biflustra perfragilis	0.41	0.41	1.82	0.67	0.81	0.49
Encrusting Orange Broyozoan	4.69	1.50	6.29	1.69	12.90	1.15
Membranipora membranacea	0.00	0.00	0.00	0.00	0.00	0.00
Triphyllozoan sp	0.61	0.41	0.41	0.25	0.00	0.00
SPONGE						
Orange Encrusting Sponge	0.00	0.00	0.20	0.20	0.00	0.00
Purple Sponge	0.00	0.00	0.20	0.20	0.00	0.00
Yellow Encrusting Sponge	0.00	0.00	0.61	0.40	0.61	0.61
White Encrusting Sponge	0.00	0.00	0.00	0.00	0.00	0.00
White Globular Sponge	0.61	0.40	0.20	0.20	0.00	0.00
White Papillate Sponge	2.06	1.42	2.84	0.88	4.24	1.85
White Tubular Sponge	0.00	0.00	0.00	0.00	0.00	0.00
ASCIDIAN						
Colonial Ascidian	0.00	0.00	1.42	0.94	0.00	0.00
Herdmania momus	3.25	0.98	7.50	1.91	4.42	2.01
Botryloides magnicoecum	0.21	0.21	0.20	0.20	0.00	0.00
White Encrusting Solitary Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
White Tubular Solitary Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
Unidentified Globular Ascidian	0.00	0.00	0.00	0.00	0.41	0.41
ABIOTIC						
Bare Ships Surface	0.00	0.00	1.02	0.79	0.61	0.25
CRUSTACEAN						
Dead Barnacle	0.00	0.00	0.00	0.00	0.00	0.00
POLYCHAETE						
Filograna implexa	0.00	0.00	0.00	0.00	0.00	0.00
CNIDARIAN						
Spare Category 21	0.00	0.00	0.00	0.00	0.00	0.00
MATRIX						
Large Barnacle,sediment,brown fil	1.24	0.60	10.15	3.56	18.18	4.26
Serpulid Barnacle and Encrusting Algae Matrix	86.92	1.18	66.95	3.71	57.03	7.24
Serpulid Matrix	0.00	0.00	0.00	0.00	0.00	0.00
FISH MOBILE						
Fish Mobile	0.00	0.00	0.00	0.00	0.61	0.61
INDETERMINATE						
Indeterminate	0.00	0.00	0.00	0.00	0.00	0.00
TAPE, WAND, SHADOW						
Shadow	0.00	0.00	0.00	0.00	0.00	0.00
Wand	2.00	0.45	1.40	0.24	0.80	0.37

Appendix B: (Continued).

	Vertical Super Port Bow		Vertical Super Port Stern		Vertical Super Starbord Bow	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
PHAEOPHYTA						
Ecklonia radiata	0.00	0.00	0.00	0.00	0.00	0.00
Lobed Brown Algae	0.00	0.00	0.00	0.00	0.00	0.00
Sargassum Indeterminate	0.00	0.00	0.00	0.00	0.00	0.00
Brown Filamentous Algae	0.00	0.00	0.00	0.00	0.00	0.00
Orange Filamentous Algae	0.00	0.00	0.00	0.00	0.00	0.00
Turfing Brown Algae	2.04	2.04	0.40	0.25	0.00	0.00
RHODOPHYTA						
Encrusting Red Algae	0.20	0.20	0.20	0.20	0.00	0.00
Encrusting Coralline	0.00	0.00	0.00	0.00	0.00	0.00
Red Branching Algae	0.00	0.00	0.00	0.00	0.00	0.00
Red Filamentous	0.00	0.00	0.00	0.00	0.00	0.00
BRYOZOA						
Biflustra perfragilis	1.65	1.65	1.01	0.78	29.76	13.29
Encrusting Orange Broyozoan	2.86	1.14	1.81	0.66	2.04	1.58
Membranipora membranacea	0.00	0.00	0.00	0.00	0.00	0.00
Triphyllozoan sp	1.63	1.19	0.00	0.00	0.63	0.42
SPONGE						
Orange Encrusting Sponge	0.41	0.41	0.60	0.40	1.24	0.82
Purple Sponge	0.00	0.00	0.00	0.00	0.00	0.00
Yellow Encrusting Sponge	0.00	0.00	0.00	0.00	0.00	0.00
White Encrusting Sponge	0.00	0.00	0.00	0.00	0.20	0.20
White Globular Sponge	0.00	0.00	0.00	0.00	0.00	0.00
White Papillate Sponge	3.08	1.18	6.02	2.07	8.44	2.31
White Tubular Sponge	0.00	0.00	0.00	0.00	0.00	0.00
ASCIDIAN						
Colonial Ascidian	0.41	0.25	0.61	0.61	0.20	0.20
Herdmania momus	4.91	0.95	21.07	5.73	3.71	1.44
Botryloides magnicoecum	0.20	0.20	0.00	0.00	0.62	0.41
White Encrusting Solitary Ascidian	0.41	0.41	0.00	0.00	0.00	0.00
White Tubular Solitary Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
Unidentified Globular Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
ABIOTIC						
Bare Ships Surface	0.00	0.00	0.00	0.00	0.21	0.21
CRUSTACEAN						
Dead Barnacle	0.00	0.00	0.00	0.00	0.20	0.20
POLYCHAETE						
Filograna implexa	0.00	0.00	1.01	1.01	1.04	0.58
CNIDARIAN						
Spare Category 21	0.00	0.00	0.00	0.00	0.00	0.00
MATRIX						
Large Barnacle,sediment,brown fil	1.86	1.86	10.04	2.87	0.00	0.00
Serpulid Barnacle and Encrusting Algae Matrix	80.33	6.53	56.63	4.68	51.08	12.00
Serpulid Matrix	0.00	0.00	0.61	0.61	0.00	0.00
FISH MOBILE						
Fish Mobile	0.00	0.00	0.00	0.00	0.62	0.25
INDETERMINATE						
Indeterminate	0.00	0.00	0.00	0.00	0.00	0.00
TAPE, WAND, SHADOW						
Shadow	0.00	0.00	0.00	0.00	0.00	0.00
Wand	2.00	0.00	0.40	0.24	2.02	0.01

Appendix B: (Continued).

	Vertical Super Starbord Stern	
	Mean	S.E.
PHAEOPHYTA		
Ecklonia radiata	0.00	0.00
Lobed Brown Algae	0.00	0.00
Sargassum Indeterminate	0.00	0.00
Brown Filamentous Algae	0.21	0.21
Orange Filamentous Algae	0.00	0.00
Turfing Brown Algae	0.00	0.00
RHODOPHYTA		
Encrusting Red Algae	0.20	0.20
Encrusting Coralline	0.00	0.00
Red Branching Algae	0.00	0.00
Red Filamentous	0.00	0.00
BRYOZOA		
Biflustra perfragilis	7.12	2.31
Encrusting Orange Broyozoan	2.27	0.69
Membranipora membranacea	0.00	0.00
Triphyllozoan sp	0.00	0.00
SPONGE		
Orange Encrusting Sponge	0.41	0.25
Purple Sponge	0.00	0.00
Yellow Encrusting Sponge	0.21	0.21
White Encrusting Sponge	0.00	0.00
White Globular Sponge	0.20	0.20
White Papillate Sponge	7.12	1.28
White Tubular Sponge	0.21	0.21
ASCIDIAN		
Colonial Ascidian	0.00	0.00
Herdmania momus	6.31	1.38
Botryloides magnicoecum	0.40	0.40
White Encrusting Solitary Ascidian	0.00	0.00
White Tubular Solitary Ascidian	0.00	0.00
Unidentified Globular Ascidian	0.00	0.00
ABIOTIC		
Bare Ships Surface	0.62	0.25
CRUSTACEAN		
Dead Barnacle	0.21	0.21
POLYCHAETE		
Filograna implexa	0.21	0.21
CNIDARIAN		
Spare Category 21	0.00	0.00
MATRIX		
Large Barnacle,sediment,brown fil	1.90	1.66
Serpulid Barnacle and Encrusting Algae Matrix	72.39	3.56
Serpulid Matrix	0.00	0.00
FISH MOBILE		
Fish Mobile	0.00	0.00
INDETERMINATE		
Indeterminate	0.00	0.00
TAPE, WAND, SHADOW		
Shadow	1.00	1.00
Wand	0.80	0.20

Appendix C: Permutational Analysis of Variance of Percent Cover of Reef Assemblages Sampled in Reef Monitoring Surveys 5 and 6. *P*-values highlighted in bold are significant. RED = Redundant term. A term becomes redundant if a lower order interaction including that term is significant. Res = Residual. This term is a measure of the variation in the data not explained by the variation attributed to the main factors in the experimental model (i.e. Time, Orientation etc. and their associated interactions).

1. Survey Time

Source	DF	SS	MS	F	P	Unique perms
Time	5	292280	58457	33.308	0.0002	4961
Residual	486	852940	1755			
Total	491	1145200				

2. Orientation

Source	DF	SS	MS	F	P	Unique perms
Time	1	2405.4	2405.4	2.6215	0.0622	4984
Orientation	1	5935.1	5935.1	6.4683	0.002	4978
Aspect	1	861.74	861.74	0.93916	0.3616	4988
Time x Orientation	1	1402.9	1402.9	1.529	0.1906	4990
Time x Aspect	1	913.07	913.07	0.9951	0.3174	4990
Orientation x Aspect	1	650.32	650.32	0.70875	0.5046	4986
Time x Orientation x Aspect	1	689.5	689.5	0.75145	0.4734	4979
Residual	76	69735	917.56			
Total	83	81908				

4. Depth and Aspect

Source	DF	SS	MS	F	P	Unique perms
Time	1	4003.2	4003.2	3.9835	0.0044	4990
Depth	1	4417.4	4417.4	3.6079	RED	315
Aspect	1	2514.9	2514.9	2.0541	0.0974	315
Time x Depth	1	695.85	695.85	0.69243	0.6574	4990
Time x Aspect	1	856.34	856.34	0.85213	0.5544	4991
Depth x Aspect	1	2780.1	2780.1	2.2707	0.0814	315
Transect (Depth x Aspect)	4	4897.4	1224.3	2.413	0.0008	4970
Time x Depth x Aspect	1	665.07	665.07	0.6618	0.6682	4992
Time x Transect (Depth x Aspect)	4	4019.8	1004.9	1.9806	0.008	4973
Residual	64	32474	507.4			
Total	79	57324				

3. Deck Position

Source	DF	SS	MS	F	P	Unique perms
Time	1	1082.3	1082.3	2.0781	0.138	4983
Position	2	29780	14890	28.59	0.0002	4989
Aspect	1	1025.7	1025.7	1.9695	0.1472	4985
Time x Position	2	939.37	469.68	0.90183	0.4326	4985
Time x Aspect	1	212.44	212.44	0.40791	0.6464	4983
Position x Aspect	2	1739	869.52	1.6695	0.173	4983
Time x Position x Aspect	2	258.73	129.36	0.24839	0.9214	4986
Residual	48	24999	520.81			
Total	59	60037				

Appendix D: Pairwise tests of reef assemblages for significant terms. Significant results in bold.

1. Survey Time

Groups	t	P(perm)	Unique perms
1, 2	3.755	0.0002	4983
1, 3	4.6327	0.0002	4992
1, 4	8.0843	0.0002	4982
1, 5	7.6337	0.0002	4990
1, 6	8.0232	0.0002	4983
2, 3	2.6146	0.0004	4987
2, 4	6.9983	0.0002	4984
2, 5	6.829	0.0002	4988
2, 6	7.1843	0.0002	4988
3, 4	5.1313	0.0002	4990
3, 5	5.1223	0.0002	4984
3, 6	5.5641	0.0002	4981
4, 5	2.4707	0.0002	4988
4, 6	2.4909	0.0002	4983
5, 6	2.1261	0.0028	4989

2. Depth and Aspect

Term 'TixTr (DexAs)' for pairs of levels of factor 'Time'
Within level 'Deep' of factor 'Depth'
Within level 'Port' of factor 'Aspect'
Within level 'Bow' of factor 'Transect'

Groups	t	P(perm)	Unique perms
5, 6	1.6289	0.055	126

Within level 'Deep' of factor 'Depth'
Within level 'Port' of factor 'Aspect'
Within level 'Stern' of factor 'Transect'

Groups	t	P(perm)	Unique perms
5, 6	2.169	0.006	126

Within level 'Deep' of factor 'Depth'
Within level 'Starboard' of factor 'Aspect'
Within level 'Bow' of factor 'Transect'

Groups	t	P(perm)	Unique perms
5,6	1.2609	0.2164	126

Within level 'Deep' of factor 'Depth'
Within level 'Starboard' of factor 'Aspect'
Within level 'Stern' of factor 'Transect'

Groups	t	P(perm)	Unique perms
5, 6	1.4879	0.0576	126

Term 'TixTr (DexAs)' for pairs of levels of factor 'Time'
Within level 'Shallow' of factor 'Depth'
Within level 'Port' of factor 'Aspect'
Within level 'Bow' of factor 'Transect'

Groups	t	P(perm)	Unique perms
5, 6	2.0565	0.015	126

Appendix D: Continued

Within level 'Shallow' of factor 'Depth'
Within level 'Port' of factor 'Aspect'
Within level 'Stern' of factor 'Transect'

Groups	t	P(perm)	Unique perms
5, 6	1.9385	0.0476	126

Within level 'Shallow' of factor 'Depth'
Within level 'Starboard of factor 'Aspect'
Within level 'Bow' of factor 'Transect'

Groups	t	P(perm)	Unique perms
5, 6	1.2571	0.2098	126

Within level 'Shallow' of factor 'Depth'
Within level 'Starboard of factor 'Aspect'
Within level 'Stern of factor 'Transect'

Groups	t	P(perm)	Unique perms
5, 6	1.7067	0.0228	126

Term 'TixTr (DexAs)' for pairs of levels of factor 'Transect'
Within level '5' of factor 'Time'
Within level 'Deep' of factor 'Depth'
Within level 'Port' of factor 'Aspect'

Groups	t	P(perm)	Unique perms
Bow, Stern	0.78761	0.7156	126

Within level '5' of factor 'Time'
Within level 'Deep' of factor 'Depth'
Within level 'Starboard' of factor 'Aspect'

Groups	t	P(perm)	Unique perms
Bow, Stern	0.97055	0.4498	126

Within level '5' of factor 'Time'
Within level 'Shallow' of factor 'Depth'
Within level 'Port' of factor 'Aspect'

Groups	t	P(perm)	Unique perms
Bow, Stern	1.3595	0.1238	126

Within level '5' of factor 'Time'
Within level 'Shallow' of factor 'Depth'
Within level 'Starboard' of factor 'Aspect'

Groups	t	P(perm)	Unique perms
Bow, Stern	1.2307	0.2792	126

Term 'TixTr (DexAs)' for pairs of levels of factor 'Transect'
Within level '6' of factor 'Time'
Within level 'Deep' of factor 'Depth'
Within level 'Port' of factor 'Aspect'

Groups	t	P(perm)	Unique perms
Bow, Stern	2.4672	0.0076	126

Appendix D: Continued

Within level '6' of factor 'Time'
Within level 'Deep' of factor 'Depth'
Within level 'Starboard' of factor 'Aspect'

Groups	t	P(perm)	Unique perms
Bow, Stern	1.5635	0.1344	126

Within level '6' of factor 'Time'
Within level 'Shallow' of factor 'Depth'
Within level 'Port' of factor 'Aspect'

Groups	t	P(perm)	Unique perms
Bow, Stern	2.3252	0.018	126

Within level '6' of factor 'Time'
Within level 'Shallow' of factor 'Depth'
Within level 'Starboard' of factor 'Aspect'

Groups	t	P(perm)	Unique perms
Bow, Stern	1.5681	0.1552	126

3. Position on Deck

Groups	t	P(perm)	Unique perms
Bow, Mid	5.1196	0.0002	4981
Bow, Stern	2.803	0.0002	4992
Mid, Stern	5.976	0.0002	4981

Appendix E : Results of SIMPER analyses of reef assemblages of fish sampled in The Ex-Hmas Adelaide Articial Reef Community Surveys 5 and 6. Cut off for percentage contribution is 90 %. Note that only relevant SIMPER results have been included in this Appendix.

1. Survey Times

Groups 5 & 6

Average dissimilarity = 38.31

Species	Group 4	Group 5				
	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	67.95	73.11	12.18	1.21	31.8	31.8
Ecklonia radiata	4.83	4.93	4.53	0.42	11.82	43.62
Large barnacle,sediment,brown fil	6.16	3.21	3.91	0.53	10.21	53.83
Herdmania momus	4.92	4.14	3.34	0.68	8.72	62.55
Biflustra perfragilis	3.35	2.7	2.62	0.46	6.84	69.39
Encrusting orange bryozoan	0.02	3.46	1.72	0.73	4.5	73.89
White papillate sponge	0.12	2.85	1.42	0.81	3.69	77.59
Encrusting red algae	1.52	1.04	1.13	0.52	2.94	80.53
Turfing brown algae	1.4	0.76	0.99	0.43	2.58	83.11
White globular sponge	1.74	0.12	0.87	0.67	2.28	85.39
Encrusting yellow bryozoan	1.01	0	0.5	0.43	1.32	86.7
Yellow encrusting sponge	0.47	0.47	0.41	0.47	1.08	87.79
Colonial ascidian	0.41	0.47	0.4	0.4	1.04	88.82
Orange encrusting sponge	0.62	0.3	0.4	0.56	1.03	89.86
Lobed Brown Algae	0.4	0.43	0.4	0.31	1.03	90.89

2. Orientation

Groups Deck & Hull

Average dissimilarity = 36.54

Species	Group Deck	Group Hull				
	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	74.15	75.73	12.17	1.09	33.3	33.3
Ecklonia radiata	13.33	0	6.64	0.52	18.18	51.48
Large barnacle,sediment,brown fil	0	6.01	3	0.32	8.21	59.69
Herdmania momus	0	3.46	1.73	0.41	4.73	64.42
Encrusting red algae	3.36	0.04	1.67	0.66	4.58	69.01
Turfing brown algae	1.34	2.36	1.62	0.53	4.43	73.44
Encrusting orange bryozoan	0.07	2.71	1.35	0.74	3.71	77.15
White papillate sponge	0.1	1.92	0.96	0.74	2.63	79.77
White globular sponge	0.61	1.02	0.74	0.54	2.02	81.8
Encrusting yellow bryozoan	0	1.16	0.58	0.5	1.58	83.38
Biflustra perfragilis	0.63	0.67	0.57	0.49	1.56	84.94
Red filamentous	1.08	0	0.54	0.39	1.47	86.41
Yellow encrusting sponge	0.89	0.35	0.52	0.52	1.43	87.85
Colonial ascidian	0	0.85	0.42	0.65	1.15	89
Bare ships surface	0.08	0.77	0.41	0.54	1.13	90.13

Appendix E: Continued

3. Depth and Aspect

Groups Deep & Shallow

Average dissimilarity = 35.14

Species	Group Deep	Group Shallow				
	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	66.49	66.02	9.8	1.22	27.88	27.88
Large barnacle,sediment,brown fil	12.53	3.07	5.86	0.82	16.68	44.55
Biflustra perfragilis	1.14	9.9	4.83	0.64	13.73	58.28
Herdmania momus	6.33	10.15	4.4	0.82	12.53	70.82
Encrusting orange bryozoan	4.26	1.15	2.2	0.82	6.26	77.08
White papillate sponge	1.6	3.18	1.73	0.91	4.94	82.02
White globular sponge	0.84	1.45	0.85	0.93	2.42	84.44
Encrusting yellow bryozoan	1.02	0.35	0.61	0.45	1.75	86.18
Colonial ascidian	1.01	0.28	0.58	0.44	1.64	87.83
Barnacle,sediment,brown fil	0.74	0.43	0.57	0.22	1.63	89.45
Turfing brown algae	0.5	0.51	0.47	0.4	1.33	90.79

4. Deck Position

Groups Bow and Mid

Average dissimilarity = 40.36

Species	Group Bow	Group Mid				
	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Ecklonia radiata	0	40	19.93	1.35	37.36	37.36
Serpulid, barnacle and encrusting algae matrix	82.29	45.7	19.81	1.59	37.13	74.49
Encrusting red algae	5.02	4.39	2.95	1.09	5.54	80.02
Turfing brown algae	3	0.45	1.59	0.52	2.98	83.01
Red filamentous	1.83	1.31	1.29	0.66	2.42	85.43
Lobed Brown Algae	0	2.37	1.18	0.67	2.22	87.65
Yellow encrusting sponge	1.77	0.4	0.93	0.62	1.74	89.38
Biflustra perfragilis	1.48	0.35	0.85	0.46	1.59	90.97

Groups Bow and Stern

Average dissimilarity = 40.36

Species	Group Bow	Group Stern				
	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	82.29	94.44	7.05	1.22	39.58	39.58
Encrusting red algae	5.02	0.66	2.53	0.75	14.22	53.8
Turfing brown algae	3	0.56	1.63	0.53	9.15	62.95
Yellow encrusting sponge	1.77	0.5	0.97	0.64	5.44	68.39
Red filamentous	1.83	0.1	0.93	0.43	5.24	73.63
Fish in frame	0.36	1.47	0.79	0.63	4.45	78.08
Biflustra perfragilis	1.48	0.05	0.75	0.4	4.24	82.32
White globular sponge	1.32	0	0.66	0.35	3.71	86.03
Orange filamentous algae	0.15	0.66	0.38	0.52	2.11	88.14
Red thin branching algae	0	0.66	0.33	0.37	1.85	89.99
Brown filamentous algae	0.66	0	0.33	0.61	1.84	91.83

Appendix E: Continued

Groups Mid and Stern

Average dissimilarity = 40.36

Species	Group Bow	Group Stern				
	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	45.7	94.44	24.46	1.85	45.52	45.52
Ecklonia radiata	40	0	19.92	1.35	37.06	82.58
Encrusting red algae	4.39	0.66	2.1	1.18	3.9	86.48
Lobed Brown Algae	2.37	0	1.18	0.67	2.2	88.68
Red thin branching algae	1.37	0.66	0.86	0.71	1.59	90.27

Appendix F: Distance based test for homogeneity of multivariate dispersion between Surveys 5 and 6. Significant results in bold

1. Survey Time

F	1.0781		
P(perm)	0.4362		
Group	Size	Average	SE
5	82	27.108	1.7672
6	82	24.484	1.8067

2. Orientation

F	3.61		
P(perm)	0.2002		
Groups	t	P(perm)	
(Deck,Hull)	1.9	0.1946	
Groups	Size	Average	SE
Deck	60	27.43	2.0511
Hull	24	20.056	3.3736

2. Depth and Aspect

F	0.043521		
P(perm)	0.8632		
Groups	Size	Average	SE
Deep	40	22.488	2.0074
Shallow	40	23.052	1.8143

F	0.043521		
P(perm)	0.8632		
Groups	t	P(perm)	
(5Bow,5Stern)	0.98864	0.4514	
(5Bow,6Bow)	0.31819	0.8138	
(5Bow,6Stern)	1.3049	0.3294	
(5Stern,6Bow)	0.74913	0.565	
(5Stern,6Stern)	0.39299	0.7714	
(6Bow,6Stern)	1.1236	0.3854	
Groups	Size	Average	SE
5 Bow	20	25.311	3.6548
5 Stern	20	21.146	2.0963
6 Bow	20	23.827	2.9003
6 Stern	20	20.113	1.5853

Appendix F: Continued

4. Deck Positions

F	43.653		
P(perm)	0.0002		
Groups	t	P(perm)	
(Bow,Mid)	5.0161	0.0002	
(Bow,Stern)	4.5388	0.0002	
(Mid,Stern)	8.8882	0.0002	
Group	Size	Average	SE
Bow	20	15.042	1.8516
Mid	20	31.984	2.8249
Stern	20	5.8799	0.80361