Cardno Ecology Lab

Shaping the Future

Marine and Freshwater Studies

Ex-HMAS Adelaide Artificial Reef

Reef Community Monitoring

Survey 7

Job Number: EL1112024 J

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Cover Image: Blue groper (*Achoerodus viridus*) near the bridge of the Ex-HMAS Adelaide, January 2013. Photographer, Chris Roberts (Cardno Ecology Lab).

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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 7 (**Table ES 1**), the seventh 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 29 and 30 April 2013. Survey methods involved using divers to take photoquadrats and under water video transects on different parts of the ship. Photoquadrats were analysed for percentage cover of encrusting biota using Coral Point Count with Excel extensions (CPCe) and compared with the previous Monitoring Surveys. Underwater video footage was reviewed and also used to describe the encrusting reef assemblage and fish species present.

Analysis of photoquadrats taken from different parts of the ship showed that the number of individual taxa or groups of taxa (35 recorded in total) were comparable to that surveyed during the previous survey (Survey 6), although the assemblage has become less variable and more uniform over the ship as a whole.

In general, similar taxa to that observed in the previous survey were recorded in Survey 7, with the serpulid, barnacle and encrusting algal matrix being numerically abundant, although there appeared to have been noticeable increases in the percent cover of bare surface, the grouping of large barnacles, sediment and brown filamentous algae, and serpulid matrix. Other taxa/groupings that were well represented during the survey (and have been abundant in previous surveys) included the ascidian *Herdmania momus,* and the common kelp *Ecklonia radiata*. Categories that decreased noticeably from Monitoring Survey 6 were encrusting red algae, white papillate sponge, the laced bryozoan *Biflustra perfragilis* and encrusting orange bryozoan. Several taxa/groupings not previously documented on the ship, but which were recorded during Monitoring Survey 7, included a small orange anemone and two unidentified solitary ascidians.

Analysis of spatial differences and comparison through time indicated that the assemblage recorded on the ship 24 months post-scuttling was significantly different to that in previous surveys, although there were similarities in some of the spatial patterns. Orientation (i.e. horizontal deck and vertical hull surfaces) continued to be an important factor in structuring the reef assemblage on the ship, although differences were not consistent for both Surveys 6 and 7. Unlike previous reports, depth was not found to be a significant factor in structuring assemblages associated with the vertical surfaces of the superstructure and the hull, although depth did appear to influence assemblages found on the more horizontal deck surfaces. Reef assemblages on different sections of the deck (i.e. bow midships and stern) also varied from one another, although differences were not consistent through time.

Inspection of the fixed photos indicated that the thick encrusting layer that had become established on certain parts of the ship, such as ladders and railings, has mostly remained, although some small patches appeared to have been dislodged between Surveys 6 and 7, in in some cases has exposed areas of bare metal. It is likely that the thick layer of encrusting biota was dislodged as a result of large swells that occurred in the period

between Surveys 6 and 7. In addition, a ladder structure that was present on the deck of the superstructure was missing and found deposited onto the sand on the ship's port side. This was likely a result of large prevailing swells from the south. Catchments and Lands were advised of this by divers, and the structure is not considered to present any hazard to divers. The associated structural inspection report will address this further. The structure, which is approximately 2 m in height is shown in **Appendix A**.

Fish abundance and species richness observed around the Ex-HMAS Adelaide has generally increased over the past year, with the current survey recording the most number of species to date with 26 species. Six new species were recorded during Survey 7. These included Gunther's butterflyfish (*Chaetodon guentheri*), magpie morwong (*Cheilodactylus vestitus*), southern fusilier (*Paracaesio xanthurus*), Gunther's wrasse (*Pseudolabrus guntheri*), luculentus wrasse (*Psuedolabrus luculentus*), and the black-banded sea perch (*Hypoplectrodes nigroruber*). These reef associated species are common to coastal reef habitats and may have become resident to the ship as the epifaunal assemblage has developed over time. No introduced marine pests were observed during the survey.

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

Survey	Sampling Dates	Timeframe
Baseline	18 April and 30 May 2011	1 week post-scuttling
Monitoring Survey 1	11 and 13 October 2011	6 months post-scuttling
Monitoring Survey 2	14 and 16 February 2012	10 months post-scuttling
Monitoring Survey 3	3 and 4 May 2012	1 year post scuttling
Monitoring Survey 4	27 July 2012	15 months post scuttling
Monitoring Survey 5	31 October and 01 November 2012	18 months post scuttling
Monitoring Survey 6	16 and 17 January 2013	21 months post scuttling
Monitoring Survey 7	29 and 30 April 2013	24 months post scuttling

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Glossary

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

1 Introduction

1.1 Background and Aims

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

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

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

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

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

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

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

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

This progress report outlines the following:

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

1.2 Study Site and Vessel

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

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

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

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

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

1.3 Previous Surveys

1.3.1 Baseline Survey

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

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

Qualitative surveys of the superstructure were also undertaken.

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

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

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

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

1.3.2 Monitoring Survey 1

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

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

1.3.3 Monitoring Survey 2

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

1.3.4 Monitoring Survey 3

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

1.3.5 Monitoring Survey 4

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

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

1.3.6 Monitoring Survey 5

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

1.3.7 Monitoring Survey 6

Although the number of taxa, or groupings of taxa recorded during survey 6 (approx. 21 months post scuttling) had decreased slightly since the previous survey, the general pattern of assemblages becoming less variable throughout time was still apparent. Again, the serpulid, barnacle and encrusting algal matrix was numerically dominant, although a noticeable increase in cover of encrusting bryozoans and sponges was apparent. As for previous surveys, the ascidian, *Herdmania momus* and the common kelp, *Ecklonia radiata* were well represented on the ships surface. A number of taxa not previously recorded in other surveys were observed, including white tubular sponges, unidentified globular ascidians and numerous dead barnacles. In terms of spatial and temporal patterns, orientation (i.e. deck vs hull surfaces), depth (i.e. superstructure vs hull) and position (i.e. bow vs mid-ships vs stern) were again key factors in structuring the reef assemblage associated with the ship. Fish abundance and species richness was similar between surveys 5 and 6, although a new species of leatherjacket (*Eubalichthys mosaicus*) was observed.

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

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

Survey	Sampling Dates	Timeframe
Baseline	18 April and 30 May 2011	1 week post-scuttling
Monitoring Survey 1	11 and 13 October 2011	6 months post-scuttling
Monitoring Survey 2	14 and 16 February 2012	10 months post-scuttling
Monitoring Survey 3	3 and 4 May 2012	1 year post scuttling
Monitoring Survey 4	27 July 2012	15 months post scuttling
Monitoring Survey 5	31 October and 01 November 2012	18 months post scuttling
Monitoring Survey 6	16 and 17 January 2013	21 months post scuttling
Monitoring Survey 7	29 and 30 April 2013	24 months post scuttling

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

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

2 Study Methods

2.1 Field Methods

2.1.1 Photoquadrats

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

Horizontal Hull

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

Vertical Hull

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

Vertical Superstructure

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

Deck

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

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

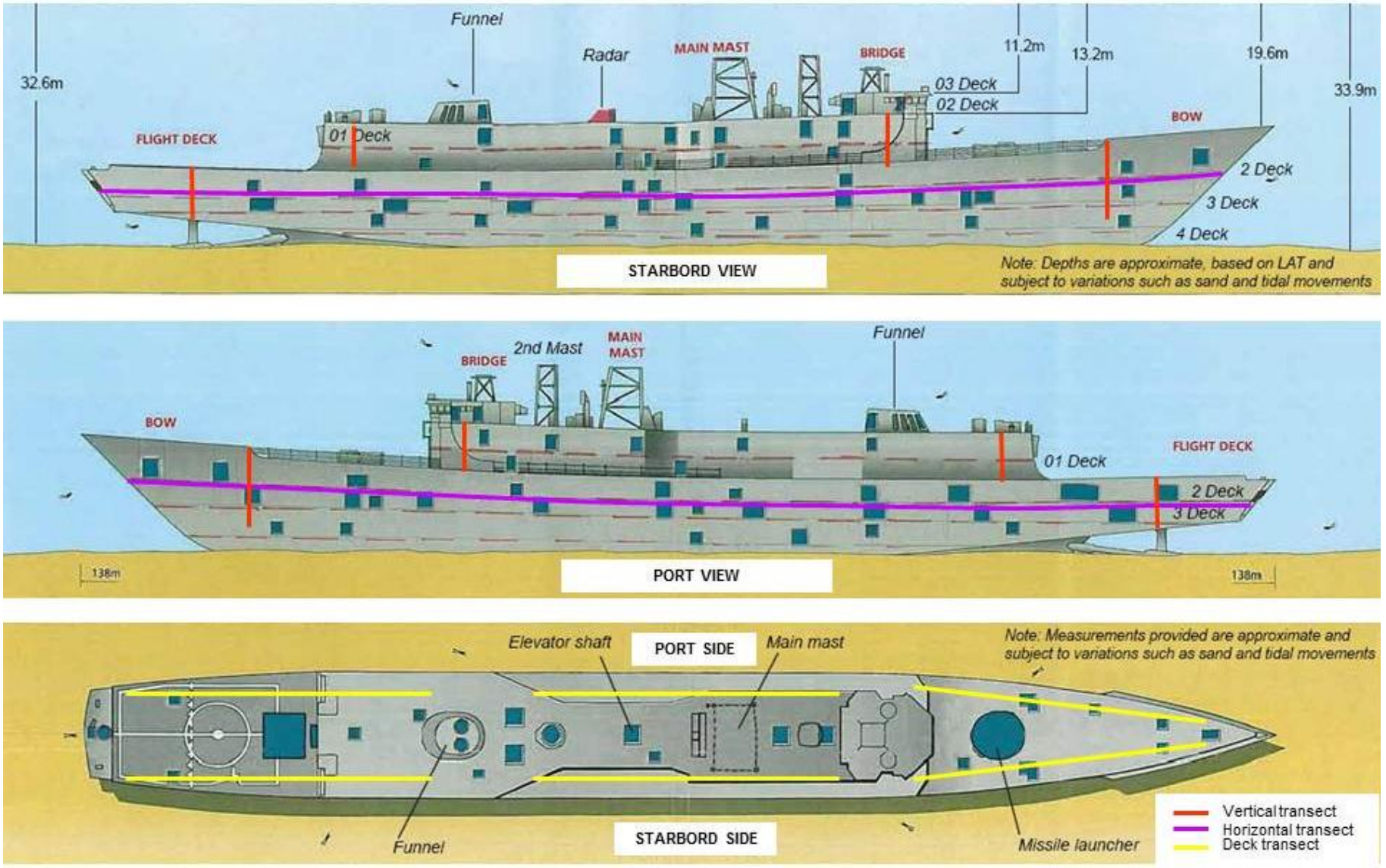

Figure 2: Plans of the Ex-HMAS Adelaide and Positions of the Reef Community Survey Sampling Transects.

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

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

2.1.2 Fixed Point Photographs

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

2.1.3 Video Transects

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

2.2 Analysis

2.2.1 Photoquadrats

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

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

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

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

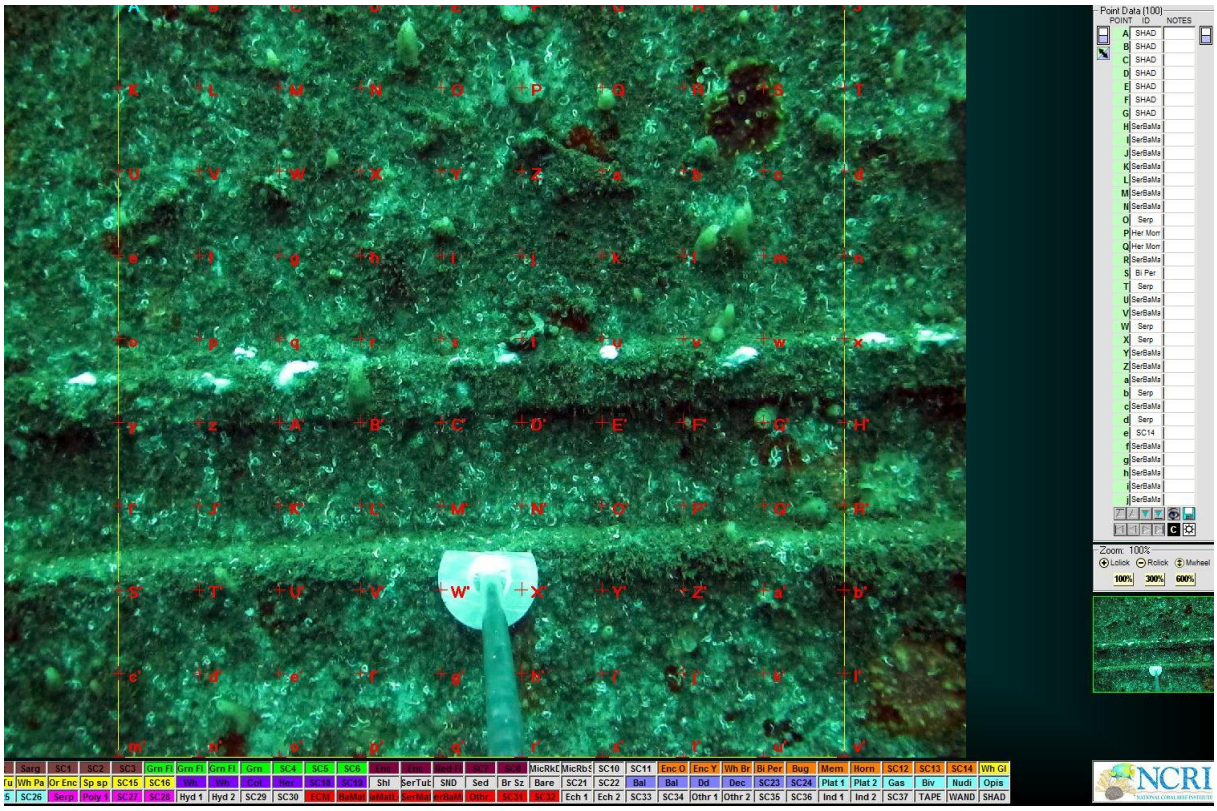

Figure 3: Screenshot of the CPCe Photoquadrat Analyses Frame with a Virtual 10 x 10 Grid Overlayed.

Analyses carried out included:

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

General Findings

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

Spatial and Temporal Analyses

Variation in reef assemblages on different parts of the ship and over time were analysed using multivariate 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 6 and 7. The four null hypotheses tested were:

1. No significant differences in reef assemblage structure among all survey times.

The design to test this hypothesis was as follows:

- Time (Surveys 1 - 7): fixed, orthogonal;

This design compared reef assemblage structure among the seven sampling surveys to date (regardless of their spatial positioning on the ship).

2. No significant differences in reef assemblage structure between horizontally orientated (i.e. deck) surfaces and vertically orientated (hull) surfaces on both the port and starboard sides of the ship among times.

The design to test these hypotheses was as follows:

- Time (Survey 6/Survey 7): fixed, orthogonal;
- Orientation (deck/hull): fixed, orthogonal;
- Aspect: (port/starboard): fixed, orthogonal.

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

3. No significant differences in reef assemblage structure between deep and shallow vertical transects on both the port and starboard sides of the ship among times.

The design to test these hypotheses was as follows:

- Time (Survey 6/Survey 7): fixed, orthogonal;
- Depth (shallow/deep): fixed, orthogonal;
- Aspect (port/starboard): fixed, orthogonal;
- Transect: nested (depth x aspect), random.

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

4. No significant differences in reef assemblage structure among positions (deck surface only) on both the port and starboard sides of the ship among times.

The design to test these hypotheses was as follows:

- Time (Survey 6/Survey 7): 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).

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, 35 categories were identified from the 82 quadrats that were sampled. Similar to previous surveys, an encrusting matrix of serpulid polychaete worms, barnacles and turfing algae was, by far, the most abundant category across the survey. The conglomeration of large barnacles, sediment and brown filamentous algae and the ascidian *Herdmania momus*, were the next most abundant categories recorded during the survey. Interestingly, bare surface was ranked as the fourth most abundant category during Monitoring Survey 7.

Other taxa/groupings that were well represented (and have been abundant in previous surveys) included the common kelp *Ecklonia radiata*, a serpulid matrix, a brown coloured flocculent and an encrusting orange sponge. Several taxa/groupings not previously documented on the ship, but which were recorded during Monitoring Survey 7, included a small orange anemone, two unidentified solitary ascidians and shell grit. In general, similar taxa to that observed in the previous survey were recorded in Survey 7, although there was a marked increase in the cover of bare surface, the grouping of large barnacles, sediment and brown filamentous algae, and serpulid matrix. Categories that decreased noticeably from Monitoring Survey 6 were encrusting red algae, white papillate sponge, the laced bryozoan *Biflustra perfragilis* and encrusting orange bryozoan.

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

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

3.1.2 Spatial and Temporal Variation in Reef Communities

All Times

Overall, the reef assemblage associated with the ship was significantly different through time, with assemblages sampled during each successive survey being different from those sampled during the respective previous survey (**Appendix C, Appendix D**). Although approximately 64% of the total variation among samples appeared to be explained by the two axes within the PCoA, differences among surveys were not clear, especially those samples from later surveys (i.e. Surveys 5, 6 and 7) (**Figure 4**). PERMDISP indicated that the variability among photoquadrats analysed during Survey 6 was similar to Survey 7. This is evident in **Figure 4** which shows a similar spread of data points in both surveys (**Appendix F**). This suggests that the differences detected within the PERMANOVA test were in fact a result of differences among surveys and not from the variability (or spread) among replicate samples within a particular survey. Interestingly, the PCoA shows quite clearly, the pattern of decreasing spread or dispersion among replicate samples in each successive survey (**Figure 4**).

Differences in assemblage structure among Surveys 6 and 7 was best described by increases in the cover of serpulid, barnacle and encrusting algal matrix, the large barnacle, sediment and brown filamentous algal conglomeration, the ascidian *Herdmania momus* and the cover of bare ships surface (**Appendix E**). The decrease in cover of the brown kelp *Ecklonia radiata* also contributed substantially to the differences in reef assemblages between the two previous surveys (**Appendix E**).

Time, Orientation (deck and hull) and Aspect (port and starboard)

Differences in sessile assemblages found on horizontal deck surfaces and those along the vertical hull of the ship were detected, although these differences were not consistent for both surveys (i.e. surveys 6 and 7) (**Appendix C**). It appears that differences between the deck and hull surfaces were greater during Survey 7 compared to the differences detected for Survey 6 (**Appendix D**). A clear difference between replicates taken from deck and hull surfaces of the ship was apparent within the PCoA (**Figure 5**). From the analyses, Aspect (i.e. port vs starboard) played little part in structuring reef assemblages associated with the deck and hull (**Appendix C**).

SIMPER analyses indicated that the serpulid, barnacle and encrusting algal matrix was the best category/taxa that explained the differences in assemblage structure between the deck and hull surfaces (**Appendix E**). Generally, a greater cover of this category was found on the deck (approx. 83%) compared with the hull (approx.

76%). In addition, the cover of *Ecklonia radiata* (common kelp) was far greater on the deck surfaces of the ship (approx. 10%) compared with the vertical surface of the hull (0%). Bare surface also contributed highly to these differences between the two surface types, with a greater cover of bare surface (approx. 4%) on the ship's hull compared to the deck (approx. 1%).

PERMDISP indicated that the variation among samples was similar for Surveys 6 and 7 (**Appendix F**).

Time, Depth (shallow and deep) and Aspect (port and starboard)

In relation to the vertical transects on the hull and superstructure, significant differences in reef assemblages were detected between surveys 6 and 7, and these were consistent for both depth strata and the ship's aspect (**Appendix C**). This time difference can be seen in the PCoA, with a relatively clear distinction between the two survey times (**Figure 6**). PERMANOVA results indicated that no differences in sessile assemblages could be attributed to depth (Appendix C). Smaller-scale spatial variability was also evident, with assemblages along transects within each depth strata and aspect often showing differences (**Appendix C**). This smaller-scale variability was consistent for both surveys. According to PERMDISP results, very little difference in the dispersion of replicates within each survey was evident. This non-significance of the PERMDISP test for time indicates the differences in reef assemblages between surveys were actual temporal differences and not as a result of the variability (spread) among replicate samples taken at during each survey (**Appendix F**).

The differences in reef assemblages between Surveys 6 and 7 were generally as a result of a decrease in percent cover of serpulid, barnacle and encrusting algae matrix, and the bryozoan *Biflustra perfragilis.* (**Appendix E**). In addition, differences between the two surveys could also be attributed to an increase in cover of the conglomeration of large barnacles, sediment and brown filamentous algae, and the solitary ascidian *Herdmania momus* (**Appendix E**).

Time, Position (bow, midships, stern) and Aspect (port and starboard)

Significant differences in sessile reef assemblages among the various positions on the ship's deck surface (i.e. bow, midships or stern) were detected, although differences were dependant on time (**Appendix C**). Pair-wise tests indicated that all three deck positions (bow, mid-ships and stern) were different from one another during both surveys 6 and 7, although the magnitude of these differences was not consistent through time (**Appendix D**). This is illustrated in the corresponding PCoA which shows that approximately 92% of the total variation among samples could be explained by the two axes in the ordination (**Figure 7**). The PCoA also showed that the variability among replicate samples was far greater for the midships position compared with either the bow or the stern of the ship (**Figure 7**). This pattern was highlighted within the PERMDISP results, with significant differences in the dispersion of samples detected among the different positions on the ship (**Appendix F**).

SIMPER analyses (**Appendix E**) indicated that the positional differences in reef assemblages on the ship's deck were generally due to differences in the percent cover of serpulid, barnacle and encrusting algae matrix, common kelp *Ecklonia radiata* and turfing brown algae. When comparing the percent cover of various species between the three positions on the ship, a much greater cover of *Ecklonia radiata* was evident on the midships (approx. 30%) compared to both the bow and stern, where very little cover was recorded for this species (**Appendix E**). The cover of serpulid, barnacle and encrusting algae matrix was also much greater on both the bow and stern sections of the ship (generally greeater than 90%) compared to the midships position (approx. 58%). Differences in sessile assemblages between the bow and stern were generally due to a greater cover of of serpulid, barnacle and encrusting algae matrix on the stern of the ship (approximately 98%) compared with around 92% on the bow (**Appendix E**). Other taxa/groupings that contributed to the differences in reef assemblages on the deck were encrusting red algae and turfing brown algae (**Appendix E**).

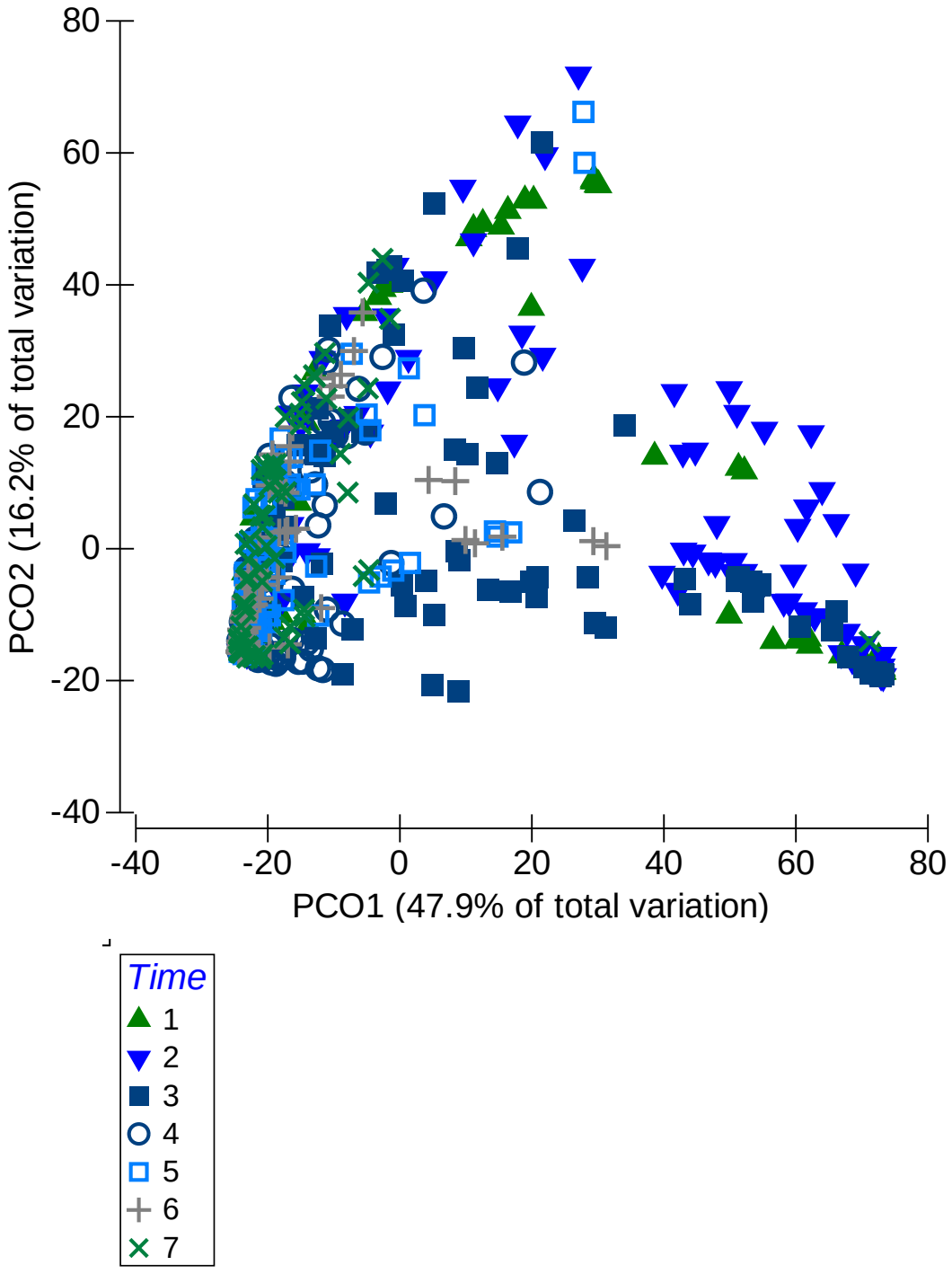

Figure 4: Principal Coordinates Analyses (PCoA) of Percent Cover of Encrusting Assemblages from Transects Taken at all Positions on the Ex-HMAS Adelaide for Surveys 1, 2, 3, 4, 5, 6 and 7.

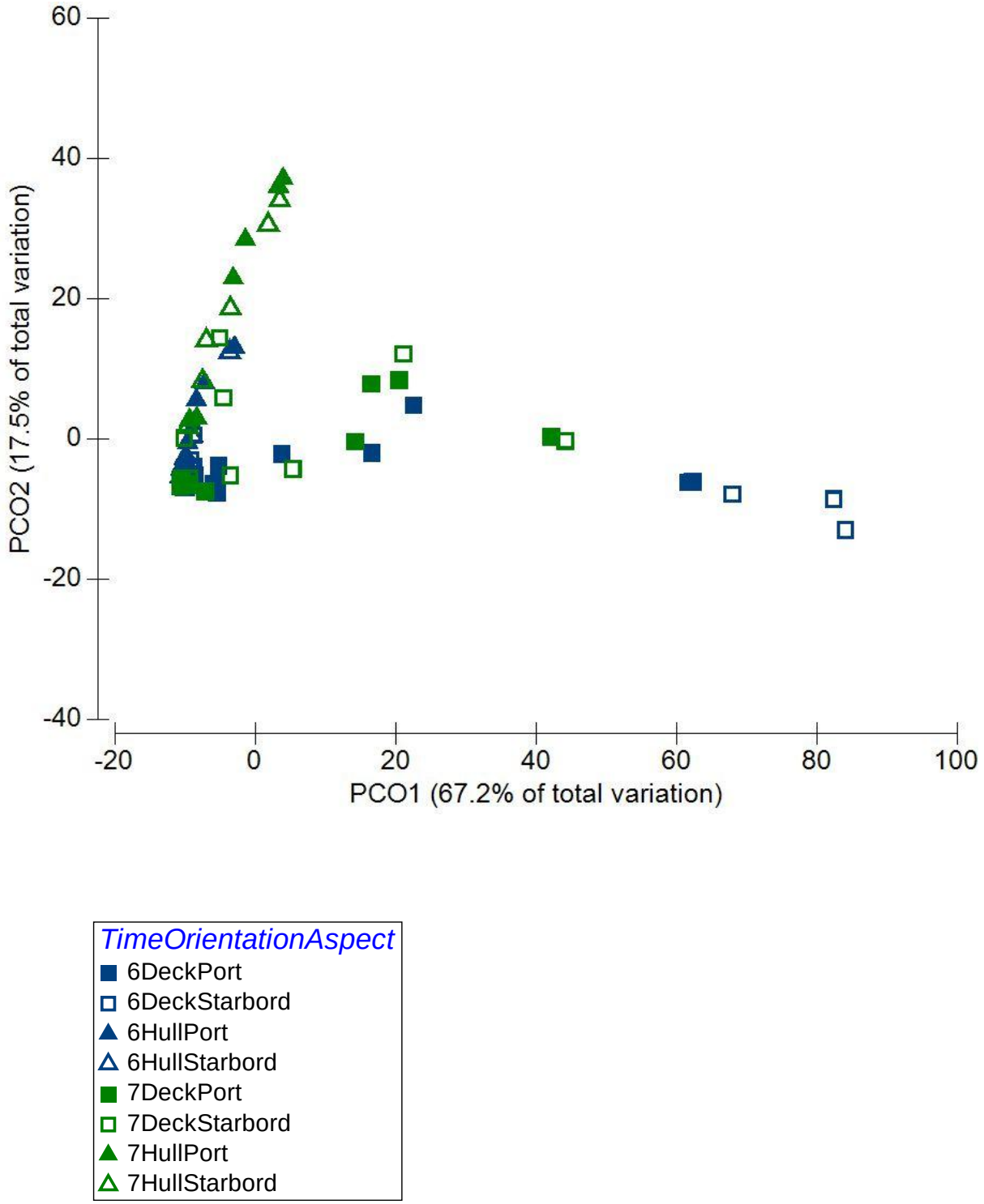

Figure 5: Principal Coordinates Analyses (PCoA) of Percent Cover of Encrusting Assemblages from Transects Taken on Hull and Deck Surfaces of the Ex-HMAS Adelaide for Surveys 6 and 7.

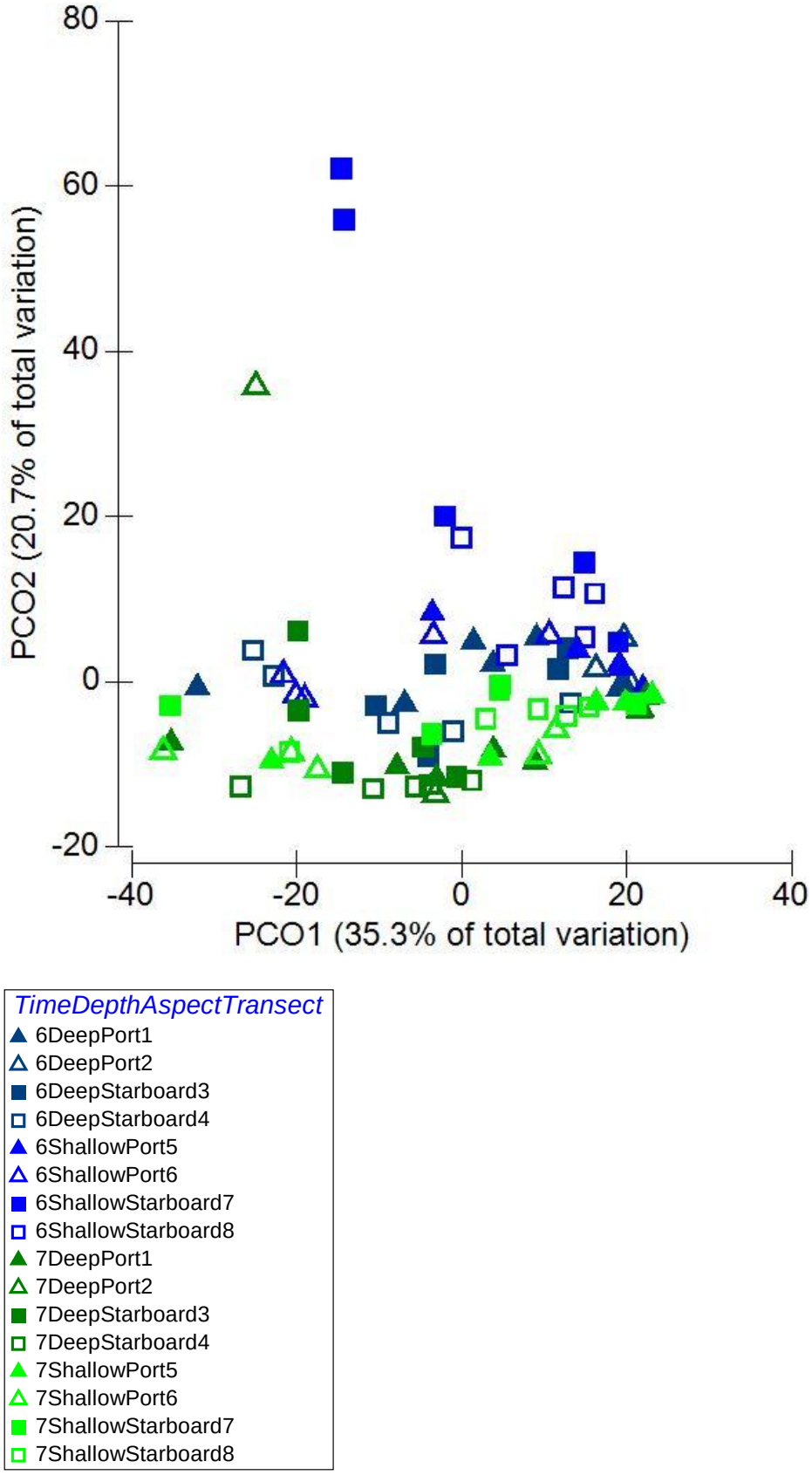

Figure 6: Principal Coordinates Analyses (PCoA) of Percent Cover of Encrusting Assemblages from Transects at Different Depths and Aspect on the Ex-HMAS Adelaide for Surveys 6 and 7.

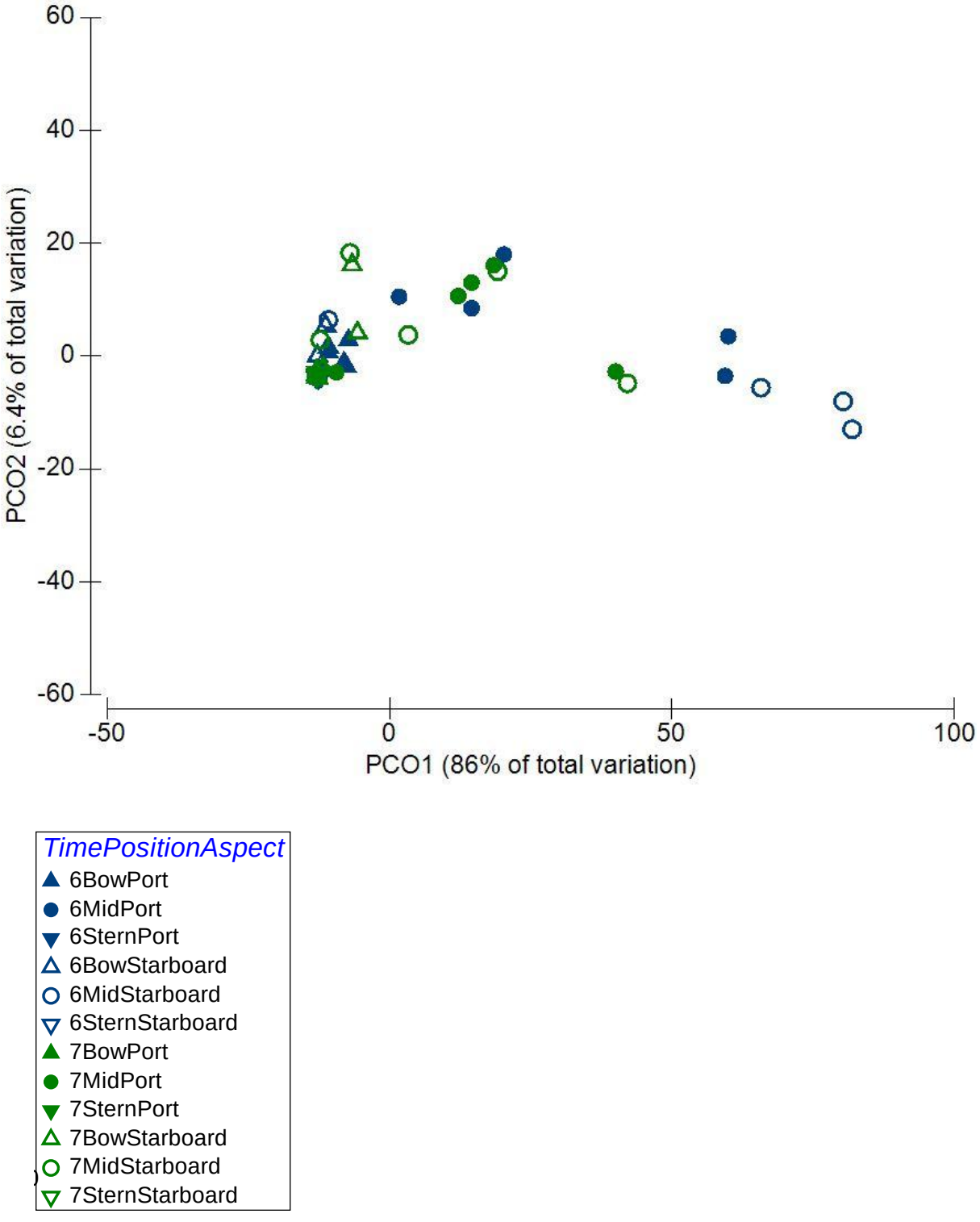

Figure 7: Principal Coordinates Analyses (PCoA) of Percent Cover of Encrusting Assemblages from Transects Taken at Different Positions on the Deck Ex-HMAS Adelaide for Surveys 6 and 7.

3.2 Fixed Photographs

Photographs taken from fixed locations are presented in **Appendix A.** Inspection of fixed photos taken during Survey 7 shows layers of thick encrusting biota remains visible over the majority of the ship i.e. ladders, railings and mast structures (e.g. fixed photographs 4, 5, 9 and 10). However, there appears to be a lower cover of encrusting organisms, and in some cases bare metal or paint, noticeable in some areas since the previous survey. It is likely that this thick layer of encrusting biota was dislodged either as a result of diving activities or when big swells impacted the ship between Surveys 6 and 7. This is particularly evident where some structure (fixed photograph 4) was missing from the deck of the ship and was deposited onto the sand on the ship's port side, likely as a result of large prevailing swells from the south. The light coloured sponge or encrusting bryozoan on some areas of the ship (e.g. fixed photographs 1, 2, 4, 6 and 10) remains. In addition, as with previous surveys, other flat, less complex surfaces of the ship e.g. fixed photographs 1, 7 and 8 show marginal changes if any in sessile biota cover between surveys 6 and 7.

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 7) are listed in **Table 3**. Species of recreational, commercial or conservation value are also indicated. Six new species of fish were recorded during Survey 7, yielding a total of 26 taxa. These new species of fish included the Gunther's butterflyfish (*Chaetodon guentheri*), magpie morwong (*Cheilodactylus vestitus*), southern fusilier (*Paracaesio xanthurus*), Gunther's wrasse (*Pseudolabrus guntheri*), luculentus wrasse (*Psuedolabrus luculentus*), and the black-banded sea perch (*Hypoplectrodes nigroruber*).

Table 2: Summary of Observations of Attached Encrusting and Fish Assemblages Observed from Video Footage of the Ex-HMAS Adelaide in January 2013 (Survey 7).

Position	Description of Assemblage
Deck Port Bow	The deck surface is heavily encrusted with growth of barnacles, encrusting algae, hydroids and fine filamentous algae. Occasional patches of bright yellow and orange encrusting and white papillate sponges are seen on the flat of the deck with some clumps of erect tubular sponges. Tarwhine (*Rhabdosargus sarba*) were abundant in schools, the eastern hulafish (*Trachinops taeniatus*) was abundant on vertical structure. Other species of fish in this area included juvenile snapper (*Pagrus auratus*), silver sweep (*Scorpis lineolatus*), and red morwong (*Cheilodactylus fuscus*). A newly recorded species at this location was the magpie morwong (*Cheilodactylus vestitus*).
Deck Port Mid	Kelp (*Ecklonia radiata*) remained present in this area however it appears that a weather event has reduced the cover since the last survey. An unknown bright white encrusting substance and small branching red filamentous algae attached to the deck (observed in previous surveys) remains. The majority of the deck is still otherwise heavily encrusted with barnacles, encrusting algae, hydroids and fine filamentous algae. Rock cale (*Crinodus lophodon*), a kelp associated species, was abundant in this area. Other species included tarwhine (*Rhabdosargus sarba*), red morwong (*Cheilodactylus fuscus*), six-spine leatherjacket (*Meuschenia freycineti*), yellow-fin leatherjacket (*Meuschenia trachylepis*), and the eastern blue groper (*Achoerodus viridis*) along with the luculentus wrasse (*Psuedolabrus luculentus*), a newly recorded labrid species.
Deck Port Stern	The deck is still predominantly covered in serpulid tubes, barnacles, encrusting algae, hydroids and fine filamentous algae. Occasional patches of orange encrusting sponge and red encrusting algae were observed along with small white sponges. Poor visibility and green water on the second sampling day inhibited identification of fishes and sessile organisms. As a result, only one individual silver trevally (*Psuedocarynx dentex*), white ear (*Parma microlepis*), and bastard trumpeter (*Latridopsis forsteri*) were observed.

Deck Starboard Bow	As with previous surveys, encrusting growth includes barnacles, algae and hydroids with patches of encrusting sponges. Small clumps of green filamentous algae remain on the deck. Kelp (*Ecklonia radiata*) fronds can be seen along the internal side of the bow. Schools of eastern hulafish (*Trachinops taeniatus*) were present in several large but distinctly separate schools (approx. 50-150 individuals) along vertical structure in this area. Silver sweep (*Scorpis lineolata*), tarwhine (*Rhabdosargus sarba*), red morwong (*Cheilodactylus fuscus*), white ear (*Parma microlepis*), girdled scalyfin (*Parma unifasciata*), half-banded sea perch (*Hypoplectrodes maccullochi*), and mado (*Atypicthys strigatus*) were present in small numbers. A new serranid species, black-banded sea perch (*Hypoplectrodes nigroruber*) was also recorded.
Deck Starboard Mid	Kelp (*Ecklonia radiata*) remains in this section, particularly along the edges of the midship however it appears to be less abundant. As per previous surveys, the majority of the deck is otherwise heavily encrusted with barnacles, encrusting algae, hydroids, fine red filamentous algae and small branching hard corals. The vertical superstructure and areas of railing remain heavily colonised with ascidians and branching and papillate white bryozoans and sponges. Eastern hulafish (*Trachinops taeniatus*), blotched hawkfish (Cirritichthys aprinis), half-banded sea perch (*Hypoplectrodes maccullochi*), and black-banded sea perch (*Hypoplectrodes nigroruber*) were abundant around railings and vertical habitat. Sweep, leatherjackets, red morwong, tarwhine, snapper, white ear and girdled scalyfin were also found in this area. Two new species, the southern fusilier (*Paracaesio xanthurus*) and Gunther's wrasse (*Pseudolabrus guntheri*) were observed in this area.
Deck Starboard Stern	Poor visibility and green water on the second sampling day inhibited identification of fishes and sessile organisms. Serpulid worm tubes, small barnacles, encrusting algae, hydroids and fine filamentous algae cover are still abundant on flat areas of the deck. Snapper (*Pagrus auratus*) was also observed along this transect.
Horizontal Hull Port and Starboard	Poor visibility and green water on the second sampling day inhibited identification of fishes and sessile organisms on the port side. However, the hull remains heavily colonised by sessile invertebrates on both the port and starboard sides. As with previous surveys, these include ascidians (*Herdmania momus, Botryloides magnicoecum*), large barnacles, and yellow, orange and white encrusting sponges and bryozoans. A white sponge has also become heavily colonised along the sides of the ship. Growth still appears thickest around the gunwale, and around the edges of holes in the hull. Otherwise, the hull remains heavily encrusted with serpulid worm tubes covered with small barnacles, encrusting algae, hydroids and fine filamentous algae. The encrusting layer had broken off exposing some fairly large bare patches of metal in places. Tarwhine (*Rhabdosargus sarba*), trevally (*Psuedocarynx dentex*), six-spine leatherjacket (*Meuschenia freycineti*), yellow-fin leatherjacket (*Meuschenia trachylepis*), black-spot goatfish (*Parupeneus spilurus*), the eastern hulafish (*Trachinops taeniatus*), juvenile snapper (*Pagrus auratus*), silver sweep (*Scorpis lineolatus*), the red, magpie, and blue morwong (*Cheilodactylus fuscus*, *Cheilodactylus vestitus*, and *Nemadactylus douglasii*) were observed along this transect. Gunther's butterflyfish (*Chaetodon guentheri*) was also recorded.
Vertical Hull Bow	Similar to previous surveys, large ascidians and barnacles dominated the encrusting biota on the hull of the ship. Various encrusting and papillate sponges and small branching white bryozoans remain. In addition, the vertical plane of the hull was encrusted with a layer of serpulid worm tubes covered with small barnacles, encrusting algae, hydroids and fine filamentous algae.
Vertical Hull Stern	As with previous surveys, ascidians and large barnacles were more prevalent on the hull of the ship, in comparison to the deck surfaces, while bryozoans, sponges and clumps of small branching white bryozoans were also observed. The vertical plane of the hull was otherwise encrusted with a layer of serpulid worm tubes covered with barnacles, encrusting algae, hydroids and a fine filamentous algae and in some areas a turfing like algae. A large school of tarwhine (*Rhabdosargus sarba*), a single eastern red scorpioncod (*Scorpaena cardinalis*) and a half-banded sea perch (*Hypoplectrodes maccullochi*) were observed along this transect.

Vertical Hull Superstructure	Poor visibility on the second sampling day inhibited clear identification of fishes and sessile organisms on the port side of the superstructure. Ascidians, bryozoans, a layer of serpulid worm tubes, barnacles, encrusting algae, hydroids and fine filamentous algae were observed on the superstructure. A large school of sub-adult yellowtail kingfish (*Seriola lalandi*) was recorded toward the end of this transect.

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

Family	Species Name	Common Name	Species Number (Hutchins & Swainston)	Baseline Survey (April/May 2011)	Survey 1 (October 2011)	Survey 2 (February 2012)	Survey 3 (May 2012)	Survey 4 (August 2012)	Survey 5 (October 2012)	Survey 6 (January 2013)	Survey 7 (April 2013)
Aulopodidae	*Aulopus purpurrissatus*	Sergeant baker	83		●	●	●		●	●	
Scorpaenidae	*Centropogon australis*	Eastern fortesque	166		●	●	●				
Scorpaenidae	*Scorpaena cardinalis*	Eastern red scorpioncod	176		●	●			●		●
Platycephalidae	*Platycephalus fuscus*	Dusky flathead*+	203					●			
Serranidae	*Hypoplectrodes maccullochi*	Half-banded sea perch	225				●	●			●
Serranidae	*Hypoplectrodes nigroruber*	Black-banded sea perch									●
Plesiopidae	*Trachinops taeniatus*	Eastern hulafish	246						●	●	●
Dinolestidae	*Dinolestes lewini*	Longfinned pike	263		●			●			
Carangidae	*Pseudocaranx dentex*	Silver trevally	292				●	●	●		●
Carangidae	*Trachurus novaezelandiae*	Yellowtail scad+	294		●			●			
Carangidae	*Seriola lalandi*	Yellowtail kingfish*#	298			●	●		●	●	●
Sparidae	*Pagrus auratus*	Snapper (juv)*+	310		●	●	●		●	●	●
Sparidae	*Rhabdosargus sarba*	Tarwhine*	311			●	●	●	●	●	●
Mullidae	*Parupeneus spilurus*	Blackspot goatfish	323	●					●	●	●
Kyphosidae	*Kyphosus sydneyanus*	Silver drummer*	346				●				
Scorpididae	*Atypicthys strigatus*	Mado	349		●	●	●	●			●
Scorpididae	*Microcanthus strigatus*	Stripey	350		●	●	●				
Scorpididae	*Scorpis lineolatus*	Silver sweep*	353		●	●	●			●	●
Ephippidae	*Platax sp.*	Batfish	355					●			
Chaetodontidae	*Heniochus diphreutes*	Schooling bannerfish	372	●	●				●		
Chaetodontidae	*Chaetodon guentheri*	Gunther's butterflyfish	358								●
Enoplosidae	*Enoplosus armatus*	Old wife	376				●	●			●
Pomacentridae	*Parma microlepis*	White ear	388		●			●	●	●	●
Pomacentridae	*Parma unifasciata*	Girdled scalyfin	393			●			●	●	●
Cirritidae	*Cirrhitichthys aprinus*	Blotched hawkfish	406						●	●	●
Chironemidae	*Chironemus marmoratus*	Eastern kelpfish	411						●		
Aplodactylidae	*Crinodus lophodon*	Rock cale	415						●		●
Cheilodactylidae	*Cheilodactylus fuscus*	Red morwong*	416		●	●	●	●	●	●	●
Cheilodactylidae	*Nemadactylus douglasii*	Blue morwong*	424		●	●				●	●
Cheilodactylidae	*Cheilodactylus vestitus*	Magpie morwong	421								●
Latridae	*Latridopsis forsteri*	Bastard trumpeter	427		●				●	●	●
Labridae	*Achoerodus viridis*	Eastern blue groper#	438		●	●	●	●	●	●	●
Labridae	*Coris picta*	Comb wrasse	446						●		
Labridae	*Notolabrus gymnogenis*	Crimson banded wrasse	481				●		●	●	
Labridae	*Notolabrus parilus*	Brown spotted wrasse	483				●				
Labridae	*Psuedolabrus luculentus*	Luculentus wrasse	487								●
Lutjanidae	*Paracaesio xanthurus*	Southern fusilier	320								●
Blenniidae	*Petroscirtes lupus*	Brown sabretooth blenny	532	●						●	
Blenniidae	*Parablennius intermedius*	Horned blenny	?								
Monacanthidae	*Monacanthus chinensis*	Fan belly leatherjacket*	636						●		
Monacanthidae	*Meuschenia freycineti*	Six-spined leatherjacket*	643						●		●
Monacanthidae	*Meuschenia trachylepis*	Yellow-finned leatherjacket*	646				●		●	●	●
Monacanthidae	*Nelusetta ayraudi*	Chinaman leather jacket*+	648		●	●	●				
Monacanthidae	*Eubalichthys mosaicus*	Mosiac leatherjacket*	652							●	
Monacanthidae	*Meuschenia spp.*	Unidentified leatherjackets	?				●	●	●		
Tetraodonitdae	*Dicotlichthys punctulatus*	Three-bar porcupinefish	682		●				●	●	
Total Number of Taxa				**3**	**17**	**14**	**19**	**13**	**23**	**19**	**26**

4 Discussion

4.1 Encrusting Biota

Overall, the reef assemblage associated with the ship during Survey 7 (carried out approximately 24 months post-scuttling) was different to that sampled during earlier surveys. The number of categories recorded during the current survey (35) was similar to that of Survey 6 (36). Results of Survey 7 show that although several new categories have been recorded since the previous survey, differences among surveys were attributed to changes in percent cover of existing taxa rather than the colonisation of new taxa, which were generally present in low abundance. It is difficult to determine the causality of any differences in cover through time, although, changes in percent cover of existing taxa may be a result of several biotic, density dependant interactions (such as predation and competition) and/or changes to physical conditions (e.g. from storms or seasonal fluctuations in sea temperature and current patterns). The increase in cover of bare surface from Survey 6 to Survey 7, especially on the midships deck section of the ship was most likely due to the removal of the kelp *Ecklonia radiata* by storm surges that occurred between surveys, as numerous holdfasts with fronds broken off were observed by divers during the field survey and also in photoquadrats. The area of bare surface on the vertical hull section of the ship had also increased since the previous survey. It is also likely that the surge created by recent storm events had the capacity to remove any heavier sections of the assemblage that were unable to maintain their weight during the physical disturbance. It should also be noted that poor water visibility, especially on the second day of the diver surveys, was evident throughout the day, decreasing the clarity of any photos or video footage taken. This made processing of images for this particular day difficult and had the potential to overestimate taxa categories such as the serpulid matrix and underestimate many of the other more inconspicuous categories that are resident on the ship. Notwithstanding this, the variability among samples taken during Survey 7 remained relatively stable and showed little difference in the spread of replicates for the current survey compared with that of the previous surveys (Surveys 5 and 6). This indicates that the variability among replicate samples on the ship as a whole, has become more uniform over time. As for previous surveys, this stabilised variability among samples within a particular survey is attributed to the succession of the underlying encrusting matrix which has become progressively colonised by barnacles and encrusting algae over the majority of the vessel.

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

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

Apart from orientation (i.e. horizontal deck and vertical hull), deck position (i.e. bow, midships and stern) also played a role in structuring sessile invertebrate assemblages associated with the ship. As mentioned in previous reports, however, this factor is confounded by depth, as the midships deck position is situated on top of the superstructure, whereas the bow and stern deck positions are situated at the level of the flight deck in deeper water. Notwithstanding this, spatial differences on the deck surfaces were evident as bow and stern reef assemblages were also found to be different with both deck positions occurring at similar depths. This pattern

was also apparent for the previous survey (i.e. Survey 6). By nature of the ships design and its partial burial within the seabed, there may be subtle depth differences on various sections of the deck that may influence shading on these parts of the ship, ultimately affecting the benthic assemblages in these areas.

4.2 Fish and Macroinvertebrates

Fish abundance and species richness observed around the Ex-HMAS Adelaide has generally increased over time, since its scuttling in April 2011. Six new species of fish were recorded during the current survey, bringing the total number of species observed to 26 for Survey 7, greater than any other survey to date. The new species included Gunther's butterflyfish (*Chaetodon guentheri*), magpie morwong (*Cheilodactylus vestitus*), southern fusilier (*Paracaesio xanthurus*), Gunther's wrasse (*Pseudolabrus guntheri*), luculentus wrasse (*Psuedolabrus luculentus*), and the black-banded sea perch (*Hypoplectrodes nigroruber*). All are largely reef associated species and generally common to coastal reef habitat. This suggests that the development of the reef habitat over time may be influencing the fish assemblage in and around the ship

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

5 Acknowledgements

This report was written by Brendan Alderson and Guy Graham and reviewed by Kate Reeds. Field Work was done by Dr Lachlan Barnes, Chris Roberts, Brendan Alderson and Dan Pygas of Cardno Ecology Lab. Cardno Ecology Lab thanks Terrigal Dive Centre in assisting with this survey.

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7 Plates

Deck, Port Bow

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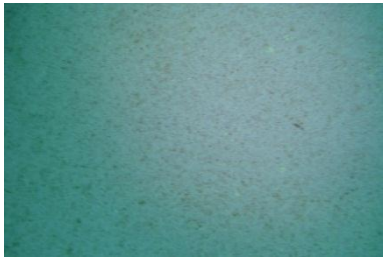	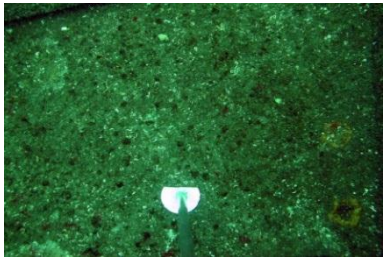	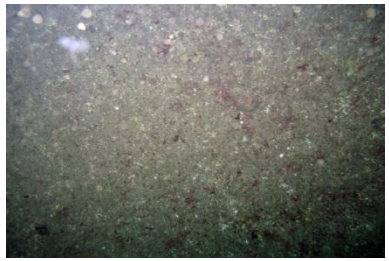	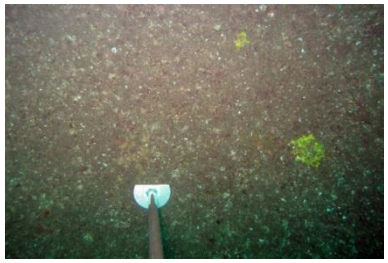	
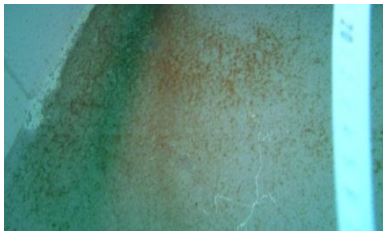		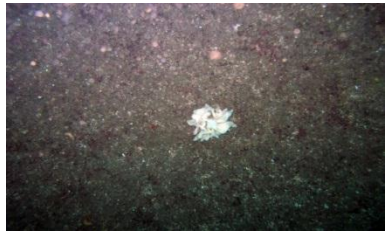	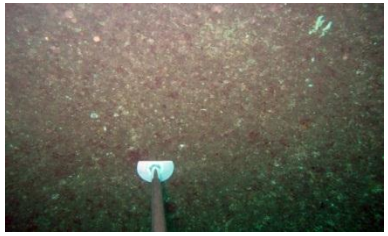	
		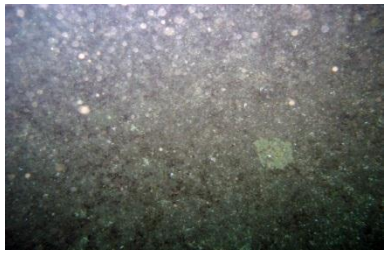	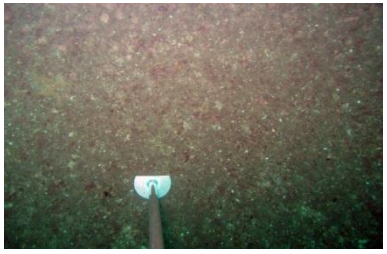	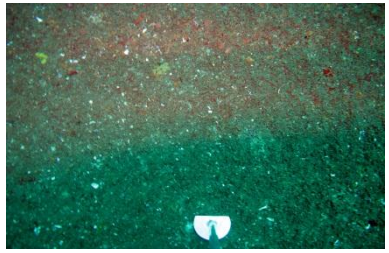

Plate 1: Deck port bow

Deck, Port Bow

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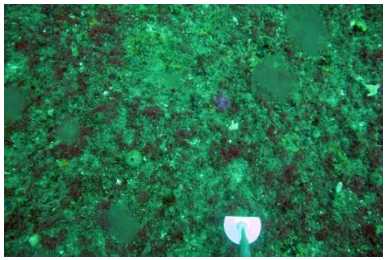	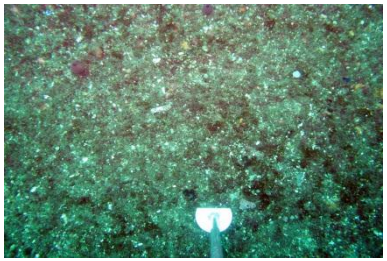	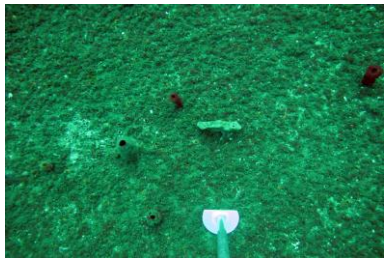
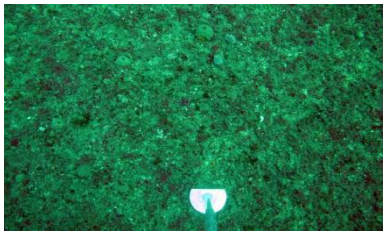	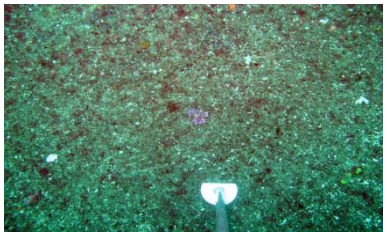	
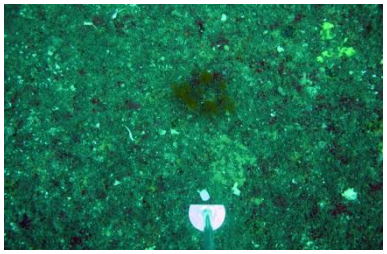	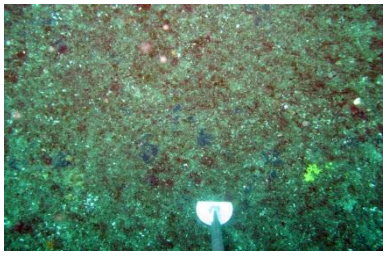	

Plate 1: Deck port bow

Deck, Port Mid

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	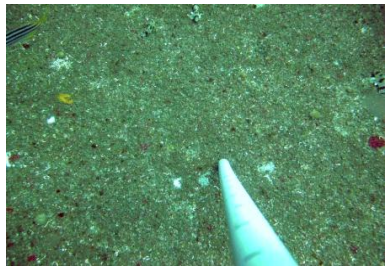	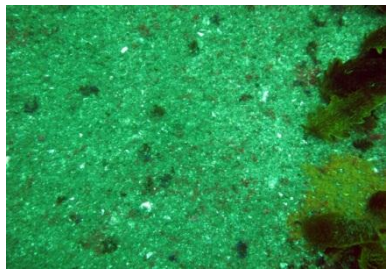	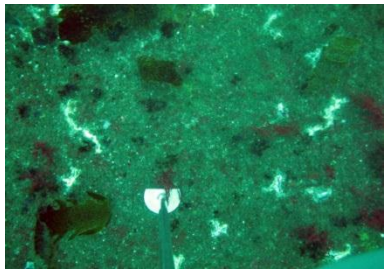	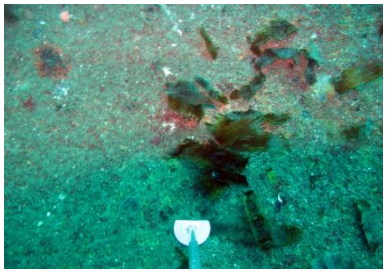
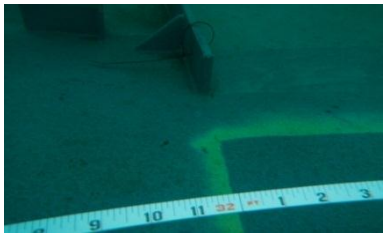	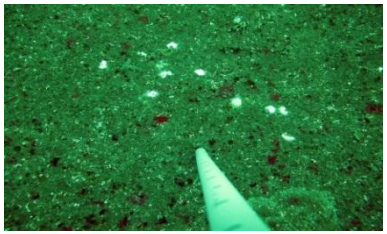	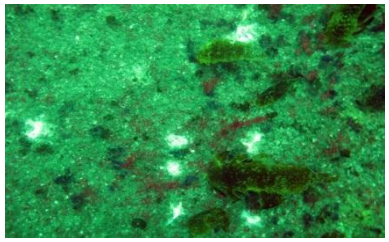	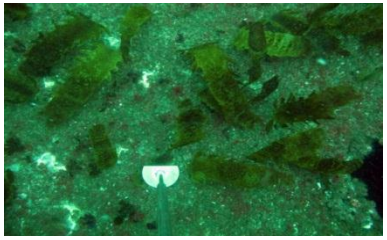	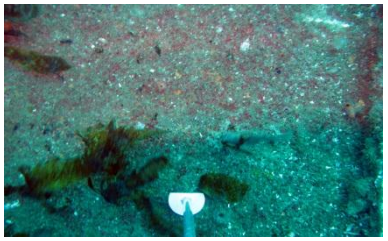
	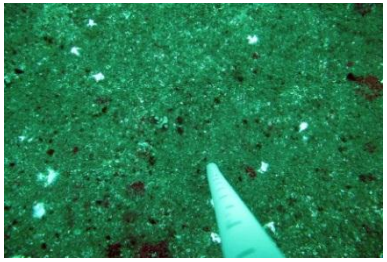	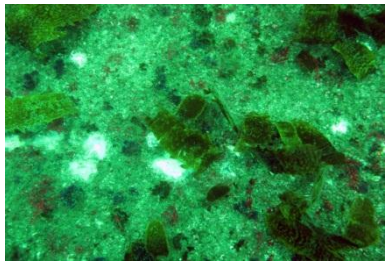	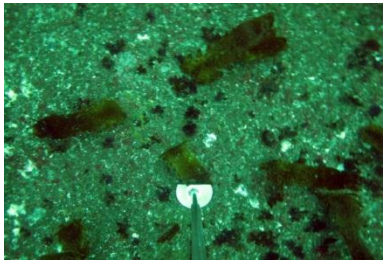	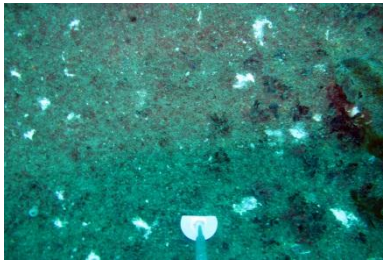

Plate 2: Deck Port Mid

Deck, Port Mid

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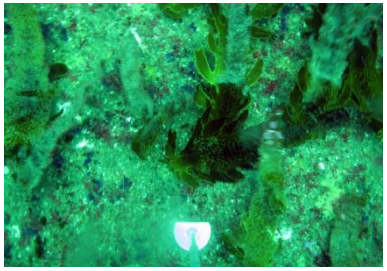		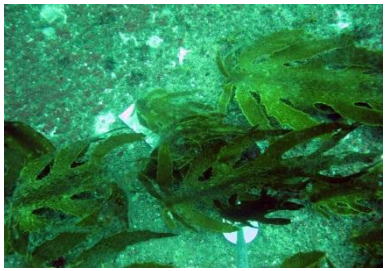
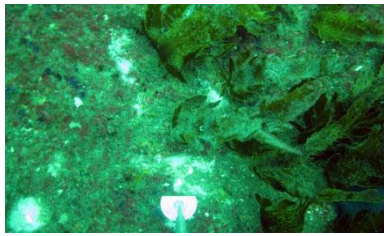	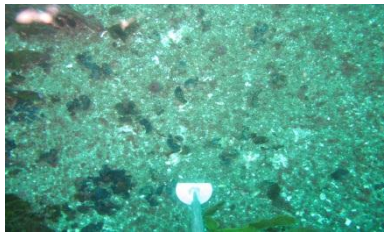	
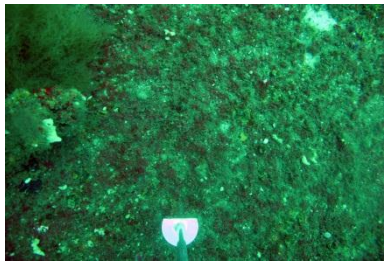	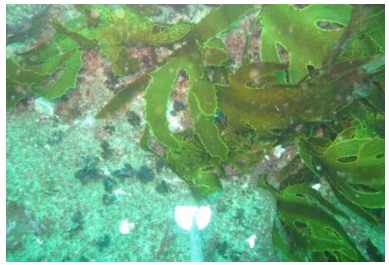	

Plate 2: Deck Port Mid

Deck, Port , Stern

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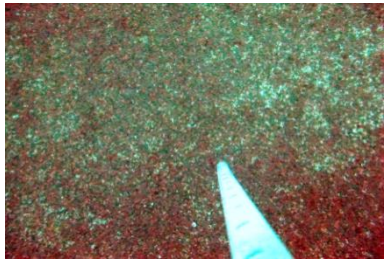
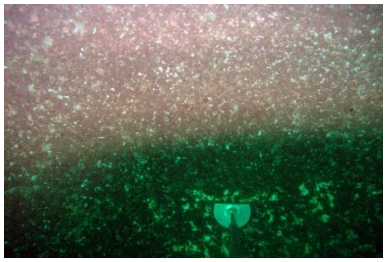
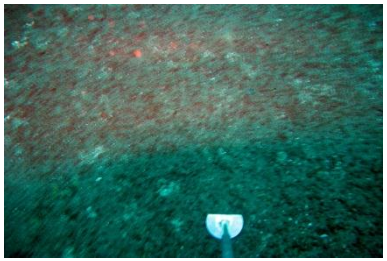
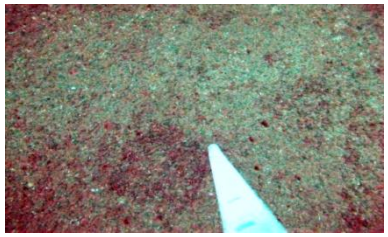
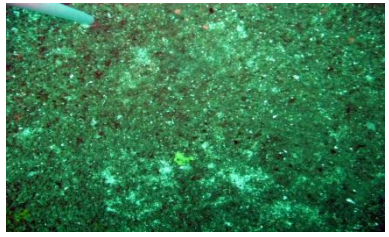
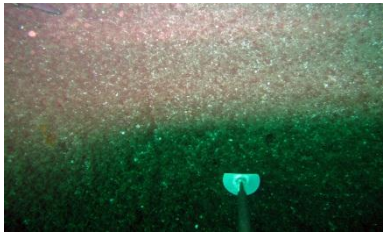
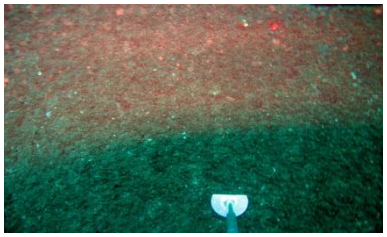
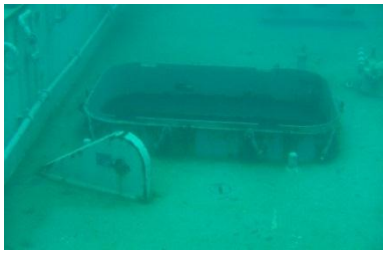
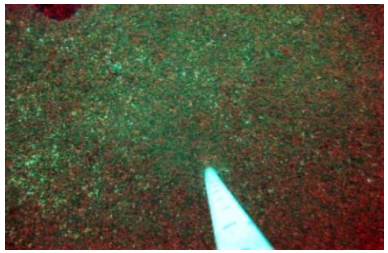
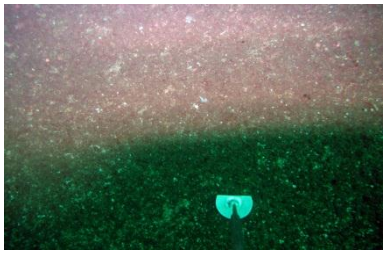
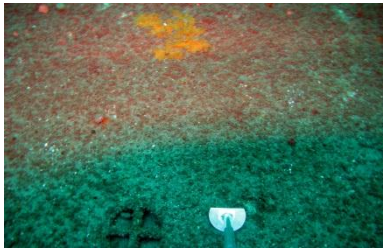
				
				
				

Plate 3: Deck Port Stern

Deck, Port, Stern

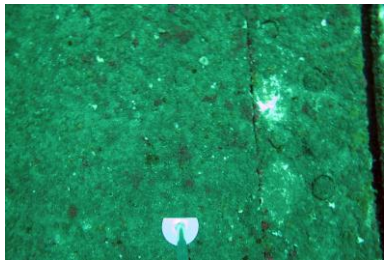
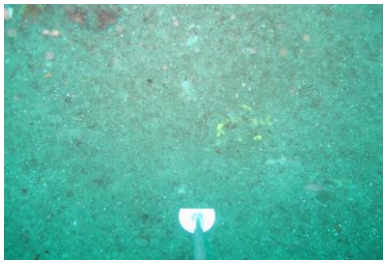
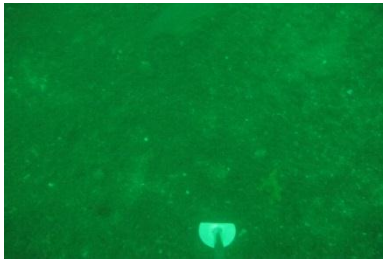
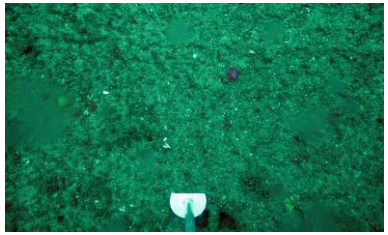
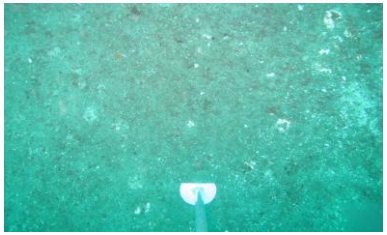
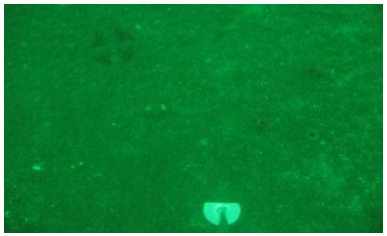
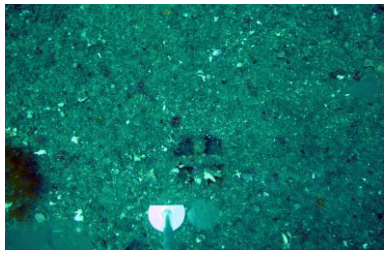
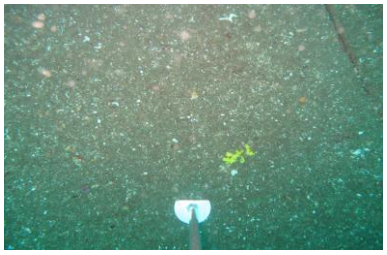
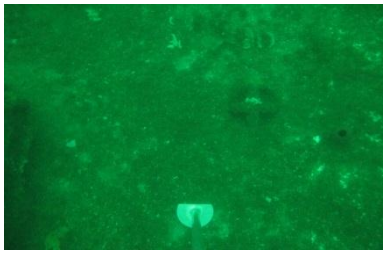
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)
		
		
		

Plate 3: Deck Port Stern

Deck, Starbord, Bow

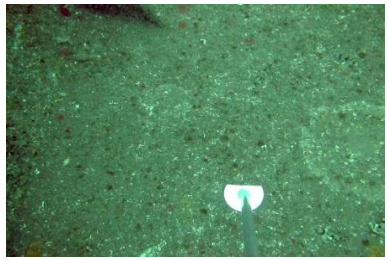
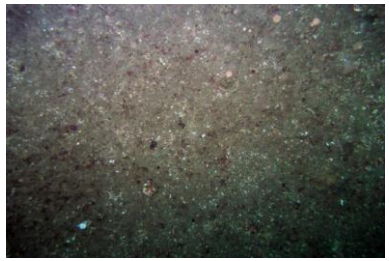
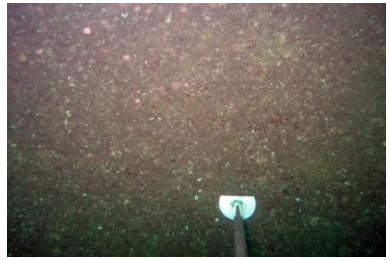
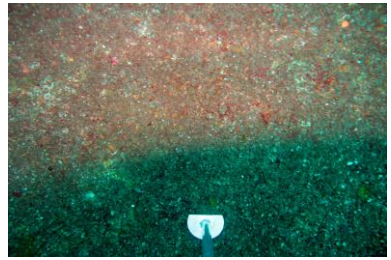
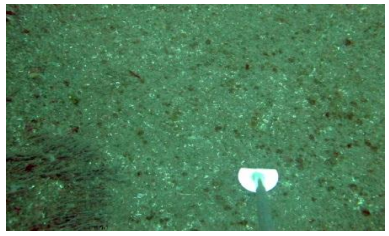
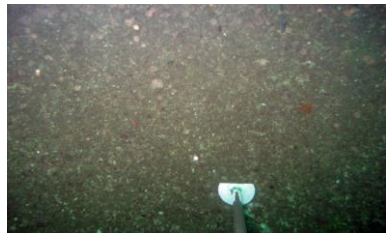
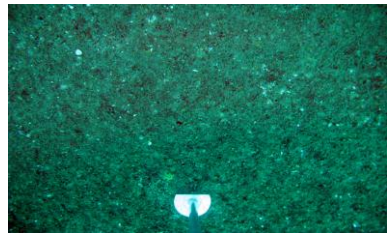
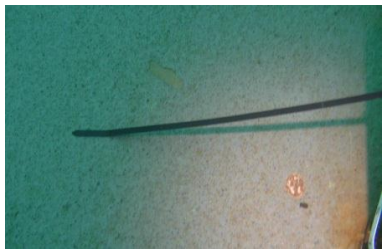
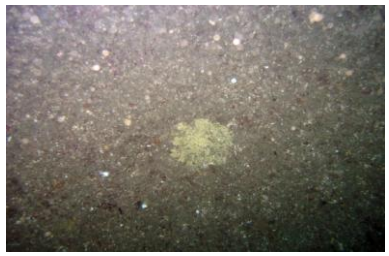
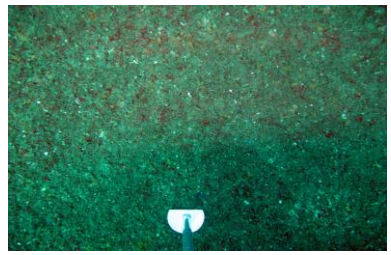
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 4: Deck Starbord Bow

Deck, Starbord, Bow

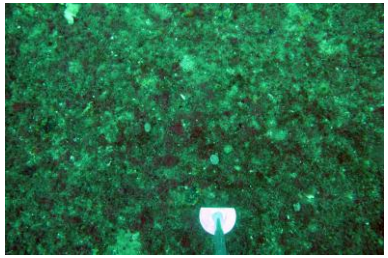
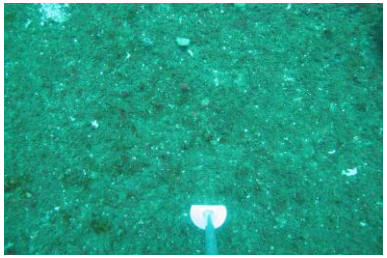
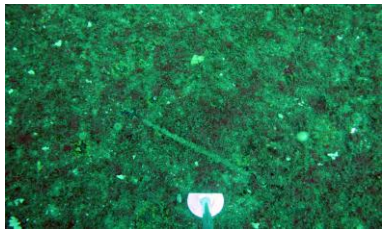
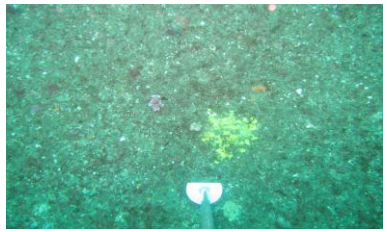
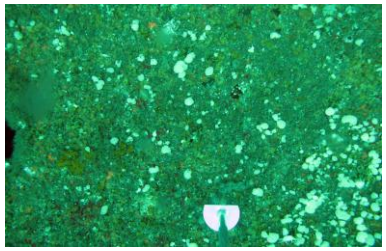
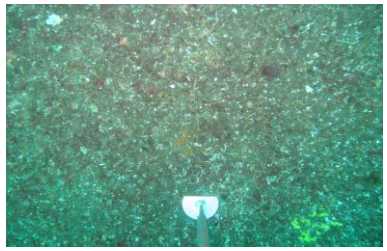
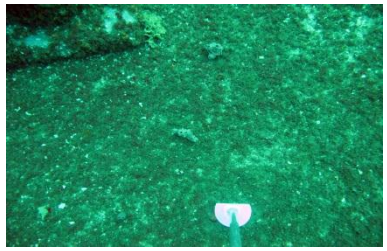
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)
		
		
		

Plate 4: Deck Starbord Bow

Deck, Starbord, Mid

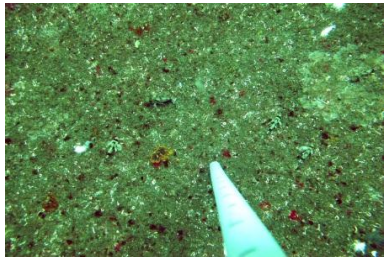
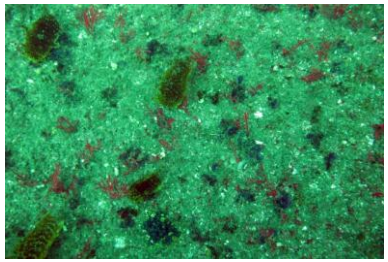
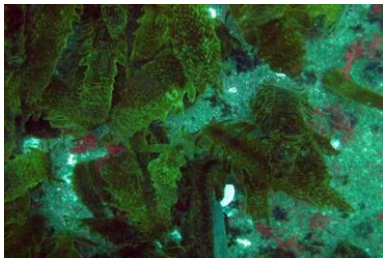
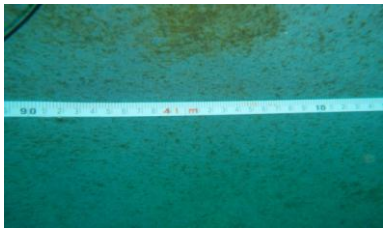
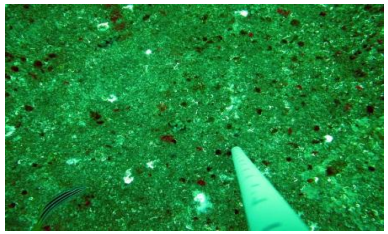
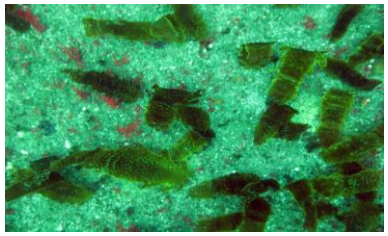
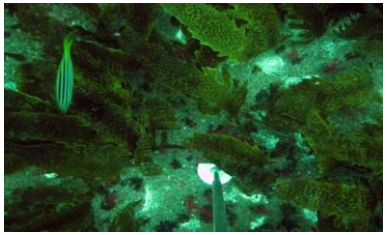
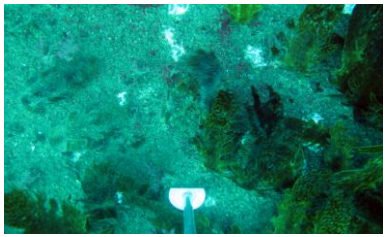
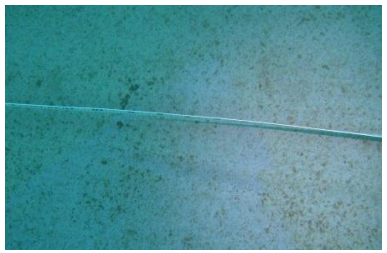
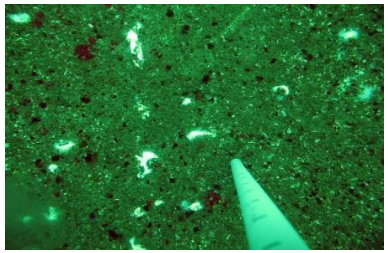
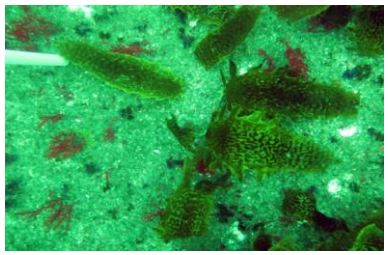
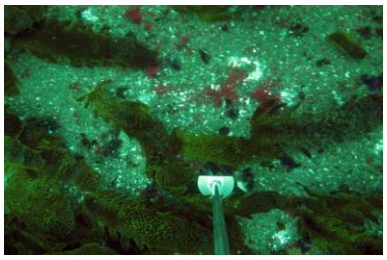
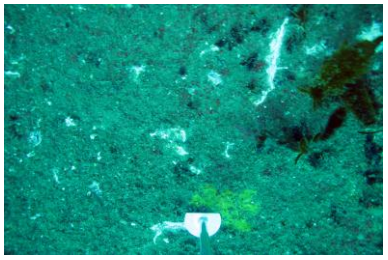
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 5: Deck Starbord Mid

Deck, Starbord, Mid

Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)

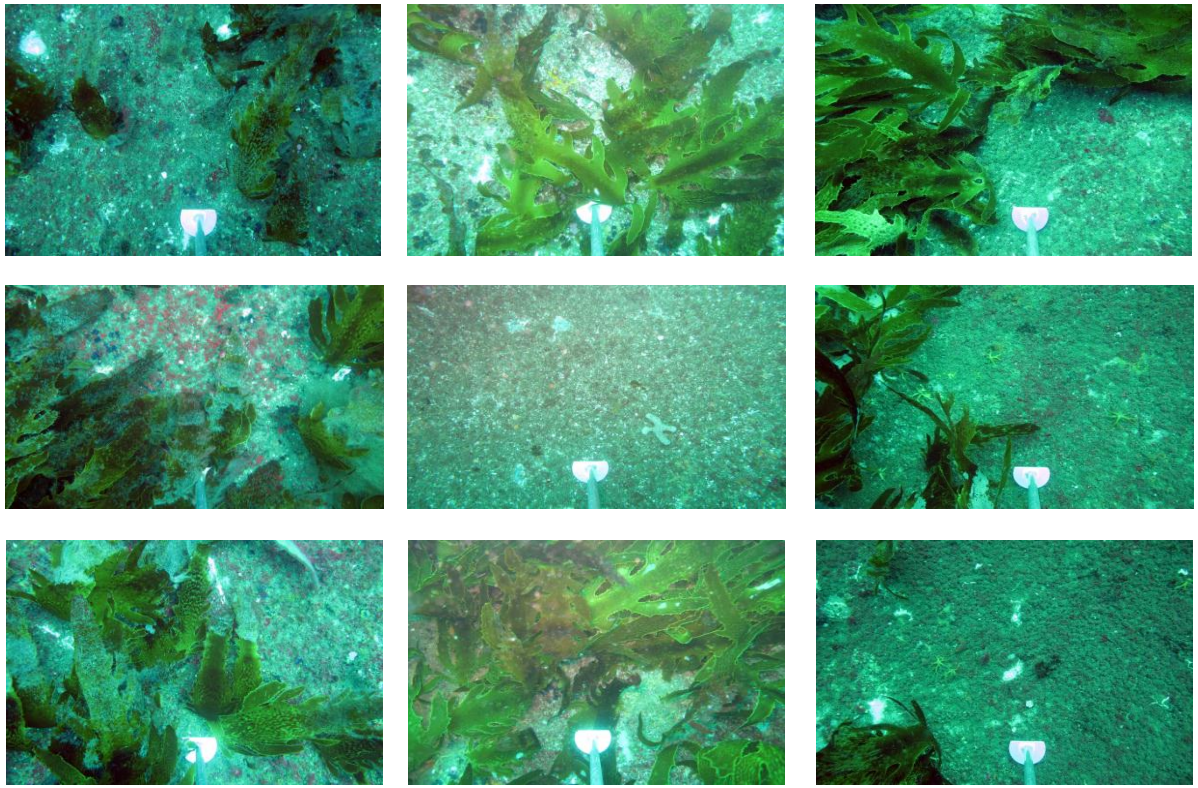


Plate 5: Deck Starbord Mid

Deck, Starbord, Stern

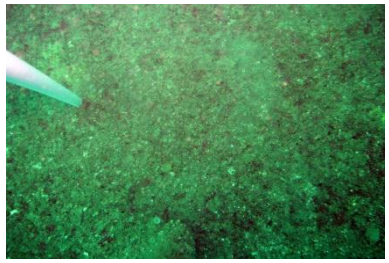
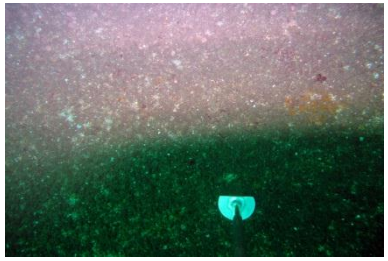
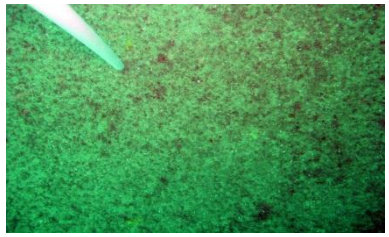
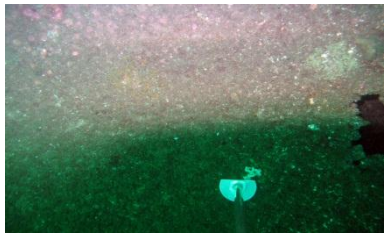
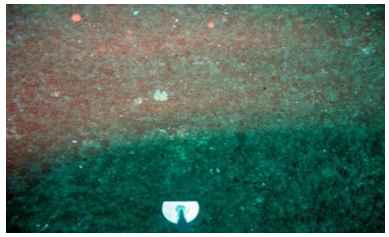
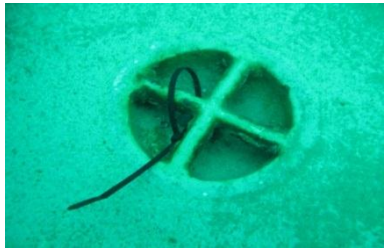
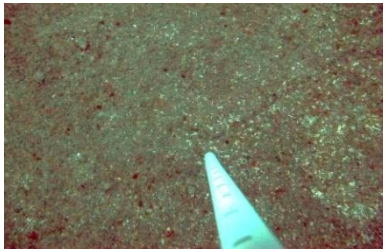
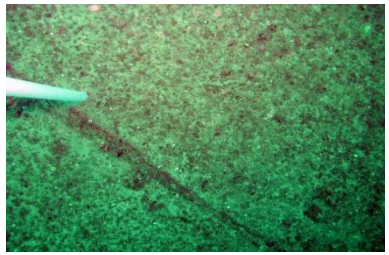
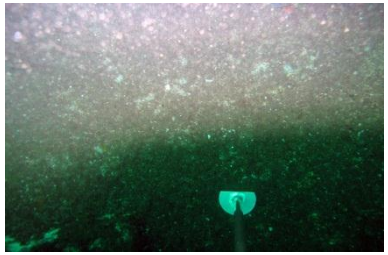
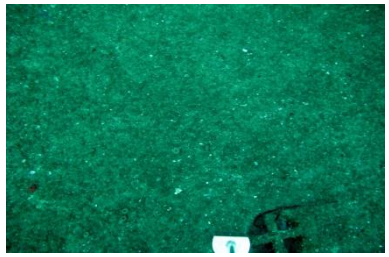
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 6: Deck Starbord Stern

Deck, Starbord, Stern

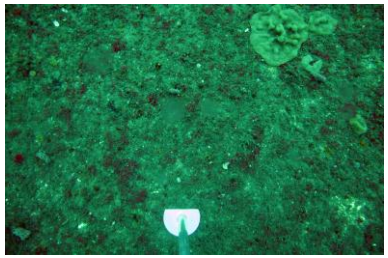
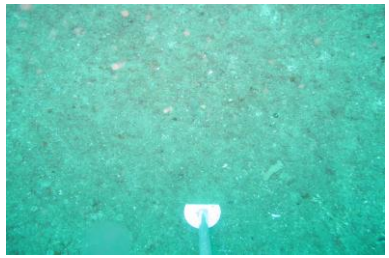
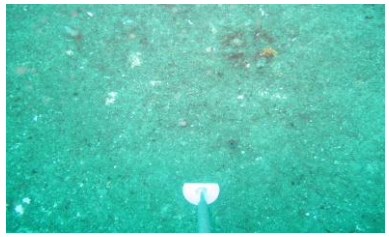
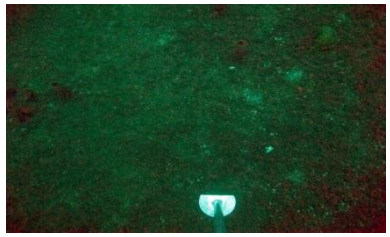
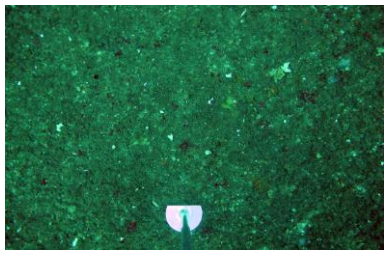
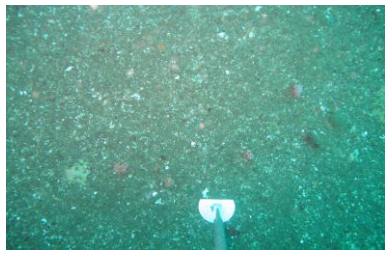
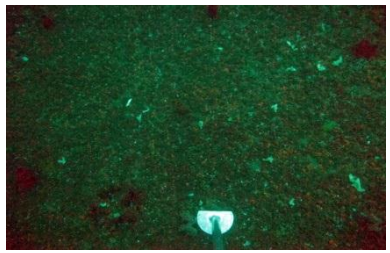
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)
		
		
		

Plate 6: Deck Starbord Stern

Horizontal Hull Port

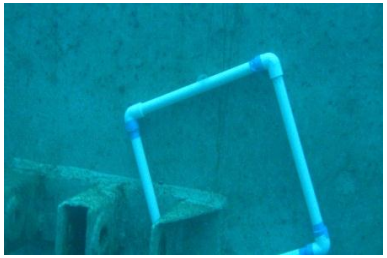
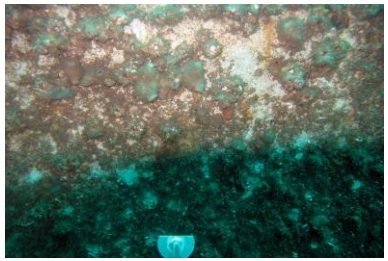
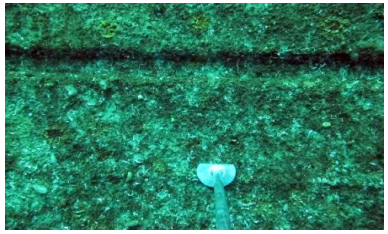
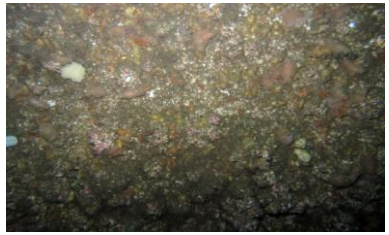
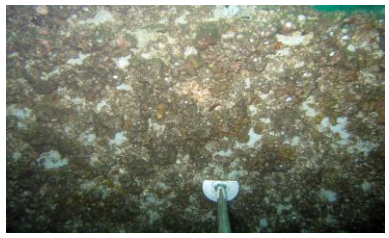
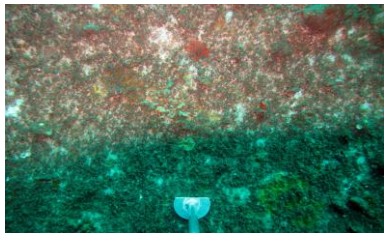
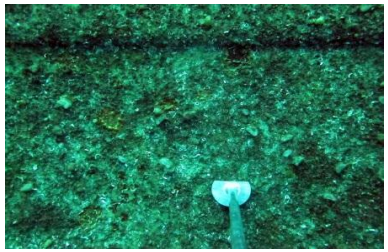
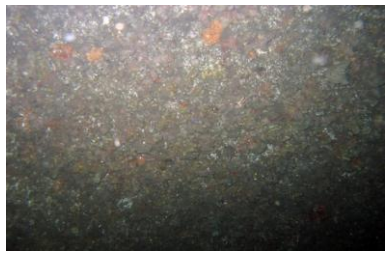
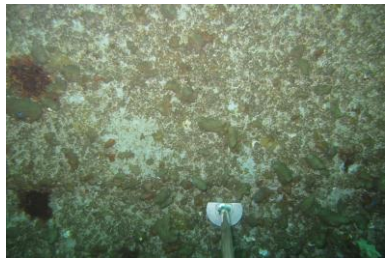
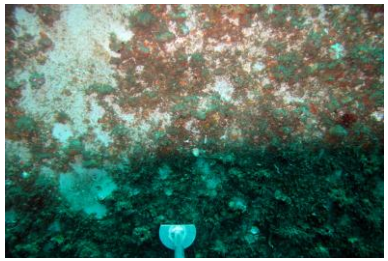
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 7: Horizontal Hull Port

Horizontal Hull Port

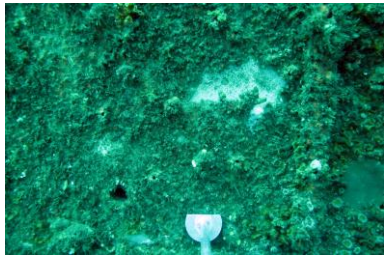
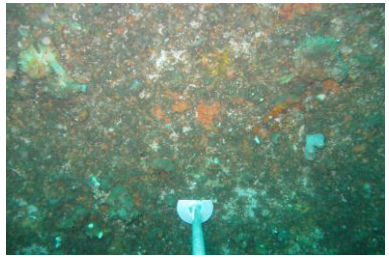
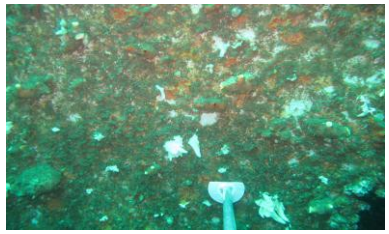
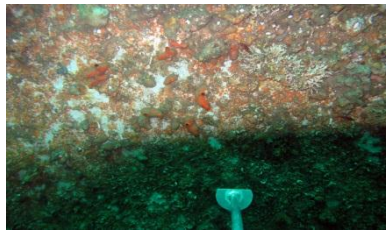
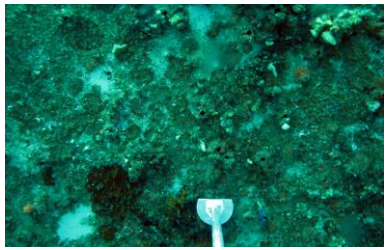
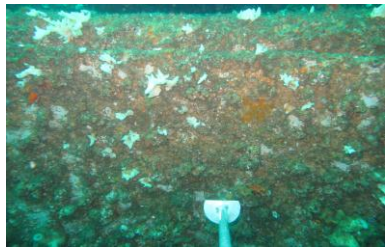
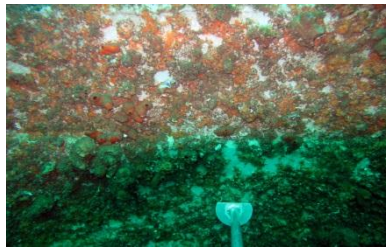
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)
		
		
		

Plate 7: Horizontal Hull Port

Horizontal Hull Starboard

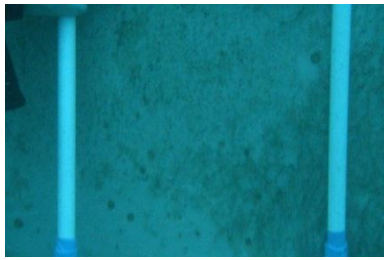
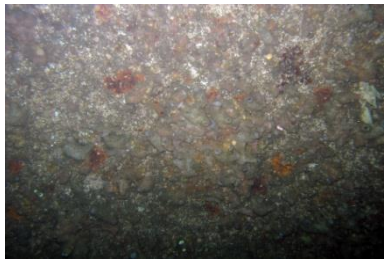
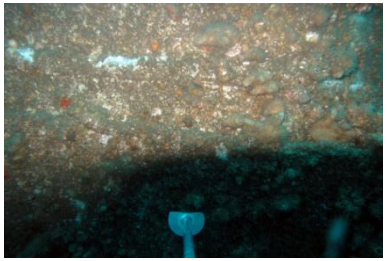
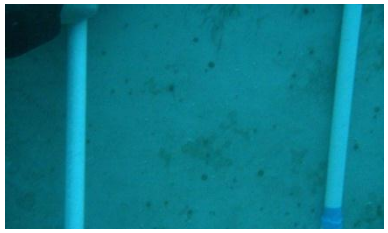
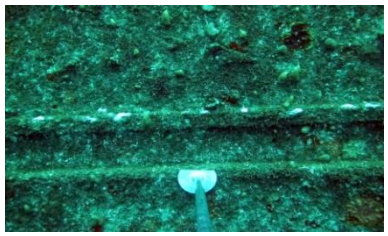
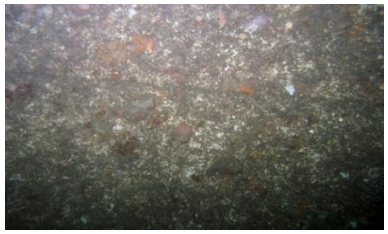
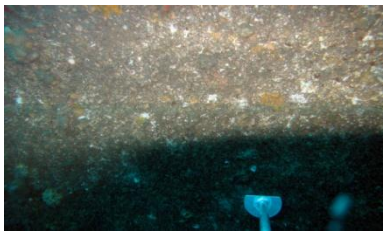
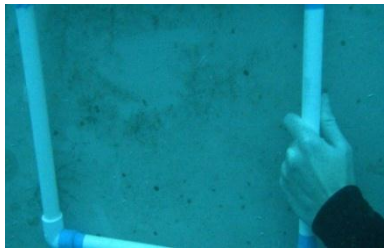
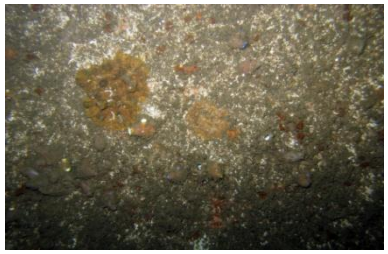
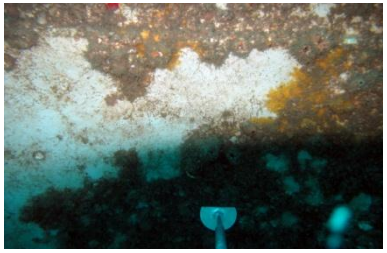
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 8: Horizontal Hull Starboard

Horizontal Hull Starbord

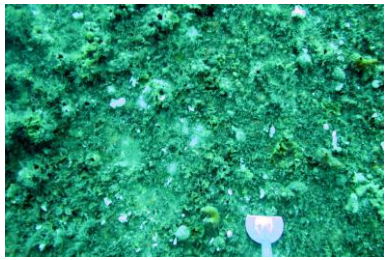
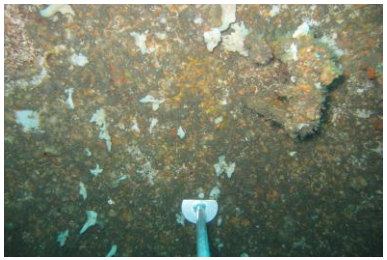
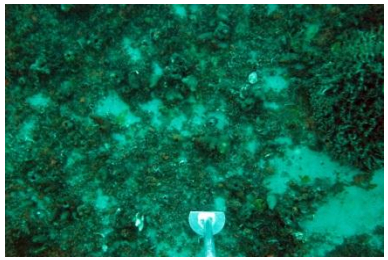
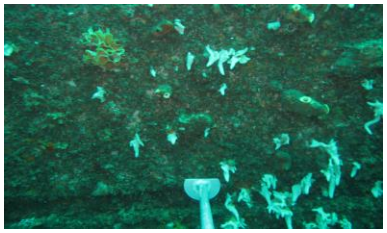
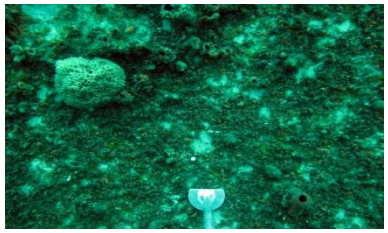
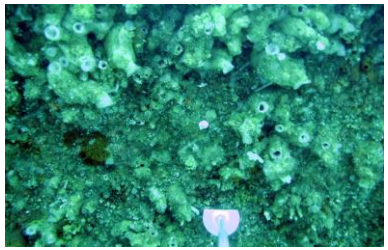
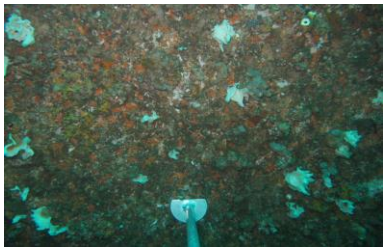
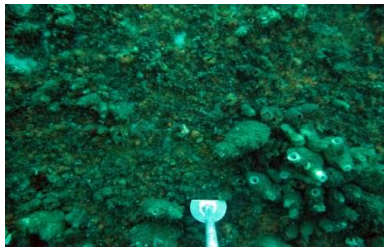
Monitoirng Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)
		
		
		

Plate 8: Horizontal Hull Starbord

Vertical Hull Port Bow

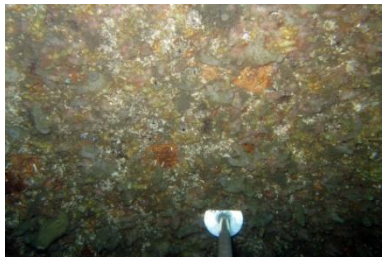
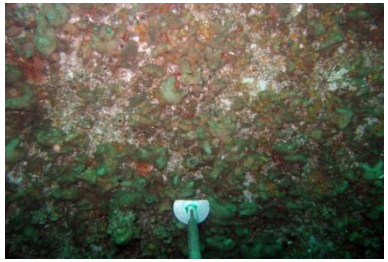
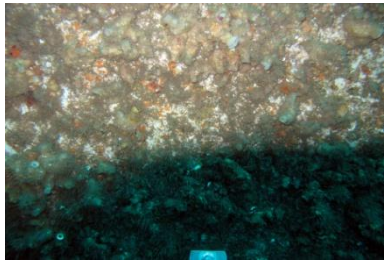
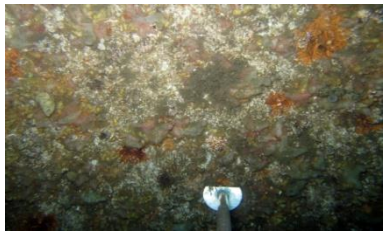
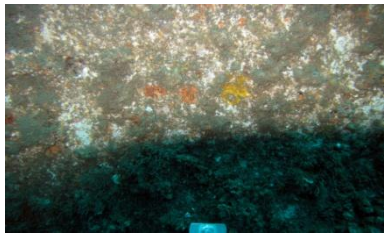
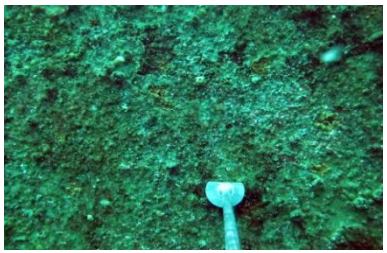
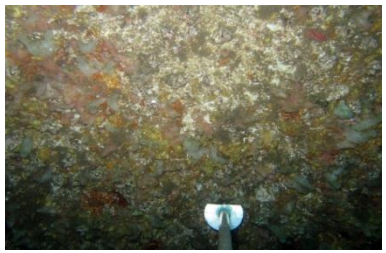
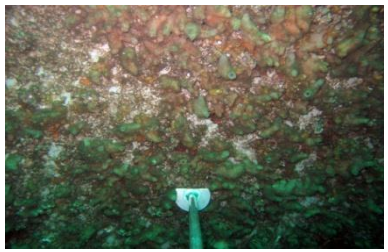
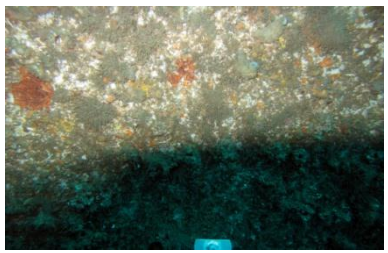
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 9: Vertical Hull Port Bow

Vertical Hull Port Bow

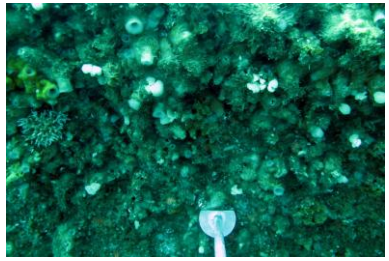
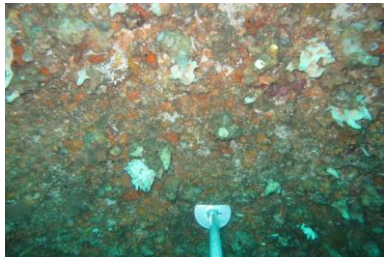
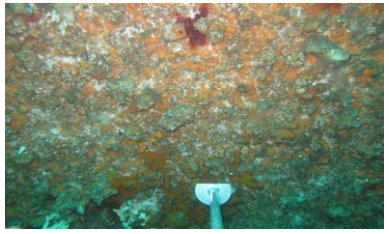
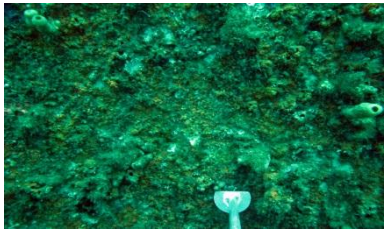
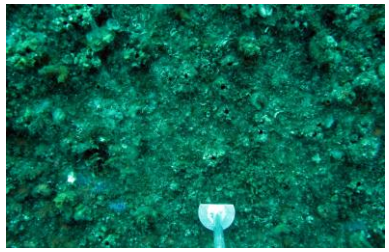
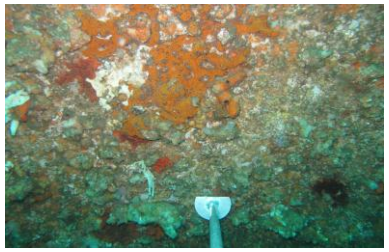
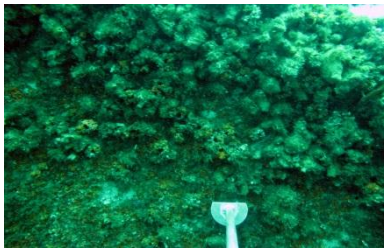
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)
		
		
		

Plate 9: Vertical Hull Port Bow

Vertical Hull Port Stern

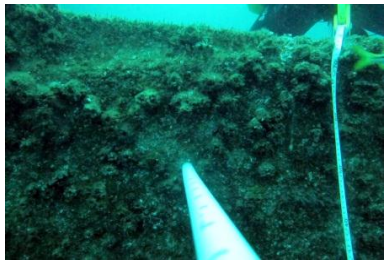
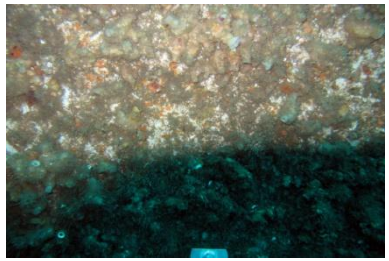
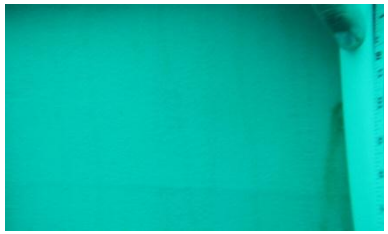
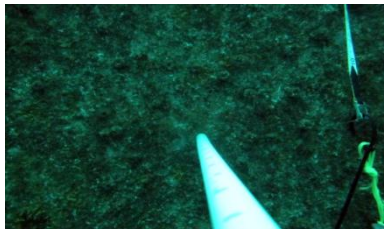
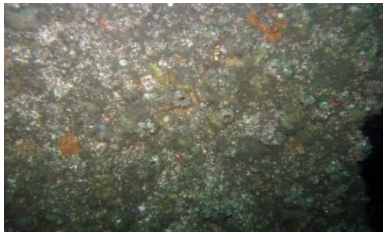
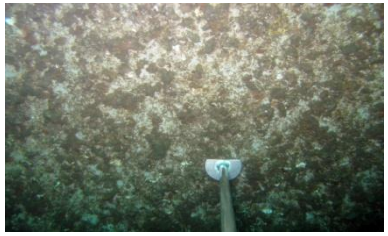
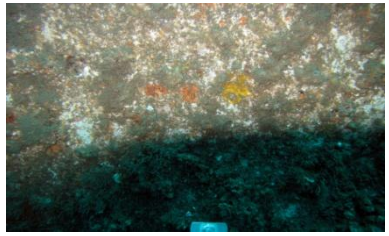
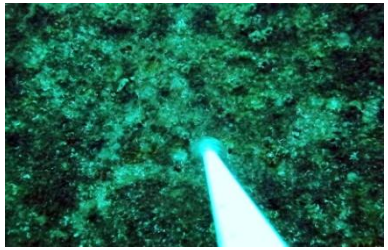
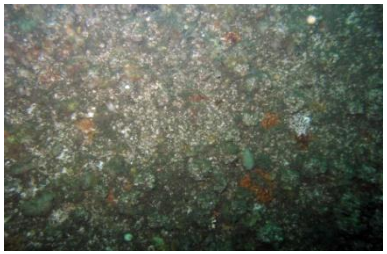
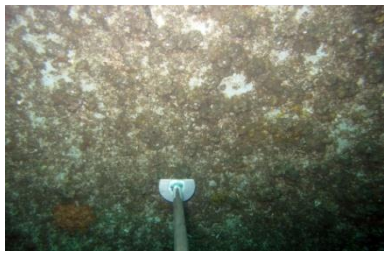
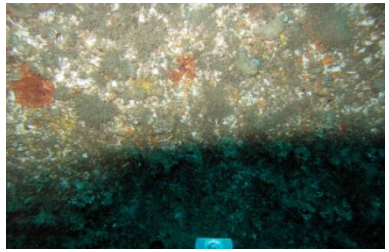
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 10: Vertical Hull Port Stern

Vertical Hull Port Stern

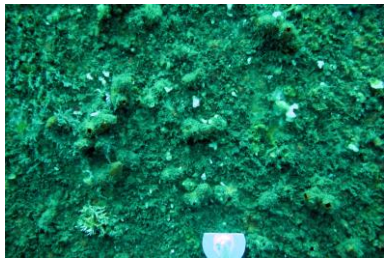
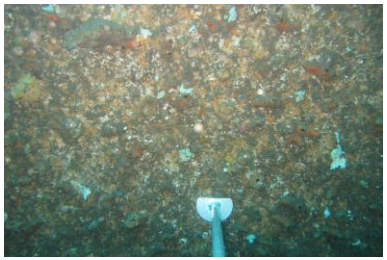
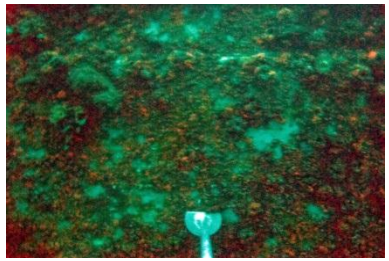
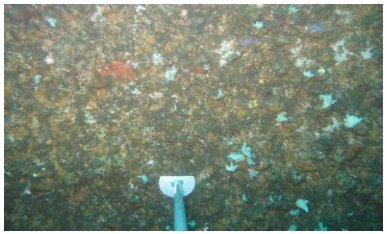
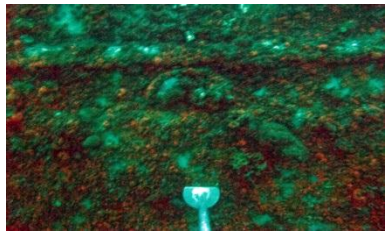
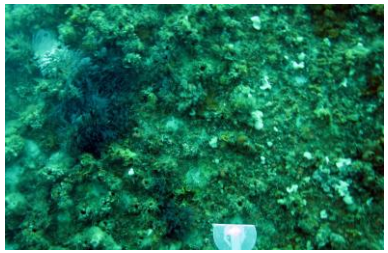
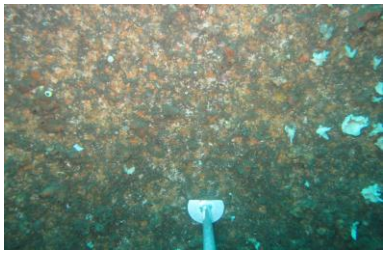
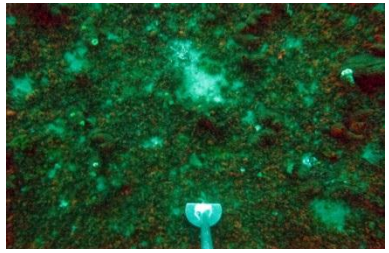
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)
		
		
		

Plate 10: Vertical Hull Port Stern

Vertical Hull Starbord Bow

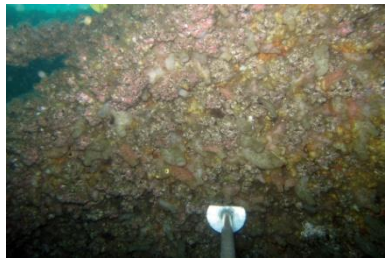
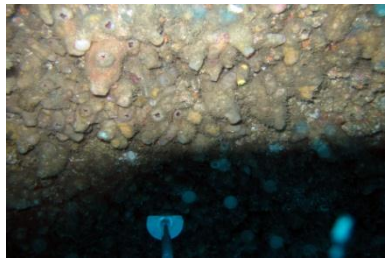
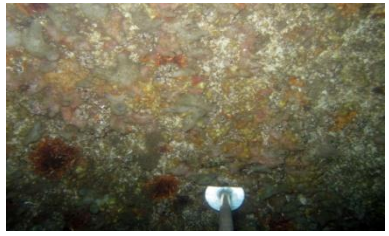
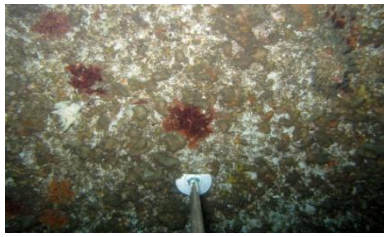
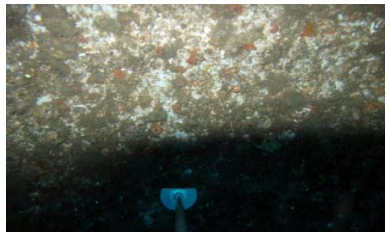
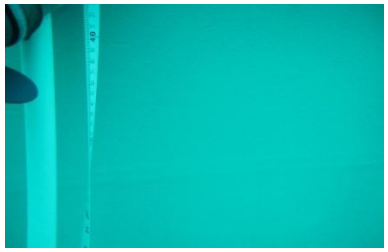
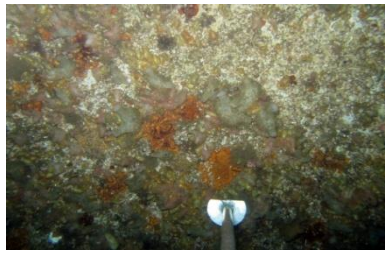
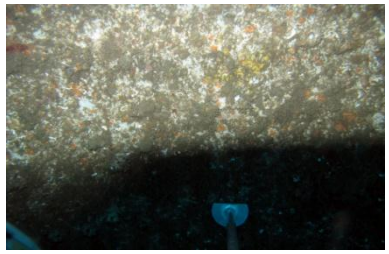
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 11: Vertical Hull Starbord Bow

Vertical Hull Starbord Bow

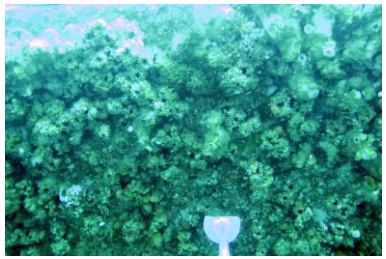
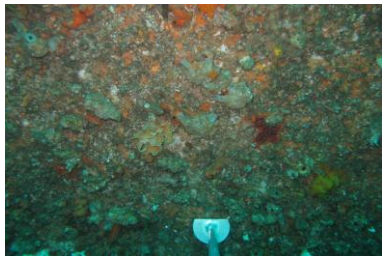
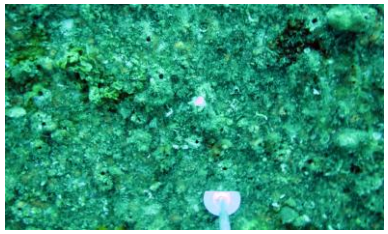
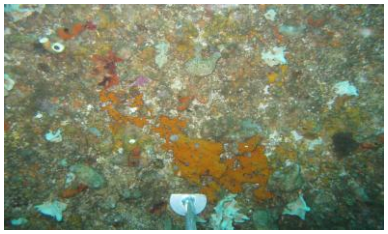
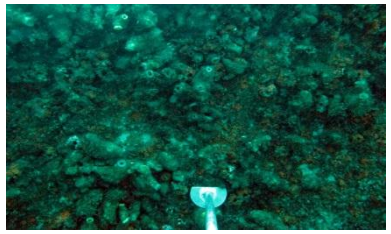
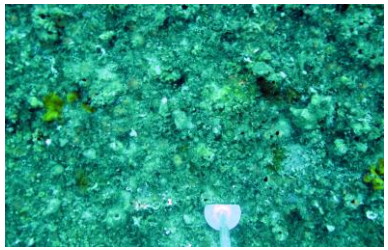
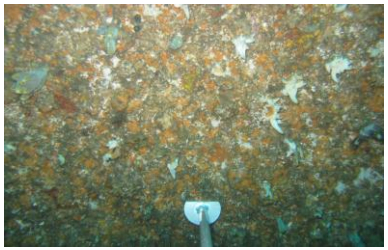
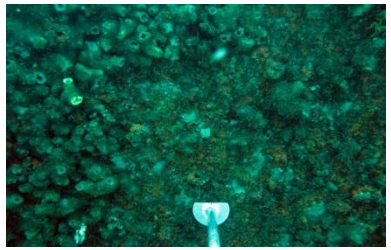
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)
		
		
		

Plate 11: Vertical Hull Starbord Bow

Vertical Hull Starbord Stern

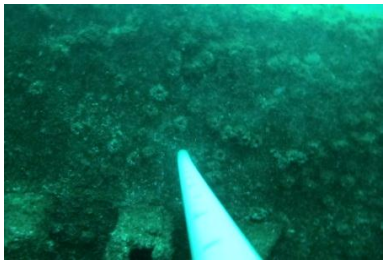
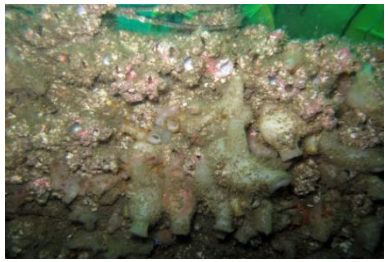
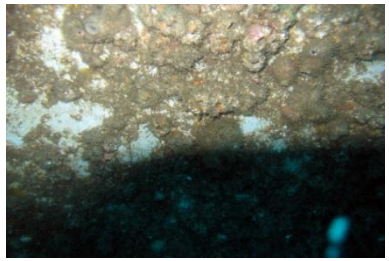
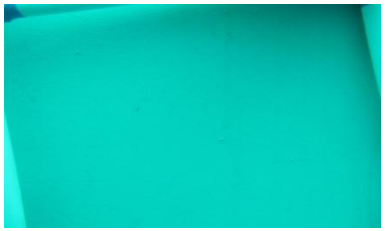
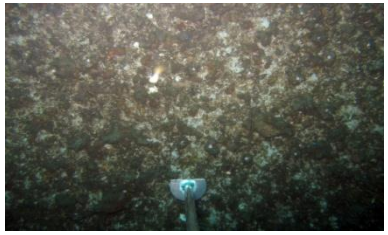
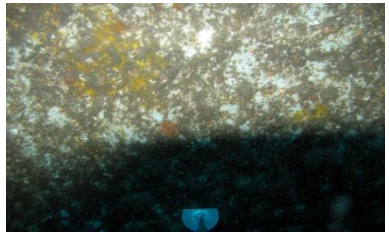
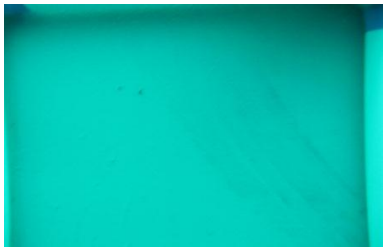
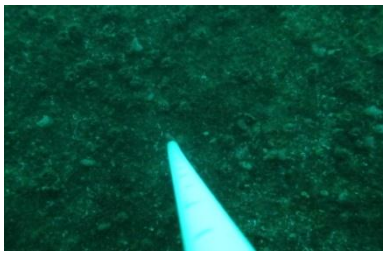
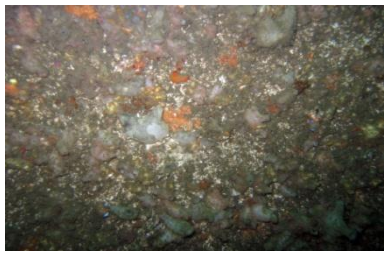
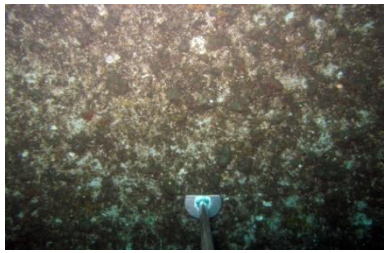
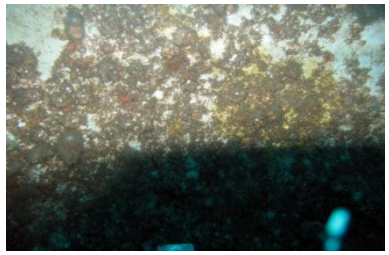
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 12: Vertical Hull Starbord Stern

Vertical Hull Starbord Stern

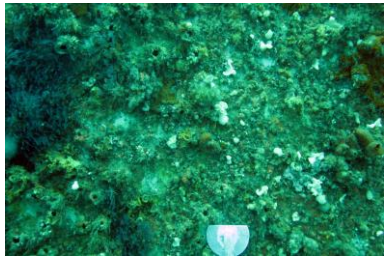
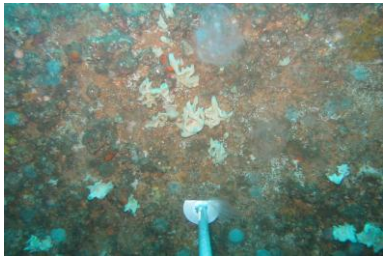
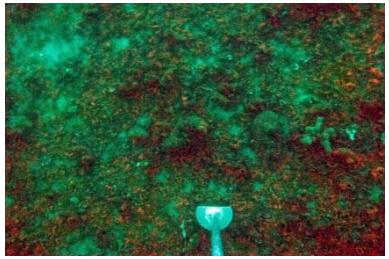
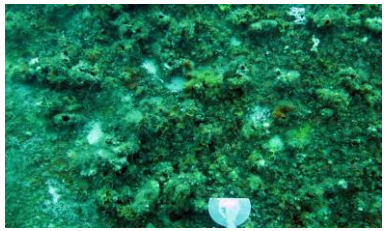
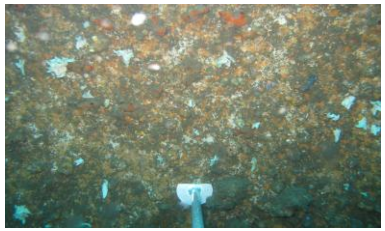
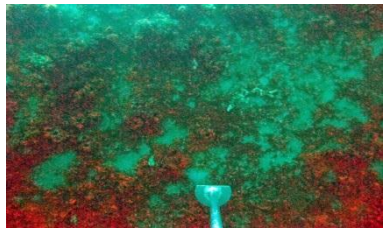
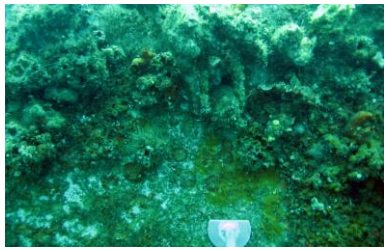
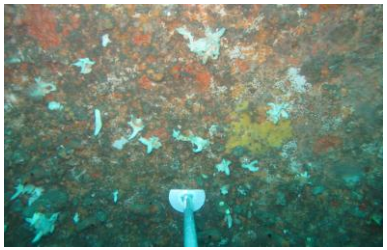
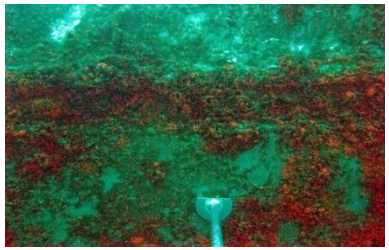
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)
		
		
		

Plate 12: Vertical Hull Starbord Stern

Vertical Superstructure Port Bow

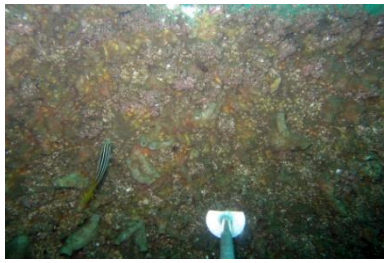
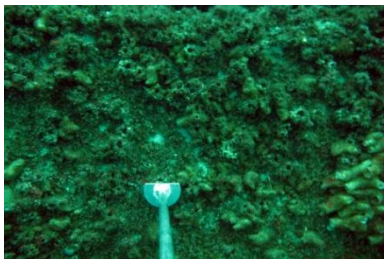
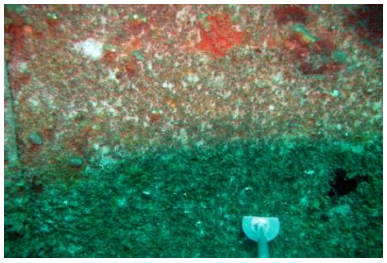
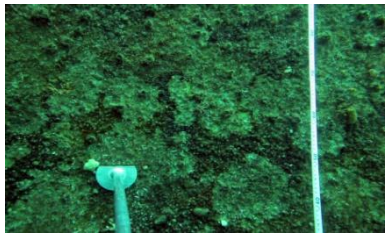
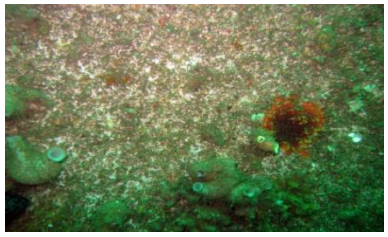
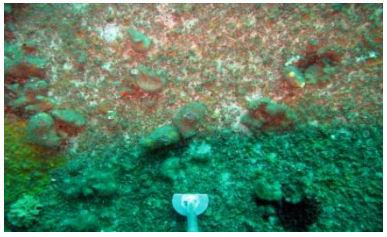
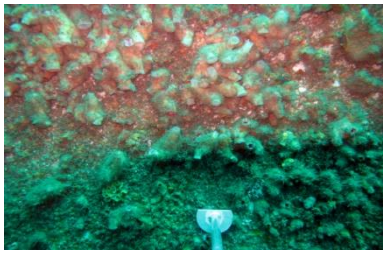
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
Not Sampled				
Not Sampled				
Not Sampled				

Plate 13: Vertical Superstructure Port Bow

Vertical Superstructure Port Bow

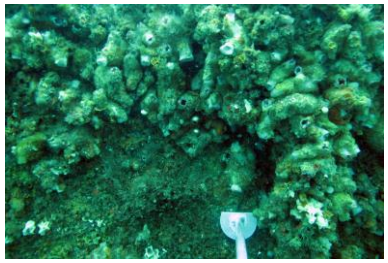
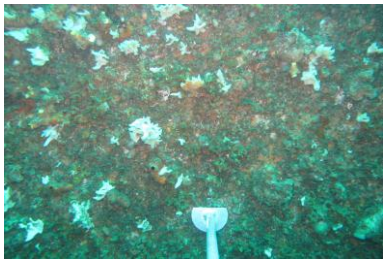
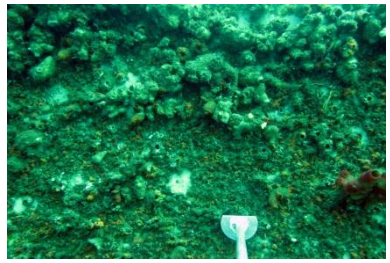
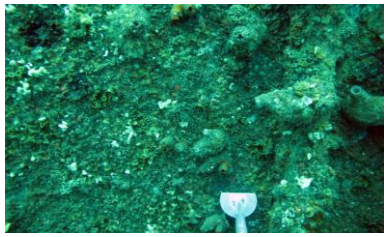
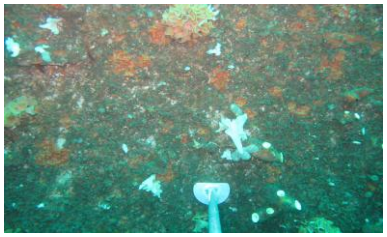
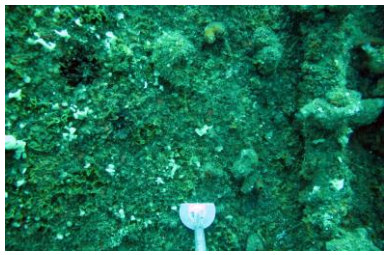
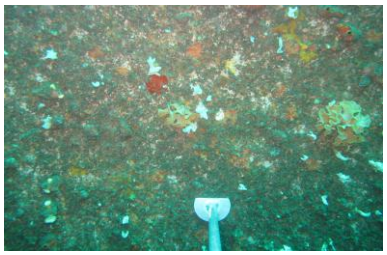
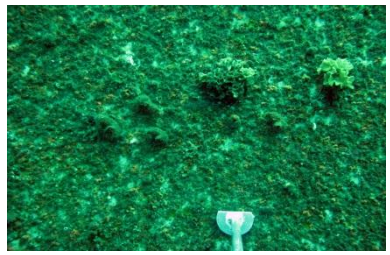
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)
		
		
		

Plate 13: Vertical Superstructure Port Bow

Vertical Superstructure Port Stern

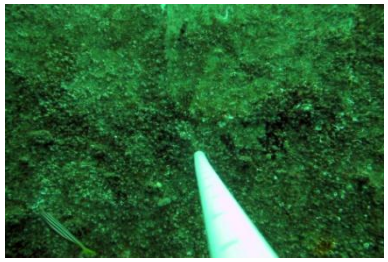
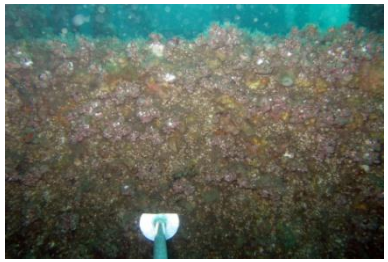
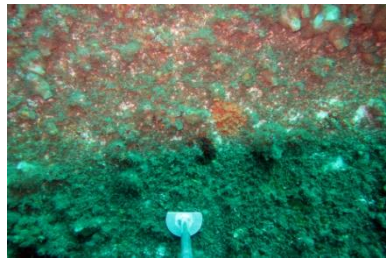
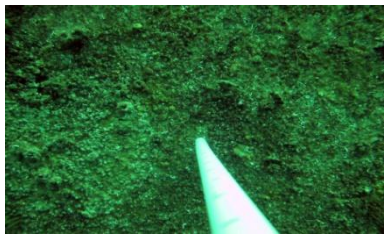
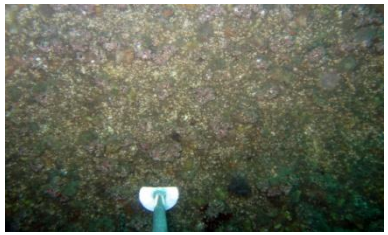
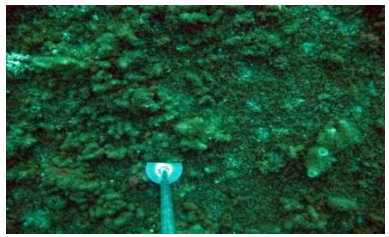
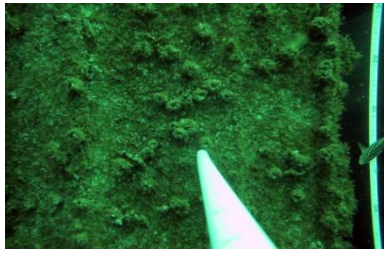
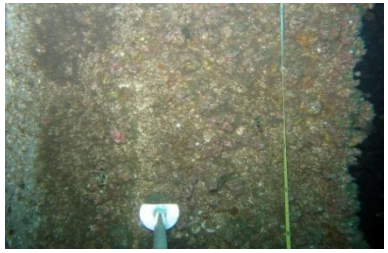
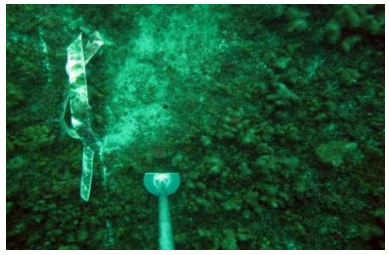
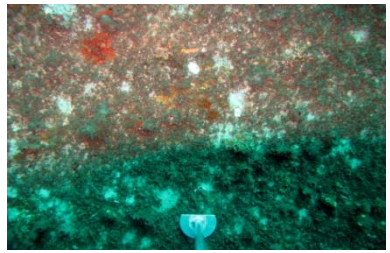
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
Not Sampled				
Not Sampled				
Not Sampled				

Plate 14: Vertical Superstructure Port Stern

Vertical Superstructure Port Stern

Survey 5 (October/November 2012)	Survey 6 (January 2013)	Survey 7 (April 2013)

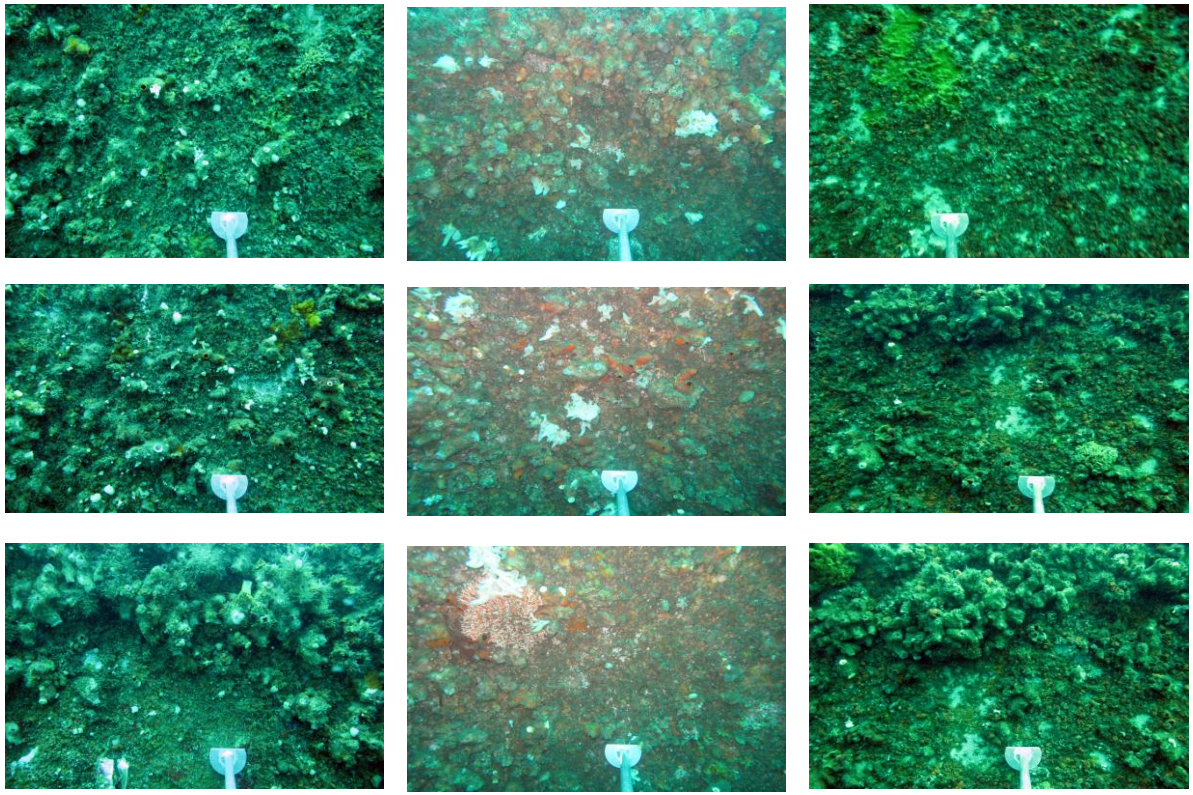


Plate 14: Vertical Superstructure Port Stern

Vertical Superstructure Starboard Bow

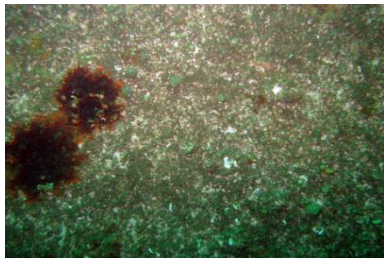
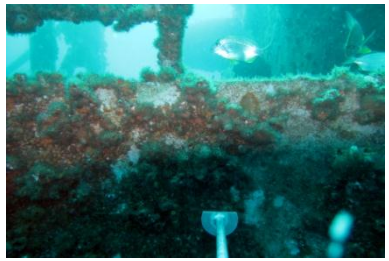
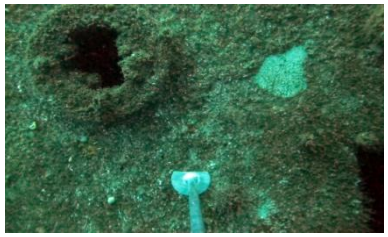
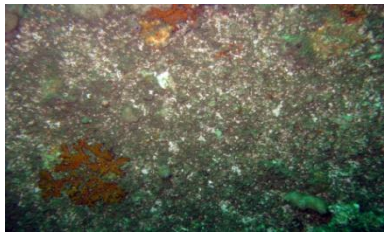
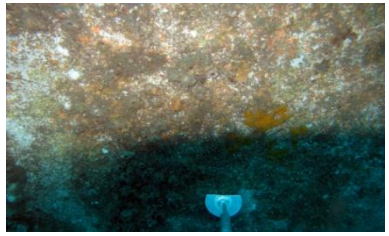
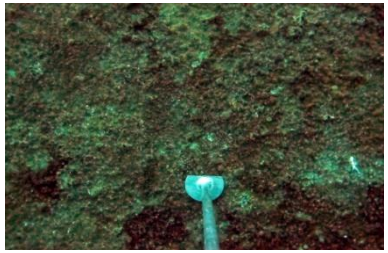
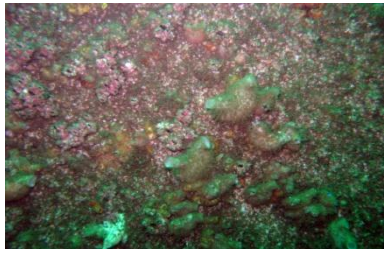
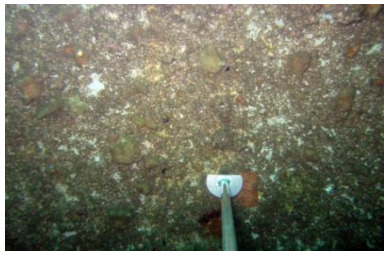
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
Not Sampled				
Not Sampled				
Not Sampled				

Plate 15: Vertical Superstructure Starbord Bow

Vertical Superstructure Starboard Bow

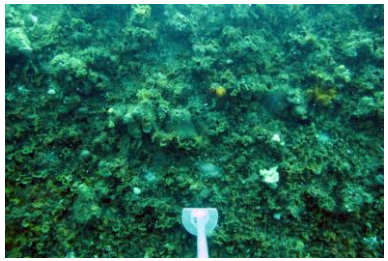
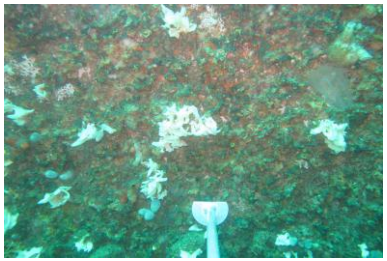
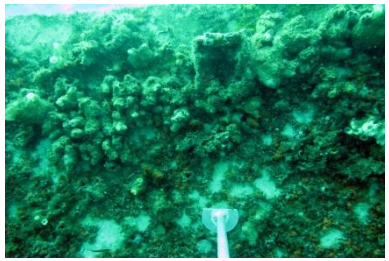
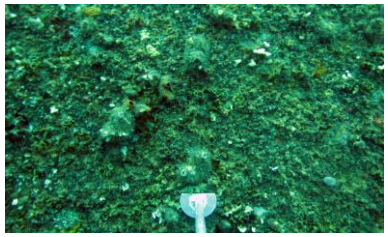
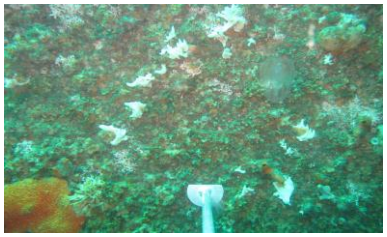
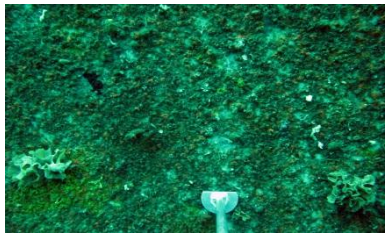
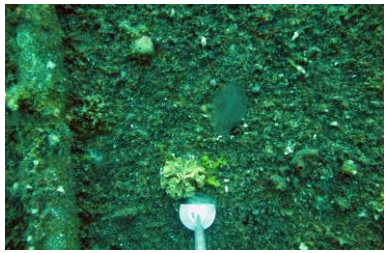
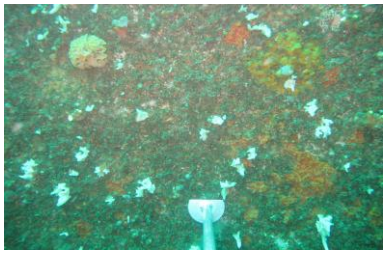
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)
		
		
		

Plate 15: Vertical Superstructure Starbord Bow

Vertical Superstructure Starboard Stern

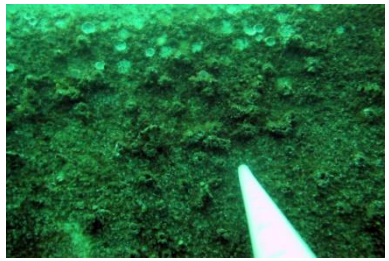
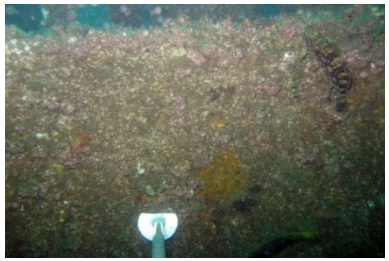
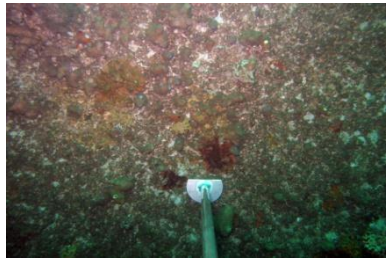
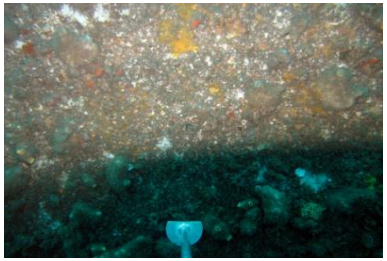
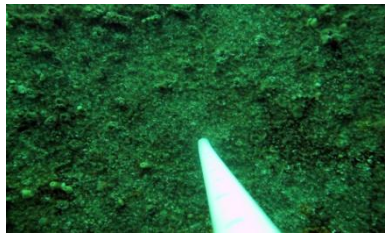
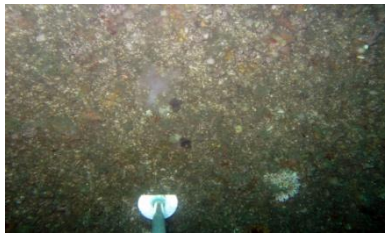
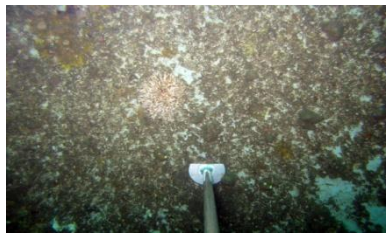
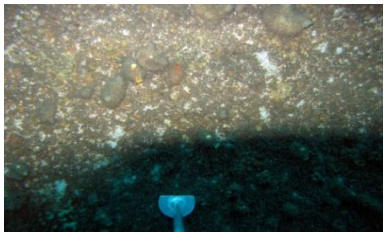
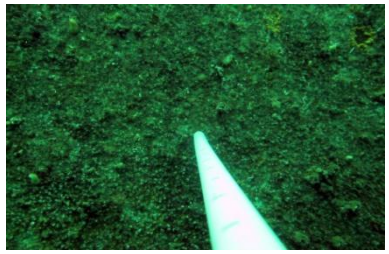
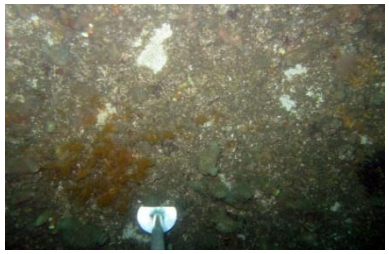
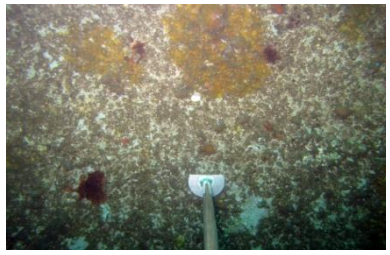
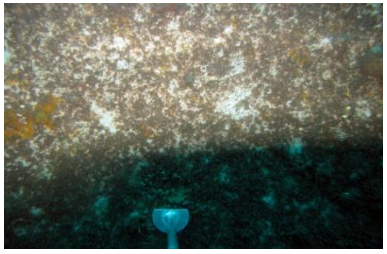
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
Not Sampled				
Not Sampled				
Not Sampled				

Plate 16: Vertical Superstructure Starboard Stern

Vertical Superstructure Starboard Stern

Monitoring Survey 5 (October/November 2012)

Monitoring Survey 6 (January 2013)

Monitoring Survey 7 (April 2013)

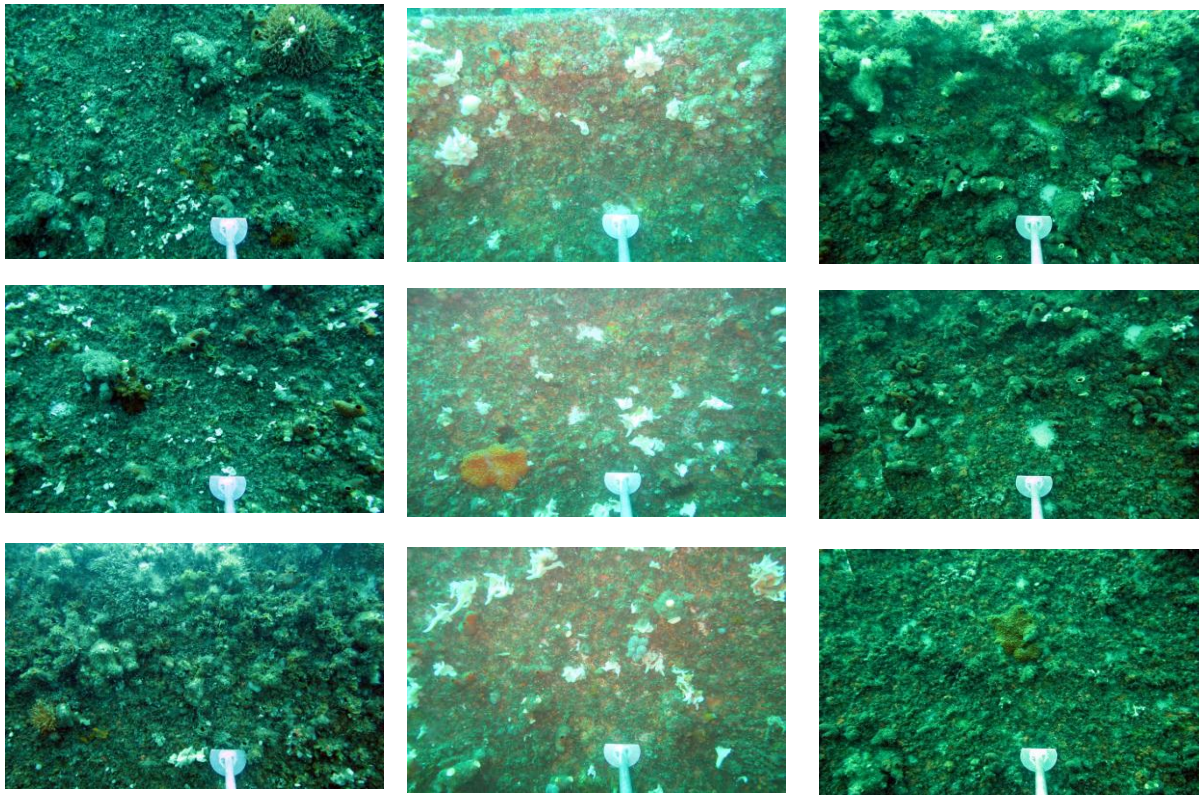


Plate 16: Vertical Superstructure Starbord Stern

8 Appendices

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

Appendix A: Fixed Photo Locations and Descriptions

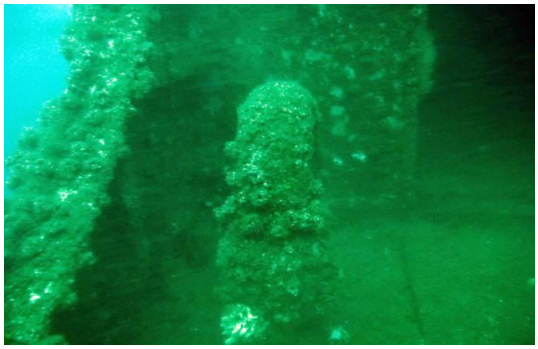
Fixed Photo: 1

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

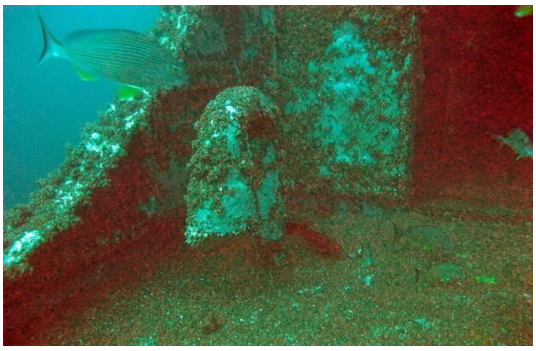
Depth: Approximately 27 m

Survey 1

Survey 2



Survey 3



Survey 4

Survey 5

Survey 6

Survey 7

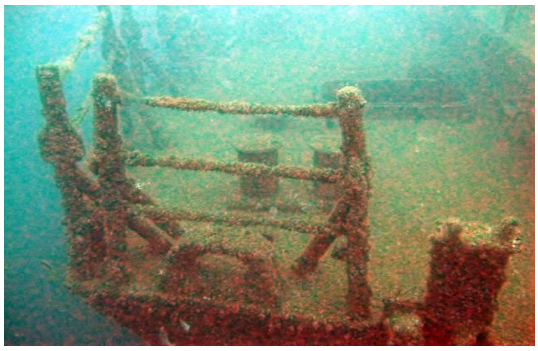
Appendix A: (Continued).

Fixed Photo: 2

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

Depth: Approximately 27 m

Survey 1

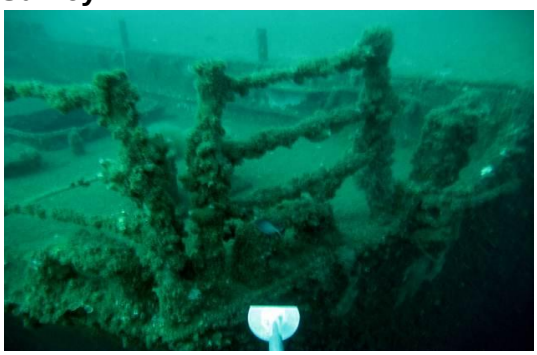


Survey 2

Survey 3

No Data

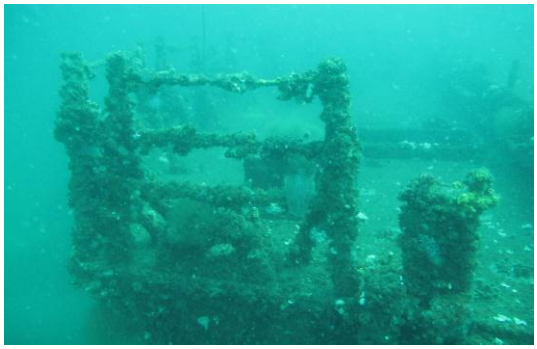
Survey 4



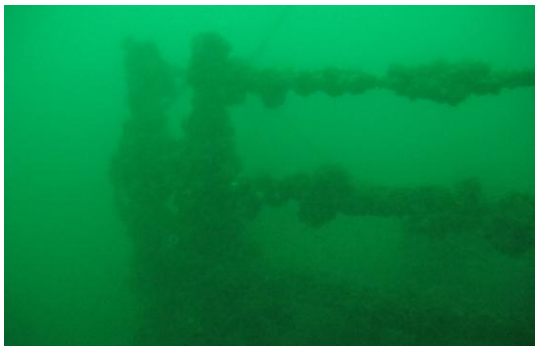
Survey 5

No Data

Survey 6



Survey 7



Appendix A: (Continued).

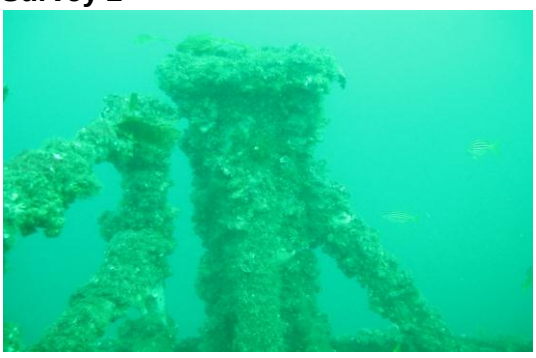
Fixed Photo: 3

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

Depth: Approximately 23 m

Survey 1

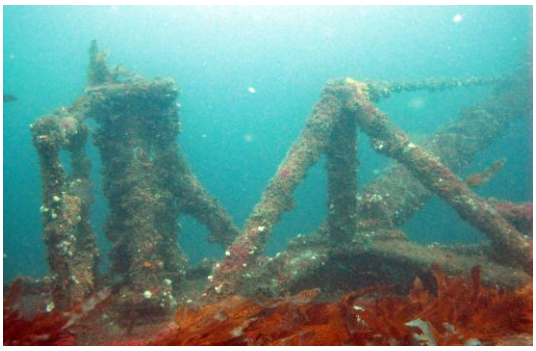
Survey 2



Survey 3

Survey 4

Survey 5



Survey 6

Survey 7

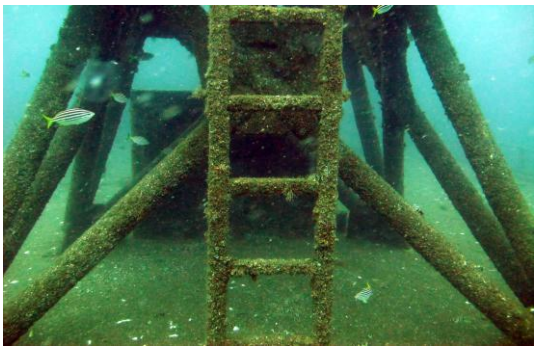
Appendix A: (Continued).

Fixed Photo: 4

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

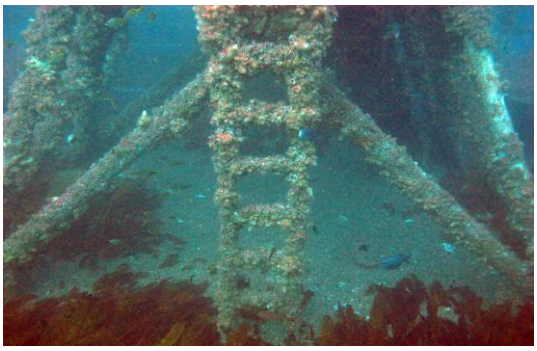
Depth: Approximately 23 m

Survey 1



Survey 2

Survey 3



Survey 4

Survey 5

Survey 6

Survey 7 (Structure missing; found over port side of ship)

Appendix A: (Continued).

Fixed Photo: 5

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

Depth: Approximately 18 m

Survey 1

Survey 2

Survey 3

Survey 4

Survey 5

Survey 6

Survey 7

Appendix A: (Continued).

Fixed Photo: 6

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

Depth: Approximately 26 m

Survey 1

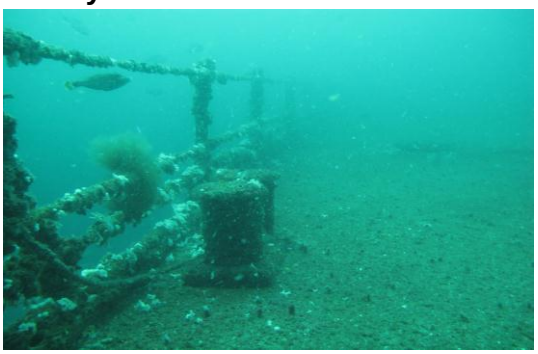
Survey 2

Survey 3

Survey 4

Survey 5

Survey 6



Survey 7

Appendix A: (Continued).

Fixed Photo: 7

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

Depth: Approximately 25 m.

Survey 1

Survey 2

Survey 3

Survey 4

Survey 5

Survey 6

Survey 7

Appendix A: (Continued).

Fixed Photo: 8

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

Depth: Approximately 25 m.

Survey 1

Survey 2

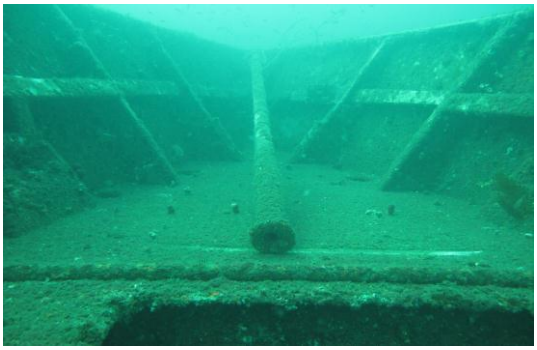
Survey 3

Survey 4

Survey 5

Survey 6

Survey 7

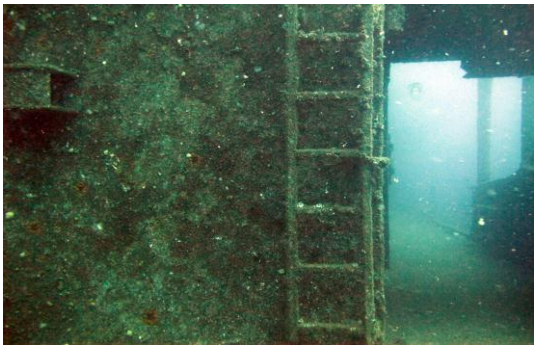


Appendix A: (Continued).
Fixed Photo: 9

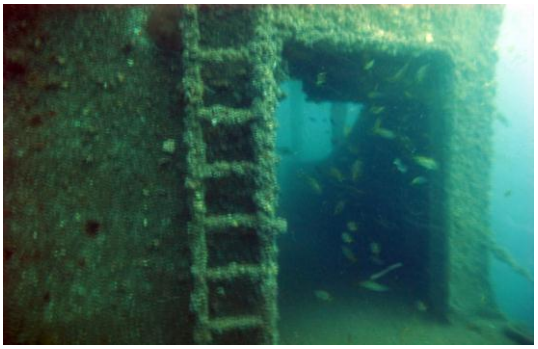
Location: Wall below the bridge on the starboard side. Photo taken standing on front deck 2 m in front of the ladder.

Depth: Approximately 26 m.

Survey 1

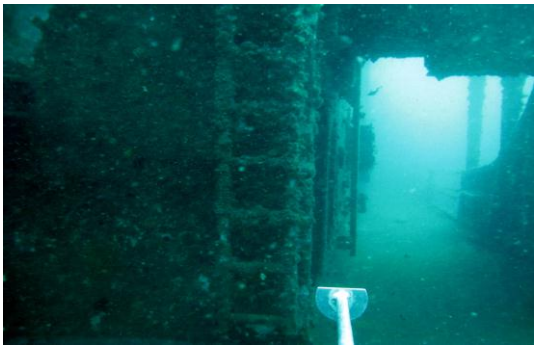


Survey 2



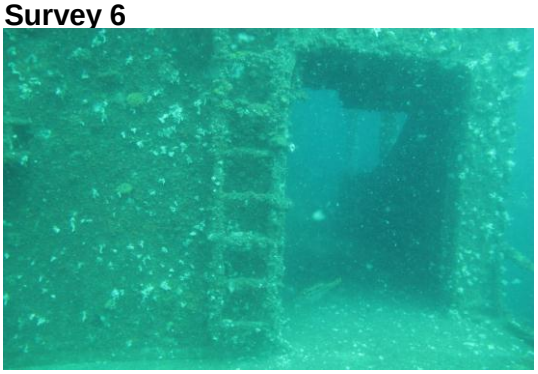
Survey 3

Survey 4



Survey 5

Survey 6



Survey 7

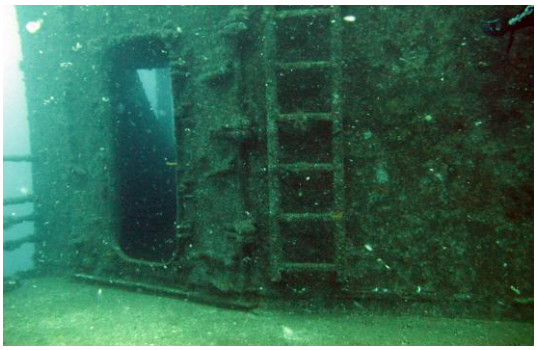
Appendix A: (Continued).

Fixed Photo: 10

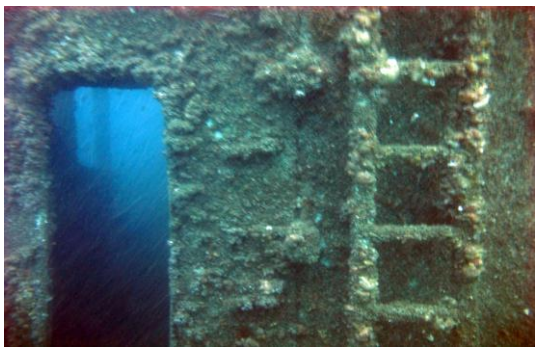
Location: Wall below the bridge on the port side. Photo was taken standing on the front deck 2 m in front of the ladder.

Depth: Approximately 26 m.

Survey 1



Survey 2



Survey 3

Survey 4

Survey 5

Survey 6

Survey 7

Appendix B: Mean percentage cover (± standard error) of reef communities for each transect analysed during Survey 7.

	Deck Port Bow		Deck Port Mid		Deck Port Stern	
Categories	Mean	S.E.	Mean	S.E.	Mean	S.E.
PHAEOPHYTA						
Ecklonia radiata	0.00	0.00	23.27	7.75	0.00	0.00
Lobed Brown Algae	0.00	0.00	0.82	0.59	0.00	0.00
Turfing Brown Algae	0.00	0.00	0.00	0.00	0.00	0.00
RHODOPHYTA						
Encrusting Coralline	0.00	0.00	0.00	0.00	0.00	0.00
Encrusting Red Algae	0.00	0.00	0.82	0.38	0.00	0.00
Red Filamentous	0.00	0.00	0.82	0.82	0.00	0.00
Thin Branching Red Algae	0.00	0.00	0.61	0.61	0.00	0.00
BRYOZOA						
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
Triphyllozoan sp	0.00	0.00	0.00	0.00	0.00	0.00
SPONGE						
Orange Encrusting Sponge	0.00	0.00	0.20	0.20	0.20	0.20
White Papillate Sponge	0.00	0.00	0.00	0.00	0.41	0.25
Yellow Encrusting Sponge	0.20	0.20	1.43	1.43	0.21	0.21
ASCIDIAN						
Botryloides magnicoecum	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
Orange Colonial Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
Pink Spikey Solitary Ascidian	0.00	0.00	0.20	0.20	0.00	0.00
Red Solitary Ascidian	0.40	0.25	0.20	0.20	0.00	0.00
Orange Colonial Ascidian 2	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						
Bare Ships Surface	0.00	0.00	2.65	1.81	0.00	0.00
Shell Grit	0.00	0.00	0.00	0.00	0.00	0.00
CRUSTACEAN						
Dead Barnacle	0.20	0.20	0.00	0.00	0.00	0.00
POLYCHAETE						
Serpulid Polychaete	0.00	0.00	0.00	0.00	0.00	0.00
Filograna implexa	0.00	0.00	0.00	0.00	0.00	0.00
CNIDARIAN						
Hydroid 2	0.00	0.00	0.00	0.00	0.00	0.00
Orange Tiny Anemone	0.00	0.00	0.00	0.00	0.00	0.00
MATRIX						
Barnacle,Sediment,Brown Fil	0.00	0.00	0.00	0.00	0.00	0.00
Brown Flocculant	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	98.59	0.75	67.96	7.98	98.96	0.58
Serpulid Matrix	0.60	0.60	0.00	0.00	0.00	0.00
FISH MOBILE						
Fish Mobile	0.00	0.00	0.00	0.00	0.00	0.00
INDETERMINATE						
Unknown White Crust	0.00	0.00	1.02	0.46	0.21	0.21
TAPE, WAND, SHADOW						
Shadow	0.00	0.00	0.00	0.00	1.00	1.00
Wand	1.00	0.32	2.00	0.00	1.00	0.45

Appendix B: (Continued).

	Deck Starbord Bow		Deck Starbord Mid		Deck Starbord Stern	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
PHAEOPHYTA						
Ecklonia radiata	1.24	1.24	18.18	10.21	0.00	0.00
Lobed Brown Algae	0.00	0.00	0.00	0.00	0.00	0.00
Turfing Brown Algae	5.08	3.73	2.50	1.78	0.00	0.00
RHODOPHYTA						
Encrusting Coralline	0.00	0.00	0.00	0.00	0.00	0.00
Encrusting Red Algae	0.62	0.25	1.01	1.01	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						
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
Triphyllozoan sp	0.21	0.21	0.00	0.00	0.00	0.00
SPONGE						
Orange Encrusting Sponge	0.81	0.59	0.62	0.42	0.00	0.00
White Papillate Sponge	0.00	0.00	0.41	0.25	0.61	0.25
Yellow Encrusting Sponge	0.00	0.00	0.42	0.42	0.00	0.00
ASCIDIAN						
Botryloides magnicoecum	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
Orange Colonial Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
Pink Spikey Solitary Ascidian	0.21	0.21	0.00	0.00	0.00	0.00
Red Solitary Ascidian	0.82	0.20	0.62	0.42	0.20	0.20
Orange Colonial Ascidian 2	0.00	0.00	0.00	0.00	0.00	0.00
White Encrusting Solitary Ascidian	0.21	0.21	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						
Bare Ships Surface	0.00	0.00	4.69	1.91	0.20	0.20
Shell Grit	0.00	0.00	0.00	0.00	0.00	0.00
CRUSTACEAN						
Dead Barnacle	0.00	0.00	0.00	0.00	0.00	0.00
POLYCHAETE						
Serpulid Polychaete	0.00	0.00	0.00	0.00	0.00	0.00
Filograna implexa	0.21	0.21	0.00	0.00	0.00	0.00
CNIDARIAN						
Hydroid 2	0.00	0.00	0.00	0.00	0.00	0.00
Orange Tiny Anemone	0.00	0.00	0.00	0.00	0.00	0.00
MATRIX						
Barnacle,Sediment,Brown Fil	0.00	0.00	0.00	0.00	0.00	0.00
Brown Flocculant	0.00	0.00	0.00	0.00	0.00	0.00
Large Barnacle,Sediment,Brown Fil	0.00	0.00	1.26	1.26	0.00	0.00
Serpulid Barnacle and Encrusting Algae Matrix	89.39	4.95	69.85	7.88	98.99	0.00
Serpulid Matrix	1.22	0.81	0.41	0.25	0.00	0.00
FISH MOBILE						
Fish Mobile	0.00	0.00	0.00	0.00	0.00	0.00
INDETERMINATE						
Unknown White Crust	0.00	0.00	0.00	0.00	0.00	0.00
TAPE, WAND, SHADOW						
Shadow	0.80	0.37	1.00	0.77	0.00	0.00
Wand	1.80	0.20	1.00	0.00	1.00	0.32

Appendix B: (Continued).

	Horizontal Hull Port		Horizontal Hull Starbord		Vertical Hull Port Bow	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
PHAEOPHYTA						
Ecklonia radiata	0.00	0.00	0.00	0.00	0.00	0.00
Lobed Brown Algae	0.00	0.00	0.00	0.00	0.00	0.00
Turfing Brown Algae	0.00	0.00	0.00	0.00	0.00	0.00
RHODOPHYTA						
Encrusting Coralline	0.35	0.35	0.00	0.00	0.00	0.00
Encrusting Red Algae	0.17	0.17	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						
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
Triphyllozoan sp	0.17	0.17	0.87	0.57	0.40	0.40
SPONGE						
Orange Encrusting Sponge	5.30	0.74	0.69	0.34	0.20	0.20
White Papillate Sponge	0.17	0.17	0.00	0.00	0.00	0.00
Yellow Encrusting Sponge	0.17	0.17	1.37	0.97	0.00	0.00
ASCIDIAN						
Botryloides magnicoecum	0.00	0.00	0.17	0.17	0.00	0.00
Herdmania momus	2.57	0.74	4.30	3.28	3.04	2.09
Orange Colonial Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
Pink Spikey Solitary Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
Red Solitary Ascidian	0.00	0.00	0.18	0.18	0.00	0.00
Orange Colonial Ascidian 2	0.00	0.00	0.00	0.00	0.00	0.00
White Encrusting Solitary Ascidian	0.00	0.00	0.35	0.22	0.00	0.00
White Tubular Solitary Ascidian	0.00	0.00	0.35	0.22	0.21	0.21
ABIOTIC						
Bare Ships Surface	7.83	0.96	5.76	2.69	1.23	0.39
Shell Grit	0.00	0.00	0.00	0.00	0.00	0.00
CRUSTACEAN						
Dead Barnacle	0.00	0.00	0.00	0.00	0.00	0.00
POLYCHAETE						
Serpulid Polychaete	0.00	0.00	0.00	0.00	0.00	0.00
Filograna implexa	0.68	0.68	0.71	0.71	0.00	0.00
CNIDARIAN						
Hydroid 2	0.00	0.00	0.17	0.17	0.00	0.00
Orange Tiny Anemone	0.86	0.86	1.04	0.38	1.83	0.93
MATRIX						
Barnacle,Sediment,Brown Fil	0.00	0.00	0.88	0.57	2.24	2.24
Brown Flocculant	0.34	0.34	0.69	0.69	0.00	0.00
Large Barnacle,Sediment,Brown Fil	12.45	4.42	12.12	3.97	25.46	6.95
Serpulid Barnacle and Encrusting Algae Matrix	68.94	6.41	70.37	5.46	63.27	7.69
Serpulid Matrix	0.00	0.00	0.00	0.00	2.11	2.11
FISH MOBILE						
Fish Mobile	0.00	0.00	0.00	0.00	0.00	0.00
INDETERMINATE						
Unknown White Crust	0.00	0.00	0.00	0.00	0.00	0.00
TAPE, WAND, SHADOW						
Shadow	0.67	0.42	1.50	0.67	0.80	0.58
Wand	1.50	0.22	2.00	0.00	1.20	0.20

Appendix B: (Continued).

	Vertical Hull Port Stern		Vertical Hull Starbord Bow		Vertical Hull Starbord Stern	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
PHAEOPHYTA						
Ecklonia radiata	0.00	0.00	0.00	0.00	0.00	0.00
Lobed Brown Algae	0.00	0.00	0.00	0.00	0.00	0.00
Turfing Brown Algae	0.00	0.00	1.65	1.07	0.00	0.00
RHODOPHYTA						
Encrusting Coralline	0.00	0.00	0.00	0.00	0.00	0.00
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						
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
Triphyllozoan sp	0.00	0.00	0.20	0.20	0.00	0.00
SPONGE						
Orange Encrusting Sponge	0.20	0.20	0.61	0.61	0.20	0.20
White Papillate Sponge	0.00	0.00	0.00	0.00	0.00	0.00
Yellow Encrusting Sponge	0.41	0.25	0.42	0.42	0.00	0.00
ASCIDIAN						
Botryloides magnicoecum	0.00	0.00	0.00	0.00	0.00	0.00
Herdmania momus	0.21	0.21	22.01	9.71	0.20	0.20
Orange Colonial Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
Pink Spikey Solitary Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
Red Solitary Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
Orange Colonial Ascidian 2	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						
Bare Ships Surface	2.26	0.60	0.20	0.20	8.14	1.56
Shell Grit	0.00	0.00	0.00	0.00	0.00	0.00
CRUSTACEAN						
Dead Barnacle	0.00	0.00	0.00	0.00	0.00	0.00
POLYCHAETE						
Serpulid Polychaete	0.00	0.00	0.00	0.00	0.00	0.00
Filograna implexa	0.00	0.00	0.00	0.00	0.00	0.00
CNIDARIAN						
Hydroid 2	0.00	0.00	0.00	0.00	0.00	0.00
Orange Tiny Anemone	0.00	0.00	2.08	1.14	0.00	0.00
MATRIX						
Barnacle,Sediment,Brown Fil	0.00	0.00	0.00	0.00	1.42	1.00
Brown Flocculant	1.03	0.32	0.20	0.20	8.14	2.82
Large Barnacle,Sediment,Brown Fil	6.18	5.17	14.27	4.96	21.73	3.57
Serpulid Barnacle and Encrusting Algae Matrix	70.94	18.52	57.09	5.14	59.34	4.39
Serpulid Matrix	18.78	18.78	1.25	1.25	0.82	0.82
FISH MOBILE						
Fish Mobile	0.00	0.00	0.00	0.00	0.00	0.00
INDETERMINATE						
Unknown White Crust	0.00	0.00	0.00	0.00	0.00	0.00
TAPE, WAND, SHADOW						
Shadow	1.20	0.97	1.20	0.80	0.00	0.00
Wand	1.60	0.24	2.00	0.00	1.60	0.24

Appendix B: (Continued).

	Vertical Super Port Bow		Vertical Super Port Stern		Vertical Super Starbord Bow	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
PHAEOPHYTA						
Ecklonia radiata	0.00	0.00	0.00	0.00	0.00	0.00
Lobed Brown Algae	0.00	0.00	0.00	0.00	0.00	0.00
Turfing Brown Algae	0.00	0.00	0.00	0.00	0.00	0.00
RHODOPHYTA						
Encrusting Coralline	0.00	0.00	0.00	0.00	0.00	0.00
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						
Biflustra perfragilis	0.00	0.00	0.20	0.20	1.02	0.65
Encrusting Orange Bryozoan	0.00	0.00	0.22	0.22	0.00	0.00
Triphyllozoan sp	0.82	0.82	0.61	0.40	1.01	0.64
SPONGE						
Orange Encrusting Sponge	0.21	0.21	1.85	1.34	0.00	0.00
White Papillate Sponge	0.00	0.00	0.00	0.00	0.00	0.00
Yellow Encrusting Sponge	0.20	0.20	0.00	0.00	2.06	0.92
ASCIDIAN						
Botryloides magnicoecum	0.00	0.00	0.00	0.00	0.00	0.00
Herdmania momus	4.94	1.78	10.48	4.73	11.26	6.58
Orange Colonial Ascidian	0.20	0.20	0.00	0.00	0.20	0.20
Pink Spikey Solitary Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
Red Solitary Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
Orange Colonial Ascidian 2	0.41	0.41	0.00	0.00	1.43	1.43
White Encrusting Solitary Ascidian	0.20	0.20	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						
Bare Ships Surface	2.47	0.70	6.43	1.79	12.54	2.76
Shell Grit	0.00	0.00	0.00	0.00	0.20	0.20
CRUSTACEAN						
Dead Barnacle	0.00	0.00	0.00	0.00	0.00	0.00
POLYCHAETE						
Serpulid Polychaete	0.21	0.21	0.00	0.00	0.00	0.00
Filograna implexa	0.00	0.00	0.00	0.00	0.00	0.00
CNIDARIAN						
Hydroid 2	0.20	0.20	0.00	0.00	0.00	0.00
Orange Tiny Anemone	1.84	0.88	0.82	0.59	0.82	0.38
MATRIX						
Barnacle,Sediment,Brown Fil	0.42	0.42	1.05	0.66	0.00	0.00
Brown Flocculant	0.41	0.25	0.61	0.40	2.28	1.06
Large Barnacle,Sediment,Brown Fil	9.72	6.34	18.26	4.37	4.78	2.19
Serpulid Barnacle and Encrusting Algae Matrix	77.55	7.64	59.07	7.58	61.58	8.66
Serpulid Matrix	0.00	0.00	0.00	0.00	0.20	0.20
FISH MOBILE						
Fish Mobile	0.21	0.21	0.41	0.41	0.61	0.41
INDETERMINATE						
Unknown White Crust	0.00	0.00	0.00	0.00	0.00	0.00
TAPE, WAND, SHADOW						
Shadow	0.40	0.40	1.80	1.32	1.80	0.73
Wand	2.00	0.00	1.20	0.20	0.80	0.20

Appendix B: (Continued).

	Vertical Super Starbord Stern	
	Mean	S.E.
PHAEOPHYTA		
Ecklonia radiata	0.00	0.00
Lobed Brown Algae	0.00	0.00
Turfing Brown Algae	0.61	0.61
RHODOPHYTA		
Encrusting Coralline	0.00	0.00
Encrusting Red Algae	0.00	0.00
Red Filamentous	0.00	0.00
Thin Branching Red Algae	0.00	0.00
BRYOZOA		
Biflustra perfragilis	0.20	0.20
Encrusting Orange Bryozoan	0.00	0.00
Triphyllozoan sp	0.40	0.40
SPONGE		
Orange Encrusting Sponge	0.21	0.21
White Papillate Sponge	0.00	0.00
Yellow Encrusting Sponge	1.01	1.01
ASCIDIAN		
Botryloides magnicoecum	0.20	0.20
Herdmania momus	12.18	4.02
Orange Colonial Ascidian	0.00	0.00
Pink Spikey Solitary Ascidian	0.00	0.00
Red Solitary Ascidian	0.00	0.00
Orange Colonial Ascidian 2	0.20	0.20
White Encrusting Solitary Ascidian	0.00	0.00
White Tubular Solitary Ascidian	0.00	0.00
ABIOTIC		
Bare Ships Surface	2.84	0.92
Shell Grit	0.00	0.00
CRUSTACEAN		
Dead Barnacle	0.00	0.00
POLYCHAETE		
Serpulid Polychaete	0.00	0.00
Filograna implexa	0.00	0.00
CNIDARIAN		
Hydroid 2	1.05	1.05
Orange Tiny Anemone	0.62	0.25
MATRIX		
Barnacle,Sediment,Brown Fil	0.00	0.00
Brown Flocculant	1.21	0.49
Large Barnacle,Sediment,Brown Fil	6.43	3.15
Serpulid Barnacle and Encrusting Algae Matrix	72.63	5.58
Serpulid Matrix	0.20	0.20
FISH MOBILE		
Fish Mobile	0.00	0.00
INDETERMINATE		
Unknown White Crust	0.00	0.00
TAPE, WAND, SHADOW		
Shadow	1.20	0.80
Wand	1.00	0.00

Appendix C: Permutational Analysis of Variance of Percent Cover of Reef Assemblages Sampled in Reef Monitoring Surveys 6 and 7. *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 Surveys Time

Source	DF	SS	MS	F	P	Unique perms
Time	6	328930	54821	34.215	**0.0002**	4973
Residual	567	908490	1602			
Total	573	1237400				

2. Time, Orientation and Aspect

Source	DF	SS	MS	F	P	Unique perms
Time	1	2843	2843	4.82	RED	4983
Orientation	1	5344	5344	9.05	RED	4979
Aspect	1	195	195	0.33	0.7808	4975
Time x Orientation	1	2664	2664	4.51	**0.0128**	4988
Time x Aspect	1	320	320	0.54	0.6010	4982
Orientation x Aspect	1	404	404	0.68	0.5006	4988
Time x Orientation x Aspect	1	245	245	0.42	0.7152	4983
Residual	76	44855	590			
Total	83	56110				

3. Time, Depth and Aspect

Source	DF	SS	MS	F	P	Unique perms
Time	1	6879	6879	10.77	**0.0002**	4985
Depth	1	2394	2394	1.12	0.4044	315
Aspect	1	1116	1116	0.52	0.7386	315
Time x Depth	1	1162	1162	1.82	0.1286	4981
Time x Aspect	1	1527	1527	2.39	0.0540	4986
Depth x Aspect	1	2224	2224	1.04	0.4532	315
Transect (Depth x Aspect)	4	8546	2136	4.05	**0.0002**	4973
Time x Depth x Aspect	1	379	379	0.59	0.7534	4986
Time x Transect (Depth x Aspect)	4	2555	639	1.21	0.2292	4973
Residual	64	33792	528			
Total	79	60572				

4. Time, Deck Position and Aspect

Source	DF	SS	MS	F	P	Unique perms
Time	1	1397	1397	3.62	RED	4978
Position	2	18006	9003	23.31	RED	4984
Aspect	1	381	381	0.99	0.3326	4988
Time x Position	2	2162	1081	2.80	**0.0494**	4992
Time x Aspect	1	291	291	0.75	0.4096	4985
Position x Aspect	2	579	290	0.75	0.5110	4990
Time x Position x Aspect	2	565	282	0.73	0.5112	4986
Residual	48	18542	386			
Total	59	41922				

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

1. All Times

Groups	t	P(perm)	Unique perms
1, 2	3.76	**0.0002**	4987
1, 3	4.63	**0.0002**	4983
1, 4	8.08	**0.0002**	4988
1, 5	7.63	**0.0002**	4981
1, 6	8.02	**0.0002**	4987
1, 7	8.07	**0.0002**	4986
2, 3	2.61	**0.0002**	4987
2, 4	7.00	**0.0002**	4984
2, 5	6.83	**0.0002**	4985
2, 6	7.18	**0.0002**	4982
2, 7	7.48	**0.0002**	4986
3, 4	5.13	**0.0002**	4985
3, 5	5.12	**0.0002**	4989
3, 6	5.56	**0.0002**	4982
3, 7	5.61	**0.0002**	4985
4, 5	2.47	**0.0004**	4983
4, 6	2.48	**0.0002**	4984
4, 7	2.13	**0.0014**	4990
5, 6	2.11	**0.0016**	4989
5, 7	2.46	**0.0002**	4983
6, 7	2.91	**0.0002**	4982

2. Time, Orientation and Aspect

Term 'TixOr' for pairs of levels of factor 'Time'
Within level 'Deck' of factor 'Orientation'

Groups	t	P(perm)	Unique perms
6, 7	1.401	0.1528	4986

Within level 'Hull' of factor 'Orientation'

Groups	t	P(perm)	Unique perms
6, 7	3.6302	**0.0002**	4989

Term 'TixOr' for pairs of levels of factor 'Orientation'
Within level '6' of factor 'Time'

Groups	t	P(perm)	Unique perms
Deck, Hull	2.0101	0.0222	4989

Within level '7' of factor 'Time'

Groups	t	P(perm)	Unique perms
Deck, Hull	3.6335	**0.0002**	4987

3. Time, Depth and Aspect

Term 'Ti'

Groups	t	P(perm)	Unique perms
6, 7	3.2818	**0.0002**	4982

Term 'Tr (DexAs)'
Within level 'Deep' of factor 'Depth'
Within level 'Port' of factor 'Aspect'

Groups	t	P(perm)	Unique perms
1, 2	1.9515	**0.0004**	4983

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

Groups	t	P(perm)	Unique perms
3, 4	2.0459	**0.002**	4991

Appendix D: Continued

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

Groups	t	P(perm)	Unique perms
5, 6	2.5367	**0.006**	4991

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

Groups	t	P(perm)	Unique perms
7, 8	1.6103	0.0514	4981

4. Time, Position and Aspect

Term 'TixPo' for pairs of levels of factor 'Time'
Within level 'Bow' of factor 'Position'

Groups	t	P(perm)	Unique perms
6, 7	1.3981	0.106	4984

Within level 'Mid' of factor 'Position'

Groups	t	P(perm)	Unique perms
6, 7	1.7736	0.0778	4987

Within level 'Stern' of factor 'Position'

Groups	t	P(perm)	Unique perms
6, 7	1.4051	**0.0446**	4978

Term 'TixPo' for pairs of levels of factor 'Position'
Within level '6' of factor 'Time'

Groups	t	P(perm)	Unique perms
Bow, Mid	3.61	**0.0012**	4979
Bow, Stern	2.50	**0.0002**	4985
Mid, Stern	3.85	**0.0012**	4980

Within level '7' of factor 'Time'

Groups	t	P(perm)	Unique perms
Bow, Mid	3.19	**0.0008**	4986
Bow, Stern	1.75	**0.0014**	4984
Mid, Stern	3.69	**0.0002**	4988

Appendix E : Results of SIMPER analyses of reef assemblages of fish sampled in The Ex-Hmas Adelaide Articial Reef Community Surveys 6 and 7. Cut off for percentage contribution is 90 %. Note that only relevant SIMPER results have been included in this Appendix.

1. All Times

Groups 6 & 7

Average dissimilarity = 35.55

Species	Group 6 Av.Abund	Group 7 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	73.11	73.93	12.01	1.25	33.80	33.80
Large barnacle,sediment,brown fil	3.21	8.39	4.58	0.87	12.87	46.67
Ecklonia radiata	4.93	2.60	3.56	0.38	10.02	56.69
Herdmania momus	4.14	4.42	3.32	0.71	9.34	66.03
Bare ships surface	0.38	3.66	1.80	0.81	5.07	71.11
Encrusting orange bryozoan	3.46	0.01	1.73	0.73	4.86	75.96
White papillate sponge	2.85	0.10	1.42	0.80	3.98	79.95
Biflustra perfragilis	2.70	0.09	1.37	0.28	3.85	83.80
Serpulid matrix	0.08	1.56	0.81	0.16	2.28	86.07
Turfing brown algae	0.76	0.60	0.64	0.38	1.80	87.87
Encrusting red algae	1.04	0.16	0.57	0.46	1.59	89.46
Orange encrusting sponge	0.30	0.76	0.46	0.56	1.31	90.77

2. Time, Orientation and Aspect

Times 6 & 7

Average dissimilarity = 28.81

Species	Group 6 Av.Abund	Group 7 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	79.77	82.25	11.27	1.05	39.11	39.11
Ecklonia radiata	9.62	5.08	6.58	0.55	22.82	61.94
Large barnacle,sediment,brown fil	0.11	3.66	1.86	0.50	6.45	68.39
Bare ships surface	0.34	2.84	1.46	0.71	5.06	73.44
Encrusting red algae	1.88	0.31	0.99	0.64	3.45	76.89
Turfing brown algae	1.18	0.90	0.96	0.46	3.32	80.21
Encrusting orange bryozoan	1.64	0.00	0.82	0.54	2.85	83.06
Herdmania momus	0.61	0.98	0.71	0.42	2.47	85.53
White papillate sponge	1.12	0.20	0.60	0.57	2.08	87.60
Orange encrusting sponge	0.22	1.07	0.58	0.61	2.03	89.63
Yellow encrusting sponge	0.75	0.49	0.56	0.45	1.94	91.57

Orientation Deck & Hull

Average dissimilarity = 30.97

Species	Group Deck Av.Abund	Group Hull Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	82.92	76.23	11.30	1.30	36.49	36.49
Ecklonia radiata	10.29	0.00	5.15	0.47	16.62	53.10
Large barnacle,sediment,brown fil	0.11	6.33	3.17	0.71	10.25	63.36
Bare ships surface	0.71	3.78	1.94	0.89	6.28	69.63
Herdmania momus	0.00	2.78	1.39	0.65	4.48	74.12
Encrusting orange bryozoan	0.07	2.71	1.36	0.74	4.38	78.49
White papillate sponge	0.15	1.92	0.96	0.75	3.10	81.60
Orange encrusting sponge	0.20	1.75	0.89	0.79	2.86	84.46
Turfing brown algae	1.16	0.75	0.88	0.43	2.85	87.31
Encrusting red algae	1.50	0.08	0.76	0.55	2.46	89.77
Yellow encrusting sponge	0.68	0.48	0.52	0.46	1.67	91.44

Appendix E: Continued

3. Time, Depth and Aspect

Times 6 & 7

Average dissimilarity = 37.19

Species	Group 6 Av.Abund	Group 7 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	66.12	65.18	10.26	1.27	27.60	27.60
Large barnacle,sediment,brown fil	6.47	13.35	6.13	1.17	16.48	44.08
Herdmania momus	7.85	8.04	4.95	0.96	13.31	57.39
Biflustra perfragilis	5.45	0.18	2.73	0.41	7.34	64.73
Encrusting orange bryozoan	5.36	0.03	2.67	0.99	7.18	71.91
White papillate sponge	4.66	0.00	2.33	1.21	6.26	78.17
Bare ships surface	0.43	4.51	2.14	0.91	5.76	83.93
Serpulid matrix	0.13	2.92	1.51	0.21	4.05	87.98
Brown floculant	0.00	1.74	0.87	0.52	2.33	90.32

Appendix E: Continued

4. Time, Position and Aspect

Times 6 & 7

Average dissimilarity = 26.88

Species	Group 6 Av.Abund	Group 7 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	78.55	87.29	11.79	0.91	43.86	43.86
Ecklonia radiata	13.47	7.11	8.77	0.67	32.63	76.50
Encrusting red algae	2.60	0.41	1.32	0.78	4.93	81.43
Turfing brown algae	1.05	1.26	1.05	0.48	3.90	85.32
Bare ships surface	0.17	1.26	0.68	0.48	2.54	87.86
Lobed Brown Algae	1.17	0.14	0.63	0.42	2.35	90.21

Groups Bow and Mid

Average dissimilarity = 41.57

Species	Group Bow Av.Abund	Group Mid Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	92.39	57.90	17.94	1.33	43.17	43.17
Ecklonia radiata	0.31	30.57	15.20	1.05	36.57	79.74
Encrusting red algae	1.17	3.28	1.68	0.98	4.05	83.79
Turfing brown algae	2.54	0.93	1.52	0.61	3.66	87.45
Bare ships surface	0.00	2.09	1.04	0.63	2.51	89.96
Lobed Brown Algae	0.00	1.96	0.98	0.56	2.36	92.32

Groups Bow and Stern

Average dissimilarity = 7.83

Species	Group Bow Av.Abund	Group Stern Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	92.39	98.48	3.40	0.99	43.38	43.38
Turfing brown algae	2.54	0.00	1.27	0.50	16.22	59.60
Yellow encrusting sponge	1.26	0.20	0.69	0.45	8.75	68.34
Encrusting red algae	1.17	0.05	0.59	0.52	7.54	75.89
Serpulid matrix	0.46	0.00	0.23	0.40	2.91	78.80
White papillate sponge	0.05	0.31	0.16	0.69	2.08	80.88
Red solitary ascidian	0.31	0.05	0.16	0.69	2.08	82.95
Ecklonia radiata	0.31	0.00	0.15	0.23	1.97	84.93
Orange encrusting sponge	0.25	0.05	0.14	0.41	1.85	86.77
White encrusting sponge	0.10	0.20	0.13	0.59	1.67	88.45
Orange filamentous algae	0.00	0.25	0.13	0.23	1.60	90.04

Groups Bow and Stern

Average dissimilarity = 41.93

Species	Group Mid Av.Abund	Group Stern Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	57.90	98.48	20.30	1.46	48.42	48.42
Ecklonia radiata	30.57	0.00	15.28	1.05	36.45	84.87
Encrusting red algae	3.28	0.05	1.63	0.90	3.90	88.77
Bare ships surface	2.09	0.05	1.05	0.64	2.51	91.27

Appendix F: Distance based test for homogeneity of multivariate dispersion between Surveys 6 and 7. Significant results in bold

1. All Times

F	0.3208		
P(perm)	0.644		
Group	Size	Average	SE
6	82	24.484	1.8067
7	82	23.221	1.3061

2. Time, Orientation and Aspect

F	5.002		
P(perm)	0.086		
Groups	t	P(perm)	
(6Deck,6Hull)	2.6965	0.1056	
(6Deck,7Deck)	2.65	0.1306	
(6Deck,7Hull)	1.4876	0.3166	
(6Hull,7Deck)	1.4886	0.3426	
(6Hull,7Hull)	3.3618	0.008	
(7Deck,7Hull)	0.69307	0.6302	
Groups	Size	Average	SE
6Deck	30	25.768	3.4759
6Hull	12	10.609	1.5684
7Deck	30	15.296	1.88
7Hull	12	17.445	1.2944

Appendix F: Continued.

3. Time, Depth and Aspect

F	0.4008		
P(perm)	0.6028		
Groups	Size	Average	SE
6	40	21.997	1.752
7	40	23.738	2.1198

F	1.99	
P(perm)	0.2906	
Groups	t	P(perm)
(1,2)	0.13276	0.9904
(1,3)	0.77904	0.4974
(1,4)	1.2068	0.322
(1,5)	1.7732	0.195
(1,6)	0.66915	0.523
(1,7)	2.0042	0.1422
(1,8)	2.4062	7.74E-02
(2,3)	0.21741	0.9834
(2,4)	0.31994	0.9902
(2,5)	0.66579	0.8648
(2,6)	0.12033	0.9984
(2,7)	1.1989	0.4724
(2,8)	0.82729	0.8822
(3,4)	0.223	0.8528
(3,5)	0.92003	0.469
(3,6)	0.24306	0.817
(3,7)	2.4791	7.50E-02
(3,8)	1.3596	0.2652
(4,5)	0.86267	0.5288
(4,6)	0.59212	0.5652
(4,7)	2.9147	3.84E-02
(4,8)	1.4285	0.2538
(5,6)	1.3143	0.246
(5,7)	3.2147	3.14E-02
(5,8)	0.32195	0.8172
(6,7)	2.5447	5.64E-02
(6,8)	1.9534	7.12E-02
(7,8)	3.7137	6.40E-03

Groups	Size	Average	SE
1	10	22.763	2.2612
2	10	21.73	7.4444
3	10	20.007	2.721
4	10	19.28	1.7936
5	10	16.446	2.753
6	10	20.807	1.8526
7	10	31.809	3.9066
8	10	15.33	2.1046

Appendix F: Continued

4. Time, Position and Aspect

F	45.239		
P(perm)	**0.0002**		
Groups	t	P(perm)	
(6Bow,6Mid)	7.7328	4.00E-04	
(6Bow,6Stern)	6.9569	2.00E-04	
(6Bow,7Bow)	0.46356	0.8182	
(6Bow,7Mid)	4.4866	6.00E-04	
(6Bow,7Stern)	9.1872	2.00E-04	
(6Mid,6Stern)	9.4585	2.00E-04	
(6Mid,7Bow)	7.1624	2.00E-04	
(6Mid,7Mid)	3.6349	2.40E-03	
(6Mid,7Stern)	9.8301	2.00E-04	
(6Stern,7Bow)	2.4427	1.48E-02	
(6Stern,7Mid)	6.8111	2.00E-04	
(6Stern,7Stern)	2.4028	8.76E-02	
(7Bow,7Mid)	4.0234	1.40E-03	
(7Bow,7Stern)	3.0762	2.00E-04	
(7Mid,7Stern)	7.3193	2.00E-04	

Group	Size	Average	SE
6Bow	10	7.7533	0.72994
6Mid	10	36.151	3.5991
6Stern	10	1.87	0.42704
7Bow	10	6.7816	1.9649
7Mid	10	19.965	2.6221
7Stern	10	0.69213	0.24067