Cardno Ecology Lab

Shaping the Future

Marine and Freshwater Studies

Ex-HMAS Adelaide Artificial Reef

Reef Community Monitoring

Survey 4

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Cover Image: Ex-HMAS Adelaide reef assemblage and White ear (*Parma microlepis*) feeding, August 2012. Photographer, Alan Mclennan (Mclennan Diving Services).

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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 4 (**Table ES 1**), the fourth 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 27 July 2012. Survey methods involved using divers to take photoquadrats and under water video 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 baseline and previous Monitoring Surveys. Underwater video footage was reviewed and also used to describe the encrusting reef assemblage.

Analysis of photoquadrats taken from different parts of the ship showed that the number of individual taxa or groups of taxa (37 recorded) was similar to that of previous surveys, although the assemblage in Survey 4 was less variable, indicated that the assemblage has become more uniform over the ship as a whole.

Similar to the previous survey, the most abundant group throughout the survey was the serpulid polychaete, barnacle and encrusting algae matrix. Other 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. Several taxa/groupings not previously documented on the ship, but were recorded during monitoring Survey 4, included an orange colonial ascidian (likely to be *Botryloides leachi*) and a purple sponge, although these groups were present in low abundances. Some species of bryozoan, algae and sponges that were present in the previous survey were not recorded in the current survey. Overall there has 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 15 months post-scuttling was significantly different to that in previous surveys, although there were similarities in some of the spatial patterns. Orientation continues to be an important factor in structuring the reef assemblage although neither time nor position (depth and/or aspect) independently caused significant differences to assemblage composition. Species assemblages on the deck surfaces of the ship varied significantly between Surveys 3 and 4, although this was dependent on position (bow, mid and stern). Assemblages recorded on the port side of the deck were also consistently different from those on the starboard side, regardless of survey time.

Inspection of the fixed photos indicated that the encrusting layer has become marginally thicker on certain parts of the ship such as ladders and railings, but not on others, since the previous survey. All surfaces are now covered with an encrusting assemblage of barnacles, ascidians, bryozoans, sponges, and algae. It is presumed that bare patches observed in some photographs have occurred where thick crusts of reef have become unstable and broken off in large swells.

Fish abundance and species richness observed around the Ex-HMAS Adelaide has generally increased over the past year, although in the current survey, fewer taxa (13) were observed than the previous three surveys. This may have been due to the fact that sampling for the current survey was carried out over one single day rather than two days, so fewer individuals are likely to have been recorded. Two new species (batfish (*Platax* sp.) and dusky flathead (*Platycephalus fuscus*)) were however, recorded in the current survey.

The eastern blue groper (*Archoerodus viridis*) (observed in Monitoring Surveys 1, 2, 3 and 4) is protected under the NSW *Fisheries Management Act 1994*. 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

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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
LAT	Lowest Astronomical Tide
Epiphytic	Growing on the surface of.
LTMMP	Long Term Monitoring and Management Plan
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.
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 fourth 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. This will be verified as part of the 12 month structural inspection.

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.

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

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**.

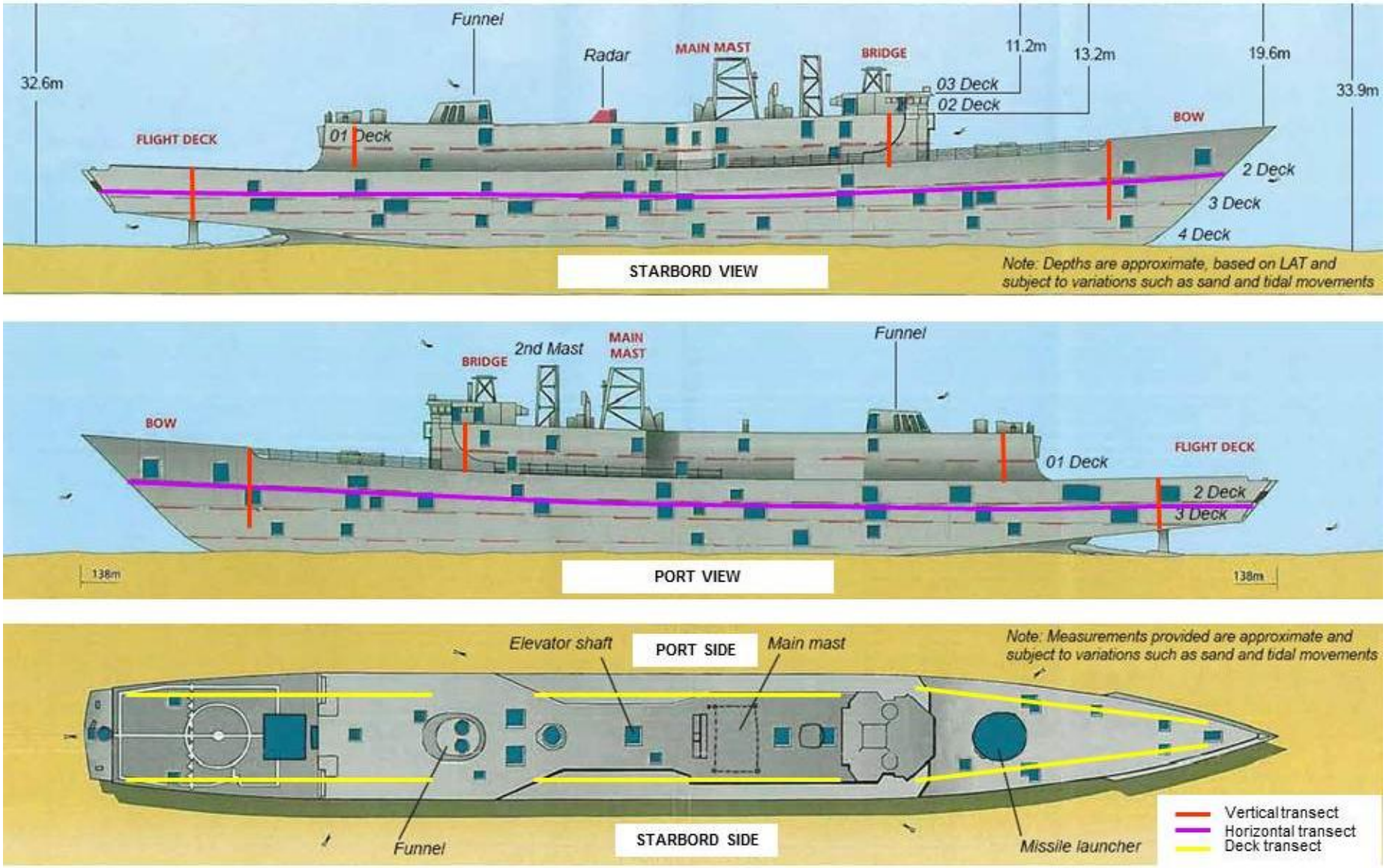

Figure 2: Plans of the Ex-HMAS Adelaide and Positions of the Reef Community Survey Sampling Transects.

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 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 is to provide a qualitative record of changes to reef assemblages over time. These locations were marked with luminous flagging tape and locations noted to assist in identifying these points in future surveys. 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 at this early stage of colonisation, species level identification of many encrusting organisms such as sponges, bryozoans and ascidians was not 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.

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 3 and 4. 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 3/Survey 4): 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 3/Survey 4): 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 3/Survey 4): 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.

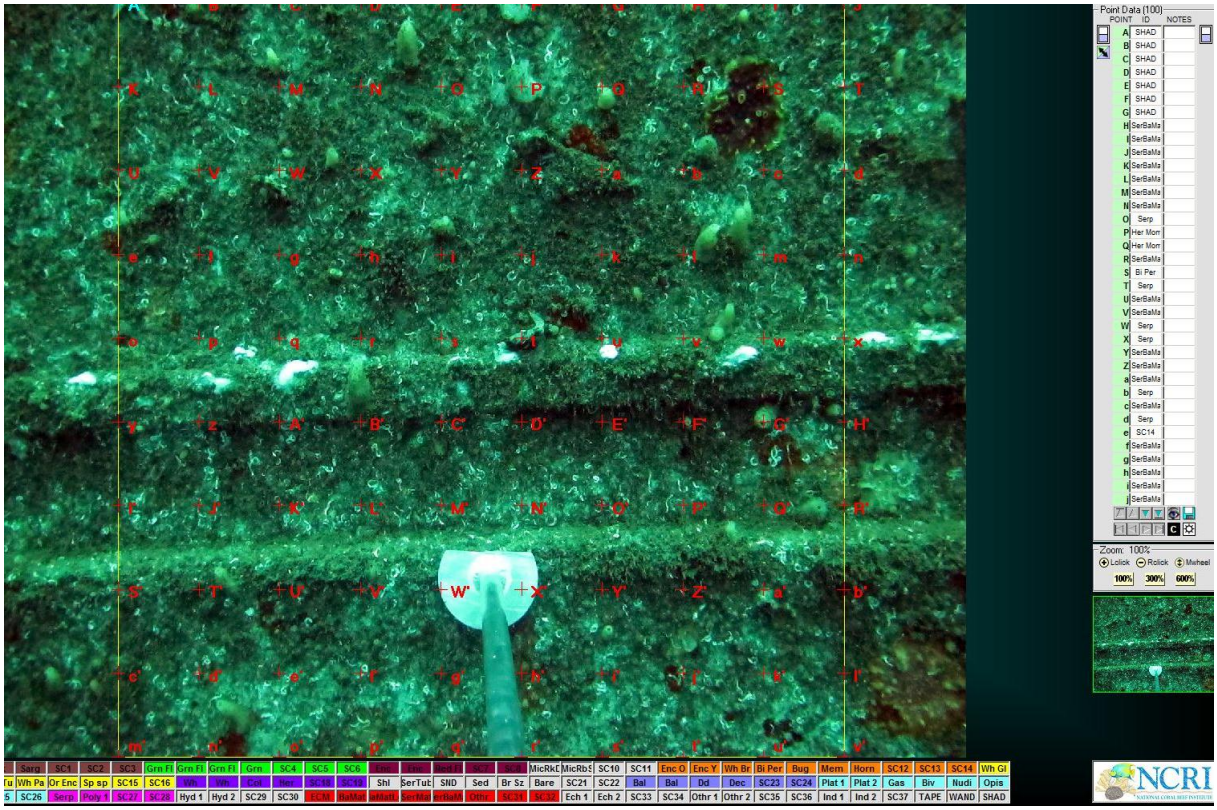

Figure 3: Screenshot of the CPCe Photoquadrat Analyses Frame with a Virtual 10 x 10 Grid Overlayed.

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, 37 categories were identified from the 82 quadrats that were sampled. An encrusting matix of serpulid polychaete worms, barnacles, turfing algae and sediment had on average, the greatest percentage cover across the survey. Bryozoans, hydroids, ascidians, sponges and anemones were also present but in relatively lower abundances. Other 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. Several taxa/groupings not previously documented on the ship, but were recorded during monitoring survey 4, included an orange colonial ascidian (likely to be *Botryloides leachi*) and a purple sponge, although these groups were present in low abundances. Some species of bryozoan, algae and sponges that were present in the previous survey were not recorded in the current survey. Overall there has appeared to be a transition from an assemblage numerically dominated by an encrusting serpulid matrix to that dominated by barnacles and ascidians. The brown algae (*Ecklonia radiata*) appeared to have decreased in percentage cover in comparison to the previous survey.

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 are presented in **Plates 1 – 16**.

3.1.2 Spatial and Temporal Variation in Reef Communities

Overall, the assemblage sampled at Survey 4 was significantly different to those sampled during Surveys 1, 2 and 3 (**Appendix C**), which is indicated within the PCoA (**Figure 4**). Approximately 49 % of the total variation among samples appeared to be explained by the differences between Survey 4 and earlier surveys.

The taxa/groupings that best described the differences in assemblage structure between Survey 4 and the previous survey (Survey 3) included serpulid, barnacle and encrusting algal matrix, which increased from 41 % to 73 % in average abundance), serpulid matrix and the solitary ascidian (*Herdmania momus*) which both decreased in average abundance (**Appendix E**).

PERMDISP indicated that the variability among samples observed during Survey 4 was significantly less than in previous surveys. This is shown in **Figure 4** where data points in survey 4 are more closely clustered than in earlier surveys (**Appendix F**).

Orientation

A similar pattern to earlier surveys was observed in Survey 4 whereby assemblages on the hull and deck surfaces varied significantly, but patterns were not consistent through time (**Appendix C**). Pair-wise tests indicated that this was due to differences between Surveys 3 and 4 for both vertically (hull) and horizontally (deck) orientated transects (**Appendix D**). This is illustrated in the corresponding PCoA (**Figure 5**). Species groups characterising vertical and horizontal surfaces in Survey 3 were generally similar to that of Survey 4 but less varied in composition and showed differing patterns in abundance (**Appendix E**). SIMPER analyses indicated that the difference in assemblages between the deck and the hull in Survey 3 was mainly due to a greater abundance (% cover) of serpulid, barnacle and encrusting algae matrix on the hull surface compared to the deck (**Appendix E**). In Survey 4 the serpulid, barnacle and encrusting algae matrix accounted for over 50 % cover on both vertical and hull surfaces, although there was a greater abundance of turfing brown sediment and serpulid matrix/serpulid matrix on the deck compared to the hull. In both Surveys, the solitary ascidian *Herdmania momus* was more abundant on hull surfaces compared to deck surfaces.

PERMDISP indicated that the variation among samples was significantly less for Survey 4 than for the previous survey (**Appendix F**).

Depth and Aspect

Assemblage patterns relating to depth and aspect were similar for Surveys 3 and 4 (**Figure 6**). Neither depth nor aspect independently attributed to significant differences among assemblages associated with the ship. A significant interaction was, however, evident among time, depth, aspect and transect (**Appendix C**), which indicated that the differences among transects (**Appendix C**) were dependent on time as well as depth (deep/shallow) and aspect (port/starboard). Pair-wise tests indicated that within Survey 3, assemblages sampled from the shallow and deep port bow, shallow and deep port stern and shallow and deep starboard bow varied significantly. Assemblages sampled from shallow and deep transects from the port bow during Survey 4 also varied significantly (**Figure 6**, **Appendix D**). The main groups responsible for these differences were the serpulid, barnacle and encrusting algae matrix and the solitary ascidian *Herdmania momus* although no consistent pattern was observed in relation to depth (**Appendix E**).

PERMDISP indicated that the assemblage in Survey 4 was less variable than that of Survey 3 (**Appendix F**).

Deck Position (Bow, Midships, Stern)

Species assemblages on the deck surfaces of the ship varied significantly between Surveys 3 and 4 although this was dependent on position (bow, mid and stern) (**Figure 7**, **Appendix D**). SIMPER analyses (**Appendix E**) indicated that this was due to an overall increase in abundance of the serpulid, barnacle and encrusting algae matrix and decrease in the amount of serpulid matrix and turfing brown sediment and serpulid matrix. In Survey 4, the serpulid, barnacle and encrusting algae matrix accounted for over 90 % of the average abundance for the bow, midships and stern positions whereas turfing brown sediment, serpulid matrix and *Ecklonia radiata* were numerically dominant at different positions of the ship in earlier surveys. It is noted that *Ecklonia radiata* was important in structuring the midship assemblage for both Surveys 3 and 4, but not at the bow or stern.

Assemblages recorded on the port side of the deck were also consistently different from those on the starboard side, regardless of survey time (**Appendix C and D**). The serpulid, barnacle and encrusting algal matrix was again the main group structuring these differences although the differences were not consistent among positions on the deck. For example, cover was greater on the starboard side at the bow but less on the starboard side at the midship and stern positions. These broader patterns are evident within the PCoA (**Figure 7**).

PERMDISP indicated that the variation among samples was significantly less for Survey 4 than for the previous survey (**Appendix F, Figure 7**).

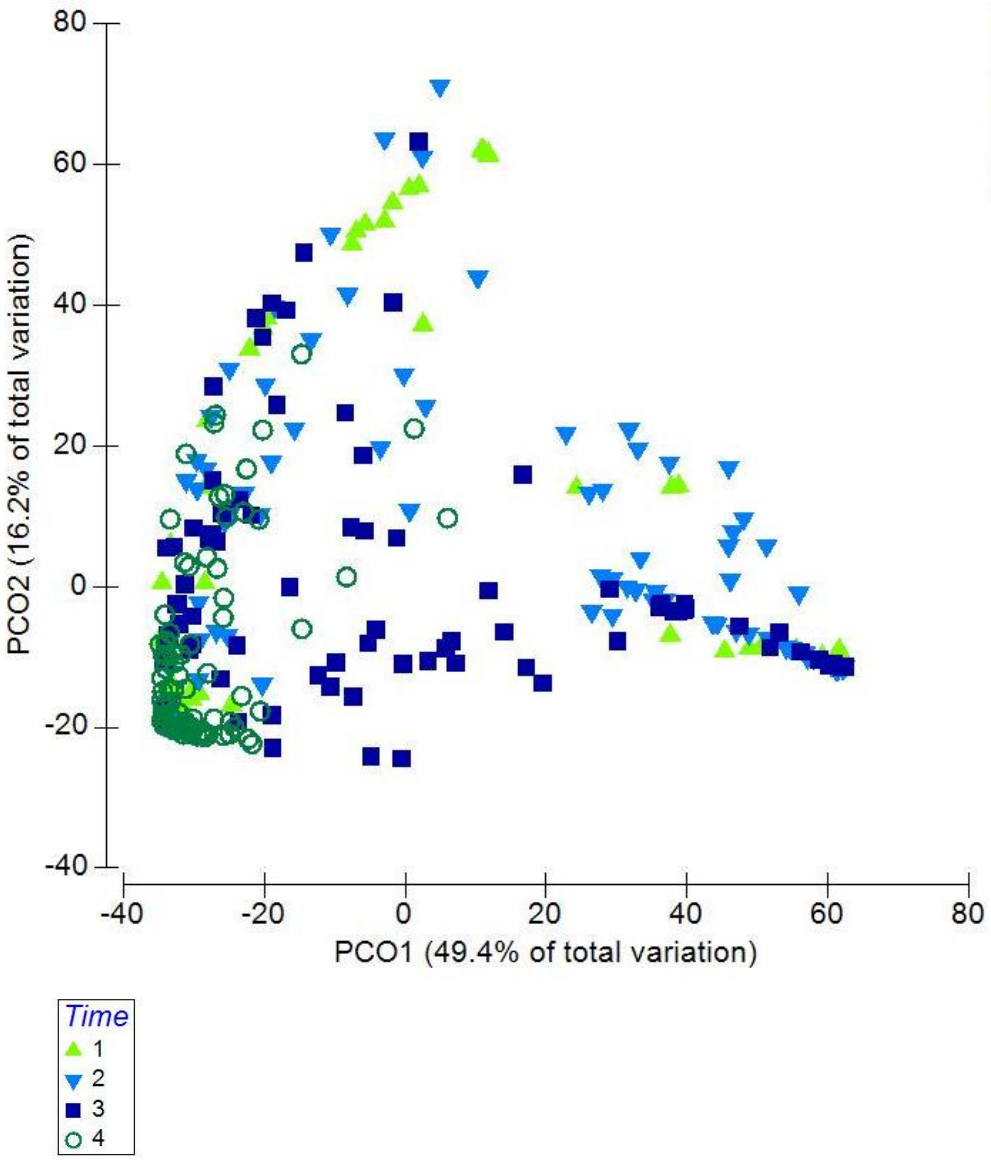

Figure 4: Principal Coordinates Analyses (PCoA) of Percent Cover of Encrusting Assemblages from Transects Taken at all Positions on the Ex-HMAS Adelaide for Surveys 1, 2, 3 and 4.

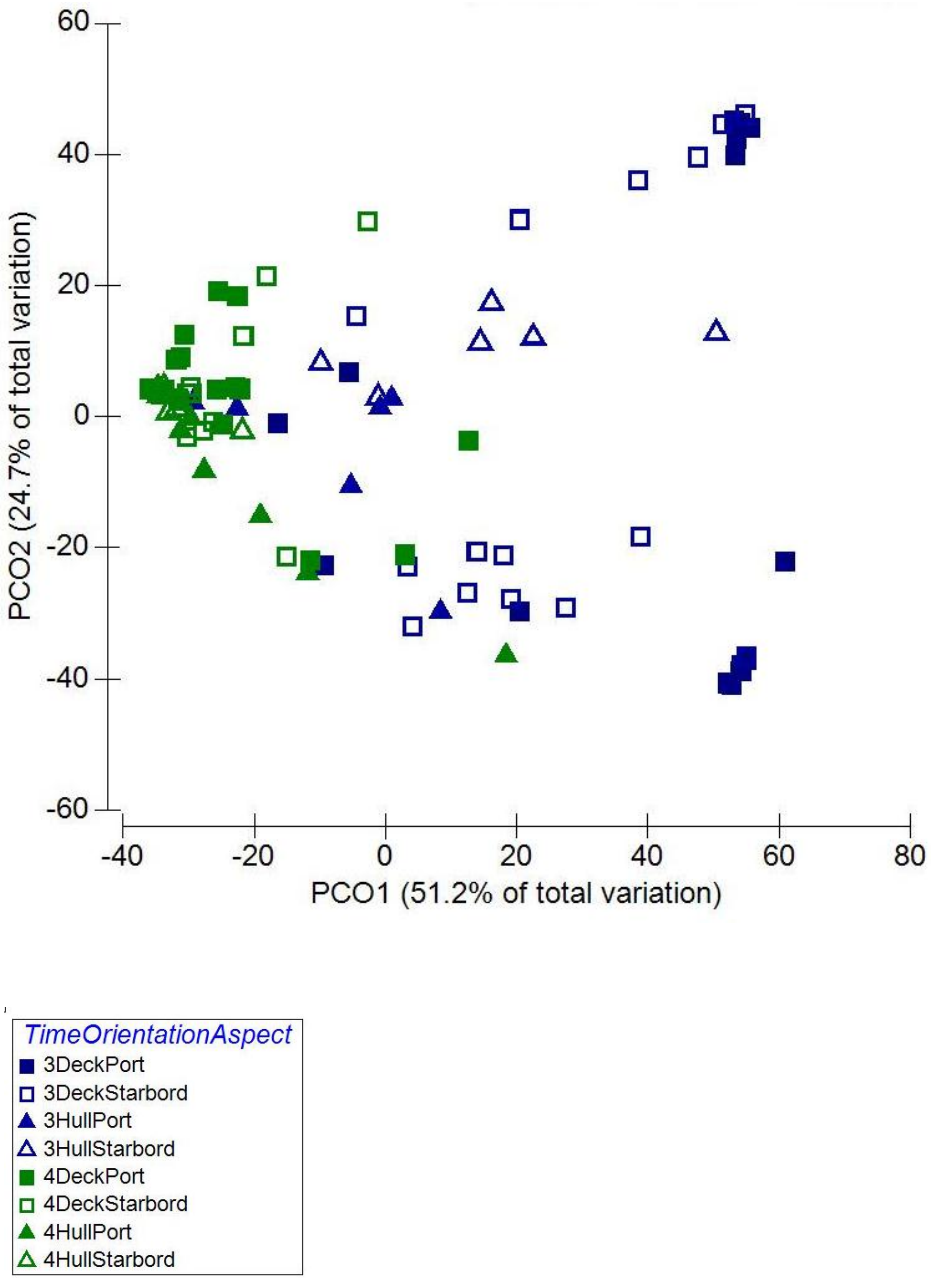

Figure 5: Principal Coordinates Analyses (PCoA) of Percent Cover of Encrusting Assemblages from Transects Taken on Hull and Deck Surfaces of the Ex-HMAS Adelaide for Surveys 3 and 4.

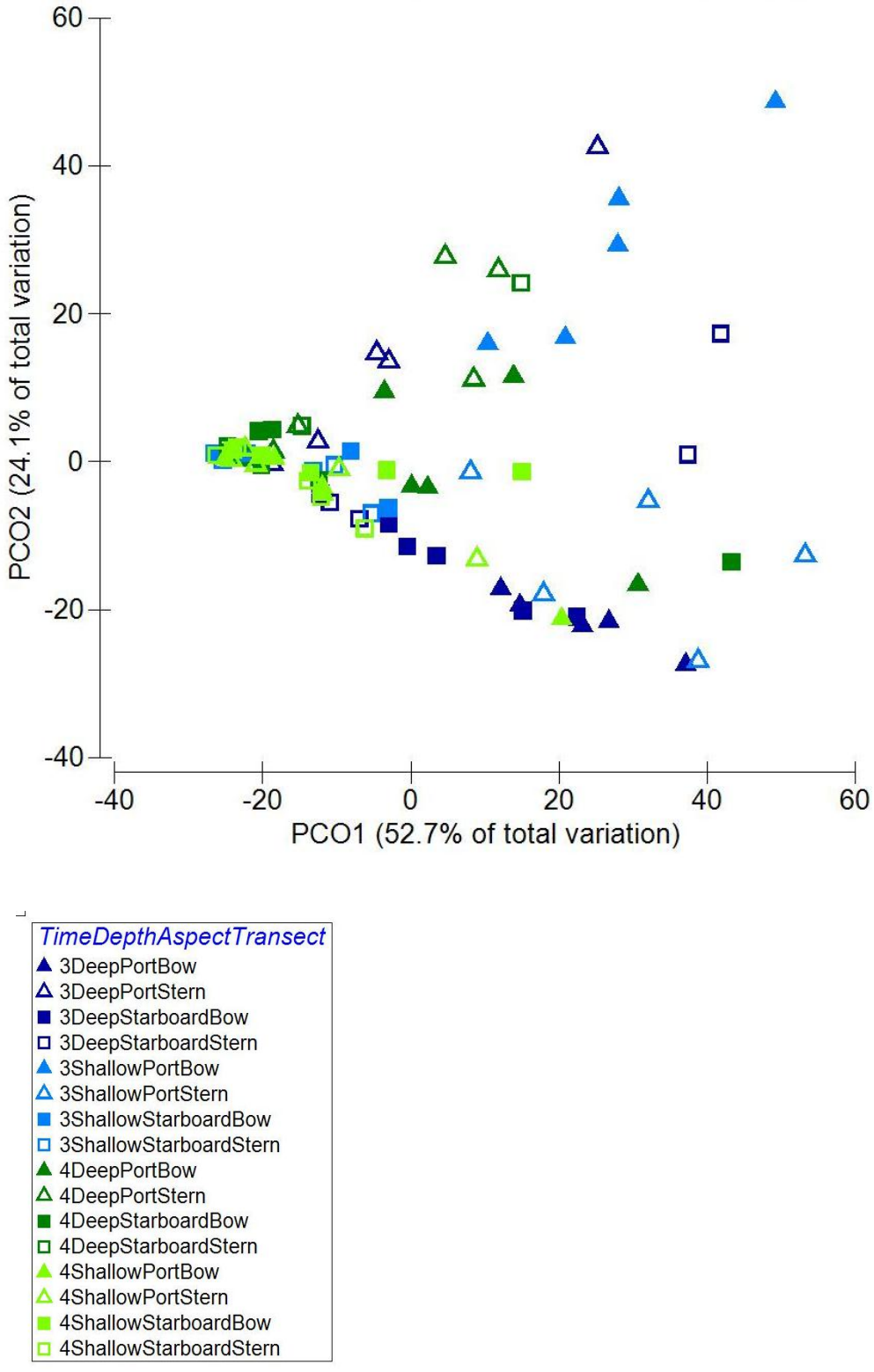

Figure 6: Principal Coordinates Analyses (PCoA) of Percent Cover of Encrusting Assemblages from Transects at Different Depths and Aspect on the Ex-HMAS Adelaide for Surveys 3 and 4.

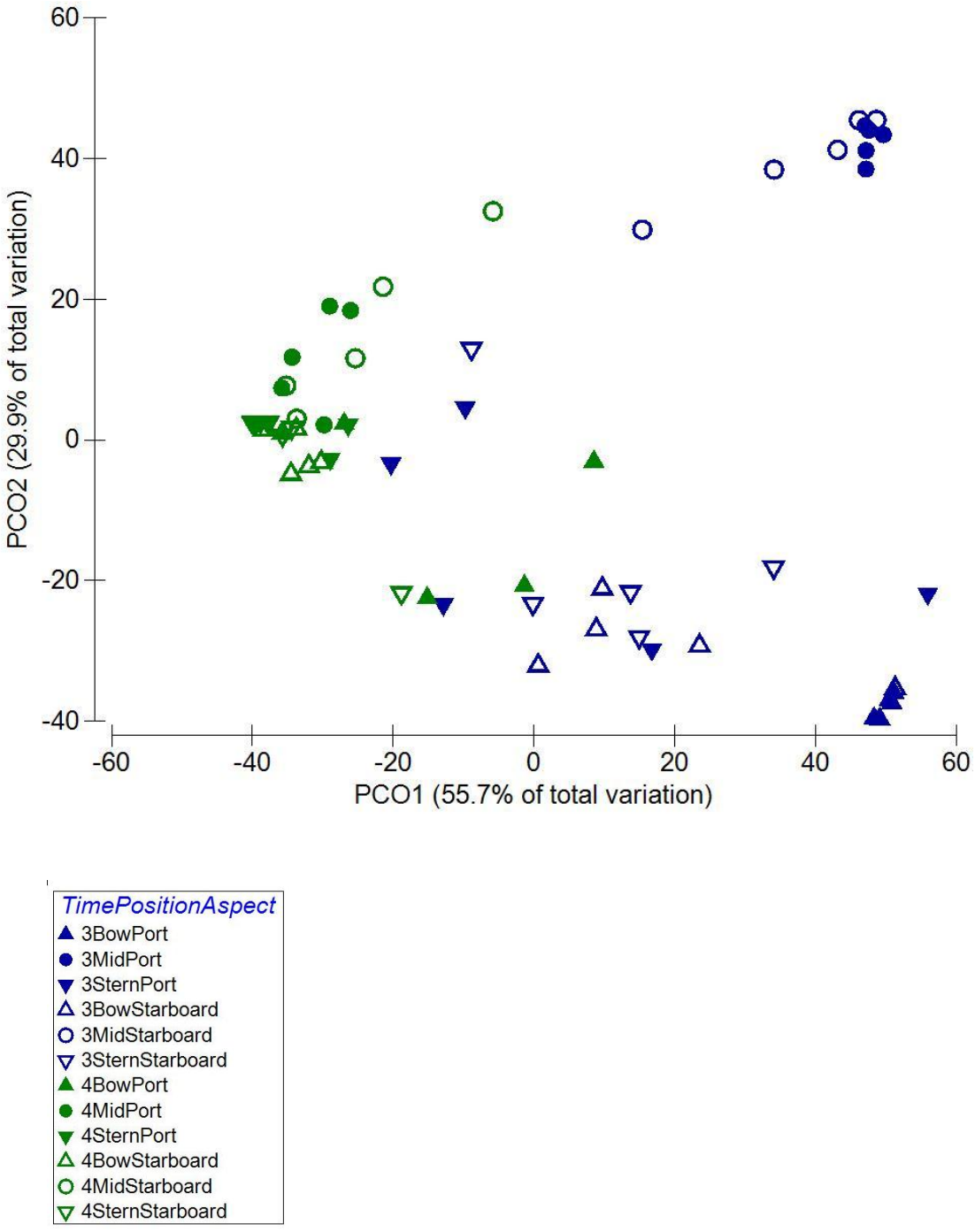

Figure 7: Principal Coordinates Analyses (PCoA) of Percent Cover of Encrusting Assemblages from Transects Taken at Different Positions on the Deck Ex-HMAS Adelaide for Surveys 3 and 4.

3.2 Fixed Photographs

Photographs taken from fixed locations are presented in **Appendix A.** Inspection of the fixed photos indicates that the encrusting layer has become marginally thicker on certain parts of the ship such as ladders and railings, but not on others, since the previous survey.

All surfaces are now covered with an encrusting assemblage of barnacles, ascidians, bryozoans, sponges, and algae. Railings, ladders, door frames were also covered in a thick layer of large ascidians, hydroids, anemones and mobile invertebrates such as gastropod molluscs and crabs. *Ecklonia radiata* and small clumps of hydroids have colonised and developed on new parts of the ship (e.g. Fixed Photos 3, 6 and 7). In some photos (e.g. fixed photo 1 and 5), white patches can be seen where the bare ships surface has become visible. It is presumed that this is because thick crusts of encrusting reef have become unstable and been either broke off in storms or accidentally brushed off by divers.

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 4) are listed in **Table 3**. Species of recreational, commercial or conservation value are indicated.

Table 2: Summary of Observations of Attached Encrusting and Fish Assemblages Observed from Video Footage of the Ex-HMAS Adelaide in May 2012 (Survey 4).

Position	Description of Assemblage
Deck Port Bow	The deck surface is heavily encrusted with growth of serpulid worm tubes, small 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 on the deck.
Deck Port Mid	Kelp (*Ecklonia radiata*) fronds have grown notably 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 serpulid worm tubes, small barnacles, encrusting algae, hydroids and fine filamentous algae. 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 again abundant in schools and observed feeding on the deck. Dusky flathead (*Platycephalus fuscus*) were also observed laying stationary on the deck.
Deck Port Stern	The deck was predominantly covered in serpulid worm tubes, covered with small barnacles, encrusting algae, hydroids and fine filamentous algae. Some sand and occasional patches of orange encrusting sponge and red encrusting algae was also observed.
Deck Starboard Bow	Encrusting growth of predominantly serpulid worm tubes, small barnacles, encrusting algae, hydroids and fine filamentous algae was abundant on the flat areas of the deck with patches of encrusting sponges. Tarwhine (*Rhabdosargus sarba*) were abundant in schools and observed feeding on the deck.
Deck Starboard Mid	Kelp (*Ecklonia radiata*) fronds have grown notably following the previous survey particularly along the edges of the midships (although this was not evident from the photoquadrats). An unknown bright white encrusting substance (observed in previous survey) remained present. The majority of the deck is otherwise heavily encrusted with serpulid worm tubes, small barnacles, encrusting algae, hydroids and fine filamentous algae. 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 again abundant in schools and observed feeding on the deck.

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. Schools of tarwhine (*Rhabdoglosus sarba*) were observed.
Horizontal Hull Port and Starboard	The hull has become heavily colonised by sessile invertebrates on both the port and starboard aspects of the ship. These included ascidians (predominantly *Herdmania momus,* but also *Botryloides magnicoecum*), large barnacles (*Balanus* spp.) yellow, orange and white encrusting sponges and bryozoans such as *Tryphyllozoan* sp. 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.
Vertical Hull Bow	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. 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. Longfin pike (*Dinolestes lewini*) were observed swimming along the hull in a small school.
Vertical Hull Stern	Ascidians and large barnacles were again more prevalent on the hull of the ship, in comparison to the deck surfaces, while barnacles, bryozoans and sponges were also observed. The vertical plane of the hull was otherwise encrusted with a layer of serpulid worm tubes covered with small 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 small barnacles, encrusting algae, hydroids and fine filamentous algae.

Table 3: Species of Fish Observed in Association with the Ex-HMAS Adelaide Artificial Reef between April/May 2011 and August 2012. (*) = recreationally important species, (+) = commercially important species, (#) = species of conservation significance.

Family	Species Name	Common Name	Baseline Survey (April/May 2011)	Survey 1 (October 2011)	Survey 2 (February 2012)	Survey 3 (May 2012)	Survey 4 (August 2012)
Aulopidae	*Aulopus purpurrissatus*	Sergeant baker		●	●	●	
Scorpaenidae	*Centropogon australis*	Eastern fortesque		●	●	●	
Scorpaenidae	*Scorpaena cardinalis*	Red rock cod		●	●		
Dinolestidae	*Dinolestes leweni*	Longfin pike		●			●
Carangidae	*Trachurus novaezelandiae*	Yellowtail scad+		●			●
Carangidae	*Seriola lalandi*	Yellowtail kingfish			●	●	
Sparidae	*Pagrus auratus*	Snapper (juv)*+		●	●	●	
Sparidae	*Rhabdosargus sarba*	Tarwhine			●	●	●
Mullidae	*Parupeneus spilurus*	Blackspot goatfish	●				
Chaetodontidae	*Hemiochus* sp.	Bannerfish	●	●			
Scorpididae	*Scorpis lineolata*	Silver sweep*		●	●	●	
Platycephalidae	*Platycephalus fuscus*	Dusky flathead*+					●
Microcanthidae	*Atypicthys strigatus*	Mado		●	●	●	●
Microcanthidae	*Microcanthus strigatus*	Stripey		●	●	●	
Ephippidae	*Platax sp.*	Batfish					●
Cheilodactylidae	*Nemadactylus douglasii*	Blue morwong*		●	●		
Cheilodactylidae	*Cheilodactylus fuscus*	Red morwong		●	●	●	●
Latridiidae	*Latridopsis forsteri*	Bastard trumpeter		●	●		
Pomacentridae	*Parma microlepis*	White ear		●			●
Pomacentridae	*Parma unifasciata*	Girdled scalyfin			●		
Labridae	*Achoerodus viridis*	Eastern blue groper#		●	●	●	●

Labridae	*Notolabrus parilus*	Brown spotted wrasse				●	
Labridae	*Notolabrus gymnogenis*	Crimson banded wrasse				●	
Blenniidae	*Petroscirtes lupus*	Sabretooth blenny	●				
Monacanthidae	*Nelusetta ayraudi*	Chinaman leather jacket*+		●	●	●	
Monacanthidae	*Meuschenia trachylepis*	Yellowfin leatherjacket				●	
Monacanthidae	*Meuschenia sp.*	Unidentified leatherjacket				●	●
Tetraodonitdae	*Dicotlichthys punctulatus*	Three-bar porcupinefish		●			
Enoplosidae	*Enoplosus armatus*	Old wife				●	●
Kyphosidae	*Kyphosus sydneyanus*	Silver drummer				●	
Lutjanidae	*Pseudocaranx dentex*	Silver trevally				●	●
Serranidae	*Hypoplectrodes maccullochi*	Half-banded sea perch				●	●
Total Taxa			**3**	**17**	**15**	**19**	**13**

4 Discussion

4.1 Encrusting Biota

Overall, the assemblage sampled at Survey 4 (carried out approximately 15 months post-scuttling) was different to that sampled during Surveys 1, 2 and 3. Results of Survey 4, shows that new taxa/groups are being observed which were not seen in previous surveys, although in relative low abundances. Based on the monitoring results of other long-term studies of benthic assemblages on artificial reefs, this would be expected, with many examples showing changes continuing over several years and even decades (e.g. Perkol-Finkel and Benayahu 2004, Nicoletti *et al*. 2007). While the number of taxa/groups recorded had increased, the variability among samples decreased between surveys 3 and 4. This indicates that the species assemblage on the ship as a whole, has become more uniform over time, although distinct spatial patterns are still evident. This is attributed to the succession of the underlying encrusting matrix which has become progressively colonised by small barnacles in addition to the existing scrupled tubes and encrusting algae over the majority of the vessel. It is possible that barnacles had initially colonised the surface of the ship but have not become visible in the photoquadrats until the current survey as they have grown. In many of the photoquadrats these are only identifiable by the small dark slits of their operculum.

The greatest coverage throughout the ships surface was a matrix of serpulid worms and barnacles associated with an encrusting algal matrix. Other taxa/groupings that were well represented during Monitoring Survey 4 included the ascidian *Herdmania momus* and a matrix of large barnacles, sediment and brown filamentous algae. These encrusting matrices are likely to provide habitat for small invertebrates such as polychaetes, amphipod crustaceans and bivalves among others. Close up photographs and video footage showed that larger mobile macroinvertebrates such as gastropod molluscs and crabs have also begun to inhabit the encrusting reef assemblage in places.

Analysis of photoquadrats taken from different parts of the ship indicated that species assemblages varied through time, but that these differences were not necessarily consistent among transects. It is likely that there are several bio-physical factors which are driving spatial and temporal differences in species assemblages. In the current and previous surveys, transects on the deck (horizontally orientated) were generally different from the hull (vertically orientated). These differences were mainly due to a greater presence of ascidians (*Herdmania momus*) and a greater cover of turfing brown algae/sediment/serpulid matrix on the deck of the ship. 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. Video footage also showed that large filter feeding barnacles and ascidians tend to occur around portholes, doorframes and ladders, which may be related to increased current velocities and eddies created in association with these more complex structures.

Depth or aspect alone did not appear to be important structuring the ships assemblage. It is noted that *Ecklonia radiata* was important in structuring the midship assemblage for both Surveys 3 and 4, but not at the bow or stern. Video footage also showed that *Ecklonia* had grown substantially on the top of the superstructure, where light availability is likely to be optimum.

4.2 Fish and Macroinvertebrates

Fish abundance and species richness observed around the Ex-HMAS Adelaide has generally increased over the past year, although in the current survey, fewer taxa (13) were observed than the previous three surveys. Two new species (batfish (*Platax* sp.) and dusky flathead (*Platycephalus fuscus*)), not recorded in previous surveys, were, however, observed in the current survey. Dusky flathead are generally associated with soft sediments and estuaries rather than offshore reefs, but several individuals were observed sitting stationary on the surface of the ship's deck. This is likely to provide sufficient camouflage for the species while feeding, as they are primarily ambush (lie and wait) predators, preying on small fish, prawns, crabs and squid (Scandol *et al.* 2008). Large schools of tarwhine (*Rhabdosargus sarba*) were also recorded in association with the deck where they were observed feeding on the encrusting benthic assemblage. Tarwhine spawn in winter and are often associated with coastal rocky reef where they are known to feed on sessile invertebrates such as molluscs, crustaceans and polychaete worms (Scandol *et al*. 2008). It is important to note that observations of fish carried out as part of this survey is not quantitative and should be treated as indicative only. It is possible that the smaller number of

species observed is due to seasonal differences, but may also be due to the fact that sampling for the current survey was carried out over one single day rather than two days, so fewer individuals are likely to have been observed.

5 Acknowledgements

This report was written by Kate Reeds and reviewed by Brendan Alderson. Field Work was done by Craig Blount and Mclennan Diving Services. Cardno Ecology Lab thanks Terrigal Dive Centre and Mclennan Diving Services in assisting with this survey.

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7 Plates

Deck, Port Bow

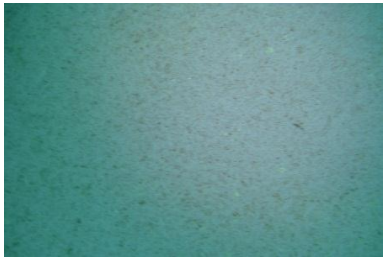
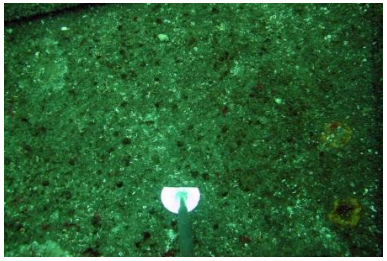
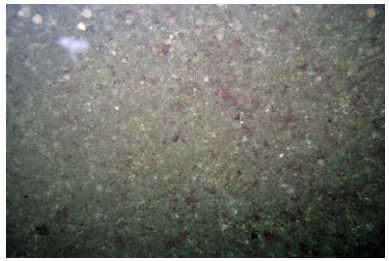
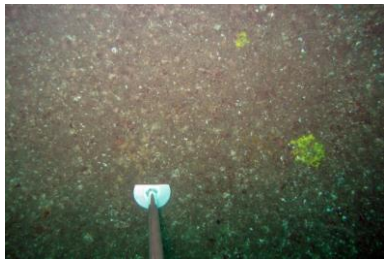
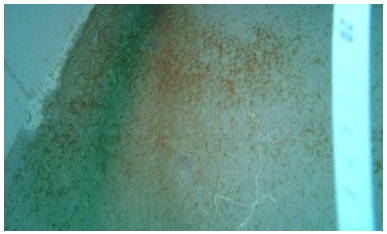
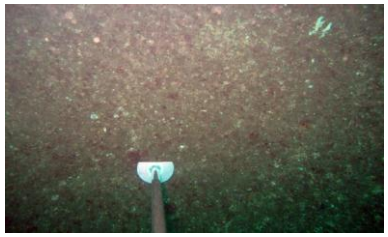
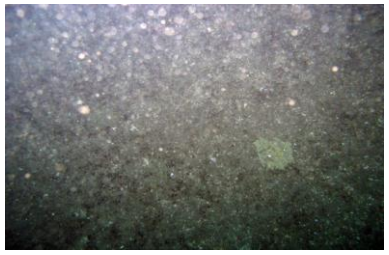
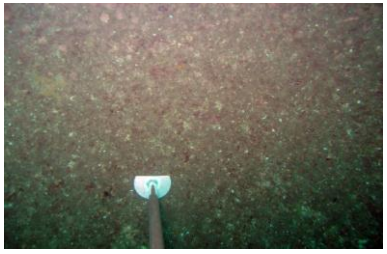
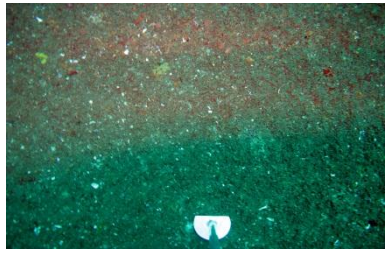
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 1: Deck port bow

Deck, Port Mid

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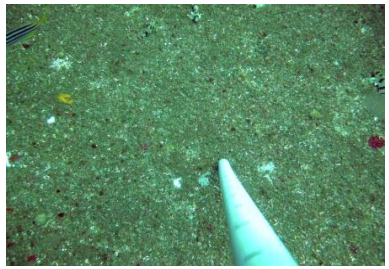
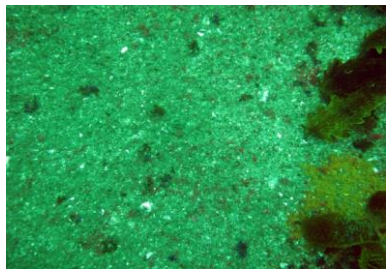
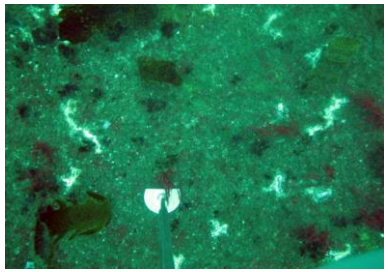
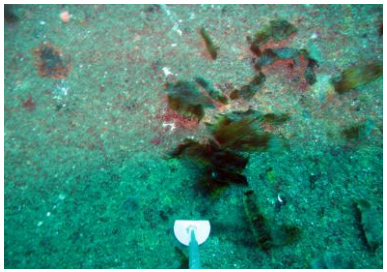
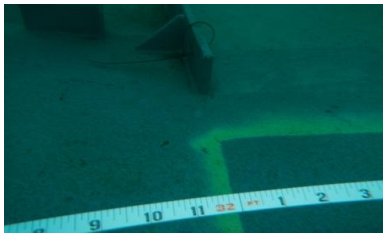
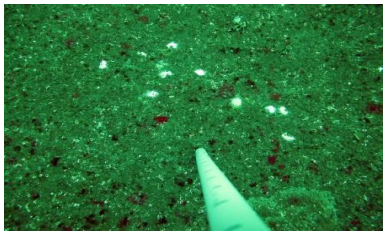
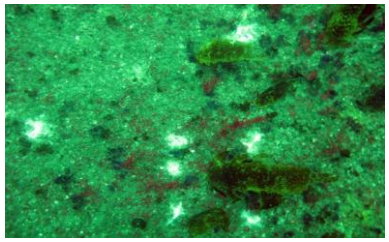
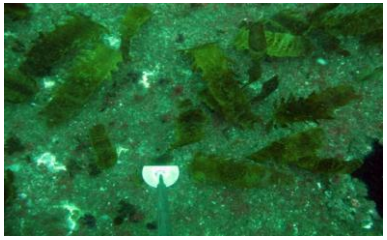
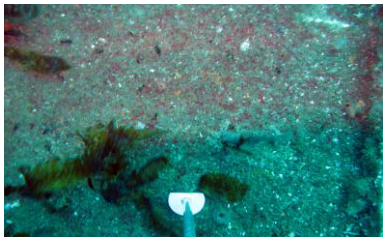
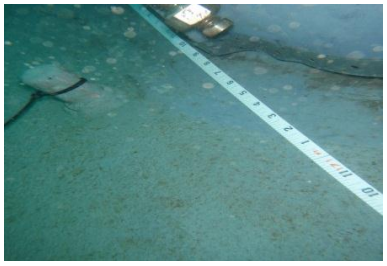
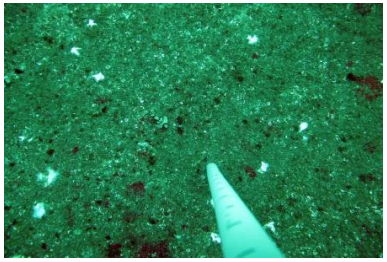
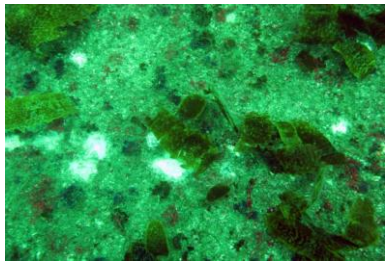
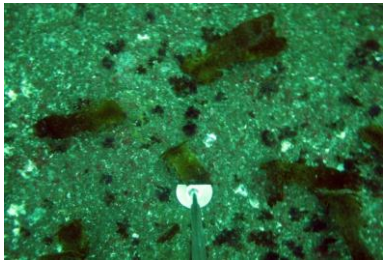
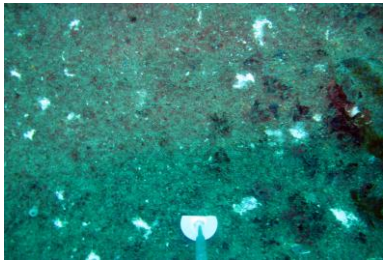
				
				
				

Plate 2: Deck Port Mid

Deck, Port , Stern

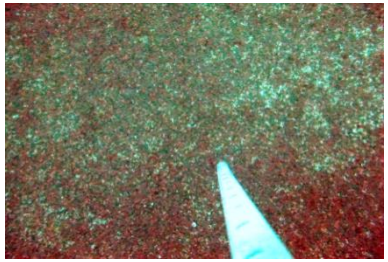
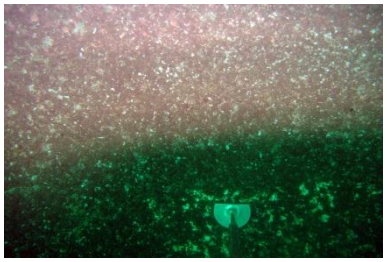
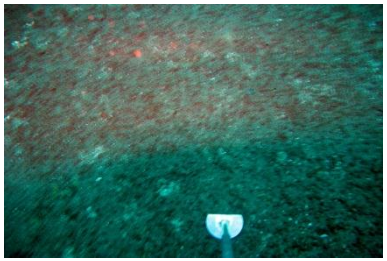
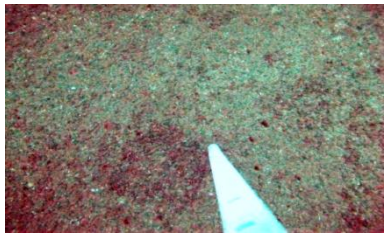
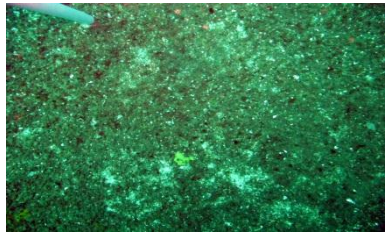
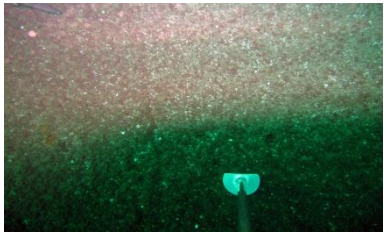
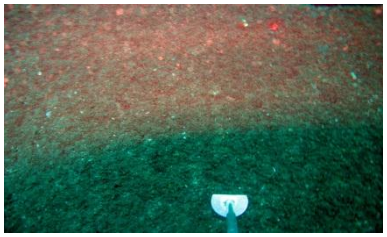
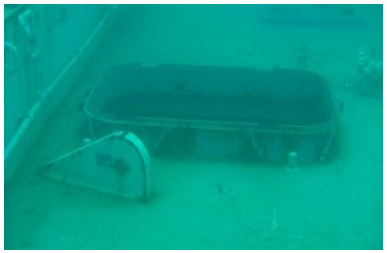
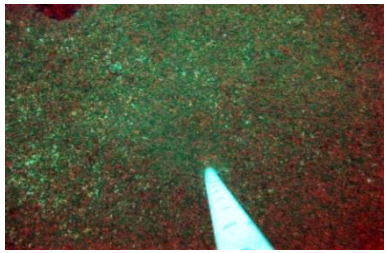
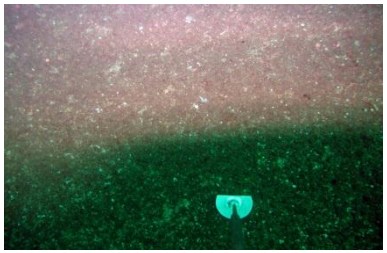
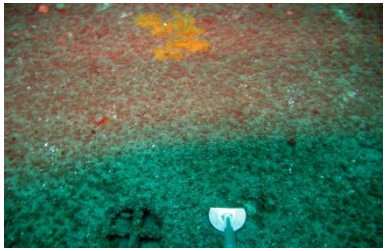
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 3: Deck Port Stern

Deck, Starbord, Bow

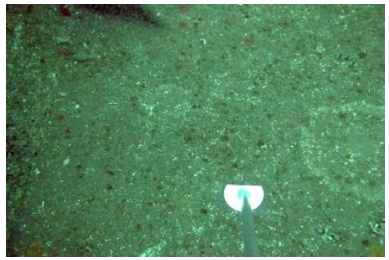
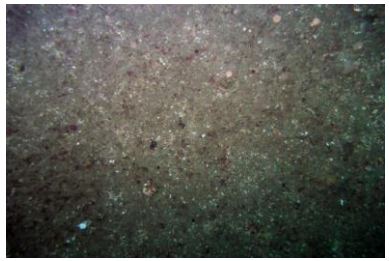
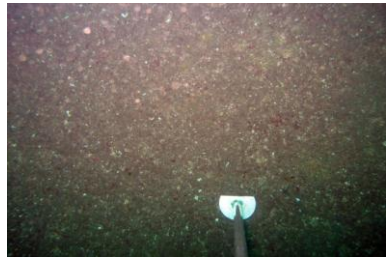
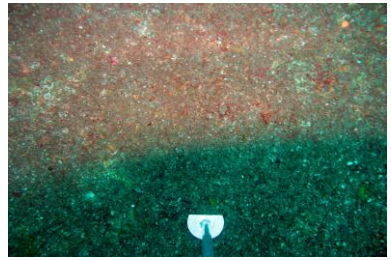
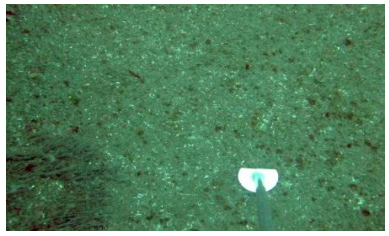
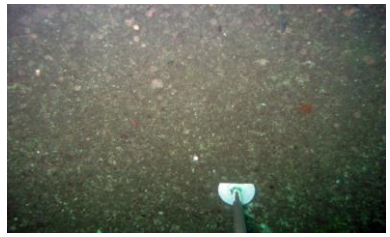
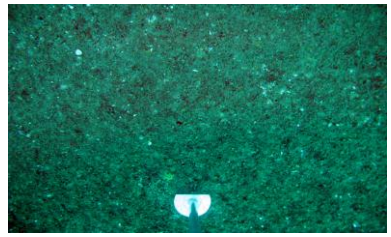
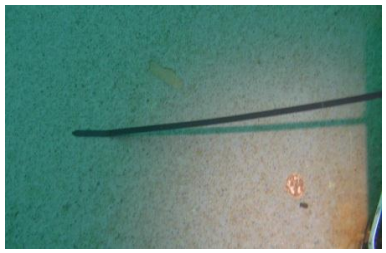
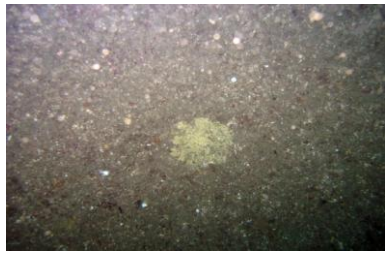
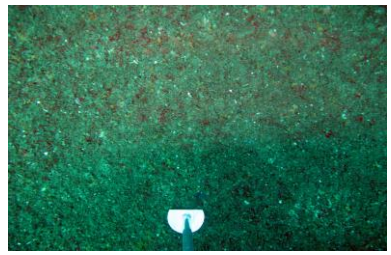
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 4: Deck Starbord Bow

Deck, Starbord, Mid

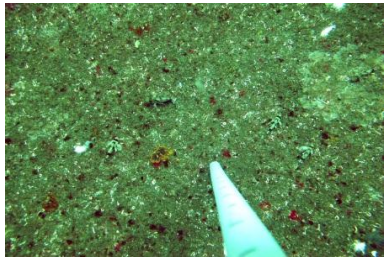
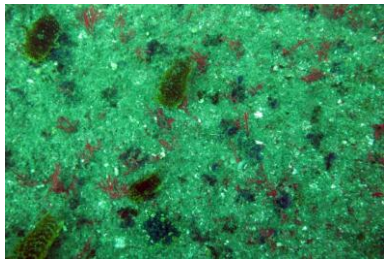
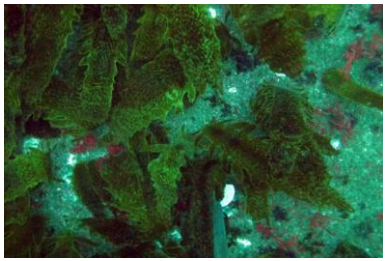
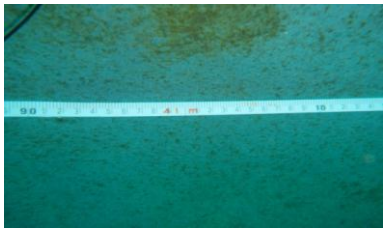
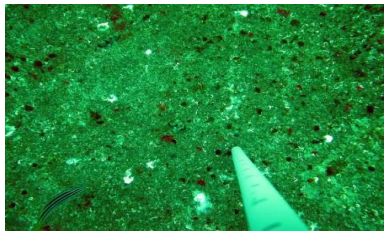
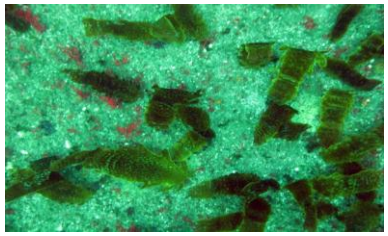
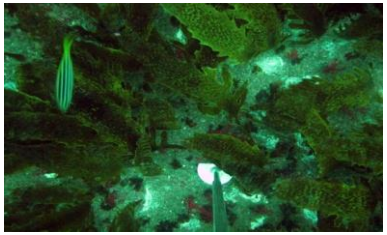
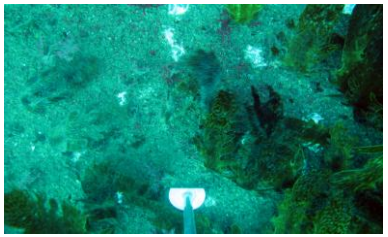
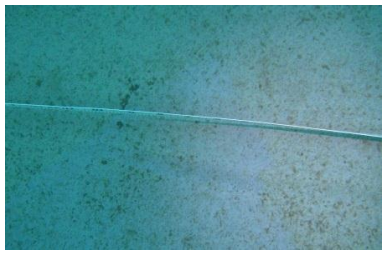
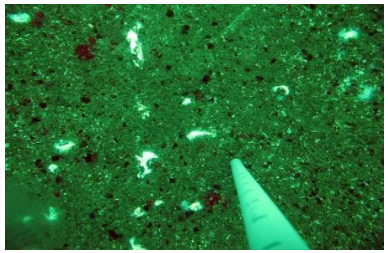
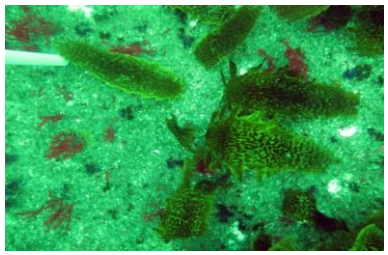
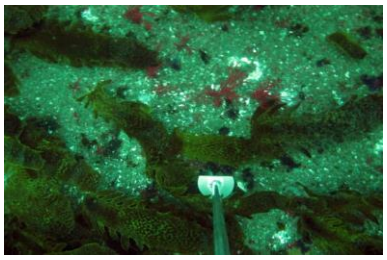
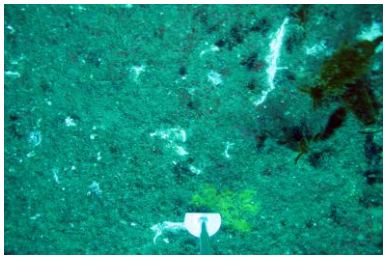
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 5: Deck Starbord Mid

Deck, Starbord, Stern

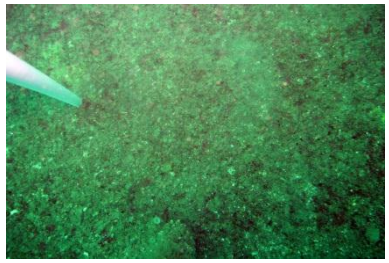
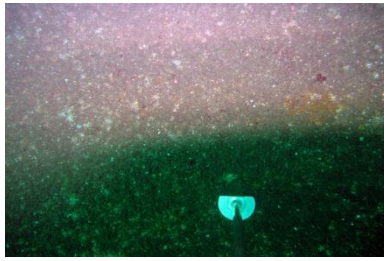
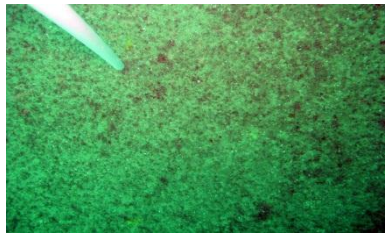
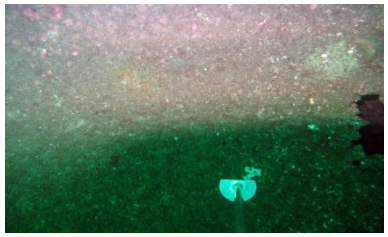
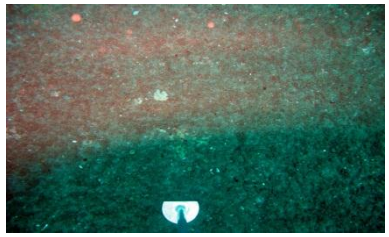
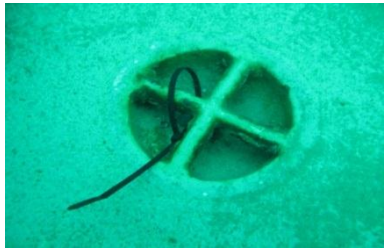
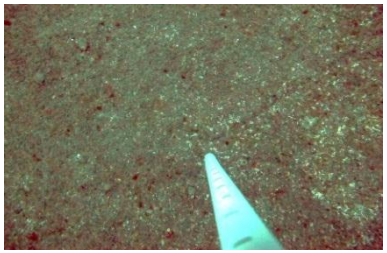
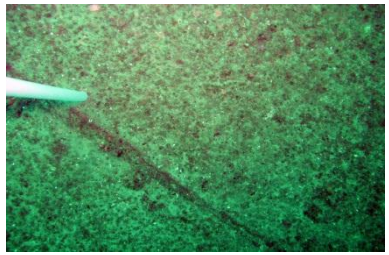
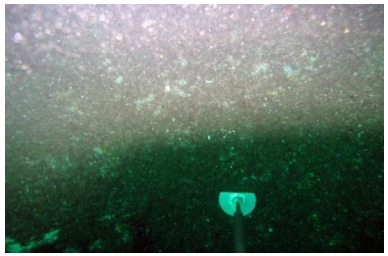
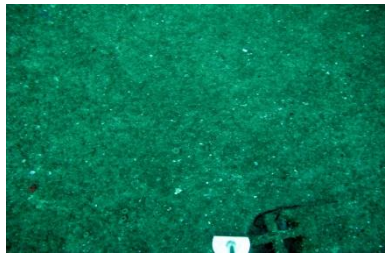
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 6: Deck Starbord Stern

Horizontal Hull Port

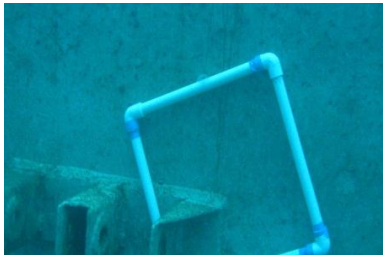
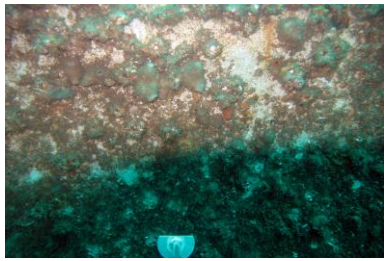
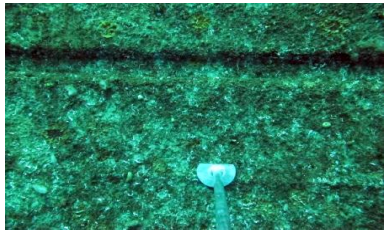
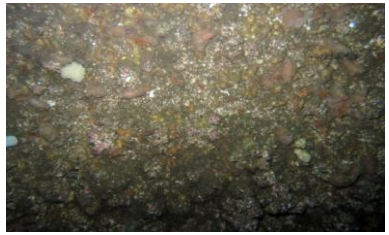
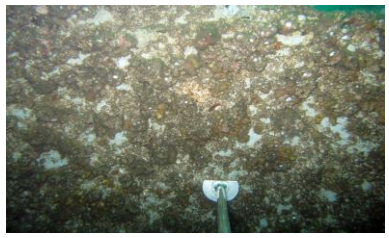
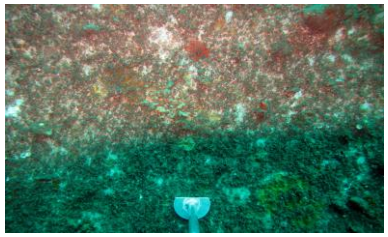
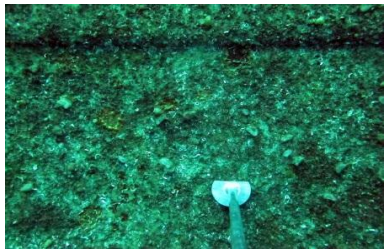
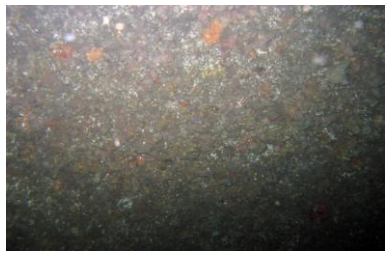
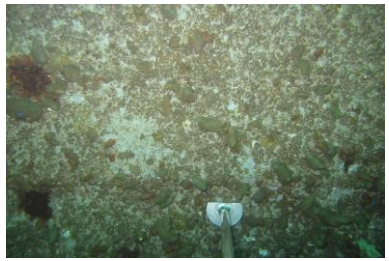
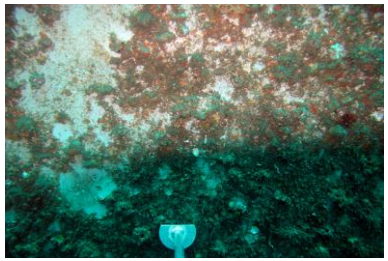
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 7: Horizontal Hull Port

Horizontal Hull Starbord

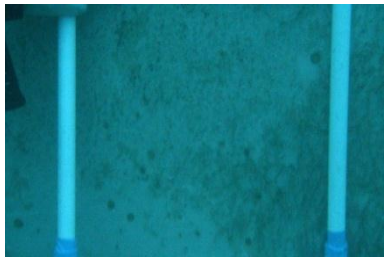
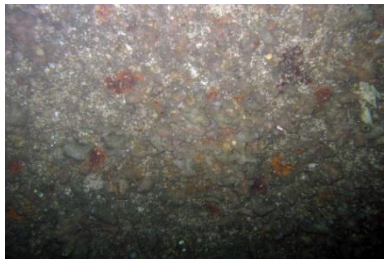
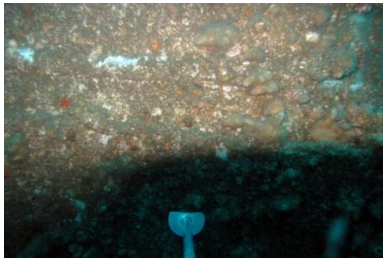
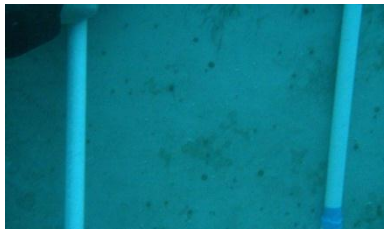
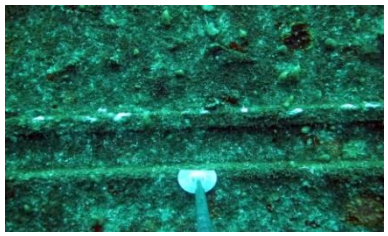
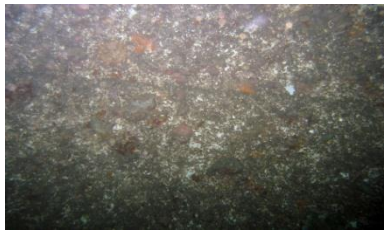
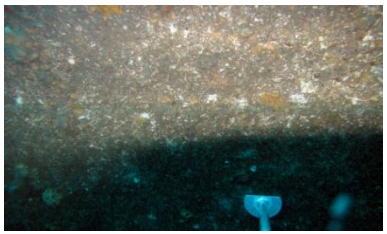
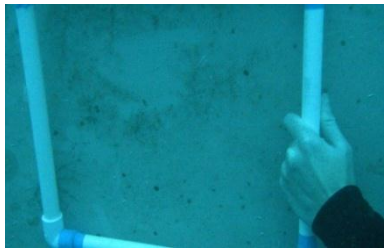
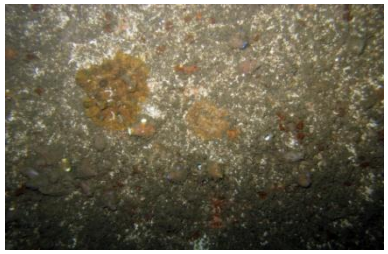
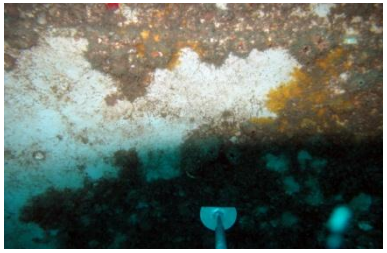
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 8: Horizontal Hull Starbord

Vertical Hull Port Bow

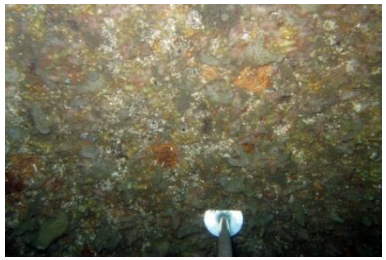
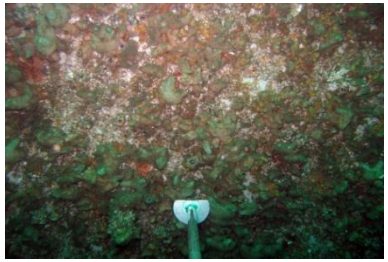
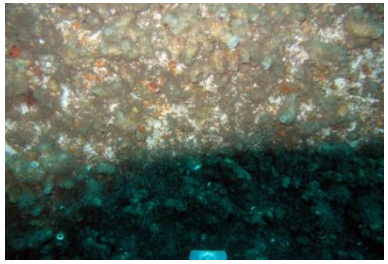
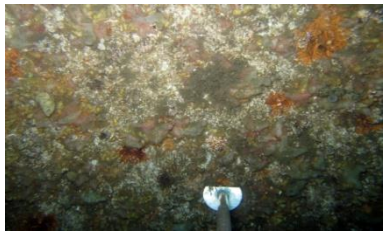
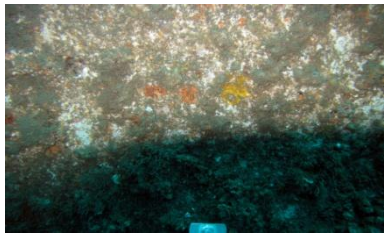
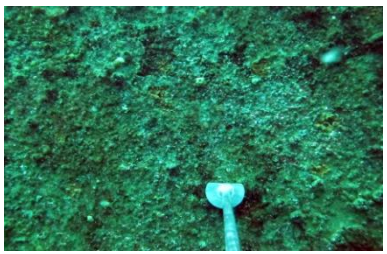
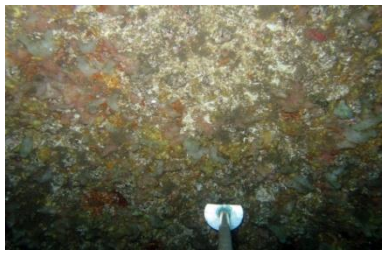
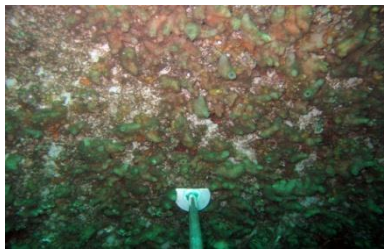
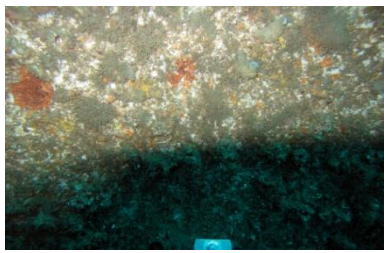
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 9: Vertical Hull Port Bow

Vertical Hull Port Stern

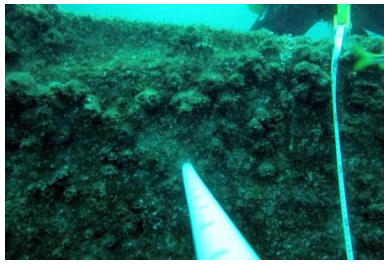
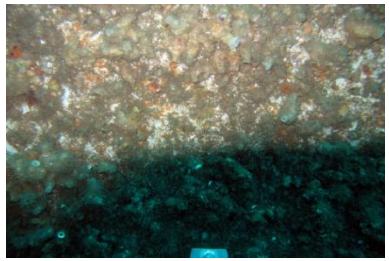
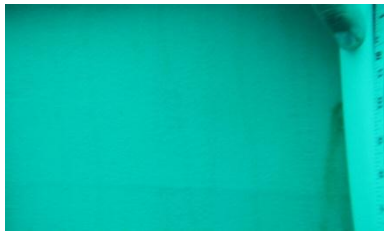
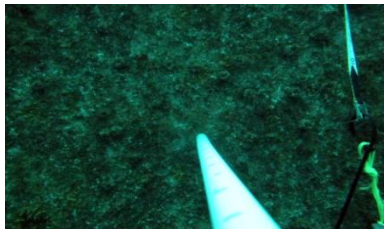
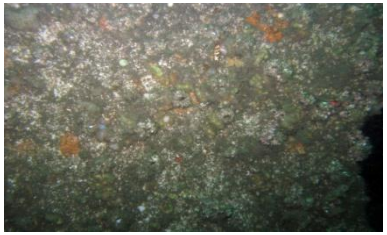
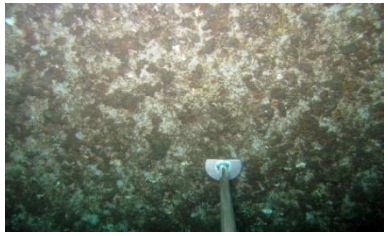
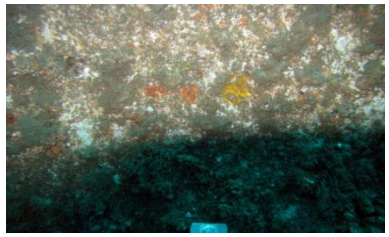
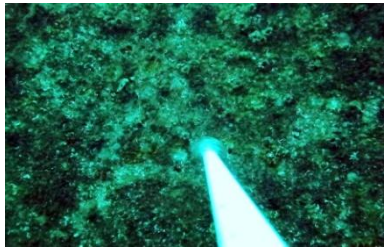
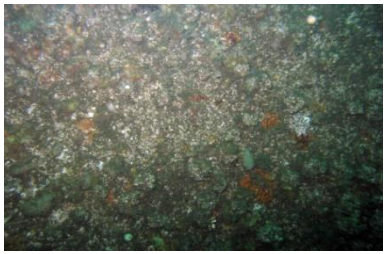
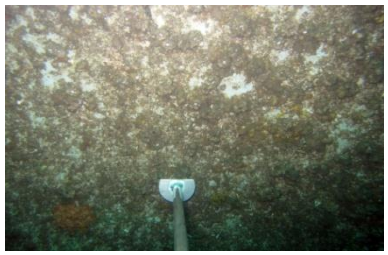
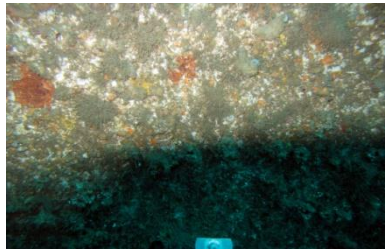
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 10: Vertical Hull Port Stern

Vertical Hull Starbord Bow

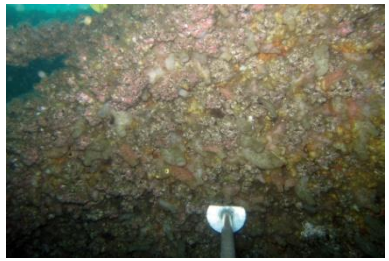
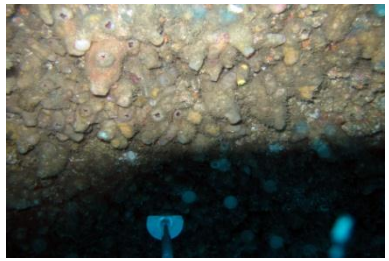
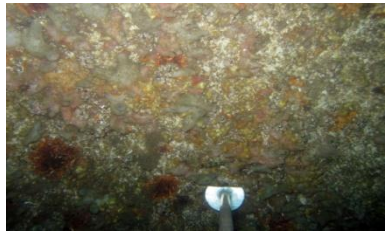
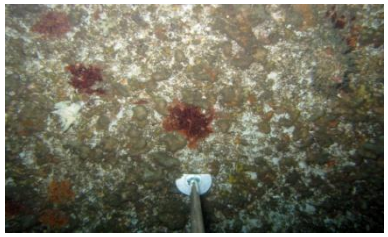
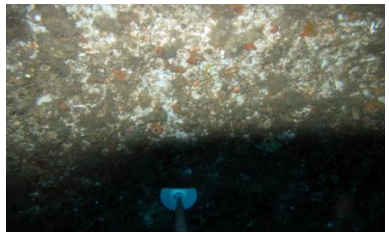
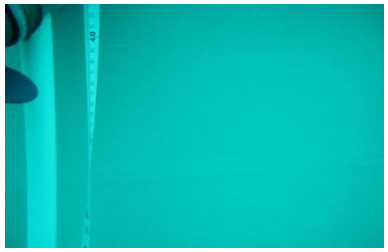
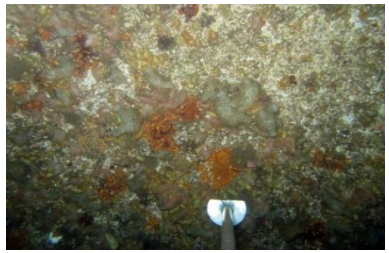
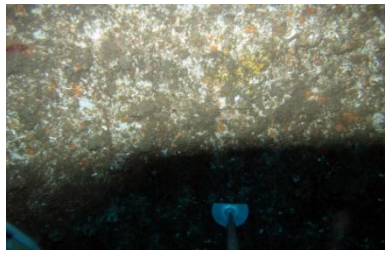
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 11: Vertical Hull Starbord Bow

Vertical Hull Starbord Stern

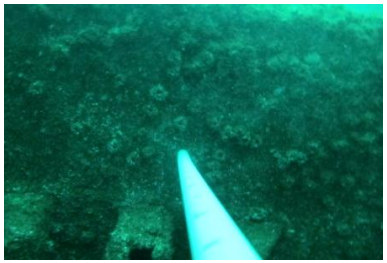
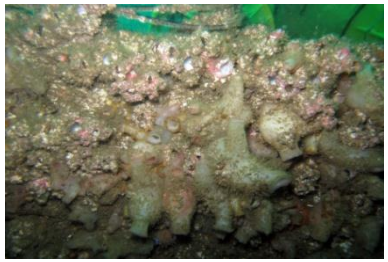
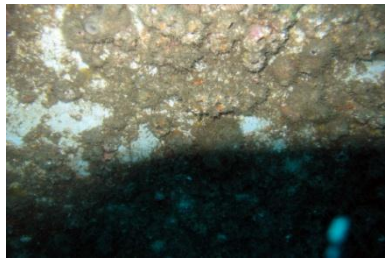
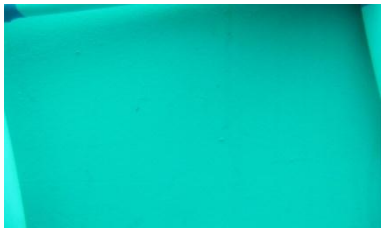
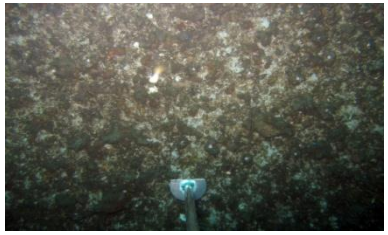
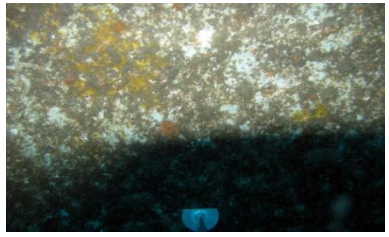
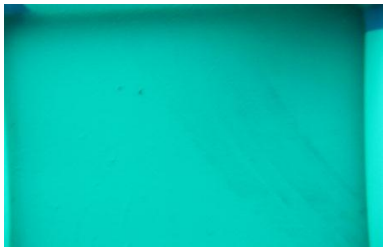
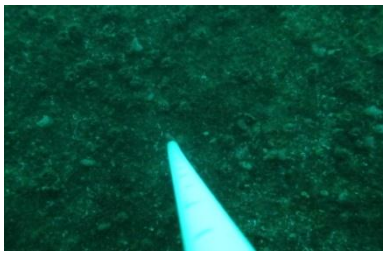
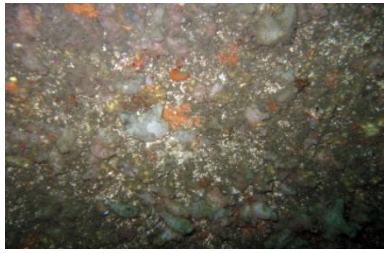
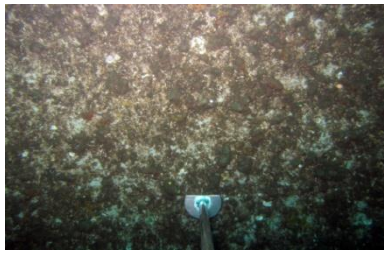
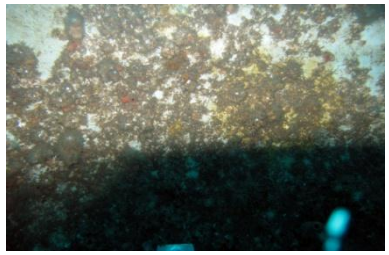
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 12: Vertical Hull Starbord Stern

Vertical Superstructure Port Bow

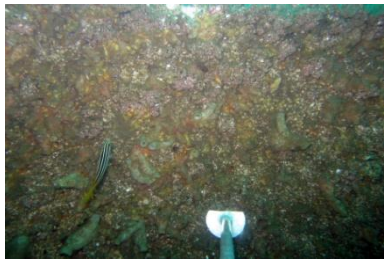
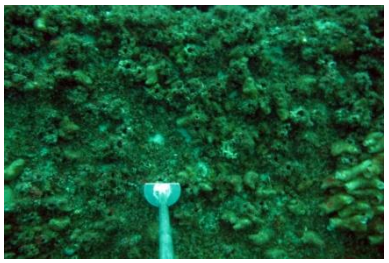
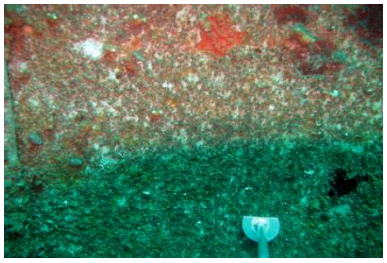
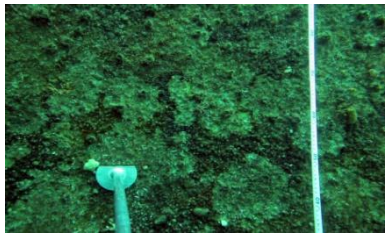
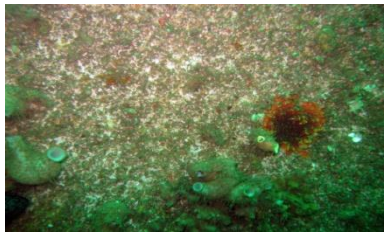
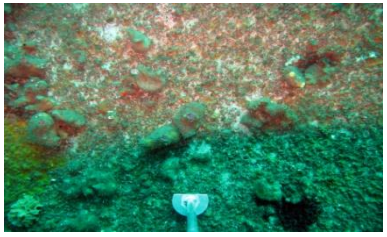
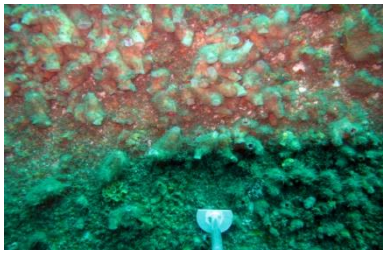
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
Not Sampled				
Not Sampled				
Not Sampled				

Plate 13: Vertical Superstructure Port Bow

Vertical Superstructure Port Stern

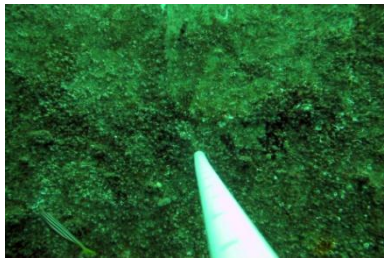
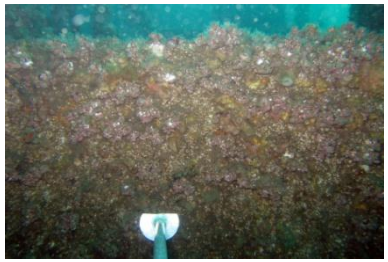
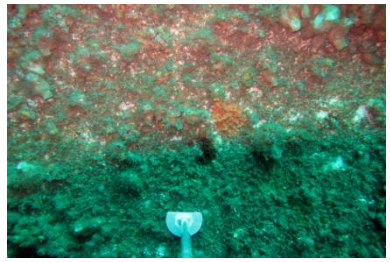
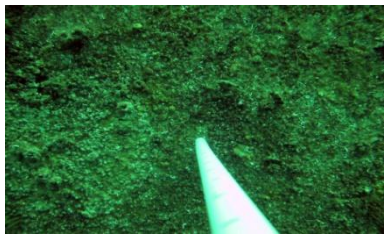
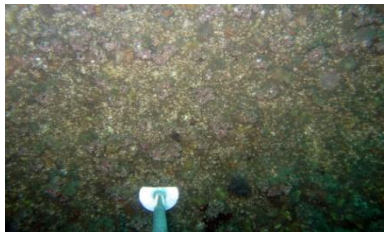
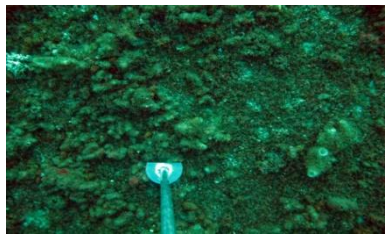
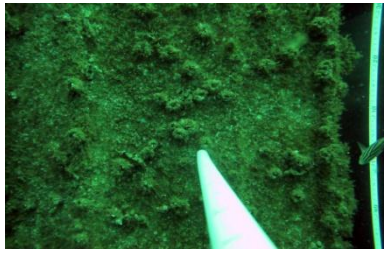
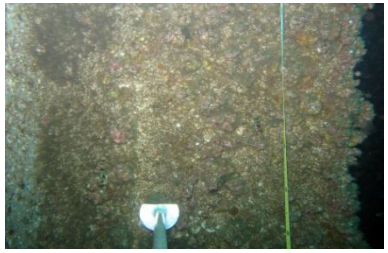
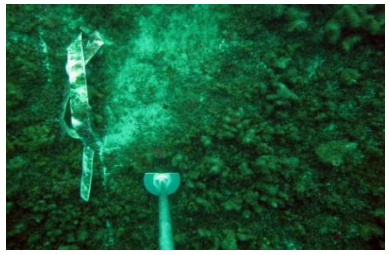
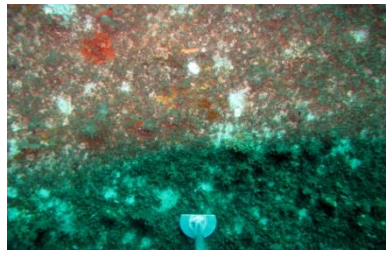
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
Not Sampled				
Not Sampled				
Not Sampled				

Plate 14: Vertical Superstructure Port Stern

Vertical Superstructure Starboard Bow

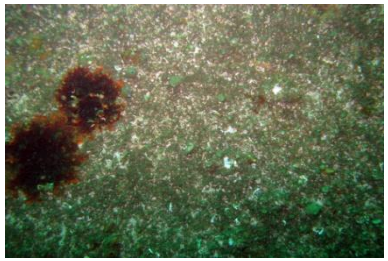
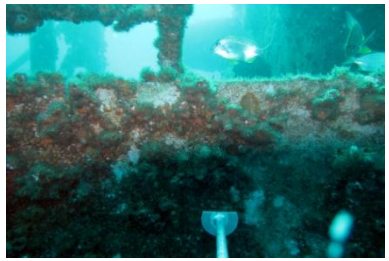
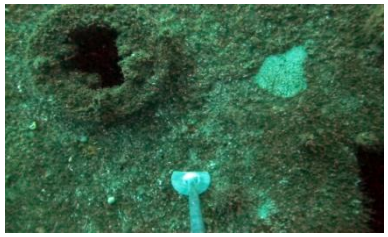
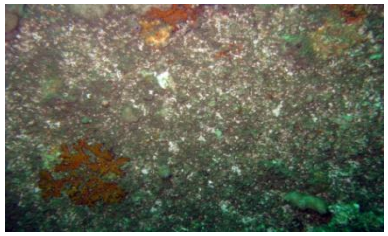
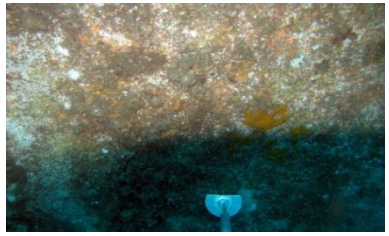
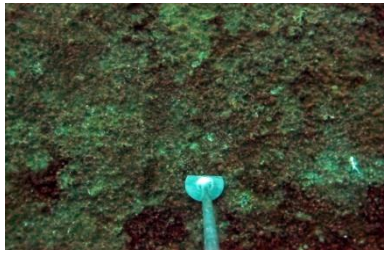
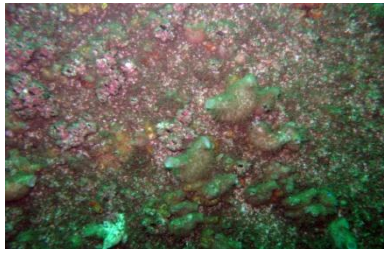
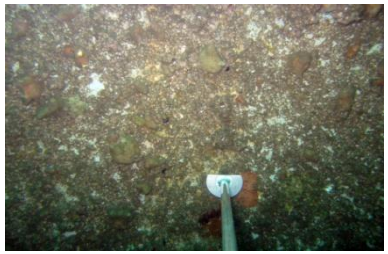
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
Not Sampled				
Not Sampled				
Not Sampled				

Plate 15: Vertical Superstructure Starboard Bow

Vertical Superstructure Starboard Stern

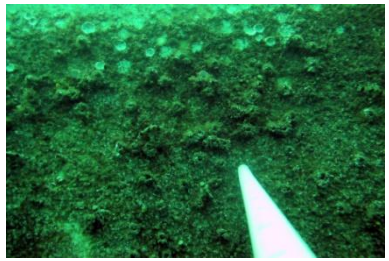
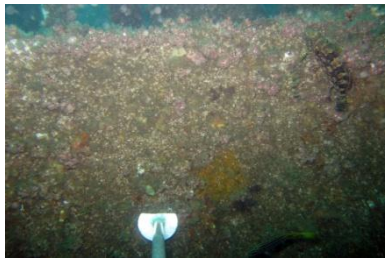
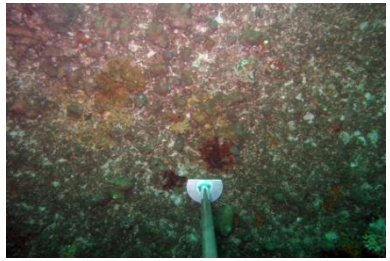
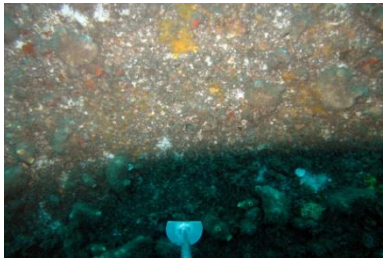
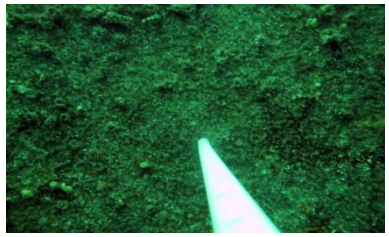
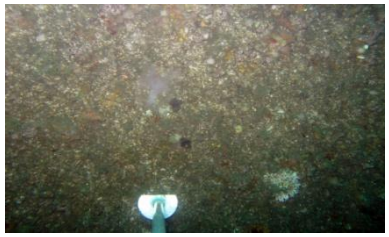
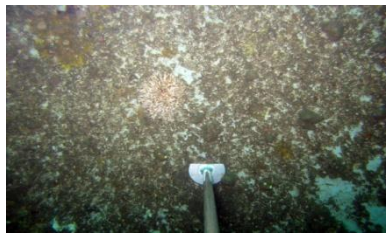
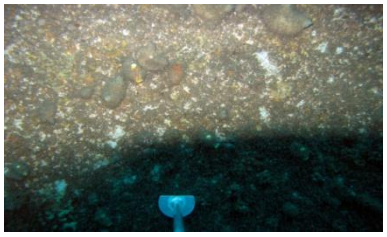
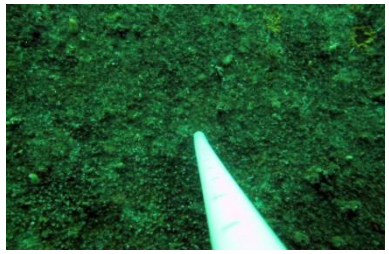
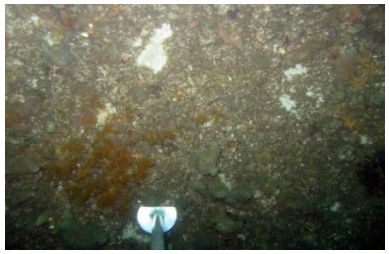
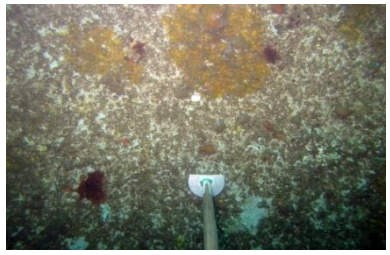
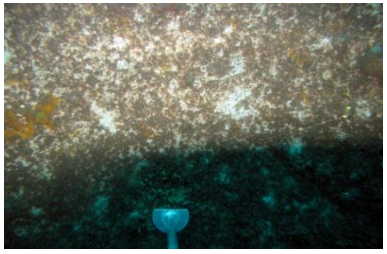
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
Not Sampled				
Not Sampled				
Not Sampled				

Plate 16: Vertical Superstructure Starboard Stern

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

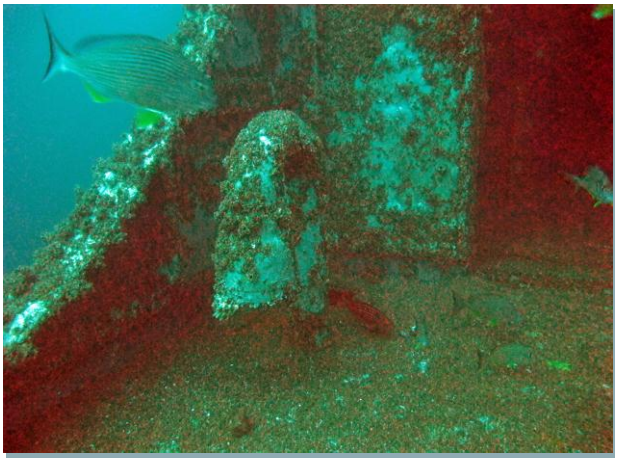
Location: Flight deck port side between the hanger and hull. Photo taken standing 2 m towards the stern from the pipe.

Depth: Approximately 27 m

Survey 1

Survey 2

Survey 3



Survey 4

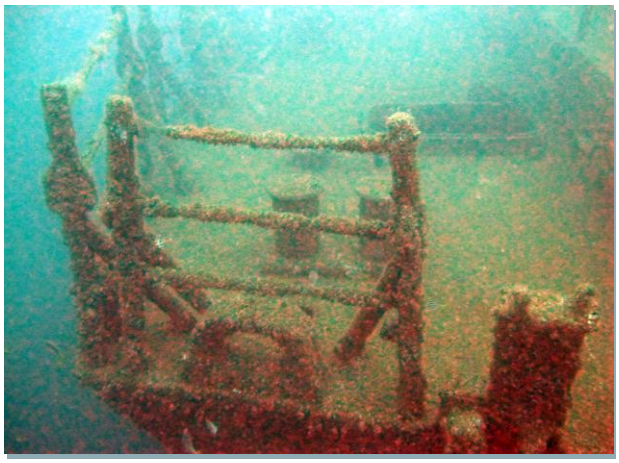
Appendix A: (Continued).

Fixed Photo: 2

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

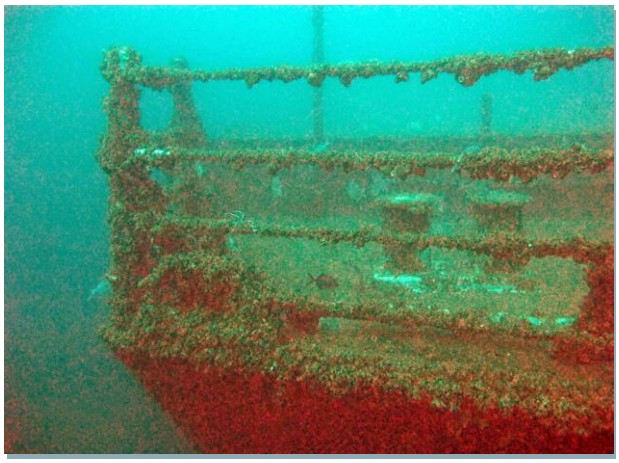
Depth: Approximately 27 m

Survey 1



Survey 2

Survey 3



Survey 4

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

Appendix A: (Continued).

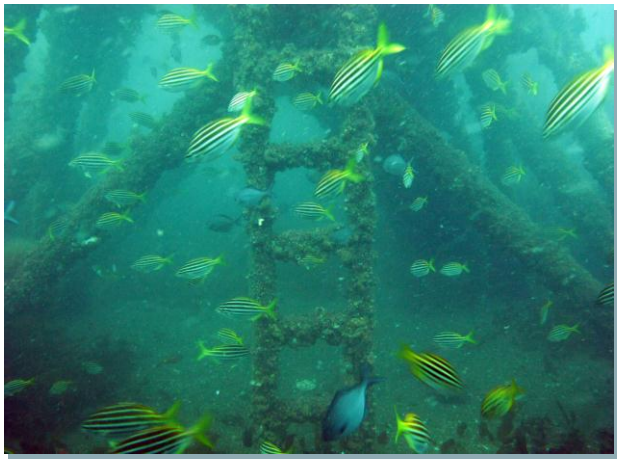
Fixed Photo: 4

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

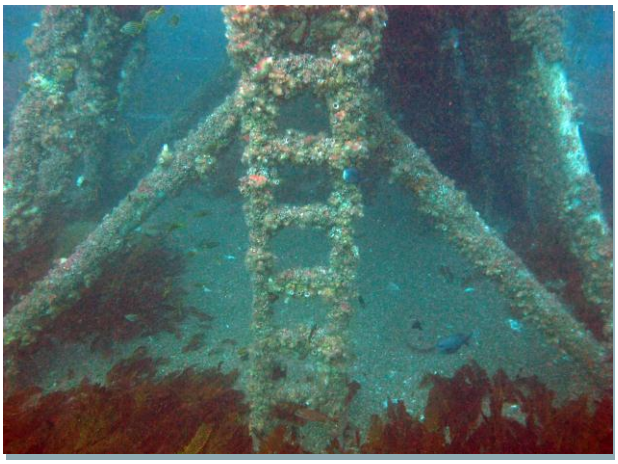
Depth: Approximately 23 m

Survey 1

Survey 2



Survey 3



Survey 4

Appendix A: (Continued).

Fixed Photo: 5

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

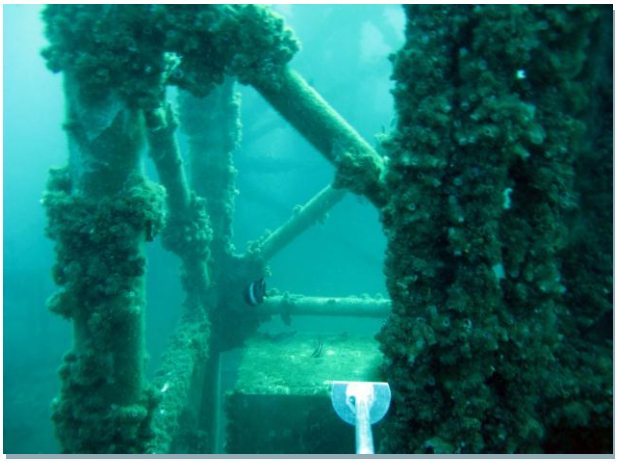
Depth: Approximately 18 m

Survey 1

Survey 2

Survey 3

Survey 4



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

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

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

Appendix A: (Continued).

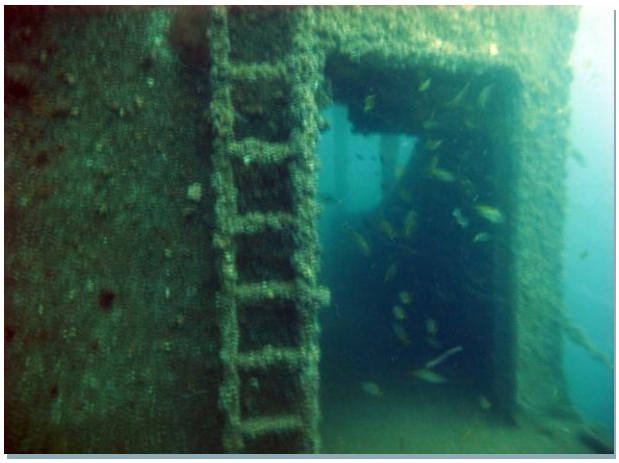
Fixed Photo: 9

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

Appendix A: (Continued).

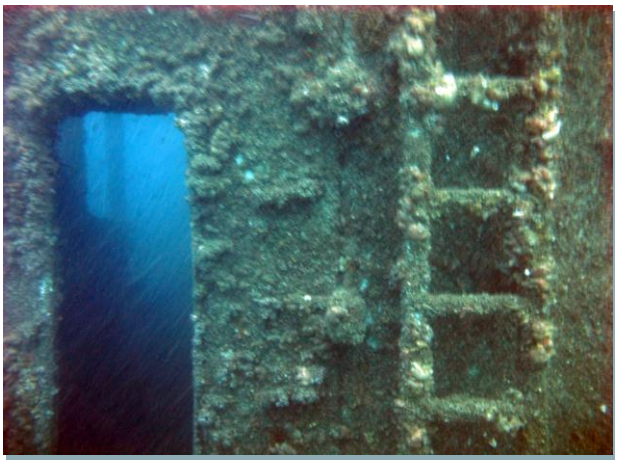
Fixed Photo: 10

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

Appendix B: Mean percentage cover (± standard error) of reef communities for each transect analysed during Survey 4.

	Deck Port Bow		Deck Port Mid		Deck Port Stern	
Categories	Mean	S.E.	Mean	S.E.	Mean	S.E.
PHAEOPHYTA (PH)						
Ecklonia radiata	0.00	0.00	8.90	3.69	0.20	0.20
Lobed brown algae	0.00	0.00	0.61	0.61	0.00	0.00
Filamentous brown algae	0.00	0.00	1.91	1.02	0.41	0.41
Orange filamentous algae	0.00	0.00	0.00	0.00	0.00	0.00
Turfing brown algae	10.17	5.34	0.00	0.00	1.22	1.22
RHODOPHYTA (RH)						
Encrusting red algae	0.00	0.00	1.82	0.98	2.02	1.06
Red filamentous	0.41	0.41	0.00	0.00	0.00	0.00
Thin branching red algae	0.00	0.00	0.23	0.23	0.00	0.00
BRYOZOA (BZ)						
Biflustra perfragilis	0.00	0.00	0.20	0.20	0.00	0.00
Encrusting orange bryozoan	0.00	0.00	0.00	0.00	0.00	0.00
Encrusting yellow bryozoan	0.00	0.00	0.00	0.00	0.00	0.00
Hornea foliacea	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
White branching bryozoan	0.00	0.00	0.00	0.00	0.00	0.00
SPONGE (SP)						
Orange encrusting sponge	0.62	0.25	0.66	0.45	0.40	0.40
Purple sponge	0.20	0.20	0.00	0.00	0.00	0.00
White encrusting sponge	0.61	0.61	0.00	0.00	0.00	0.00
White papillate sponge	0.00	0.00	0.00	0.00	0.00	0.00
Yellow encrusting sponge	2.66	0.69	2.05	1.53	0.00	0.00
ASCIDIAN (AS)						
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	0.20	0.20	0.00	0.00	0.00	0.00
ABIOTIC (AB)						
Bare ships surface	0.00	0.00	0.00	0.00	0.00	0.00
Brown scuzz	0.00	0.00	0.00	0.00	0.00	0.00
Sand	0.00	0.00	0.00	0.00	0.81	0.81
Sediment	0.00	0.00	0.00	0.00	0.00	0.00
POLYCHAETE (POLY)						
Serpulid polychaete	0.20	0.20	0.00	0.00	0.00	0.00
CNIDARIAN (CNI)						
Anthothoe albocincta	0.20	0.20	0.00	0.00	0.00	0.00
Hydroid 1	0.41	0.25	0.00	0.00	0.00	0.00
MATRIX (MAT)						
Barnacle,sediment,brown fil	21.43	14.42	0.00	0.00	0.00	0.00
Large barnacle,sediment,brown fil	0.20	0.20	0.00	0.00	0.00	0.00
Serpulid barnacle and encrusting algae matrix	55.74	15.02	80.39	3.44	90.88	4.07
Serpulid matrix	4.08	1.86	2.22	1.47	4.05	2.05
FISH MOBILE (FSH)						
Fish mobile	1.02	0.79	0.00	0.00	0.00	0.00
INDETERMINATE (IN)						
Unknown white material	1.44	0.95	1.01	0.78	0.00	0.00
TAPE, WAND, SHADOW (TWS)						
Shadow	0.80	0.80	2.20	2.20	0.00	0.00
Camera pole in frame	1.40	0.24	1.40	0.24	1.20	0.20

Appendix B: (Continued).

	Deck Starbord Bow		Deck Starbord Mid		Deck Starbord Stern	
Categories	Mean	S.E.	Mean	S.E.	Mean	S.E.
PHAEOPHYTA (PH)						
Ecklonia radiata	0.00	0.00	16.58	10.30	0.00	0.00
Lobed brown algae	0.00	0.00	3.26	1.87	0.00	0.00
Filamentous brown 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	2.11	1.29	0.20	0.20	4.90	4.65
RHODOPHYTA (RH)						
Encrusting red algae	0.00	0.00	0.00	0.00	2.86	2.86
Red filamentous	2.02	1.78	0.20	0.20	0.20	0.20
Thin branching red algae	0.00	0.00	1.01	0.32	0.20	0.20
BRYOZOA (BZ)						
Biflustra perfragilis	0.00	0.00	0.00	0.00	0.00	0.00
Encrusting orange bryozoan	0.00	0.00	0.00	0.00	0.00	0.00
Encrusting yellow bryozoan	0.00	0.00	0.00	0.00	0.00	0.00
Hornea foliacea	0.22	0.22	0.00	0.00	0.00	0.00
Triphyllozoan sp	0.00	0.00	0.20	0.20	0.00	0.00
White branching bryozoan	0.00	0.00	0.61	0.61	0.00	0.00
SPONGE (SP)						
Orange encrusting sponge	0.83	0.60	1.82	1.82	0.41	0.41
Purple sponge	0.00	0.00	0.00	0.00	0.00	0.00
White encrusting sponge	0.81	0.59	0.00	0.00	0.00	0.00
White papillate sponge	0.00	0.00	0.00	0.00	0.00	0.00
Yellow encrusting sponge	2.05	0.96	1.42	0.61	0.61	0.41
ASCIDIAN (AS)						
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
ABIOTIC (AB)						
Bare ships surface	0.00	0.00	0.00	0.00	0.00	0.00
Brown scuzz	0.00	0.00	0.00	0.00	0.00	0.00
Sand	0.00	0.00	0.00	0.00	0.00	0.00
Sediment	0.00	0.00	0.00	0.00	0.00	0.00
POLYCHAETE (POLY)						
Serpulid polychaete	0.00	0.00	0.00	0.00	0.00	0.00
CNIDARIAN (CNI)						
Anthothoe albocincta	0.00	0.00	0.00	0.00	0.00	0.00
Hydroid 1	1.09	1.09	0.41	0.41	0.00	0.00
MATRIX (MAT)						
Barnacle,sediment,brown fil	0.00	0.00	0.00	0.00	0.00	0.00
Large barnacle,sediment,brown fil	0.00	0.00	0.00	0.00	0.00	0.00
Serpulid barnacle and encrusting algae matrix	87.62	2.86	69.81	8.03	88.79	7.52
Serpulid matrix	3.26	0.92	2.43	0.82	2.03	0.72
FISH MOBILE (FSH)						
Fish mobile	0.00	0.00	0.00	0.00	0.00	0.00
INDETERMINATE (IN)						
Unknown white material	0.00	0.00	2.03	0.85	0.00	0.00
TAPE, WAND, SHADOW (TWS)						
Shadow	1.40	1.40	0.00	0.00	0.20	0.20
Camera pole in frame	1.20	0.20	1.40	0.24	1.40	0.24

Appendix B: (Continued).

	Horizontal Hull Port		Horizontal Hull Starbord		Vertical Hull Port Bow	
Categories	Mean	S.E.	Mean	S.E.	Mean	S.E.
PHAEOPHYTA (PH)						
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
Filamentous brown algae	0.00	0.00	0.00	0.00	6.74	1.83
Orange filamentous algae	0.00	0.00	0.00	0.00	0.00	0.00
Turfing brown algae	15.49	5.11	0.17	0.17	3.69	1.72
RHODOPHYTA (RH)						
Encrusting red algae	0.00	0.00	0.17	0.17	0.00	0.00
Red filamentous	0.00	0.00	0.00	0.00	0.00	0.00
Thin branching red algae	0.00	0.00	0.00	0.00	0.00	0.00
BRYOZOA (BZ)						
Biflustra perfragilis	0.00	0.00	0.00	0.00	0.62	0.41
Encrusting orange bryozoan	1.69	0.82	2.77	0.83	1.86	0.71
Encrusting yellow bryozoan	0.00	0.00	0.17	0.17	0.63	0.42
Hornea foliacea	0.00	0.00	0.00	0.00	0.00	0.00
Triphyllozoan sp	0.51	0.23	0.35	0.22	0.20	0.20
White branching bryozoan	0.51	0.35	0.17	0.17	0.00	0.00
SPONGE (SP)						
Orange encrusting sponge	0.34	0.21	0.00	0.00	0.00	0.00
Purple sponge	0.00	0.00	0.00	0.00	0.00	0.00
White encrusting sponge	0.34	0.34	0.00	0.00	0.00	0.00
White papillate sponge	0.00	0.00	0.00	0.00	0.00	0.00
Yellow encrusting sponge	0.00	0.00	0.00	0.00	0.20	0.20
ASCIDIAN (AS)						
Colonial ascidian	0.00	0.00	0.00	0.00	0.00	0.00
Herdmania momus	1.52	0.82	2.61	1.28	19.91	7.27
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
ABIOTIC (AB)						
Bare ships surface	5.57	2.21	5.52	3.63	1.65	0.70
Brown scuzz	2.36	1.68	2.25	1.47	2.25	1.13
Sand	0.00	0.00	0.00	0.00	0.00	0.00
Sediment	0.17	0.17	0.00	0.00	0.00	0.00
POLYCHAETE (POLY)						
Serpulid polychaete	0.00	0.00	0.00	0.00	0.00	0.00
CNIDARIAN (CNI)						
Anthothoe albocincta	0.00	0.00	0.00	0.00	0.00	0.00
Hydroid 1	0.00	0.00	0.17	0.17	0.61	0.61
MATRIX (MAT)						
Barnacle,sediment,brown fil	0.00	0.00	0.00	0.00	0.00	0.00
Large barnacle,sediment,brown fil	8.40	3.89	11.39	3.84	7.84	2.71
Serpulid barnacle and encrusting algae matrix	61.74	10.79	73.54	6.53	52.98	5.58
Serpulid matrix	1.35	0.57	0.35	0.22	0.83	0.40
FISH MOBILE (FSH)						
Fish mobile	0.00	0.00	0.00	0.00	0.00	0.00
INDETERMINATE (IN)						
Unknown white material	0.00	0.00	0.35	0.35	0.00	0.00
TAPE, WAND, SHADOW (TWS)						
Shadow	0.00	0.00	2.67	0.49	1.00	1.00
Camera pole in frame	1.33	0.33	1.50	0.22	1.00	0.00

Appendix B: (Continued).

	Vertical Hull Port Stern		Vertical Hull Starbord Bow		Vertical Hull Starbord Stern	
Categories	Mean	S.E.	Mean	S.E.	Mean	S.E.
PHAEOPHYTA (PH)						
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
Filamentous brown algae	1.83	1.14	0.91	0.68	0.00	0.00
Orange filamentous algae	0.00	0.00	0.00	0.00	0.00	0.00
Turfing brown algae	0.40	0.40	3.77	2.75	0.00	0.00
RHODOPHYTA (RH)						
Encrusting red 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
Thin branching red algae	0.00	0.00	0.00	0.00	0.00	0.00
BRYOZOA (BZ)						
Biflustra perfragilis	0.00	0.00	0.00	0.00	0.00	0.00
Encrusting orange bryozoan	2.43	0.82	1.42	0.61	1.63	0.69
Encrusting yellow bryozoan	0.00	0.00	0.00	0.00	0.00	0.00
Hornea foliacea	0.00	0.00	0.00	0.00	0.00	0.00
Triphyllozoan sp	0.20	0.20	0.00	0.00	0.00	0.00
White branching bryozoan	0.20	0.20	0.00	0.00	0.00	0.00
SPONGE (SP)						
Orange encrusting sponge	0.00	0.00	0.20	0.20	2.13	1.10
Purple sponge	0.00	0.00	0.00	0.00	0.00	0.00
White encrusting sponge	0.00	0.00	0.00	0.00	0.00	0.00
White papillate sponge	0.00	0.00	0.20	0.20	0.00	0.00
Yellow encrusting sponge	0.00	0.00	0.00	0.00	1.12	0.87
ASCIDIAN (AS)						
Colonial ascidian	0.00	0.00	0.00	0.00	0.22	0.22
Herdmania momus	5.89	1.43	14.74	11.40	2.05	1.28
Botryloides magnicoecum	0.00	0.00	0.00	0.00	0.22	0.22
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
ABIOTIC (AB)						
Bare ships surface	1.01	0.78	0.47	0.47	7.34	1.52
Brown scuzz	2.22	1.25	0.47	0.47	4.70	1.67
Sand	0.00	0.00	0.00	0.00	0.00	0.00
Sediment	0.00	0.00	0.00	0.00	0.00	0.00
POLYCHAETE (POLY)						
Serpulid polychaete	0.00	0.00	0.00	0.00	0.00	0.00
CNIDARIAN (CNI)						
Anthothoe albocincta	0.00	0.00	0.00	0.00	0.00	0.00
Hydroid 1	0.00	0.00	0.00	0.00	0.00	0.00
MATRIX (MAT)						
Barnacle,sediment,brown fil	0.00	0.00	5.10	5.10	0.00	0.00
Large barnacle,sediment,brown fil	19.24	7.19	3.96	2.24	7.08	6.05
Serpulid barnacle and encrusting algae matrix	65.74	7.35	68.51	10.90	73.51	7.62
Serpulid matrix	0.82	0.82	0.24	0.24	0.00	0.00
FISH MOBILE (FSH)						
Fish mobile	0.00	0.00	0.00	0.00	0.00	0.00
INDETERMINATE (IN)						
Unknown white material	0.00	0.00	0.00	0.00	0.00	0.00
TAPE, WAND, SHADOW (TWS)						
Shadow	0.00	0.00	2.60	2.60	12.24	2.80
Camera pole in frame	1.40	0.24	1.60	0.24	0.40	0.24

Appendix B: (Continued).

	Vertical Super Port Bow		Vertical Super Port Stern		Vertical Super Starbord Bow	
Categories	Mean	S.E.	Mean	S.E.	Mean	S.E.
PHAEOPHYTA (PH)						
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
Filamentous brown algae	0.00	0.00	0.00	0.00	0.82	0.51
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	0.27	0.27
RHODOPHYTA (RH)						
Encrusting red algae	1.22	0.59	0.00	0.00	0.00	0.00
Red filamentous	0.00	0.00	0.00	0.00	0.00	0.00
Thin branching red algae	0.00	0.00	0.00	0.00	0.00	0.00
BRYOZOA (BZ)						
Biflustra perfragilis	0.00	0.00	1.01	0.55	0.62	0.42
Encrusting orange bryozoan	0.40	0.40	1.62	1.04	4.08	1.61
Encrusting yellow bryozoan	0.00	0.00	0.00	0.00	0.00	0.00
Hornea foliacea	0.41	0.25	0.00	0.00	0.00	0.00
Triphyllozoan sp	0.61	0.41	0.81	0.38	0.00	0.00
White branching bryozoan	0.00	0.00	0.00	0.00	0.00	0.00
SPONGE (SP)						
Orange encrusting sponge	0.82	0.82	0.20	0.20	0.20	0.20
Purple sponge	0.00	0.00	0.00	0.00	0.00	0.00
White encrusting sponge	0.00	0.00	0.00	0.00	0.00	0.00
White papillate sponge	0.00	0.00	0.00	0.00	0.00	0.00
Yellow encrusting sponge	1.22	0.59	0.00	0.00	2.23	1.12
ASCIDIAN (AS)						
Colonial ascidian	0.00	0.00	0.20	0.20	0.61	0.41
Herdmania momus	17.44	8.89	7.07	4.09	7.60	3.14
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
ABIOTIC (AB)						
Bare ships surface	0.82	0.82	4.24	3.50	7.78	3.79
Brown scuzz	0.00	0.00	0.20	0.20	3.76	2.75
Sand	0.00	0.00	0.00	0.00	0.00	0.00
Sediment	0.00	0.00	0.00	0.00	0.00	0.00
POLYCHAETE (POLY)						
Serpulid polychaete	0.00	0.00	0.00	0.00	0.00	0.00
CNIDARIAN (CNI)						
Anthothoe albocincta	0.00	0.00	0.00	0.00	0.00	0.00
Hydroid 1	0.20	0.20	0.20	0.20	0.00	0.00
MATRIX (MAT)						
Barnacle,sediment,brown fil	0.00	0.00	6.46	4.07	0.00	0.00
Large barnacle,sediment,brown fil	0.20	0.20	0.20	0.20	2.00	1.52
Serpulid barnacle and encrusting algae matrix	76.04	7.40	76.95	8.39	67.07	7.32
Serpulid matrix	0.61	0.25	0.81	0.59	2.69	1.17
FISH MOBILE (FSH)						
Fish mobile	0.00	0.00	0.00	0.00	0.27	0.27
INDETERMINATE (IN)						
Unknown white material	0.00	0.00	0.00	0.00	0.00	0.00
TAPE, WAND, SHADOW (TWS)						
Shadow	0.40	0.40	0.00	0.00	5.20	4.72
Camera pole in frame	1.20	0.20	1.20	0.20	1.40	0.24

Appendix B: (Continued).

	Vertical Super Starbord Stern	
Categories	Mean	S.E.
PHAEOPHYTA (PH)		
Ecklonia radiata	0.00	0.00
Lobed brown algae	0.00	0.00
Filamentous brown algae	0.00	0.00
Orange filamentous algae	0.81	0.81
Turfing brown algae	0.00	0.00
RHODOPHYTA (RH)		
Encrusting red algae	0.00	0.00
Red filamentous	0.00	0.00
Thin branching red algae	0.00	0.00
BRYOZOA (BZ)		
Biflustra perfragilis	0.00	0.00
Encrusting orange bryozoan	0.81	0.59
Encrusting yellow bryozoan	0.00	0.00
Hornea foliacea	0.00	0.00
Triphyllozoan sp	0.00	0.00
White branching bryozoan	0.00	0.00
SPONGE (SP)		
Orange encrusting sponge	0.81	0.59
Purple sponge	0.00	0.00
White encrusting sponge	1.02	0.56
White papillate sponge	0.41	0.41
Yellow encrusting sponge	0.82	0.50
ASCIDIAN (AS)		
Colonial ascidian	0.00	0.00
Herdmania momus	9.55	4.17
Botryloides magnicoecum	0.00	0.00
White encrusting solitary ascidian	0.00	0.00
White tubular solitary ascidian	0.00	0.00
ABIOTIC (AB)		
Bare ships surface	2.65	1.90
Brown scuzz	1.02	1.02
Sand	0.00	0.00
Sediment	0.00	0.00
POLYCHAETE (POLY)		
Serpulid polychaete	0.00	0.00
CNIDARIAN (CNI)		
Anthothoe albocincta	0.00	0.00
Hydroid 1	0.00	0.00
MATRIX (MAT)		
Barnacle,sediment,brown fil	0.00	0.00
Large barnacle,sediment,brown fil	0.00	0.00
Serpulid barnacle and encrusting algae matrix	82.1	3.42
Serpulid matrix	0.00	0.00
FISH MOBILE (FSH)		
Fish mobile	0.00	0.00
INDETERMINATE (IN)		
Unknown white material	0.00	0.00
TAPE, WAND, SHADOW (TWS)		
Shadow	0.00	0.00
Camera pole in frame	1.60	0.24

Appendix C: Permutational Analysis of Variance of Percent Cover of Reef Assemblages Sampled in Reef Monitoring Surveys 3 and 4. *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. All Positions

Source	df	SS	MS	F	*P*
Time	3	1.739E5	57965	27.326	**0.0001**
Residual	324	6.8729E5	2121.3		
Total	327	8.6118E5			

2. Orientation (Deck/Hull)

Source	df	SS	MS	F	*P*
Time	1	35044	35044	29.975	**RED**
Orientation	1	12308	12308	10.528	**RED**
Aspect	1	1667.5	1667.5	1.4263	0.2127
Time x Orientation	1	7144.1	7144.1	6.1109	**0.0012**
Time x Aspect	1	1102.8	1102.8	0.94327	0.4016
Orientation x Aspect	1	2496.1	2496.1	2.1351	0.0892
Time x Position x Aspect	1	2423.4	2423.4	2.0729	0.0991
Residual	76	88850	1169.1		
Total	83	1.6832E5			

3. Depth

Source	df	SS	MS	F	*P*
Time	1	5531.3	5531.3	23.162	0.249
Depth	1	1186	1186	0.23911	0.4974
Aspect	1	5068.2	5068.2	7.3268	0.2561
Transect	1	1685.3	1685.3	3.3284	**RED**
Time x Depth	1	1694.8	1694.8	0.9167	0.5334
Time x Aspect	1	1485.7	1485.7	2.1381	0.196
Time x Transect	1	238.81	238.81	0.47163	0.7544
Depth x Aspect	1	1805	1805	0.80013	0.5367
Depth x Transect	1	4959.9	4959.9	9.7953	**0.0001**
Aspect x Transect	1	691.74	691.74	1.3661	0.2301
Time x Depth x Aspect	1	4376.7	4376.7	2.57	0.235
Time x Depth x Transect	1	1848.9	1848.9	3.6513	**0.0141**
Time x Aspect x Transect	1	694.85	694.85	1.3723	0.2245
Depth x Aspect x Transect	1	2255.9	2255.9	4.4552	**0.0052**
Time x Depth x Aspect x Transect	1	1703	1703	3.3633	**0.0196**
Res	64	32407	506.35		
Total	79	67633			

Continued.

Appendix C: Continued.

4. Deck Position (Bow, Mid, Stern)

Source	df	SS	MS	F	*P*
Time	1	49591	49591	95.551	**RED**
Aspect	1	2129.8	2129.8	4.1036	0.0168
Position	2	30001	15001	28.903	**RED**
Time x Aspect	1	972.05	972.05	1.8729	0.1375
Time x Position	2	10901	5450.4	10.502	**0.0001**
Aspect x Position	2	4148.4	2074.2	3.9965	**0.0034**
Time x Aspect x Position	2	1493.6	746.8	1.4389	0.207
Residual	48	24912	519		
Total	59	1.2415E5			

Appendix D: Pairwise tests of reef assemblages of fish for significant term TimexPosition. Significant results in bold.

Orientation

Term 'TixOr' for pairs of levels of factor 'Time'

Within level 'Deck' of factor 'Orientation'

Groups	t	P(perm)	Unique perms
3, 4	6.2341	**0.0001**	9958

Within level 'Hull' of factor 'Orientation'

Groups	t	P(perm)	Unique perms
3, 4	3.4135	**0.0001**	9951

Depth/Aspect

Term 'TixDexAsxTr' for pairs of levels of factor 'Depth'

Within level '3' of factor 'Time'
Within level 'Port' of factor 'Aspect'
Within level 'Bow' of factor 'Transect'

Groups	t	P(perm)	Unique perms
Deep, Shallow	3.8711	**0.0076**	126

Within level '3' of factor 'Time'
Within level 'Port' of factor 'Aspect'
Within level 'Stern' of factor 'Transect'

Groups	t	P(perm)	Unique perms
Deep, Shallow	2.5131	**0.0074**	126

Within level '3' of factor 'Time'
Within level 'Starbord' of factor 'Aspect'
Within level 'Bow' of factor 'Transect'

Groups	t	P(perm)	Unique perms
Deep, Shallow	2.8181	**0.008**	126

Continued

Appendix D: Continued

Depth/Aspect

Term 'TixDexAsxTr' for pairs of levels of factor 'Depth'

Within level '4' of factor 'Time'
Within level 'Port' of factor 'Aspect'
Within level 'Bow' of factor 'Transect'

Groups	t	P(perm)	Unique perms
Deep, Shallow	1.9719	**0.0322**	126

Position on Deck

Term 'TixPo' for pairs of levels of factor 'Time'

Within level 'Bow' of factor 'Postion'

Groups	t	P(perm)	Unique perms
3, 4	6.0855	**0.0001**	9937

Within level 'Mid' of factor 'Postion'

Groups	t	P(perm)	Unique perms
3, 4	7.7416	**0.0001**	9941

Within level 'Stern' of factor 'Postion'

Groups	t	P(perm)	Unique perms
3, 4	4.6156	**0.0003**	9958

Term 'AsxPo' for pairs of levels of factor 'Aspect'

Within level 'Bow' of factor 'Position'

Groups	t	P(perm)	Unique perms
Port, Starboard	2.5399	**0.0114**	9947

Within level 'Mid' of factor 'Position'

Groups	t	P(perm)	Unique perms
Port, Starboard	2.224	**0.0265**	9950

Appendix E : Results of SIMPER analyses of reef assemblages of fish sampled in The Ex-Hmas Adelaide Articial Reef Community Surveys 3 and 4. Cut off for percentage contribution is 90 %. Note that only relevant SIMPER results have been included in this Appendix.

Time

Groups 3 & 4
Average dissimilarity = 56.17

Species	Group 1 Av.Abund	Group 2 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	41.48	73.08	19.11	1.45	34.02	34.02
Serpulid matrix	14.99	1.59	7.32	0.77	13.03	47.05
Herdmania momus	13	5.44	7.06	0.89	12.56	59.61
Turfing brown sediment and serpulid matrix	12.07	2.78	6.7	0.61	11.92	71.53
Large barnacle,sediment,brown fil	5.56	3.93	4.11	0.56	7.32	78.85
Ecklonia radiata	4.45	1.57	2.86	0.38	5.09	83.94
Bare ships surface	1.46	2.39	1.56	0.67	2.78	86.72
Barnacle,sediment,brown fil	0.77	2.01	1.35	0.27	2.4	89.13
Brown floculant	0.57	1.23	0.84	0.45	1.49	90.61

Orientation

Groups Deck & Hull (Survey 3)
Average dissimilarity = 64.84

Species	Group Deck Av.Abund	Group Hull Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	21.3	41.23	15.3	1.57	23.6	23.6
Turfing brown sediment and serpulid matrix	29.94	6.43	14.61	1.11	22.53	46.13
Serpulid matrix	29.03	23.42	10.93	1.12	16.86	62.98
Herdmania momus	0	20.05	10.04	1.13	15.48	78.47
Ecklonia radiata	12.17	0	6.09	0.57	9.39	87.85
Bare ships surface	0.07	4.01	1.99	0.88	3.07	90.93

Groups Deck & Hull (Survey 4)
Average dissimilarity = 58.29

Species	Group Deck Av.Abund	Group Hull Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	50.09	54.44	18.15	1.5	31.14	31.14
Turfing brown sediment and serpulid matrix	16.52	7.13	9.35	0.83	16.04	47.18
Serpulid matrix	16.02	12.13	9.24	0.94	15.85	63.03
Herdmania momus	0	11.06	5.53	0.71	9.49	72.52
Ecklonia radiata	8.23	0	4.11	0.47	7.06	79.58
Large barnacle,sediment,brown fil	0.02	5.24	2.63	0.67	4.51	84.09
Bare ships surface	0.03	4.78	2.39	0.83	4.09	88.18
Red filamentous	1.82	0	0.91	0.61	1.56	89.74
Barnacle,sediment,brown fil	1.79	0	0.89	0.17	1.53	91.27

Appendix E:Continued

Groups Deck & Hull (Across Surveys 3 and 4)
Average dissimilarity = 50.79

Species	Group Deck Av.Abund	Group Hull Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	50.09	54.44	13.58	1.35	26.73	26.73
Turfing brown sediment and serpulid matrix	16.52	7.13	9.51	0.84	18.72	45.46
Serpulid matrix	16.02	12.13	6.13	0.72	12.06	57.52
Herdmania momus	0	11.06	5.54	0.71	10.9	68.41
Ecklonia radiata	8.23	0	4.11	0.47	8.1	76.51
Large barnacle,sediment,brown fil	0.02	5.24	2.62	0.67	5.16	81.67
Bare ships surface	0.03	4.78	2.38	0.82	4.69	86.36
Red filamentous	1.82	0	0.91	0.61	1.79	88.15
Barnacle,sediment,brown fil	1.79	0	0.89	0.17	1.76	89.91
Encrusting orange bryozoan	0	1.67	0.84	0.89	1.65	91.56

Depth/Aspect

Groups 3DeepPortStern & 3ShallowPortStern
Average dissimilarity = 54.53

Species	Group 3DeepPortSp Av.Abund	3ShallowPort Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	66	35.2	17.04	1.8	31.25	31.25
Herdmania momus	5.32	33.84	14.26	2.93	26.16	57.4
Large barnacle,sediment,brown fil	20.54	7.4	8.87	0.93	16.27	73.68
Barnacle,sediment,brown fil	0	12.6	6.3	1.02	11.55	85.23
Brown floculant	0	4.84	2.42	0.49	4.44	89.67
Bare ships surface	2.45	2.72	1.81	1.08	3.32	92.99
Serpulid matrix	2.23	1.2	1.23	0.88	2.26	95.25
Turfing brown sediment and serpulid matrix	1.62	0	0.81	0.49	1.48	96.73
Encrusting orange bryozoan	0.61	0.8	0.46	1.03	0.85	97.59
Hydroid 2	0	0.8	0.4	0.67	0.73	98.32
Biflustra perfragilis	0.41	0	0.21	0.49	0.38	98.7
Orange encrusting sponge	0.41	0	0.21	0.49	0.38	99.08
White branching bryozoan	0	0.4	0.2	0.49	0.37	99.44
Encrusting yellow bryozoan	0.21	0	0.1	0.49	0.19	99.63
Anthothoe albocincta	0.2	0	0.1	0.49	0.19	99.82
Encrusting red algae	0	0.2	0.1	0.49	0.18	100

Appendix E:Continued

Groups 3DeepStarboardBow & 3ShallowStarboardBow
Average dissimilarity = 32.95

	Group 3DeepStarboa	3ShallowStarbo				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Herdmania momus	32.82	6.24	13.32	1.97	40.43	40.43
Serpulid, barnacle and encrusting algae matrix	58.47	80.29	10.91	1.52	33.12	73.55
Brown floculant	0	2.62	1.31	0.6	3.98	77.53
Encrusting yellow bryozoan	2.23	1.41	1.18	1.19	3.57	81.1
Biflustra perfragilis	2.63	1.21	1.11	1.03	3.38	84.48
Bare ships surface	0.41	2.22	1.07	0.88	3.25	87.73
Serpulid matrix	0.4	1.8	1.02	0.6	3.1	90.83
Large barnacle,sediment,brown fil	0.2	1.4	0.72	0.77	2.19	93.02
Encrusting orange bryozoan	1.22	0.81	0.61	0.98	1.86	94.88
Yellow encrusting sponge	0	0.8	0.4	1.05	1.21	96.09
Turfing brown sediment and serpulid matrix	0.8	0	0.4	0.49	1.21	97.31
Encrusting red algae	0.2	0.4	0.26	0.68	0.79	98.09
White papillate sponge	0.2	0.4	0.22	0.87	0.68	98.77
Hydroid 2	0.2	0	0.1	0.49	0.31	99.08
Botryloides magnicoecum	0.2	0	0.1	0.49	0.31	99.39
White encrusting solitary ascidian	0	0.2	0.1	0.49	0.31	99.7
Orange encrusting sponge	0	0.2	0.1	0.49	0.3	100

Groups 3DeepPortBow & 3ShallowPortBow
Average dissimilarity = 57.33

	Group 3DeepPortBo	3ShallowPor				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Large barnacle,sediment,brown fil	0.2	46.9	23.35	2.27	40.73	40.73
Herdmania momus	45.49	11.02	17.23	2.95	30.06	70.79
Serpulid, barnacle and encrusting algae matrix	42.42	35.27	7.6	1.18	13.26	84.05
Serpulid matrix	7.79	0	3.9	1.08	6.8	90.84
Hydroid 2	0	2.2	1.1	0.49	1.92	92.76
Encrusting orange bryozoan	1.64	0	0.82	1.04	1.43	94.19
Encrusting red algae	0	1.4	0.7	0.7	1.22	95.41
White tubular solitary ascidian	0	1.2	0.6	1.2	1.05	96.46
Fish in frame	0	1.2	0.6	0.49	1.05	97.51
Biflustra perfragilis	0.61	0.4	0.34	0.99	0.6	98.11
Encrusting yellow bryozoan	0.62	0	0.31	0.73	0.54	98.65
White branching bryozoan	0.41	0	0.21	0.8	0.36	99.01
Bare ships surface	0.41	0	0.2	0.49	0.36	99.37
Turfing brown sediment and serpulid matrix	0.2	0.2	0.16	0.67	0.28	99.65
Botryloides magnicoecum	0.2	0	0.1	0.49	0.18	99.83
White encrusting solitary ascidian	0	0.2	0.1	0.49	0.17	100

Appendix E:Continued

Groups 4DeepPortBow & 4ShallowPortBow
Average dissimilarity = 37.14

Species	Group 4DeepPortBow Av.Abund	Group 4ShallowPortBow Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	52.98	76.04	13.19	1.93	35.51	35.51
Herdmania momus	19.91	17.44	8.51	1.07	22.93	58.44
Large barnacle,sediment,brown fil	7.84	0.2	3.86	1.42	10.39	68.83
Brown filamentous algae	6.74	0	3.37	1.81	9.08	77.9
Turfing brown sediment and serpulid matrix	3.69	0	1.85	1.05	4.97	82.87
Brown floculant	2.25	0	1.13	0.98	3.04	85.91
Bare ships surface	1.65	0.82	0.9	1.23	2.43	88.34
Encrusting orange bryozoan	1.86	0.4	0.85	1.21	2.29	90.63
Encrusting red algae	0	1.22	0.61	1.01	1.64	92.27
Yellow encrusting sponge	0.2	1.22	0.59	1.05	1.59	93.86
Orange encrusting sponge	0	0.82	0.41	0.49	1.1	94.96
Hydroid 1	0.61	0.2	0.36	0.63	0.98	95.94
Serpulid matrix	0.83	0.61	0.36	1.08	0.96	96.9
Tryphyllozoan sp.	0.2	0.61	0.33	0.84	0.88	97.78
Encrusting yellow bryozoan	0.63	0	0.31	0.73	0.84	98.62
Biflustra perfragilis	0.62	0	0.31	0.74	0.83	99.45
Hornea foliacea	0	0.41	0.2	0.8	0.55	100

Position on Deck

Time x Position

Groups 3Bow & 4Bow
Average dissimilarity = 74.50

Species	Group 3Bow Av.Abund	Group 4Bow Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	15.23	71.68	29.73	2.11	39.91	39.91
Turfing brown sediment and serpulid matrix	60.79	6.14	27.47	2.63	36.87	76.77
Serpulid matrix	14.93	3.67	5.7	2.65	7.66	84.43
Barnacle,sediment,brown fil	0	10.71	5.38	0.46	7.22	91.65

Groups 3Mid & 4Mid
Average dissimilarity = 81.33

Species	Group 3Mid Av.Abund	Group 4Mid Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	3.93	75.1	35.59	4.23	43.75	43.75
Serpulid matrix	50.23	2.33	23.95	2.04	29.45	73.2
Ecklonia radiata	36.52	12.74	14.51	1.32	17.84	91.05

Appendix E:Continued

Groups 3Stern & 4Stern
Average dissimilarity = 50.04

Species	Group 3Stern Av.Abund	Group 4Stern Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	44.73	89.84	22.87	1.88	45.71	45.71
Turfing brown sediment and serpulid matrix	29.03	3.06	13.72	1.5	27.41	73.12
Serpulid matrix	21.92	3.04	9.49	1.77	18.96	92.08

Aspect x Position
Groups PortBow & StarboardBow
Average dissimilarity = 56.84

Species	Group PortBow Av.Abund	oup StarboardB Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	27.87	59.04	23.62	1.51	41.55	41.55
Turfing brown sediment and serpulid matrix	42.18	24.74	18.62	1.39	32.76	74.31
Barnacle,sediment,brown fil	10.71	0	5.36	0.46	9.43	83.74
Serpulid matrix	9.54	9.06	3.75	1.4	6.6	90.34

Groups PortMid & StarboardMid
Average dissimilarity = 58.36

Species	Group PortMid Av.Abund	oup StarboardM Av.Abunc	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	40.2	38.84	20.69	1.24	35.44	35.44
Serpulid matrix	34.68	17.87	16.84	1.27	28.86	64.31
Ecklonia radiata	15.06	34.19	13.86	1.3	23.74	88.05
Lobed Brown Algae	3.5	3.54	2.12	1.05	3.64	91.68

Groups PortStern & StarboardStern
Average dissimilarity = 37.03

Species	Group PortStern Av.Abund	up StarboardSt Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	69.41	65.16	16.49	1.36	44.52	44.52
Turfing brown sediment and serpulid matrix	14.54	17.55	10.48	1.18	28.31	72.83
Serpulid matrix	12	12.95	6.68	1.23	18.04	90.87

Appendix F : Distance based test for homogeneity of multivariate dispersion between Surveys 3 and 4. Significant results in bold

All Sites (Time)			
F	106.98		
P(perm)	**0.0001**		
Groups	Size	Average	SE
1	82	51.229	0.92291
2	82	52.538	0.98063
3	82	43.621	1.70760
4	82	23.195	1.46150
Orientation			
F	46.938		
P(perm):	**0.0001**		
Groups	Size	Average	SE
3	42	43.244	1.8596
4	42	22.478	2.3936
Depth/Aspect			
F	7.5688		
P(perm):	**0.03**		
Groups	Size	Average	SE
3	40	28.845	1.8924
4	40	22.195	1.5038
Position on Deck			
F	43.227		
P(perm):	**0.0001**		
Groups	Size	Average	SE
3	30	42.022	1.9559
4	30	19.371	2.8361