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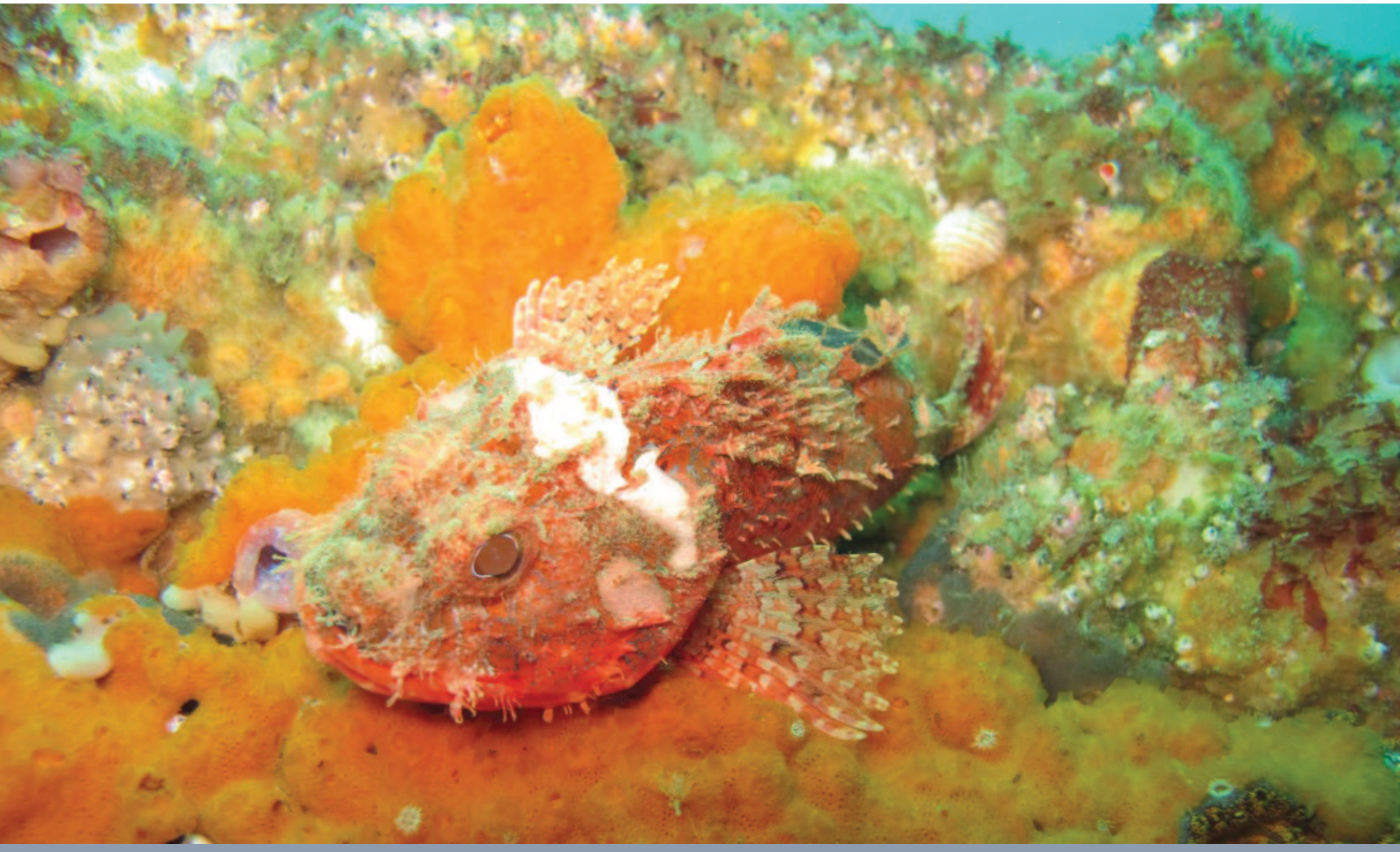

Ex-HMAS Adelaide Artificial Reef

Reef Community Monitoring

Survey 9

Job Number: EL1112024 L

Prepared for: Department of Primary Industries – Catchments and Lands

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Cardno (NSW/ACT) Pty Ltd
Trading as Cardno Ecology Lab

ABN 95 001 145 035
Level 9
203 Pacific Highway
St Leonards
New South Wales 2065
Australia
Telephone: 02 9496 7700
Facsimile: 02 9436 5170
International: +61 2 9907 4440
ecologylab@cardno.com.au
www.cardno.com.au

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EL1112024 L	Draft	11 November 2013	Kate Reeds	KAR	Dr Lachlan Barnes	LB
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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 9 (**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 scope of work to be carried out by Cardno Ecology Lab was initially for a two year period post-scuttling (a total of eight reef community surveys), however, as the LTMMP is currently under review, a ninth reef community survey was undertaken in the interim. This Progress Report outlines the methodology and findings for the ninth reef community survey to continue surveys which have been carried out on a quarterly basis.

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

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

Field surveys done as part of Survey 9 were carried out on 16 and 21 October 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 8, carried out in July 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 9, with the serpulid, barnacle and encrusting algal matrix being numerically most abundant, followed by an early colonising matrix, the conglomeration of large barnacles, sediment and brown filamentous algae and solitary ascidians. Two new species (an echinoderm and colonial ascidian) were also recorded by divers in Survey 9, but were not captured in any photoquadrats.

Overall, results of the survey show that the variability among samples taken during Survey 9 remained similar to that of the previous survey with little difference in the spread of replicates between surveys. Time series analysis suggests that the reef assemblage associated with the ship as a whole has become more uniform over the past two years and six months.

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, mid ship and stern) also appeared to be a significant factor whereas depth was not.

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 the same (26 species in total) from the previous to the current survey. No new species of fish were observed, however, a pair of cuttlefish (*Sepia* sp.) was filmed near the wheelhouse of the ship camouflaged against the deck.

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	1 year 3 months post scuttling
Monitoring Survey 5	31 October and 01 November 2012	1 year 6 months post scuttling
Monitoring Survey 6	16 and 17 January 2013	1 year 9 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 3 months post-scuttling
Monitoring Survey 9	16 and 21 October 2013	2 years 6 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 Analysis. 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 and a review is currently underway. It includes the following environmental monitoring components:

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

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, however, during this interim review period, the scope has been extended to include an additional survey. This Progress Report outlines the methodology and findings for the ninth reef community survey to continue surveys which have been 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 Ex-HMAS Adelaide 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 had 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 temporal comparison 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, mid ship 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 had generally increased during Survey 5 compared to previous surveys and several new species were observed. These included eastern hula fish (*Trachinops taeniatus*), schooling bannerfish (*Heniochus diphreutes*), blotched hawkfish (*Cirrithichthys 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 during this survey.

1.3.7 Monitoring Survey 6

Although the number of epibenthic 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 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 (Gunther's butterflyfish (*Chaetodon guentheri*), magpie morwong (*Cheilodactylus vestitus*), southern fusilier (*Paracaesio xanthurus*), Gunther's wrasse (*Pseudolabrus guntheri*), luculentus wrasse (*Psuedolabrus luculentus*), and the black-banded sea perch (*Hypoplectrodes nigroruber*), were recorded during Survey 7.

1.3.9 Monitoring Survey 8

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, mid ship and stern) also appeared to be a significant factor whereas depth was not. Some less abundant taxa of soft corals, hydroids and other unidentified algae were observed growing on the deck and superstructure, but were not captured within the photoquadrat survey as they were sparsely distributed. 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 Survey 8. New species identified 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 migrating whales and a pod of dolphins were also observed by divers during the field survey.

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

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

Survey	Sampling Dates	Timeframe
Baseline	18 April and 30 May 2011	1 week post-scuttling
Monitoring Survey 1	11 and 13 October 2011	6 months post-scuttling
Monitoring Survey 2	14 and 16 February 2012	10 months post-scuttling
Monitoring Survey 3	3 and 4 May 2012	1 year post scuttling
Monitoring Survey 4	27 July 2012	1 year 3 months post scuttling
Monitoring Survey 5	31 October and 01 November 2012	1 year 6 months post scuttling
Monitoring Survey 6	16 and 17 January 2013	1 year 9 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 3 months post-scuttling
Monitoring Survey 9	16 and 21 October 2013	2 years 6 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. 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 on port and starboard aspects).
- x 30 photoquadrats in total (x 5 per transect).

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

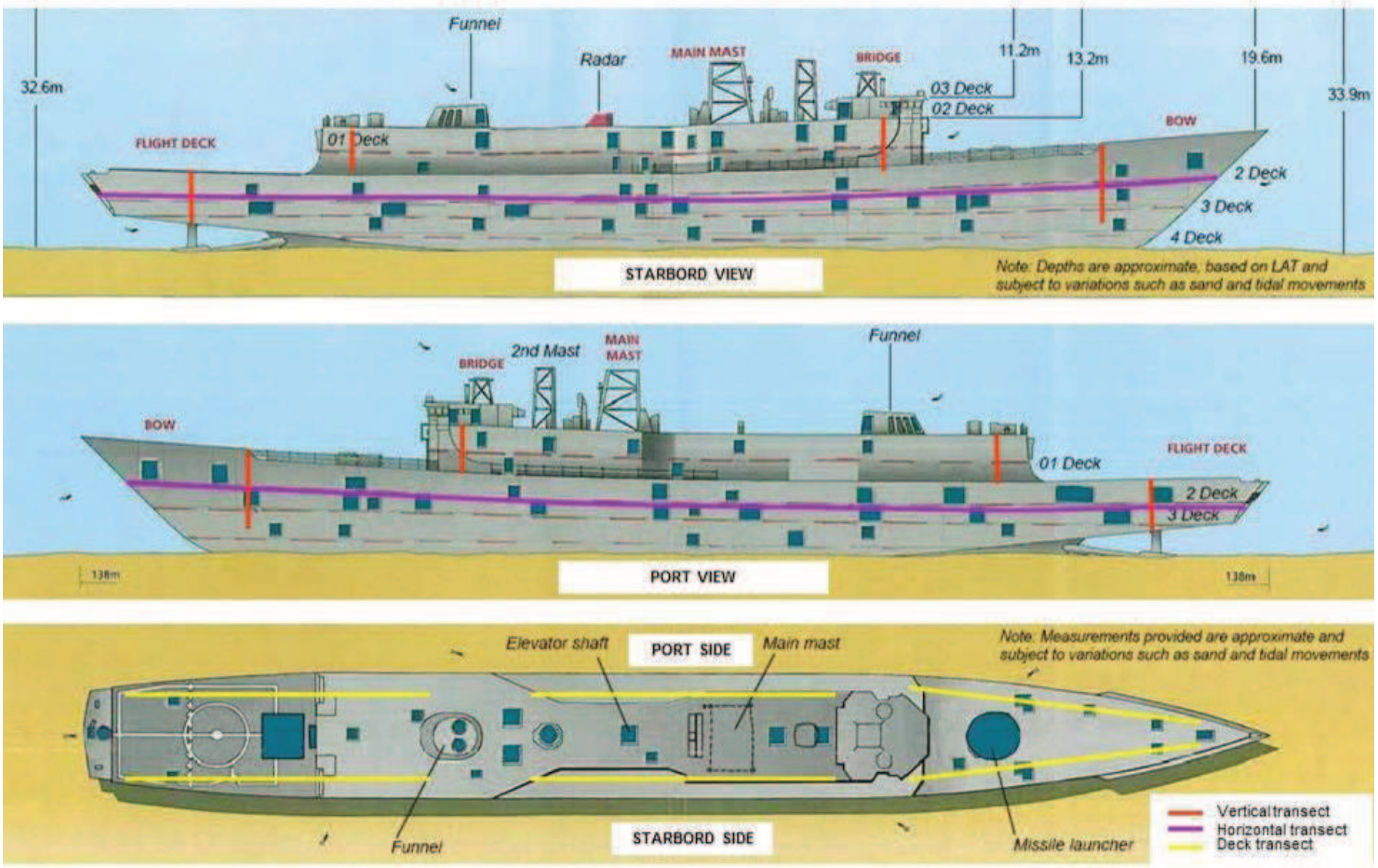

Figure 2: Plans of the Ex-HMAS Adelaide and Positions of the Reef Community Survey Sampling Transects.

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 with 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. The total number of each taxon/group 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.

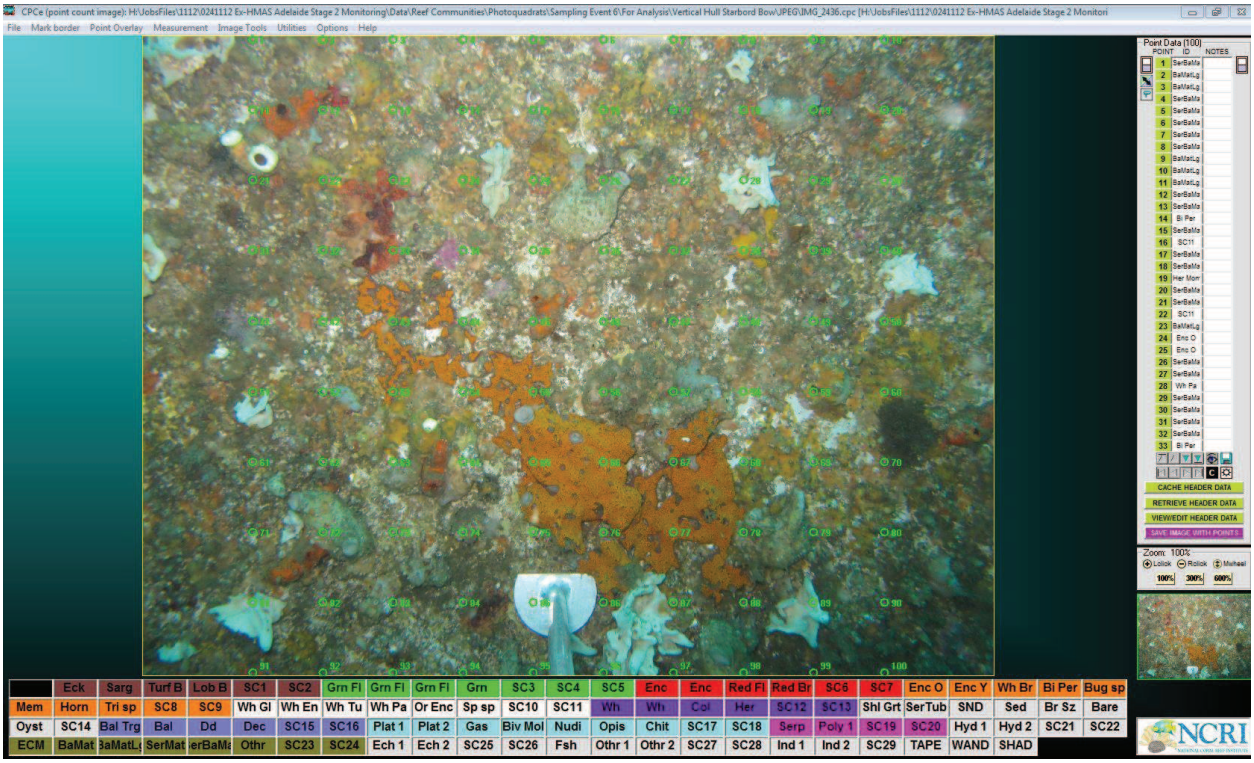

Figure 3: Screenshot of the CPCe Photoquadrat Analyses Frame with a Virtual 10 x 10 Grid Overlayed.

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. 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 8 and 9. 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 - 9): fixed, orthogonal;

This design compared reef assemblage structure among the nine sampling surveys to date (regardless of their spatial positioning on the ship). Note that for this ninth survey, mean, total percentage cover per survey 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 between times.

The design to test these hypotheses was as follows:

- Time (Survey 8/Survey 9): fixed, orthogonal;
- Orientation (deck/hull): fixed, orthogonal;
- Aspect: (port/starboard): fixed, orthogonal.

This design compared transects from the deck (bow, mid ship and stern 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 between times.

The design to test these hypotheses was as follows:

- Time (Survey 8/Survey 9): 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 between times.

The design to test these hypotheses was as follows:

- Time (Survey 8/Survey 9): 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). Although the CPCe coral code file used in Survey 9 was the same as for previous surveys, categories were grouped into broader classifications for purpose of the statistical analysis to reduce the chance of inconsistencies and subjectivity in identifications due to variability in photographic quality or colour across surveys.

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

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.

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 during 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.

2.3 Limitations

- Photographic quality and hence the ability to accurately identify taxa was dependent on the conditions at the time of sampling. Good quality photoquadrats may therefore result in the identification of a greater number of taxa than would be the case for photoquadrats where visibility was poor;
- Certain taxa were harder to distinguish and identify than others, potentially resulting in a bias towards more conspicuous species. Sponges, bryozoans and colonial ascidians were often difficult to distinguish from one another;
- Only organisms visible on the surface of the encrusting layer were recorded in photoquadrats. Organisms living embedded within or beneath the encrusting layer may therefore be under represented;
- Fish observations carried out as part of these surveys were not quantitative and should be treated as indicative only.

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 9 (**Appendix B**). The most abundant category identified in Survey 9 in terms of total percentage cover was an encrusting matrix of serpulid polychaete worms, barnacles and turfing algae (serpulid/barnacle matrix), which was also the most abundant category in the previous survey. Other categories contributing greater than 1% of total mean percent cover included 'early colonising matrix', the conglomeration of large barnacles, sediment and brown filamentous algae (large barnacle matrix), solitary ascidian (including *Herdmania momus* and other taxa), tiny orange anemone (*Corynactis* sp.) and red encrusting algae. Between Surveys 8 and 9, the total percent cover of serpulid, barnacles and turfing algae had decreased, whereas the large barnacle matrix, early colonising matrix, solitary ascidian and red encrusting algae had all increased in total percentage 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 from the Baseline and Monitoring Surveys 1-9 are presented in **Plates 1 – 16**.

3.1.2 Spatial and Temporal Variation in Reef Communities

All Times (Surveys 1-9)

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 69.5% of the total variation among samples was explained by the two axes within the PCoA (**Figure 4**). This difference is further explained by the significant PERMDISP result for the factor 'time' which shows greater variability (or dispersion) among transects in Surveys 1-3 and less variability (greater clustering of points) in Surveys 4-9 (**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 that of the vertical hull surfaces, although this was dependent on time (**Appendix C**). Pairwise tests indicated, however, that these differences between deck and hull surfaces were consistent for both Surveys 8 and 9 (**Appendix D**).

This difference is clear from the grouping of points in the PCoA which explains 76% of the total variation among samples (**Figure 5)**. Aspect (i.e. port vs starboard) did not, however, influence the composition of reef assemblages associated with the deck and hull (**Appendix D**).

SIMPER analyses indicated that the percent cover of serpulid, barnacle and encrusting algal matrix contributed the most (39.3% and 32.5% respectively) to the dissimilarity between the deck and hull surfaces in Surveys 8 and 9. In Survey 9 the large barnacle matrix had the next greatest percentage contribution to differences in orientation followed by solitary ascidians, red encrusting algae, *E. radiata*, tiny orange anemone, early colonising matrix, brown filamentous algae/hydroid and orange encrusting sponge. In both surveys *E. radiata* occurred only on deck surfaces but not the hull and the large barnacle matrix was recorded only on the hull surfaces but not the deck. In Survey 8 this was followed by *Ecklonia radiata*, large barnacle matrix, bare ships surface, red encrusting algae, solitary ascidian, orange encrusting sponge and orange colonial ascidian. The average abundance of solitary ascidians was also greater on the hull surfaces than on the deck during Surveys 8 and 9 (**Appendix E**).

PERMDISP for the factor orientation x time was not significant, indicating that the differences in orientation (between hull and deck) and time were due to actual spatial/temporal differences and not dispersion among samples (**Appendix F**).

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

No clear patterns in assemblage structure relating to time, depth or aspect were evident, although there was a significant interaction at the level of transects. These were not, however, consistent through time, between depths or aspect (**Figure 6, Appendix C**). Pair wise tests showed that within Survey 8 assemblages associated with shallow transects were significantly different from those of deep transects but only at the port, bow, port stern and starboard bow transects (**Appendix D**). SIMPER analyses indicated that in Survey 9, assemblages associated with deep and shallow transects differed from each other, but only on the starboard side of the ship. These differences were attributed to a greater percentage cover of the serpulid and barnacle matrix recorded within shallow transects and a greater percentage cover of large barnacle matrix on deep transects (**Appendix E**). Shallow transects in Survey 8 were also characterised by a greater percentage cover of the serpulid and barnacle matrix but also a greater percentage cover of orange colonial ascidian. Deep transects, were also characterised by a greater abundance of large barnacle matrix, solitary ascidians, orange encrusting sponge and bare surface. No significant difference in the dispersion of samples within each survey was evident for the significant interaction term (**Appendix F**).

Time, Position (bow, mid ship, 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, mid ship or stern) were detected, with these differences consistent during Surveys 8 and 9 (**Appendix C**). Pair-wise tests indicated that all three deck positions were significantly different from one another during both Surveys 8 and 9 (**Appendix D**). This is illustrated in the corresponding PCoA plot which shows that approximately 89% of the total variation among samples could be explained by the two axes in the ordination (**Figure 7**). The PCoA also shows 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 further 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*, red encrusting algae, orange encrusting sponge and bare surface. 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 whereas the mid-ship deck was characterised by a larger percent cover of *Ecklonia radiata,* red encrusting algae and bare surface and a smaller percent cover of serpulid, barnacle and encrusting algal matrix (**Appendix E**).

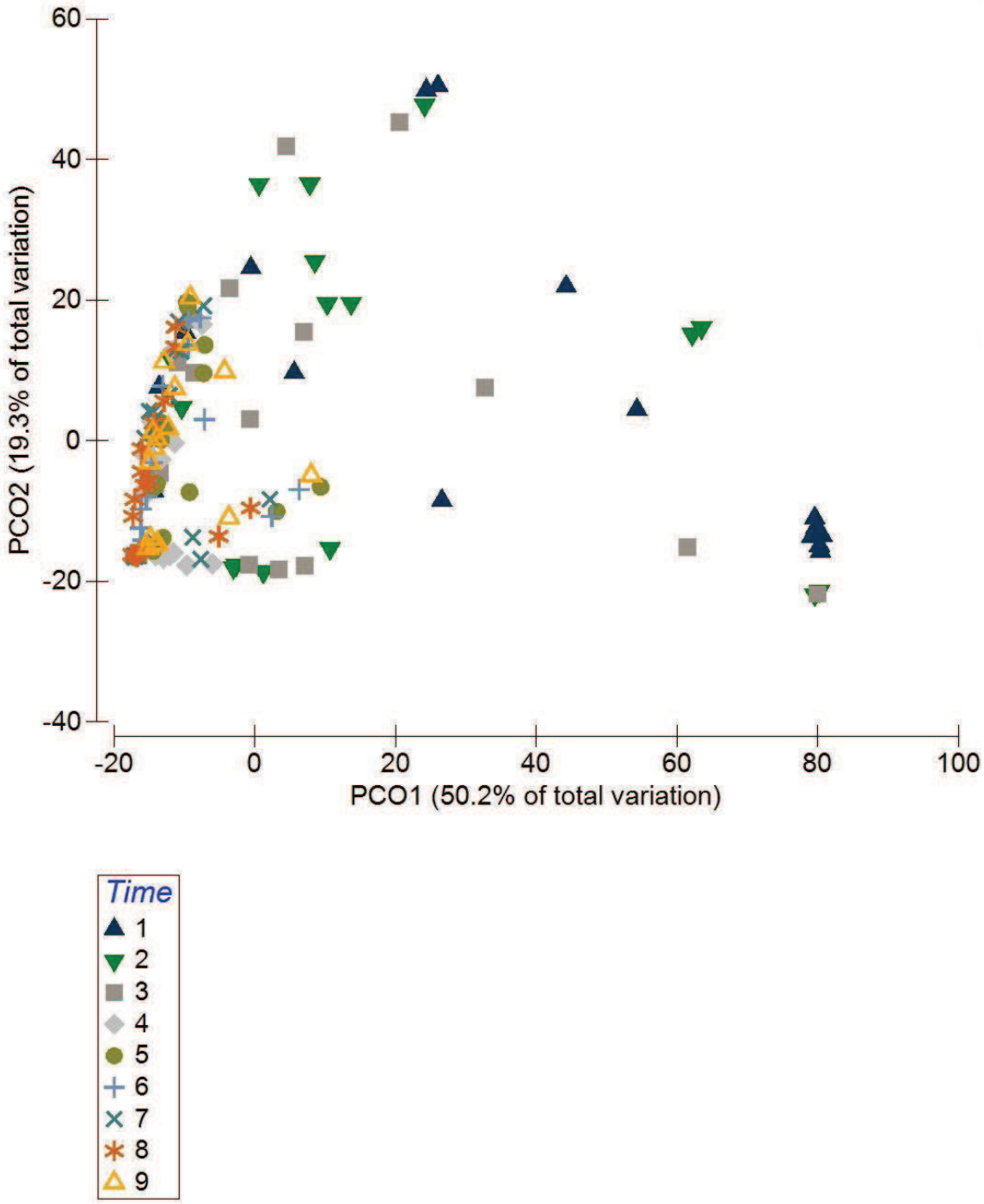

Figure 4: Principal Coordinates Analyses (PCoA) of Percent Cover of Encrusting Assemblages from Transects Taken at all Positions on the Ex-HMAS Adelaide for Surveys 1 to 9.

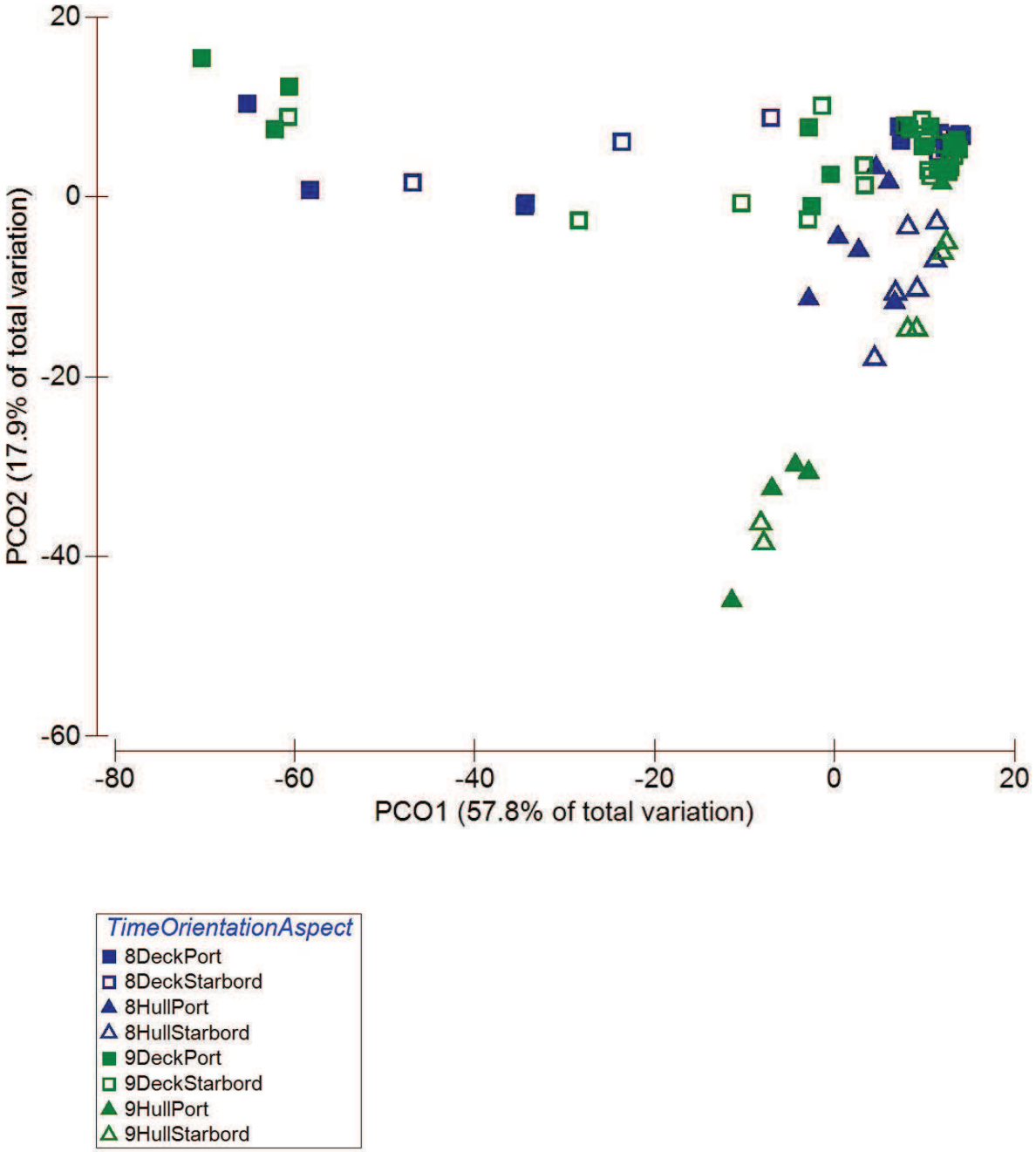

Figure 5: Principal Coordinates Analyses (PCoA) of Percent Cover of Encrusting Assemblages from Transects Taken on Hull and Deck Surfaces of the Ex-HMAS Adelaide for Surveys 8 and 9.

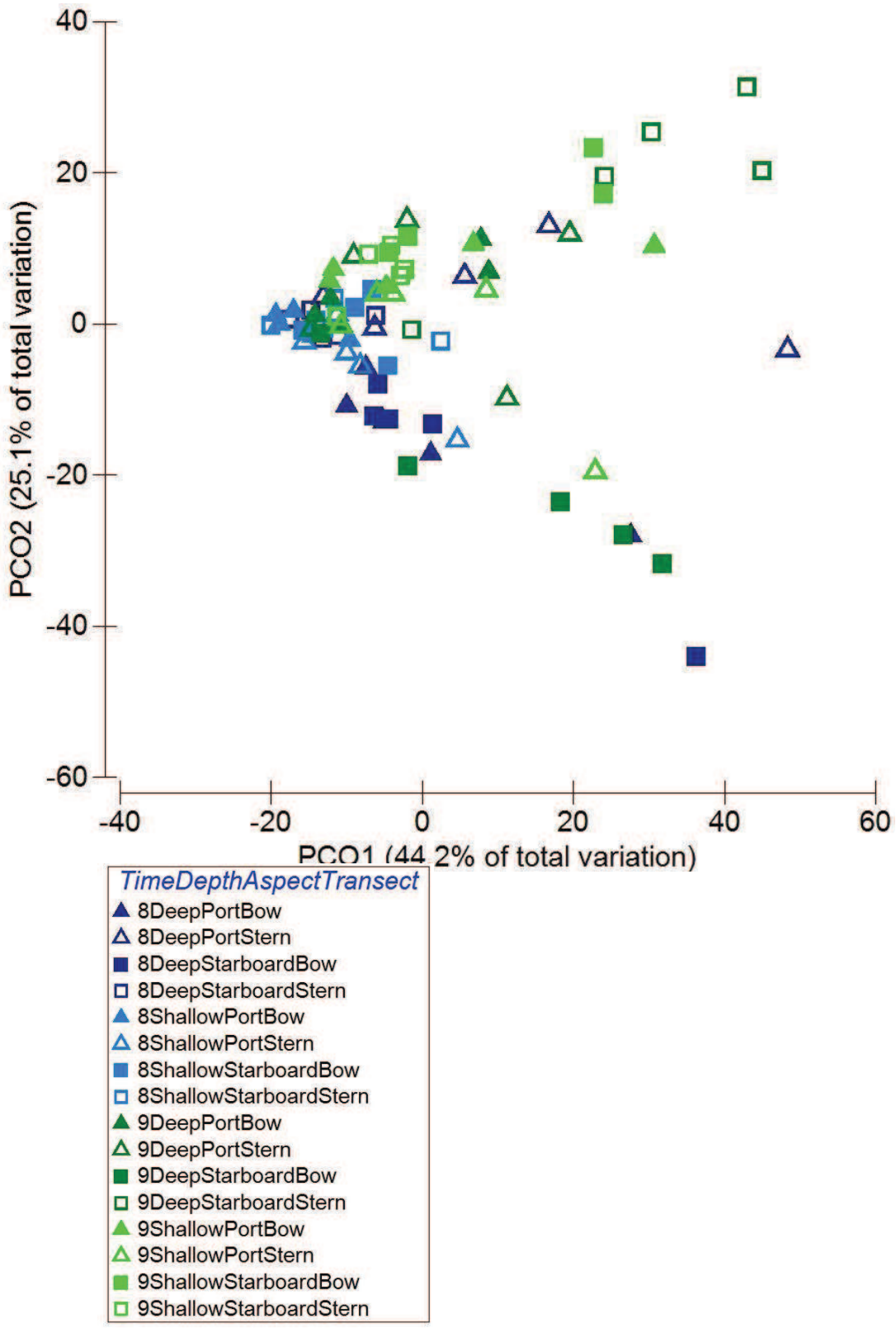

Figure 6: Principal Coordinates Analyses (PCoA) of Percent Cover of Encrusting Assemblages from Transects at Different Depths and Aspect on the Ex-HMAS Adelaide for Surveys 8 and 9.

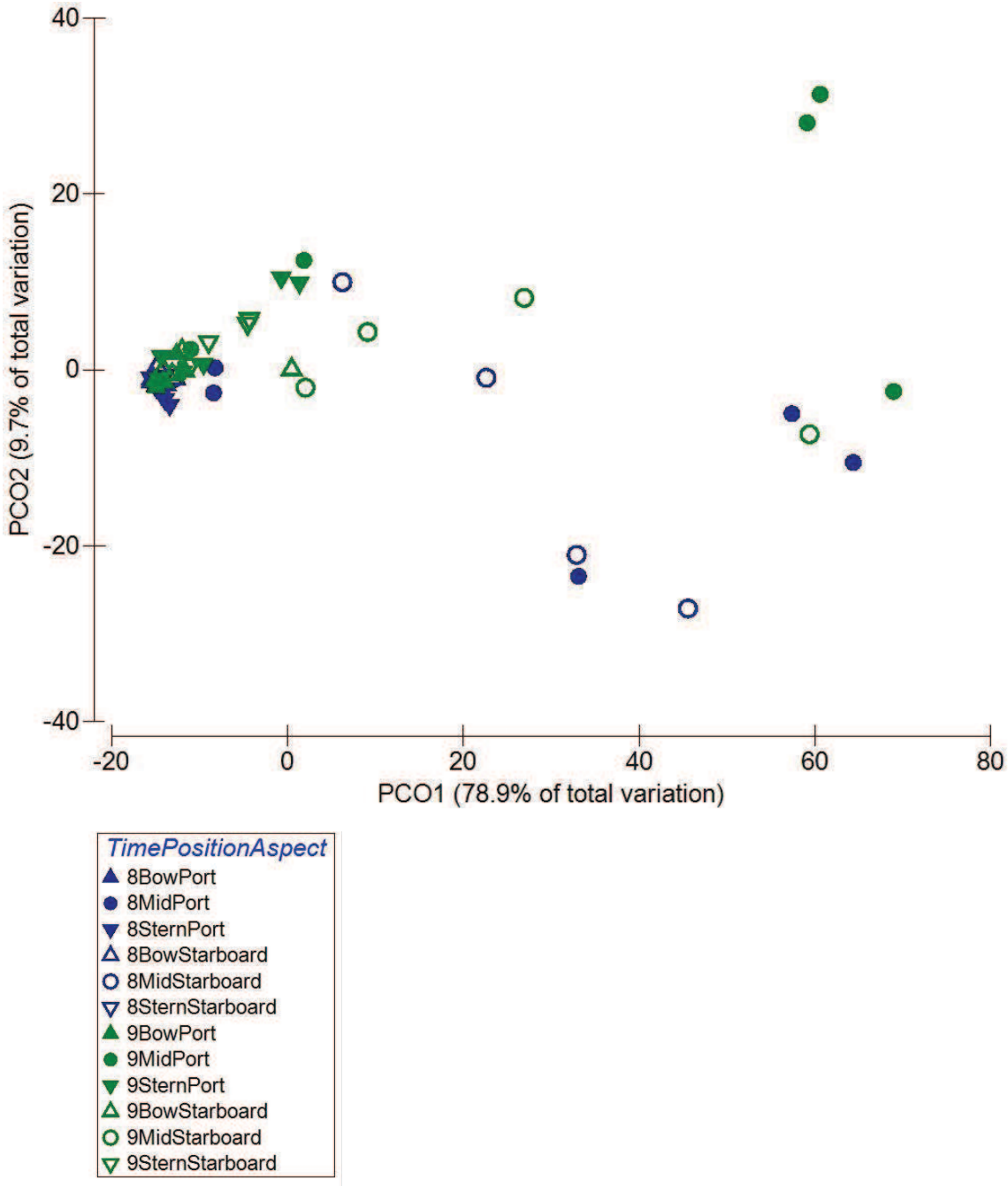

Figure 7: Principal Coordinates Analyses (PCoA) of Percent Cover of Encrusting Assemblages from Transects Taken at Different Positions on the Deck Ex-HMAS Adelaide for Surveys 8 and 9.

3.2 Fixed Photographs

Photographs taken from fixed locations are presented in **Appendix A.** Overall the encrusting assemblage does not appear to have changed significantly over the past three months, although notable areas of bare patches, particularly in fixed photograph 10, have started to become recolonised.

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 9) are listed in **Table 3**. Species of recreational, commercial or conservation value are also indicated. A total of 25 species of fish and one species of cuttlefish (*Sepia* sp.) were recorded.

Table 2: Summary of Observations of Attached Encrusting and Fish Assemblages Observed from Video Footage of the Ex-HMAS Adelaide in July 2013 (Survey 9).

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 and orange encrusting sponge were also conspicuous. Eastern hula fish (*Trachinops taeniatus*) were abundant, forming schools, while yellowtail kingfish (*Seriola lalandi*), tarwhine (*Rhabdosargus sarba*) and blackspot goatfish (*Parupeneus spilurus*) were also observed. Blackspot goatfish were noted feeding on the deck. Other species of fish in this area included yellow-finned leatherjacket (*Meuschenia trachylepis*), old wife (*Enoplosus armatus*) and girdled scalyfin (*Parma unifasciata*).
Deck Port Mid	As per previous surveys, kelp (*Ecklonia radiata*) remained present in this area. The majority of the deck was otherwise heavily encrusted with barnacles, encrusting red algae, hydroids and fine filamentous algae, with patches of white encrusting sponges. Rock cale (*Crinodus lophodon*), a kelp associated species, was present in this area. Other species observed included tarwhine, red morwong (*Cheilodactylus fuscus*), yellow-fin leatherjacket, old wife and girdled scalyfin.
Deck Port Stern	The deck was predominantly covered in serpulid tubes, barnacles, encrusting algae and fine filamentous algae. Tubular solitary sponges and white papillate encrusting sponges were conspicuous on the deck surface. Silver drummer (*Kyphosus sydneyanus*) and an Eastern blue groper (*Achoerodus viridis*) were observed.
Deck Starboard Bow	As with previous surveys, encrusting growth included barnacles, algae and hydroids with patches of encrusting sponges. Patches of kelp were present. A fine layer of sediment was noted on the surface. Solitary, tubular, red, pink and white sponges were common on the deck. Tarwhine and eastern hula fish were present in schools. Rock cale, blue groper and yellowtail kingfish were also recorded.
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. There were also large amounts of kelp (*Ecklonia radiata*). A layer of fine sediment was noted on the surface. Rock cale, a kelp associated species, was present in this area. Red morwong, tarwhine, girdled scalyfin, yellow-finned leatherjacket, crimson banded wrasse (*Notolabrus gymnogenis*) and eastern blue groper were also found in this area.
Deck Starboard Stern	Small barnacles, encrusting algae, hydroids, fine filamentous algae and white encrusting sponges were abundant on flat areas of the deck. A fine layer of sediment was noted on the surface. Red morwong, tarwhine and white ear (*Parma microlepis*) were also observed in this area.
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 included 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, trevally (*Psuedocaranx dentex*), six-spine leatherjacket (*Meuschenia freycineti*), yellow-fin leatherjacket, eastern hulafish, magpie morwong (*Cheilodactylus vestitus*), white ear, blackspot goatfish, rock cale, longfinned pike (*Dinolestes lewenі*), red morwong (*Cheilodactylus fuscus*), blue morwong (*Nemadactylus douglasii*) and eastern blue groper 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. Growth appeared thickest around edges of holes in the hull.
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 barnacles, encrusting algae, hydroids and a fine, filamentous or turfing algae.
Vertical Hull Superstructure	Ascidians, bryozoans, barnacles, encrusting algae, hydroids and fine filamentous algae were observed on the superstructure. An orange colonial ascidian was also prevalent on this surface. Tarwhine 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)	Survey 9 (October 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 leweni*	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		•				•	•			
Sepiidae	*Sepia* sp.	Cuttlefish	n/a										•
Total Number of Taxa				**3**	**17**	**14**	**19**	**13**	**23**	**19**	**26**	**26**	**26**

4 Discussion

4.1 Encrusting Biota

Overall, despite some small scale variability, the reef assemblage associated with the ship during Survey 9 (carried out two years and six months post-scuttling), was similar to that reported previously, with small changes in the abundance and composition of taxa were evident between surveys 8 and 9. Numerically dominant categories such as early colonising matrix, red encrusting algae and tiny orange anemone had increased in total percentage cover between Surveys 8 and 9. While there was a notable increase in the early colonising matrix, there was also a notable reduction in the total percentage cover of bare ships surface between Surveys 8 and 9. These observations indicate that the bare surface recorded in Survey 8 has become colonised over the past three months.

Several categories recorded in photoquadrats in Survey 9 were not recorded in Survey 8, but had occurred in earlier surveys. These included hydroids, red filamentous/branching red algae, the encrusting bryozoan (*Biflustra perfragilis*) and pink solitary spikey sponge. Conversely, purple sponge was recorded in photoquadrats taken in Survey 8 but not in Survey 9.

The new category (tiny orange anemone, *Corynactis* sp.) was assigned in Survey 9 but was recorded in earlier surveys as a colonial ascidian, as individual polyps in the early stages of development were not easily distinguished and appear to be joined in a sheet like base. Improved photographic conditions and further growth of the anemones has made the identification clearer in Survey 9. Orange colonial ascidian may therefore have been over represented in earlier surveys and the tiny orange anemone not represented where it should have been. This type of jewel anemone are known to occur in shaded conditions which is consistent with the findings of this survey. In addition, this species is also known to occur on wave exposed coasts and often forms large colonies at entrances to sea caves (Edgar 2003).

Two new species (an echinoderm (*Centrostephanus* sp.) and colonial ascidian (*Pseudodiazona claviformis*)) were also recorded by divers in Survey 9, but were not recorded in any photoquadrats. Echinoderms are likely to be under represented in the photoquadrat survey as they are often found in crevices and overhangs.

Overall, results of the survey show that the variability among samples taken during Survey 9 remained similar to that of the previous survey. Time series analysis suggests that the reef assemblage associated with the ship as a whole has become more uniform over the past two years and six months. This may be due to the succession of the underlying encrusting matrix which has become progressively colonised by barnacles and encrusting algae over the majority of the vessel.

As 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, mid ship and stern) was a significant factor influencing assemblage composition. As discussed in previous reports, this factor is confounded by depth, as the mid ship 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 8) 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 the same (26 species in total) from the previous to the current survey. No new species of fish were observed, however, a pair of cuttlefish (*Sepia* sp.) was filmed near the wheelhouse of the ship camouflaged against the deck.

5 Acknowledgements

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

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7 Plates

Deck, Port Bow

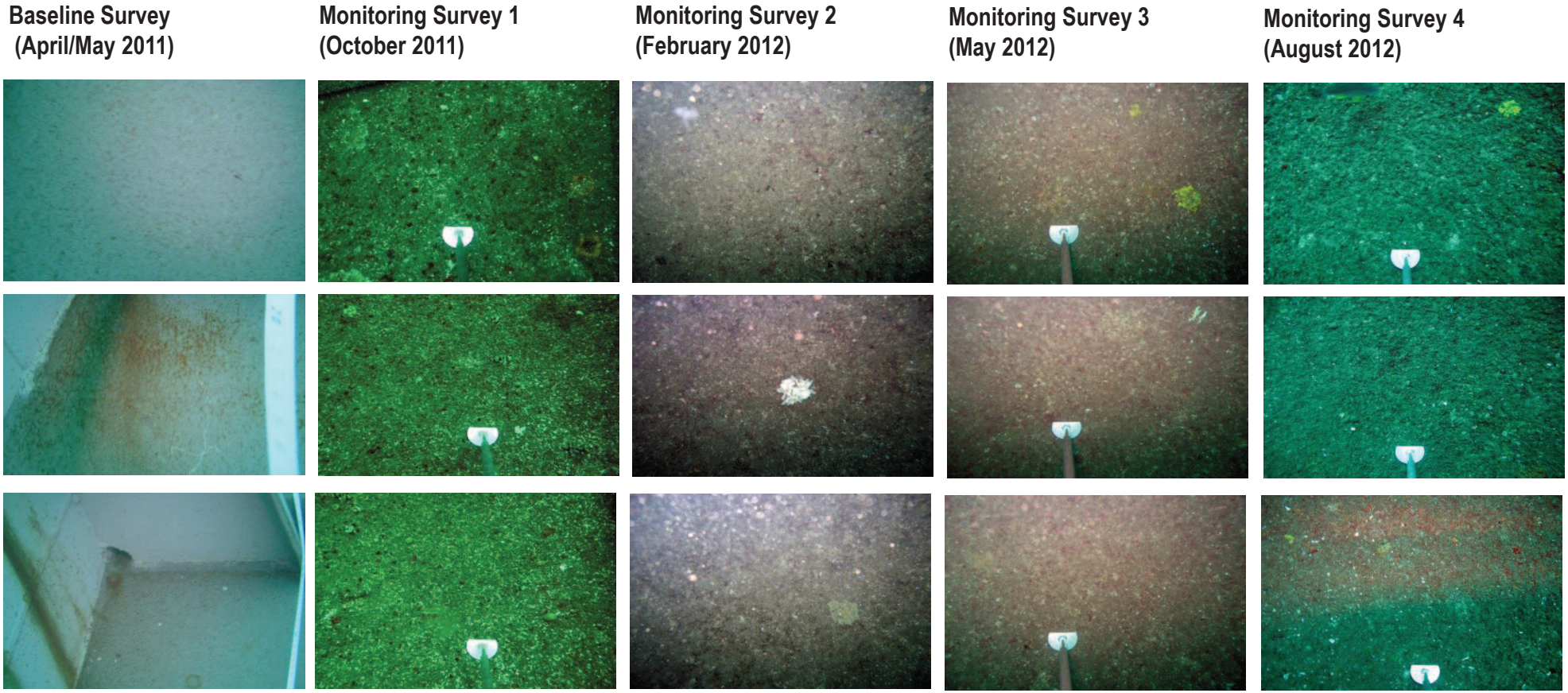

Plate 1: Deck port bow

Deck, Port Bow

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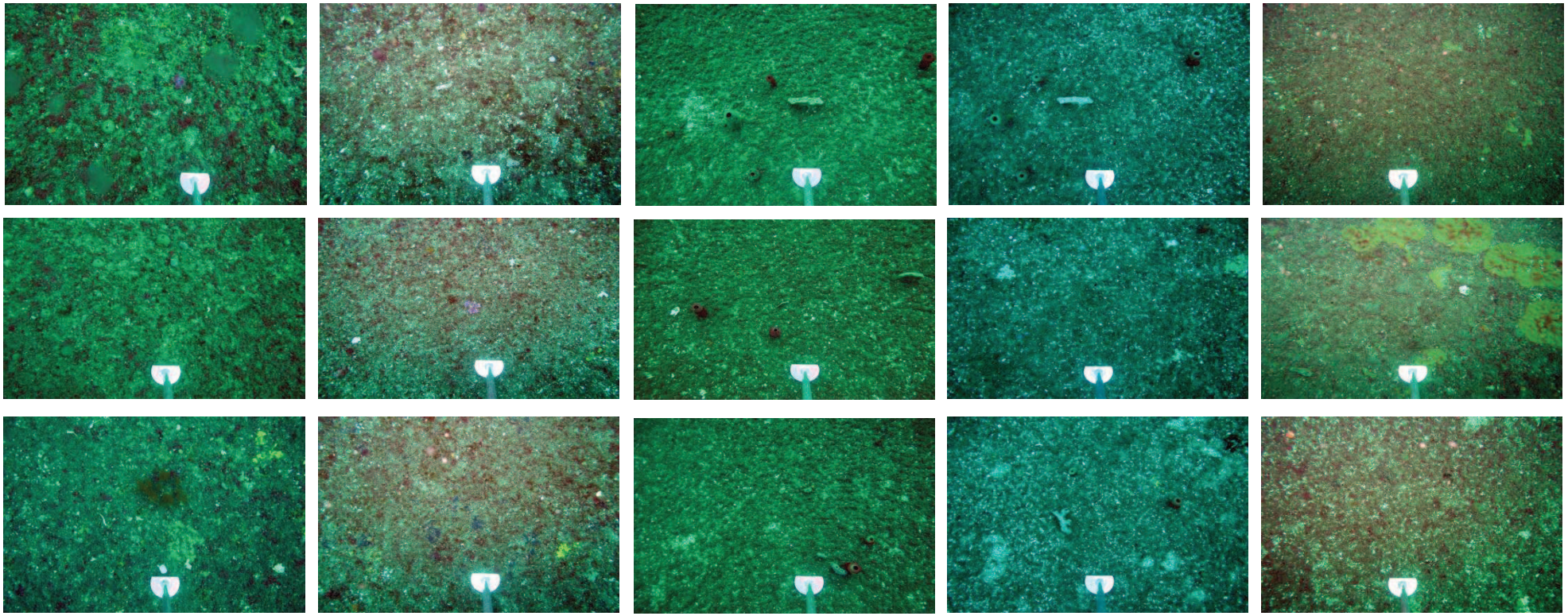


Plate 1 Continued: Deck port bow

Deck, Port Mid

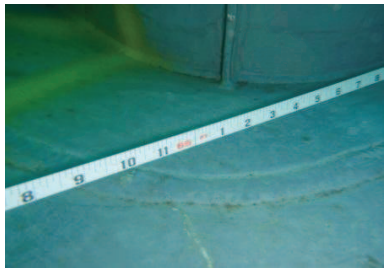
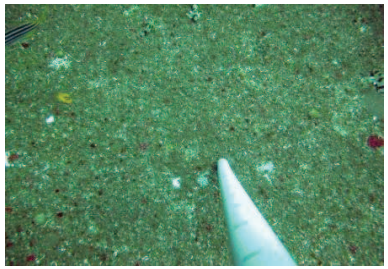
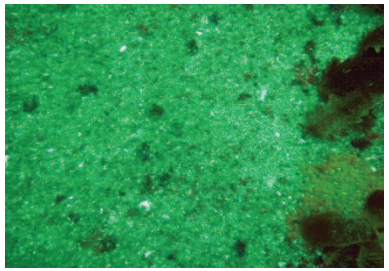
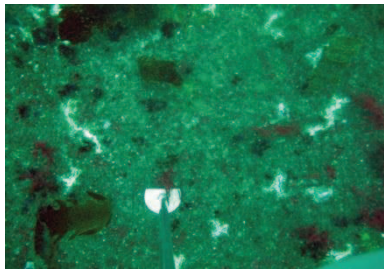
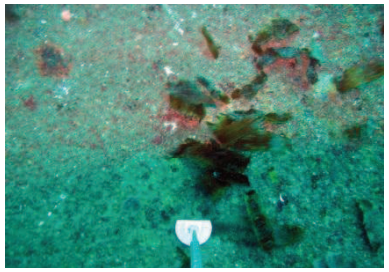
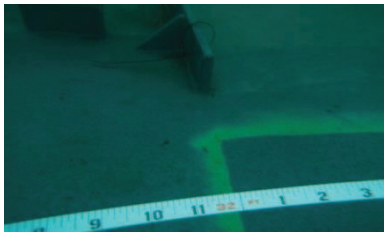
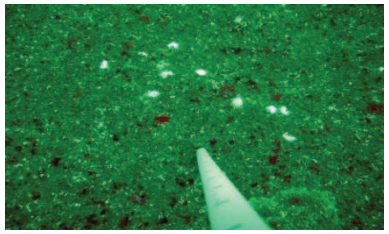
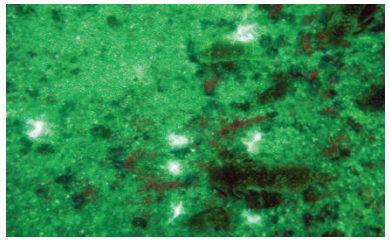
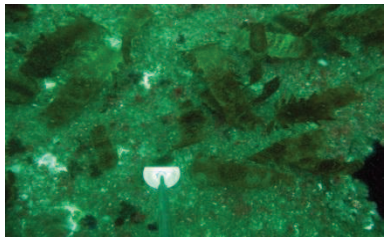
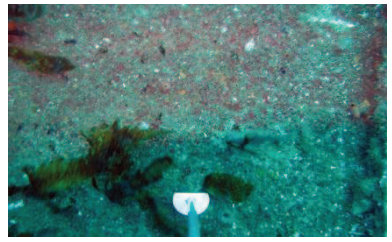
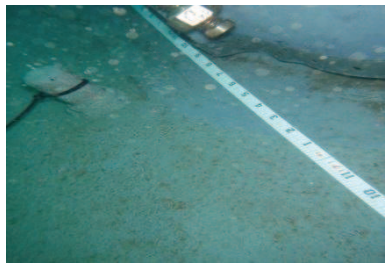
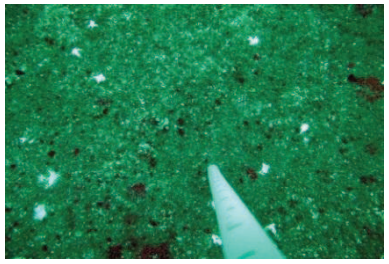
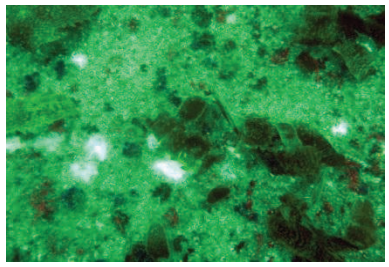
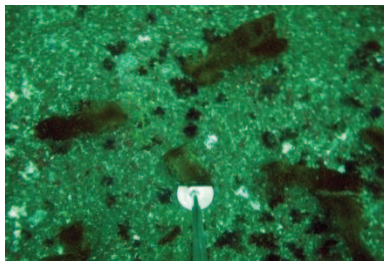
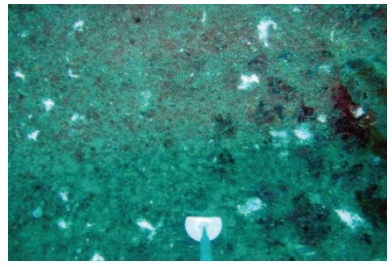
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 2: Deck Port Mid

Deck, Port Mid

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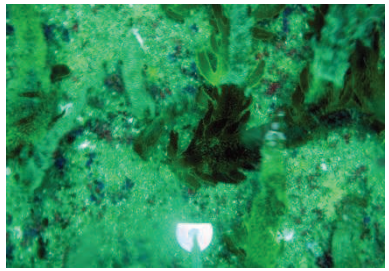
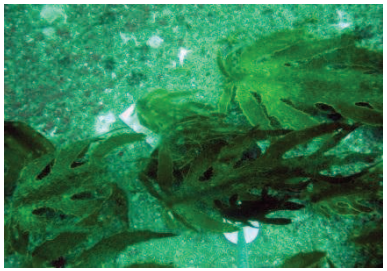
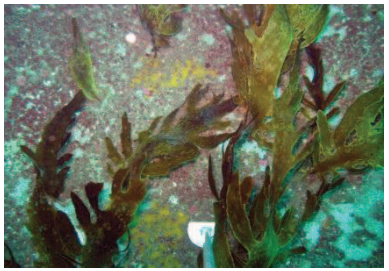
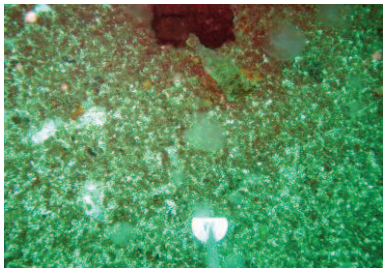
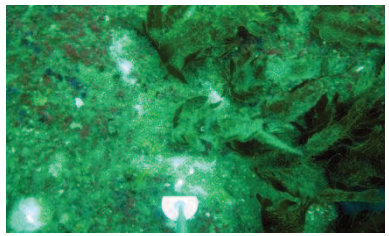
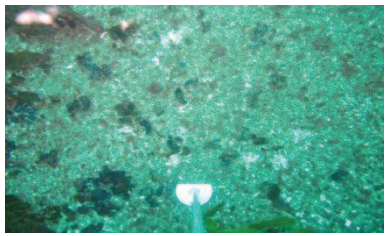
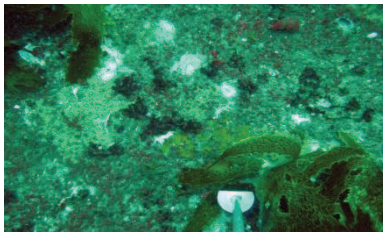
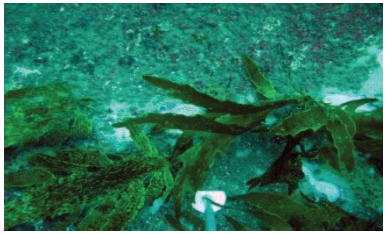
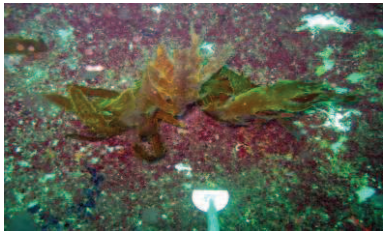
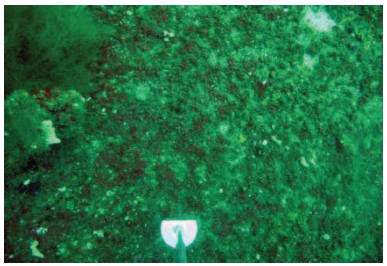
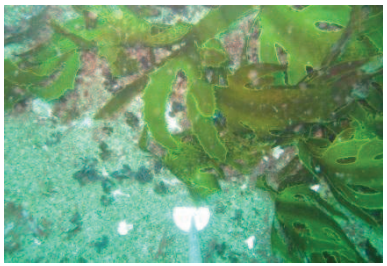
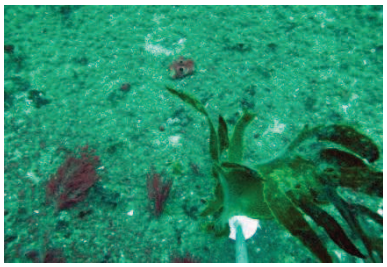
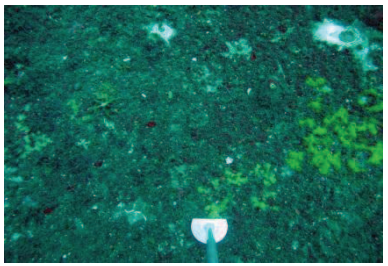
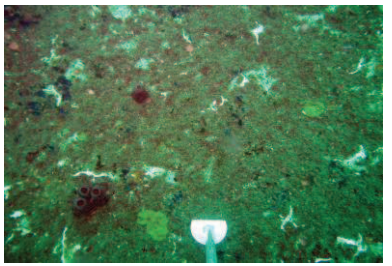
				
				
				

Plate 2 Continued: Deck Port Mid

Deck, Port , Stern

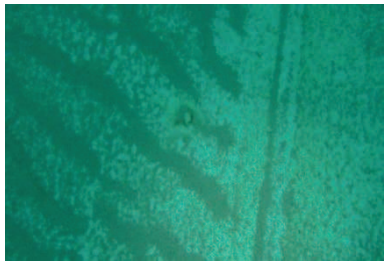
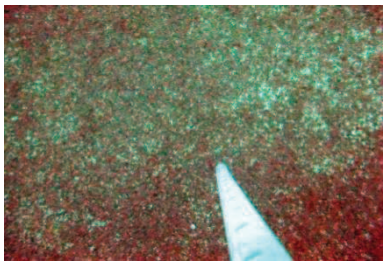
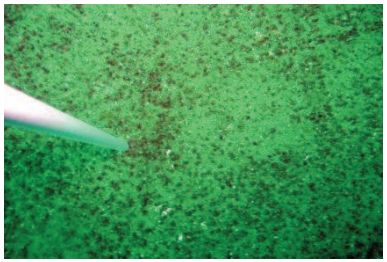
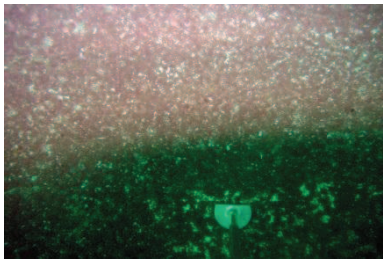
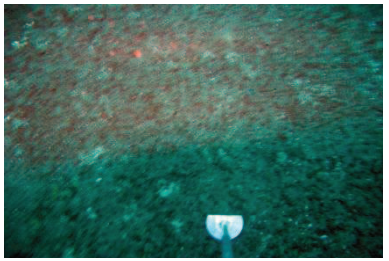
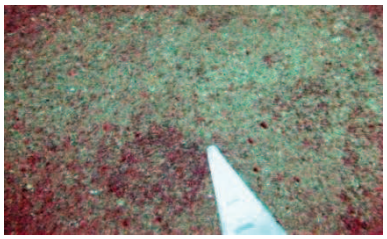
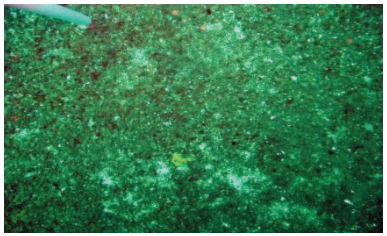
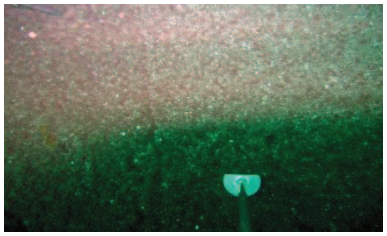
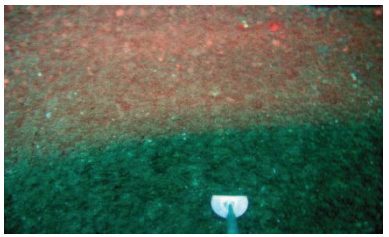
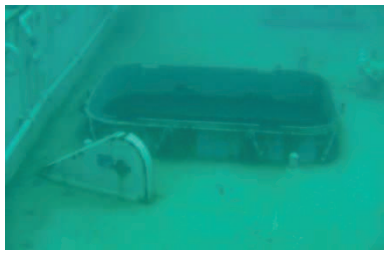
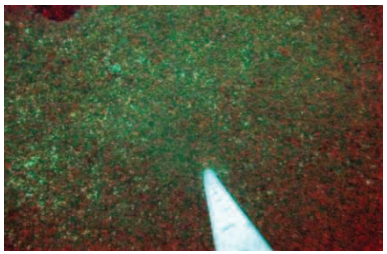
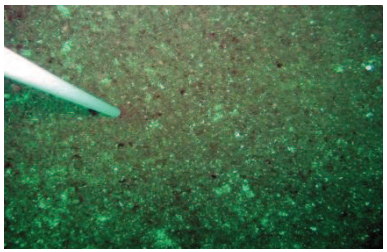
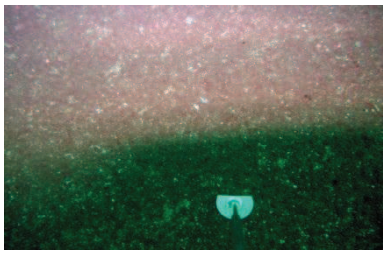
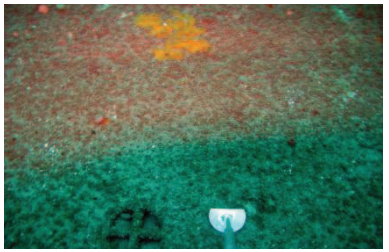
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 3: Deck Port Stern

Deck, Port, Stern

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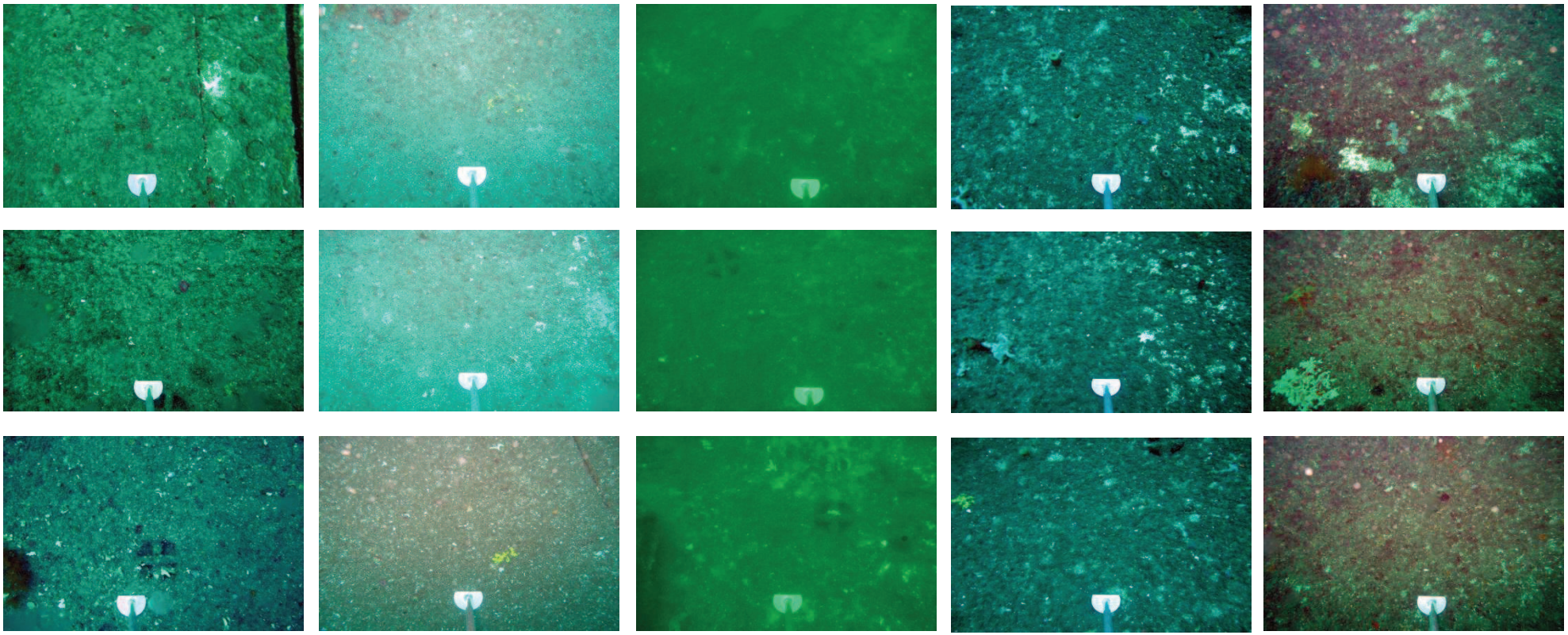


Plate 3 Continued: Deck Port Stern

Deck, Starbord, Bow

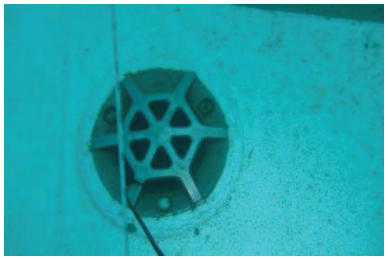
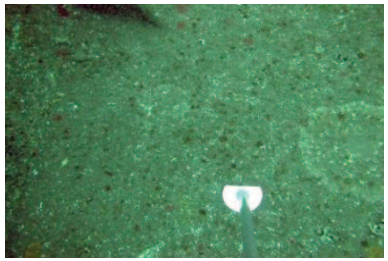
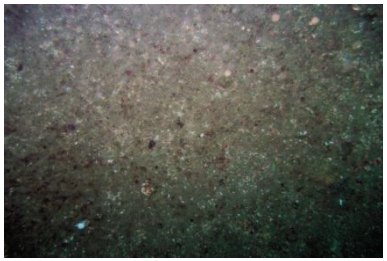
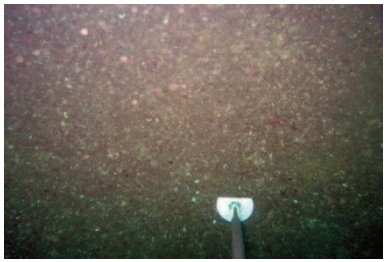
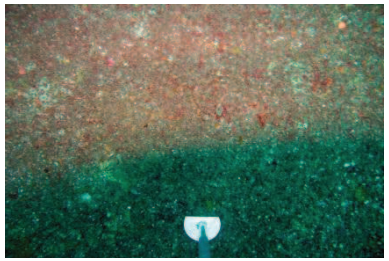
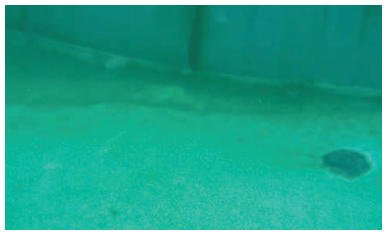
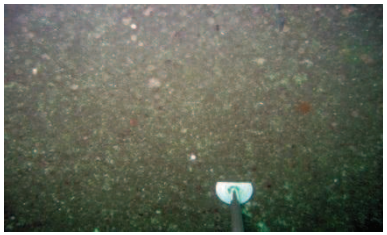
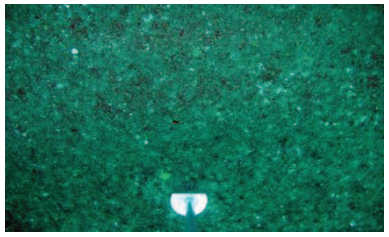
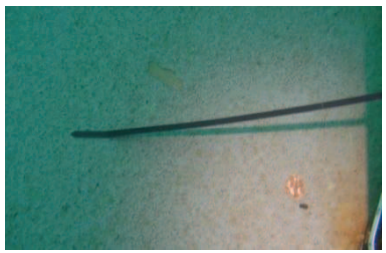
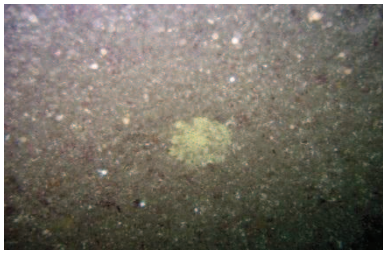
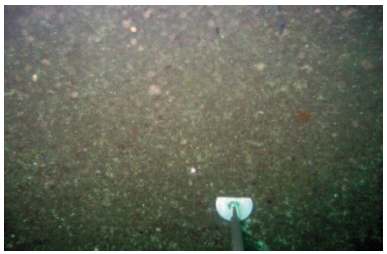
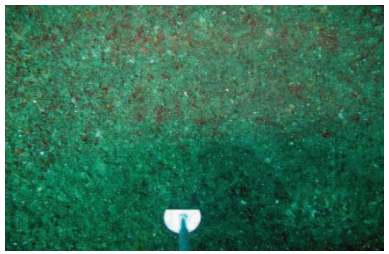
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

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)	Monitoring Survey 9 (October 2013)

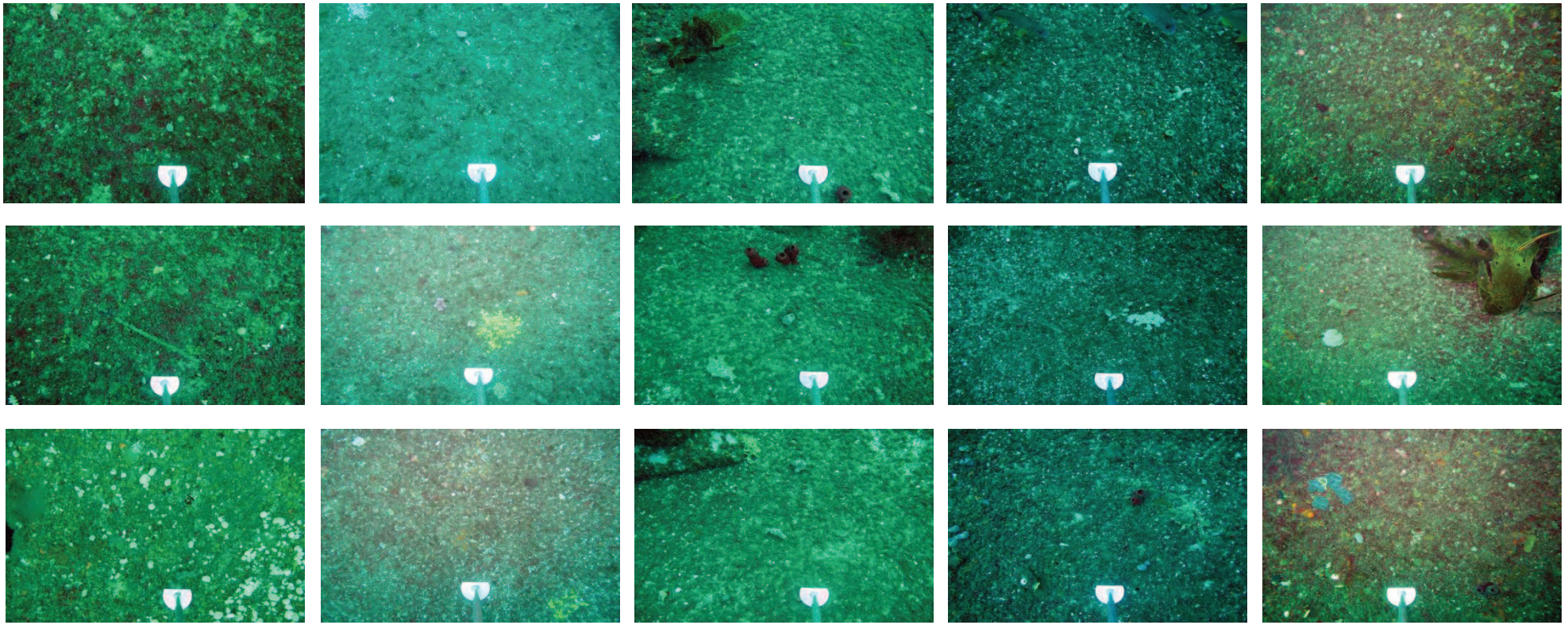


Plate 4 Continued: Deck Starbord Bow

Deck, Starbord, Mid

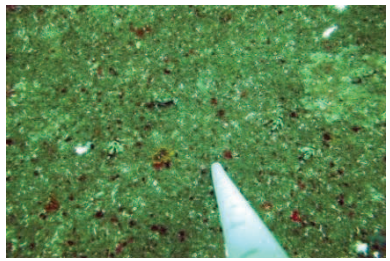
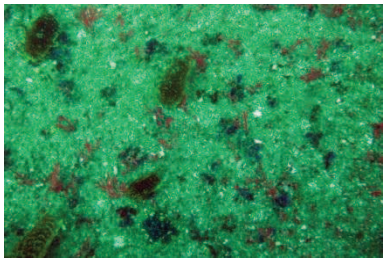
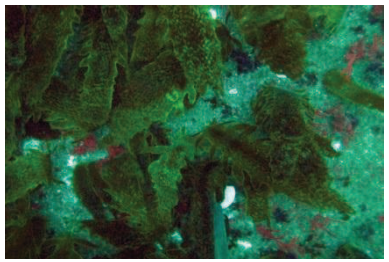
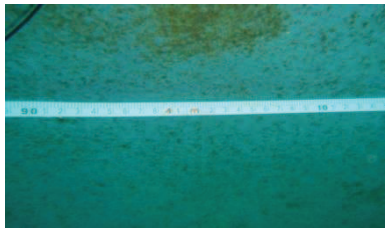
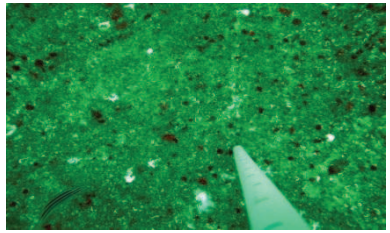
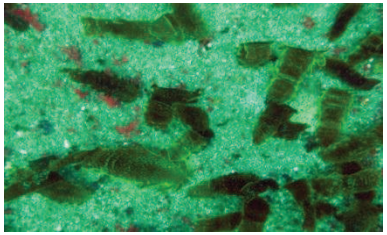
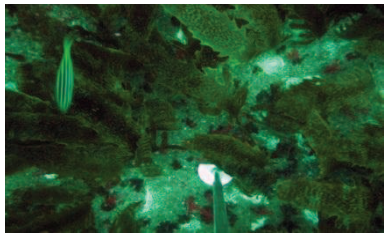
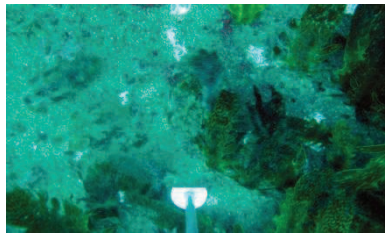
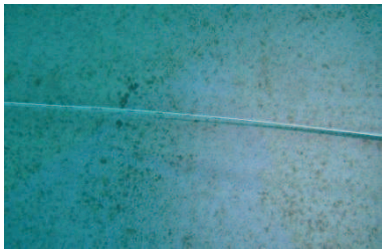
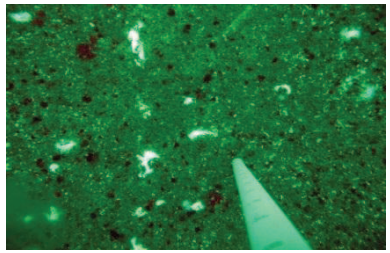
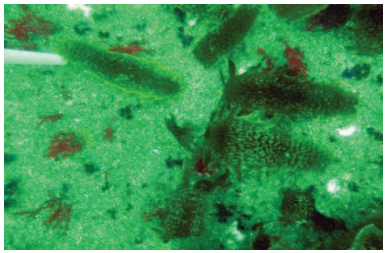
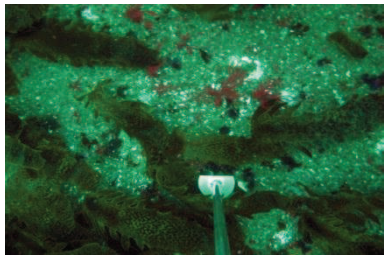
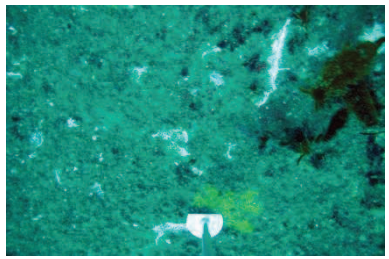
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 5: Deck Starbord Mid

Deck, Starbord, Mid

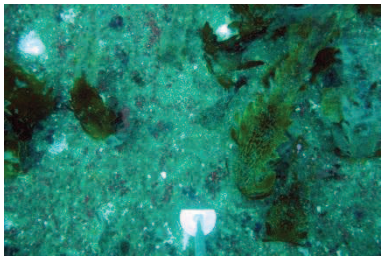
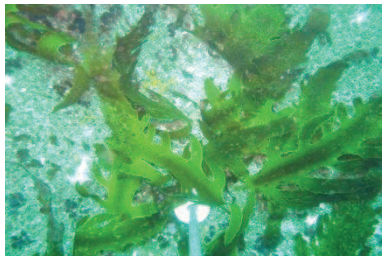
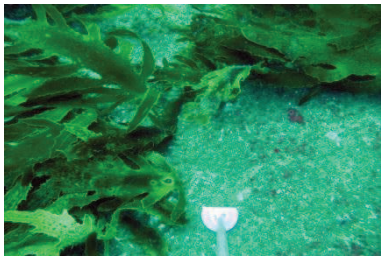
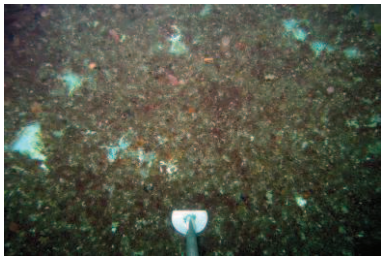
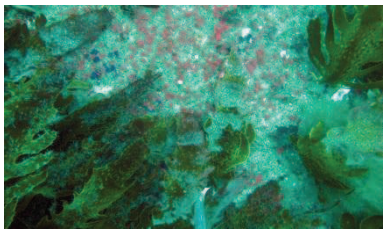
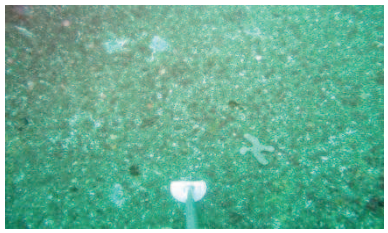
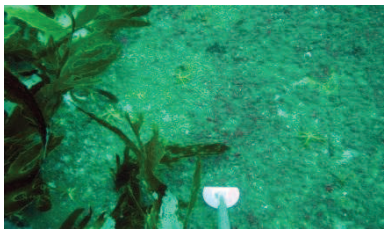
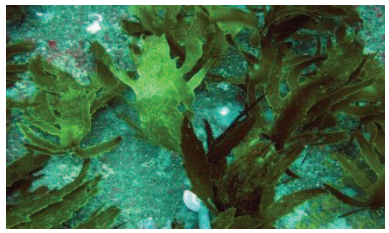
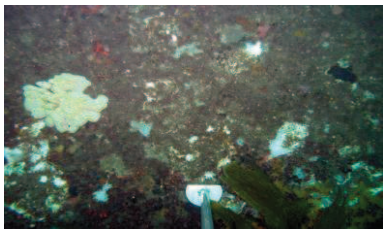
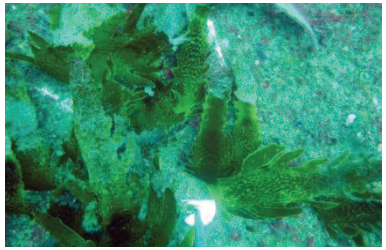
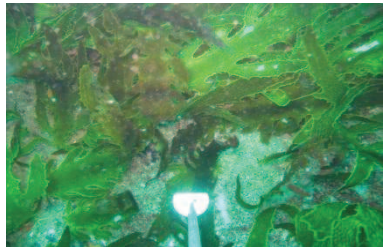
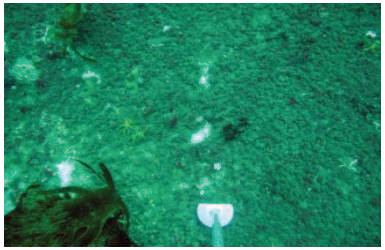
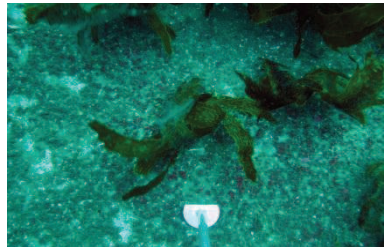
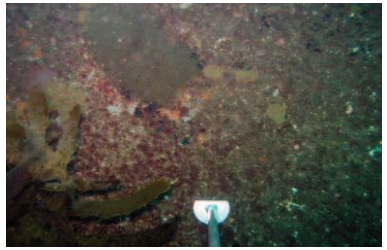
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)	Monitoring Survey 9 (October 2013)
				
				
				

Plate 5 Continued: Deck Starbord Mid

Deck, Starbord, Stern

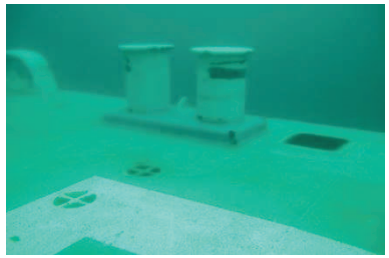
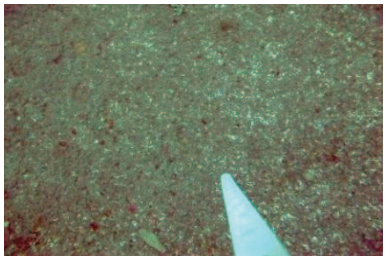
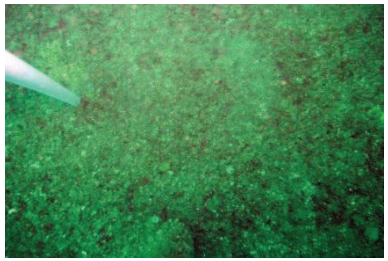
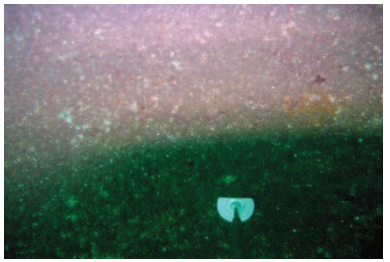
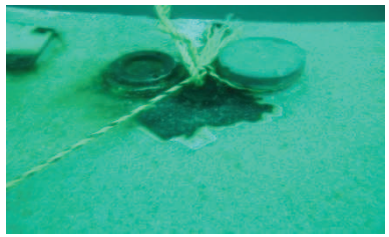
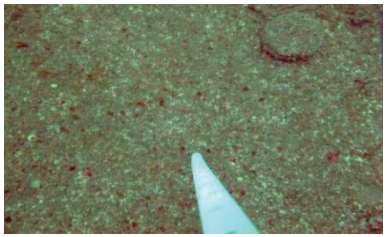
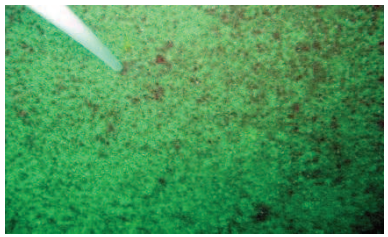
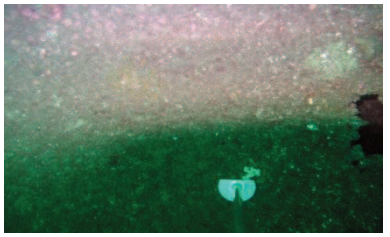
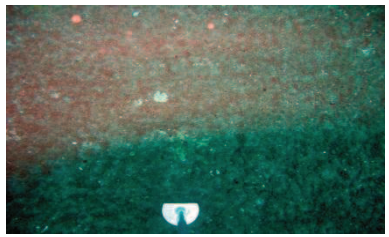
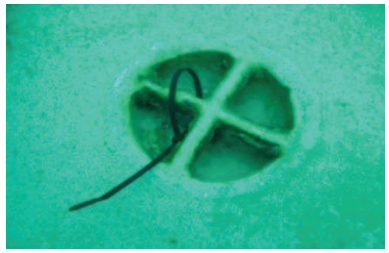
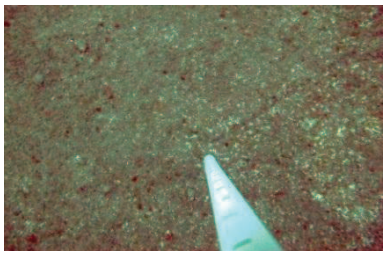
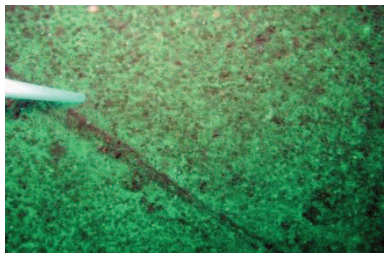
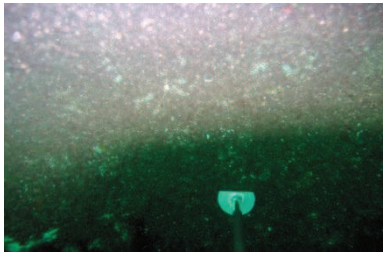
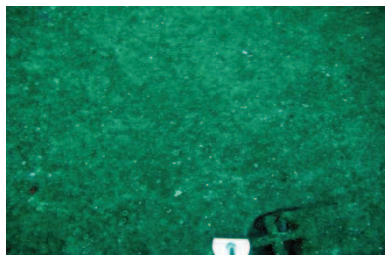
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

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)	Monitoring Survey 9 (October 2013)

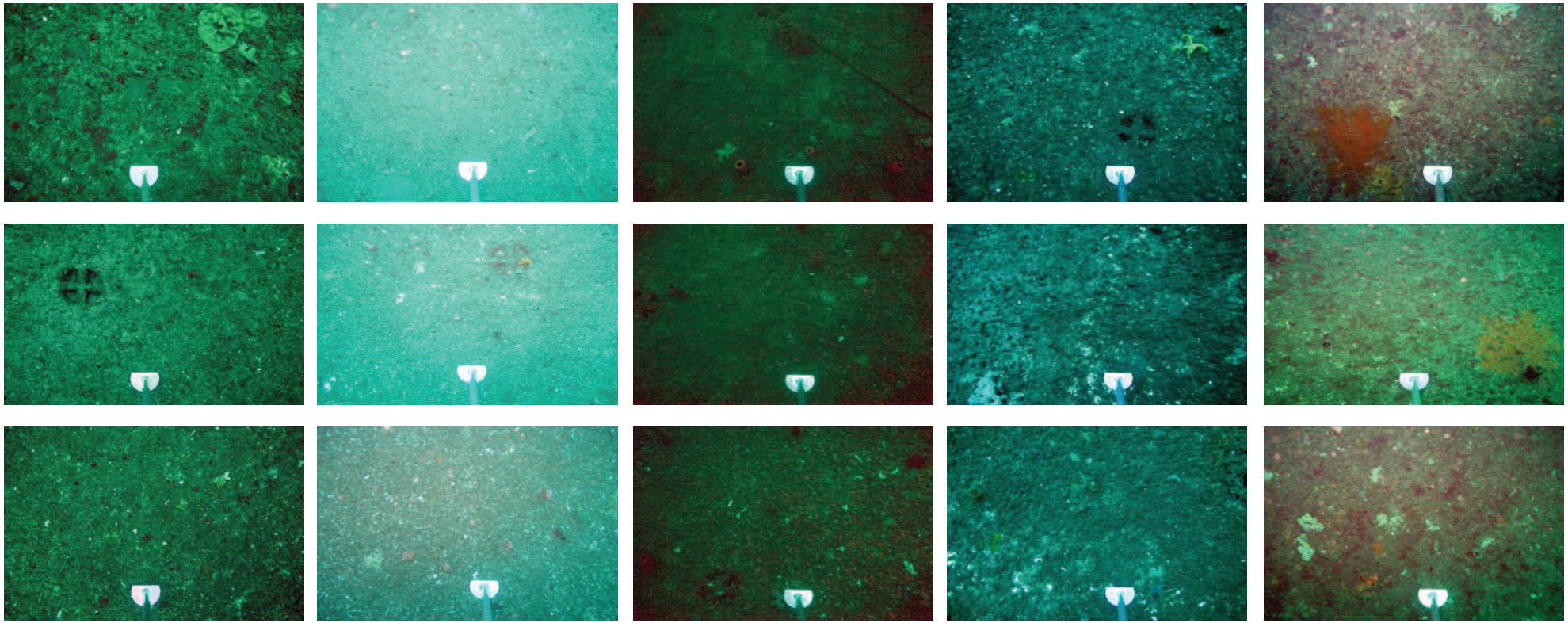


Plate 6 Continued: Deck Starbord Stern

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)

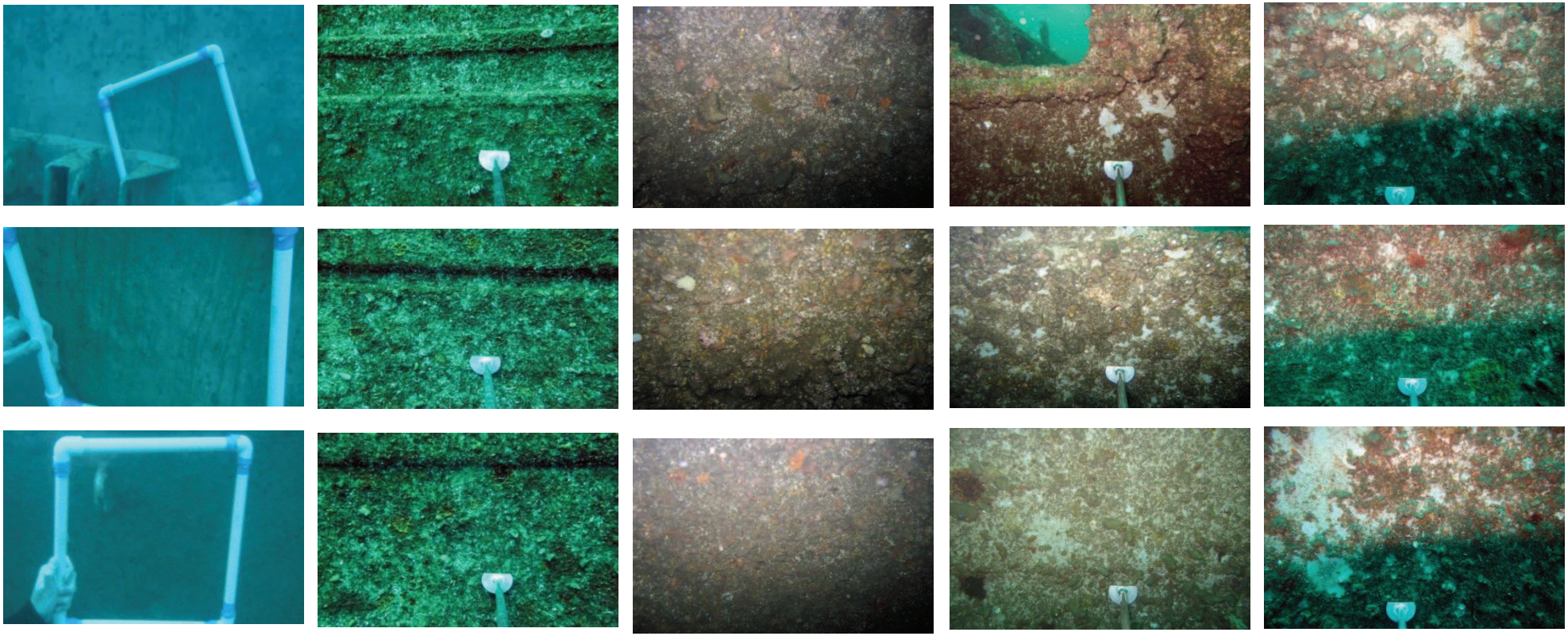


Plate 7: Horizontal Hull Port

Horizontal Hull Port

Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)	Monitoring Survey 9 (October 2013)

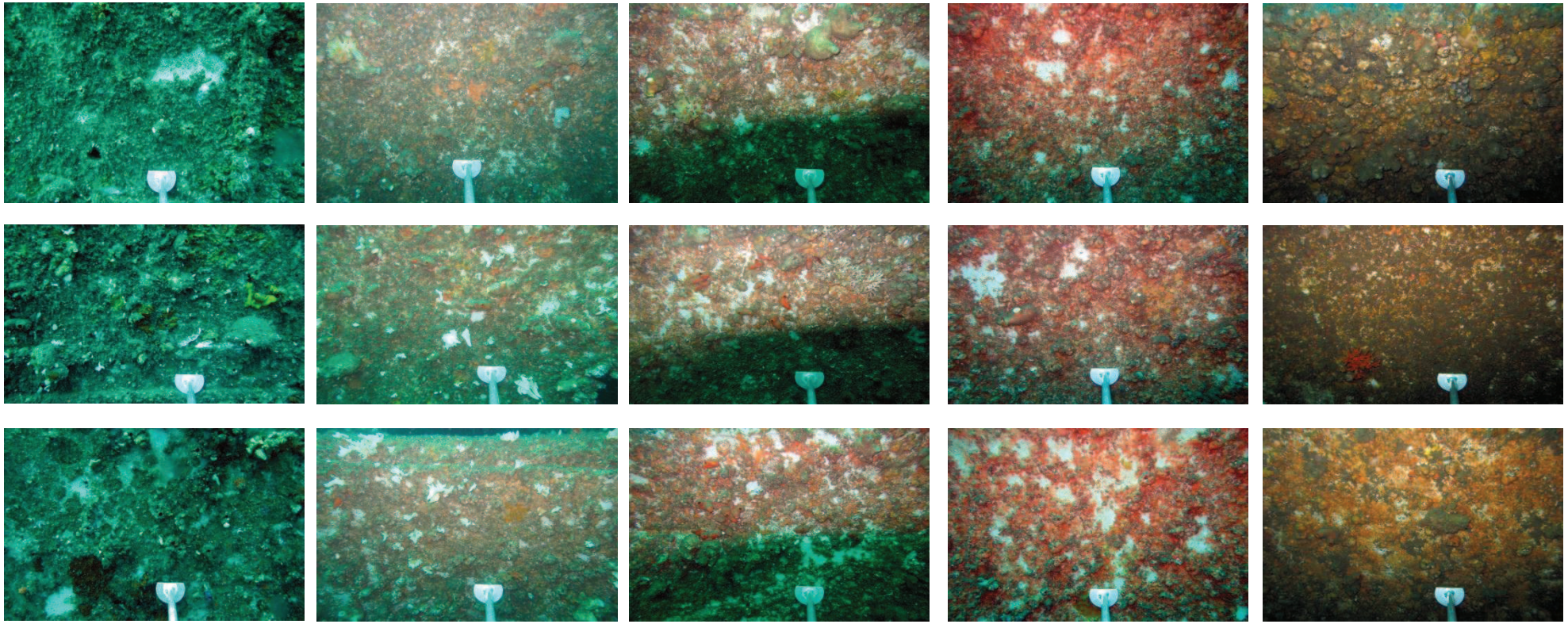


Plate 7 Continued: Horizontal Hull Port

Horizontal Hull Starbord

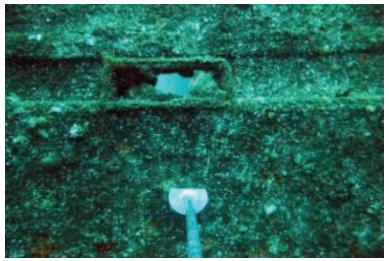
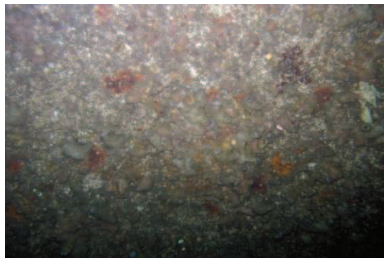
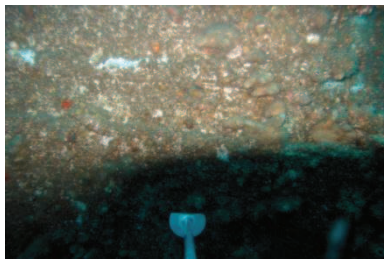
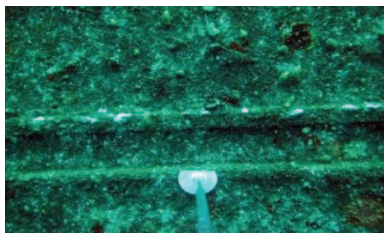
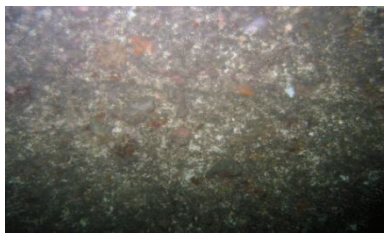
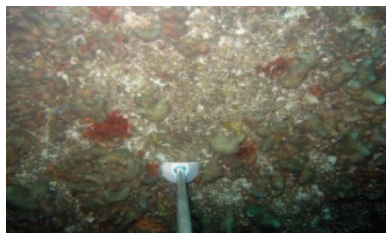
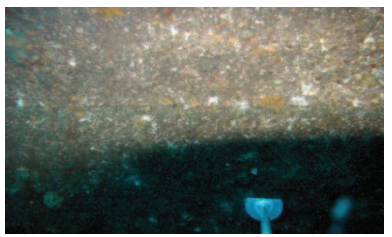
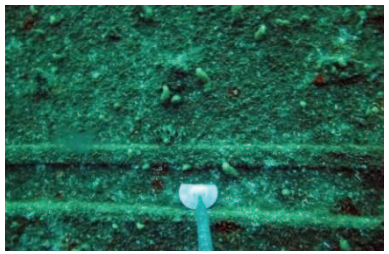
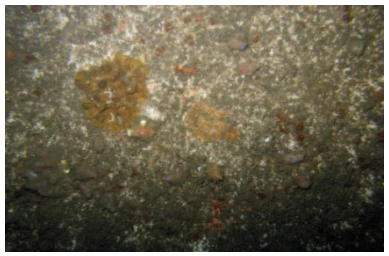
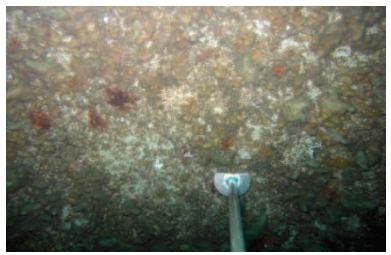
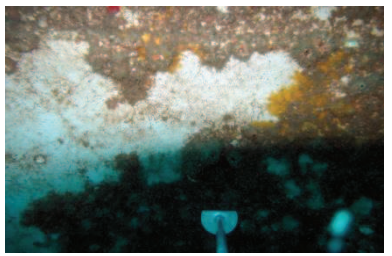
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 8: Horizontal Hull Starbord

Horizontal Hull Starbord

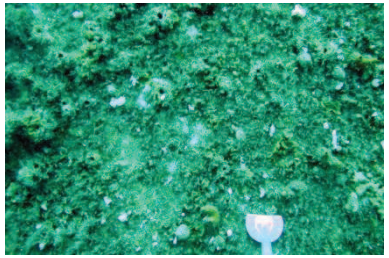
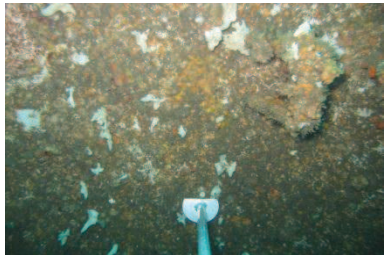
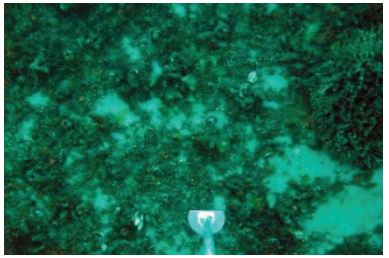
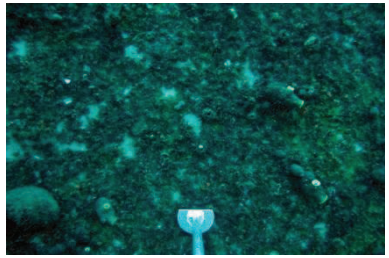
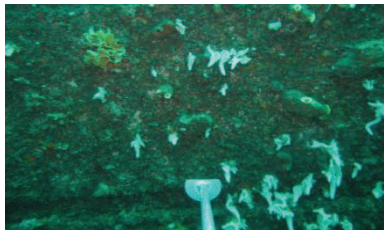
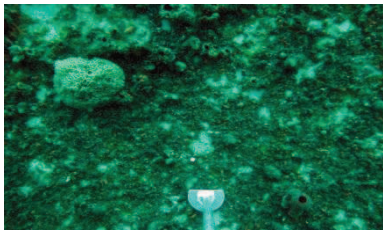
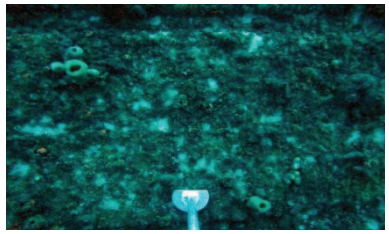
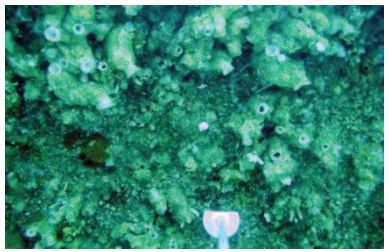
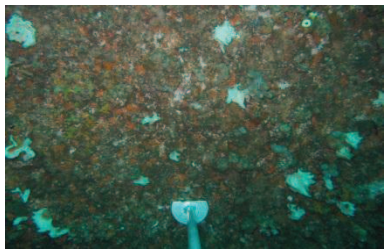
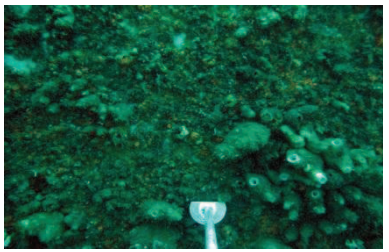
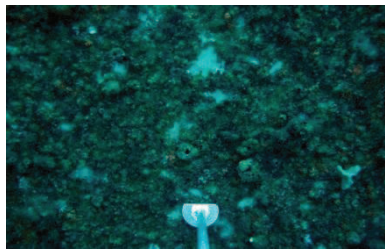
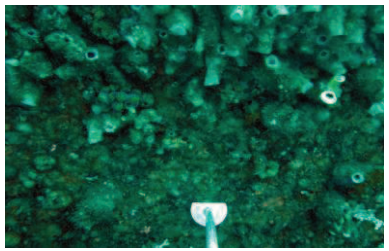
Monitoirng Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)	Monitoring Survey 9 (October 2013)
				
				
				

Plate 8 Continued: Horizontal Hull Starbord

Vertical Hull Port Bow

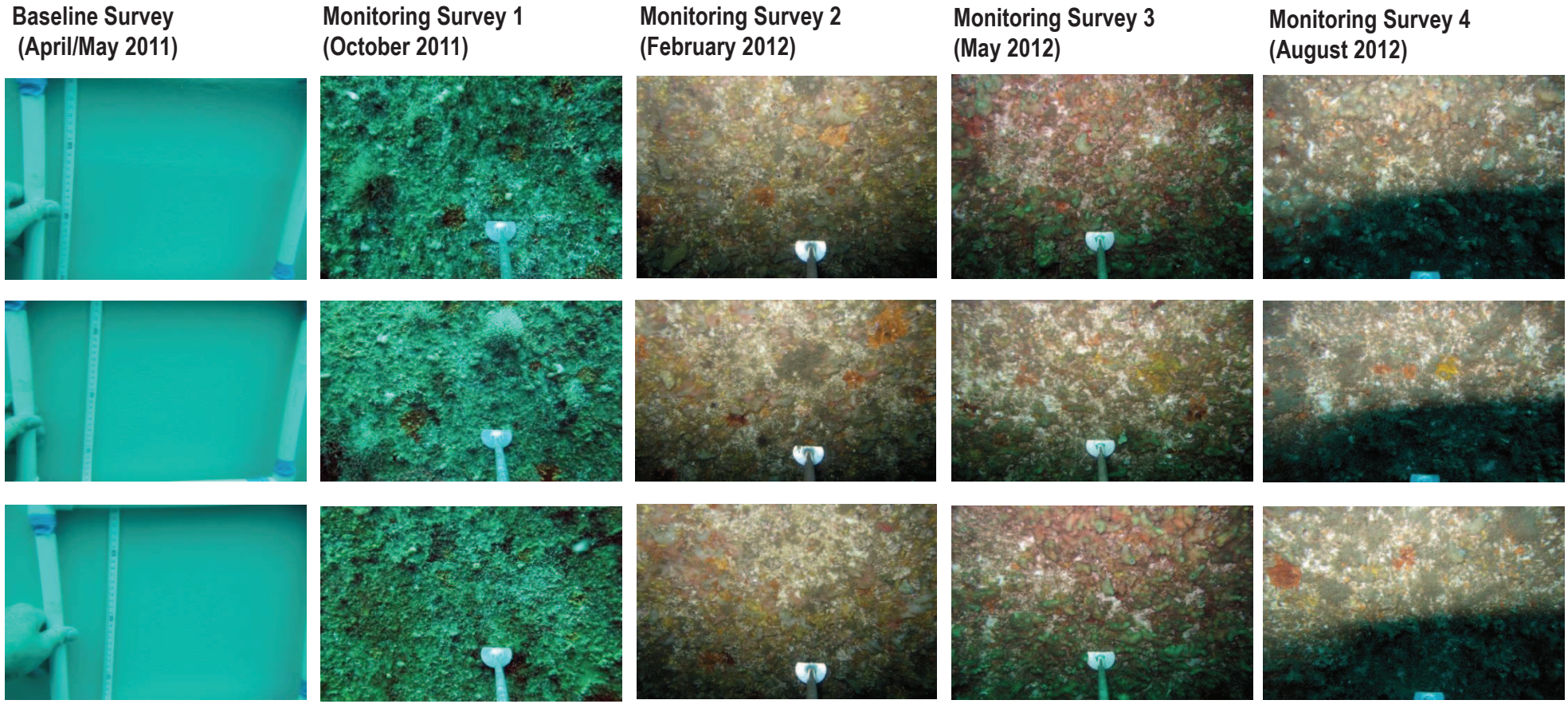


Plate 9: Vertical Hull Port Bow

Vertical Hull Port Bow

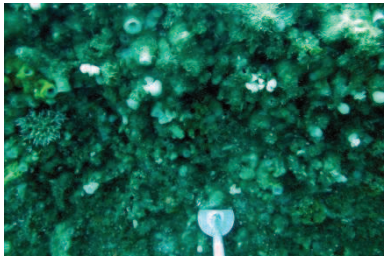
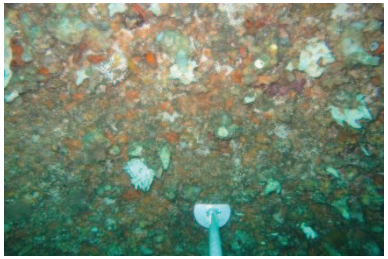
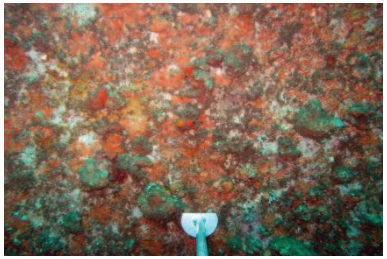
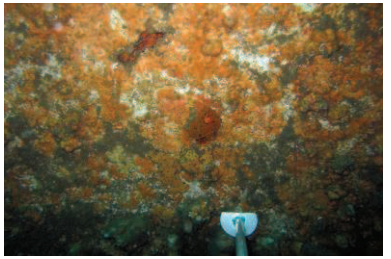
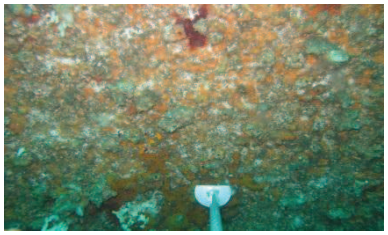
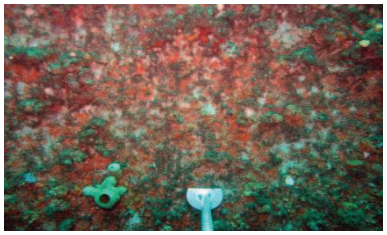
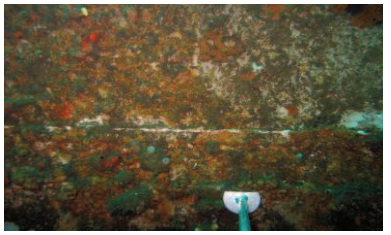
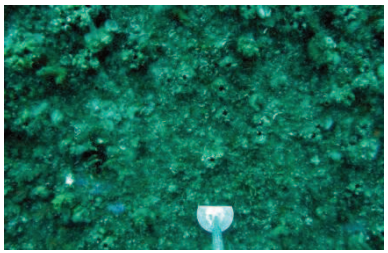
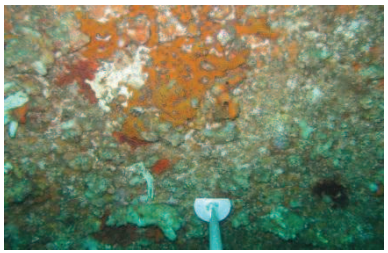
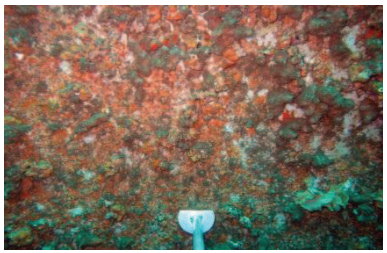
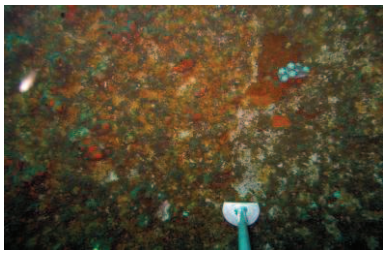
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)	Monitoring Survey 9 (October 2013)
				
				
				

Plate 9 Continued: Vertical Hull Port Bow

Vertical Hull Port Stern

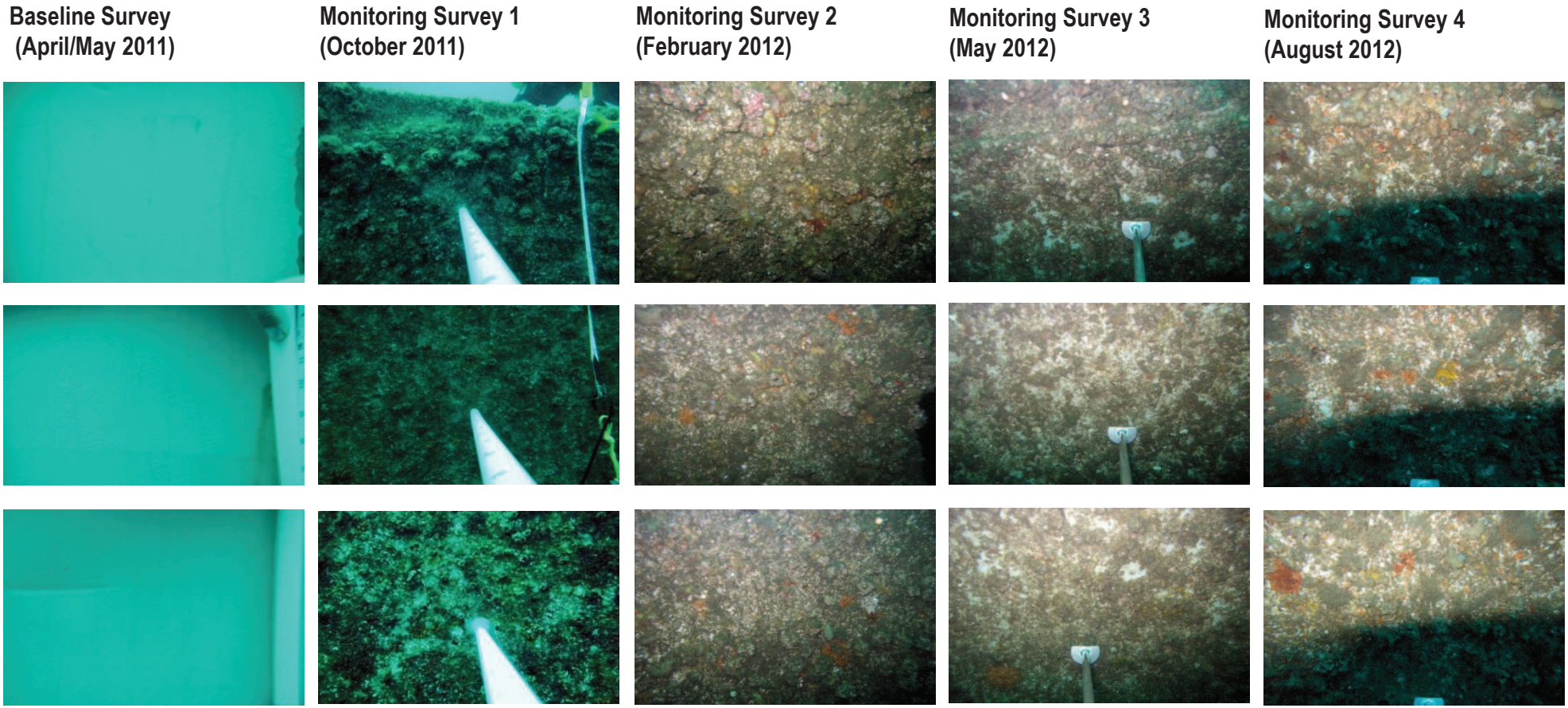


Plate 10: Vertical Hull Port Stern

Vertical Hull Port Stern

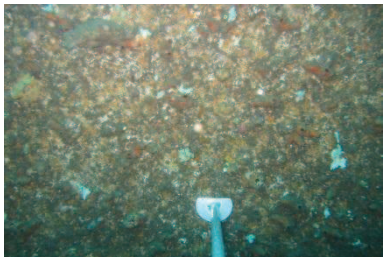
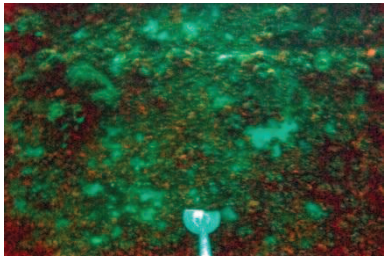
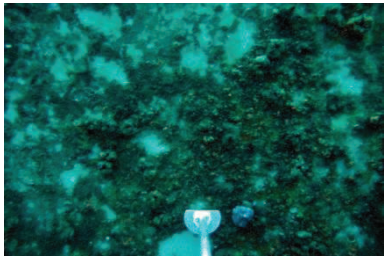
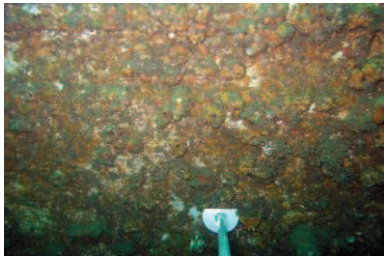
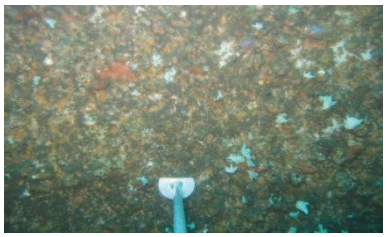
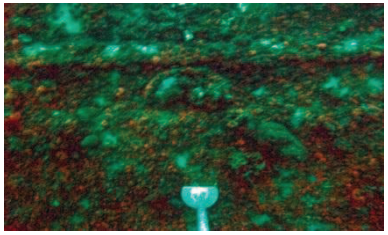
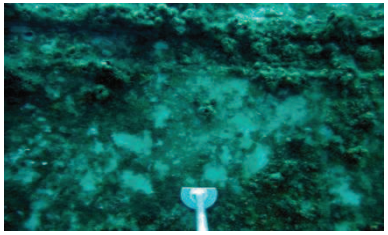
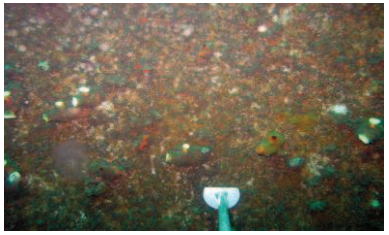
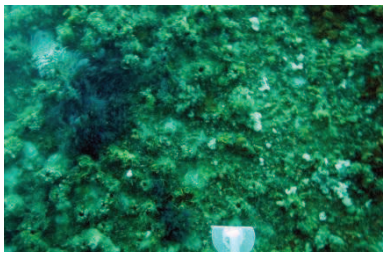
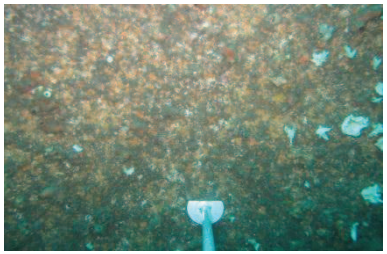
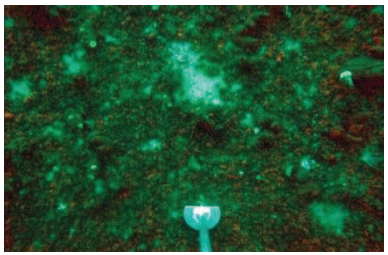
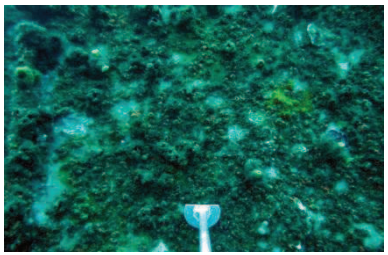
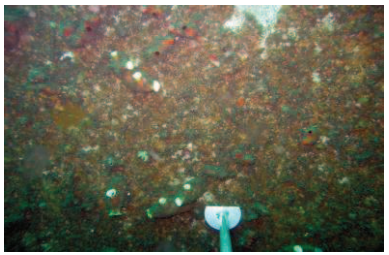
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)	Monitoring Survey 9 (October 2013)
				
				
				

Plate 10 Continued: Vertical Hull Port Stern

Vertical Hull Starbord Bow

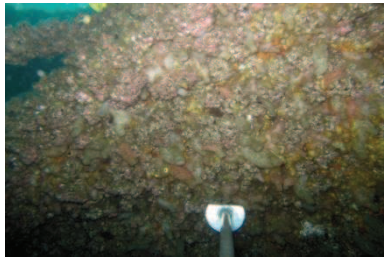
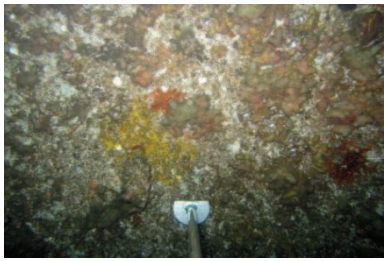
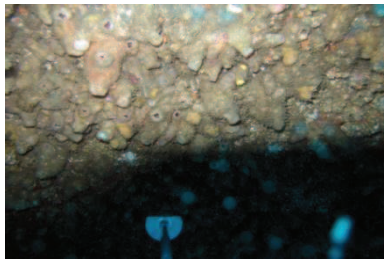
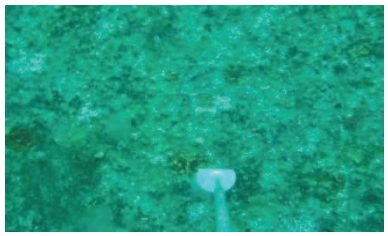
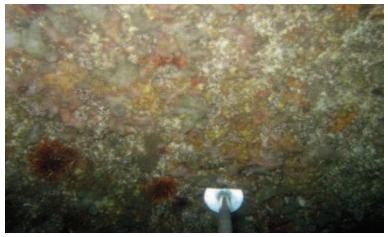
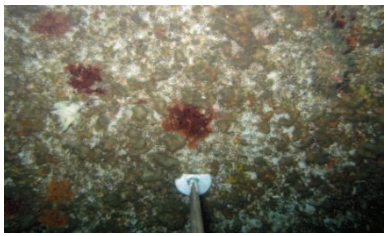
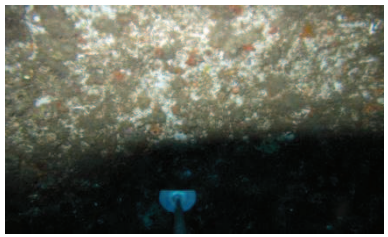
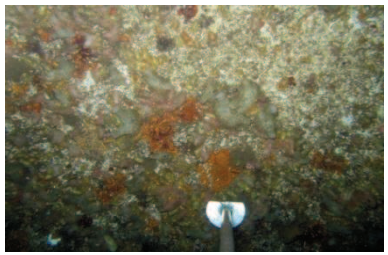
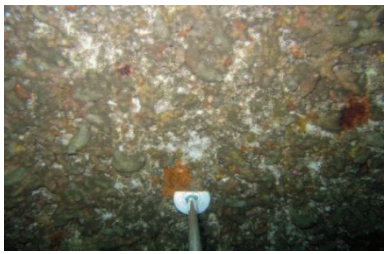
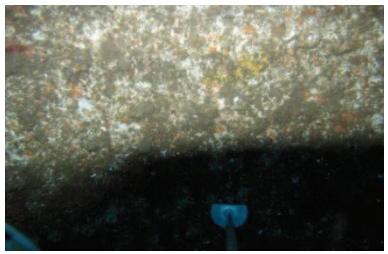
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 11: Vertical Hull Starbord Bow

Vertical Hull Starbord Bow

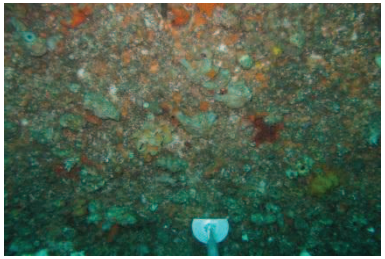
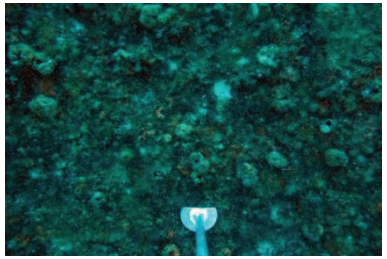
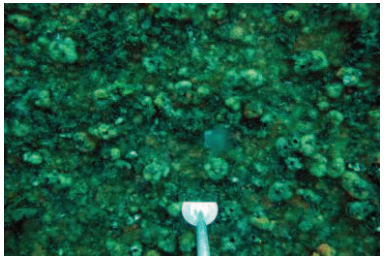
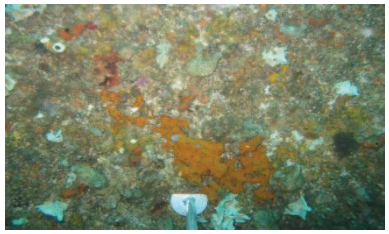
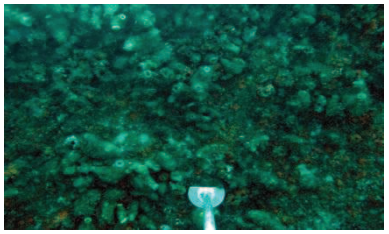
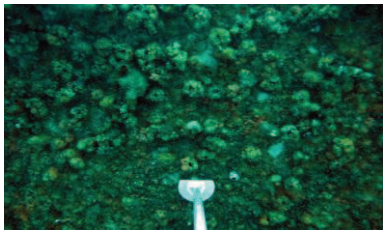
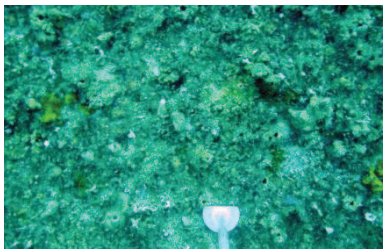
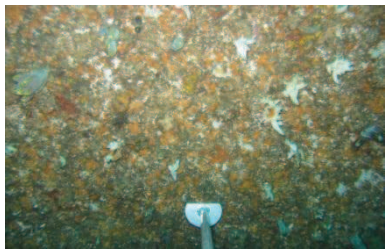
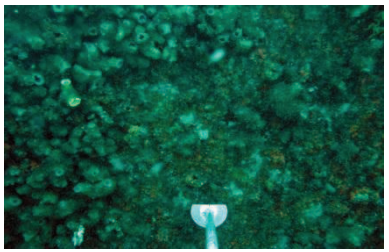
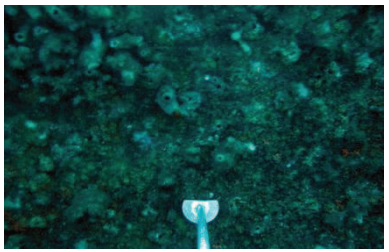
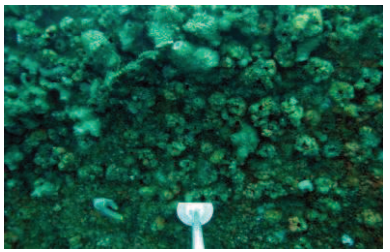
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)	Monitoring Survey 9 (October 2013)
				
				
				

Plate 11 Continued: Vertical Hull Starbord Bow

Vertical Hull Starbord Stern

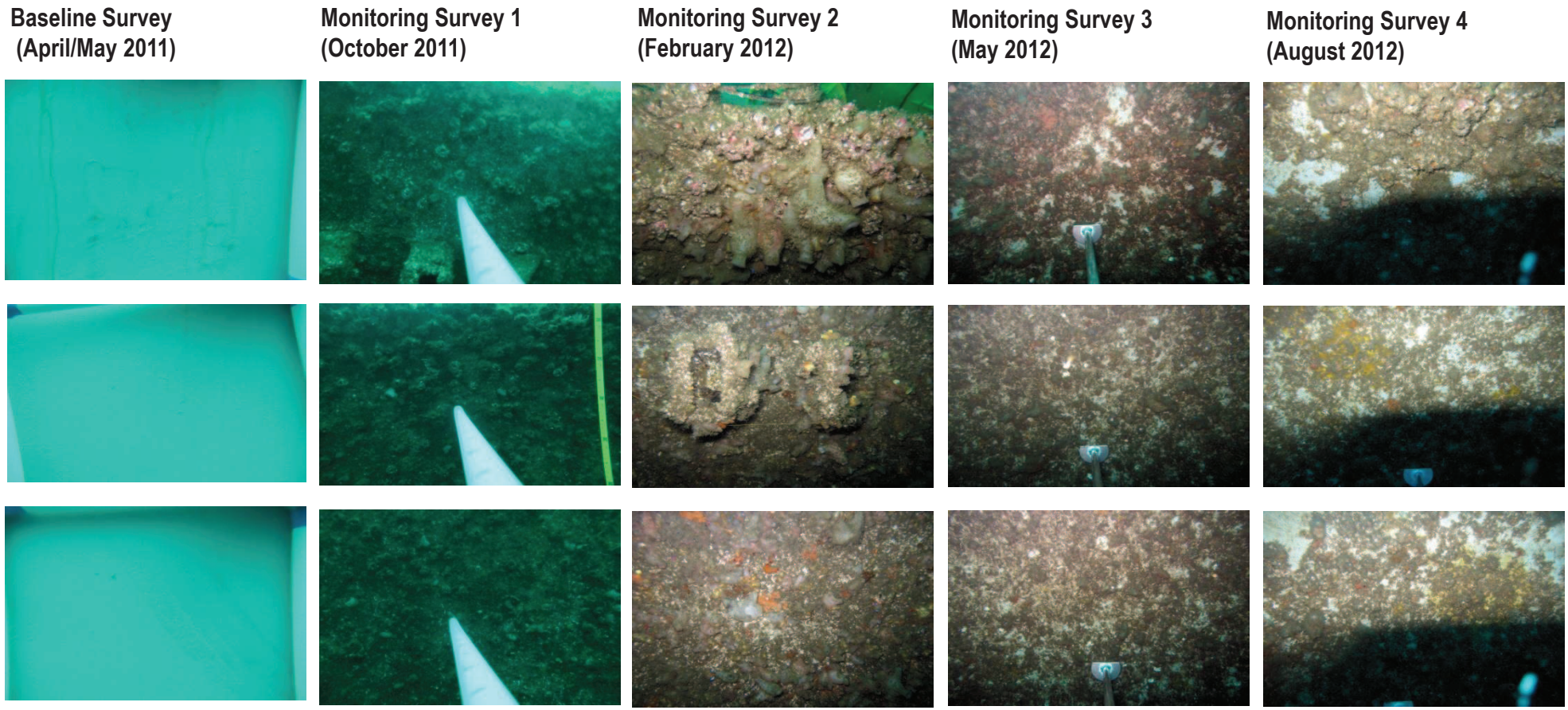


Plate 12: Vertical Hull Starbord Stern

Vertical Hull Starbord Stern

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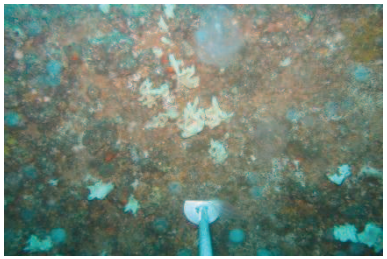
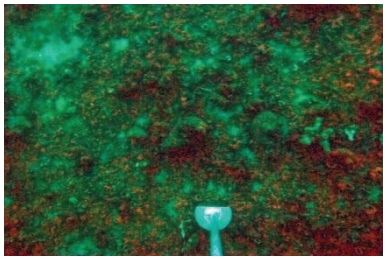
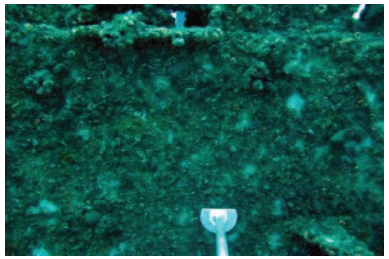
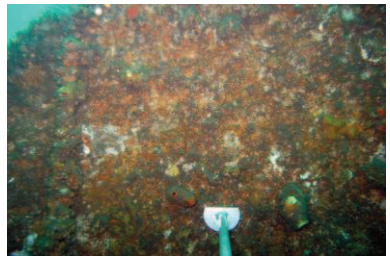
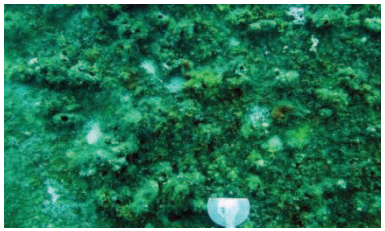
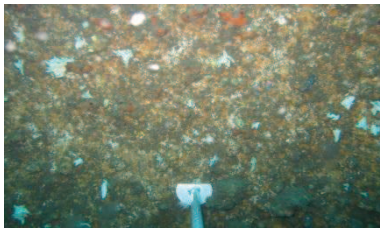
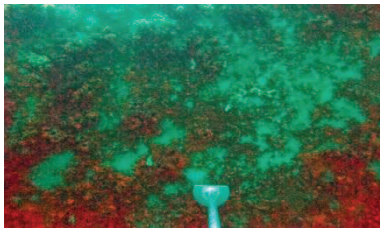
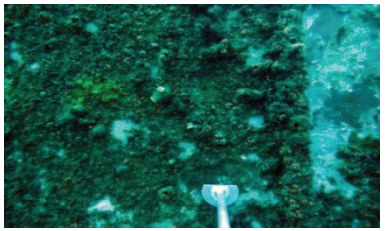
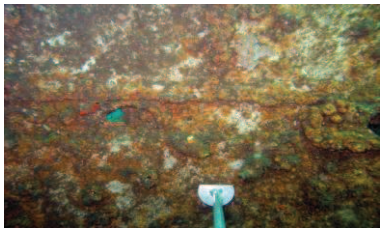
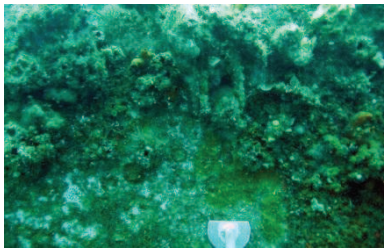
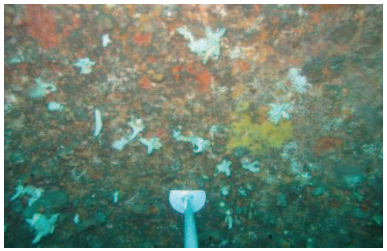
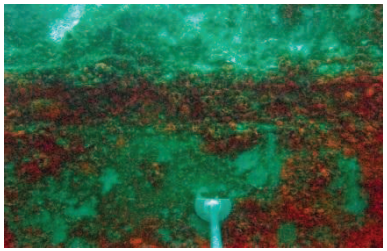
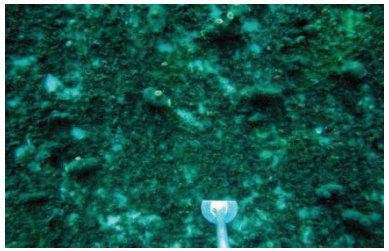
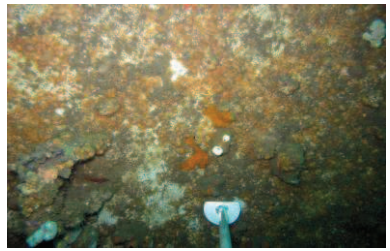
				
				
				

Plate 12 Continued: Vertical Hull Starbord Stern

Vertical Superstructure Port Bow

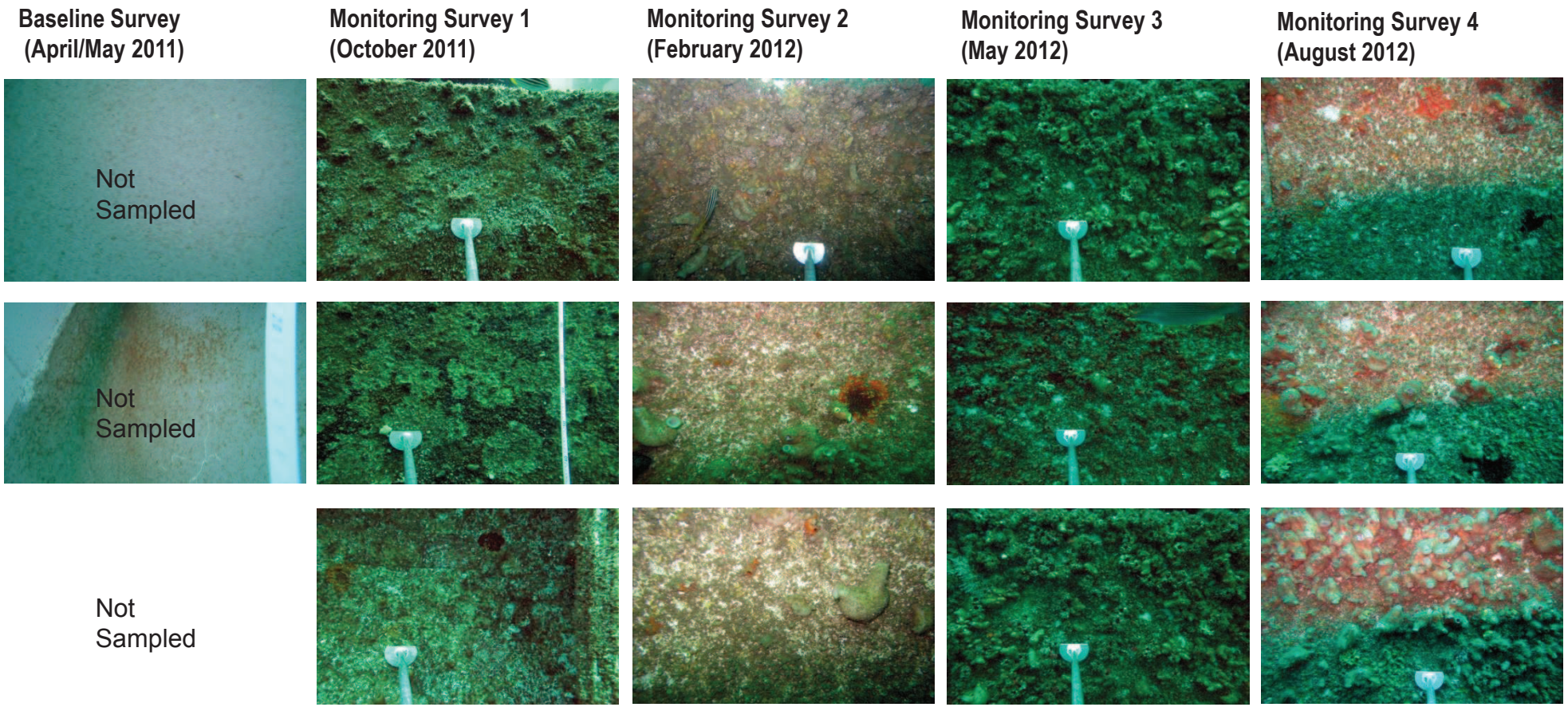


Plate 13: Vertical Superstructure Port Bow

Vertical Superstructure Port Bow

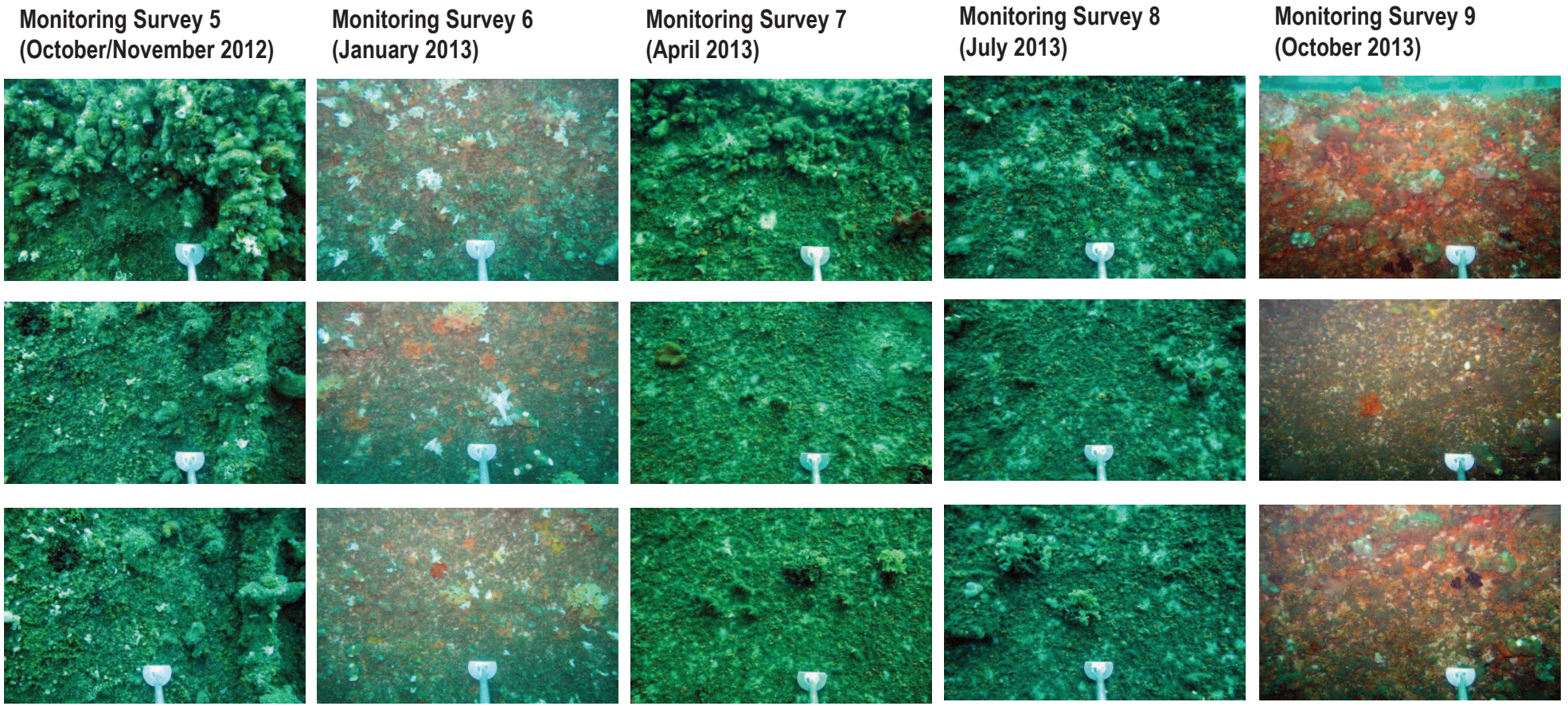


Plate 13 Continued: Vertical Superstructure Port Bow

Vertical Superstructure Port Stern

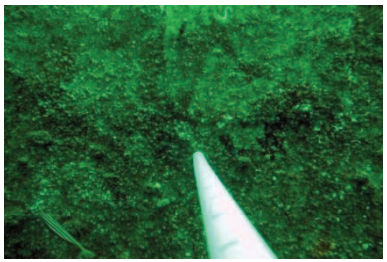
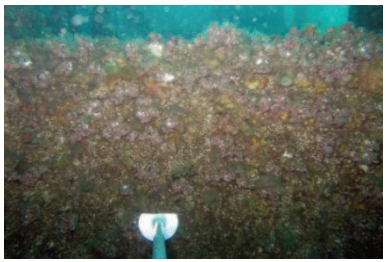
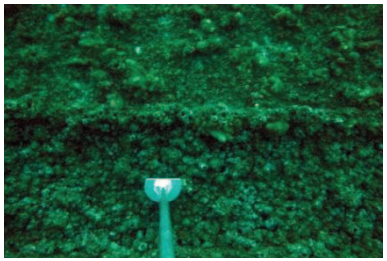
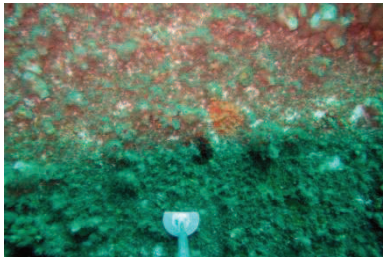
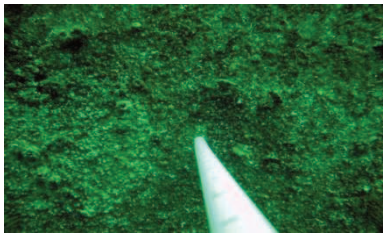
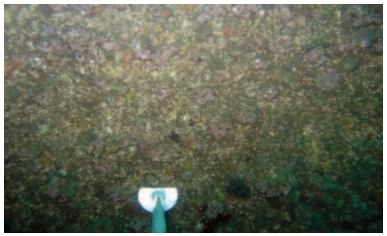
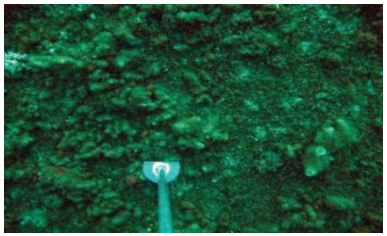
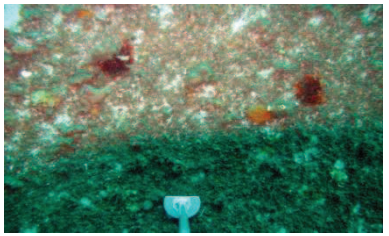
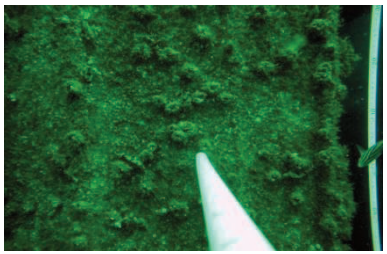
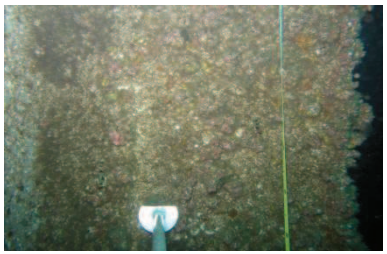
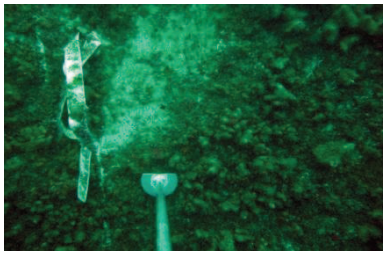
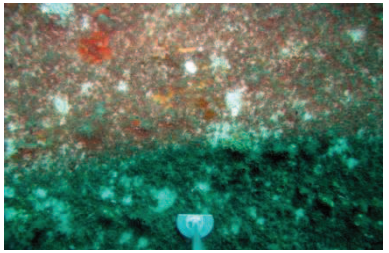
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
Not Sampled				
Not Sampled				
Not Sampled				

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)	Monitoring Survey 9 (October 2013)

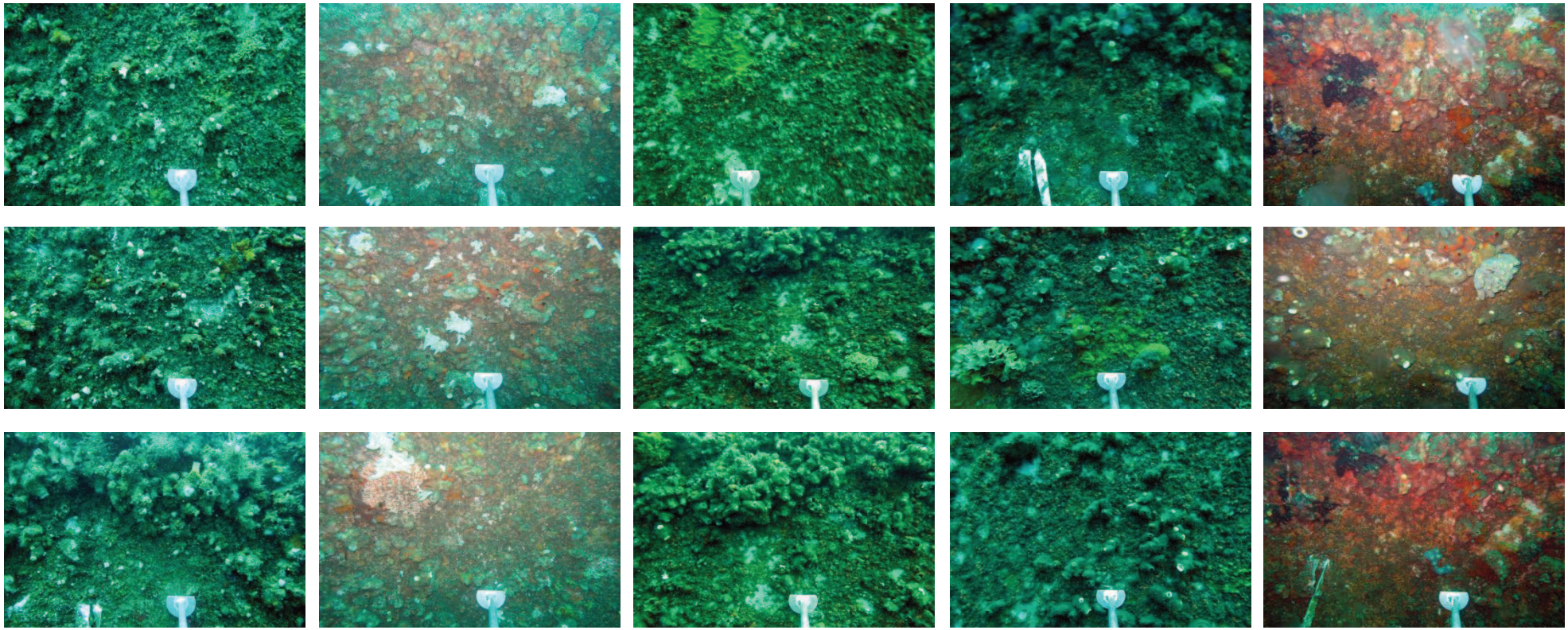


Plate 14 Continued: Vertical Superstructure Port Stern

Vertical Superstructure Starboard Bow

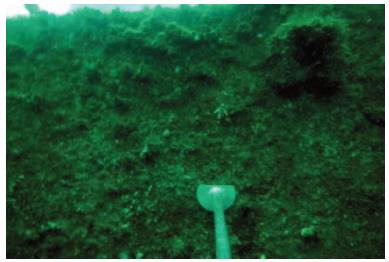
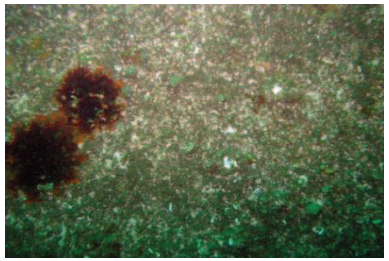
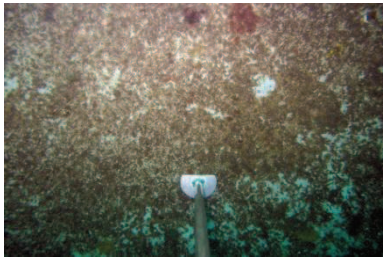
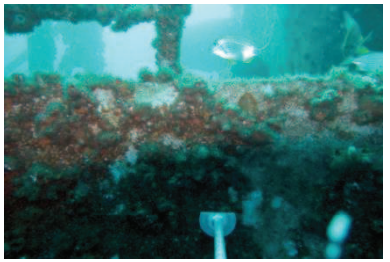
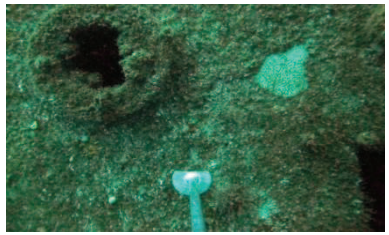
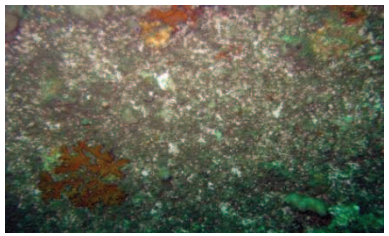
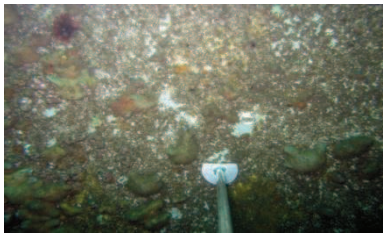
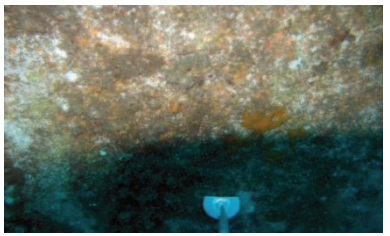
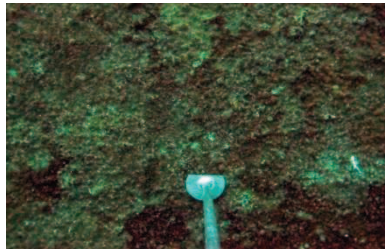
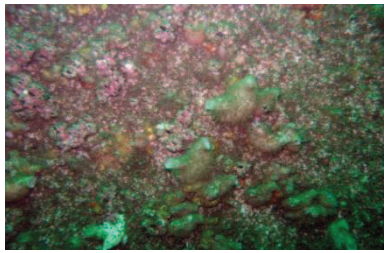
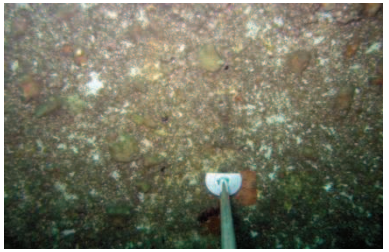
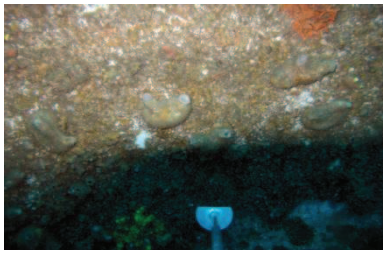
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
Not Sampled				
Not Sampled				
Not Sampled				

Plate 15: Vertical Superstructure Starboard Bow

Vertical Superstructure Starboard Bow

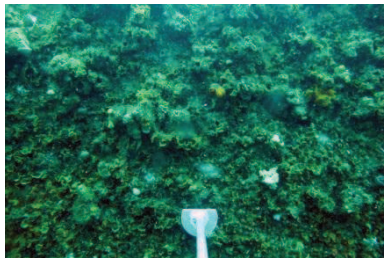
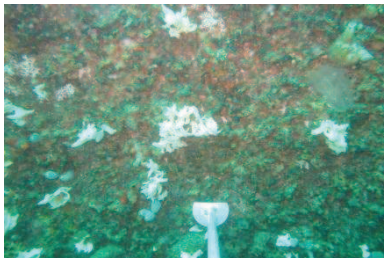
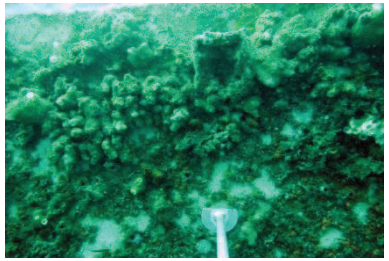
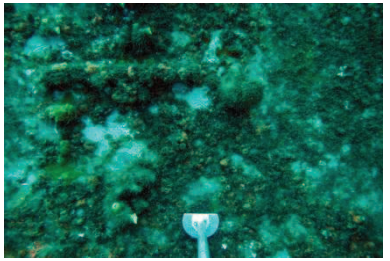
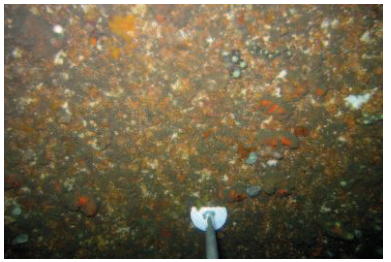
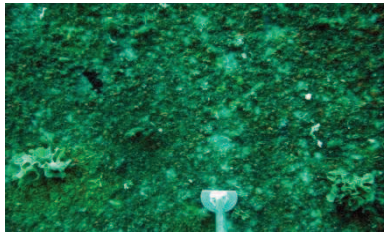
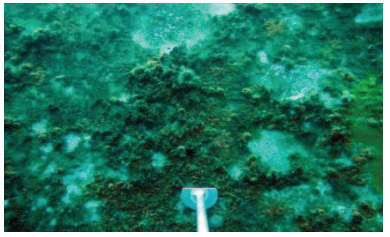
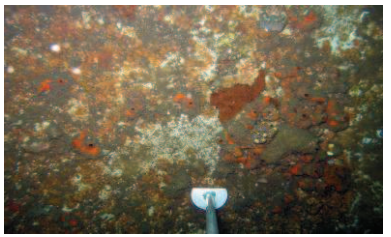
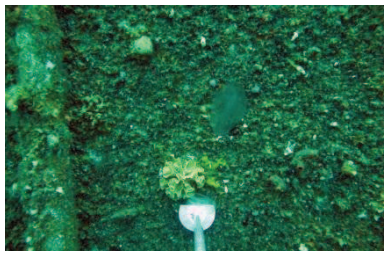
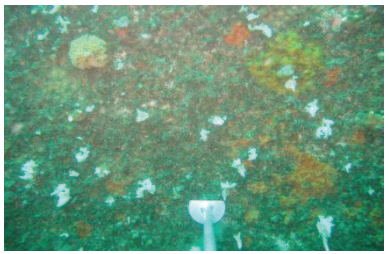
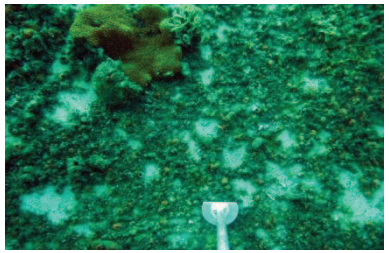
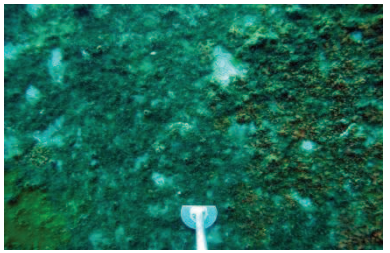
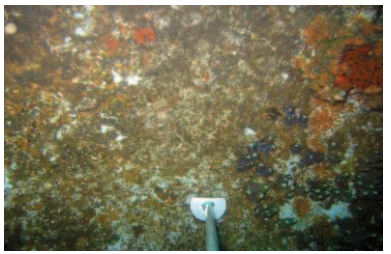
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)	Monitoring Survey 9 (October 2013)
				
				
				

Plate 15 Continued: Vertical Superstructure Starboard Bow

Vertical Superstructure Starboard Stern

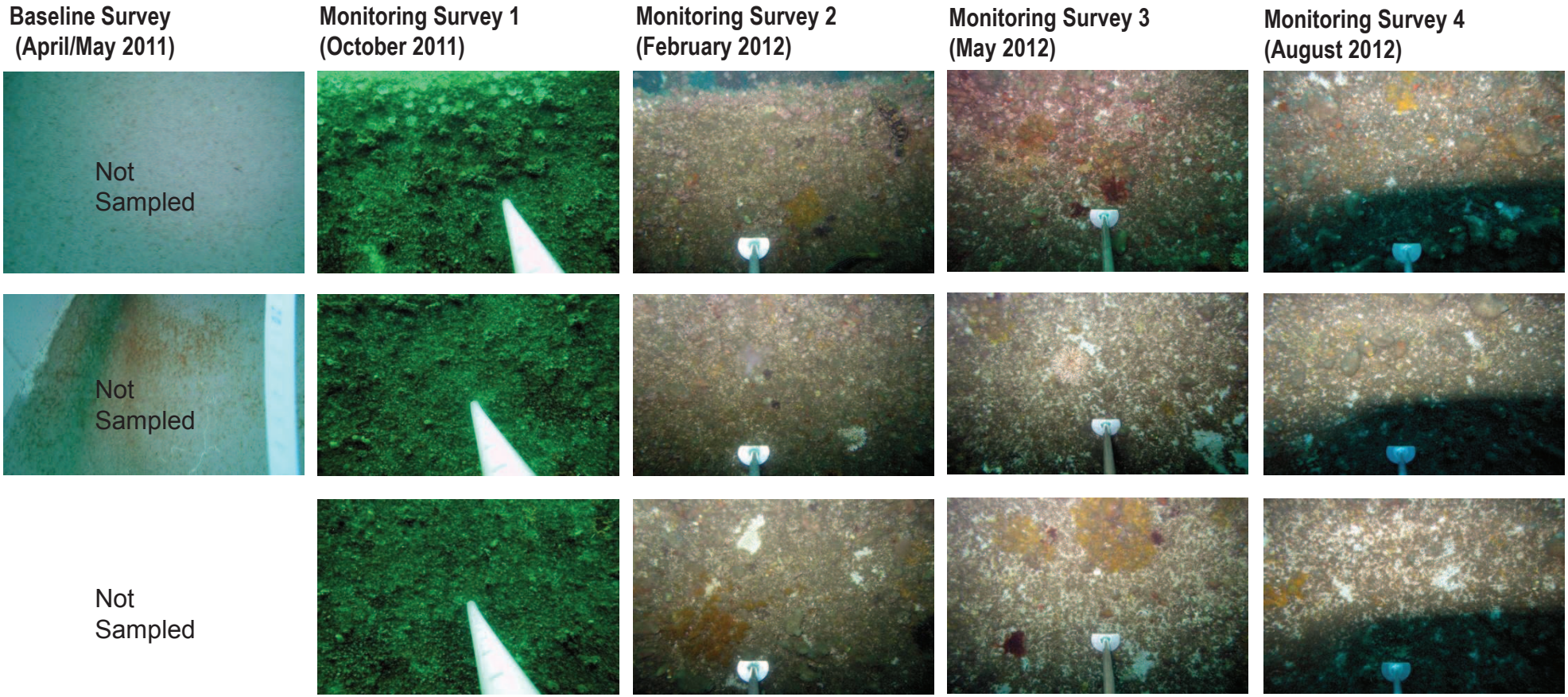


Plate 16: Vertical Superstructure Starboard Stern

Vertical Superstructure Starboard Stern

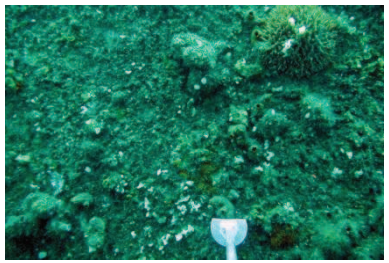
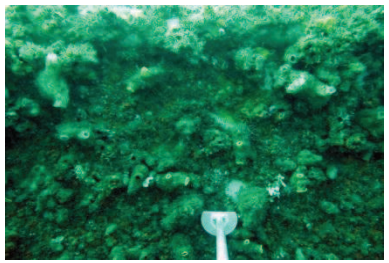
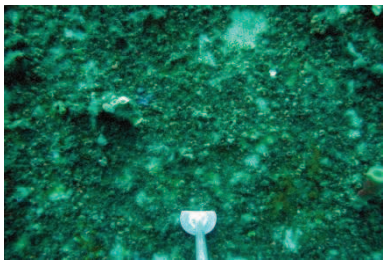
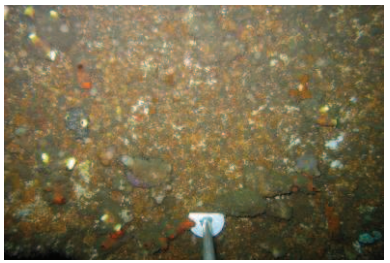
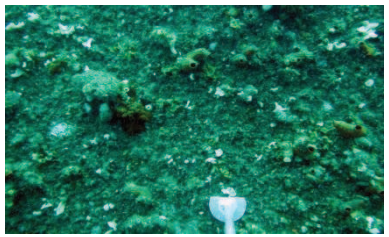
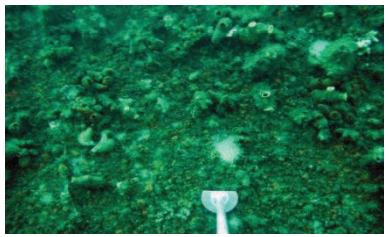
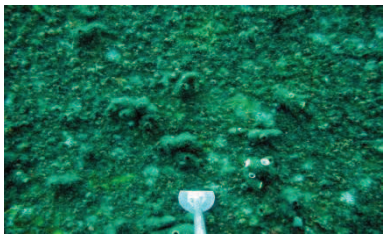
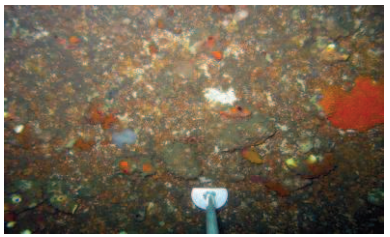
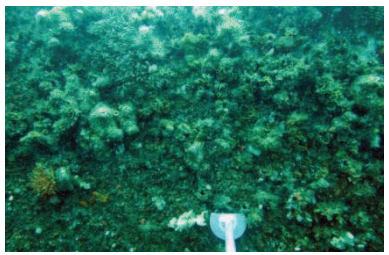
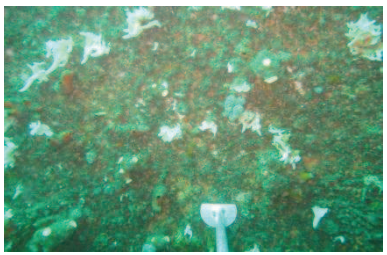
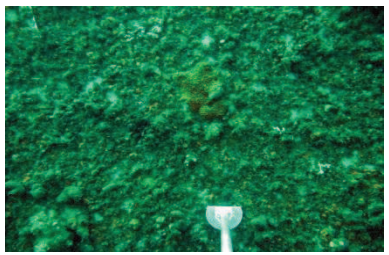
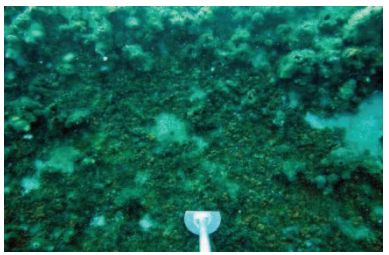
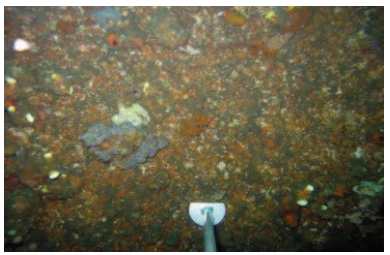
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)	Monitoring Survey 9 (October 2013)
				
				
				

Plate 16 Continued: Vertical Superstructure Starboard Stern

8 Appendices

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

Appendix A: Fixed Photo Locations and Descriptions

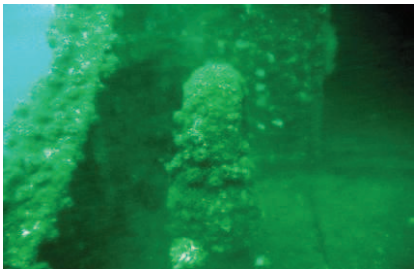
Fixed Photo: 1

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

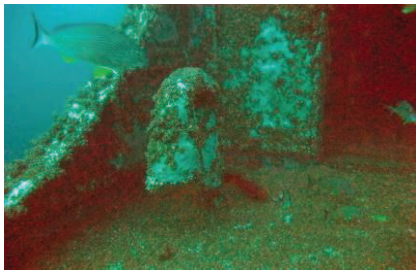
Depth: Approximately 27 m

Survey 1

Survey 2



Survey 3

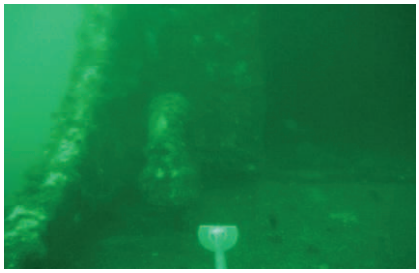


Survey 4

Survey 5

Survey 6

Survey 7



Survey 8

Survey 9

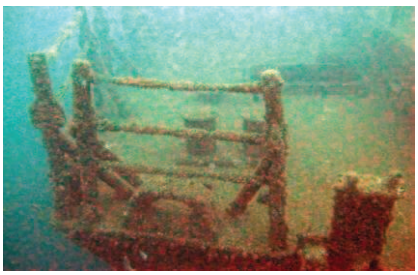
Appendix A: (Continued).

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

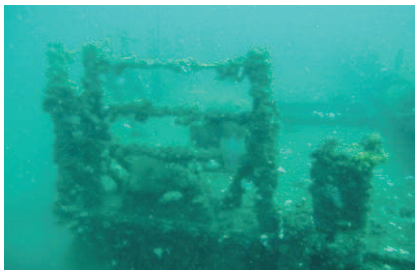
No Data

Survey 4

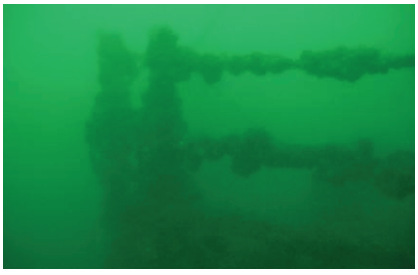
Survey 5

No Data

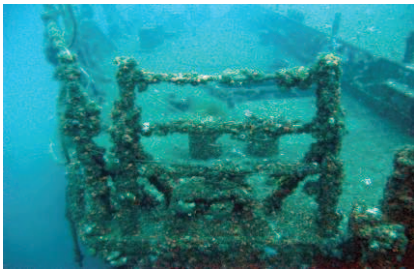
Survey 6



Survey 7



Survey 8



Survey 9

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.

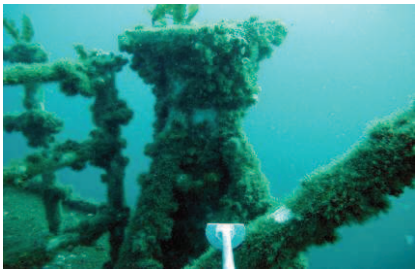
Depth: Approximately 23 m

Survey 1

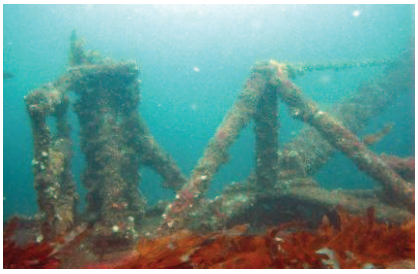
Survey 2

Survey 3

Survey 4



Survey 5



Survey 6

Survey 7

Survey 8

Survey 9

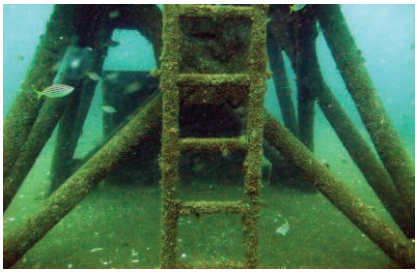
Appendix A: (Continued).

Fixed Photo: 4

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

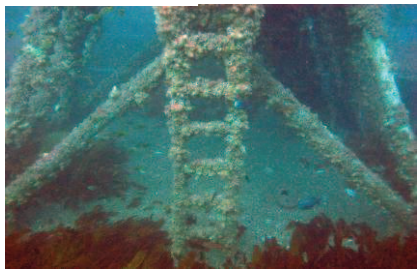
Depth: Approximately 23 m

Survey 1

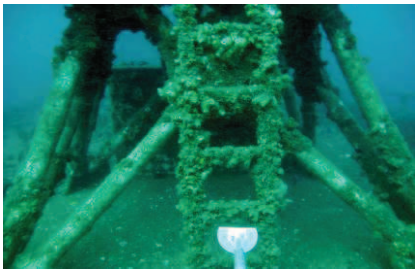


Survey 2

Survey 3



Survey 4



Survey 5

Survey 6

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

No Data

No Data

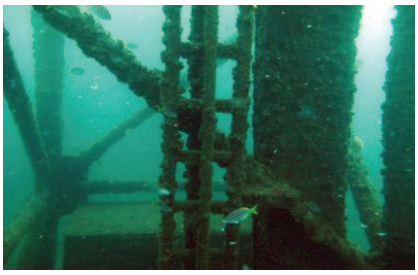
Appendix A: (Continued).

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

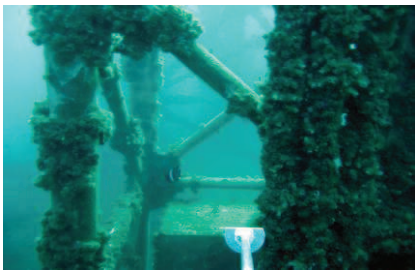
Survey 1



Survey 2

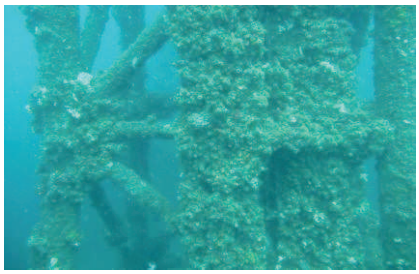
Survey 3

Survey 4



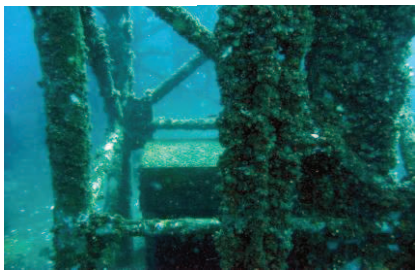
Survey 5

Survey 6



Survey 7

Survey 8



Survey 9

Appendix A: (Continued).

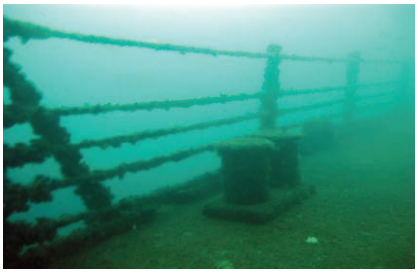
Fixed Photo: 6

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

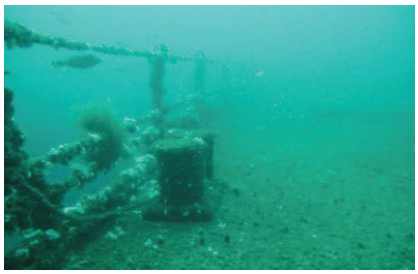


Survey 3

Survey 4

Survey 5

Survey 6



Survey 7

Survey 8

Survey 9

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

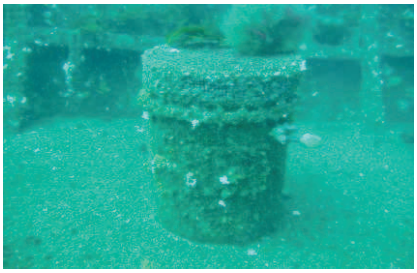
Survey 2

Survey 3

Survey 4

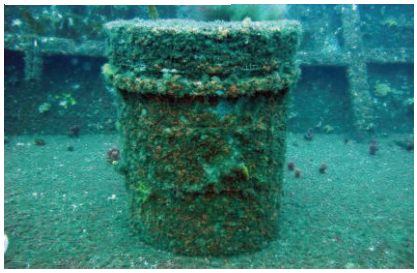
Survey 5

Survey 6



Survey 7

Survey 8



Survey 9

Appendix A: (Continued).

Fixed Photo: 8

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

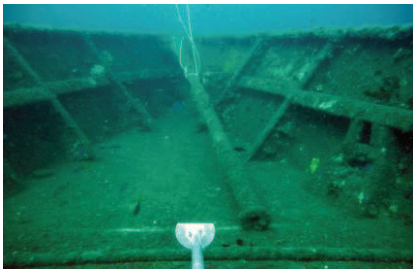
Depth: Approximately 25 m.

Survey 1

Survey 2

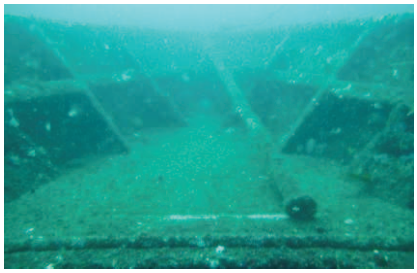
Survey 3

Survey 4

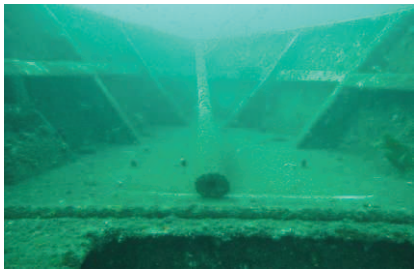


Survey 5

Survey 6

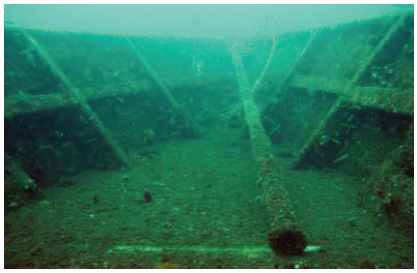


Survey 7



Survey 8

Survey 9



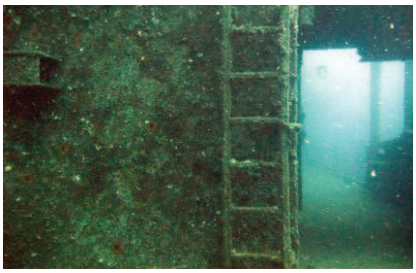
Appendix A: (Continued).

Fixed Photo: 9

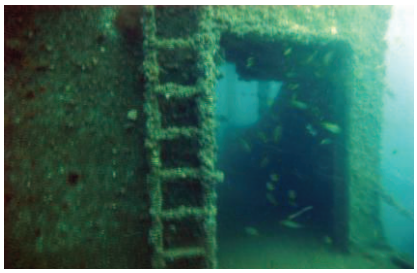
Location: Wall below the bridge on the starboard side. Photo taken standing on front deck 2 m in front of the ladder.

Depth: Approximately 26 m.

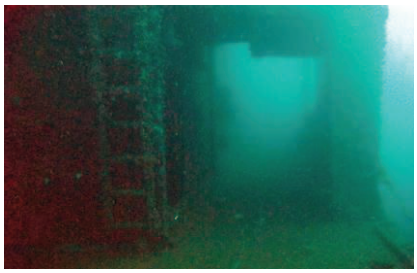
Survey 1



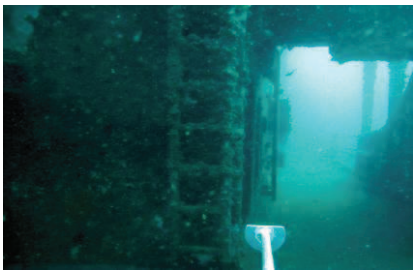
Survey 2



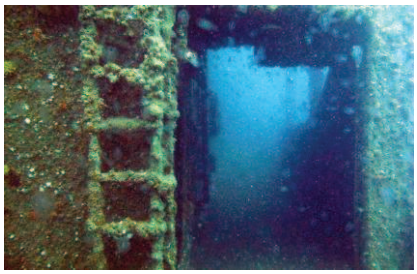
Survey 3



Survey 4



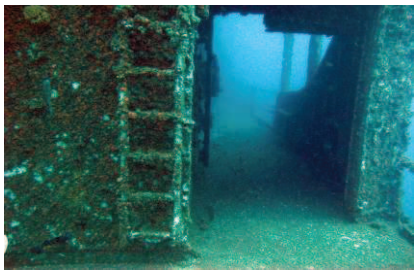
Survey 5



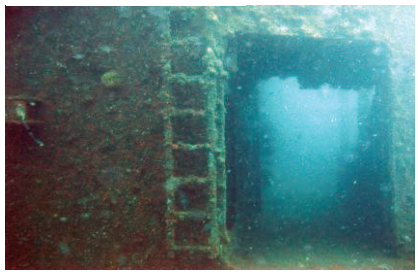
Survey 6

Survey 7

Survey 8



Survey 9



Appendix A: (Continued).

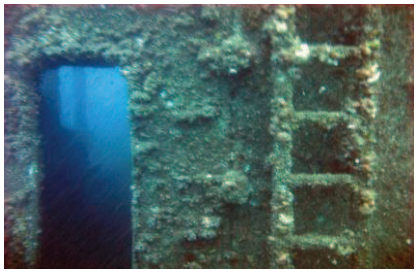
Fixed Photo: 10

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.

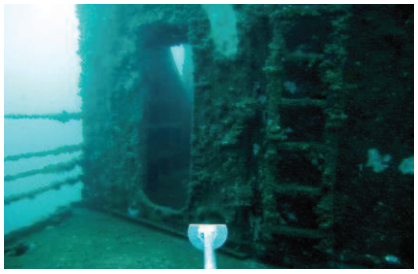
Survey 1

Survey 2



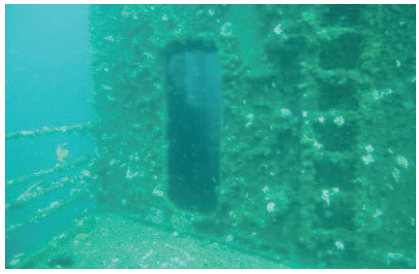
Survey 3

Survey 4



Survey 5

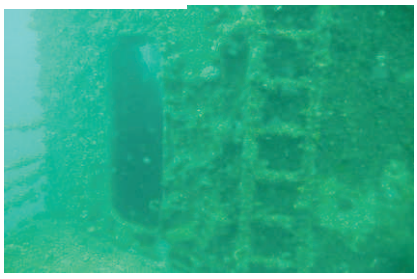
Survey 6



Survey 7

Survey 8

Survey 9



Appendix B: Mean percentage cover (± standard error) of reef communities for each transect analysed during Survey 9 (October 2013).

	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	17.14	9.32	0.00	0.00
Lobed Brown Algae	0.00	0.00	2.86	1.92	0.00	0.00
Orange Filamentous	0.40	0.25	0.00	0.00	0.61	0.40
Turfing Brown Algae	0.00	0.00	0.61	0.41	0.00	0.00
RHODOPHYTA						
Encrusting Coralline	0.00	0.00	1.22	1.22	0.00	0.00
Encrusting Red Algae	0.00	0.00	25.71	9.45	5.25	1.79
Thin Branching Red Algae	0.00	0.00	0.20	0.20	0.00	0.00
BRYOZOA						
Biflustra perfragilis	0.00	0.00	0.00	0.00	0.20	0.20
Encrusting Orange Bryozoan	0.20	0.20	1.84	0.94	0.20	0.20
Encrusting Yellow 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	3.44	2.44	0.20	0.20	0.61	0.40
White Encrusting Sponge	0.41	0.25	0.00	0.00	0.61	0.61
White Globular Sponge	0.00	0.00	0.00	0.00	0.00	0.00
White Papillate Sponge	0.00	0.00	0.00	0.00	0.00	0.00
Yellow Encrusting Sponge	0.00	0.00	0.00	0.00	0.00	0.00
Pink Spikey Sponge	0.20	0.20	0.00	0.00	0.20	0.20
Red Tubular Solitary Sponge	0.40	0.40	0.41	0.41	0.20	0.20
ASCIDIAN						
Botryloides magnicoecum	0.40	0.40	0.00	0.00	0.20	0.20
Herdmania momus	0.20	0.20	0.00	0.00	0.20	0.20
Orange Colonial Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
Orange Bubbly Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
White Encrusting Solitary Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
ABIOTIC						
Bare Ships Surface	0.61	0.40	0.41	0.41	0.00	0.00
Serpulid Tubes	0.00	0.00	0.20	0.20	0.61	0.61
CNIDARIAN						
Hydroid 2	0.61	0.40	0.41	0.41	0.00	0.00
Tiny Orange Anemone	0.20	0.20	0.00	0.00	0.40	0.25
MATRIX						
Barnacle,Sediment,Brown Fil	0.00	0.00	0.00	0.00	0.00	0.00
Early Colonising Matrix	0.00	0.00	0.61	0.61	4.04	2.45
Large Barnacle,Sediment,Brown Fil	0.00	0.00	0.00	0.00	0.00	0.00
Serpulid Barnacle and Encrusting Algae Matrix	91.31	2.27	42.24	16.20	84.65	4.83
Serpulid Matrix	1.62	1.62	1.02	0.65	1.01	0.45
FISH MOBILE						
Fish in Frame	0.00	0.00	1.02	0.56	0.00	0.00
INDETERMINATE						
Unknown White Crust	0.00	0.00	3.88	1.59	1.01	0.78
TAPE, WAND, SHADOW						
Shadow	0.00	0.00	0.00	0.00	0.00	0.00
Wand	1.20	0.20	2.00	0.00	1.00	0.00

Appendix B: (Continued).

	Deck Starbord Bow		Deck Starbord Mid		Deck Starbord Stern	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
PHAEOPHYTA						
Brown Filamentous	0.00	0.00	1.63	1.63	0.00	0.00
Ecklonia radiata	2.45	2.45	14.49	7.83	0.00	0.00
Lobed Brown Algae	0.00	0.00	1.22	0.75	0.00	0.00
Orange Filamentous	0.00	0.00	0.00	0.00	1.62	1.62
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	1.82	0.50	7.96	3.57	5.45	1.68
Thin Branching Red Algae	0.00	0.00	6.31	1.18	0.40	0.40
BRYOZOA						
Biflustra perfragilis	0.20	0.20	0.00	0.00	0.00	0.00
Encrusting Orange Bryozoan	0.41	0.41	0.20	0.20	0.20	0.20
Encrusting Yellow 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	0.20	0.20	3.06	1.94	1.63	1.19
White Encrusting Sponge	0.20	0.20	0.00	0.00	0.20	0.20
White Globular Sponge	0.20	0.20	0.20	0.20	0.00	0.00
White Papillate Sponge	0.81	0.59	0.00	0.00	0.40	0.40
Yellow Encrusting Sponge	0.00	0.00	0.41	0.41	0.20	0.20
Pink Spikey Sponge	0.20	0.20	0.20	0.20	0.00	0.00
Red Tubular Solitary Sponge	0.00	0.00	0.00	0.00	0.41	0.25
ASCIDIAN						
Botryloides magnicoecum	0.20	0.20	0.82	0.82	0.40	0.40
Herdmania momus	1.22	0.82	0.20	0.20	1.21	0.74
Orange Colonial Ascidian	0.00	0.00	0.41	0.25	0.00	0.00
Orange Bubbly Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
White Encrusting Solitary Ascidian	0.40	0.25	0.00	0.00	0.00	0.00
ABIOTIC						
Bare Ships Surface	0.00	0.00	2.24	1.27	0.20	0.20
Serpulid Tubes	0.00	0.00	0.00	0.00	0.00	0.00
CNIDARIAN						
Hydroid 2	0.00	0.00	0.00	0.00	0.00	0.00
Tiny Orange Anemone	1.41	0.75	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
Early Colonising Matrix	0.00	0.00	0.41	0.41	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	89.25	1.86	58.80	10.96	87.26	3.15
Serpulid Matrix	0.61	0.25	0.00	0.00	0.40	0.40
FISH MOBILE						
Fish in Frame	0.20	0.20	0.41	0.25	0.00	0.00
INDETERMINATE						
Unknown White Crust	0.20	0.20	1.02	0.64	0.00	0.00
TAPE, WAND, SHADOW						
Shadow	0.00	0.00	0.00	0.00	0.00	0.00
Wand	1.20	0.37	1.80	0.20	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	6.33	1.81	0.00	0.00	7.86	1.96
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	0.20	0.20	0.00	0.00	0.00	0.00
Turfing Brown Algae	0.00	0.00	0.00	0.00	0.00	0.00
RHODOPHYTA						
Encrusting Coralline	0.00	0.00	0.00	0.00	0.00	0.00
Encrusting Red Algae	0.00	0.00	0.00	0.00	0.00	0.00
Thin Branching Red Algae	0.00	0.00	0.00	0.00	0.00	0.00
BRYOZOA						
Biflustra perfragilis	0.62	0.62	0.00	0.00	0.00	0.00
Encrusting Orange Bryozoan	0.00	0.00	0.00	0.00	0.00	0.00
Encrusting Yellow Bryozoan	0.00	0.00	0.00	0.00	0.00	0.00
Triphyllozoan sp	0.00	0.00	0.17	0.17	0.00	0.00
SPONGE						
Orange Encrusting Sponge	0.61	0.41	1.22	0.84	0.00	0.00
White Encrusting Sponge	0.00	0.00	0.00	0.00	0.00	0.00
White Globular Sponge	0.00	0.00	0.17	0.17	0.20	0.20
White Papillate Sponge	0.00	0.00	0.00	0.00	0.00	0.00
Yellow Encrusting Sponge	0.20	0.20	0.00	0.00	0.00	0.00
Pink Spikey Sponge	0.00	0.00	0.00	0.00	0.00	0.00
Red Tubular Solitary Sponge	0.00	0.00	0.00	0.00	0.00	0.00
ASCIDIAN						
Botryloides magnicoecum	0.20	0.20	1.38	0.52	0.00	0.00
Herdmania momus	11.39	4.82	10.08	6.45	5.40	0.79
Orange Colonial Ascidian	0.21	0.21	0.35	0.22	2.27	0.59
Orange Bubbly Ascidian	0.00	0.00	0.17	0.17	0.00	0.00
White Encrusting Solitary Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
ABIOTIC						
Bare Ships Surface	0.81	0.38	0.18	0.18	1.44	0.77
Serpulid Tubes	0.00	0.00	0.00	0.00	0.00	0.00
CNIDARIAN						
Hydroid 2	0.41	0.41	0.00	0.00	0.00	0.00
Tiny Orange Anemone	8.16	3.58	3.68	1.38	5.77	4.04
MATRIX						
Barnacle,Sediment,Brown Fil	0.20	0.20	0.35	0.35	0.00	0.00
Early Colonising Matrix	6.10	1.59	0.53	0.24	4.56	1.20
Large Barnacle,Sediment,Brown Fil	8.03	6.31	15.20	6.63	2.68	0.95
Serpulid Barnacle and Encrusting Algae Matrix	56.51	8.67	66.51	7.61	69.80	6.40
Serpulid Matrix	0.00	0.00	0.00	0.00	0.00	0.00
FISH MOBILE						
Fish in Frame	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	0.20	0.20	2.50	0.96	1.00	0.77
Wand	1.80	0.20	1.50	0.34	2.01	0.00

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	1.82	1.37	0.00	0.00	1.22	0.75
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	0.20	0.20	0.00	0.00	0.00	0.00
Turfing Brown Algae	0.00	0.00	0.00	0.00	0.00	0.00
RHODOPHYTA						
Encrusting Coralline	0.00	0.00	0.00	0.00	0.00	0.00
Encrusting Red Algae	0.00	0.00	0.00	0.00	0.00	0.00
Thin Branching Red Algae	0.00	0.00	0.00	0.00	0.00	0.00
BRYOZOA						
Biflustra perfragilis	0.00	0.00	0.00	0.00	0.00	0.00
Encrusting Orange Bryozoan	0.00	0.00	0.00	0.00	0.00	0.00
Encrusting Yellow Bryozoan	0.00	0.00	0.00	0.00	0.00	0.00
Triphyllozoan sp	0.00	0.00	0.21	0.21	0.00	0.00
SPONGE						
Orange Encrusting Sponge	0.40	0.40	0.00	0.00	0.20	0.20
White Encrusting Sponge	0.00	0.00	0.00	0.00	0.00	0.00
White Globular Sponge	0.00	0.00	0.00	0.00	0.20	0.20
White Papillate Sponge	0.00	0.00	0.00	0.00	0.00	0.00
Yellow Encrusting Sponge	0.00	0.00	0.00	0.00	0.00	0.00
Pink Spikey Sponge	0.00	0.00	0.00	0.00	0.00	0.00
Red Tubular Solitary Sponge	0.00	0.00	0.00	0.00	0.00	0.00
ASCIDIAN						
Botryloides magnicoecum	0.20	0.20	0.21	0.21	1.01	0.45
Herdmania momus	5.45	1.68	2.63	2.37	1.42	0.25
Orange Colonial Ascidian	0.00	0.00	0.00	0.00	0.41	0.41
Orange Bubbly Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
White Encrusting Solitary Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
ABIOTIC						
Bare Ships Surface	2.22	0.87	0.43	0.27	0.20	0.20
Serpulid Tubes	0.00	0.00	0.00	0.00	0.00	0.00
CNIDARIAN						
Hydroid 2	0.00	0.00	0.00	0.00	0.00	0.00
Tiny Orange Anemone	1.21	1.21	3.02	0.65	6.68	1.51
MATRIX						
Barnacle,Sediment,Brown Fil	0.00	0.00	0.63	0.43	0.00	0.00
Early Colonising Matrix	13.49	5.41	0.00	0.00	38.94	8.41
Large Barnacle,Sediment,Brown Fil	5.86	4.31	34.74	8.51	5.09	1.86
Serpulid Barnacle and Encrusting Algae Matrix	68.95	6.12	57.46	10.11	44.62	8.29
Serpulid Matrix	0.00	0.00	0.00	0.00	0.00	0.00
FISH MOBILE						
Fish in Frame	0.20	0.20	0.66	0.66	0.00	0.00
INDETERMINATE						
Unknown White Crust	0.00	0.00	0.00	0.00	0.00	0.00
TAPE, WAND, SHADOW						
Shadow	0.00	0.00	5.20	1.50	0.80	0.20
Wand	0.80	0.20	1.20	0.37	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	0.00	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	0.00	0.00	3.07	1.42	0.00	0.00
Thin Branching Red Algae	0.00	0.00	0.00	0.00	0.00	0.00
BRYOZOA						
Biflustra perfragilis	0.00	0.00	0.00	0.00	0.00	0.00
Encrusting Orange Bryozoan	0.20	0.20	0.41	0.41	0.26	0.26
Encrusting Yellow Bryozoan	0.00	0.00	0.00	0.00	0.26	0.26
Triphyllozoan sp	0.00	0.00	0.00	0.00	0.00	0.00
SPONGE						
Orange Encrusting Sponge	0.00	0.00	0.00	0.00	0.51	0.30
White Encrusting Sponge	0.00	0.00	0.00	0.00	0.00	0.00
White Globular Sponge	0.00	0.00	0.00	0.00	0.00	0.00
White Papillate Sponge	0.00	0.00	0.00	0.00	0.26	0.26
Yellow Encrusting Sponge	0.00	0.00	0.20	0.20	0.00	0.00
Pink Spikey Sponge	0.00	0.00	0.00	0.00	0.00	0.00
Red Tubular Solitary Sponge	0.20	0.20	0.00	0.00	0.00	0.00
ASCIDIAN						
Botryloides magnicoecum	0.63	0.26	1.43	0.95	3.58	1.59
Herdmania momus	9.94	4.16	10.61	2.67	5.14	2.89
Orange Colonial Ascidian	0.00	0.00	1.83	0.59	2.05	0.93
Orange Bubbly Ascidian	0.00	0.00	0.20	0.20	0.00	0.00
White Encrusting Solitary Ascidian	0.00	0.00	0.00	0.00	0.00	0.00
ABIOTIC						
Bare Ships Surface	0.63	0.26	1.22	0.49	0.77	0.77
Serpulid Tubes	0.00	0.00	0.00	0.00	0.00	0.00
CNIDARIAN						
Hydroid 2	0.00	0.00	1.44	1.44	0.00	0.00
Tiny Orange Anemone	6.08	2.52	2.65	0.82	6.14	1.26
MATRIX						
Barnacle,Sediment,Brown Fil	0.00	0.00	0.00	0.00	0.00	0.00
Early Colonising Matrix	10.25	2.11	4.89	1.09	20.22	5.19
Large Barnacle,Sediment,Brown Fil	1.92	1.19	5.96	4.47	1.54	0.51
Serpulid Barnacle and Encrusting Algae Matrix	67.46	8.99	62.18	6.72	59.30	7.73
Serpulid Matrix	0.00	0.00	0.00	0.00	0.00	0.00
FISH MOBILE						
Fish in Frame	2.70	0.77	3.89	1.00	0.00	0.00
INDETERMINATE						
Unknown White Crust	0.00	0.00	0.00	0.00	0.00	0.00
TAPE, WAND, SHADOW						
Shadow	1.40	1.40	0.40	0.40	0.25	0.25
Wand	2.00	0.00	1.60	0.24	2.00	0.00

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	0.00	0.00
Turfing Brown Algae	0.00	0.00
RHODOPHYTA		
Encrusting Coralline	0.00	0.00
Encrusting Red Algae	0.00	0.00
Thin Branching Red Algae	0.00	0.00
BRYOZOA		
Biflustra perfragilis	0.00	0.00
Encrusting Orange Bryozoan	0.00	0.00
Encrusting Yellow Bryozoan	0.00	0.00
Triphyllozoan sp	0.00	0.00
SPONGE		
Orange Encrusting Sponge	0.20	0.20
White Encrusting Sponge	0.64	0.64
White Globular Sponge	0.00	0.00
White Papillate Sponge	0.00	0.00
Yellow Encrusting Sponge	0.00	0.00
Pink Spikey Sponge	0.00	0.00
Red Tubular Solitary Sponge	0.00	0.00
ASCIDIAN		
Botryloides magnicoecum	0.83	0.60
Herdmania momus	10.71	2.21
Orange Colonial Ascidian	1.85	0.20
Orange Bubbly Ascidian	0.20	0.20
White Encrusting Solitary Ascidian	0.00	0.00
ABIOTIC		
Bare Ships Surface	0.00	0.00
Serpulid Tubes	0.00	0.00
CNIDARIAN		
Hydroid 2	0.64	0.64
Tiny Orange Anemone	8.44	1.63
MATRIX		
Barnacle,Sediment,Brown Fil	0.00	0.00
Early Colonising Matrix	5.15	0.85
Large Barnacle,Sediment,Brown Fil	0.00	0.00
Serpulid Barnacle and Encrusting Algae Matrix	71.35	2.39
Serpulid Matrix	0.00	0.00
FISH MOBILE		
Fish in Frame	0.00	0.00
INDETERMINATE		
Unknown White Crust	0.00	0.00
TAPE, WAND, SHADOW		
Shadow	0.80	0.80
Wand	2.00	0.00

Appendix C: Permutational Analysis of Variance of Percent Cover of Reef Assemblages Sampled in Reef Monitoring Surveys 8 and 9. *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. Time (All Surveys)

Source	DF	SS	MS	F	P	Unique perms
Time	8	61393	7674.2	7.9517	**0.0001**	9896
Residual	135	3029E5	965.1			
Total	143	9168E5				

2. Time, Orientation, Aspect

Source	DF	SS	MS	F	P	Unique perms
Time	1	2988.6	2988.6	4.439	**0.0079 RED**	9952
Orientation	1	7538.6	7538.6	11.197	**0.0003 RED**	9932
Aspect	1	1410.1	1410.1	2.0944	0.097	9946
Time x Orientation	1	2249.6	2249.6	3.3412	**0.0249**	9937
Time x Aspect	1	580.22	580.22	0.86178	0.4269	9947
Orientation x Aspect	1	802.44	802.44	1.1918	0.2802	9948
Time x Orientation x Aspect	1	620.26	620.26	0.92127	0.4009	9949
Residual	75	.50495	673.27			
Total	82	.65170				

3. Time, Depth, Aspect, Transect

Source	DF	SS	MS	F	P	Unique perms
Ti	1	5602.2	5602.2	15.471	**0.0001 RED**	9955
De	1	3841.8	3841.8	10.609	**0.0001 RED**	9945
As	1	1013.1	1013.1	2.7979	**0.0305 RED**	9956
Tr	1	939.3	939.3	2.594	**0.0413 RED**	9943
TixDe	1	369.08	369.08	1.0193	0.3829	9960
TixAs	1	1641.2	1641.2	4.5325	**0.0028 RED**	9948
TixTr	1	243.85	243.85	0.67342	0.6071	9950
DexAs	1	1093.9	1093.9	3.0208	**0.0214 RED**	9949
DexTr	1	4219.7	4219.7	11.653	**0.0001 RED**	9934
AsxTr	1	1566.8	1566.8	4.327	**0.0038 RED**	9946
TixDexAs	1	1840.9	1840.9	5.084	**0.0015 RED**	9949
TixDexTr	1	1083	1083	2.9909	**0.0242 RED**	9945
TixAsxTr	1	985.05	985.05	2.7203	**0.0355 RED**	9949
DexAsxTr	1	629.97	629.97	1.7397	0.1437	9949
TixDexAsxTr	1	1587.8	1587.8	4.385	**0.0028**	9943
Res	63	22813	362.11			
Total	78	49522				

4. Time, Deck Position, Aspect

Source	DF	SS	MS	F	P	Unique perms
Ti	1	1433.7	1433.7	3.2134	0.0551	9932
Po	2	18853	9426.3	21.128	**0.0001**	9952
As	1	696.39	696.39	1.5609	0.2017	9957
TixPo	2	964.41	482.21	1.0808	0.3478	9945
TixAs	1	344.21	344.21	0.7715	0.4186	9947
PoxAs	2	1293	646.5	1.4491	0.2209	9949
TixPoxAs	2	674.49	337.25	0.75589	0.5195	9956
Res	48	21415	446.16			
Total	59	45674				

Appendix D: Pairwise tests of reef assemblages for significant terms. Only significant pairwise results for the interaction term Time x Depth x Aspect x Transect are presented. Significant results in bold.

1. Times (All Surveys)

Term 'Ti'

Groups	t	P(perm)	Unique perms
1, 2	1.902	**0.0289**	9954
1, 3	2.2409	**0.0096**	9946
1, 4	4.3128	**0.0001**	9957
1, 5	3.8913	**0.0001**	9931
1, 6	4.0002	**0.0001**	9952
1, 7	4.0715	**0.0001**	9953
1, 8	4.2386	**0.0001**	9943
1, 9	3.9414	**0.0001**	9947
2, 3	1.0401	0.3436	9959
2, 4	3.2352	**0.0001**	9960
2, 5	2.7874	**0.0001**	9949
2, 6	2.9683	**0.0001**	9955
2, 7	3.1645	**0.0001**	9958
2, 8	3.4435	**0.0001**	9949
2, 9	3.023	**0.0001**	9950
3, 4	2.3061	**0.0001**	9942
3, 5	1.998	**0.0023**	9944
3, 6	2.1216	**0.0009**	9951
3, 7	2.1354	**0.0005**	9953
3, 8	2.3774	**0.0001**	9959
3, 9	2.1324	**0.0002**	9951
4, 5	1.7909	**0.0092**	9942
4, 6	1.5849	**0.0359**	9957
4, 7	1.3004	0.1465	9945
4, 8	1.2995	0.1395	9952
4, 9	2.0158	**0.0049**	9951
5, 6	1.1947	0.2078	9943
5, 7	1.6529	**0.0228**	9940
5, 8	1.8101	**0.0089**	9948
5, 9	1.6509	**0.0162**	9927
6, 7	1.7059	**0.0191**	9950
6, 8	1.62	**0.0367**	9947
6, 9	1.759	**0.0098**	9942
7, 8	0.88275	0.5221	9948
7, 9	1.7415	**0.0109**	9942
8, 9	1.6928	**0.0159**	9933

2. Time, Orientation, Aspect

Term 'Time xOrientation' for pairs of levels of factor 'Orientation'

Within level '8' of factor 'Time'

Groups	t	P(perm)	Unique perms
Deck, Hull	2.2882	**0.0111**	9946

Within level '9' of factor 'Time'

Groups	t	P(perm)	Unique perms
Deck, Hull	2.9053	**0.0009**	9943

Within level 'Hull' of factor 'Orientation'

Groups	t	P(perm)	Unique perms
8, 9	2.8279	**0.0002**	9946

Appendix D: Continued.

3. Time, Depth, Aspect, Transect

Term 'Time x Depth x Aspect x Tr'ansect for pairs of levels of factor 'Depth'.

Within level '8' of factor 'Time'
Within level 'Port' of factor 'Aspect'
Within level 'Bow' of factor 'Transect'

Groups	t	P(perm)	Unique perms
Deep, Shallow	2.3306	**0.0091**	126

Within level '8' of factor 'Time'
Within level 'Port' of factor 'Aspect'
Within level 'Stern' of factor 'Transect'

Groups	t	P(perm)	Unique perms
Deep, Shallow	2.3196	**0.0171**	126

Within level '8' of factor 'Time'
Within level 'Starboard' of factor 'Aspect'
Within level 'Bow' of factor 'Transect'

Groups	t	P(perm)	Unique perms
Deep, Shallow	1.9954	**0.0075**	126

Within level '9' of factor 'Time'
Within level 'Starboard' of factor 'Aspect'
Within level 'Bow' of factor 'Transect'

Groups	t	P(perm)	Unique perms
Deep, Shallow	2.5664	**0.0171**	126

Within level '9' of factor 'Time'
Within level 'Starboard' of factor 'Aspect'
Within level 'Stern' of factor 'Transect'

Groups	t	P(perm)	Unique perms
Deep, Shallow	3.4964	**0.0085**	126

4. Time, Deck Position, Aspect

Term 'Position'

Groups	t	P(perm)	Unique perms
Bow, Mid	4.8412	**0.0001**	9947
Bow, Stern	1.6655	**0.0359**	9941
Mid, Stern	4.5142	**0.0001**	9943

Appendix E: Results of SIMPER analyses of reef assemblages sampled in The Ex-HMAS Adelaide Artificial Reef Community Surveys 8 and 9. Cut off for percentage contribution is 90%. Note that only relevant SIMPER results have been included in this Appendix.

1. Time, Orientation and Aspect

Groups Hull8 & Hull9

Average dissimilarity = 34.36

Species	Group Deck Av.Abund	Group Hull Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	74.76	62.25	9.76	1.63	28.41	28.41
Large barnacle,sediment,brown fil	6.02	11.94	5.71	0.94	16.62	45.03
Solitary ascidian (Herdmania momus/)	3.54	10.67	5.02	0.91	14.62	59.65
Tiny orange anemone	0	5.72	2.86	0.99	8.32	67.97
Bare ships surface	5.73	0.47	2.64	1.65	7.68	75.65
Orange encrusting sponge	3.32	0.94	1.65	0.89	4.81	80.46
Early colonising matrix	0.68	3.06	1.51	0.92	4.4	84.86
Brown filamentous algae/hydroid	0	2.97	1.48	0.73	4.32	89.18
Red encrusting algae	2.4	0	1.2	0.81	3.49	92.67

Groups Deck8 & Hull8

Average dissimilarity = 30.60

Species	Group Deck Av.Abund	Group Hull Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	83.86	74.76	12.03	1.99	39.29	39.29
Ecklonia radiata	8.54	0	4.27	0.49	13.95	53.24
Large barnacle,sediment,brown fil	0	6.02	3.01	0.99	9.84	63.08
Bare ships surface	1.56	5.73	2.44	1.55	7.99	71.07
Red encrusting algae	2.58	2.4	1.92	0.83	6.26	77.33
Solitary ascidian (Herdmania momus/)	0.07	3.54	1.76	0.87	5.75	83.07
Orange encrusting sponge	0.2	3.32	1.65	0.83	5.4	88.48
Orange colonial ascidian	0.03	2.13	1.07	0.66	3.49	91.97

Groups Deck9 & Hull9

Average dissimilarity = 43.36

Species	Group Deck Av.Abund	Group Hull Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	75.58	62.25	14.11	1.54	32.53	32.53
Large barnacle,sediment,brown fil	0	11.94	5.97	0.83	13.77	46.3
Solitary ascidian (Herdmania momus/)	0.57	10.67	5.23	0.85	12.06	58.36
Red encrusting algae	7.9	0	3.95	0.64	9.11	67.48
Ecklonia radiata	5.68	0	2.84	0.45	6.55	74.02
Tiny orange anemone	0.34	5.72	2.74	0.95	6.32	80.34
Early colonising matrix	0.84	3.06	1.64	0.91	3.79	84.13
Brown filamentous algae/hydroid	0.81	2.97	1.61	0.83	3.72	87.85
Orange encrusting sponge	1.52	0.94	0.96	0.66	2.2	90.05

2. Time, Depth, Aspect, Transect

Groups 8DeepPortBow & 8ShallowPortBow

Average dissimilarity = 32.31

Species	Group Deck Av.Abund	Group Hull Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	61.83	87.11	12.79	1.33	39.59	39.59
Large barnacle,sediment,brown fil	13.8	1.66	6.08	2.21	18.81	58.4
Solitary ascidian (Herdmania momus/)	11.4	3.26	5.37	0.73	16.63	75.03
Orange encrusting sponge	5.26	0	2.63	0.98	8.14	83.17
Bare ships surface	4.87	2.25	1.64	1.42	5.08	88.25
Orange colonial ascidian	0.61	2.27	1.04	0.99	3.21	91.46

Appendix E: Continued

Groups 8DeepPortStern & 8ShallowPortStern
Average dissimilarity = 35.27

Species	Group Deck Av.Abund	Group Hull Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Early colonising matrix	19.92	1.23	9.34	1.3	26.49	26.49
Serpulid, barnacle and encrusting algae matrix	60.46	71.78	9.31	1.27	26.39	52.88
Solitary ascidian (Herdmania momus/)	1.05	14.7	6.82	3.39	19.34	72.22
Large barnacle,sediment,brown fil	9.04	5.02	4.19	1.08	11.87	84.1
Bare ships surface	6.42	2.26	2.12	1.83	6.01	90.11

Groups 8DeepStarboardBow & 8ShallowStarboardBow
Average dissimilarity = 31.08

Species	Group Deck Av.Abund	Group Hull Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Large barnacle,sediment,brown fil	25.43	2.85	11.29	1.05	36.32	36.32
Serpulid, barnacle and encrusting algae matrix	61.75	70.94	6.91	0.77	22.22	58.54
Orange colonial ascidian	6.21	10.73	3.98	1.63	12.79	71.33
Bare ships surface	0.2	6.5	3.15	2.13	10.13	81.46
Solitary ascidian (Herdmania momus/)	4.13	1.25	2.14	0.95	6.89	88.35
Yellow encrusting sponge	0	3.22	1.61	0.8	5.19	93.54

Groups 9DeepStarboardBow & 9ShallowStarboardBow
Average dissimilarity = 45.42

Species	Group Deck Av.Abund	Group Hull Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Large barnacle,sediment,brown fil	34.74	1.54	16.6	1.9	36.56	36.56
Early colonising matrix	0	20.22	10.11	2.19	22.26	58.81
Serpulid, barnacle and encrusting algae matrix	58.09	59.3	9.97	1.4	21.95	80.76
Solitary ascidian (Herdmania momus/)	2.63	5.14	2.76	1.12	6.08	86.84
Tiny orange anemone	3.02	6.14	1.7	1.54	3.74	90.59

Groups 9DeepStarboardStern & 9ShallowStarboardStern
Average dissimilarity = 43.18

Species	Group Deck Av.Abund	Group Hull Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Early colonising matrix	38.94	5.15	16.9	1.96	39.14	39.14
Serpulid, barnacle and encrusting algae matrix	44.62	71.35	14.08	1.86	32.6	71.73
Solitary ascidian (Herdmania momus/)	1.42	10.71	4.64	2.04	10.75	82.49
Large barnacle,sediment,brown fil	5.09	0	2.54	1.34	5.89	88.38
Tiny orange anemone	6.68	8.44	1.96	1.41	4.53	92.91

3. Time, Deck Position, Aspect

Groups Bow & Mid
Average dissimilarity = 45.07

Species	Group Deck Av.Abund	Group Hull Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	93.92	53.69	20.32	1.46	45.08	45.08
Ecklonia radiata	0.61	20.71	10.27	1.03	22.79	67.87
Red encrusting algae	0.61	12.44	6.03	0.87	13.37	81.25
Unknown white material	0.05	2.29	1.14	0.81	2.52	83.77
Bare ships surface	0.25	2.24	1.1	0.73	2.44	86.21
Orange encrusting sponge	0.91	1.02	0.84	0.51	1.87	88.08
Red filamentous/branching algae	0	1.63	0.81	0.55	1.81	89.88
Yellow encrusting sponge	0.05	1.32	0.67	0.47	1.49	91.38

Appendix E: Continued

Groups Bow & Stern

Average dissimilarity = 10.19

Species	Group Deck Av.Abund	Group Hull Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	93.92	91.56	3.67	1.09	35.98	35.98
Red encrusting algae	0.61	2.68	1.4	0.86	13.73	49.71
Orange encrusting sponge	0.91	0.66	0.69	0.48	6.79	56.49
Early colonising matrix	0	1.01	0.51	0.33	4.95	61.45
Serpulid matrix	0.66	0.51	0.5	0.53	4.95	66.4
Bare ships surface	0.25	0.71	0.41	0.7	4.02	70.43
Solitary ascidian (Herdmania momus/)	0.56	0.35	0.39	0.62	3.83	74.26
Brown filamentous algae/hydroid	0.1	0.56	0.31	0.35	3.07	77.33
Ecklonia radiata	0.61	0	0.31	0.23	3	80.33
White encrusting sponge	0.4	0.2	0.27	0.65	2.62	82.96
White papillate sponge	0.25	0.35	0.27	0.61	2.6	85.56
Tiny orange anemone	0.4	0.1	0.23	0.48	2.28	87.84
Red tubular solitary sponge	0.15	0.35	0.22	0.77	2.14	89.97
Fish in frame	0.35	0	0.18	0.27	1.74	91.71

Groups Mid & Stern

Average dissimilarity = 44.28

Species	Group Deck Av.Abund	Group Hull Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	53.69	91.56	19.6	1.44	44.26	44.26
Ecklonia radiata	20.71	0	10.36	1.03	23.39	67.64
Red encrusting algae	12.44	2.68	5.8	0.89	13.09	80.73
Bare ships surface	2.24	0.71	1.16	0.81	2.61	83.35
Unknown white material	2.29	0.25	1.15	0.84	2.61	85.95
Red filamentous/branching algae	1.63	0.1	0.84	0.57	1.89	87.84
Early colonising matrix	0.77	1.01	0.81	0.47	1.83	89.67
Orange encrusting sponge	1.02	0.66	0.71	0.59	1.6	91.27

Appendix F: Distance based test for homogeneity of multivariate dispersion. Significant values in bold.

1. Time

F	17.419
P(perm)	**0.0001**

2. Time, Orientation, Aspect (Time x Orientation)

F	1.8648
P(perm)	0.4892

3. Time, Depth, Aspect, Transect (Time x Depth x Aspect x Transect)

F	1.719
P(perm)	0.454

4. Time, Deck Position, Aspect (Position)

F	94.495
P(perm)	**0.0001**