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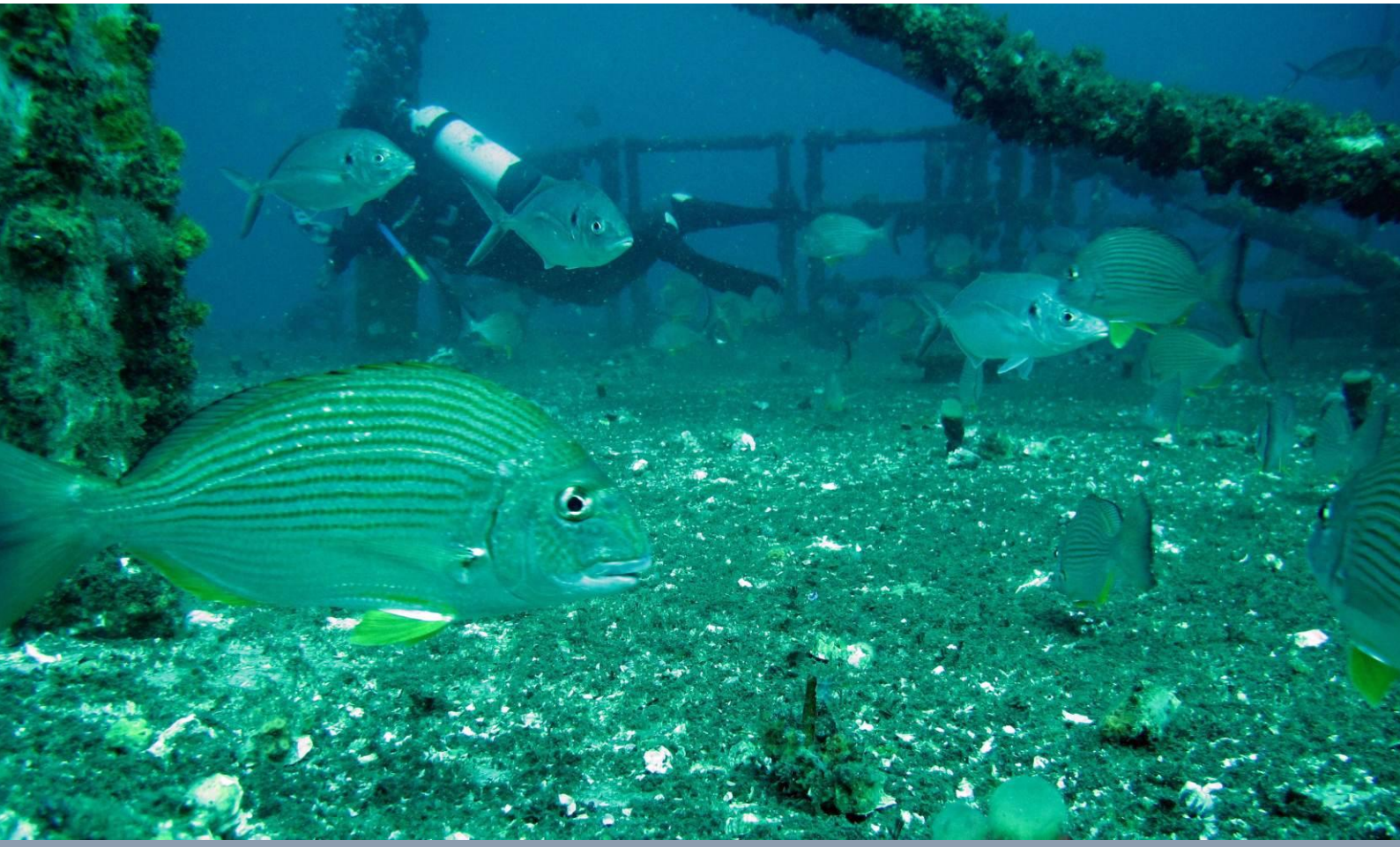

Ex-HMAS Adelaide Artificial Reef

Reef Community Monitoring

Survey 8

Job Number: EL1112024 K

Prepared for: Department of Primary Industries – Catchments and Lands

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Cover Image: Tarwhine (*Rhabdosargus sarba*) and silver trevally (*Pseudocaranx dentex*). Dan Aveling (Cardno Ecology Lab).

Document Control

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Executive Summary

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

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

This Progress Report outlines the methodology and findings of Reef Community Monitoring Survey 8 (**Table ES 1**), as required as part of the LTMMP. Surveys have been carried out on a quarterly basis since the scuttling of the ship in April 2011. 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 done as part of Survey 8 were carried out on 16 and 17 July 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 (33 recorded in total) was similar to the previous survey (Survey 7, carried out in April 2013) and that the assemblages sampled in the two surveys were not significantly different. In general, similar taxa to those observed in the previous survey were recorded in Survey 8, with the serpulid, barnacle and encrusting algal matrix being numerically most abundant, followed by the conglomeration of large barnacles, sediment and brown filamentous algae and the solitary ascidian *Herdmania momus*.

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. Deck position (i.e. bow, midships and stern) also appeared to be a significant factor whereas depth was not.

Upon review of the video footage and fixed photos, soft corals, hydroids and other unidentified algae were observed growing on the deck and superstructure, but were not captured within the photoquadrat survey. This highlights the importance of using a variety of sampling techniques to gain a better understanding of the overall species diversity rather than reliance upon a single method.

In total, 26 species of fish, including several species not previously observed, were recorded during the current survey. New species identified in Survey 8 included a Port Jackson shark (*Heterodontus portusjacksoni*), samson fish (*Seriola hippos*), moon wrasse (*Thalassoma lunare*), eastern wirrah (*Acanthistius ocellatus*), rainbow runner (*Elagatis bipinnulata*) and one spot puller (*Chromis hypsilepis*). A pod of six to seven dolphins and several migrating whales were also noted by divers during Survey 8. The dolphins were located directly above the ship and the whales several hundreds of metres seaward of the dive boat and ship. Marine mammals in NSW are protected under the *Threatened Species Conservation Act 1995* and the *NSW National Parks and Wildlife Act 1974.*

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	2 years post scuttling
Monitoring Survey 8	16 and 17 July 2013	2 years and 3 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 eighth reef community survey. 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.

1.3.8 Monitoring Survey 7

The assemblage sampled in Survey 7 was similar to that observed in the previous survey with the serpulid, barnacle and encrusting algal matrix being numerically abundant, but with notable increases in the percent cover of bare surface, large barnacle/sediment and brown filamentous algae matrix, 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 between Monitoring Surveys 6 and 7 were encrusting red algae, white papillate sponge, the laced bryozoan *Biflustra perfragilis* and encrusting orange bryozoan. New taxa recorded in Survey 7 included a small orange anemone (later identified as an ascidian) and two unidentified solitary ascidians.

Orientation 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. Depth was not found to be a significant factor in structuring assemblages associated with the vertical surfaces of the superstructure and the hull. Reef assemblages on different sections of the deck (i.e. bow mid ship and stern) also varied from one another,

although differences were not consistent through time. A total of 26 species of fish, including six new species were recorded during Survey 7.

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	2 years post scuttling
Monitoring Survey 8	16 and 17 July 2013	2 years and 3 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**.

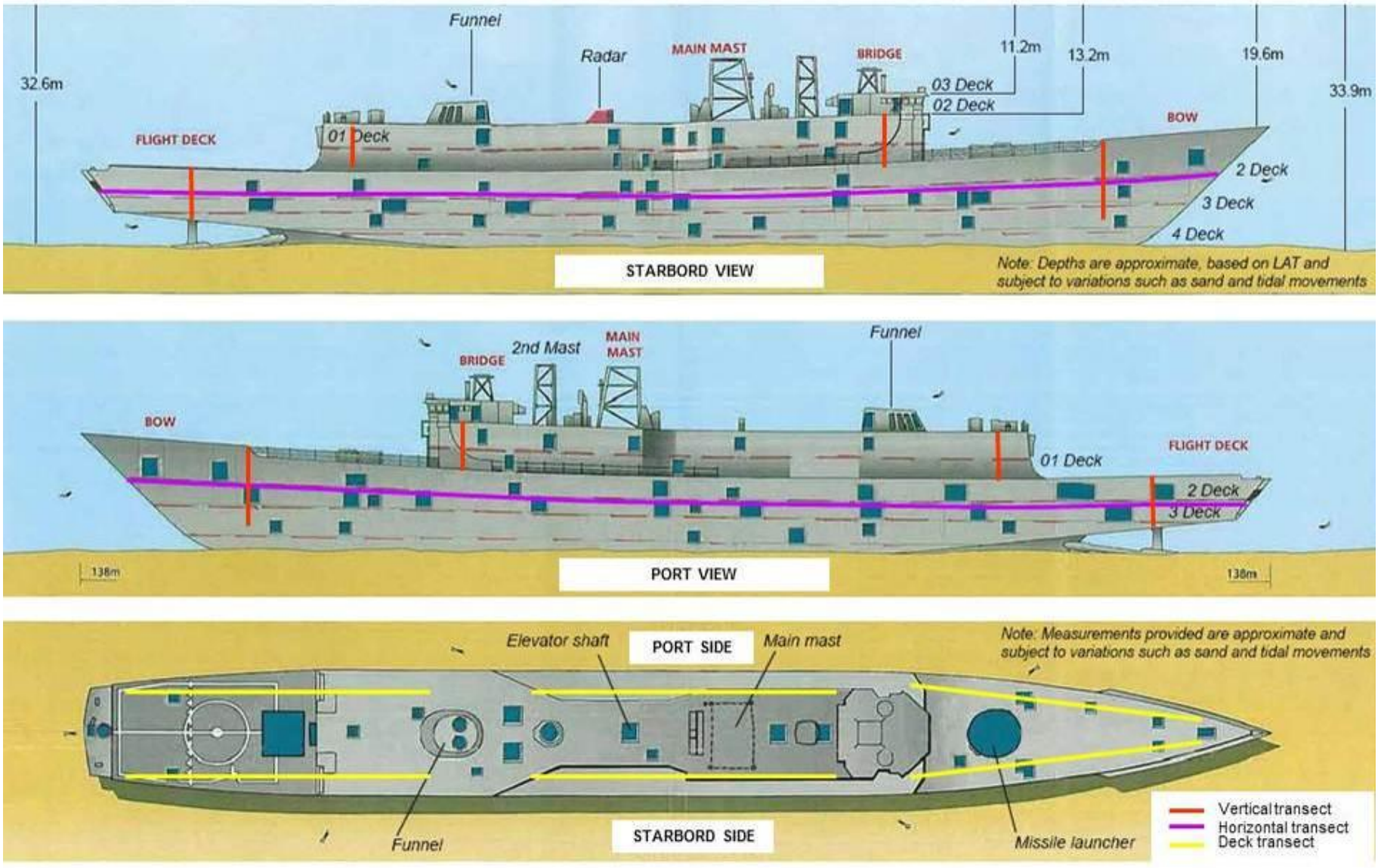

Figure 2: Plans of the Ex-HMAS Adelaide and Positions of the Reef Community Survey Sampling Transects.

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.

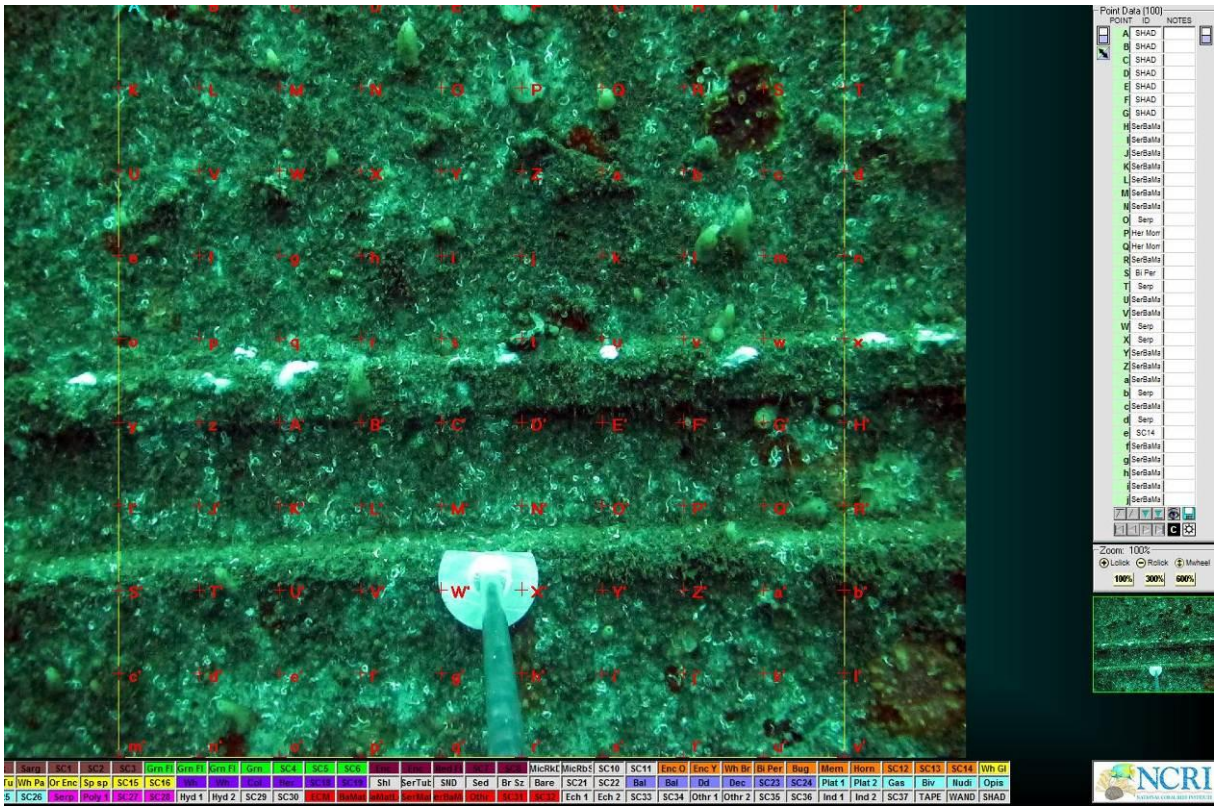

Figure 3: Screenshot of the CPCe Photoquadrat Analyses Frame with a Virtual 10 x 10 Grid Overlayed.

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 subsequent analyses to investigate both spatial and temporal trends between the current and preceeding surveys, in this case, surveys 7 and 8. 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 - 8): fixed, orthogonal;

This design compared reef assemblage structure among the seven sampling surveys to date (regardless of their spatial positioning on the ship). Note that for this eighth survey, mean % cover was used due to the large data set.

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 7/Survey 8): 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 7/Survey 8): 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 7/Survey 8): 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, 33 categories/groups of taxa were identified from the 82 quadrats that were sampled during Survey 8 (**Appendix B**). The most abundant categories across the survey were similar to those of the previous two surveys (6 and 7), with an encrusting matrix of serpulid polychaete worms, barnacles and turfing algae being, by far, the most abundant category in terms of total percent cover. This was followed by the conglomeration of large barnacles, sediment and brown filamentous algae and the solitary ascidian *Herdmania momus*. Bare surface was again ranked as the fourth most abundant category during Monitoring Survey 7 but had decreased since the previous survey.

Common kelp (*Ecklonia radiata)*, an orange colonial ascidian, red encrusting algae and orange and yellow encrusting sponges were also well represented. No new taxa were identified during Survey 8, although the small orange anemone (identified in the previous survey) was re-classified to be a colonial ascidian and re-named as such. While there was an increase in mean percent cover of some categories, e.g. *Ecklonia radiata*, encrusting red algae and various sponges, there was a notable decrease in others, namely the solitary ascidian *Herdmania momus* and the amount of bare cover.

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 for the baseline, Monitoring Surveys 1, 2, 3, 4, 5, 6, 7 and 8 are presented in **Plates 1 – 16**.

3.1.2 Spatial and Temporal Variation in Reef Communities

All Times (Surveys 1-8)

Overall, time was a significant factor in terms of explaining variability in reef assemblages associated with the ship (**Appendix C**). Pair-wise tests indicated that surveys differed significantly from each other with the exceptions of Surveys 2 and 3, 4 and 7, 4 and 8, 5 and 6, and 7 and 8 (**Appendix D**). **Figure 4** also shows that approximately 65% of the total variation among samples appeared to be explained by the two axes within the PCoA. Around 50% of this appears to be explained by the x-axis and is due to differences between early Surveys 1-3 and Surveys 4-8 (**Figure 4**). This difference is further explained by the significantly greater variability (or dispersion) among transects in Surveys 1-3 and less variability (greater clustering of points) in Surveys 4-8 (**Figure 4**, **Appendix F**).

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

The assemblage of sessile invertebrates found on horizontal deck surfaces was significantly different from those of the vertical hull surfaces for both surveys 7 and 8 regardless of whether samples were taken from the port or starboard aspect of the ship (**Appendix C**). This difference is clear from the PCoA which explains 83% of the total variation among samples, of which 60% may be attributed to differences between hull and deck surfaces along the x-axis (**Figure 5)**. Aspect (i.e. port vs starboard) did not influence the composition of reef assemblages associated with the deck and hull (**Appendix E**).

SIMPER analyses indicated that the percent cover of serpulid, barnacle and encrusting algal matrix contributed the most to the dissimilarity between the deck and hull surfaces (37.8%) (**Appendix E**). A greater cover of this category was found on the deck (approx. 85%) compared with the hull (approx. 72%). *Ecklonia radiata* was found only on the deck surface, but not on the hull. The hull was characterised by a large barnacle, sediment and brown filamentous algae matrix, high numbers of large solitary ascidians (including *Herdmania momus)*, orange encrusting sponges and orange colonial ascidians. Bare surface also contributed to differences between deck and hull surfaces, with approximately 6% on the ship's hull compared to 1% on the deck.

PERMDISP for the factor orientation was not significant, indicating that the differences (between hull and deck) surfaces was due to spatial differences and not dispersion among samples (**Appendix F**).

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

There were no clear patterns in assemblage structure relating to depth and/or aspect, although there were significant differences among transects. These were not, however, consistent through time, between depths or between aspects (**Figure 6, Appendix C**). Pair wise tests showed that the significant interaction between time and transect was due to differences between Surveys 7 and 8 along the deep, starboard stern transect (**Appendix D**). This difference was attributed to a greater percent cover of serpulid, barnacle and encrusting algae matrix in Survey 8 at that transect (**Appendix E**). Little difference in the dispersion of samples within each survey was evident (**Appendix F**).

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

Significant differences in sessile reef assemblages among the three positions on the ship's deck surface (i.e. bow, midships or stern) were detected, with these differences consistent through time (**Appendix C**). Pair-wise tests indicated that all three deck positions were significantly different from one another during both surveys 7 and 8 (**Appendix D**). This is illustrated in the corresponding PCoA plot which shows that approximately 91% 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 mid-ship position compared with either the bow or the stern positions (**Figure 7**). This pattern was highlighted within the PERMDISP results, with highly significant differences in the dispersion of samples detected among the three positions (**Appendix F**).

SIMPER analyses indicated that the differences in reef assemblages on the ship's deck were mostly due to dissimilarities in the percent cover of serpulid, barnacle and encrusting algal matrix and that of *Ecklonia radiata*. Encrusting assemblages at the bow and stern of the ship were generally characterised by a high percent cover of serpulid, barnacle and encrusting algal matrix (>96%) whereas the mid-ship deck was characterised by a larger percent cover of *Ecklonia radiata* and a smaller percent cover of serpulid, barnacle and encrusting algal matrix (**Appendix E**).

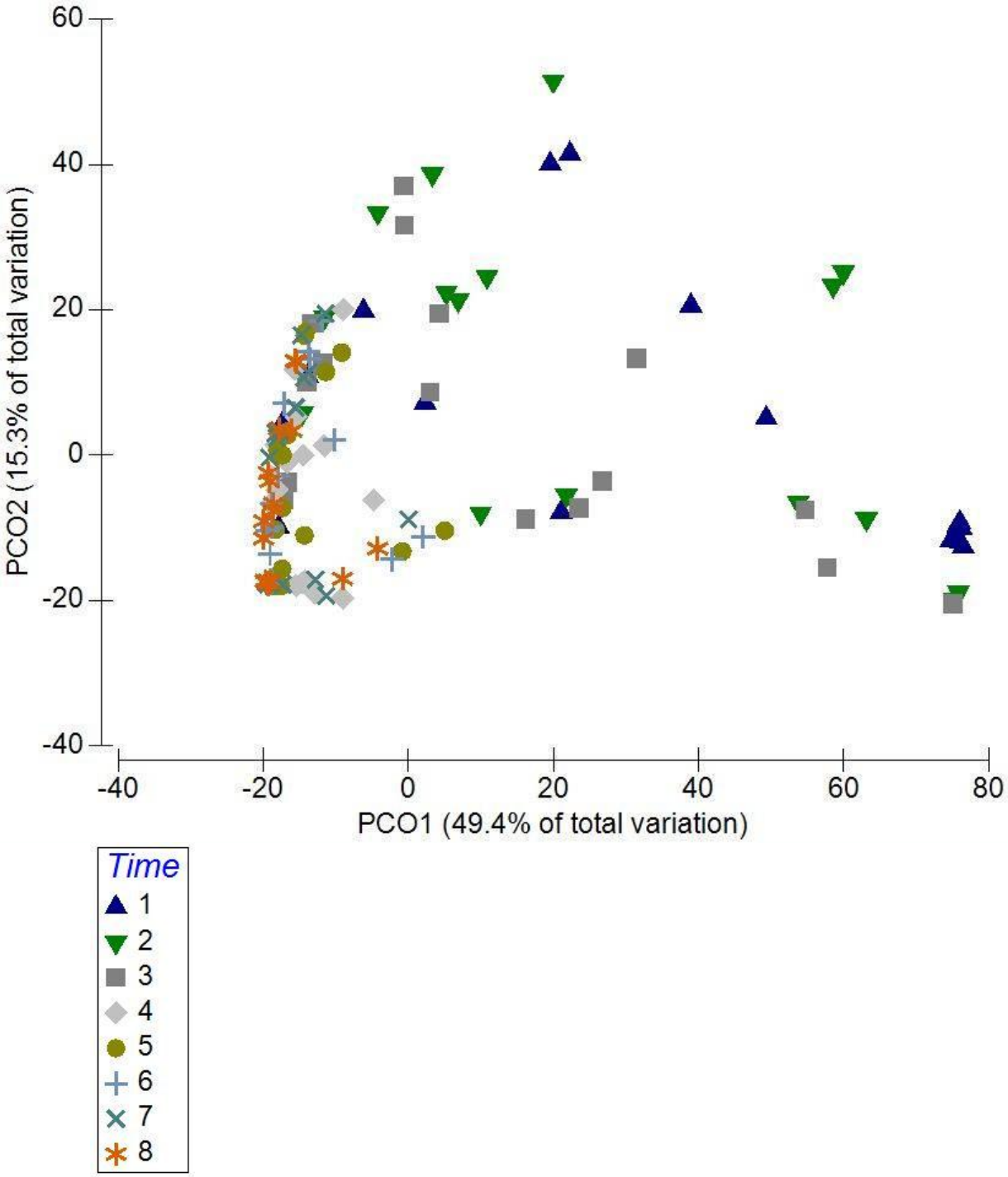

Figure 4: Principal Coordinates Analyses (PCoA) of Percent Cover of Encrusting Assemblages from Transects Taken at all Positions on the Ex-HMAS Adelaide for Surveys 1, 2, 3, 4, 5, 6, 7 and 8.

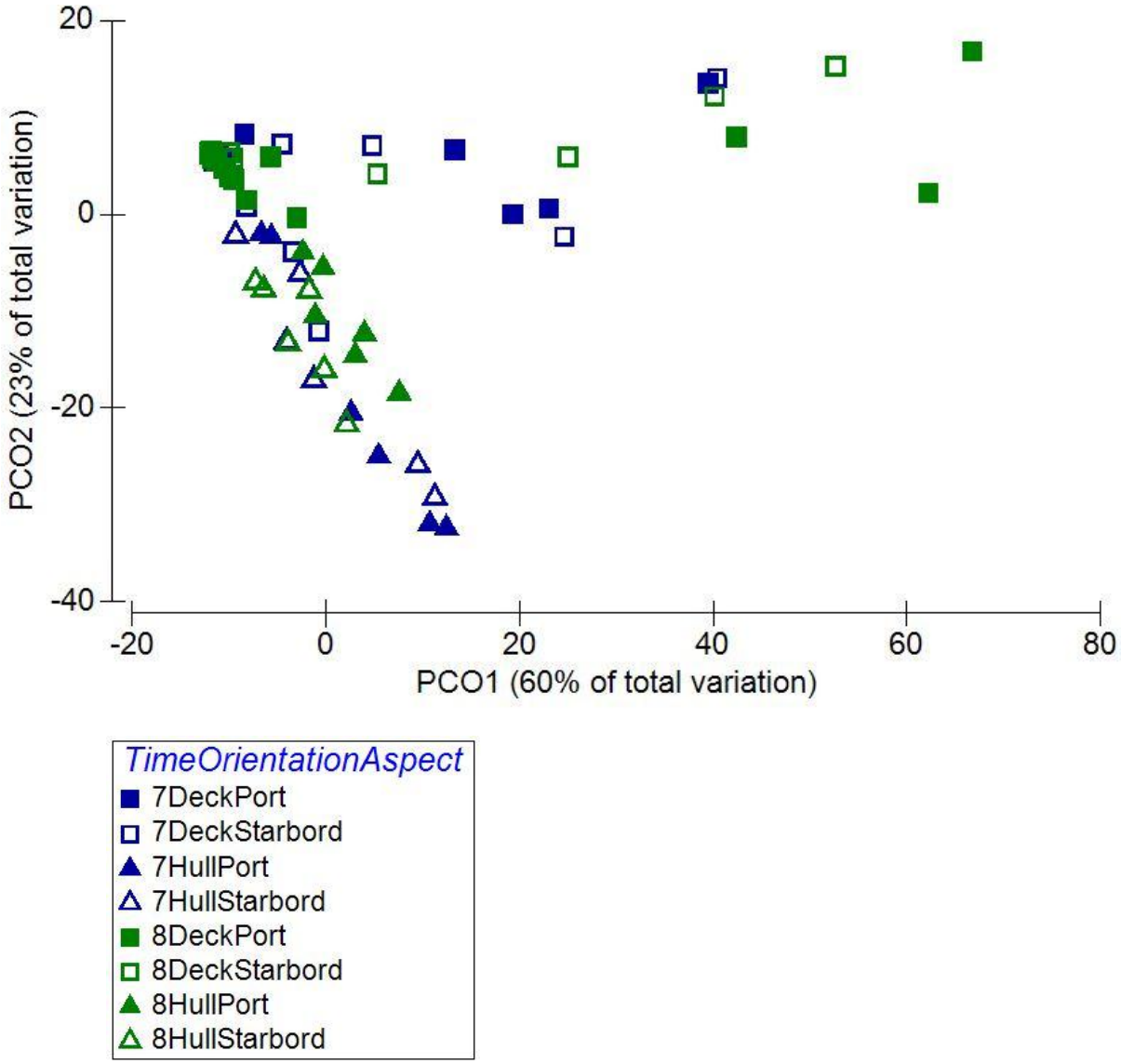

Figure 5: Principal Coordinates Analyses (PCoA) of Percent Cover of Encrusting Assemblages from Transects Taken on Hull and Deck Surfaces of the Ex-HMAS Adelaide for Surveys 7 and 8.

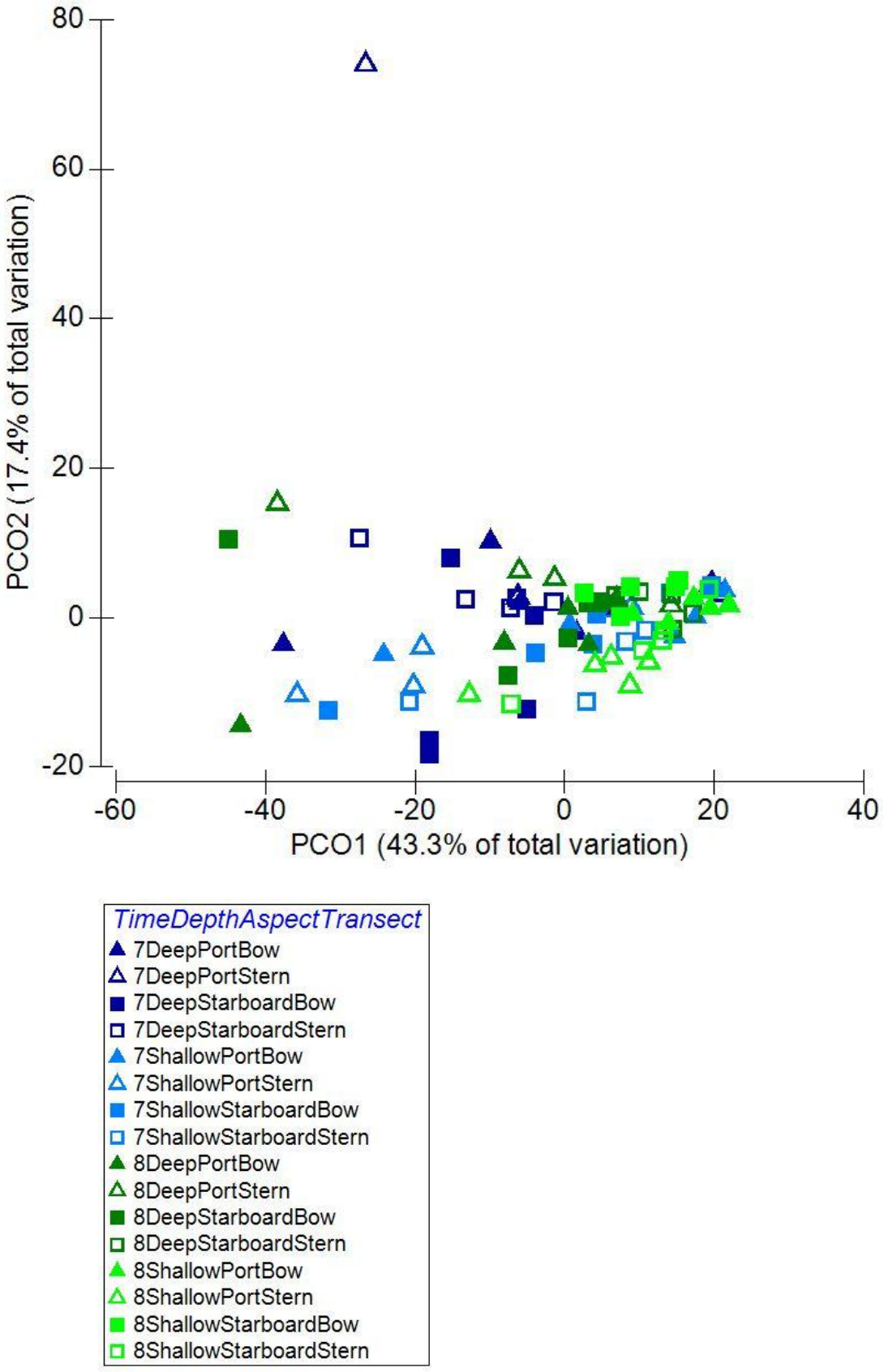

Figure 6: Principal Coordinates Analyses (PCoA) of Percent Cover of Encrusting Assemblages from Transects at Different Depths and Aspect on the Ex-HMAS Adelaide for Surveys 7 and 8.

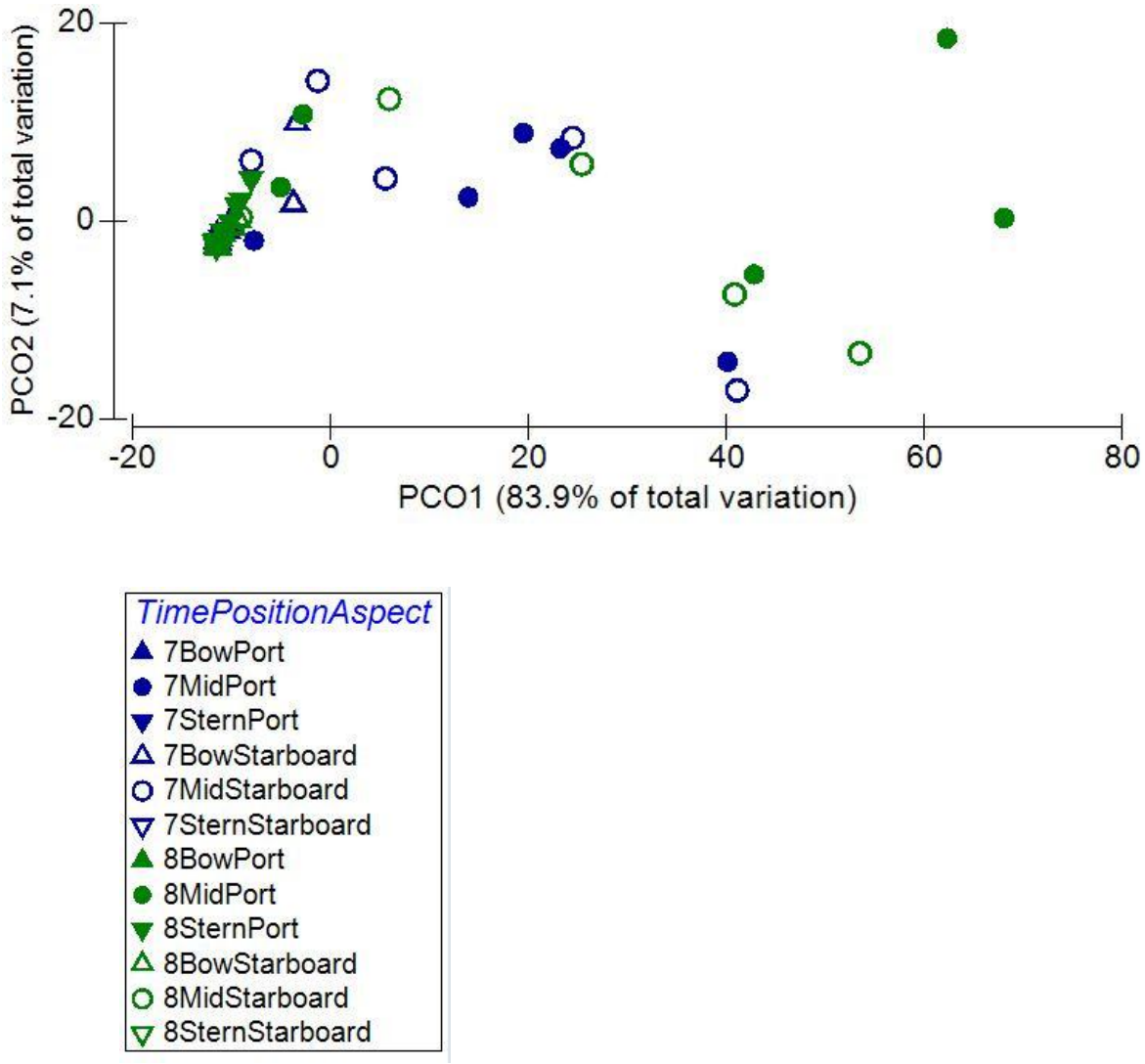

Figure 7: Principal Coordinates Analyses (PCoA) of Percent Cover of Encrusting Assemblages from Transects Taken at Different Positions on the Deck Ex-HMAS Adelaide for Surveys 7 and 8.

3.2 Fixed Photographs

Photographs taken from fixed locations are presented in **Appendix A.** Inspection of fixed photos taken during Survey 8 shows layers of thick encrusting biota remains visible over the majority of the ship particularly on ladders, railings and mast structures (e.g. fixed photographs 4, 5, 9 and 10) In some cases, there are noticeable areas of bare metal or paint, where the thick layer of encrusting biota has broken off (e.g. fixed photo 10).

Flat, less complex surfaces of the deck appear to have a thinner and more uniform encrusting layer of serpulid tubes, barnacles, encrusting algae and fine sediment, although there was a notable increase in the abundance of red/white, solitary, tubular sponges growing vertically off the deck e.g. fixed photos 1, 6 and 7.

3.3 Video Transects

The results of observations made from video transects are summarised in **Table 2** below. All fish species observed during previous surveys and the current monitoring survey (Survey 8) are listed in **Table 3**. Species of recreational, commercial or conservation value are also indicated. Six new species of fish were recorded during Survey 8, yielding a total of 26 taxa. These new species of fish included a Port Jackson shark (*Heterodontus portusjacksoni*), samson fish (*Seriola hippos*), moon wrasse (*Thalassoma lunare*), eastern wirrah (*Acanthistius ocellatus*), rainbow runner (*Elagatis bipinnulata*) and one spot puller (*Chromis hypsilepis*).

Table 2: Summary of Observations of Attached Encrusting and Fish Assemblages Observed from Video Footage of the Ex-HMAS Adelaide in July 2013 (Survey 8).

Position	Description of Assemblage
Deck Port Bow	The deck surface was encrusted with a uniform assemblage of small barnacles, encrusting algae, hydroids and fine filamentous algae. Erect red and white, tubular solitary sponges and white papillate encrusting sponges were also conspicuous. Tarwhine (*Rhabdosargus sarba)* and eastern hula fish (*Trachinops taeniatus*) were abundant, forming schools. Tarwhine were noted feeding on the deck. Other species of fish in this area included silver sweep (*Scorpis lineolatus*), rock cale (*Crinodus lophodon*) and silver trevally (*Pseudocaranx dentex*).
Deck Port Mid	Kelp (*Ecklonia radiata*) remained present in this area. The majority of the deck was otherwise heavily encrusted with barnacles, encrusting algae, hydroids and fine filamentous algae. Some bare patches where kelp thalli have been lost (likely due to storms), remained evident following the previous survey. Rock cale, a kelp associated species, was present in this area. Other species observed included tarwhine, red morwong (*Cheilodactylus fuscus*), yellow-fin leatherjacket (*Meuschenia trachylepis*) and sergeant baker (*Aulopus purpurrissatus*).
Deck Port Stern	The deck was 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. Erect red and white, tubular solitary sponges and white papillate encrusting sponges were conspicuous on the deck surface. A Port Jackson shark (*Heterodontus portjacksoni*) was observed resting on the deck. Silver trevally, were also abundant.
Deck Starboard Bow	As with previous surveys, encrusting growth included barnacles, algae and hydroids with patches of encrusting sponges. Solitary, tubular, red, pink and white sponges were common on the deck. Tarwhine and eastern hula fish were present in schools. Red morwong, white ear (*Parma microlepis*) and Luculentus wrasse (*Psuedolabrus luculentus*) were also recorded. Several eastern red scorpioncod (*Scorpaena cardinalis*) were observed well camouflaged on the deck surface.
Deck Starboard Mid	As per previous surveys, the majority of the deck was encrusted with barnacles, encrusting algae, hydroids, fine red filamentous algae and small branching hard corals. A layer of fine sediment was noted on the surface. The vertical superstructure and areas of railing remained heavily colonised with ascidians and branching and papillate white bryozoans and sponges. Red morwong, tarwhine, girdled scalyfin (*Parma unifasciata*), rock cale and silver trevally were also found in this area.

Deck Starboard Stern	Serpulid worm tubes, small barnacles, encrusting algae, hydroids and fine filamentous algae were abundant on flat areas of the deck. Red morwong, tarwhine, silver trevally and white ear were also observed in this area. Eastern wirrah (*Acanthistius ocellatus*), was a new species observed in this survey.
Horizontal Hull Port and Starboard	The hull remains heavily colonised by sessile invertebrates, particularly ascidians, on both the port and starboard sides. As with previous surveys, these include solitary ascidians such as *Herdmania momus and Botryloides magnicoecum*, large barnacles, and various encrusting sponges and bryozoans. Growth still appeared thickest around the gunwale, and around the edges of holes in the hull. Otherwise, the hull remained heavily encrusted with serpulid worm tubes covered with small barnacles, encrusting algae, hydroids and fine filamentous algae. The white papillate bryozoan (*Triphyllozoan* sp.) was conspicuous in distinct colonies. Tarwhine (*Rhabdosargus sarba*), trevally (*Psuedocarynx dentex*), six-spine leatherjacket (*Meuschenia freycineti*), yellow-fin leatherjacket (*Meuschenia trachylepis*), the eastern hulafish (*Trachinops taeniatus*) and sergeant baker (*Aulopus purpurrissatus*) were observed swimming alongside the hull.
Vertical Hull Bow	Similar to previous surveys, large globular ascidians and barnacles dominated the encrusting biota on the hull of the ship. Various encrusting and papillate sponges and bryozoans remained.
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 occasional clumps 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 or turfing algae. Eastern red scorpioncod were observed lying flat against the hull, well camouflaged among the ascidians and barnacles.
Vertical Hull Superstructure	Ascidians, bryozoans, a layer of serpulid worm tubes, barnacles, encrusting algae, hydroids and fine filamentous algae were observed on the superstructure. An orange colonial ascidian was also prevalent on this surface. Half banded sea perch (*Hypoplectrodes maccullochi*) and eastern red scorpioncod were observed in association with this part of the ship.

Table 3: Species of Fish Observed in Association with the Ex-HMAS Adelaide Artificial Reef between April/May 2011 and July 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)	Survey 8 (July 2013)
Heterodontidae	Heterodontus portusjacksoni	Port Jackson shark	4									●
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	*Acanthistius ocellatus*	Eastern wirrah	211									●
Serranidae	*Hypoplectrodes maccullochi*	Half-banded sea perch	225				●	●			●	●
Serranidae	*Hypoplectrodes nigroruber*	Black-banded sea perch	227								●	
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			●	●		●	●	●	●
Carangidae	*Seriola hippos*	Samson Fish*	300									●
Carangidae	*Elagatis bipinnulata*	Rainbow runner	303									●
Sparidae	*Pagrus auratus*	Snapper (juv)*+	310		●	●	●		●	●	●	
Sparidae	*Rhabdosargus sarba*	Tarwhine*	311			●	●	●	●	●	●	●
Lutjanidae	*Paracaesio xanthurus*	Southern fusilier	320								●	
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			●			●	●	●	●
Pomacentridae	*Chromis hypsilepis*	One-Spot Puller	396									●
Cirritidae	*Cirritichthys aprinus*	Blotched hawkfish	406						●	●	●	●
Chironemidae	*Chironemus marmoratus*	Eastern kelpfish	411						●			
Aplodactylidae	*Crinodus lophodon*	Rock cale	415						●		●	●
Cheilodactylidae	*Cheilodactylus fuscus*	Red morwong*	416		●	●	●	●	●	●	●	●
Cheilodactylidae	*Nemadactylus douglasii*	Blue morwong*	424		●	●				●	●	
Cheilodactylidae	*Cheilodactylus vestitus*	Magpie morwong	421								●	
Latrididae	*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								●	●
Labridae	*Thalassoma lunare*	Moon wrasse	505									●
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**	**26**

4 Discussion

4.1 Encrusting Biota

Overall, the reef assemblage associated with the ship during Survey 8 (carried out two years and three months months post-scuttling), was similar to that of the previous survey. The number of categories recorded (33) was slightly less than that of Survey 7 (35), possibly in part due to the grouping and/or re-classification of certain taxa. While not statistically significant, small changes in the abundance and composition of taxa were evident between surveys 7 and 8. The percent cover of kelp (*Ecklonia radiata*), encrusting red algae, various encrusting sponges and the ascidian *Botryloides magnicoecum* increased, while the percent cover of lobed brown algae, the bryozoan *Tryphyllozoan* sp. red solitary sponge, and the ascidian *Herdmania momus* decreased. The percent cover of bare surface also decreased while relatively recent bare patches appeared to be colonised by an increase in brown flocullant (possibly a type of early colonising algae). The bryozoan *biflustra perfragilis*, thin branching red algae, spikey pink sponge and the reef building polychaete *Filograna implexa* were present in the previous survey but not recorded in the current survey, although video footage indicates that some of these species were present but not detected in sampling. Soft corals, hydroids and other unidentified algae were also observed growing on the deck and superstructure upon review of the video footage and fixed photos, but were not captured within the photoquadrat survey. This highlights the importance of using a variety of sampling techniques to gain a better understanding of the overall species diversity rather than reliance upon a single method. As described in previous surveys the changes observed in relative 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). Overall, results of the survey show that the variability among samples taken during Survey 8 remained similar to that of the previous survey with little difference in the spread of replicates between surveys. Variability among replicate samples on the ship as a whole appears to have become more uniform and less patchy over time.

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. Deck surfaces were characterised by serpulid, barnacle and encrusting algal matrix and the presence of *Ecklonia radiata*, while the hull was characterised by large barnacles, high numbers of large solitary ascidians (including *Herdmania momus)*, orange encrusting sponges and orange colonial ascidians. 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.

Depth alone did not appear to influence the composition of the sessile assemblages, however, deck position (i.e. bow, midships and stern) did appear to be a significant factor. As discussed in previous reports, 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 despite occurring at similar depths. This pattern was also apparent for the previous survey (i.e. Survey 7) and largely determined by the presence of *Ecklonia radiata* on the mid-ship section of the deck.

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, Macroinvertebrates and Megafauna

The number of fish species observed by divers and from video and fixed photos has generally increased since scuttling of the ship in April 2011, but has remained quite similar from the previous survey to the current survey. While several species recorded in the previous survey were not observed in the current survey, six new species were recorded, bringing the total number of species observed in Survey 8 to 26 (the same as for Survey 7). New species included a Port Jackson shark (*Heterodontus portusjacksoni*), samson fish (*Seriola hippos*), moon wrasse (*Thalassoma lunare*), eastern wirrah (*Acanthistius ocellatus*), rainbow runner (*Elagatis bipinnulata*) and one spot puller (*Chromis hypsilepis*). Several of these species are reef associated whereas rainbow runner and Port Jackson shark may be more transient.

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 changes in the species assemblage observed were due to the development of the reef assemblage over time or seasonal differences, but may also be due to variation in sampling effort.

A pod of six to seven dolphins and several migrating whales were also noted by divers during Survey 8. The dolphins were located directly above the ship and the whales several hundreds of metres seaward of the dive boat and ship. Marine mammals in NSW are protected under the *Threatened Species Conservation Act 1995* and the *NSW National Parks and Wildlife Act 1974*.

5 Acknowledgements

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7 Plates

Deck, Port Bow

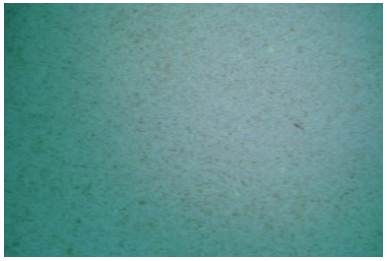
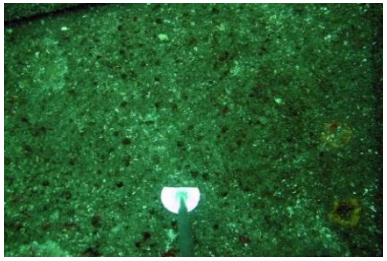
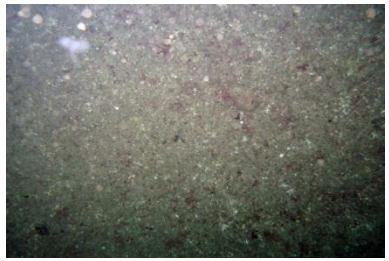
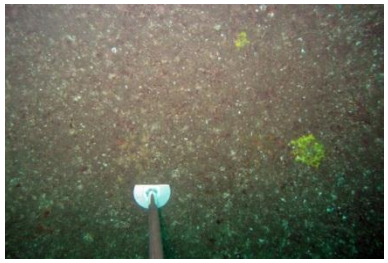
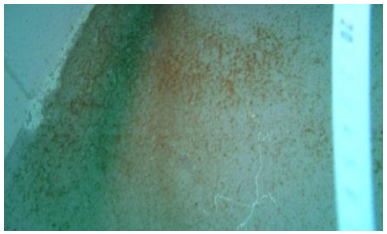
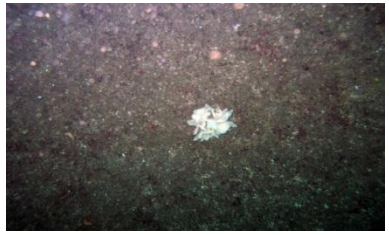
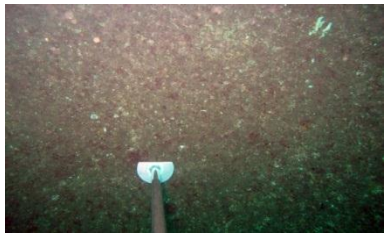
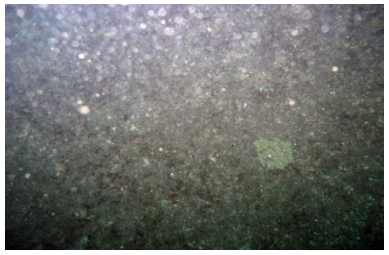
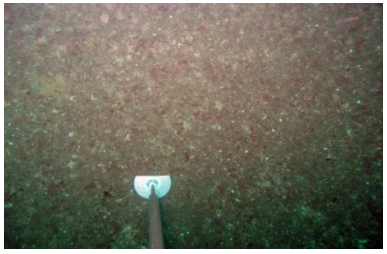
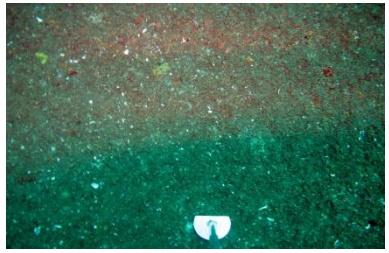
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 1: Deck port bow

Deck, Port Bow

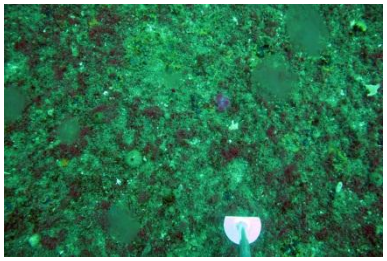
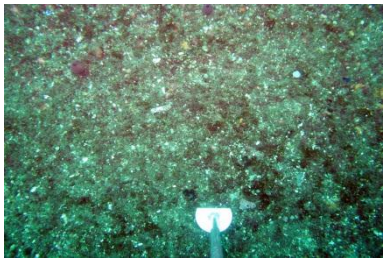
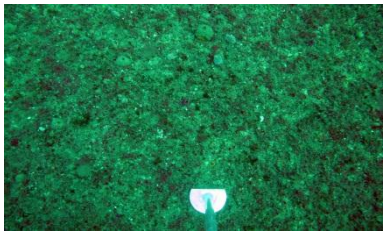
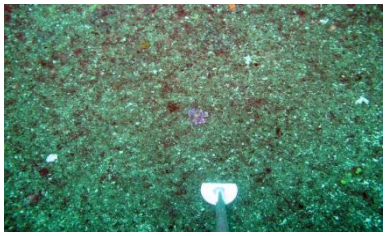
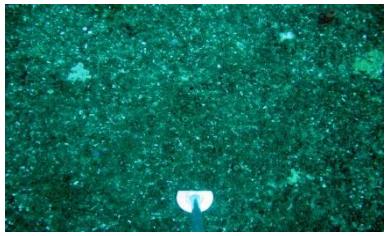
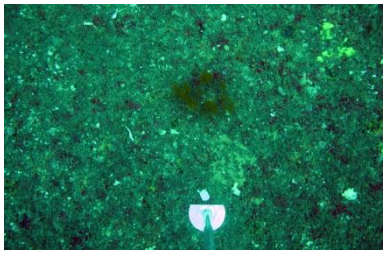
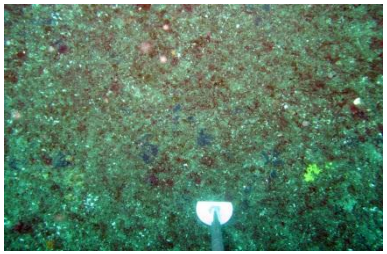
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)
			
			
			

Plate 1: Deck port bow

Deck, Port Mid

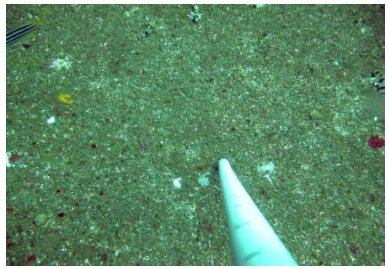
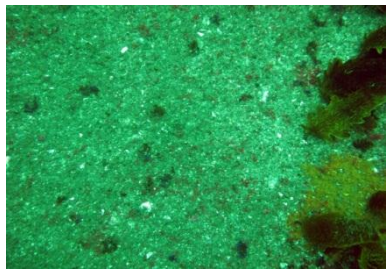
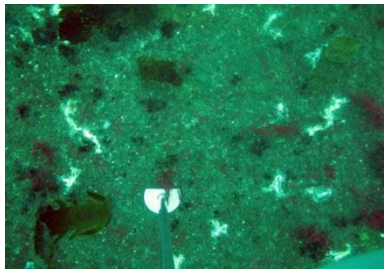
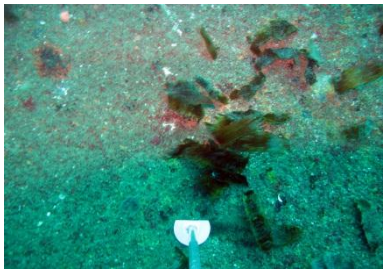
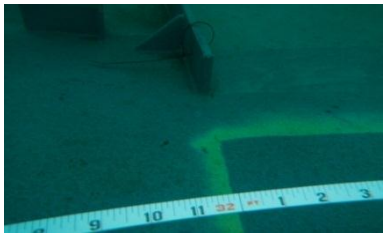
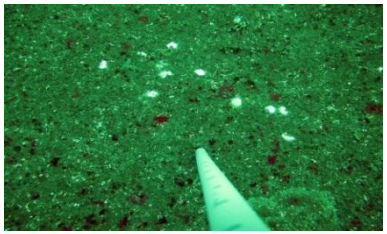
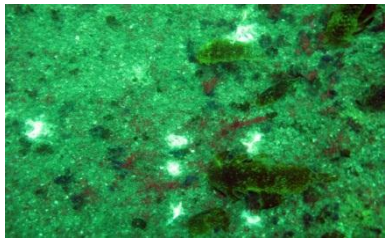
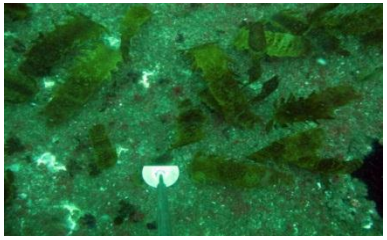
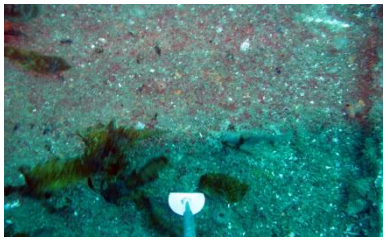
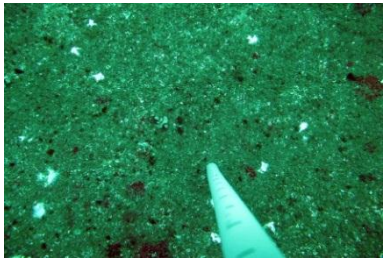
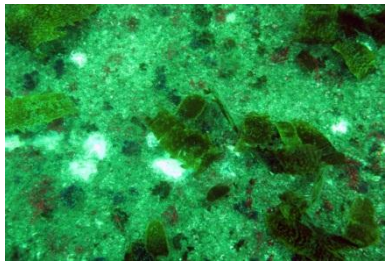
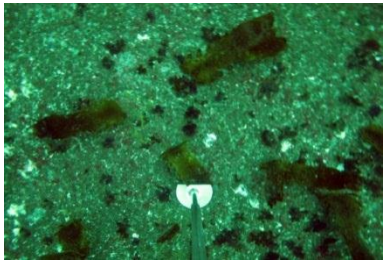
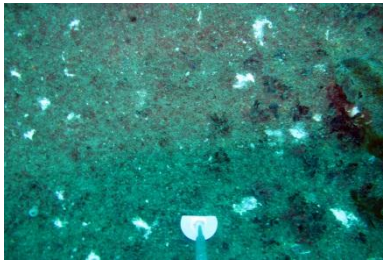
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 2: Deck Port Mid

Deck, Port Mid

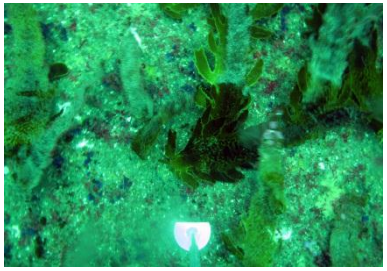
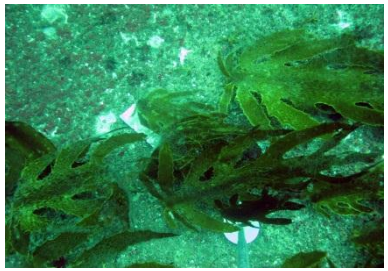
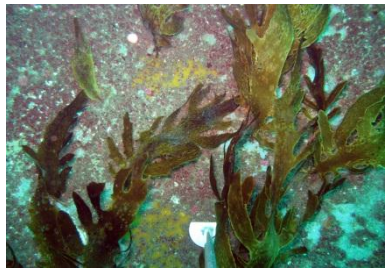
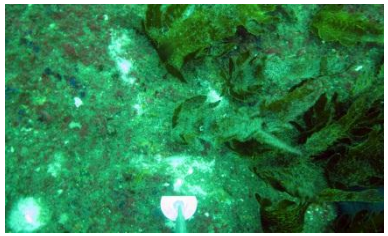
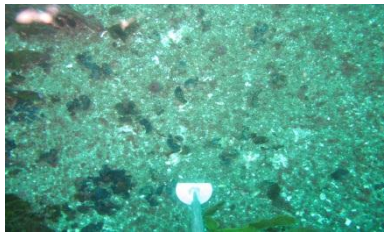
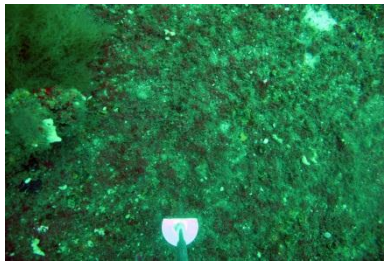
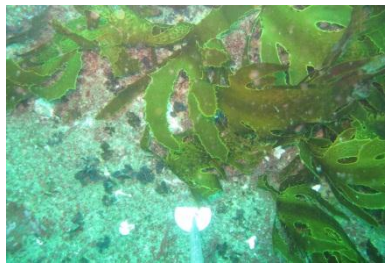
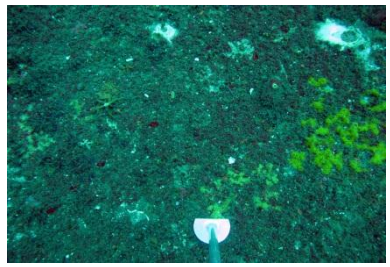
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)
			
			
			

Plate 2: Deck Port Mid

Deck, Port , Stern

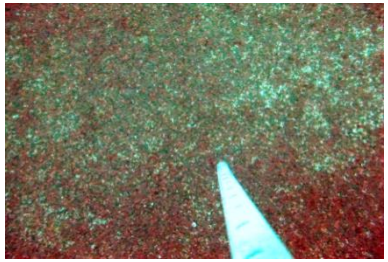
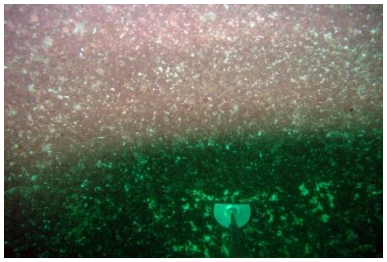
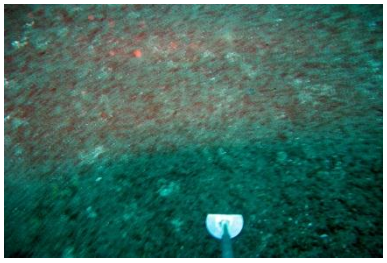
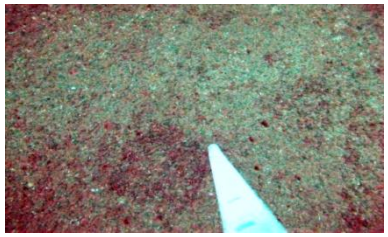
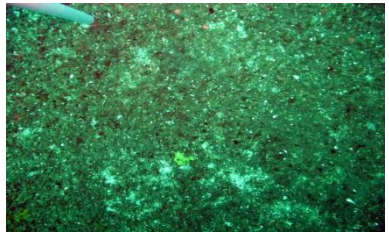
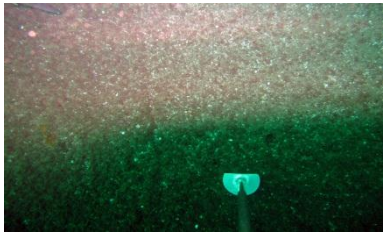
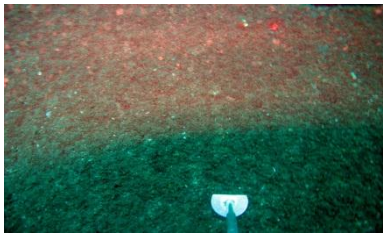
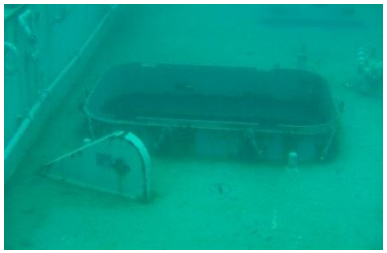
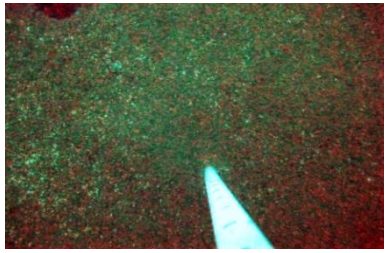
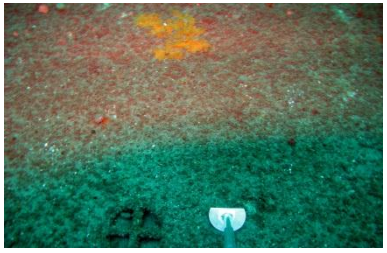
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 3: Deck Port Stern

Deck, Port, Stern

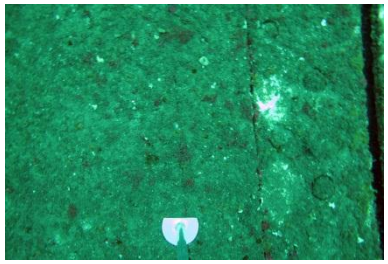
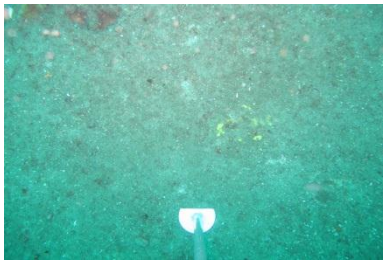
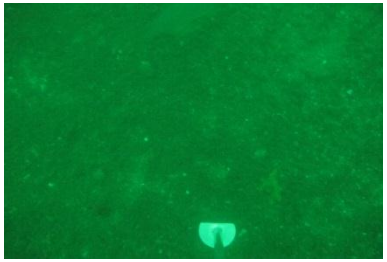
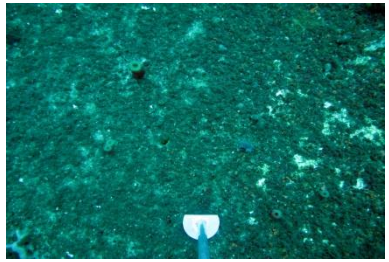
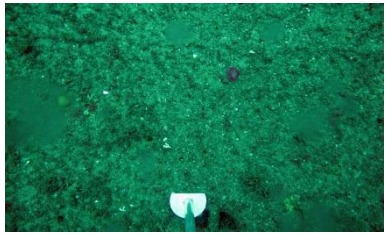
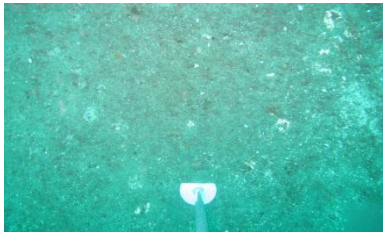
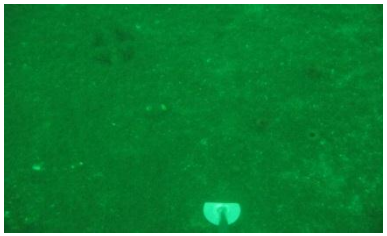
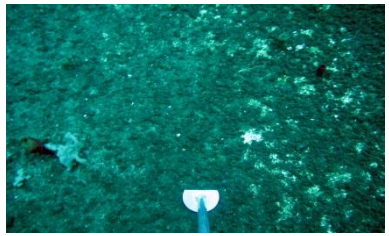
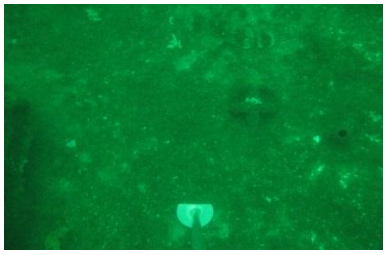
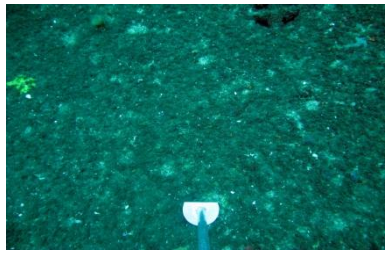
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)
			
			
			

Plate 3: Deck Port Stern

Deck, Starbord, Bow

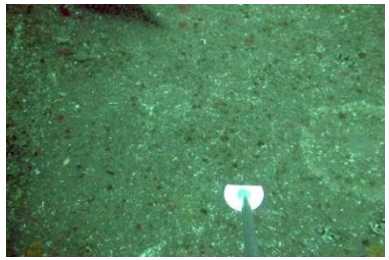
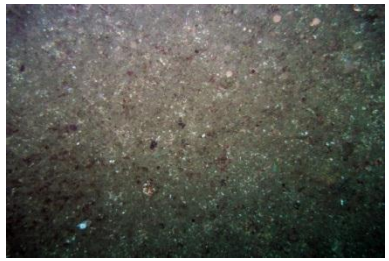
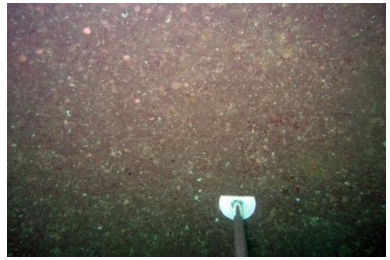
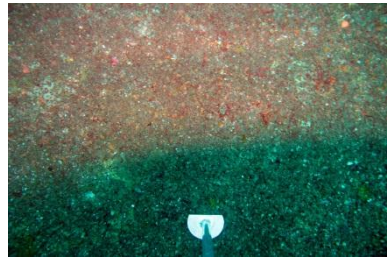
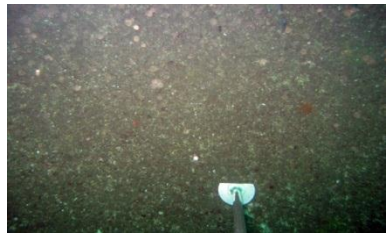
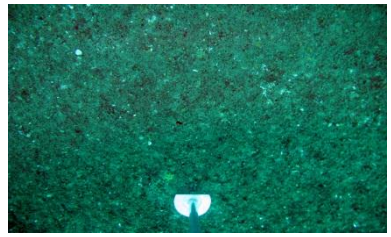
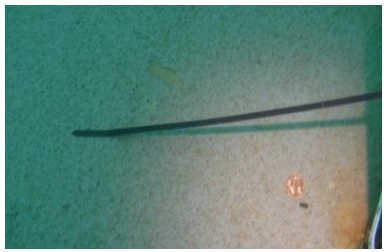
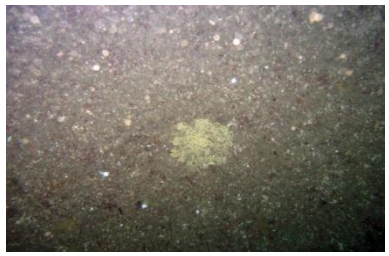
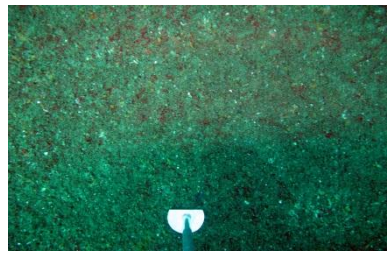
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 4: Deck Starbord Bow

Deck, Starbord, Bow

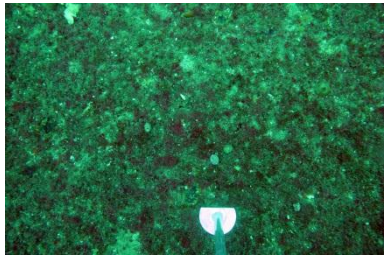
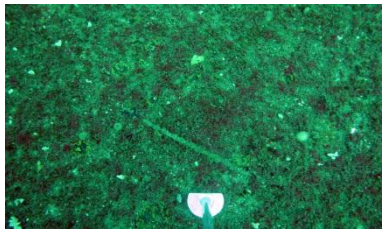
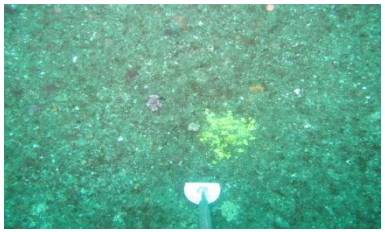
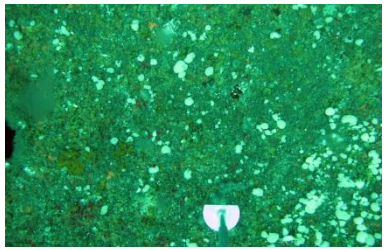
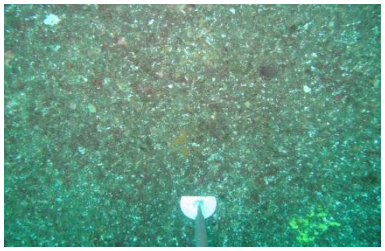
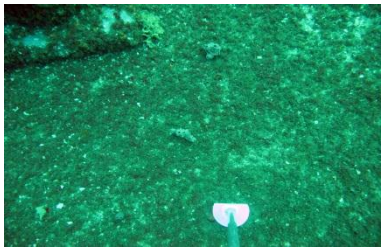
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)
			
			
			

Plate 4: Deck Starbord Bow

Deck, Starbord, Mid

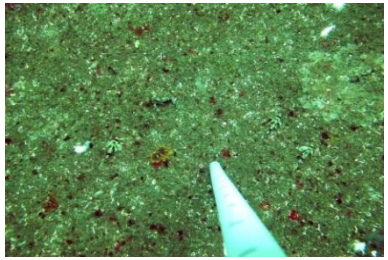
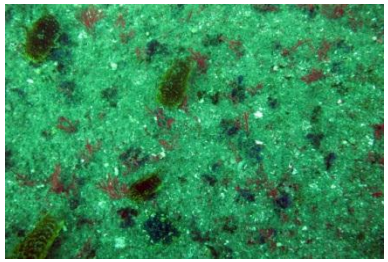
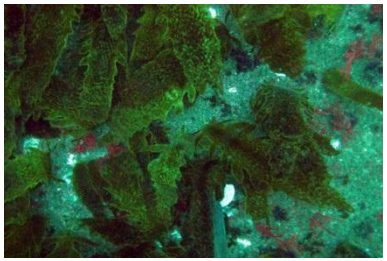
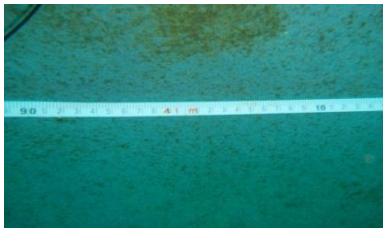
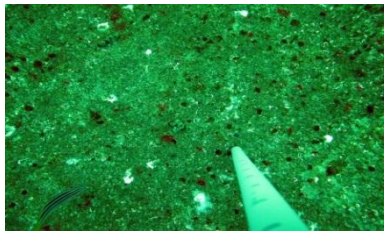
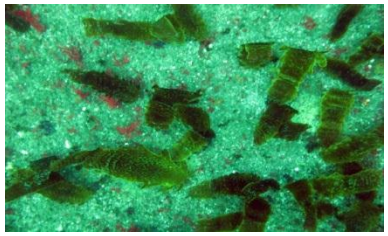
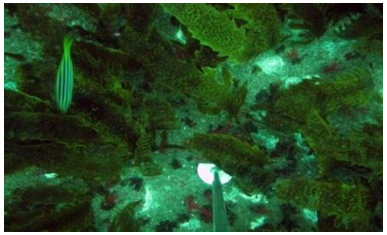
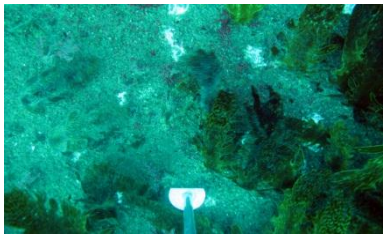
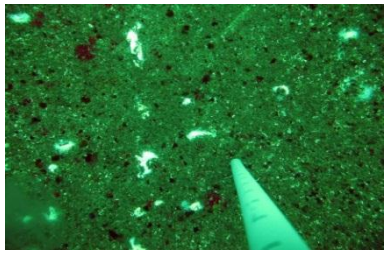
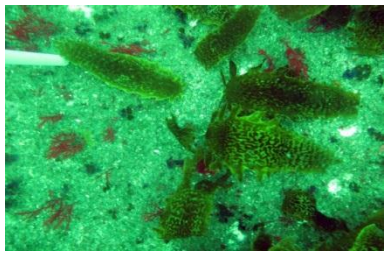
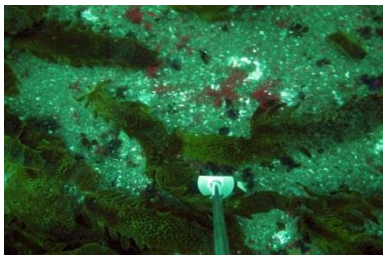
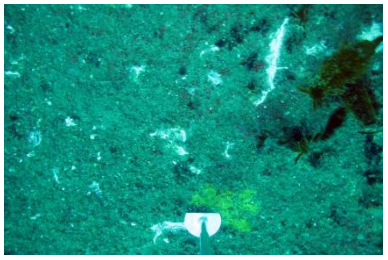
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 5: Deck Starbord Mid

Deck, Starbord, Mid

Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)

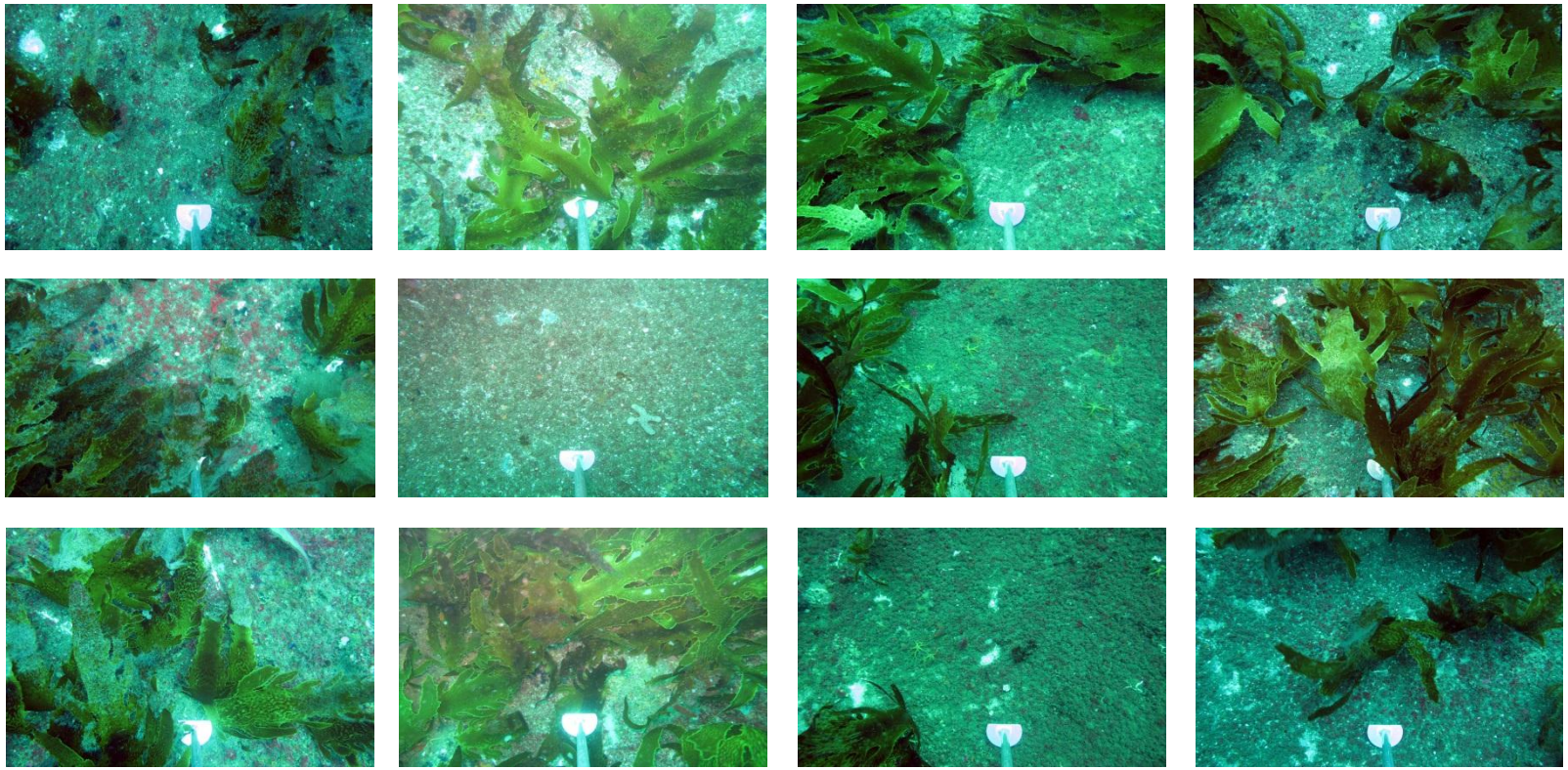


Plate 5: Deck Starbord Mid

Deck, Starbord, Stern

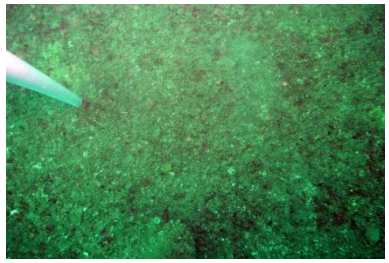
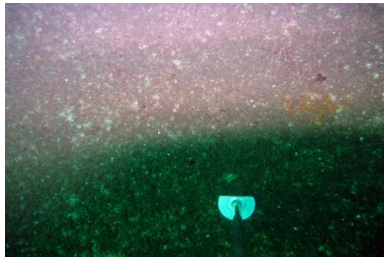
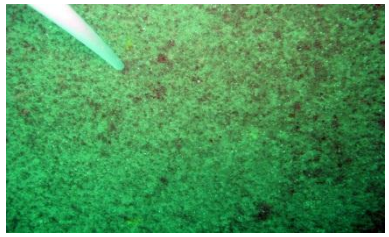
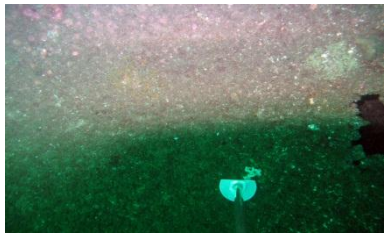
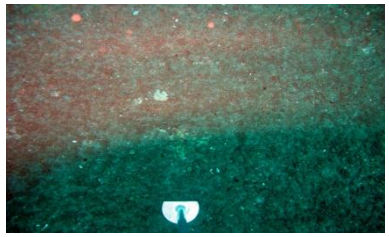
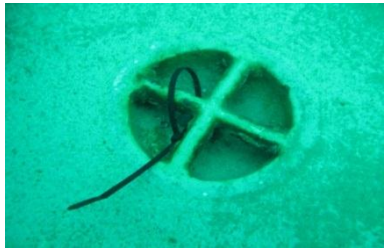
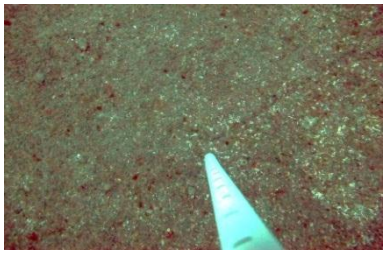
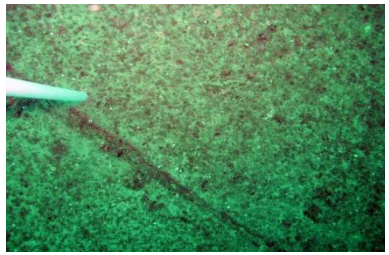
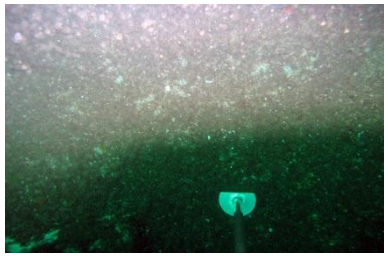
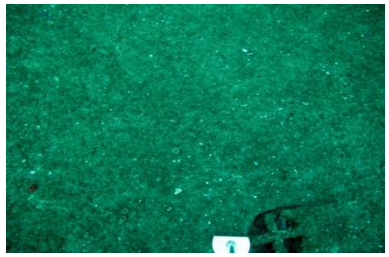
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 6: Deck Starbord Stern

Deck, Starbord, Stern

Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)

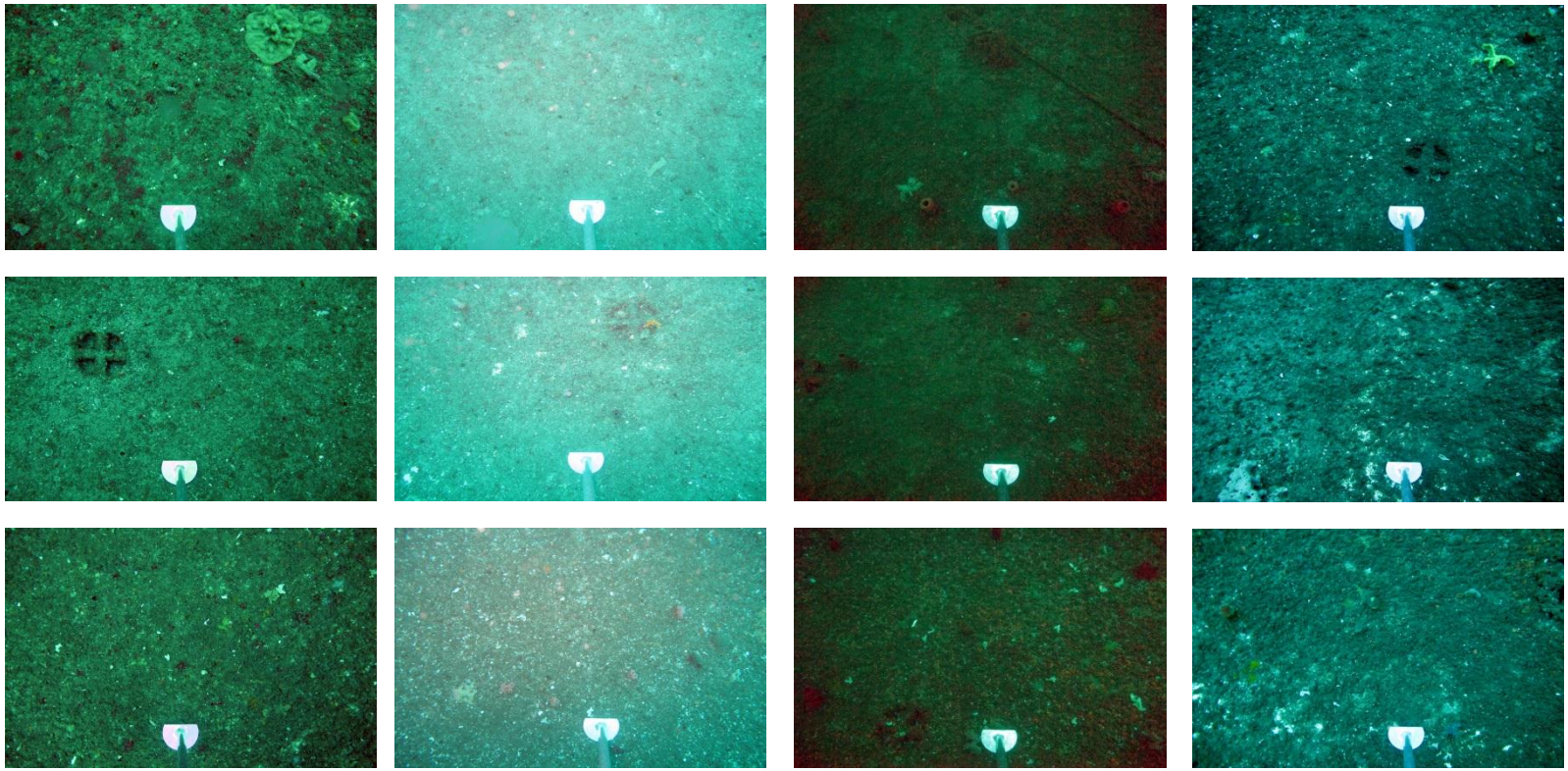


Plate 6: Deck Starbord Stern

Horizontal Hull Port

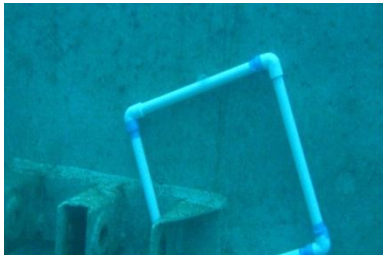
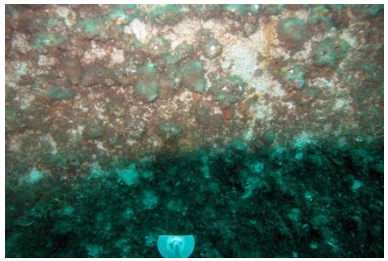
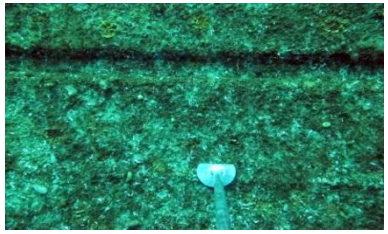
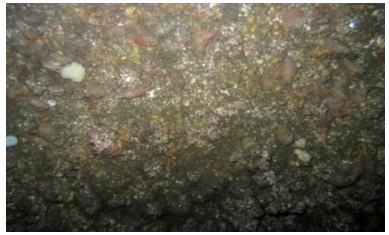
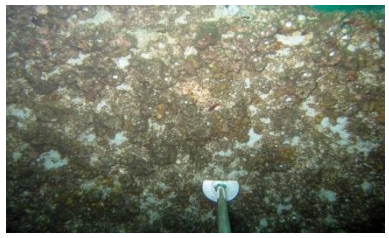
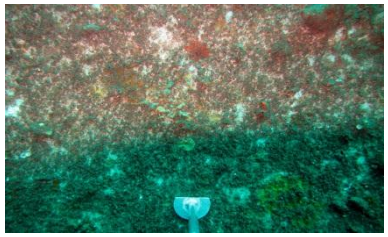
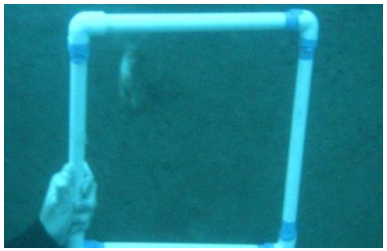
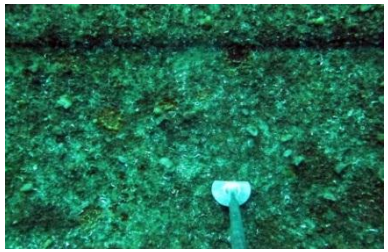
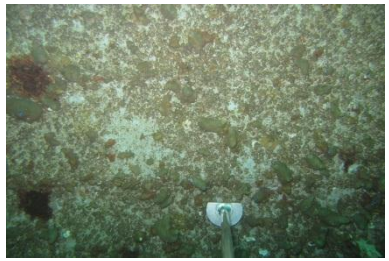
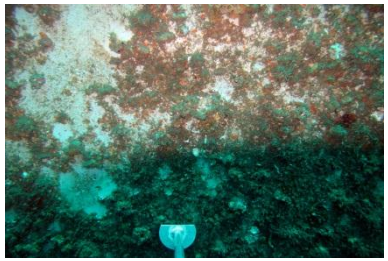
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 7: Horizontal Hull Port

Horizontal Hull Port

Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)

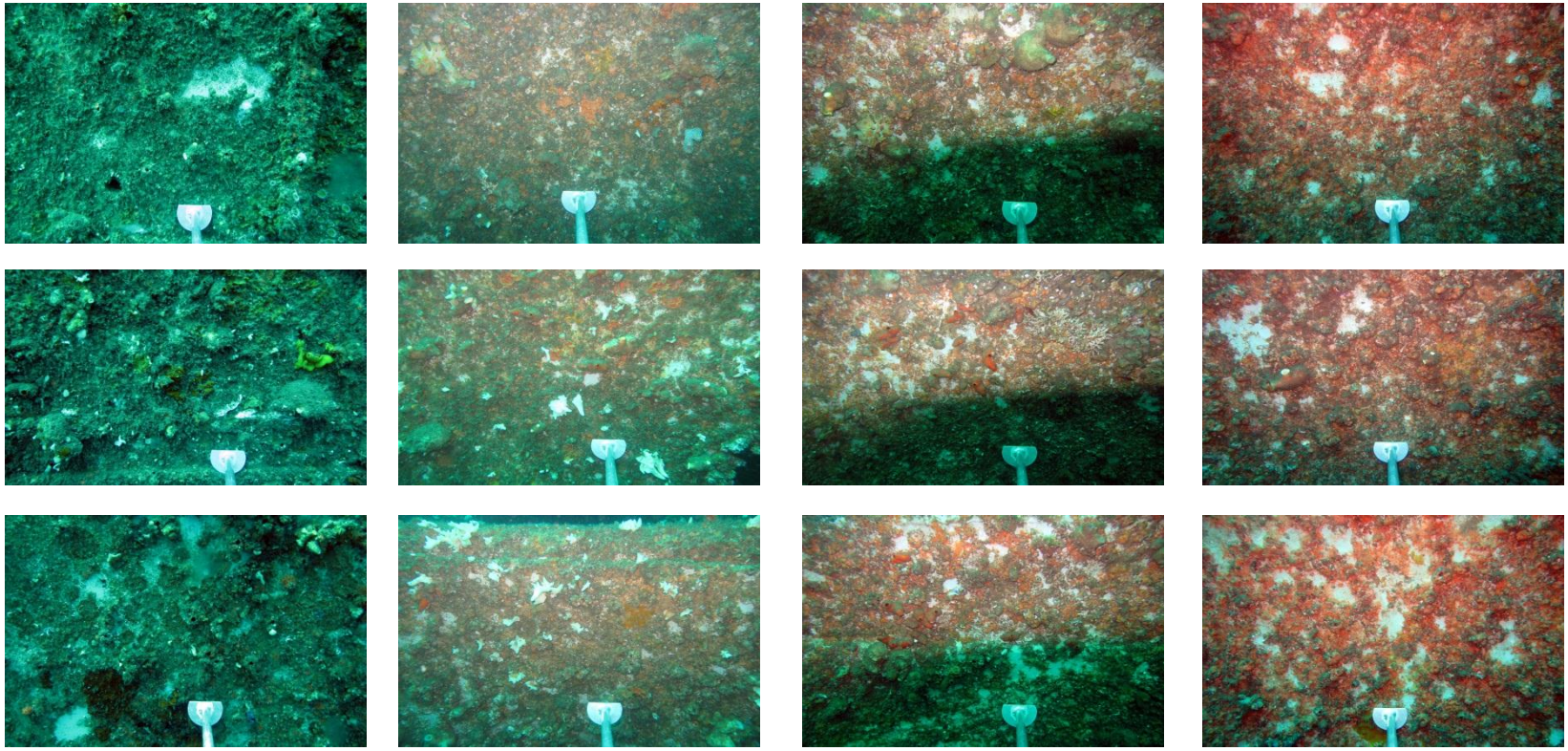


Plate 7: Horizontal Hull Port

Horizontal Hull Starboard

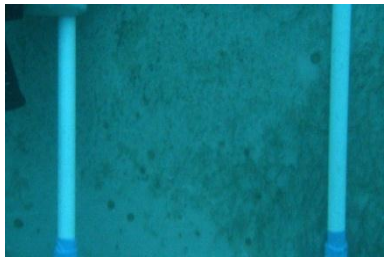
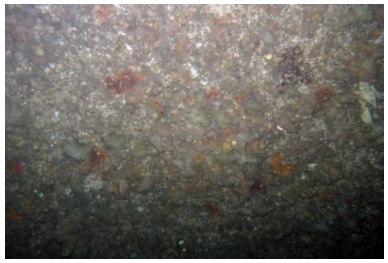
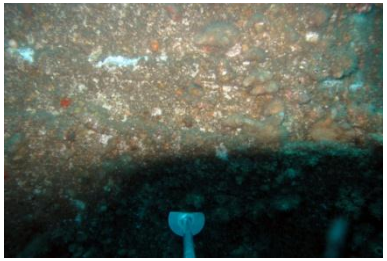
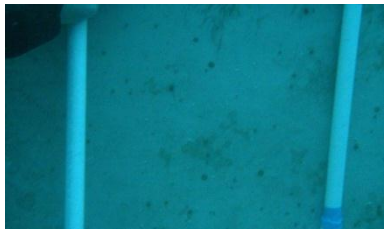
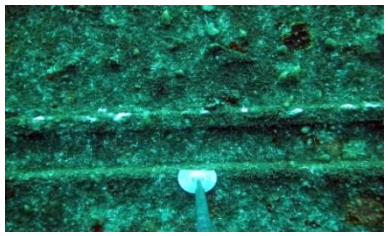
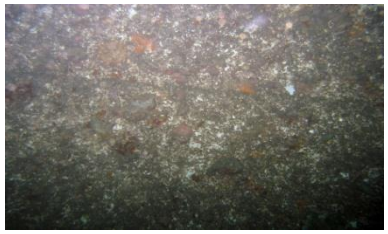
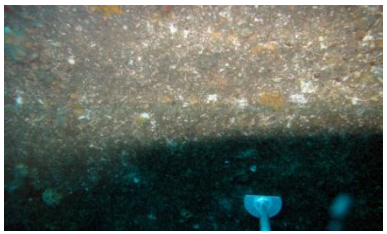
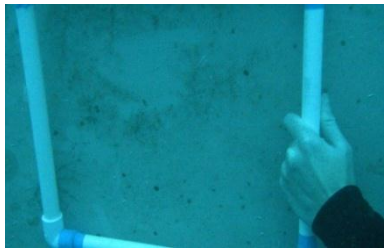
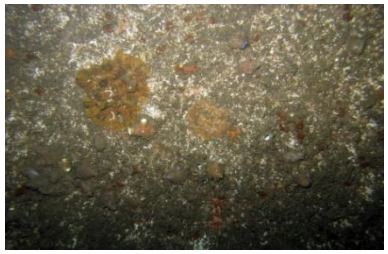
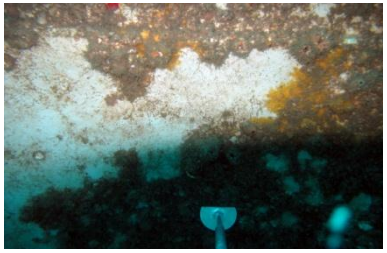
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 8: Horizontal Hull Starboard

Horizontal Hull Starbord

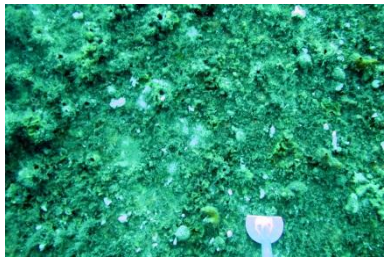
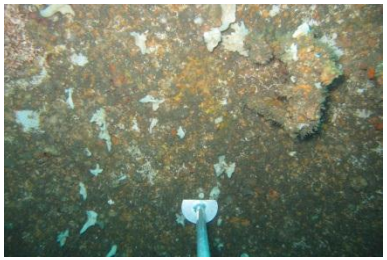
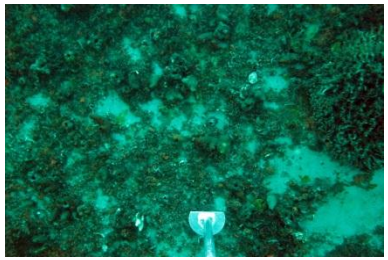
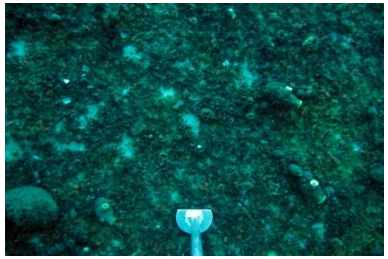
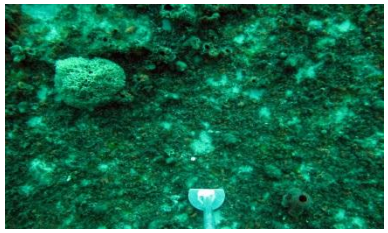
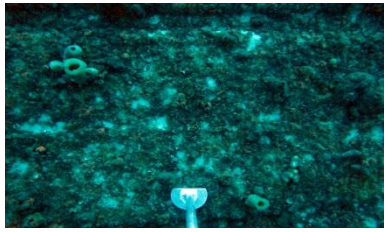
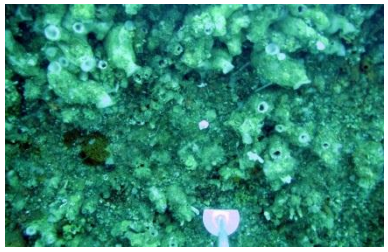
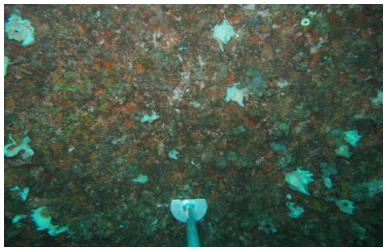
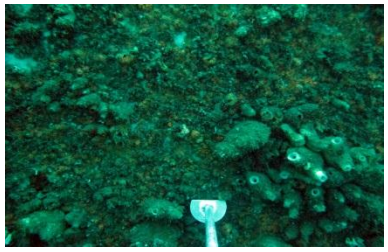
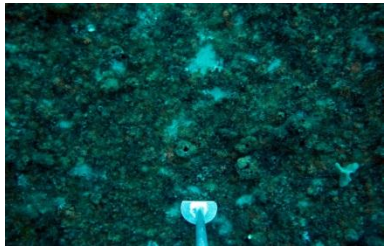
Monitoirng Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)
			
			
			

Plate 8: Horizontal Hull Starbord

Vertical Hull Port Bow

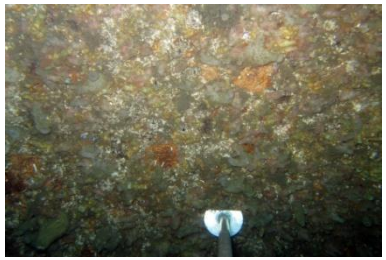
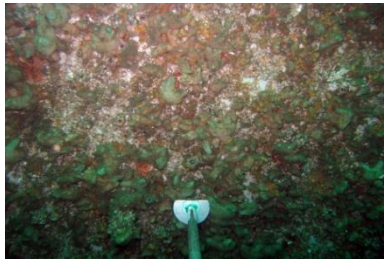
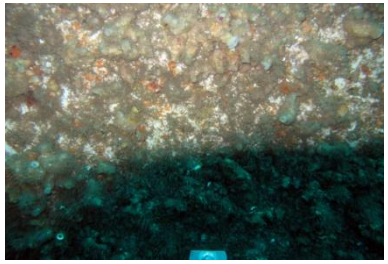
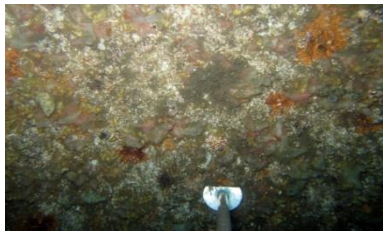
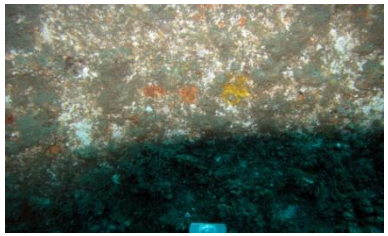
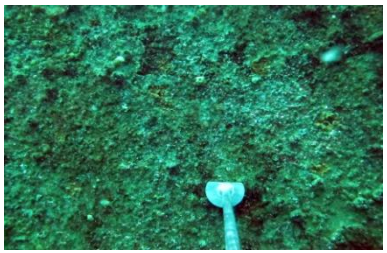
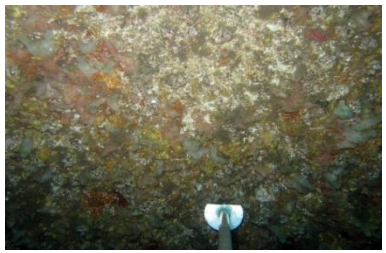
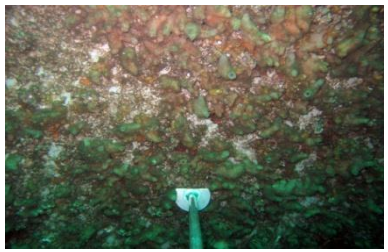
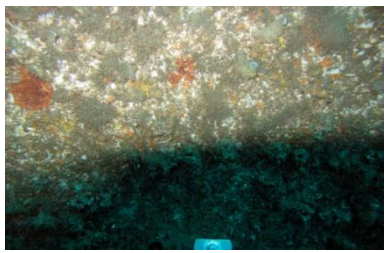
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 9: Vertical Hull Port Bow

Vertical Hull Port Bow

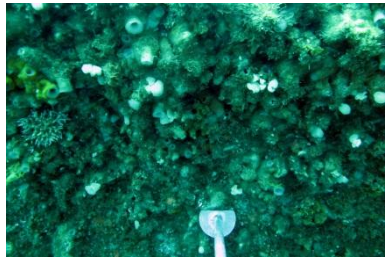
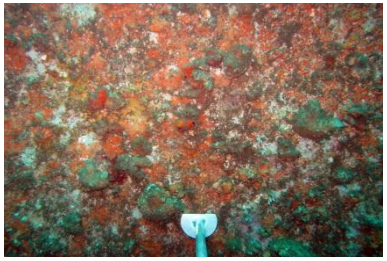
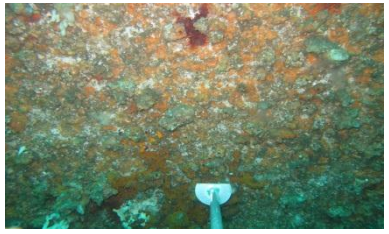
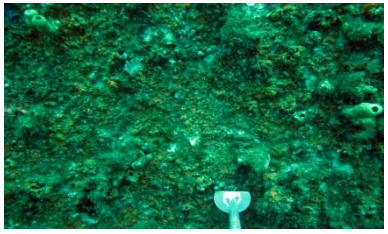
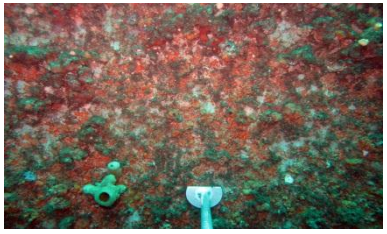
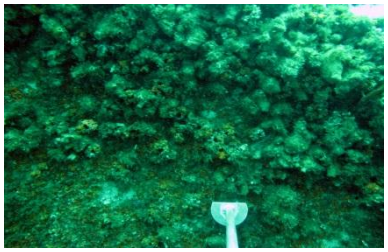
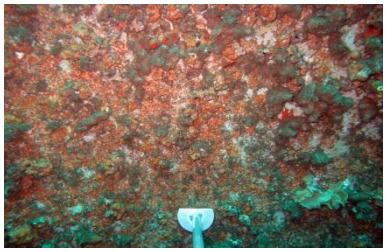
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)
			
			
			

Plate 9: Vertical Hull Port Bow

Vertical Hull Port Stern

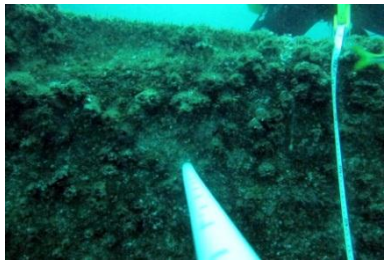
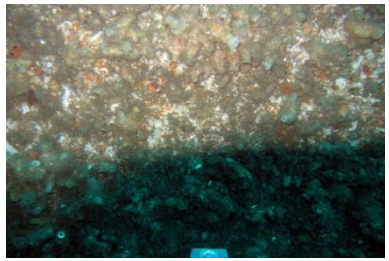
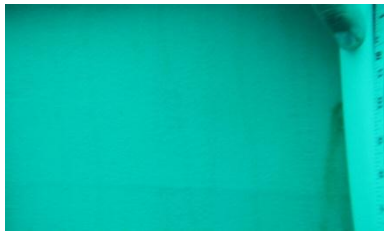
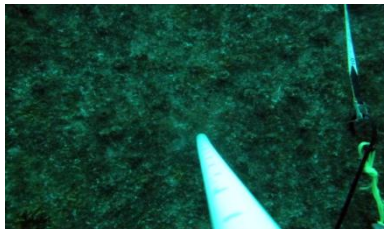
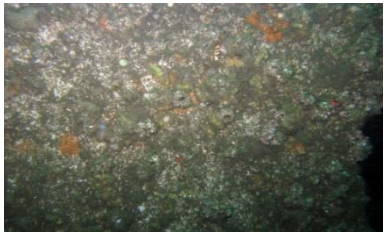
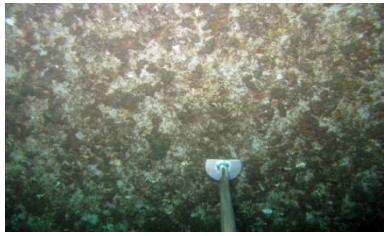
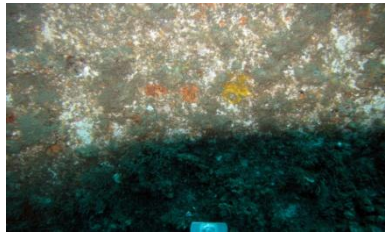
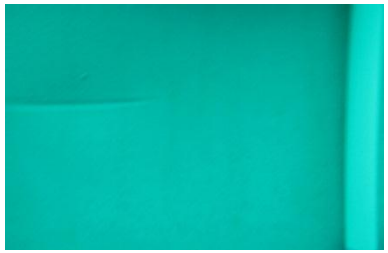
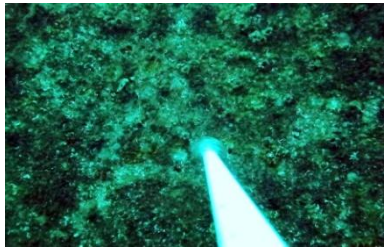
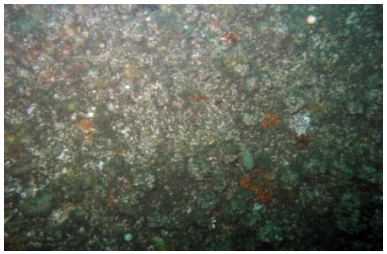
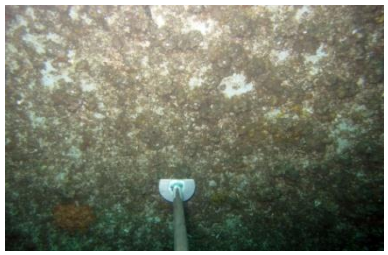
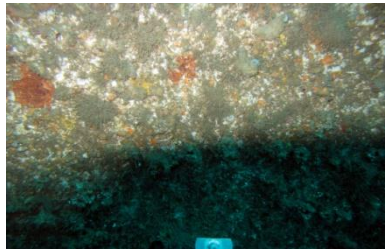
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 10: Vertical Hull Port Stern

Vertical Hull Port Stern

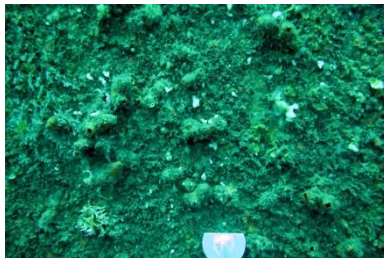
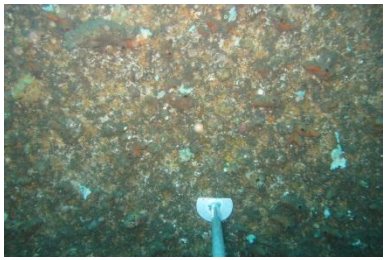
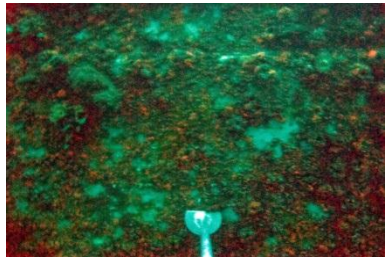
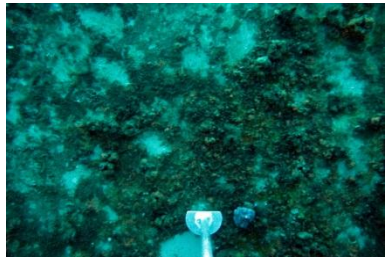
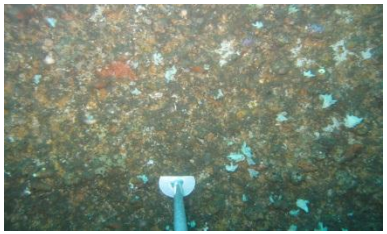
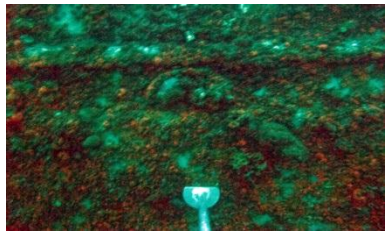
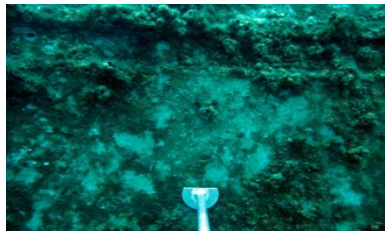
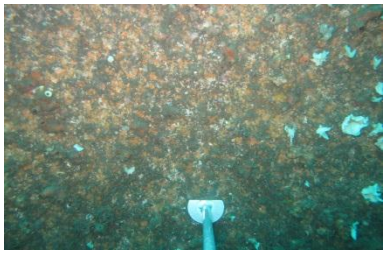
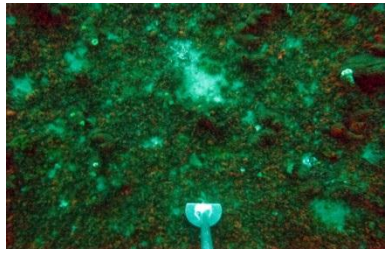
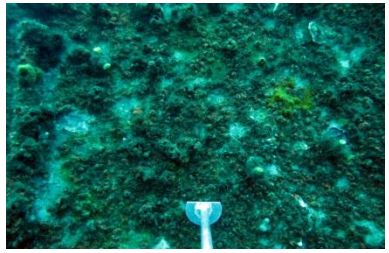
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)
			
			
			

Plate 10: Vertical Hull Port Stern

Vertical Hull Starbord Bow

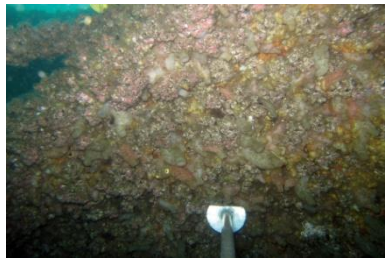
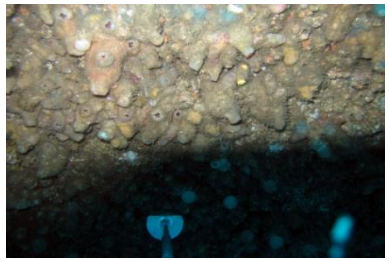
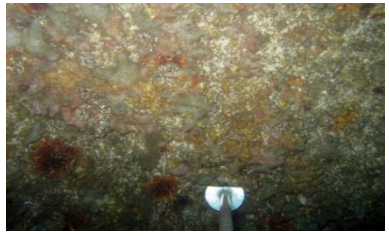
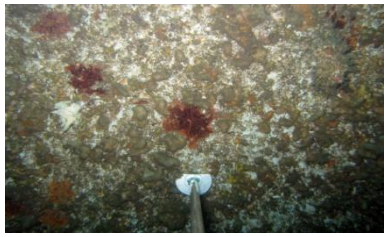
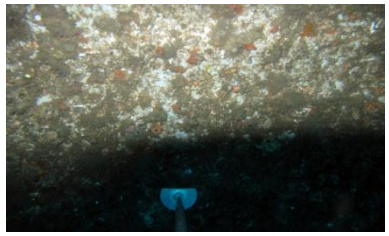
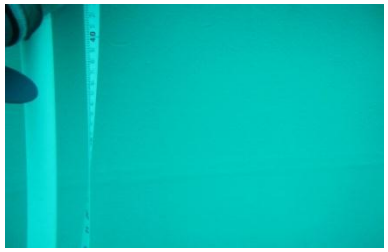
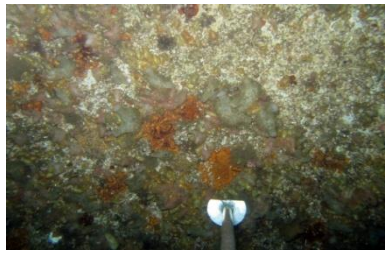
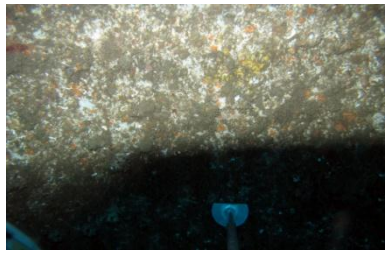
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 11: Vertical Hull Starbord Bow

Vertical Hull Starbord Bow

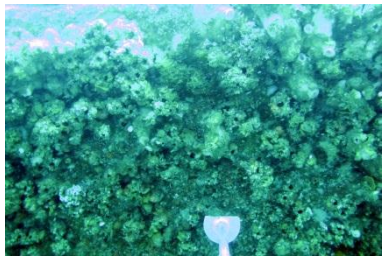
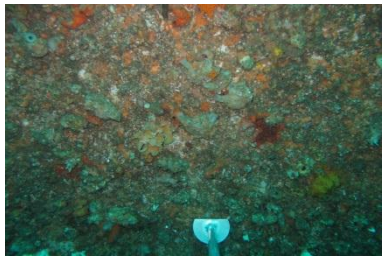
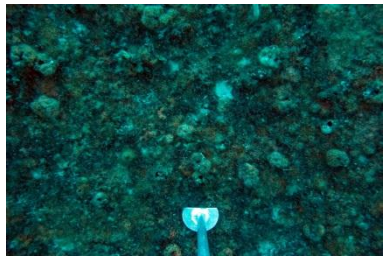
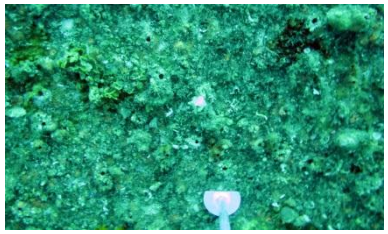
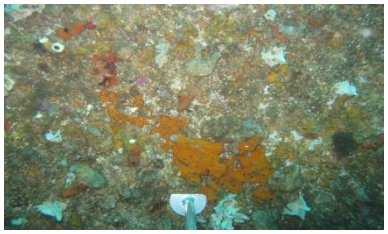
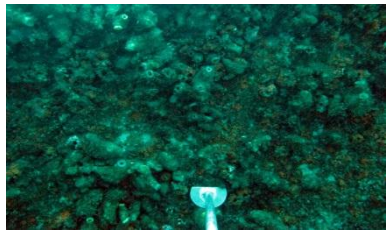
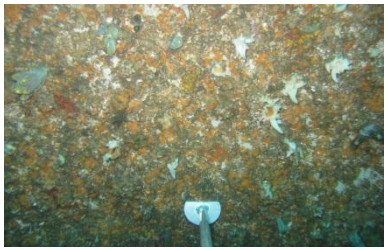
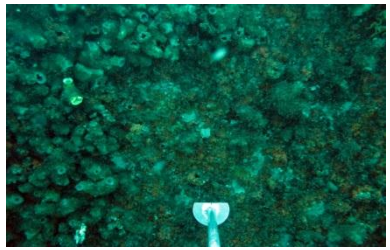
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)
			
			
			

Plate 11: Vertical Hull Starbord Bow

Vertical Hull Starbord Stern

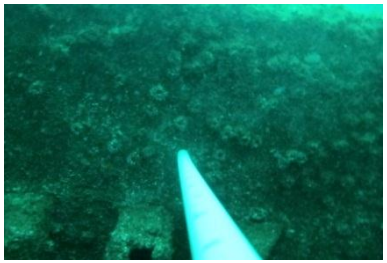
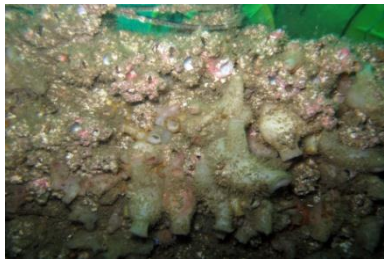
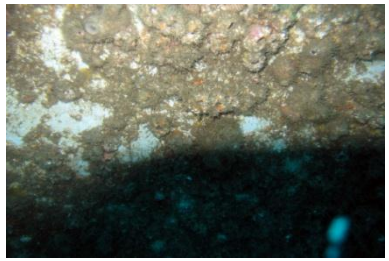
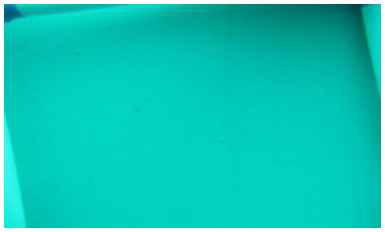
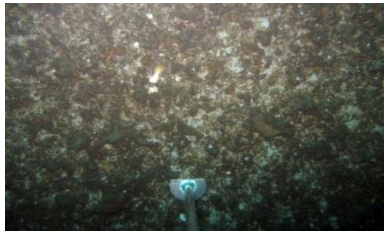
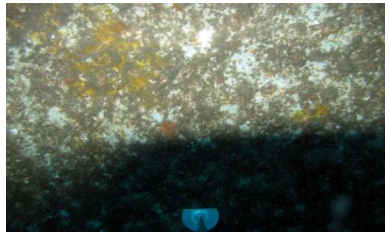
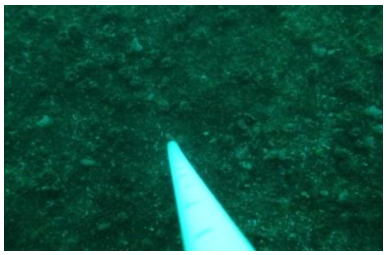
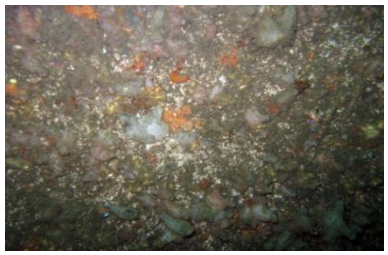
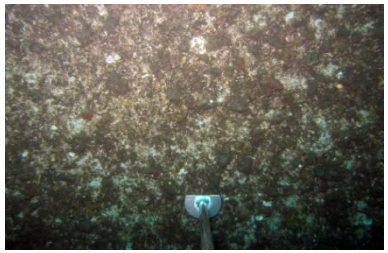
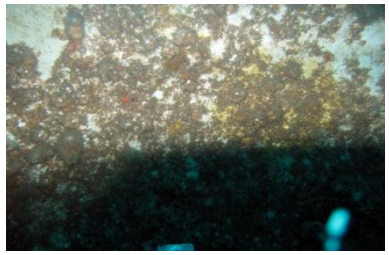
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 12: Vertical Hull Starbord Stern

Vertical Hull Starbord Stern

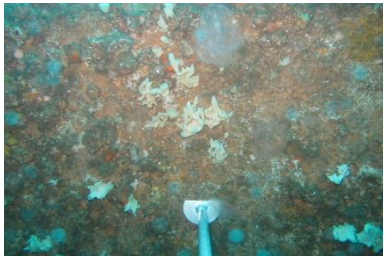
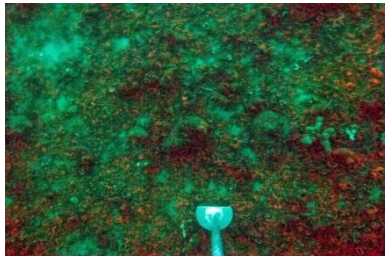
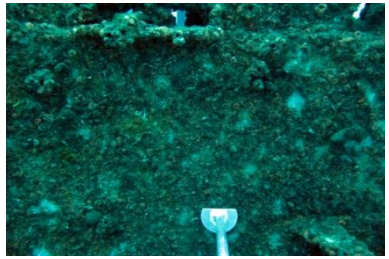
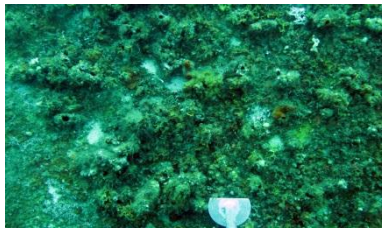
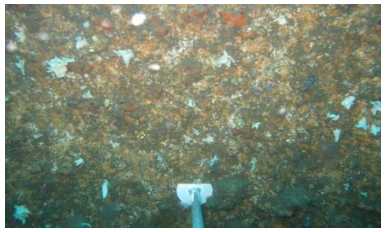
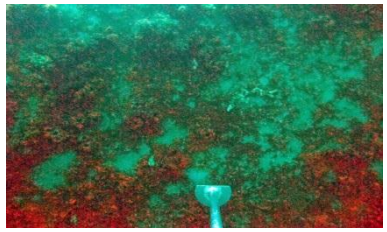
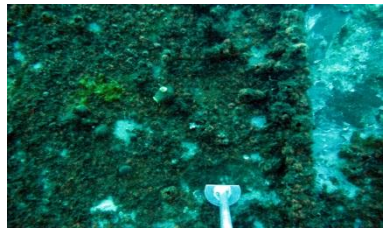
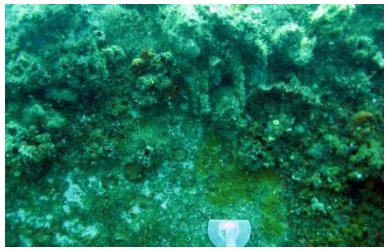
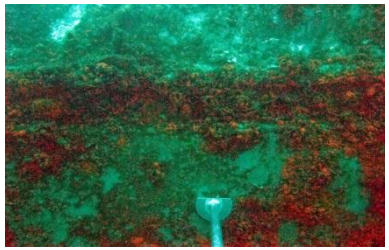
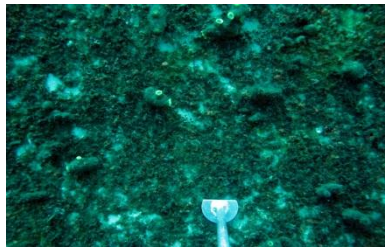
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)
			
			
			

Plate 12: Vertical Hull Starbord Stern

Vertical Superstructure Port Bow

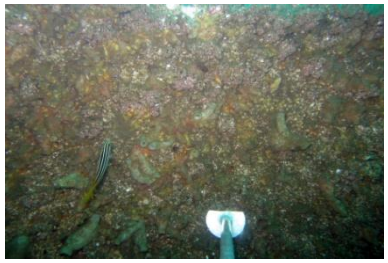
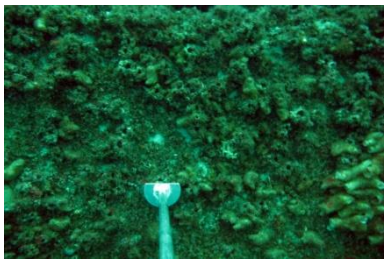
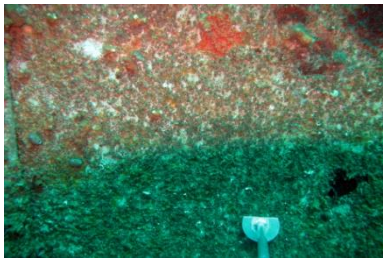
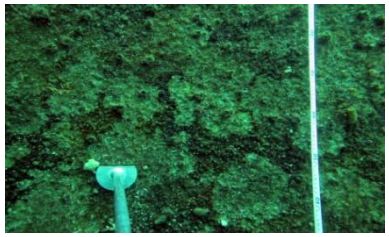
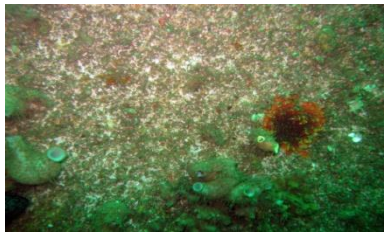
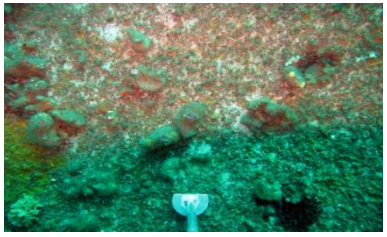
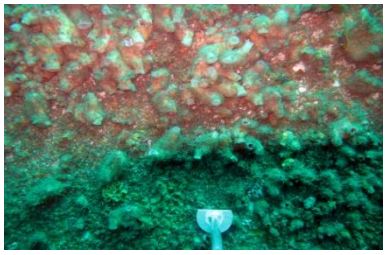
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
Not Sampled				
Not Sampled				
Not Sampled				

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)	Monitoring Survey 8 (July 2013)

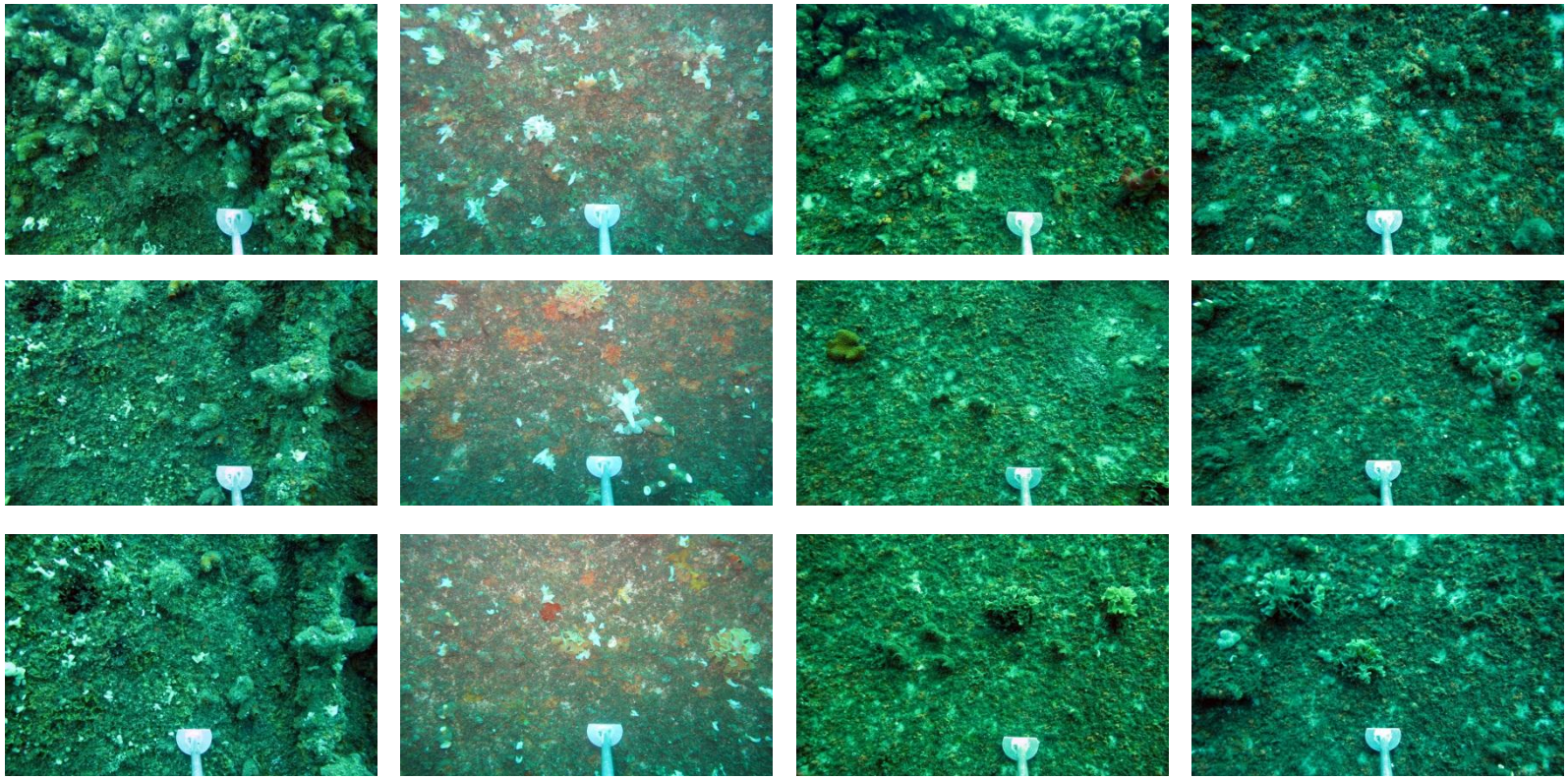


Plate 13: Vertical Superstructure Port Bow

Vertical Superstructure Port Stern

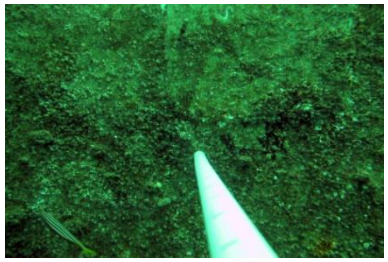
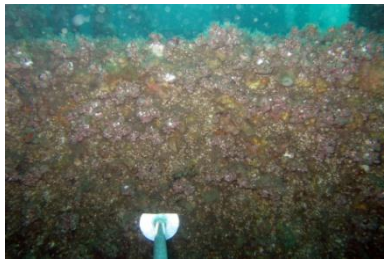
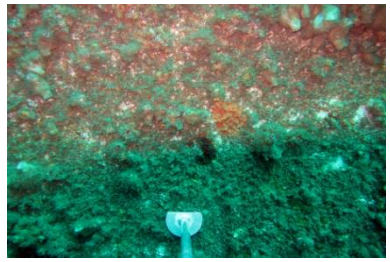
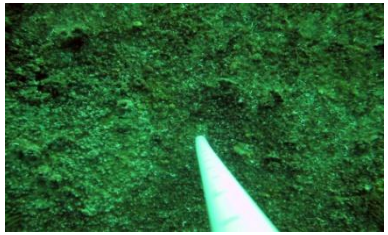
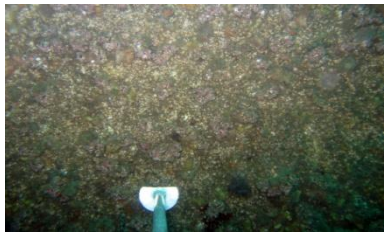
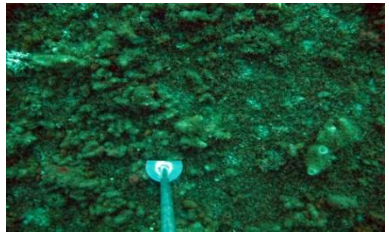
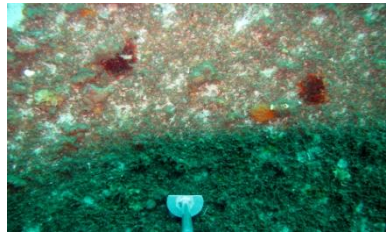
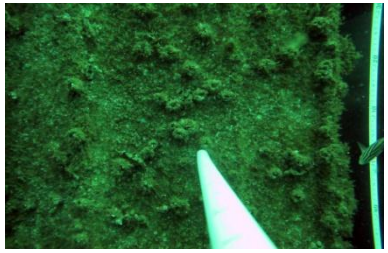
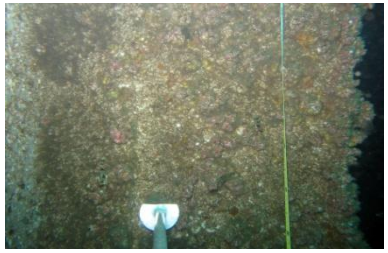
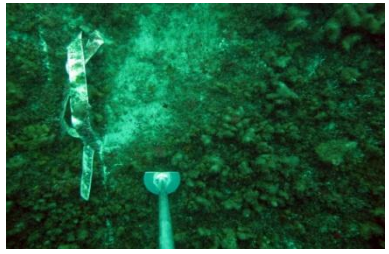
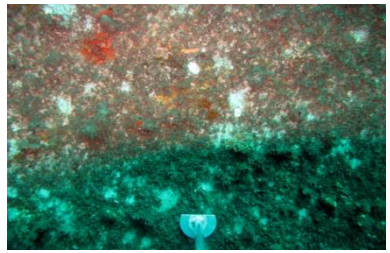
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
Not Sampled				
Not Sampled				
Not Sampled				

Plate 14: Vertical Superstructure Port Stern

Vertical Superstructure Port Stern

Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)

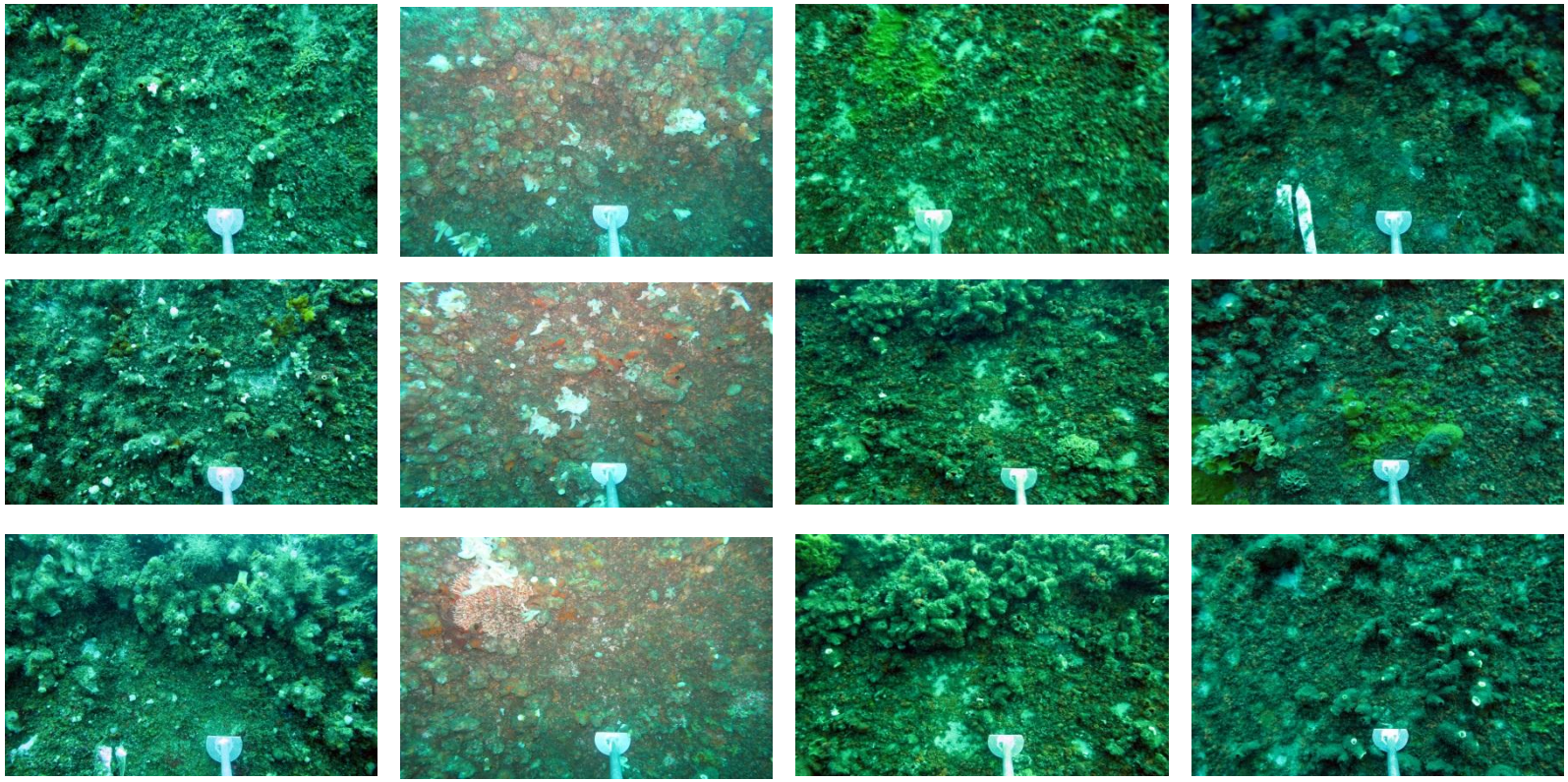


Plate 14: Vertical Superstructure Port Stern

Vertical Superstructure Starboard Bow

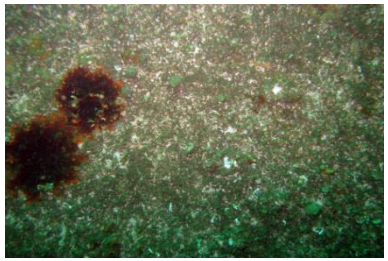
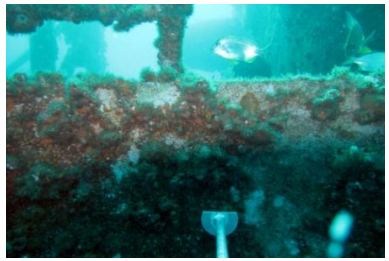
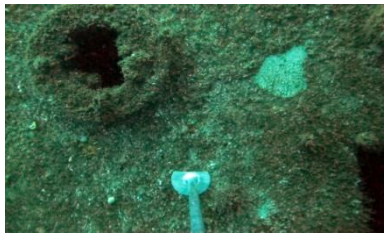
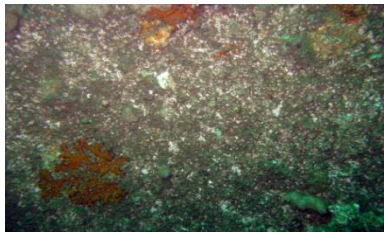
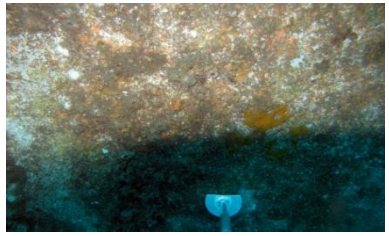
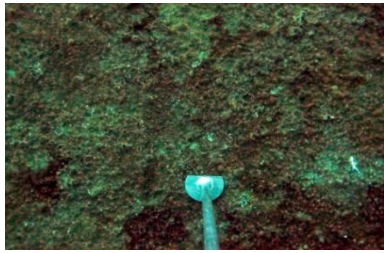
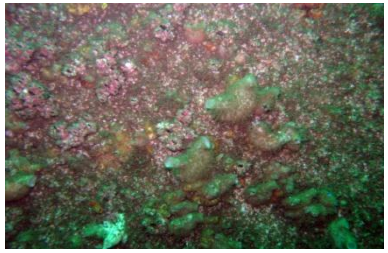
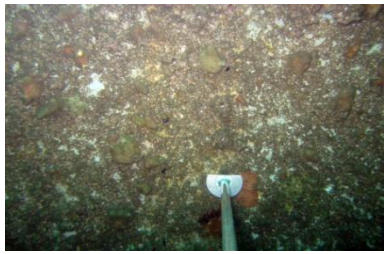
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
Not Sampled				
Not Sampled				
Not Sampled				

Plate 15: Vertical Superstructure Starboard Bow

Vertical Superstructure Starboard Bow

Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)

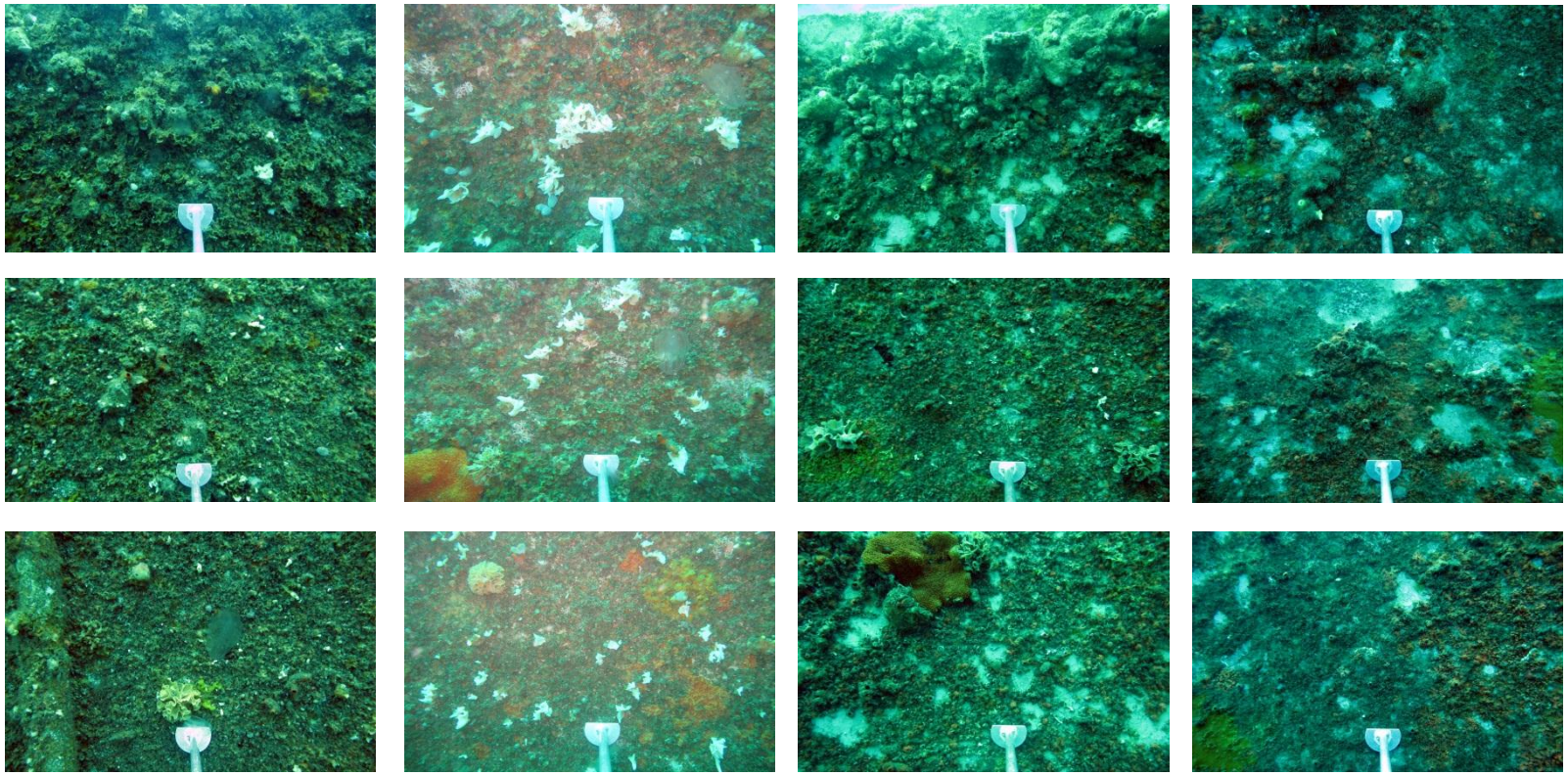


Plate 15: Vertical Superstructure Starbord Bow

Vertical Superstructure Starboard Stern

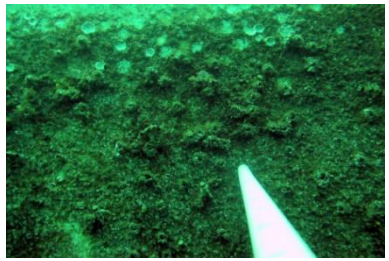
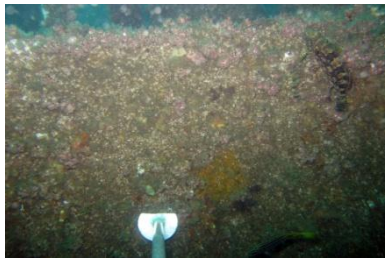
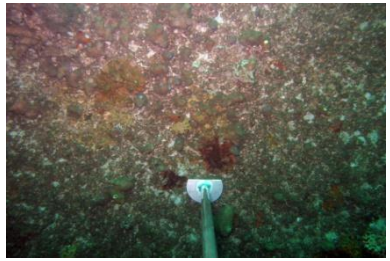
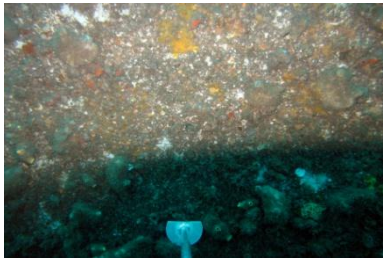
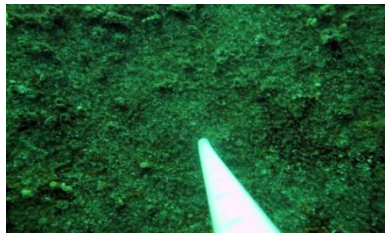
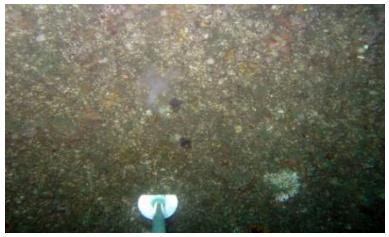
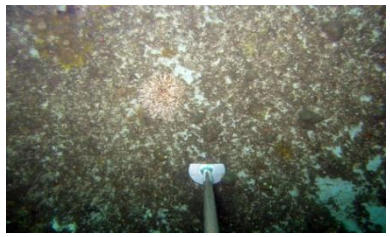
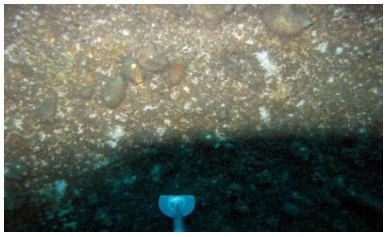
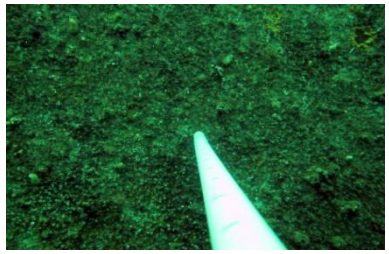
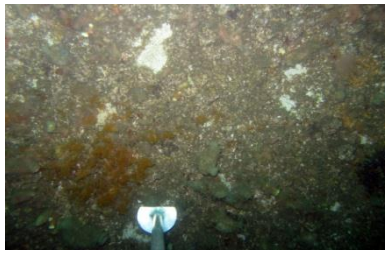
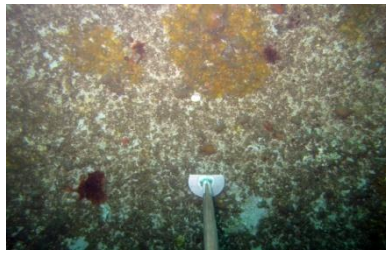
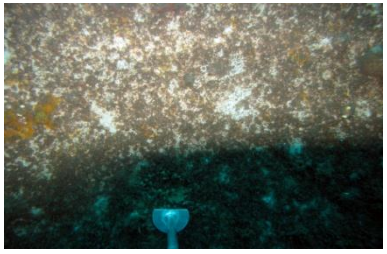
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
Not Sampled				
Not Sampled				
Not Sampled				

Plate 16: Vertical Superstructure Starboard Stern

Vertical Superstructure Starboard Stern

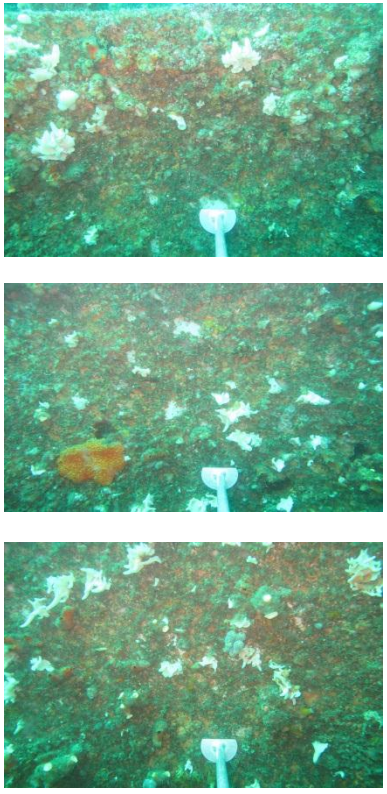
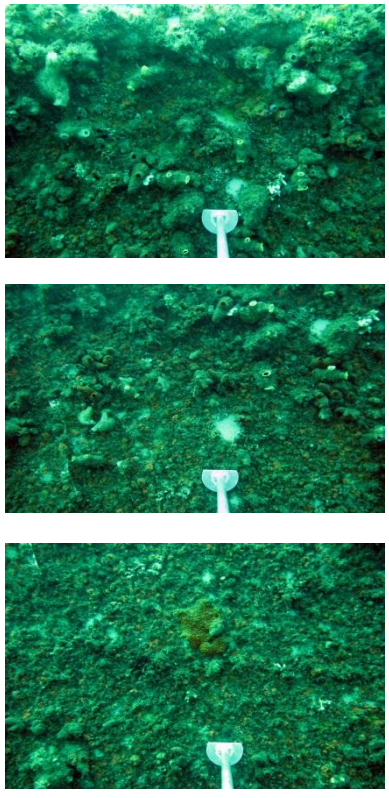
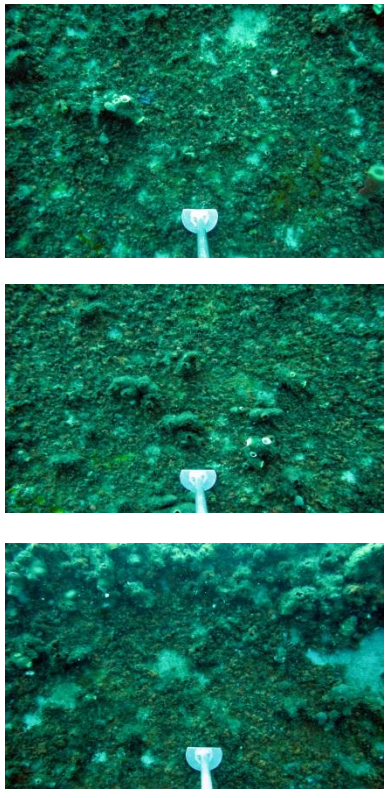
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)
			

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

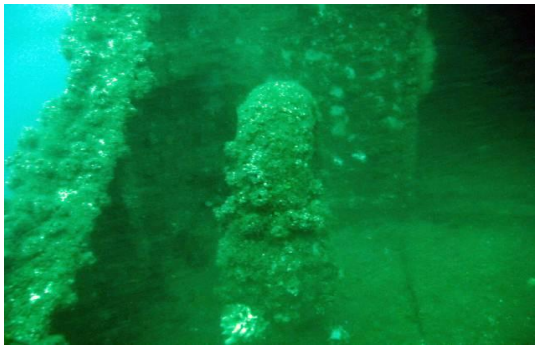
Fixed Photo: 1

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

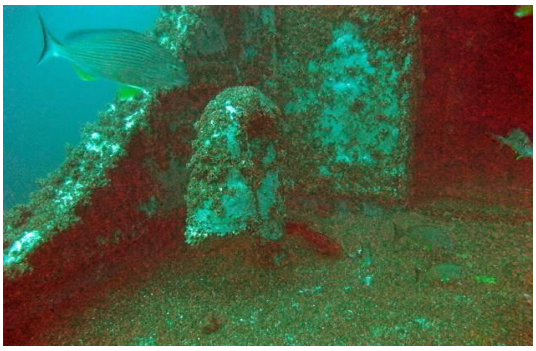
Depth: Approximately 27 m

Survey 1

Survey 2



Survey 3



Survey 4

Survey 5

Survey 6

Survey 7

Survey 8

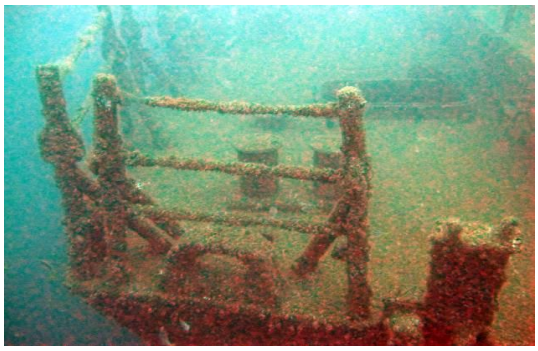
Appendix A: (Continued).

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

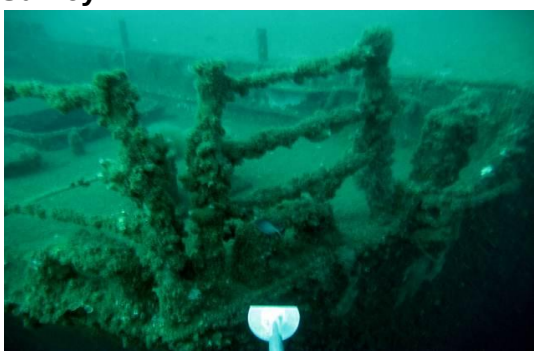


Survey 2

Survey 3

No Data

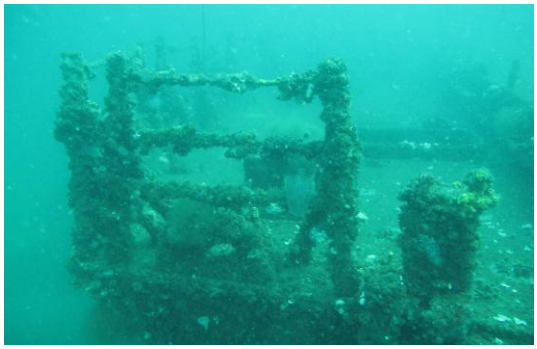
Survey 4



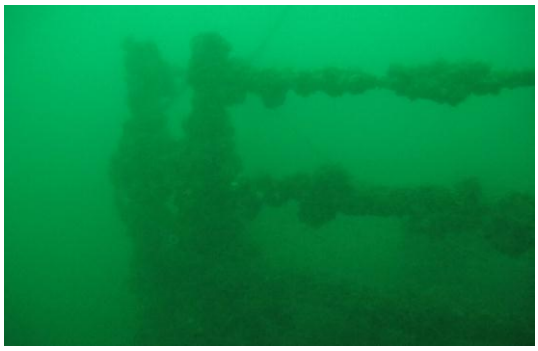
Survey 5

No Data

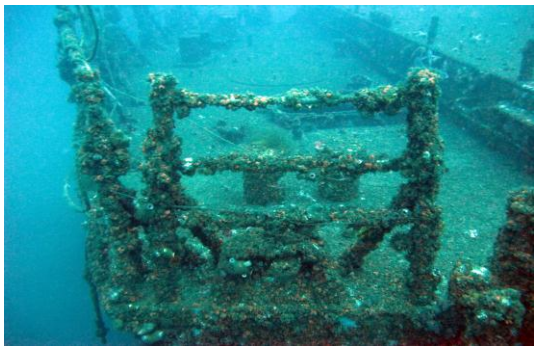
Survey 6



Survey 7



Survey 8



Appendix A: (Continued).

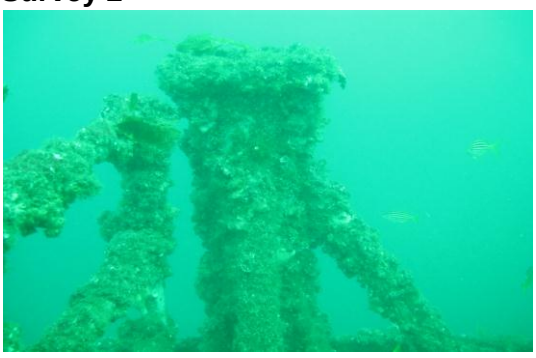
Fixed Photo: 3

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

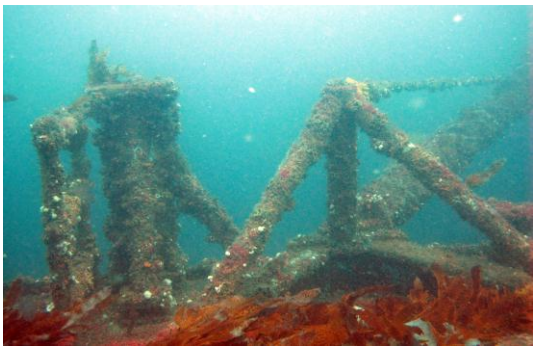
Survey 2



Survey 3

Survey 4

Survey 5



Survey 6

Survey 7

Survey 8

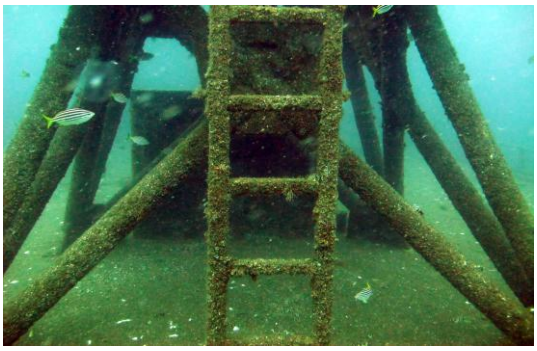
Appendix A: (Continued).

Fixed Photo: 4

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

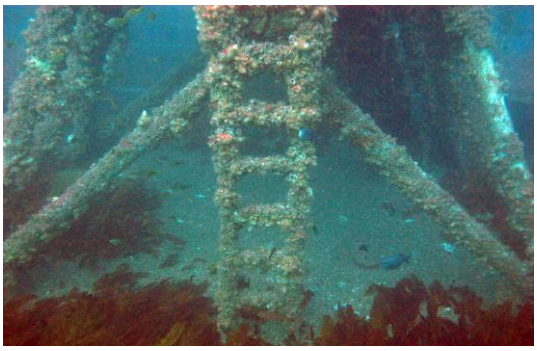
Depth: Approximately 23 m

Survey 1



Survey 2

Survey 3



Survey 4

Survey 5

Survey 6

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

No Data

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

Survey 8

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

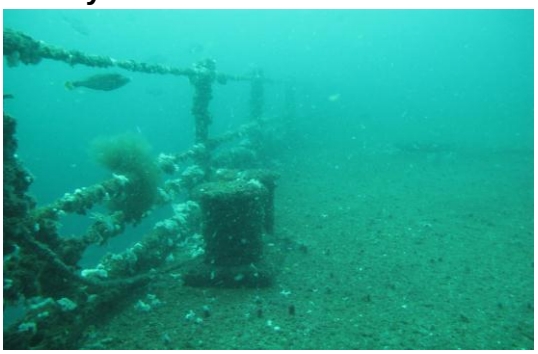
Survey 2

Survey 3

Survey 4

Survey 5

Survey 6



Survey 7

Survey 8

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

Survey 8

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

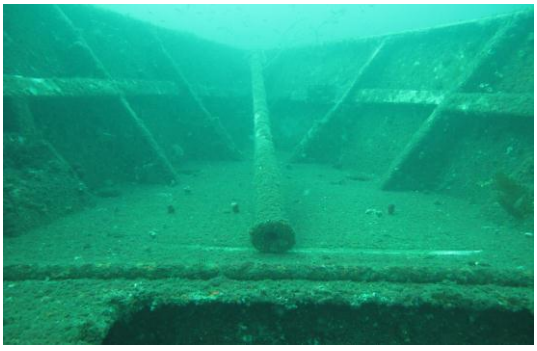
Survey 3

Survey 4

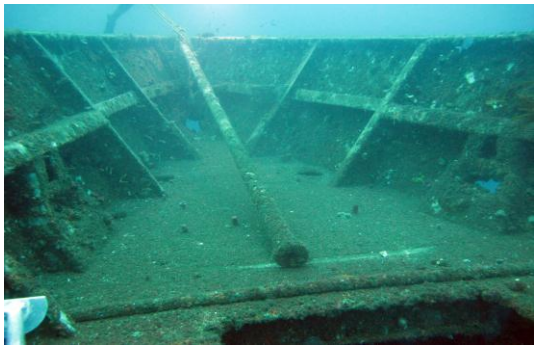
Survey 5

Survey 6

Survey 7



Survey 8

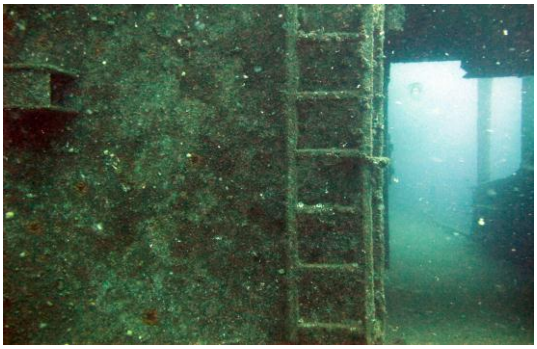


Appendix A: (Continued).
Fixed Photo: 9

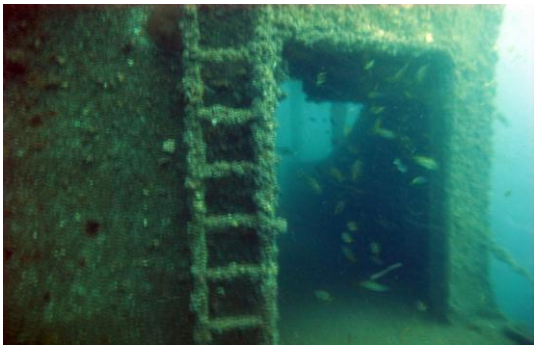
Location: Wall below the bridge on the starboard side. Photo taken standing on front deck 2 m in front of the ladder.

Depth: Approximately 26 m.

Survey 1

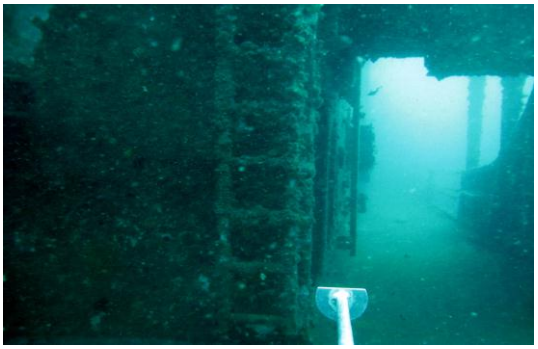


Survey 2



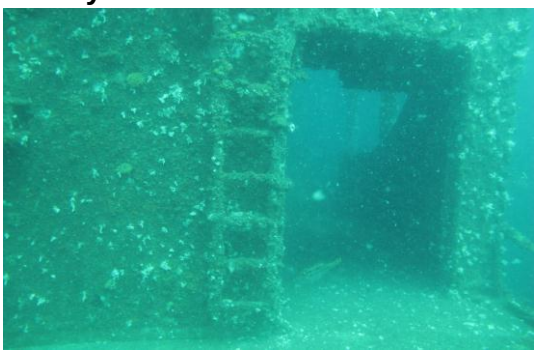
Survey 3

Survey 4



Survey 5

Survey 6



Survey 7

Survey 8

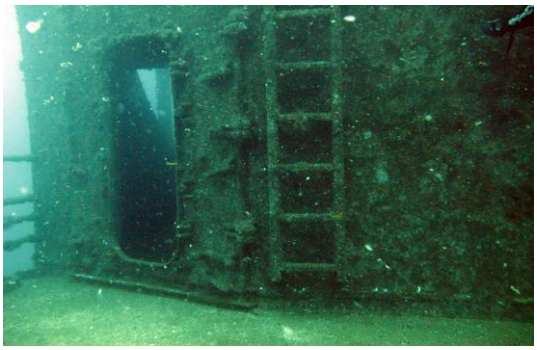
Appendix A: (Continued).

Fixed Photo: 10

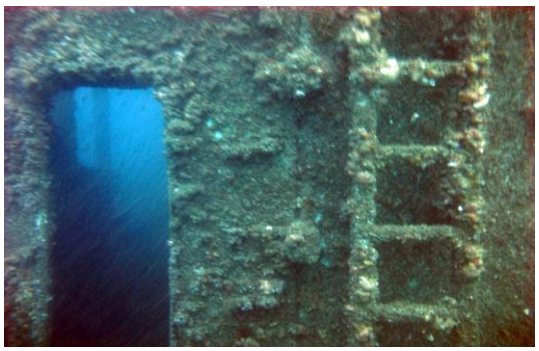
Location: Wall below the bridge on the port side. Photo was taken standing on the front deck 2 m in front of the ladder.

Depth: Approximately 26 m.

Survey 1



Survey 2



Survey 3

Survey 4

Survey 5

Survey 6

Survey 7

Survey 8

Appendix B: Mean percentage cover (± standard error) of reef communities for each transect analysed during Survey 8.

	Deck Port Bow		Deck Port Mid		Deck Port Stern	
Categories	Mean	S.E.	Mean	S.E.	Mean	S.E.
PHAEOPHYTA						
Brown Filamentous	0.00	0.00	0.00	0.00	0.00	0.00
Ecklonia radiata	0.00	0.00	25.51	10.43	0.00	0.00
Lobed Brown Algae	0.00	0.00	0.41	0.25	0.00	0.00
Orange Filamentous	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	0.20	0.20	0.00	0.00
Encrusting Red Algae	0.00	0.00	7.55	3.83	0.00	0.00
BRYOZOA						
Encrusting Orange Bryozoan	0.00	0.00	0.20	0.20	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	0.41	0.41	0.41	0.41
Purple Sponge	0.00	0.00	0.00	0.00	0.41	0.25
White Encrusting Sponge	0.60	0.40	0.41	0.25	0.00	0.00
White Papillate Sponge	0.00	0.00	0.00	0.00	0.00	0.00
White Tubular Sponge	0.00	0.00	0.00	0.00	0.00	0.00
Yellow Encrusting Sponge	0.00	0.00	2.65	1.43	0.20	0.20
Red Tubular Sponge	0.00	0.00	0.41	0.25	0.61	0.25
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
Orange Colonial Ascidian 2 (bubbly)	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
White Globular Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
ABIOTIC						
Bare Ships Surface	0.20	0.20	5.51	1.93	2.43	0.69
Serpulid Tubes	0.00	0.00	0.00	0.00	0.00	0.00
Shell Grit	0.20	0.20	0.41	0.41	0.00	0.00
Red Solitary Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
MATRIX						
Barnacle,Sediment,Brown Fil	0.00	0.00	0.61	0.61	0.00	0.00
Brown Flocullant	0.00	0.00	2.04	2.04	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	98.60	0.51	50.61	14.60	95.95	1.16
Serpulid Matrix	0.40	0.24	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	3.06	1.58	0.00	0.00
TAPE, WAND, SHADOW						
Shadow	0.00	0.00	0.00	0.00	0.00	0.00
Wand	0.40	0.24	2.00	0.00	1.20	0.20

Appendix B: (Continued).

	Deck Starbord Bow		Deck Starbord Mid		Deck Starbord Stern	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
PHAEOPHYTA						
Brown Filamentous	0.00	0.00	0.00	0.00	0.00	0.00
Ecklonia radiata	0.00	0.00	25.72	11.10	0.00	0.00
Lobed Brown Algae	0.00	0.00	0.00	0.00	0.00	0.00
Orange Filamentous	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	0.61	0.41	7.13	2.57	0.00	0.00
BRYOZOA						
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	0.40	0.40	0.00	0.00
Purple Sponge	0.00	0.00	0.00	0.00	0.20	0.20
White Encrusting Sponge	0.41	0.41	0.00	0.00	0.00	0.00
White Papillate Sponge	0.20	0.20	0.41	0.41	1.01	0.45
White Tubular Sponge	0.00	0.00	0.00	0.00	0.00	0.00
Yellow Encrusting Sponge	0.20	0.20	2.22	2.22	0.00	0.00
Red Tubular Sponge	0.20	0.20	0.00	0.00	0.20	0.20
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
Orange Colonial Ascidian 2 (bubbly)	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
White Globular Ascidian	0.41	0.41	0.00	0.00	0.00	0.00
ABIOTIC						
Bare Ships Surface	0.20	0.20	0.81	0.20	0.20	0.20
Serpulid Tubes	0.00	0.00	0.00	0.00	0.00	0.00
Shell Grit	0.20	0.20	0.41	0.25	0.00	0.00
Red Solitary Ascidian	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 Flocullant	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	96.14	1.41	61.68	10.85	98.38	0.52
Serpulid Matrix	0.00	0.00	0.00	0.00	0.00	0.00
FISH MOBILE						
Fish Mobile	1.21	1.21	0.00	0.00	0.00	0.00
INDETERMINATE						
Unknown White Crust	0.00	0.00	1.22	0.99	0.00	0.00
TAPE, WAND, SHADOW						
Shadow	0.00	0.00	0.00	0.00	0.00	0.00
Wand	1.80	0.20	1.60	0.24	1.00	0.00

Appendix B: (Continued).

	Horizontal Hull Port		Horizontal Hull Starbord		Vertical Hull Port Bow	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
PHAEOPHYTA						
Brown Filamentous	0.00	0.00	0.00	0.00	0.00	0.00
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
Orange Filamentous	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	4.79	1.08	0.00	0.00	0.61	0.40
BRYOZOA						
Encrusting Orange Bryozoan	0.00	0.00	0.00	0.00	0.00	0.00
Triphyllozoan sp	0.17	0.17	0.17	0.17	0.40	0.40
SPONGE						
Orange Encrusting Sponge	6.31	1.73	0.34	0.21	5.26	2.64
Purple Sponge	0.00	0.00	0.00	0.00	0.00	0.00
White Encrusting Sponge	0.00	0.00	0.00	0.00	0.00	0.00
White Papillate Sponge	0.00	0.00	0.17	0.17	0.41	0.25
White Tubular Sponge	0.00	0.00	0.00	0.00	0.20	0.20
Yellow Encrusting Sponge	0.00	0.00	2.03	0.94	0.00	0.00
Red Tubular Sponge	0.00	0.00	0.00	0.00	0.00	0.00
ASCIDIAN						
Botryloides magnicoecum	0.00	0.00	0.33	0.21	0.00	0.00
Herdmania momus	4.39	2.30	2.51	1.02	11.40	8.02
Orange Colonial Ascidian	0.00	0.00	4.25	1.58	0.61	0.41
Orange Colonial Ascidian 2 (bubbly)	0.00	0.00	0.00	0.00	0.00	0.00
White Tubular Solitary Ascidian	0.00	0.00	0.18	0.18	0.00	0.00
White Globular Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
ABIOTIC						
Bare Ships Surface	7.03	1.10	4.42	1.43	4.87	1.30
Serpulid Tubes	0.00	0.00	0.00	0.00	0.00	0.00
Shell Grit	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
MATRIX						
Barnacle,Sediment,Brown Fil	0.00	0.00	0.17	0.17	0.20	0.20
Brown Flocullant	1.35	0.72	0.00	0.00	0.00	0.00
Large Barnacle,Sediment,Brown Fil	2.55	1.48	9.49	2.77	13.80	2.49
Serpulid Barnacle and Encrusting Algae Matrix	73.40	2.64	75.94	2.75	61.63	9.49
Serpulid Matrix	0.00	0.00	0.00	0.00	0.00	0.00
FISH MOBILE						
Fish Mobile	0.00	0.00	0.00	0.00	0.61	0.61
INDETERMINATE						
Unknown White Crust	0.00	0.00	0.00	0.00	0.00	0.00
TAPE, WAND, SHADOW						
Shadow	0.83	0.83	1.17	0.79	0.00	0.00
Wand	1.50	0.34	0.33	0.21	1.40	0.24

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						
Brown Filamentous	0.00	0.00	0.20	0.20	0.40	0.40
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
Orange Filamentous	0.00	0.00	0.00	0.00	0.00	0.00
Turfing Brown Algae	0.00	0.00	0.65	0.44	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
BRYOZOA						
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	0.21	0.21	0.00	0.00	0.00	0.00
Purple Sponge	0.21	0.21	0.00	0.00	0.00	0.00
White Encrusting Sponge	0.00	0.00	0.00	0.00	0.00	0.00
White Papillate Sponge	0.00	0.00	0.20	0.20	0.00	0.00
White Tubular Sponge	0.00	0.00	0.00	0.00	0.00	0.00
Yellow Encrusting Sponge	0.00	0.00	0.00	0.00	2.23	0.87
Red Tubular Sponge	0.00	0.00	0.00	0.00	0.00	0.00
ASCIDIAN						
Botryloides magnicoecum	0.00	0.00	0.00	0.00	0.00	0.00
Herdmania momus	1.05	0.58	4.13	2.41	2.43	1.13
Orange Colonial Ascidian	2.70	2.23	6.21	1.51	1.42	0.51
Orange Colonial Ascidian 2 (bubbly)	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
White Globular Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
ABIOTIC						
Bare Ships Surface	6.42	0.53	0.20	0.20	5.48	2.07
Serpulid Tubes	0.00	0.00	0.00	0.00	0.00	0.00
Shell Grit	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
MATRIX						
Barnacle,Sediment,Brown Fil	0.00	0.00	0.00	0.00	0.00	0.00
Brown Flocullant	19.92	6.99	1.22	0.59	3.26	1.04
Large Barnacle,Sediment,Brown Fil	9.04	4.29	25.43	10.43	3.48	1.44
Serpulid Barnacle and Encrusting Algae Matrix	60.46	9.75	61.75	10.03	81.29	3.07
Serpulid Matrix	0.00	0.00	0.00	0.00	0.00	0.00
FISH MOBILE						
Fish Mobile	0.00	0.00	0.00	0.00	0.00	0.00
INDETERMINATE						
Unknown White Crust	0.00	0.00	0.00	0.00	0.00	0.00
TAPE, WAND, SHADOW						
Shadow	1.80	0.58	2.40	1.69	1.20	0.49
Wand	1.60	0.24	1.00	0.32	0.60	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						
Brown Filamentous	0.00	0.00	0.00	0.00	0.60	0.40
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
Orange Filamentous	0.00	0.00	0.00	0.00	0.00	0.00
Turfing Brown Algae	0.00	0.00	0.00	0.00	0.21	0.21
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
BRYOZOA						
Encrusting Orange Bryozoan	0.00	0.00	0.00	0.00	0.00	0.00
Triphyllozoan sp	1.20	1.20	0.85	0.85	0.00	0.00
SPONGE						
Orange Encrusting Sponge	0.00	0.00	0.00	0.00	0.00	0.00
Purple Sponge	0.00	0.00	0.00	0.00	0.00	0.00
White Encrusting Sponge	0.00	0.00	0.00	0.00	0.00	0.00
White Papillate Sponge	0.00	0.00	0.00	0.00	0.00	0.00
White Tubular Sponge	0.00	0.00	0.00	0.00	0.00	0.00
Yellow Encrusting Sponge	0.61	0.40	2.31	1.40	3.22	1.98
Red Tubular Sponge	0.20	0.20	0.00	0.00	0.00	0.00
ASCIDIAN						
Botryloides magnicoecum	0.40	0.25	0.00	0.00	0.00	0.00
Herdmania momus	3.06	0.73	12.22	2.86	1.25	1.25
Orange Colonial Ascidian	2.27	1.12	1.86	1.15	10.73	3.76
Orange Colonial Ascidian 2 (bubbly)	0.00	0.00	0.00	0.00	0.00	0.00
White Tubular Solitary Ascidian	0.20	0.20	0.00	0.00	0.00	0.00
White Globular Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
ABIOTIC						
Bare Ships Surface	2.25	0.75	2.26	1.09	6.50	1.43
Serpulid Tubes	0.00	0.00	0.00	0.00	0.21	0.21
Shell Grit	0.00	0.00	0.00	0.00	0.00	0.00
Red Solitary Ascidian	0.00	0.00	2.48	1.32	0.00	0.00
MATRIX						
Barnacle,Sediment,Brown Fil	0.00	0.00	0.00	0.00	0.00	0.00
Brown Flocullant	1.04	0.66	1.23	0.75	3.48	1.35
Large Barnacle,Sediment,Brown Fil	1.66	1.08	5.02	3.08	2.85	1.35
Serpulid Barnacle and Encrusting Algae Matrix	87.11	2.59	71.78	3.29	70.94	1.83
Serpulid Matrix	0.00	0.00	0.00	0.00	0.00	0.00
FISH MOBILE						
Fish Mobile	0.00	0.00	0.00	0.00	0.00	0.00
INDETERMINATE						
Unknown White Crust	0.00	0.00	0.00	0.00	0.00	0.00
TAPE, WAND, SHADOW						
Shadow	0.80	0.58	1.40	0.75	0.40	0.40
Wand	0.80	0.37	2.00	0.00	1.20	0.37

Appendix B: (Continued).

	Vertical Super Starbord Stern	
	Mean	S.E.
PHAEOPHYTA		
Brown Filamentous	0.00	0.00
Ecklonia radiata	0.00	0.00
Lobed Brown Algae	0.00	0.00
Orange Filamentous	0.20	0.20
Turfing Brown Algae	0.00	0.00
RHODOPHYTA		
Encrusting Coralline	0.00	0.00
Encrusting Red Algae	0.00	0.00
BRYOZOA		
Encrusting Orange Bryozoan	0.00	0.00
Triphyllozoan sp	0.00	0.00
SPONGE		
Orange Encrusting Sponge	0.00	0.00
Purple Sponge	0.20	0.20
White Encrusting Sponge	0.00	0.00
White Papillate Sponge	0.00	0.00
White Tubular Sponge	0.00	0.00
Yellow Encrusting Sponge	0.61	0.25
Red Tubular Sponge	0.00	0.00
ASCIDIAN		
Botryloides magnicoecum	0.21	0.21
Herdmania momus	10.61	4.18
Orange Colonial Ascidian	2.24	0.87
Orange Colonial Ascidian 2 (bubbly)	0.00	0.00
White Tubular Solitary Ascidian	0.00	0.00
White Globular Ascidian	0.00	0.00
ABIOTIC		
Bare Ships Surface	2.64	1.22
Serpulid Tubes	0.00	0.00
Shell Grit	0.00	0.00
Red Solitary Ascidian	0.00	0.00
MATRIX		
Barnacle,Sediment,Brown Fil	0.00	0.00
Brown Flocullant	3.07	0.97
Large Barnacle,Sediment,Brown Fil	1.64	0.95
Serpulid Barnacle and Encrusting Algae Matrix	78.60	5.17
Serpulid Matrix	0.00	0.00
FISH MOBILE		
Fish Mobile	0.00	0.00
INDETERMINATE		
Unknown White Crust	0.00	0.00
TAPE, WAND, SHADOW		
Shadow	0.40	0.24
Wand	1.40	0.24

Appendix C: Permutational Analysis of Variance of Percent Cover of Reef Assemblages Sampled in Reef Monitoring Surveys 7 and 8. *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	7	72650	10379	9.099	**0.0001**	9905
Residual	120	1.3687E5	1140.6			
Total	127	2.0952E5				

2. Time, Orientation and Aspect

Source	DF	SS	MS	F	P	Unique perms
Time	1	612.15	612.15	1.3593	0.2414	9944
Orientation	1	7023.7	7023.7	15.597	**0.0001**	9941
Aspect	1	772.11	772.11	1.7146	0.1585	9945
Time x Orientation	1	431.89	431.89	0.95906	0.3473	9951
Time x Aspect	1	233.77	233.77	0.51912	0.583	9933
Orientation x Aspect	1	589.08	589.08	1.3081	0.2442	9936
Time x Orientation x Aspect	1	207.52	207.52	0.46081	0.6257	9939
Residual	76	34225	450.33			
Total	83	43813				

3. Time, Depth and Aspect

Source	DF	SS	MS	F	P	Unique perms
Time	1	1663.7	1663.7	1.9969	0.1735	9846
Depth	1	2823.5	2823.5	1.7254	0.1866	270
Aspect	1	614.71	614.71	0.37563	0.8395	270
Time x Depth	1	584.21	584.21	0.701.25	0.5318	9846
Time x Aspect	1	1100.7	1100.7	1.3213	0.313	9846
Depth x Aspect	1	579.71	579.71	0.35425	0.833	270
Transect (Depth x Aspect)	4	6545.8	1636.5	3.3409	RED	9912
Time x Depth x Aspect	1	1332.7	1332.7	1599.7	0.252	9836
Time x Transect (Depth x Aspect)	4	3332.4	833.1	1.7008	**0.0474**	9907
Residual	64	31349	489.83			
Total	79	49927				

4. Time, Deck Position and Aspect

Source	DF	SS	MS	F	P	Unique perms
Time	1	522.73	522.73	1.7834	0.1611	9945
Position	2	13998	6998.9	23.887	**0.0001**	9943
Aspect	1	214.89	214.89	0.73313	0.4528	9939
Time x Position	2	884.62	442.31	1.509	0.2024	9942
Time x Aspect	1	216.22	216.22	0.73766	0.4581	9950
Position x Aspect	2	300.63	150.32	0.51282	0.7234	9943
Time x Position x Aspect	2	130.19	65.097	0.22208	0.9537	9949
Residual	48	14070	293.12			
Total	59	30337				

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	1.9308	**0.02**	9935
1, 3	2.2609	**0.0063**	9939
1, 4	4.1687	**0.0001**	9954
1, 5	3.8818	**0.0001**	9950
1, 6	3.9973	**0.0001**	9945
1, 7	4.0438	**0.0001**	9943
1, 8	4.2273	**0.0001**	9938
2, 3	1.1055	0.2897	9936
2, 4	3.5063	**0.0001**	9952
2, 5	3.3857	**0.0001**	9942
2, 6	3.5104	**0.0001**	9956
2, 7	3.6719	**0.0001**	9947
2, 8	3.8797	**0.0001**	9957
3, 4	2.6362	**0.0001**	9948
3, 5	2.5917	**0.0003**	9946
3, 6	2.7077	**0.0001**	9941
3, 7	2.7962	**0.0001**	9947
3, 8	2.9879	**0.0001**	9949
4, 5	1.7147	**0.0067**	9963
4, 6	1.6187	**0.0232**	9948
4, 7	1.3333	0.1151	9937
4, 8	1.4109	0.0746	9933
5, 6	1.3406	0.1302	9955
5, 7	1.6056	**0.0303**	9941
5, 8	1.7819	**0.0103**	9946
6, 7	1.6906	**0.0207**	9936
6, 8	1.6120	**0.0362**	9940
7, 8	0.91633	0.4716	9940

2. Time, Depth and Aspect

Term 'Tr (DexAs)'
Within level 'Deep' of factor 'Depth'
Within level 'Starboard' of factor 'Aspect'
Within level 'Stern' of factor 'Transect'

Groups	t	P(perm)	Unique perms
7, 8	3.4944	**0.009**	126

3. Time, Position and Aspect

Term 'Po'

Groups	t	P(perm)	Unique perms
Bow, Mid	4.8327	**0.0001**	9942
Bow, Stern	1.6607	**0.033**	9952
Mid, Stern	5.0603	**0.0001**	9942

Appendix E: Results of SIMPER analyses of reef assemblages of fish sampled in The Ex-HMAS Adelaide Artificial Reef Community Surveys 7 and 8. Cut off for percentage contribution is 90%. Note that only relevant SIMPER results have been included in this Appendix.

1. Time, Orientation and Aspect

Times 7 & 8

Group Deck

Average similarity = 77.26

Species	Av.Abund	Av. Sim	Sim/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	85.42	75.27	3.05	97.42	97.42

Group Hull

Average similarity = 77.47

Species	Av.Abund	Av. Sim	Sim/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	72.16	65.81	7.07	84.95	84.95
Large barnacle,sediment,brown fil	9.15	4.31	0.83	5.56	90.51

Groups Deck & Hull

Average dissimilarity = 31.51

Species	Group Deck Av.Abund	Group Hull Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	85.42	72.16	11.91	1.82	37.80	37.80
Large barnacle,sediment,brown fil	0.11	9.15	4.56	1.08	14.46	52.26
Ecklonia radiata	7.83	0.00	3.91	0.49	12.42	64.68
Bare ships surface	1.41	6.26	2.81	1.43	8.90	73.58
Herdmania momus	0.00	3.44	1.72	0.72	5.46	79.04
Orange encrusting sponge	0.26	3.16	1.55	0.93	4.91	83.96
Encrusting red algae	1.48	1.24	1.16	0.60	3.68	87.64
Orange colonial ascidian	0.00	1.54	0.77	0.59	2.44	90.08

2. Time, Depth and Aspect

Times 7 & 8

Groups 7 & 8

Average dissimilarity = 29.79

Species	Group 7 Av.Abund	Group 8 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	59.34	81.29	10.98	2.01	36.85	36.85
Large barnacle,sediment,brown fil	21.73	3.48	9.12	2.32	30.63	67.48
Brown floculant	8.14	3.26	2.85	1.07	9.58	77.06
Bare ships surface	8.14	5.48	2.43	1.47	8.15	85.20
Herdmania momus	0.20	2.43	1.16	1.02	3.88	89.09
Yellow encrusting sponge	0.00	2.23	1.12	1.26	3.75	92.83

Appendix E: Continued

3. Time, Position and Aspect

Times 7 & 8

Group Bow

Average similarity = 93.12

Species	Av.Abund	Av. Sim	Sim/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	95.68	92.81	11.65	99.66	99.66

Group Mid

Average similarity = 63.55

Species	Av.Abund	Av. Sim	Sim/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	62.53	48.97	2.46	77.06	77.06
Ecklonia radiata	23.17	11.19	0.79	17.62	94.68

Group Stern

Average similarity = 97.45

Species	Av.Abund	Av. Sim	Sim/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	98.07	97.09	46.46	99.63	99.63

Groups Bow and Mid

Average dissimilarity = 37.05

Species	Group Bow Av.Abund	Group Mid Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	95.68	62.53	16.92	1.50	45.67	45.67
Ecklonia radiata	0.31	23.17	11.51	1.15	31.08	76.76
Encrusting red algae	0.31	4.13	2.01	0.72	5.43	82.19
Bare ships surface	0.10	3.42	1.69	0.91	4.56	86.75
Turfing brown algae	1.27	0.63	0.89	0.40	2.41	89.16
Yellow encrusting sponge	0.10	1.68	0.86	0.56	2.32	91.48

Groups Bow and Stern

Average dissimilarity = 4.94

Species	Group Bow Av.Abund	Group Stern Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	95.68	98.07	1.97	0.66	39.93	39.93
Turfing brown algae	1.27	0.00	0.63	0.29	12.85	52.79
Bare ships surface	0.10	0.71	0.37	0.62	7.59	60.38
Serpulid matrix	0.56	0	0.28	0.49	5.63	66.01
White papillate sponge	0.05	0.51	0.26	0.77	5.25	71.26
Red tubular solitary sponge	0.36	0.25	0.22	0.86	4.38	75.64
Orange encrusting sponge	0.2	0.15	0.17	0.43	3.35	78.99
Ecklonia radiata	0.31	0	0.15	0.23	3.13	82.12
Encrusting red algae	0.31	0	0.15	0.54	3.11	85.23
Fish in frame	0.3	0	0.15	0.23	3.07	88.3
White encrusting sponge	0.25	0	0.13	0.4	2.55	90.86

Group Mid and Stern

Average dissimilarity = 36.87

Species	Group Bow Av.Abund	Group Stern Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	62.53	98.07	17.79	1.57	48.25	48.25
Ecklonia radiata	23.17	0.00	11.58	1.15	31.42	79.67
Encrusting red algae	4.13	0.00	2.06	0.72	5.60	85.27
Bare ships surface	3.42	0.71	1.66	0.96	4.50	89.77
Yellow encrusting sponge	1.68	0.10	0.86	0.56	2.34	92.10

Appendix F: Distance based test for homogeneity of multivariate dispersion.

1. All Times

F	24.983
P(perm)	**0.0001**

2. Time, Orientation and Aspect

F	0.49152	
P(perm)	0.6587	
Groups	t	P(perm)
(Deck, Hull)	0.70108	0.6476

3. Time, Depth and Aspect

F	1.9938
P(perm)	0.644

4. Time, Position and Aspect

F	72.037
P(perm)	**0.0001**