Cardno Ecology Lab

Shaping the Future

Marine and Freshwater Studies

Ex-HMAS Adelaide Artificial Reef

Reef Community Monitoring

Survey 12

Job Number: 59915131

Prepared for: Department of Primary Industries – Land and Natural Resources

May 2015

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Document Control

Report Number	Status	Date	Author		Reviewer	
59915131	Draft	24.04.15	Kate Reeds	KAR	Dr Brendan Alderson	BA
59915131	Final	12.05.15	Kate Reeds	KAR	Dr. Brendan Alderson	BA

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 former federal Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC), now the Department of the Environment (DoE). A condition of the Permit is that the Department of Primary Industries –Land and Natural Resources 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 12 (**Table ES 1**), as required as part of the LTMMP. Surveys have been carried out approximately 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 further four reef community surveys have been completed in the interim. This Progress Report outlines the methodology and findings of Reef Community Survey 12 (Survey 12).

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.

Monitoring Survey 12 was carried out on 26 and 27 March 2015. 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.

Results of Survey 12 showed significant changes in the composition of the sessile reef assemblage over the past six months following Survey 11 (September 2014), this was similar to previous consecutive surveys (10 and 11) which also differed in assemblage composition. These differences between surveys may partly be due to the longer (6 month) timeframe between surveys (usually 3 months), therefore allowing more time for successional changes to become evident. Seasonal conditions potentially influencing current patterns and recruitment are also likely to be a factor in these differences. In particular, there has been a distinct increase in orange jewel anemones which have overgrown the layer of calcareous tubes and barnacles on the vertically orientated parts of the ship. *E. radiata* (kelp) has been observed on the deck of the ship, particularly the mid ship area since Survey 2 (February 2012) and has varied in mean percent cover over the duration of the monitoring program. Although the occasional kelp thalli were observed on the mid deck in video footage, no kelp was recorded in photoquadrats for Survey 12. This may be due to any number of reasons including storm damage, a lack of suitable bare surface for attachment of new propagules or potentially flaking of the surface layer of the ship. New species continued to be recorded in Survey 12 which is indicative that successional changes are continuing through time as new species create secondary habitat and increased habitat complexity for other benthic invertebrates to occupy.

As for previous surveys, analysis of photoquadrats showed a recurrent pattern of assemblages occurring on horizontally orientated (deck) surfaces being different in composition from the vertically orientated (hull) assemblages. As discussed in previous monitoring survey reports, it is likely that suspension/filter feeders such as ascidians and anemones (particularly *Corynactis* sp.) tend to proliferate on more shaded portions of the ship or possibly where there is more current to improve feeding efficiency (i.e. vertical surfaces), whereas algae are more abundant where light availability is optimal on the upper horizontal surfaces.

In contrast to previous reports the comparison between Surveys 11 and 12 did not show any obvious patterns in encrusting assemblages relating to depth or position on the deck. The reduction in percent cover of *E. radiata* at the mid ship of the deck is likely to have affected the outcome of this Survey, as this has previously been a factor in distinguishing the mid ship area of the deck from the bow and stern of the ship.

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. Twenty eight fish species were recorded during Survey 12 which was the same as that recorded during Survey 11, although the composition was different. Several individuals of one species (pearl perch, *Glaucosoma scapulare*) and an individual Moses perch (*Lutjanus russelli*) were recorded in this Survey but have not previously been recorded throughout the monitoring program.

No species listed as marine pests in NSW were identified during this survey.

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

Survey	Sampling Dates	Timeframe
Baseline	18 April and 30 May 2011	1 week post-scuttling
Monitoring Survey 1	11 and 13 October 2011	6 months post-scuttling
Monitoring Survey 2	14 and 16 February 2012	10 months post-scuttling
Monitoring Survey 3	03 and 04 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
Monitoring Survey 10	03 and 04 March 2014	2 years 11 months post-scuttling
Monitoring Survey 11	22, 23 and 29 September 2014	3 years 5 months post-scuttling
Monitoring Survey 12	26 and 27 March 2015	3 years 11 months post-scuttling

Table of Contents

List of Tables

List of Figures

List of Plates

List of Appendices

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.
DoE	Department of the Environment (Commonwealth) formerly DSEWPaC
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities (Commonwealth)
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 – Land and Natural Resources 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 Government 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 former federal Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC), now the Department of the Environment (DoE).

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 – Land and Natural Resources 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 LTMMP and a review of the LTMMP is currently underway. The LTMMP 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. During this interim review period, however, the scope has been extended to include additional surveys.

The aims of the reef community monitoring survey, as outlined in the LTMMP, are 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 methodology and findings for the twelfth reef community survey. Surveys have been carried out on a near quarterly basis since April 2011 and then a 6 monthly basis since March 2014 (**Table 1**). This progress report (Survey 12) 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;
- Spatial and temporal statistical analyses of photoquadrat data;
- 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 immediately post-scuttling between the 18 April and 30 May 2011 (Worley Parsons 2011). In accordance with the methodology outlined in the LTMMP, underwater video and still photography was taken along horizontal and vertical transects of the ship by divers. The transect locations were:

- 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. The remained of 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 surveys 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 (*Cirritichthys aprinus*), eastern kelpfish (*Chironemus marmoratus*), rock cale, (*Crinodus lophodon*), comb wrasse (*Coris picta*) and six spined leatherjacket (*Meuschenia freycineti*). A pair of eastern blue groper (*Archoerodus viridis*) was also observed 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.

1.3.10 Monitoring Survey 9

Analysis of photoquadrats showed that the number of individual taxa or groups of taxa (33 recorded in total) was similar to Survey 8 and that the assemblages sampled in the two surveys were not significantly different. 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. As for previous surveys, analysis of photoquadrats showed that assemblages occurring on horizontally orientated (deck) surfaces were very 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 in determining epibenthic assemblage composition, whereas depth was not. The number of fish species observed has remained the same (26 species in total) from Surveys 8 and 9. 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.

1.3.11 Monitoring Survey 10

Analysis of photoquadrats taken from different parts of the ship showed that the number of individual taxa or groups of taxa (32 recorded in total) was similar to Survey 9 and that the assemblages sampled in the two surveys were not significantly different. Similar to previous surveys, the most abundant category identified in Survey 10 in terms of total percentage cover was an encrusting matrix of serpulid polychaete worms, barnacles and turfing algae (serpulid/barnacle matrix). Other numerically abundant categories included solitary ascidians, the conglomeration of large barnacles, sediment and brown filamentous algae, tiny orange anemones (*Corynactis* sp.), 'early colonising matrix', red encrusting algae and brown filamentous algae/hydoid.

Assemblages occurring on horizontally orientated (deck) surfaces were again different in composition from the vertically orientated (hull) assemblage mainly due to a greater percent cover of serpulid, barnacle and encrusting algal matrix, red encrusting algae and *Ecklonia radiata* on the deck than on the hull and a greater percent cover

of large barnacle, sediment and brown filamentous algae matrix, solitary ascidians, tiny orange anemones and early colonising matrix on the vertically orientated hull surfaces. No obvious patterns relating to depth or deck position were evident, although in general, the assemblage associated with the mid deck was characterised by *Ecklonia radiata* and red encrusting algae. The number of fish species observed remained similar for the past four surveys (between 25 and 26 species recorded in total). A wobbegong shark (*Orectolobus* sp.) and black reef leatherjacket (*Eubalichthys bucephalus*) were both recorded for the first time during Survey 10. Both are commonly found on coastal reefs along the New South Wales Coast.

1.3.12 Monitoring Survey 11

Over the approximately six month period between Surveys 10 and 11, the total percent cover of serpulid/barnacle and turfing algae matrix and solitary ascidians decreased overall, while there was an increase in the cover of anemones, brown filamentous algae/hydroid, large barnacle matrix and various encrusting sponges. There was also an increase in the cover of bare surface and early colonising matrix in Survey 11 compared to Survey 10. This may have been a result of mature reef detaching due to storms occurring during the winter months (particularly July 2014). As reported for the majority of previous surveys, analysis of photoquadrats showed the reef assemblages occurring on horizontally orientated (deck) surfaces were different in composition from the vertically orientated (hull) reef assemblages. Depth and Deck Position were also significant factors in structuring reef assemblages. 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. Twenty eight fish species were recorded during Survey 11 which was marginally higher than the number recorded during Survey 10 (25 species). Species of fish recorded during Survey 11 that have not previously been recorded included the pygmy scorpion fish (*Scorpaenodes scaber*) and banded parma (*Parma polylepis*).

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

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Monitoring Survey 12	26 and 27 March 2015	3 years 11 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. The approximate locations of all transects are indicated on **Figure 2**. These transects were based on those used for previous monitoring surveys. Along 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).

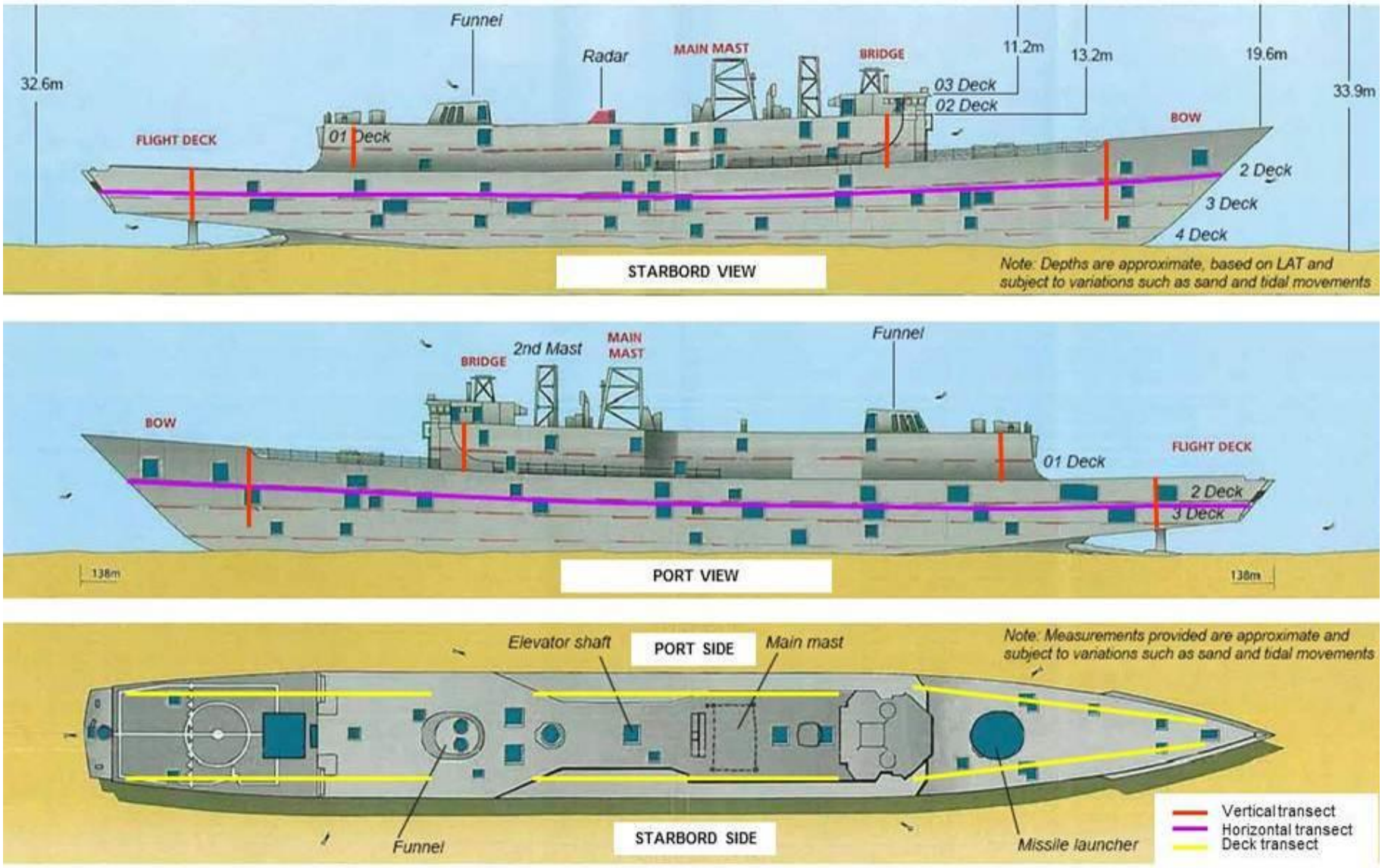

Figure 2: Plans of the Ex-HMAS Adelaide and positions of the reef assemblage survey sampling transects.

Photoquadrats were acquired at regular intervals along each transect. For the vertical transects this was approximately every 0.5 m. 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 m.

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. Dive lights were attached to the camera for better resolution of colours and clarity. 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 swam at 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 resolution 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.

Analyses carried out included:

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

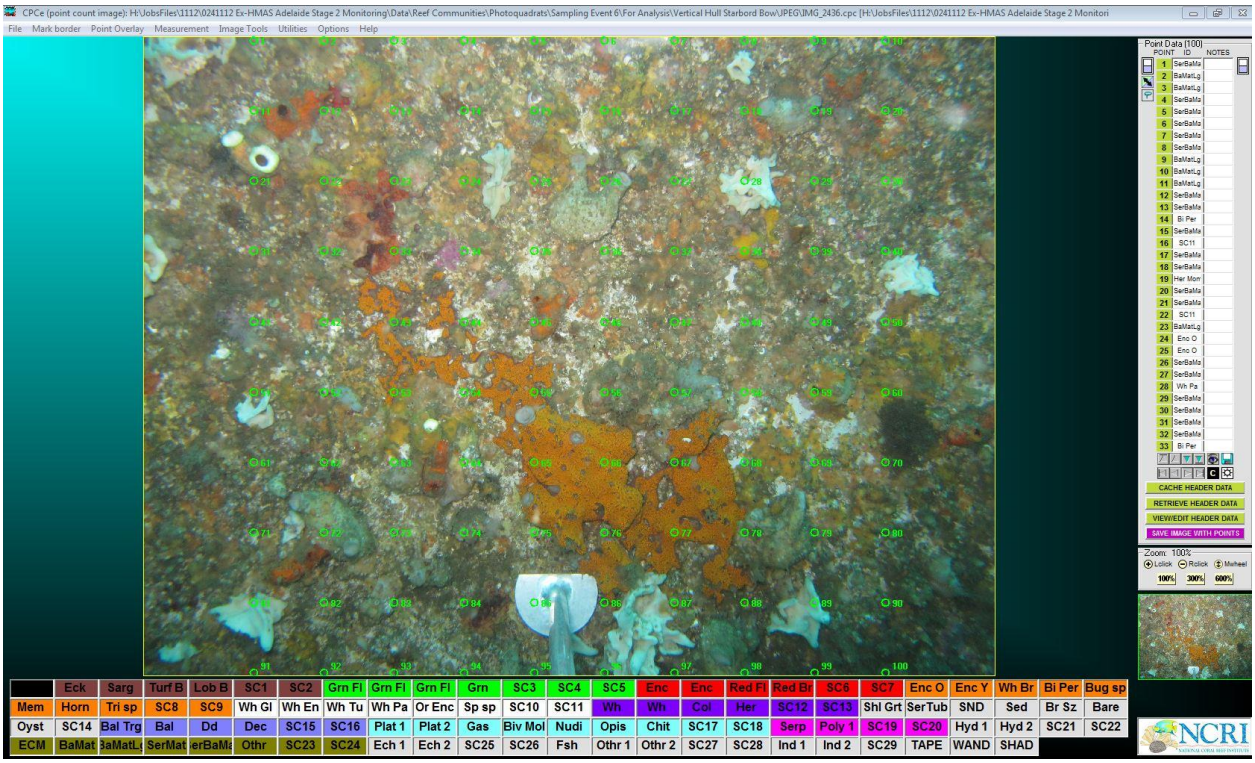

Figure 3: Screenshot of the CPCe Photoquadrat Analyses Frame with a Virtual 10 x 10 Grid Overlayed.

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 preceding surveys, in this case, Surveys 11 and 12. The four null hypotheses tested were:

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

The design to test this hypothesis was as follows:

- Time (Surveys 1 - 12): fixed, orthogonal;

This design compared reef assemblage structure among the 12 sampling surveys to date (regardless of their spatial positioning on the ship). Note that mean percentages were used (rather than individual photoquadrat data) due to the otherwise large data set.

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

The design to test these hypotheses was as follows:

- Time (Survey 11/Survey 12): 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 monitoring survey 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 consecutive monitoring survey times.

The design to test these hypotheses was as follows:

- Time (Survey 11/Survey 12): 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 monitoring survey 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 consecutive monitoring survey times.

The design to test these hypotheses was as follows:

- Time (Survey 11/Survey 12): 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 monitoring survey 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. 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 12 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

Fixed photos from the current survey were reviewed and compared to previous surveys. Succession through time was qualitatively described in terms of species diversity, cover and any other observations relevant to the patterns observed.

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 resolution 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, 24 categories/groups of taxa were identified from the 82 quadrats that were sampled during Survey 12 (**Appendix B**). The most abundant category identified during Survey 12 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 and contributed to approximately 40% of cover of the total area sampled. This was followed by tiny orange anemones (*Corynactis* sp.), solitary ascidians, brown filamentous algae, and large barnacles, sediment and brown filamentous algae (large barnacle matrix), which contributed to 25.5%, 8.5%, 8.1%, and 4.0% of total percentage cover respectively.

Over the approximately six month period between Surveys 11 and 12, the total percent cover of serpulid/barnacle and turfing algae matrix, brown filamentous algae and Large barnacle matrix decreased, while the cover of tiny orange anemone and solitary ascidian increased. Kelp (*Ecklonia radiata*) was not recorded at all in Survey 12 whereas it accounted for over 2% of total cover in Survey 11.

A summary of all taxa and groups of taxa identified in the analyses of photoquadrats for Survey 12 is given in **Appendix B**.

Comparisons of photoquadrats from the Baseline and Monitoring Surveys 1-12 are presented in **Plates 1 – 16**.

3.1.2 Spatial and Temporal Variation in Reef Communities

All Times (Surveys 1-12)

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 all times were significantly different from one another apart from Surveys 2 and 3, 4 and 7, 4 and 8, 5 and 6, 7 and 8 and Surveys 9 and 10 (**Appendix D**).

Figure 4 also shows that approximately 63.6% of the total variation among samples was explained by the two axes within the PCoA. Differences in assemblages between Surveys 11 and 12 were mainly explained by a greater mean percent cover of serpulid/barnacle matrix, brown filamentous algae and large barnacle matrix and smaller mean percent cover of tiny orange anemones, and solitary ascidians in Survey 11 compared to Survey 12 (**Appendix E**).

Differences observed were further explained by the significant PERMDISP result for the factor 'Time' which shows greater variability (or dispersion) among transects in Surveys 1, 2, 3 and 12 and less variability (i.e. greater clustering of points) in Surveys 4-11, although (**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 in both Surveys 11 and 12 regardless of aspect (**Appendix C, Appendix D**).

This difference is clear from the grouping of points in the PCoA which explains 76% of the total variation among samples and is a strong representation of the data cloud by these two axis (**Figure 5)**.

SIMPER analyses indicated that differences between the hull and deck assemblages were mainly due to a greater percent cover of tiny orange anemones and solitary ascidians and a smaller percent cover of serpulid/barnacle matrix and brown filamentous algae on the hull surface than on the deck.

Assemblages associated with deck and hull surfaces also changed significantly between Surveys 11 and 12 (**Appendix D**). On the deck surface this was due to an overall increase in mean percent cover of serpulid and barnacle matrix and a decrease in brown filamentous algae, *E. radiata* and red encrusting algae. On the hull surface, this was due to increases in the mean percent cover of tiny orange anemone and early colonising matrix while there were decreases in large barnacle matrix and serpulid/barnacle matrix (**Appendix E**).

PERMDISP for the factor Time and Orientation was not significant, indicating that the differences in orientation (between hull and deck) and time were due to locational differences among samples, rather than variability among samples within treatments (**Appendix F)**.

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

The assemblages sampled in deep transects were consistently different from those sampled in shallow transects, but this was dependent on aspect for both Surveys (**Appendix C**, **Figure 6**). Pairwise tests indicated that assemblages characteristic of deep transects were significantly different from those on shallow transects on the port side of the ship only (**Appendix D**). This was due to a greater mean percent cover of serpulid /barnacle matrix and solitary ascidians and lower percent cover of large barnacle matrix and early colonising matrix on shallow transects compared to the deep transects (**Appendix E**).

Assemblages associated with the port side of the ship were consistently different from the starboard side regardless of depth or time. Other than a greater mean percent cover of tiny, orange anemones on the port side than on the starboard side, there were no other consistent patterns to explain these differences.

Overall, assemblages characteristic of vertical transects in Surveys 11 and 12 were significantly different from one another regardless of depth or aspect (**Appendix C**). This was due to a greater mean percent cover of tiny orange anemone and solitary ascidian and lower percent cover of serpulid/barnacle matrix, large barnacle matrix and early colonising matrix in Survey 12 compared to Survey 11 (**Appendix E)**.

No significant difference in the dispersion of samples was evident for the significant factor Time or DepthxAspect, therefore the differences observed were due to locational factors rather than variability among samples within treatments (**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, although these were not consistent with Time (**Appendix C, Figure 7**). Pair-wise tests indicated that differences between Surveys 11 and 12 were generally a result of an increase in the percent cover of serpulid/barnacle matrix and a decrease in *E. radiata*, brown filamentous algae and red encrusting algae at the mid ship. A similar pattern was also evident at the stern of the ship but not at the bow.

During Survey 11 the mid assemblage was significantly different from the stern due to a greater percent cover of serpulid/barnacle matrix, *E. radiata* and red encrusting algae and lower percent cover of brown filamentous algae. During Survey 12, the mid ship assemblage was significantly different from the bow but not the stern. This was due to a greater percent cover of serpulid/barnacle matrix and lower percent cover of brown filamentous algae and red encrusting algae at the mid ship (**Appendix D**, **Appendix E**).

Results are illustrated in the corresponding PCoA plot which shows that approximately 84.4% of the total variation among samples could be explained by the two axes in the ordination (**Figure 7**). No significant difference in the dispersion of samples was evident for the significant factor Time x Position, therefore the differences observed were due to locational factors rather than variability among samples within treatments (**Appendix F**).

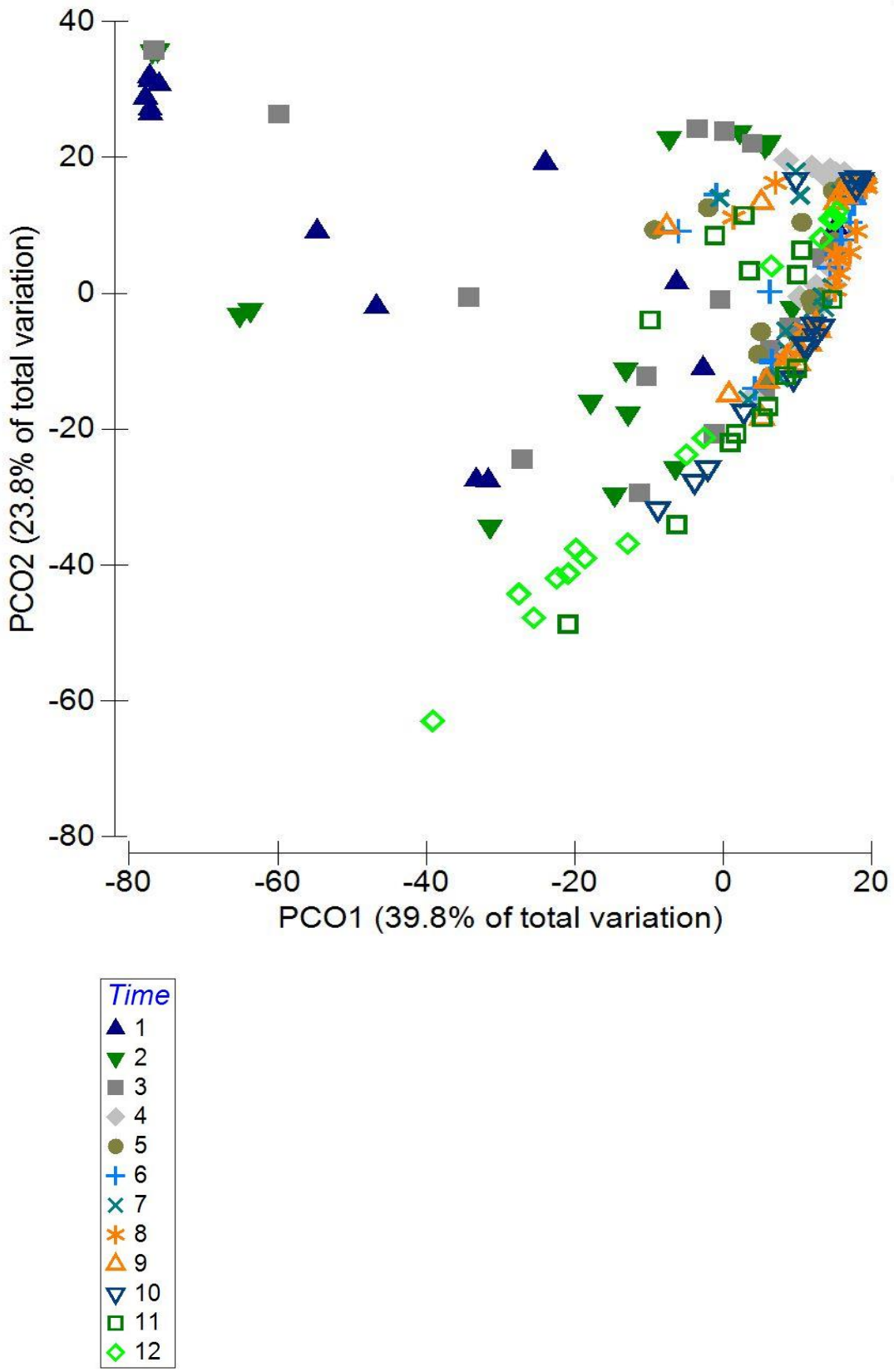

Figure 4: Principal Coordinates Analyses (PCoA) of Percent Cover of Encrusting Assemblages from Transects Taken at all Positions on the Ex-HMAS Adelaide for Surveys 1 to 12

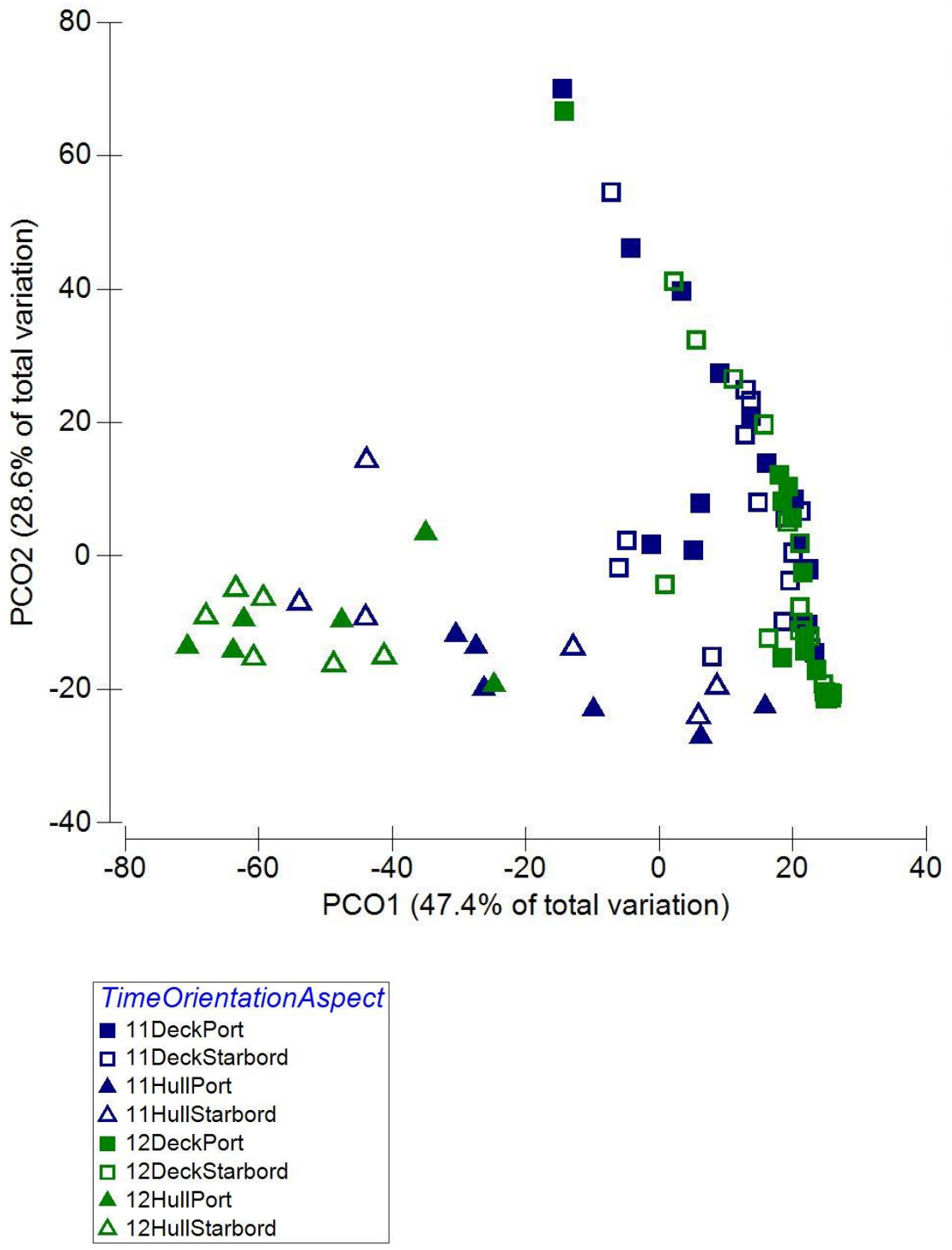

Figure 5: Principal Coordinates Analyses (PCoA) of Percent Cover of Encrusting Assemblages from Transects Taken on Hull and Deck Surfaces of the Ex-HMAS Adelaide for Surveys 11 and 12

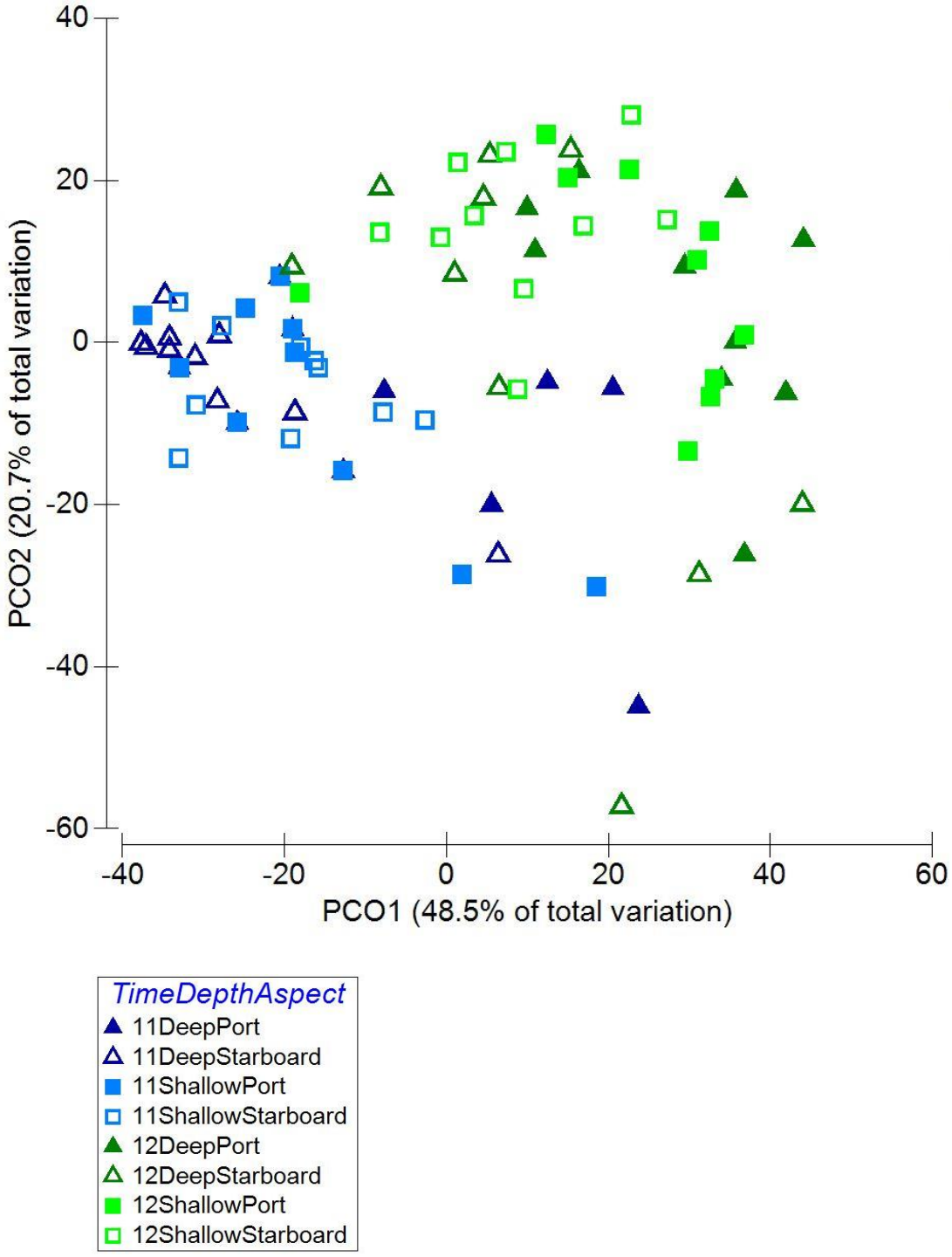

Figure 6: Principal Coordinates Analyses (PCoA) of Percent Cover of Encrusting Assemblages from Transects at Different Depths and Aspect on the Ex-HMAS Adelaide for Surveys 11 and 12

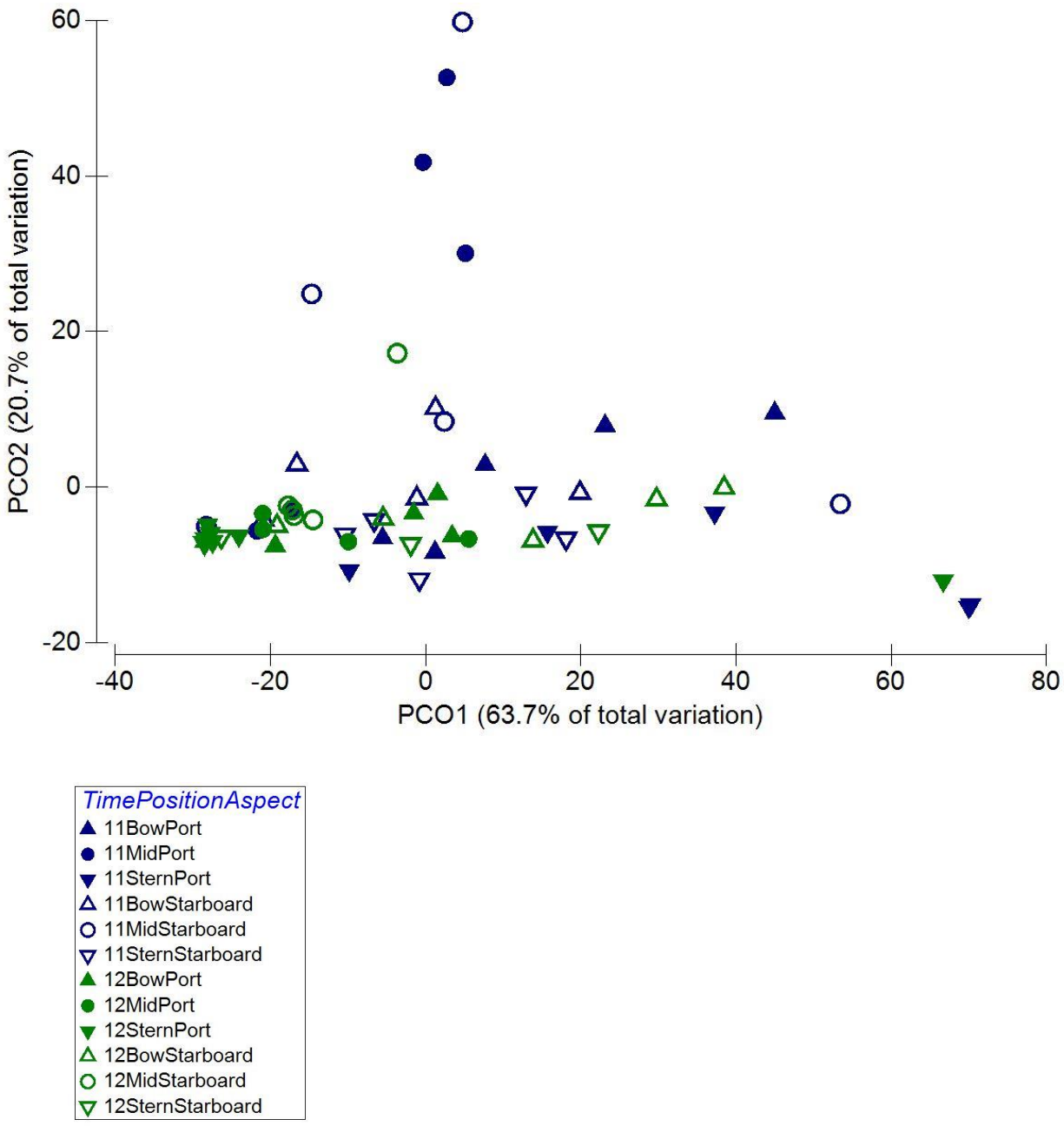

Figure 7: Principal Coordinates Analyses (PCoA) of Percent Cover of Encrusting Assemblages from Transects Taken at Different Positions on the Deck Ex-HMAS Adelaide for Surveys 11 and 12

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 six months between Surveys 11 and 12 and remains to primarily consist of a thick encrusting layer over more complex structures such as ladders, railings and masts and to a lesser extent on deck surfaces. Quality of fixed point photographs was generally low due to poor visibility which may be a factor in the inability to detect any successional changes.

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 12) are listed in **Table 3**. Species of recreational, commercial or conservation value are also indicated. A total of 28 species of fish including two species (pearl perch (*Glaucosoma scapulare)* and Moses perch *(Lutjanus russelli*)) which have not previously been recorded during the monitoring program.

Table 2: Summary of Observations of Attached Encrusting and Fish Assemblages Observed from Video Footage of the Ex-HMAS Adelaide in March 2015 (Survey 12)

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. Tubular solitary sponges, white papillate encrusting sponges and orange encrusting sponge were also conspicuous. Tarwhine (*Rhabdosargus sarba*) and six spine leatherjacket (*Meuschenia freycineti*) were all observed.
Deck Port Mid	Unlike previous surveys no kelp (*Ecklonia radiata*) was observed in this area. The majority of the deck was otherwise heavily encrusted with barnacles, encrusting red algae, hydroids and fine filamentous algae. Large patches of encrusting yellow/orange and white sponge was observed on the deck. Tarwhine and rock cale (*Crinodus lophodon*) were observed.
Deck Port Stern	The deck was predominantly covered in serpulid tubes, barnacles, encrusting algae, fine filamentous algae and a fine layer of sediment. Large tubular and papillate sponges were conspicuous on the deck surface including *Holopsama laminaefavosa.* not previously observed. Large colonies of bryozoans, also known as lace corals (*Tryphyllozoan* sp.) were also observed. Tarwhine were abundant and observed close to the deck.
Deck Starboard Bow	As with previous surveys, encrusting growth included barnacles, algae and hydroids with patches of encrusting sponges. Solitary, tubular, red, pink and white sponges were observed on the deck. Schools of eastern hulafish (*Trachinops taeniatus*), snapper (*Pagrus auratus*), girdled parma, and crimson banded wrasse (*Notolabrus gymnogenis*) were observed.
Deck Starboard Mid	As per previous surveys, the majority of the deck was encrusted with barnacles, encrusting algae, hydroids, fine red filamentous algae. Tubular solitary sponges, white papillate and orange encrusting sponges, were conspicuous on the deck surface. Kelp (*Ecklonia radiata*) was present in occasional clumps. Fish observed included tarwhine, snapper, red morwong (*Cheilodactylus fuscus*), yellowtail kingfish (*Seriola lalandi*), and stripey (*Microcanthus Strigatus*).
Deck Starboard Stern	Small barnacles, encrusting algae, hydroids, fine filamentous algae covered the majority of the deck. Large yellow and white encrusting sponges, clumps of filamentous algae and soft coral (Family: neptheidae) were conspicuous on the deck. Fish observed included tarwhine and snapper (which were abundant), sweep (*Scorpis lineolatus*) and pearl perch (*Glaucosoma scapulare*), which have not previously been recorded in association with the ship.

Horizontal Hull Port and Starboard	The hull remains colonised by sessile invertebrates, particularly large ascidians, on both the port and starboard sides of the ship. As with previous surveys, these included various ascidians such as *Herdmania momus* and a red unidentified species, large barnacles and encrusting sponges and bryozoans. Tiny orange and pink jewel anemones (*Corynactis* sp.) now form a continuous layer overgrowing barnacles and other encrusting biota. Ascidians appeared to form a notably dense layer on the starboard side of the ship than on port side. Large red solitary sponges (*Siphonochalina* sp.) were occasionally observed. Species of fish observed included: tarwhine, blue groper (*Archoerodus viridis*), crimson banded wrasse (female), eastern red scorpioncod (*Scorpaena cardinalis*), silver trevally (*Pseudocaranx dentex*), sergeant baker (*Aulopus purpurissatus*), blackspot goatfish (*Parupeneus spilurus*), chinaman leatherjacket (*Nelusetta ayraudi*), six-spine leatherjacket.
Vertical Hull Bow	Large ascidians, barnacles and tiny orange and bright purple jewel anemones (*Corynactis* sp.) were the most prevalent encrusting biota on the vertical bow of the ship. Various encrusting and papillate sponges and bryozoans were also observed with brown filamentous algae overgrowing many of the large ascidians and barnacles. Hula fish were abundant around the bow area.
Vertical Hull Stern	Generally similar to the bow hull area, Large ascidians, barnacles and tiny orange and bright purple jewel anemones (*Corynactis* sp.) were the most prevalent encrusting biota on the vertical bow of the ship. Various encrusting and papillate sponges and bryozoans were also observed with brown filamentous algae overgrowing many of the large ascidians and barnacles. Hula fish, stripey and banded parma were observed near the top of the hull.
Vertical Hull Superstructure	The superstructure surface was covered with large ascidians and barnaclea (*Balanus* sp.), bryozoans, barnacles, encrusting white and orange sponge, hydroids, fine filamentous algae and a dense covering of tiny orange jewel anemones. Tarwhine, eastern hulafish and stripey were observed at the top of the superstructure transects.

Table 3: Species of Fish Observed in Association with the Ex-HMAS Adelaide Artificial Reef between April/May 2011 and March 2015. (*) = recreationally important species, (+) = commercially important species, (#) = species of conservation significance. (x) = No Code in Hutchins and Swainston (2006).

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)	Survey 10 (March 2014)	Survey 11 (September 2014)	Survey 12 (March 2015)
Heterodontidae	*Heterodontus portusjacksoni*	Port Jackson shark	4									●				
Orectolobidae	*Orectolobus* sp.	Wobbegong shark	x											●		
Aulopodidae	*Aulopus purpurrissatus*	Sergeant baker	83		●	●	●		●	●		●	●		●	●
Scorpaenidae	*Centropogon australis*	Eastern fortesque	166		●	●	●					●	●			
Scorpaenidae	*Scorpaena cardinalis*	Eastern red scorpioncod	176		●	●			●		●	●	●	●	●	●
Scorpaenidae	*Scorpaenodes scaber*	Pygmy scorpionfish	179												●	
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						●	●	●	●	●	●	●	●
Glaucosomidae	*Glaucosoma scapulare*	Pearl perch*+	248													●
Dinolestidae	*Dinolestes lewini*	Longfinned pike	263		●			●					●			
Carangidae	*Pseudocaranx dentex*	Silver trevally	292				●	●	●		●	●	●	●	●	●
Carangidae	*Trachurus novaezelandiae*	Yellowtail scad+	294		●			●				●				
Carangidae	*Seriola lalandi*	Yellowtail kingfish*#	298			●	●		●	●	●	●	●	●	●	●
Carangidae	*Seriola hippos*	Samson Fish*	300									●				
Carangidae	*Elagatis bipinnulata*	Rainbow runner	303									●				
Sparidae	*Pagrus auratus*	Snapper (juv)*+	310		●	●	●		●	●	●				●	●
Sparidae	*Rhabdosargus sarba*	Tarwhine*	311			●	●	●	●	●	●	●	●	●	●	●
Sparidae	*Acanthopagrus australis*	Yellowfin bream	308													●
Lutjanidae	*Paracaesio xanthurus*	Southern fusilier	320								●					
Lutjanidae	*Lutjanus russelli*	Moses Perch*	x													●
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	*Parma polylepis*	Banded Parma	394												●	●
Pomacentridae	*Chromis hypsilepis*	One-Spot Puller	396									●				
Cirritidae	*Cirrhitichthys aprinus*	Blotched hawkfish	406						●	●	●	●	●	●		●
Chironemidae	*Chironemus marmoratus*	Eastern kelpfish	411						●						●	
Aplodactylidae	*Crinodus lophodon*	Rock cale	415						●		●	●	●	●	●	●
Cheilodactylidae	*Cheilodactylus fuscus*	Red morwong*	416		●	●	●	●	●	●	●	●	●	●	●	●
Cheilodactylidae	*Nemadactylus douglasii*	Blue morwong*	424		●	●				●	●		●	●	●	●
Cheilodactylidae	*Cheilodactylus vestitus*	Magpie morwong	421								●		●		●	
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	x													
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							●						
	Eubalichthys bucephalus	Black reef leatherjacket	649											●	●	●
Monacanthidae	*Meuschenia spp.*	Unidentified leatherjackets	x				●	●	●							
Tetraodonitdae	*Dicotlichthys punctulatus*	Three-bar porcupinefish	682		●				●	●				●	●	●
Sepiidae	*Sepia* sp.	Cuttlefish	x										●			
Total Number of Taxa				**3**	**17**	**14**	**19**	**13**	**23**	**19**	**26**	**26**	**26**	**25**	**28**	**28**

4 Discussion

4.1 Encrusting Biota

Results of Survey 12 showed significant changes in the composition of the sessile reef assemblage over the past six months following Survey 11 (September 2014), this was similar to previous consecutive surveys (10 and 11) which also differed in assemblage composition. These differences between surveys may partly be due to the longer (6 month) timeframe between surveys (usually 3 months), therefore allowing more time for successional changes to become evident. Seasonal conditions potentially influencing current patterns and recruitment are also likely to be a factor in these differences.

In particular, there has been a distinct increase in orange jewel anemones which have overgrown the layer of calcareous tubes and barnacles on the vertically orientated parts of the ship. This genus of anemone (*Corynactis* sp.) form colonies joined to a common 'sheet like' base, with several colonies joining one another. Bright purple and pink forms of the anemone have also been observed on the ship but in much lower densities. On natural reefs the anemone is often found in the entrances to sea caves and prefer shaded conditions (Edgar 2003), hence they are generally observed in association with the vertical (more shaded) parts of the ship.

E. radiata (kelp) has been observed on the deck of the ship, particularly the mid ship area since Survey 2 (February 2012) and has varied in mean percent cover over the duration of the monitoring program. Although the occasional kelp thalli were observed on the mid deck in video footage, none was recorded in photoquadrats for Survey 12. It was noted by divers that there has been some flaking of the ship surface which may preclude kelp from obtaining a strong enough attachment point and therefore resulting in breakage during strong currents. Alternatively this may be due to storm damage alone or a lack of suitable bare surface for attachment of new propagules. It is possible that the remaining kelp is from one initial recruitment event back in 2011/2012.

A new species of sponge (*Holopsamma laminaefavosa*) was observed in photoquadrats and video footage of the deck surface. The commonly occurring sponge is easily recognised by its large size and honeycomb surface. The continual occurrence of new species such as this is indicative that successional changes are continuing through time as new species create secondary habitat and increased habitat complexity for other benthic invertebrates to occupy.

As for previous surveys, analysis of photoquadrats showed a recurrent pattern of assemblages occurring on horizontally orientated (deck) surfaces being different in composition from the vertically orientated (hull) assemblage. The pattern of assemblage composition during Survey 12, was similar to that observed during Survey 11. As discussed in previous monitoring survey reports, it is likely that suspension/filter feeders such as ascidians and anemones (particularly *Corynactis* sp.) tend to proliferate on more shaded portions of the ship or possibly where there is more current to improve feeding efficiency (i.e. vertical surfaces), whereas algae are more abundant where light availability is optimal on the upper horizontal surfaces.

In contrast to previous reports the comparison between Surveys 11 and 12 did not show any obvious patterns in encrusting assemblages relating to depth or position on the deck. The reduction in percent cover of *E. radiata* at the mid ship of the deck is likely to have affected the outcome of this Survey, as this has previously been a factor in distinguishing the mid ship area of the deck from the bow and stern of the ship.

4.2 Fish and Macroinvertebrates

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. Twenty eight fish species were recorded during Survey 12 which was the same as that recorded during Survey 11, although the species composition was slightly different. Two new species (pearl perch (*Glaucosoma scapulare*) and Moses perch (*Lutjanus russelli*)) were recorded in this Survey. Pearl perch generally occur in proximity to submerged reefs and rock ledges or rough bottom, preferring areas of high water movement. They are also highly regarded as a species of recreational importance (Rowling *et al*. 2010). Moses perch, also called Moses snapper, are also fished recreationally although generally occur in warmer waters, north of Port Macquarie (NSW DPI 2015).

5 Acknowledgements

This report was written by Kate Reeds and reviewed by Dr. Brendan Alderson. Field work was done by Dr Brendan Alderson, Chris Roberts, Dr Lachlan Barnes and Dan Aveling of Cardno Ecology Lab. Thanks to Terrigal Dive Centre for providing a vessel and equipment.

6 References

Anderson, M.J. Gorley, R.N. and Clarke, K.R (2008). PERMANOVA+ for Primer: Guide to Software and Statistical Methods. PRIMER-E: Plymouth, UK.

Edgar, G. J. (2003). Australian Marine Life Revised Edition. The Plants and Animals of Temperate Waters. Reed New Holland.

Hutchins, B and Swainston, R. (2006). Sea Fishes of Southern Australia. Swainston Publishing, NSW, Australia.

Kohler, K.E. and Gill, S.M. (2006). Coral Point Count with Excel extensions (CPCe): A Visual Basic program for the determination of coral and substrate coverage using random point count methodology. Comparative.Geoscience. 32, 1259-1269.

NSW DPI (2015). NSW DPI Moses Perch http://www.dpi.nsw.gov.au/fisheries/recreational/saltwater/sw-species/moses-perch. Viewed April 2015.

NSW Government (2011). Life Before Scuttling – History of the HMAS Adelaide. NSW Government, Queens Square, Sydney.

Rowling, K. A., Hegarty, and M. Ives, Eds (2010). Status of Fisheries Resources in NSW 2008/09. Industry and Investment NSW, Cronulla: 392 pp.

Warton D.I. & Hui F.K.C. (2011). The arcsine is asinine: the analysis of proportions in ecology. Ecology, 92(1), 3 {10.

Worley Parsons (2011). Ex-HMAS ADELAIDE Artificial Reef Community and Sediment Movement Surveys. Worley Parsons, North Sydney, NSW.

7 Plates

Deck, Port Bow

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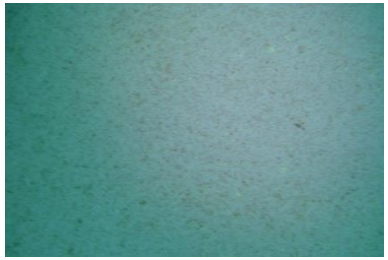	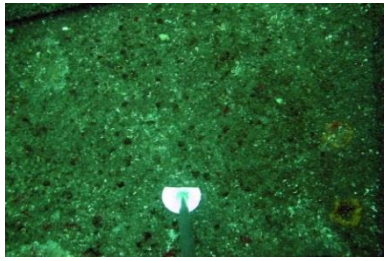	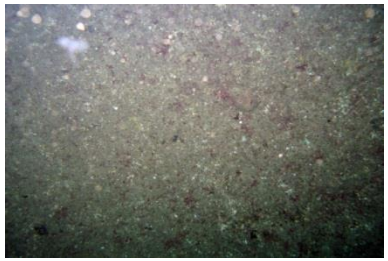	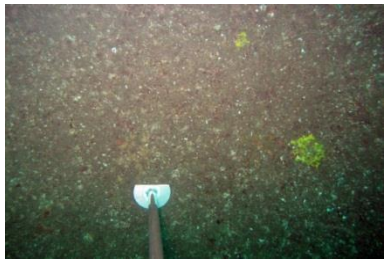	
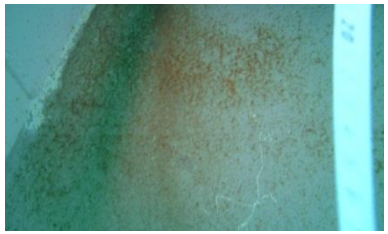			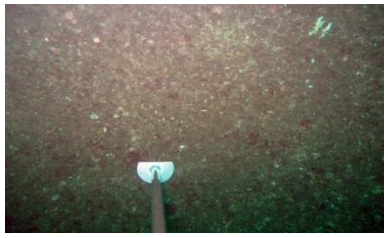	
		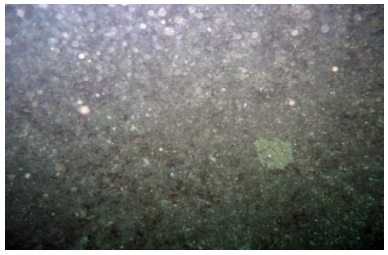	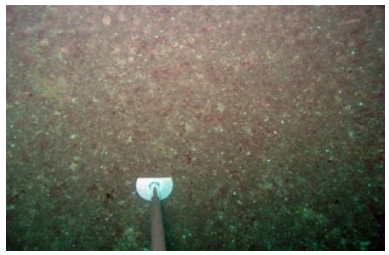	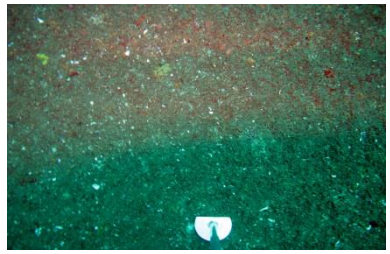

Plate 1: Deck port bow

Deck, Port Bow

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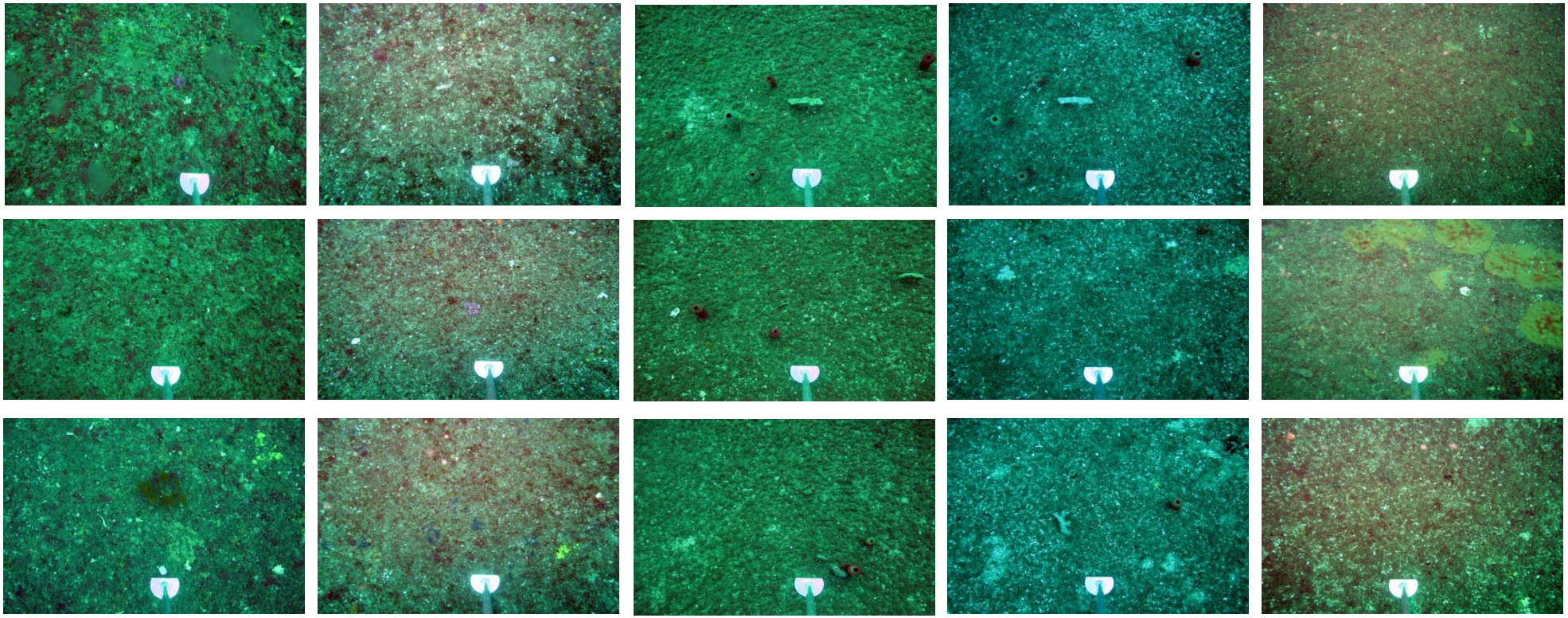

Plate 1 Continued: Deck port bow

Deck, Port Bow

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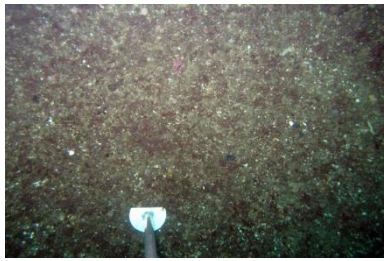	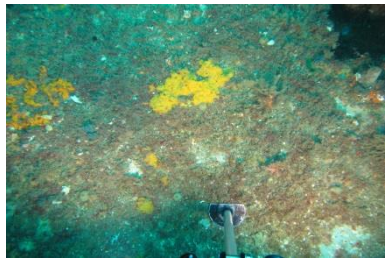	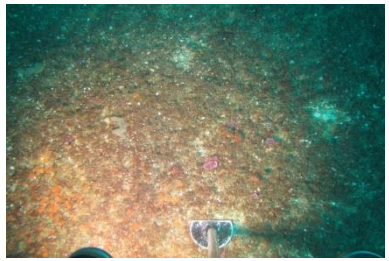
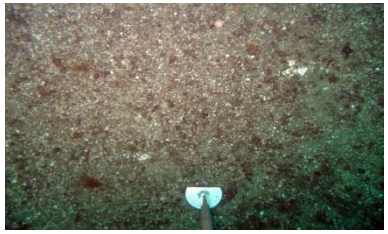		
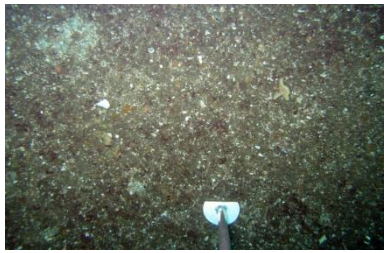		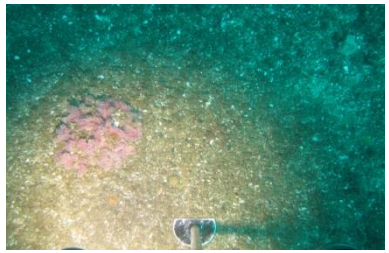

Plate 1 Continued: Deck port bow

Deck, Port Mid

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	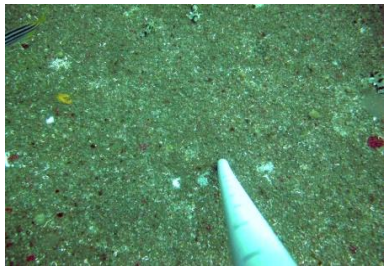	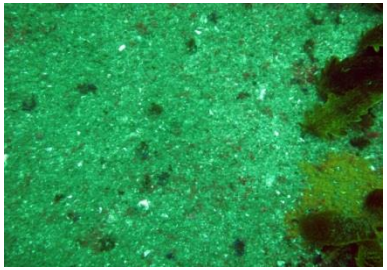	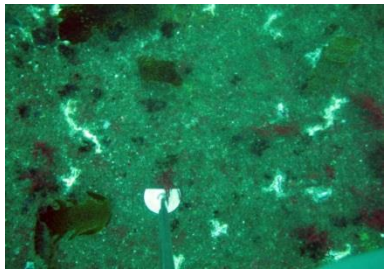	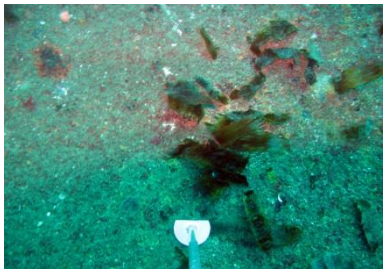
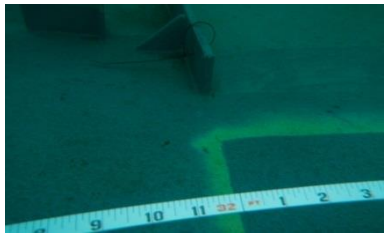	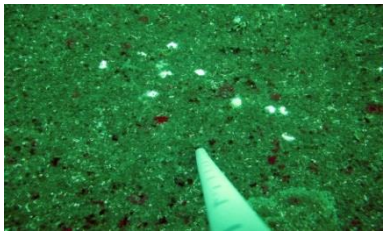	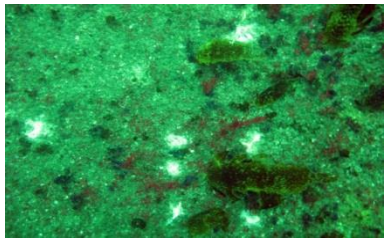	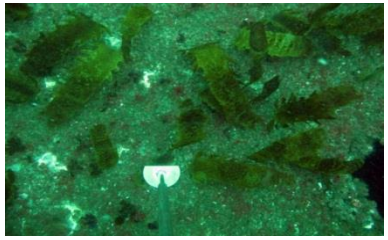	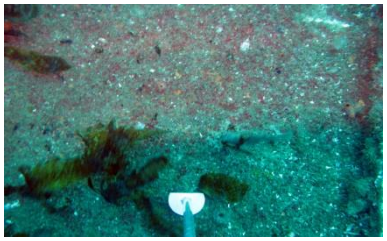
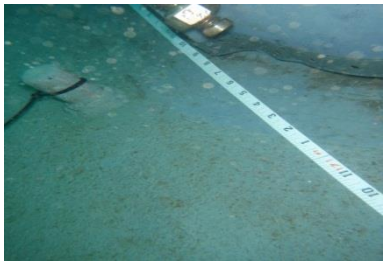	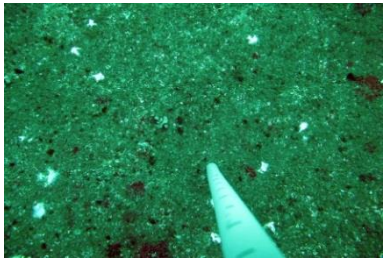	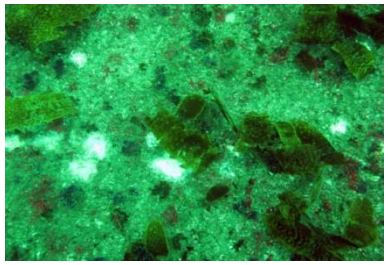	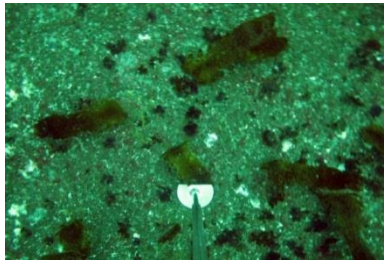	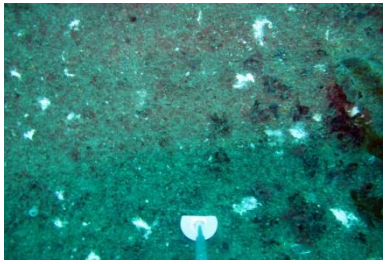

Plate 2: Deck Port Mid

Deck, Port Mid

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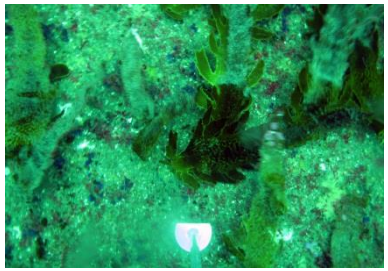
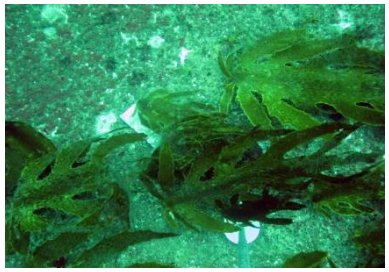
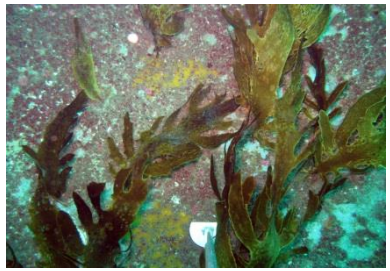
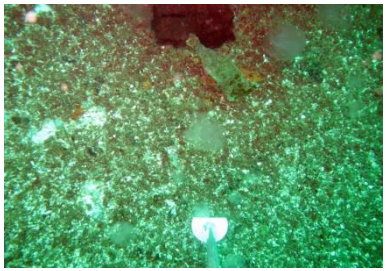
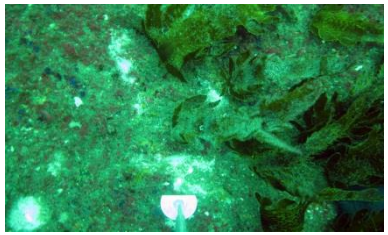
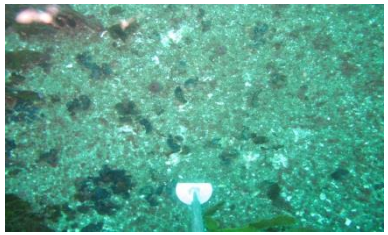
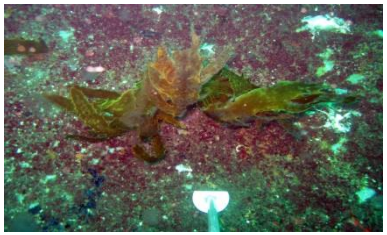
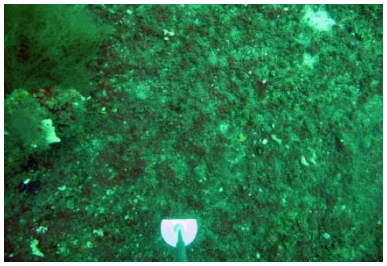
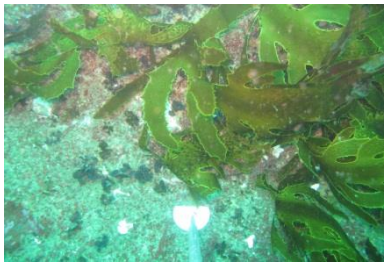
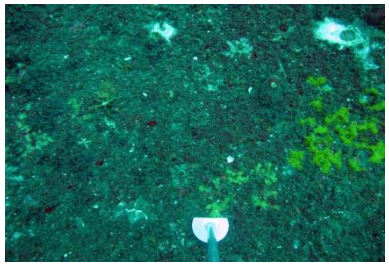
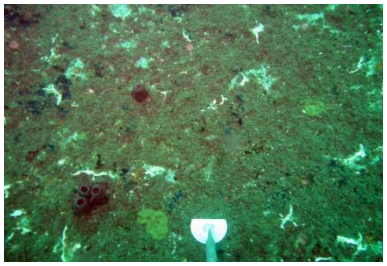
				
				
				

Plate 2 Continued: Deck Port Mid

Deck, Port Mid

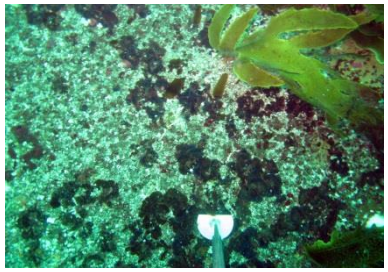
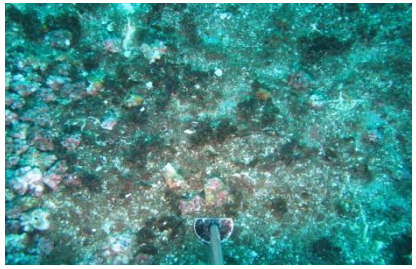
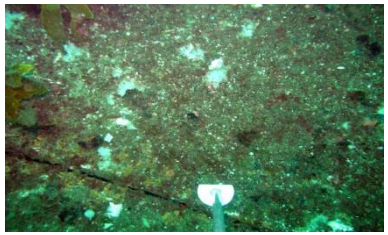
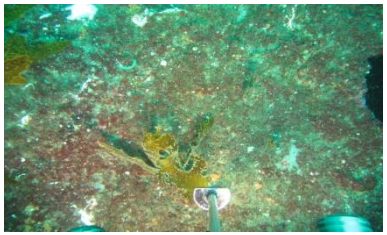
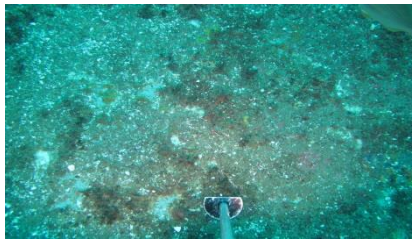
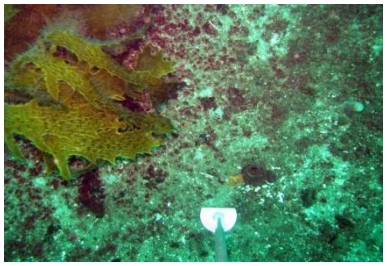
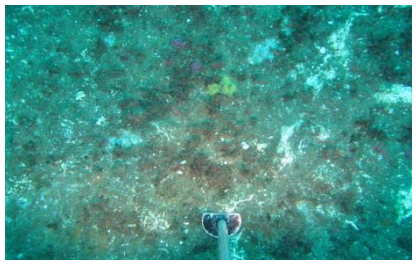
Monitoring Survey 10 (March 2014)	Monitoring Survey 11 (October 2014)	Monitoring Survey 12 (March 2015)
		
		
		

Plate 2 Continued: Deck Port Mid

Deck, Port , Stern

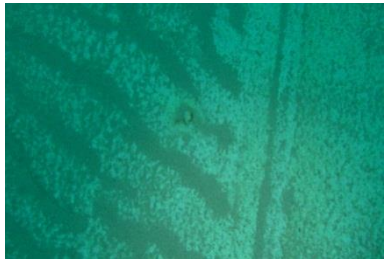
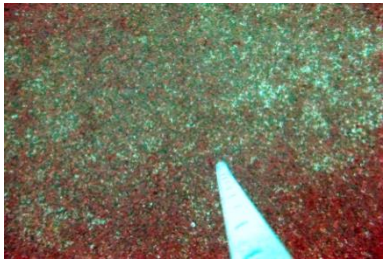
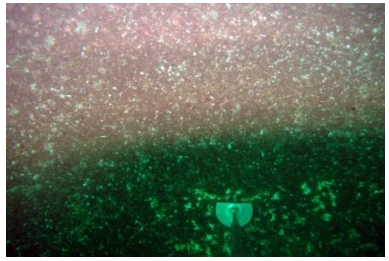
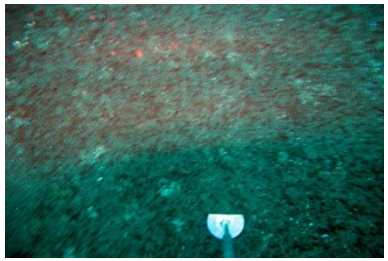
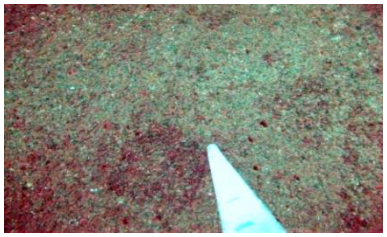
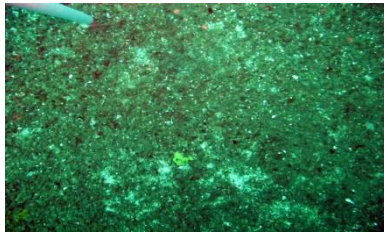
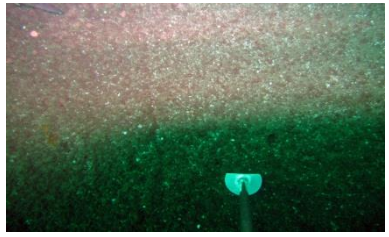
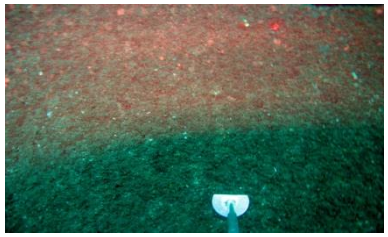
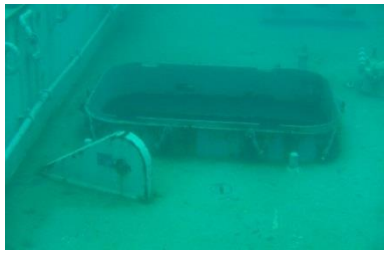
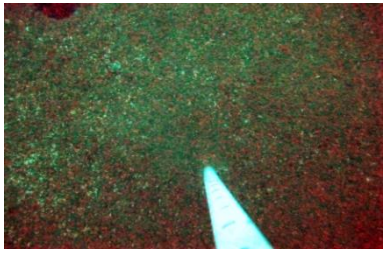
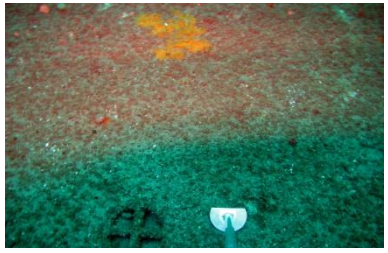
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 3: Deck Port Stern

Deck, Port, Stern

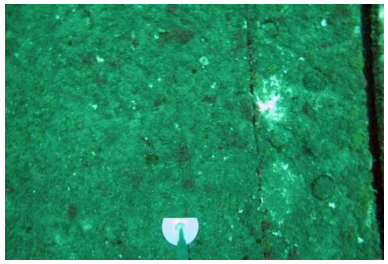
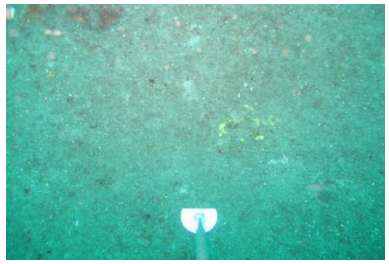
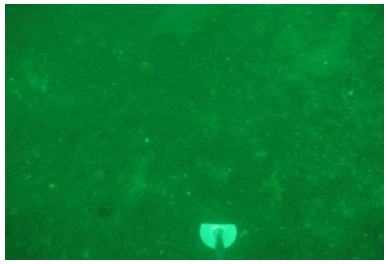
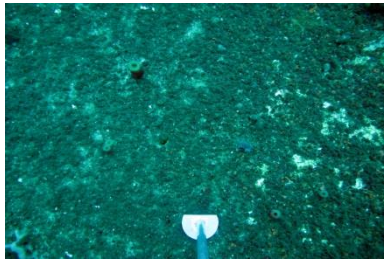
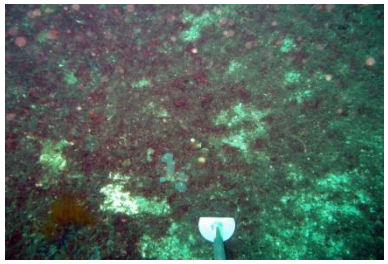
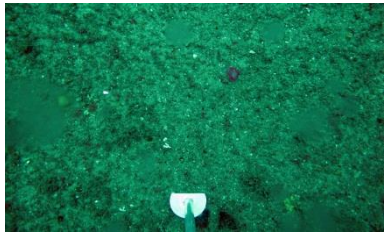
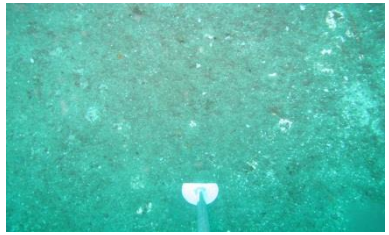
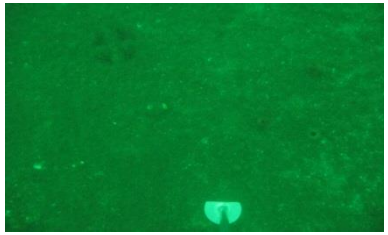
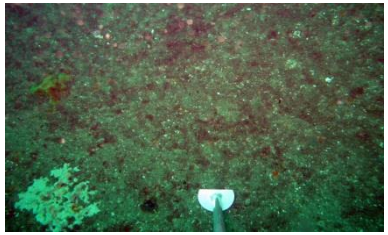
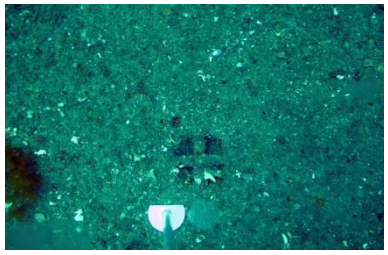
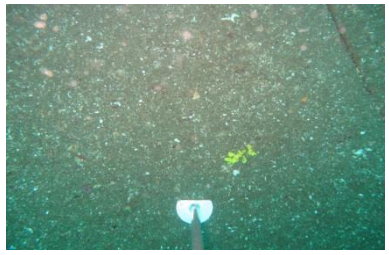
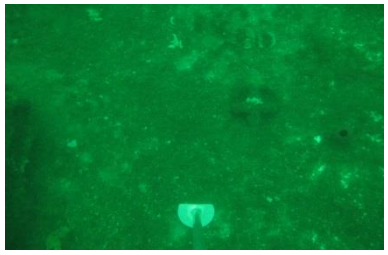
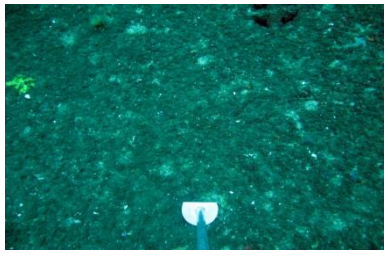
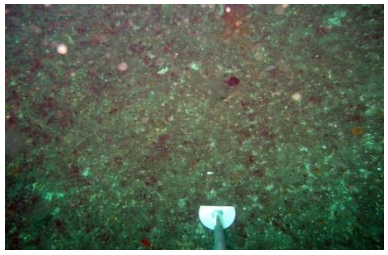
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)	Monitoring Survey 9 (October 2013)
				
				
				

Plate 3 Continued: Deck Port Stern

Deck, Port, Stern

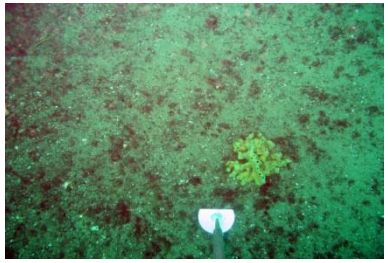
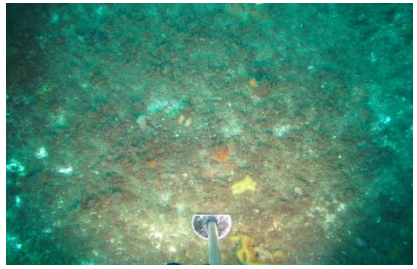
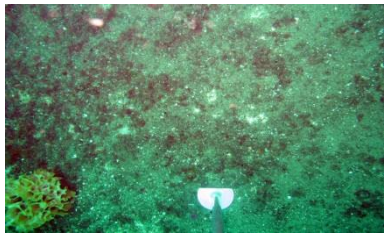
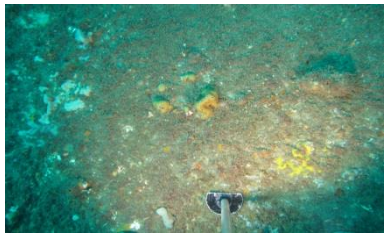
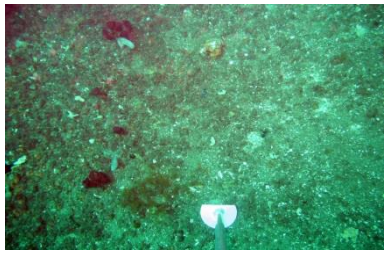
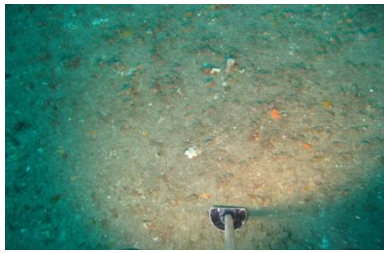
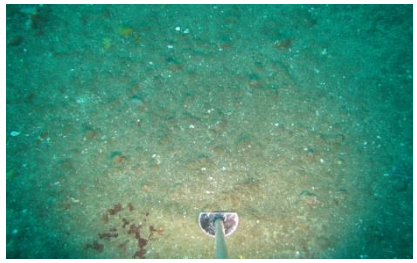
Monitoring Survey 10 (March 2014)	Monitoring Survey 11 (October 2014)	Monitoring Survey 12 (March 2015)
		
		
		

Plate 3 Continued: Deck Port Stern

Deck, Starbord, Bow

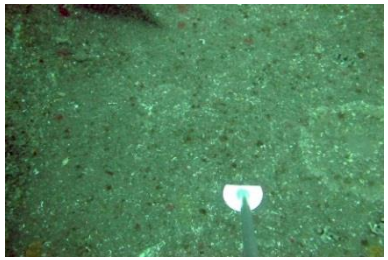
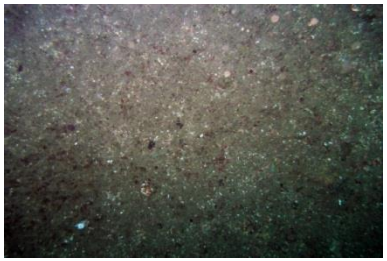
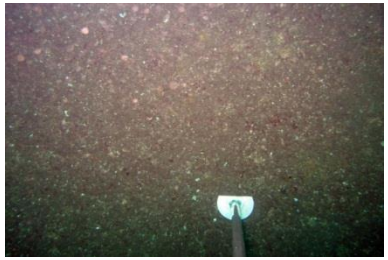
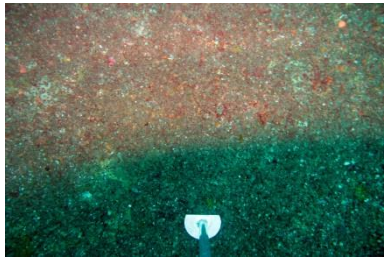
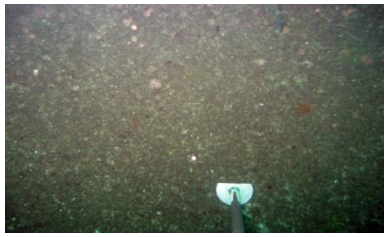
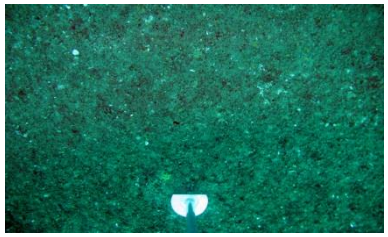
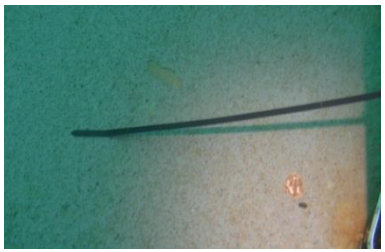
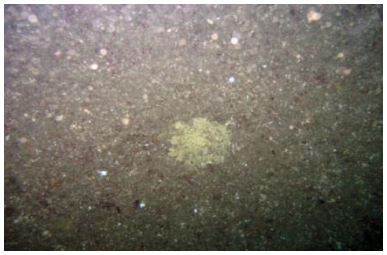
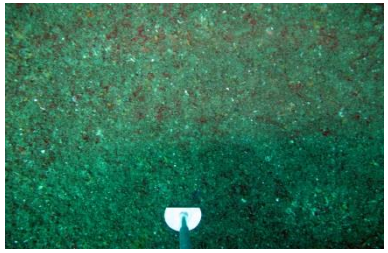
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 4: Deck Starbord Bow

Deck, Starbord, Bow

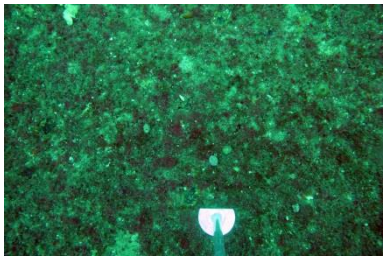
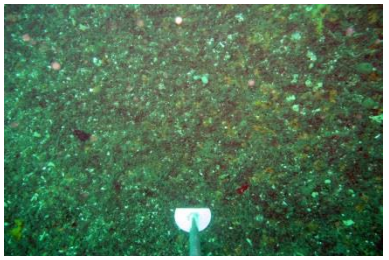
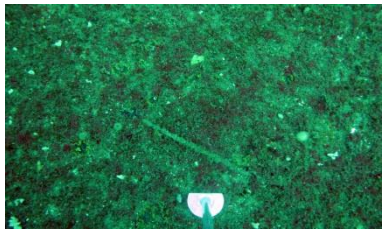
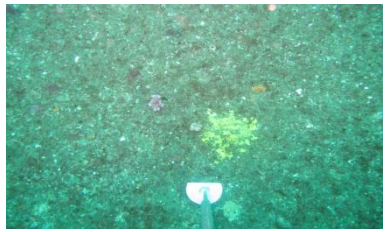
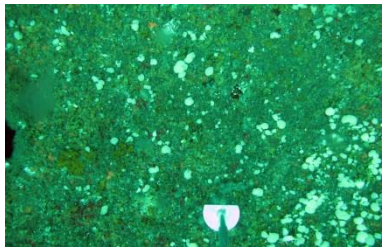
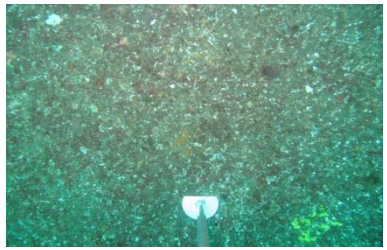
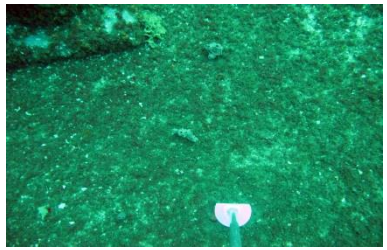
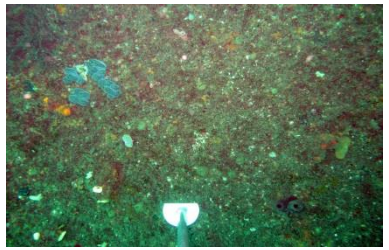
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)	Monitoring Survey 9 (October 2013)
				
				
				

Plate 4 Continued: Deck Starbord Bow

Deck, Starbord, Bow

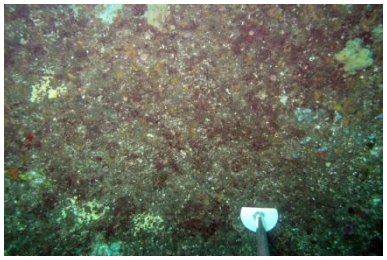
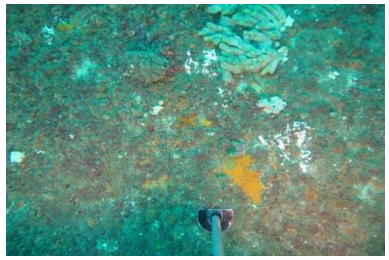
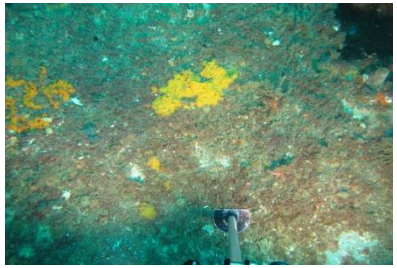
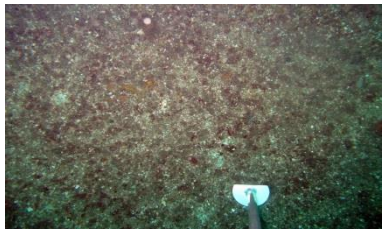
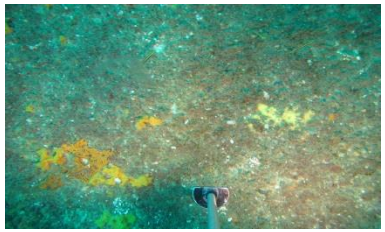
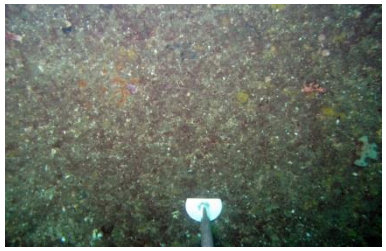
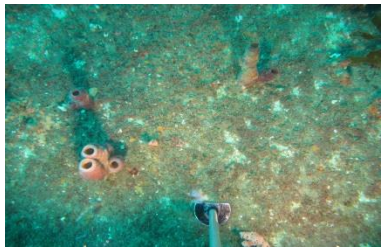
Monitoring Survey 10 (March 2014)	Monitoring Survey 11 (October 2014)	Monitoring Survey 12 (March 2015)
		
		
		

Plate 4 Continued: Deck Starbord Bow

Deck, Starbord, Mid

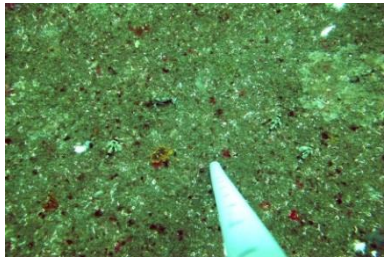
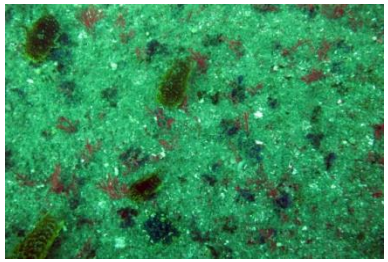
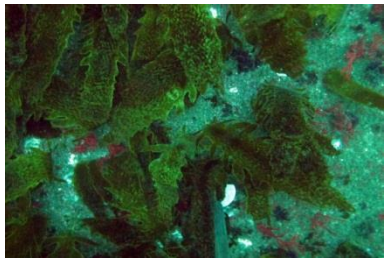
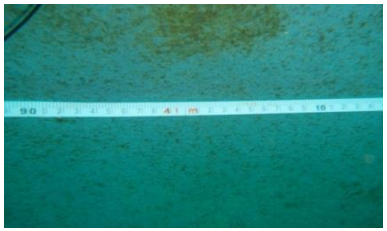
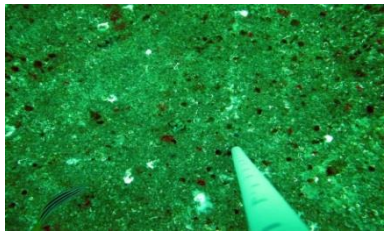
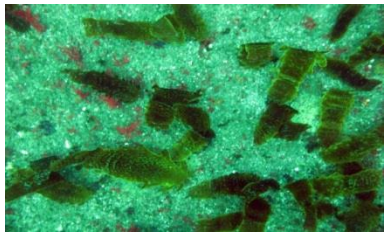
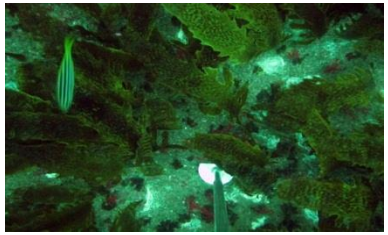
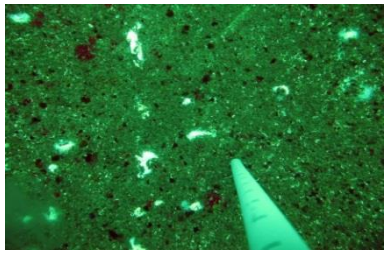
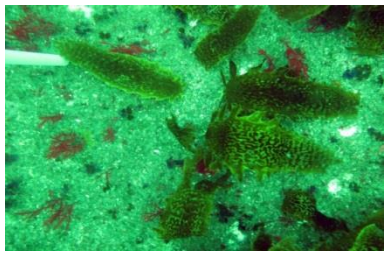
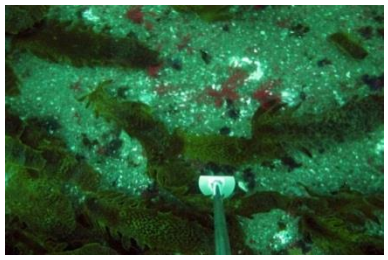
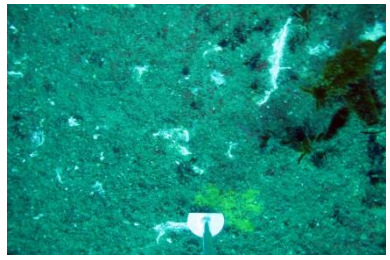
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 5: Deck Starbord Mid

Deck, Starbord, Mid

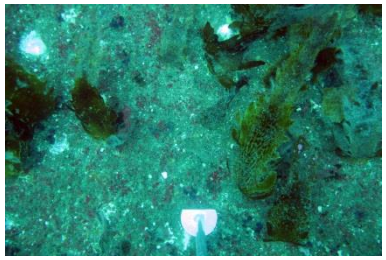
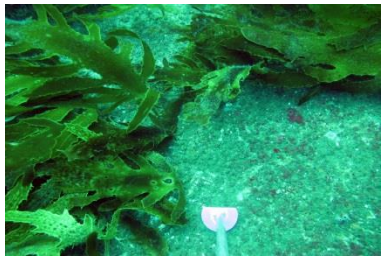
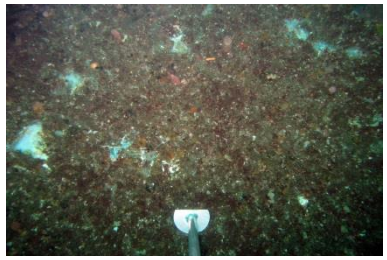
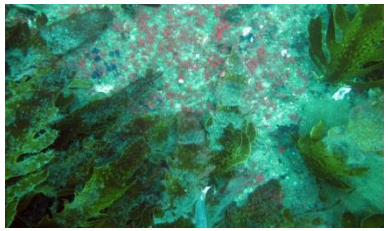
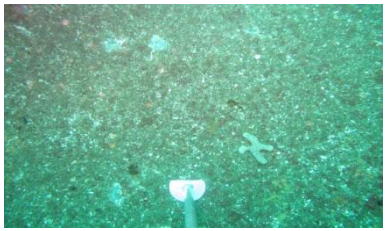
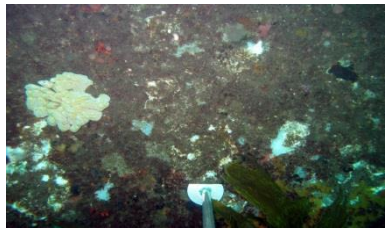
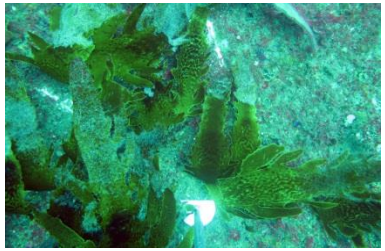
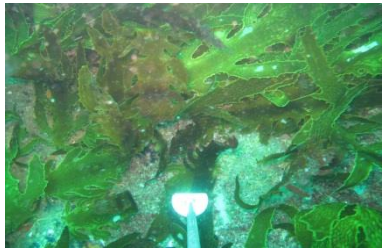
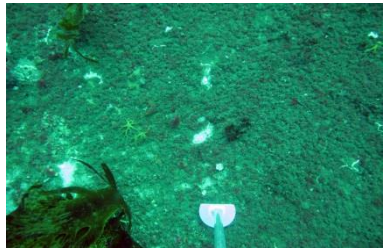
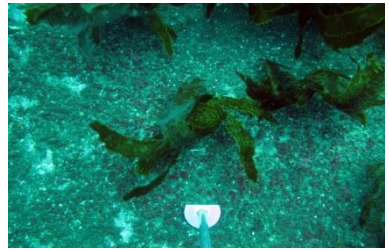
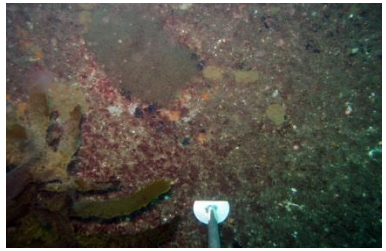
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)	Monitoring Survey 9 (October 2013)
				
				
				

Plate 5 Continued: Deck Starbord Mid

Deck, Starbord, Mid

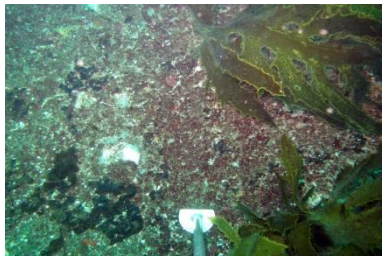
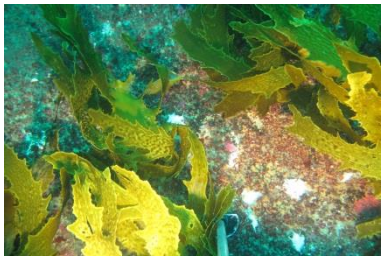
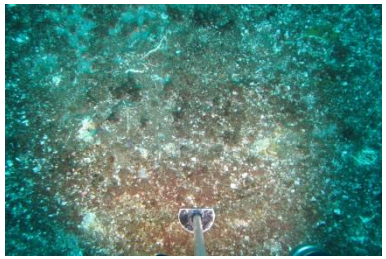
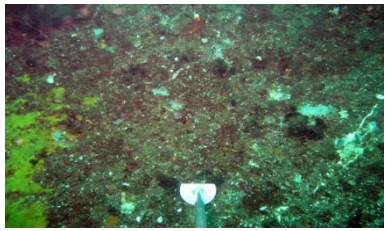
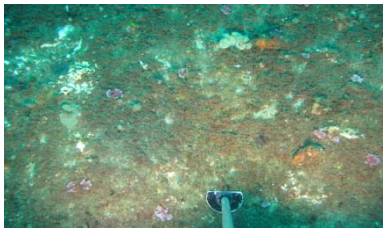
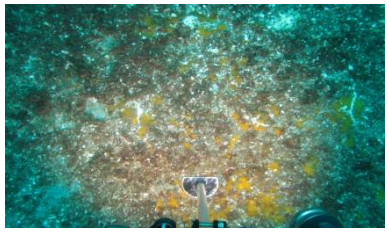
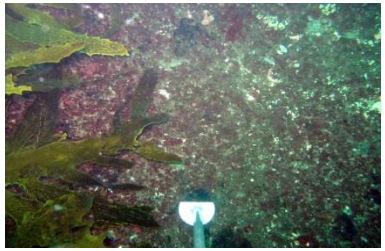
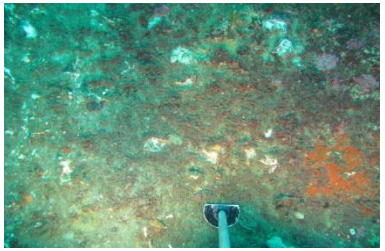
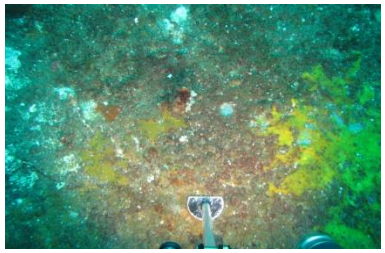
Monitoring Survey 10 (March 2014)	Monitoring Survey 11 (October 2014)	Monitoring Survey 12 (March 2015)
		
		
		

Plate 5 Continued: Deck Starbord Mid

Deck, Starbord, Stern

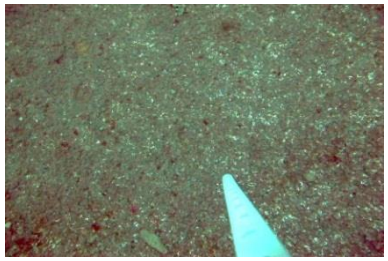
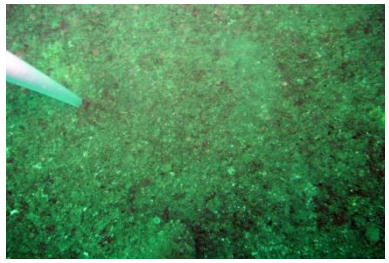
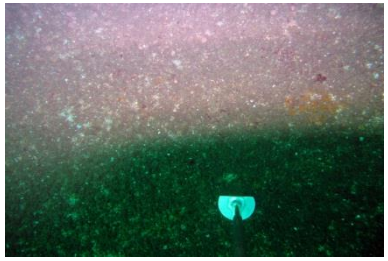
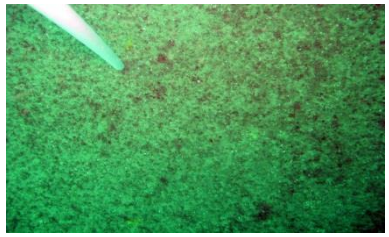
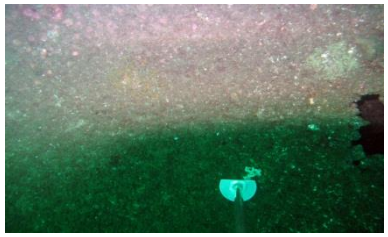
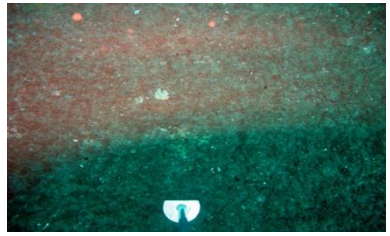
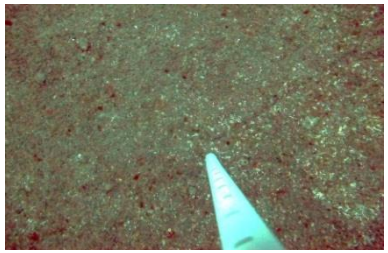
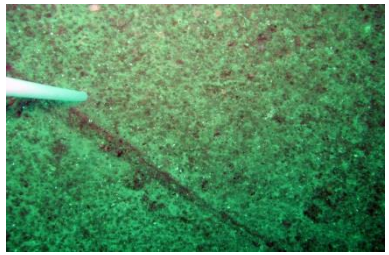
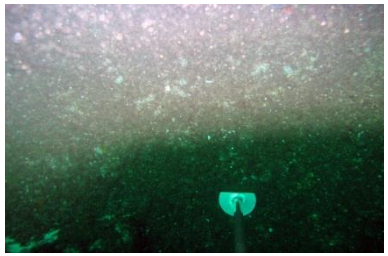
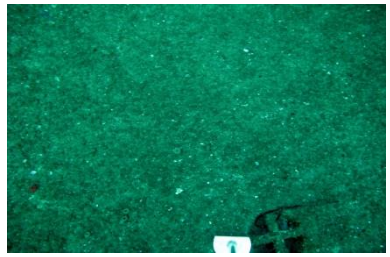
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 6: Deck Starbord Stern

Deck, Starbord, Stern

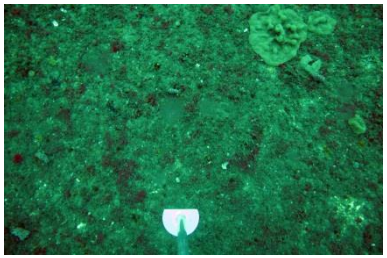
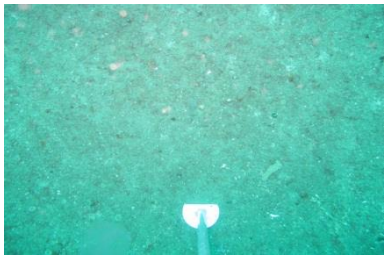
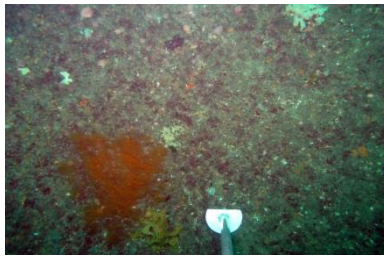
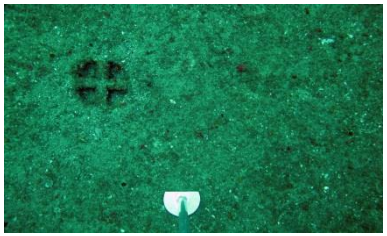
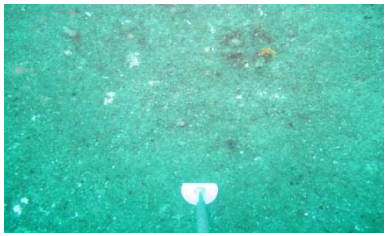
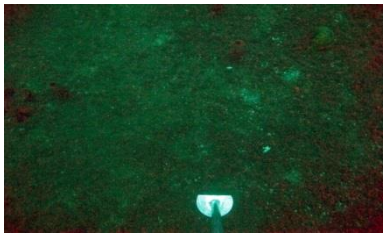
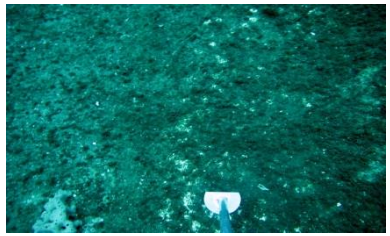
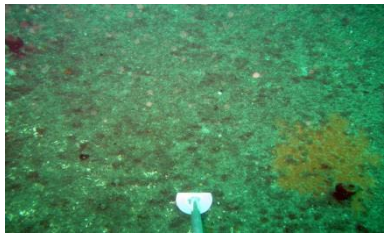
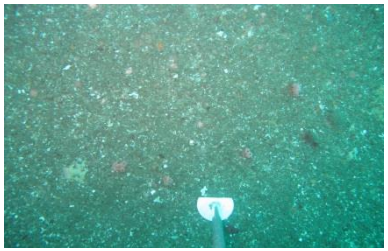
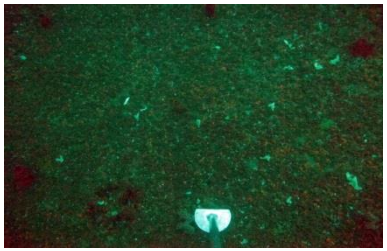
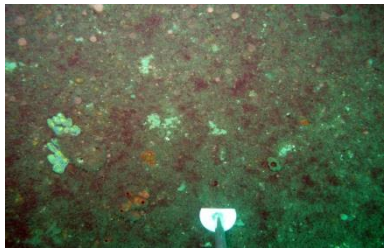
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)	Monitoring Survey 9 (October 2013)
				
				
				

Plate 6 Continued: Deck Starbord Stern

Deck, Starbord, Stern

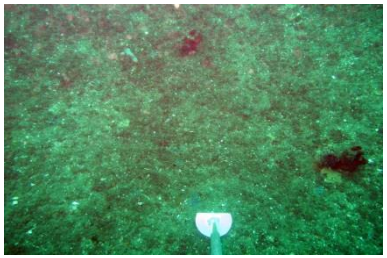
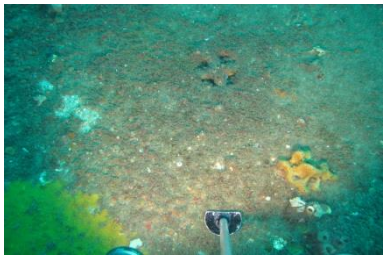
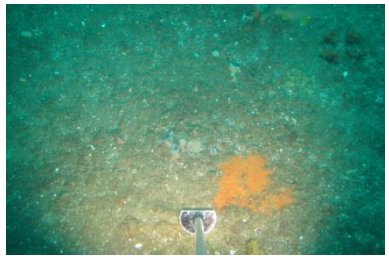
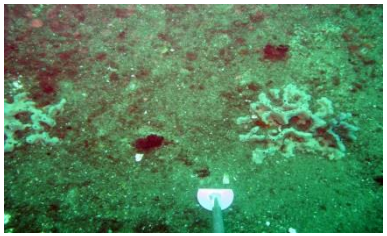
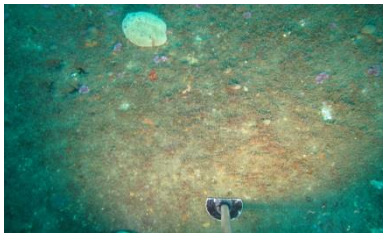
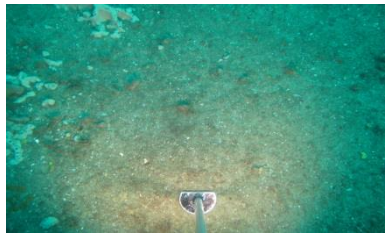
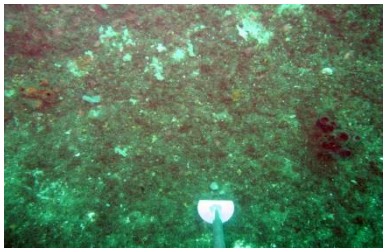
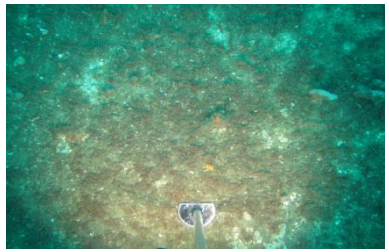
Monitoring Survey 10 (March 2014)	Monitoring Survey 11 (October 2014)	Monitoring Survey 12 (March 2015)
		
		
		

Plate 6 Continued: Deck Starbord Stern

Horizontal Hull Port

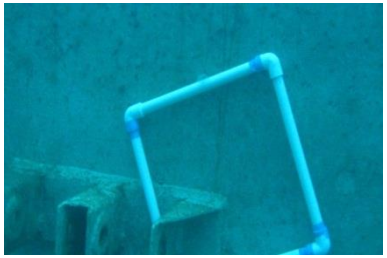
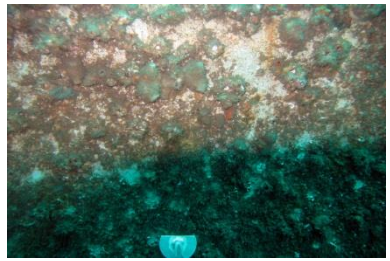
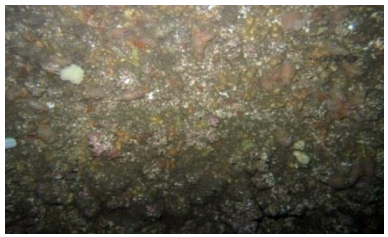
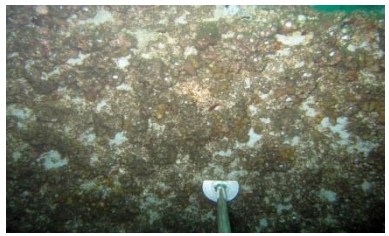
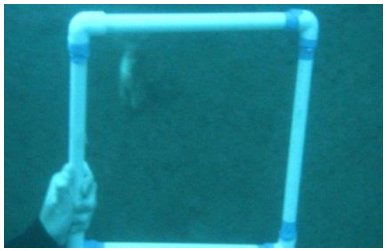
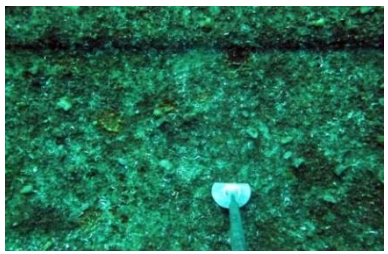
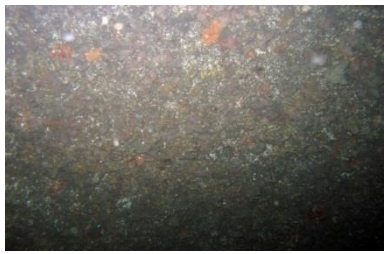
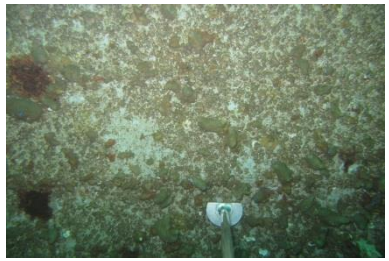
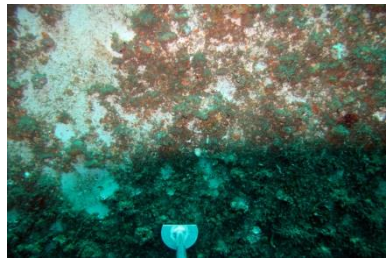
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

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)

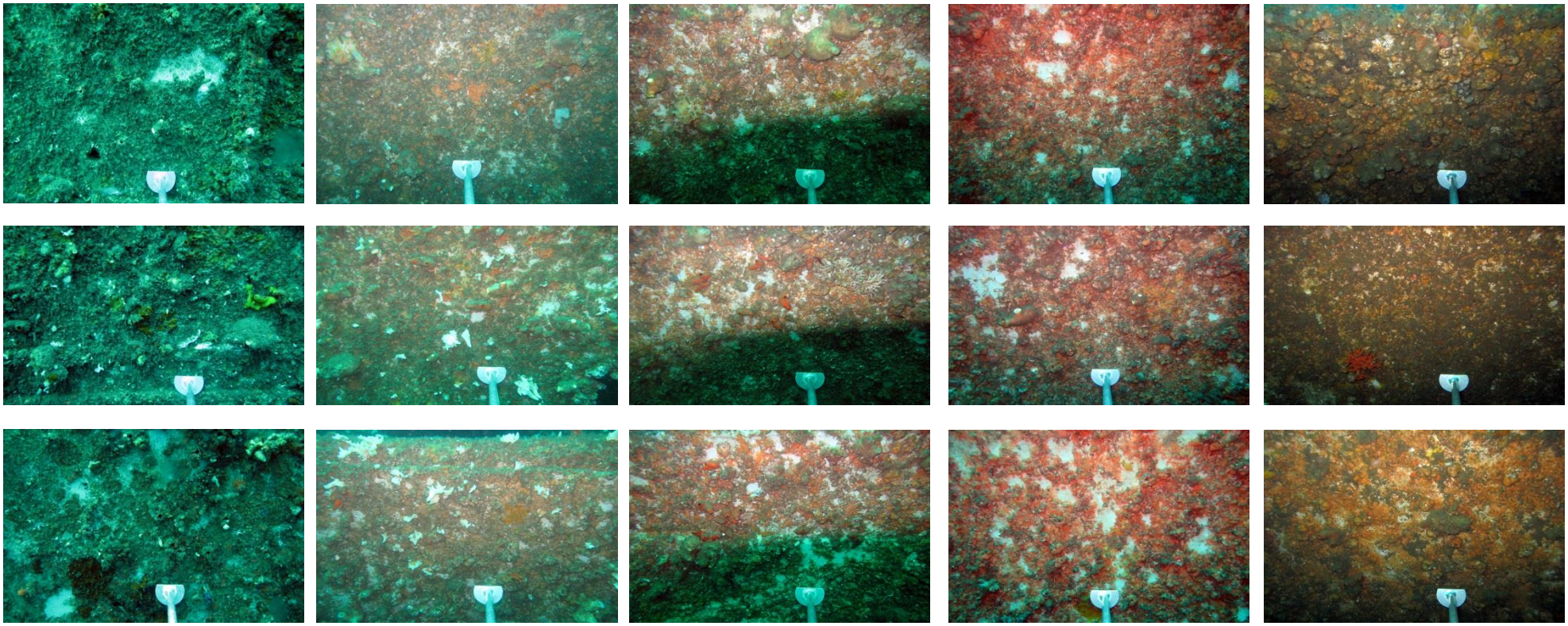


Plate 7 Continued: Horizontal Hull Port

Horizontal Hull Port

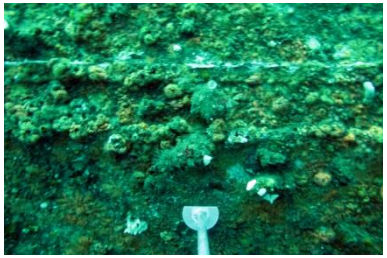
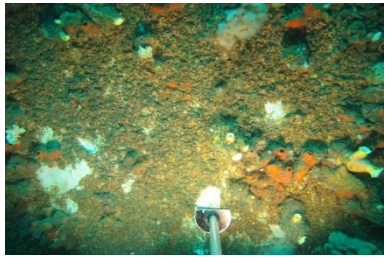
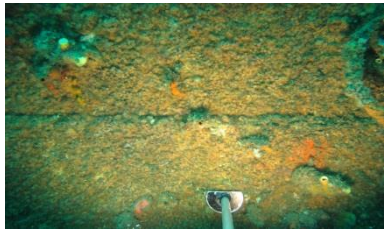
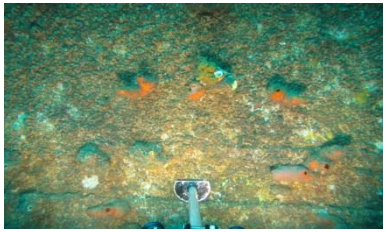
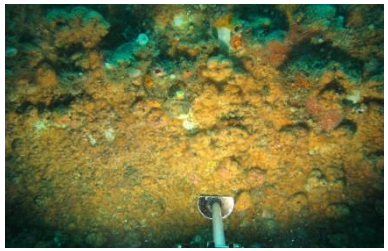
Monitoring Survey 10 (March 2014)	Monitoring Survey 11 (October 2014)	Monitoring Survey 12 (March 2015)
		
		
		

Plate 7 Continued: Horizontal Hull Port

Horizontal Hull Starboard

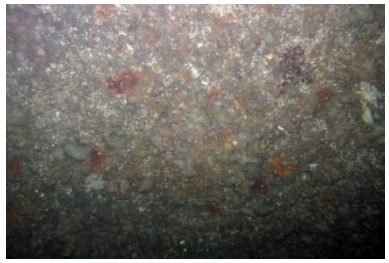
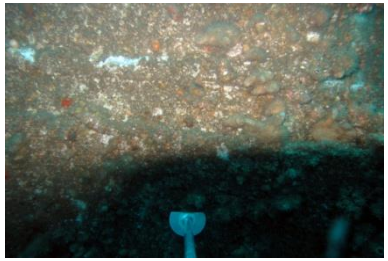
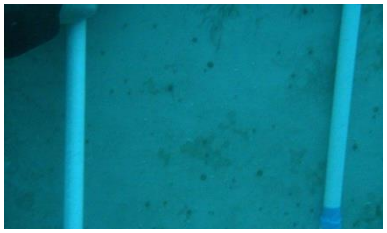
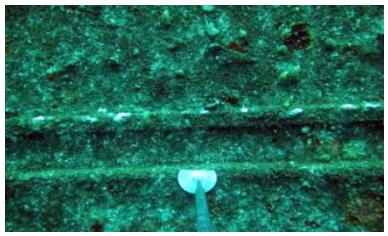
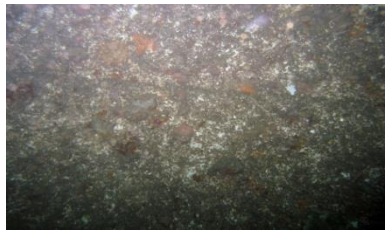
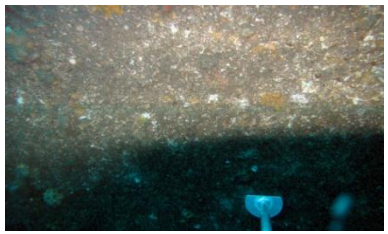
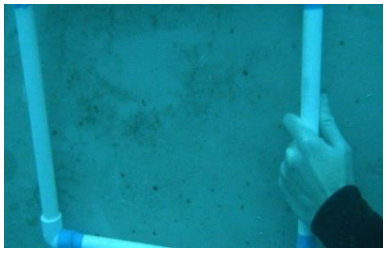
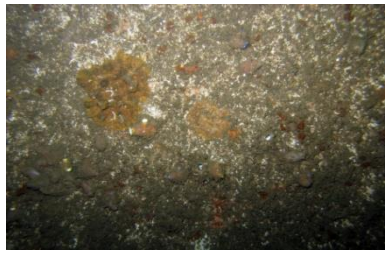
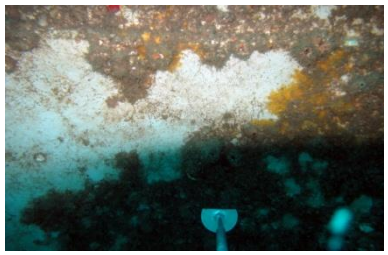
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 8: Horizontal Hull Starboard

Horizontal Hull Starbord

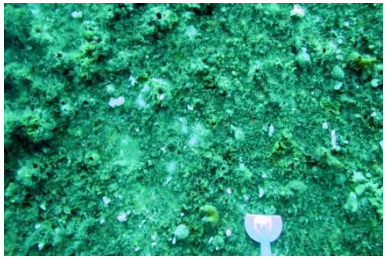
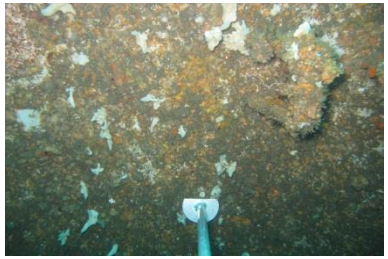
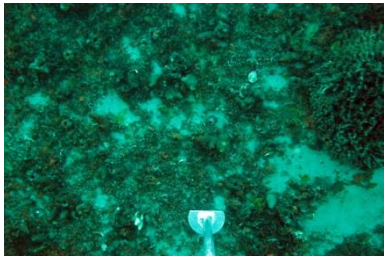
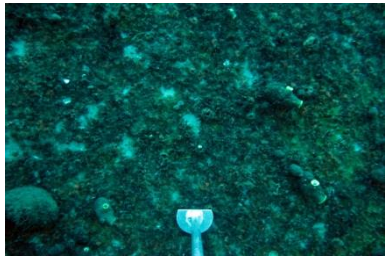
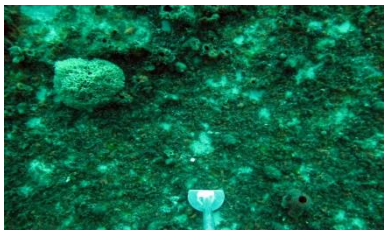
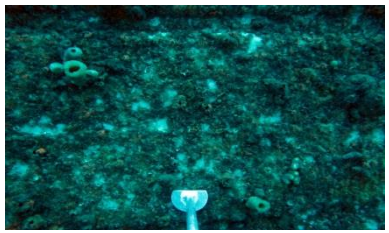
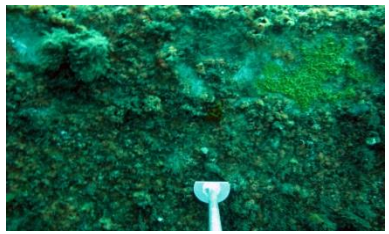
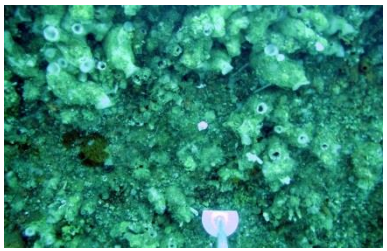
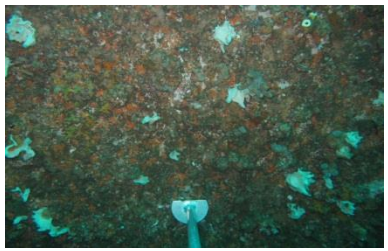
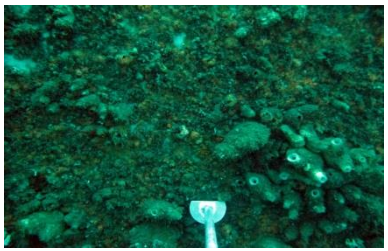
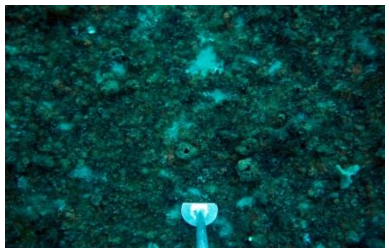
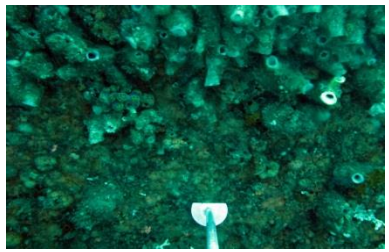
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)	Monitoring Survey 9 (October 2013)
				
				
				

Plate 8 Continued: Horizontal Hull Starbord

Horizontal Hull Starbord

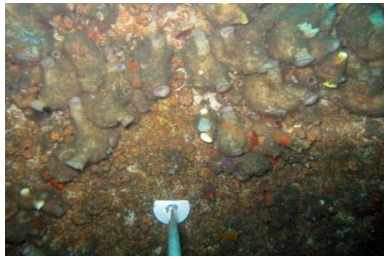
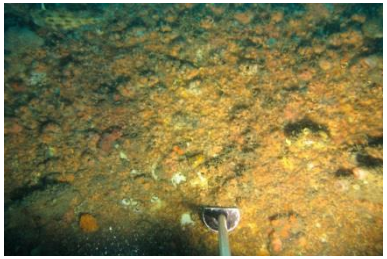
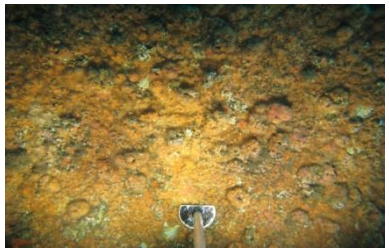
Monitoring Survey 10 (March 2014)	Monitoring Survey 11 (October 2014)	Monitoring Survey 12 (March 2015)
		
		
		

Plate 8 Continued: Horizontal Hull Starbord

Vertical Hull Port Bow

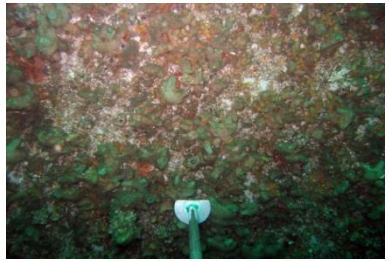
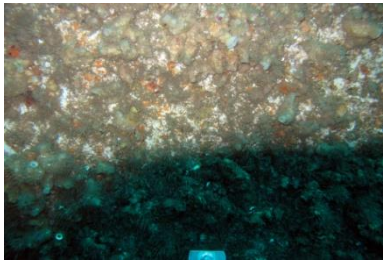
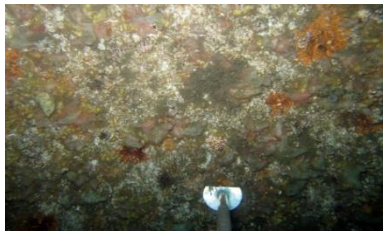
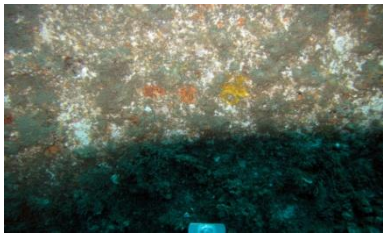
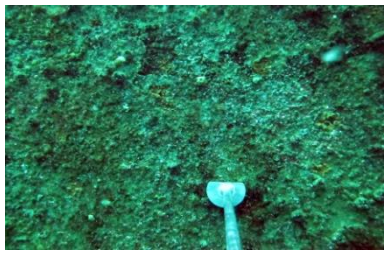
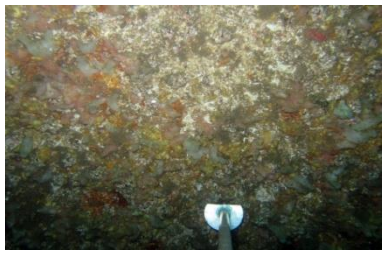
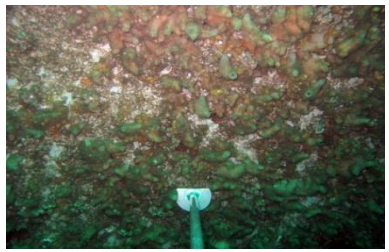
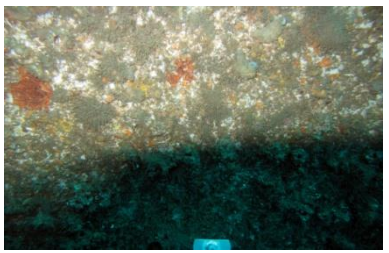
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 9: Vertical Hull Port Bow

Vertical Hull Port Bow

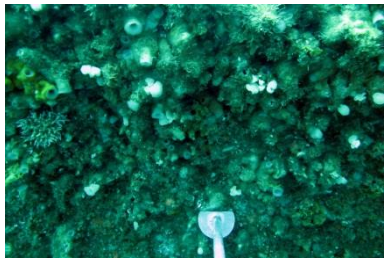
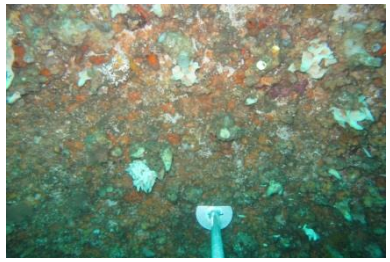
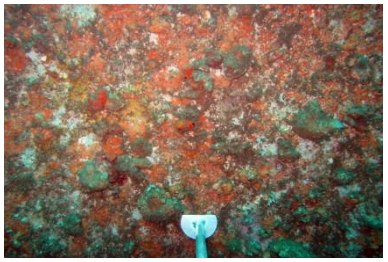
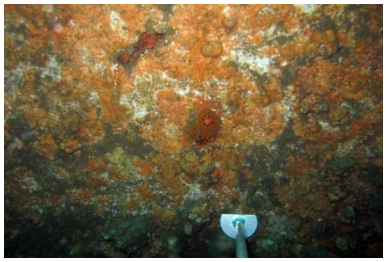
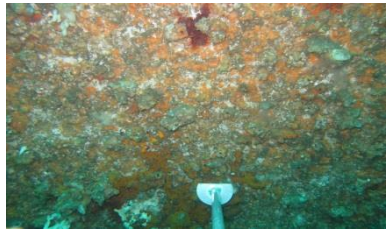
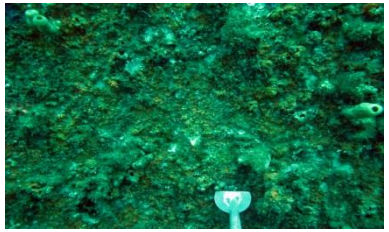
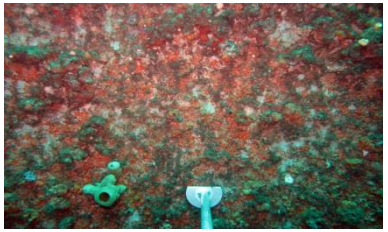
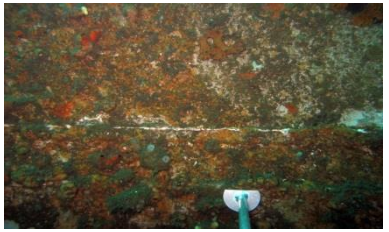
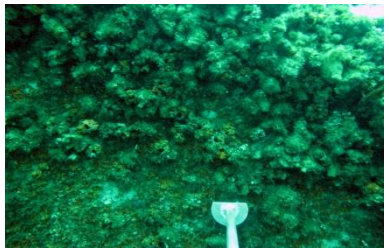
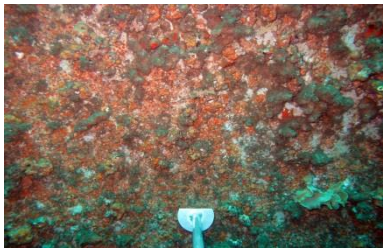
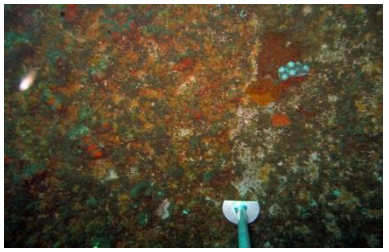
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)	Monitoring Survey 9 (October 2013)
				
				
				

Plate 9 Continued: Vertical Hull Port Bow

Vertical Hull Port Bow

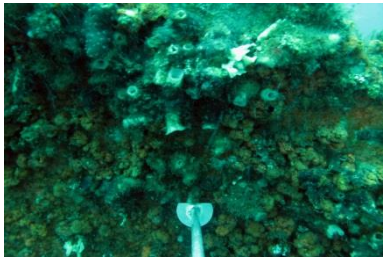
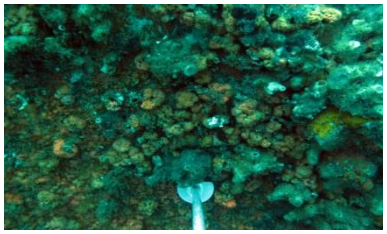
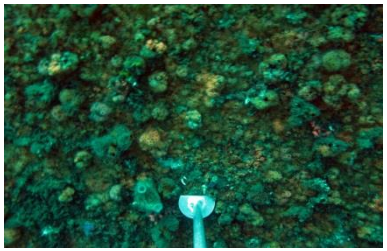
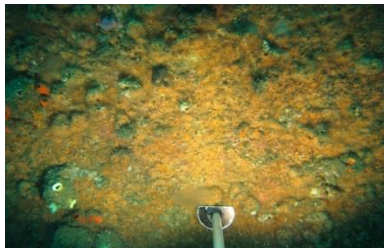
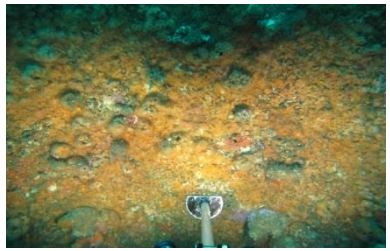
Monitoring Survey 10 (March 2014)	Monitoring Survey 11 (October 2014)	Monitoring Survey 12 (March 2015)
		
		
		

Plate 9 Continued: Vertical Hull Port Bow

Vertical Hull Port Stern

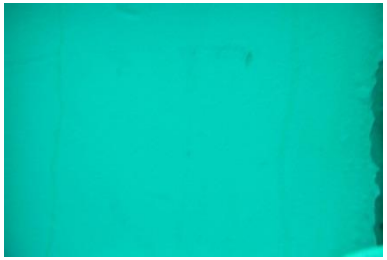
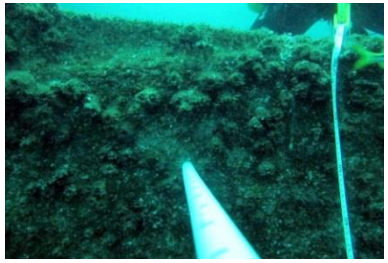
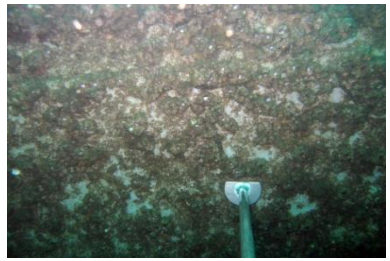
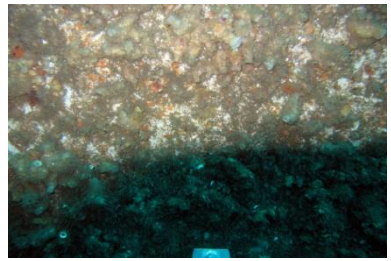
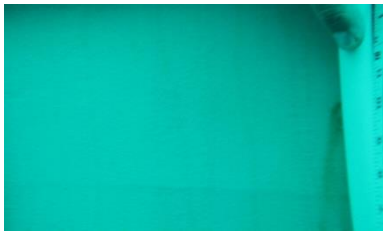
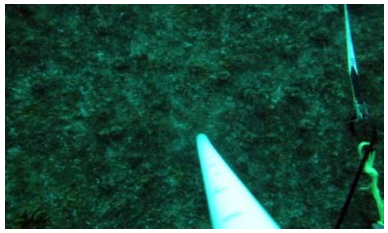
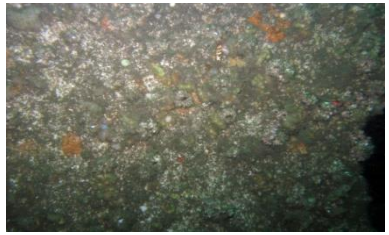
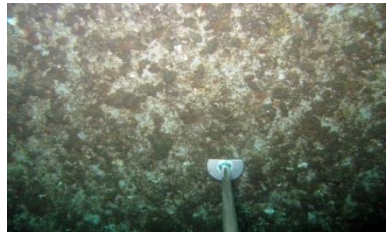
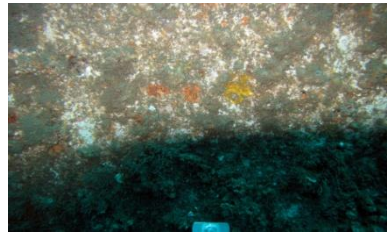
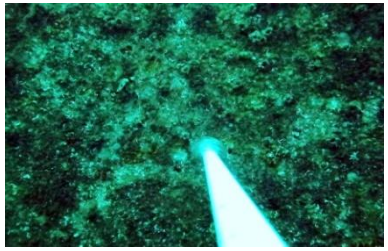
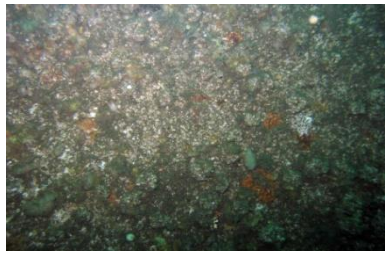
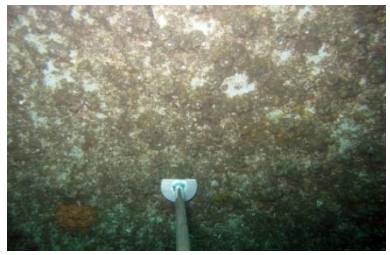
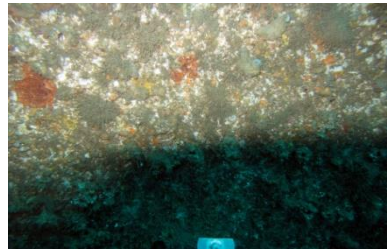
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 10: Vertical Hull Port Stern

Vertical Hull Port Stern

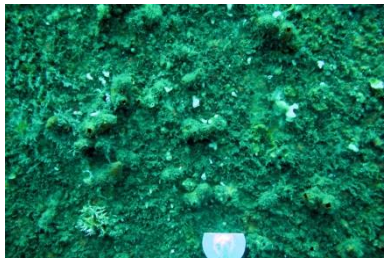
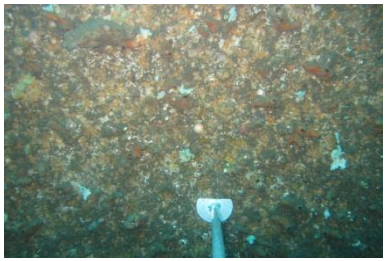
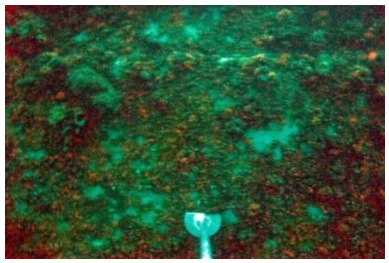
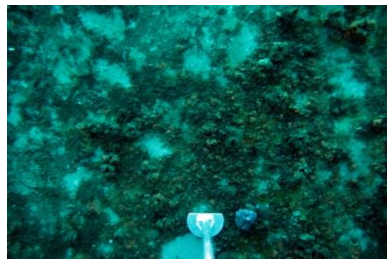
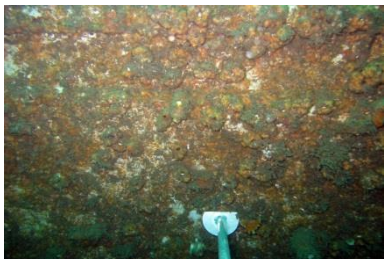
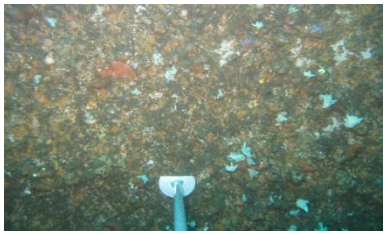
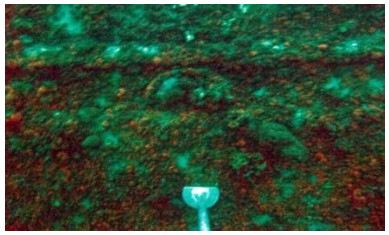
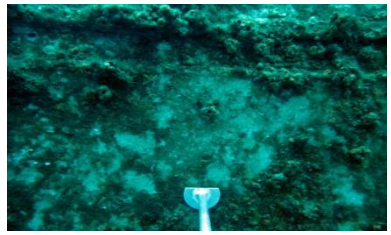
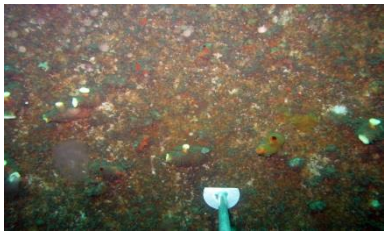
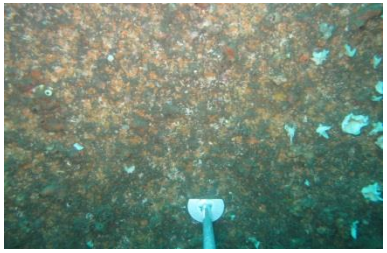
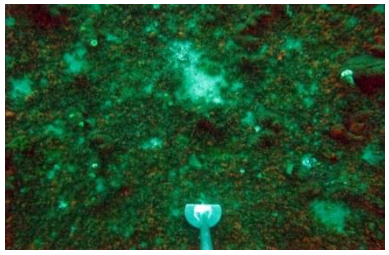
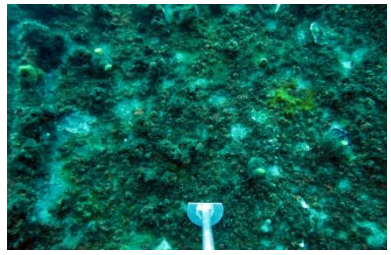
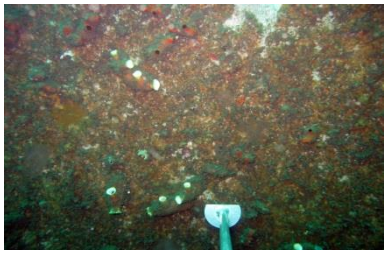
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)	Monitoring Survey 9 (October 2013)
				
				
				

Plate 10 Continued: Vertical Hull Port Stern

Vertical Hull Port Stern

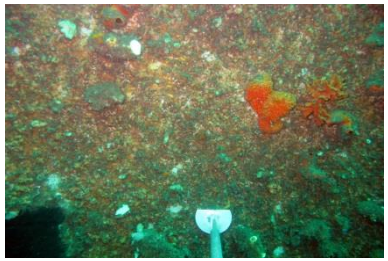
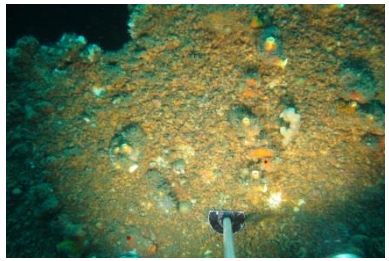
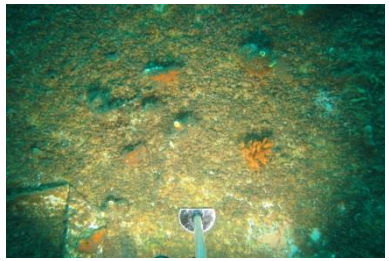
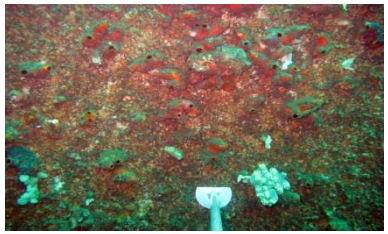
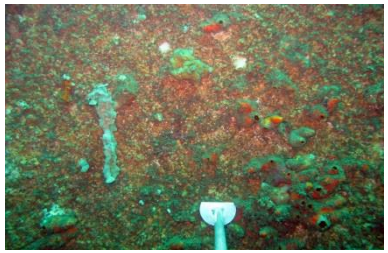
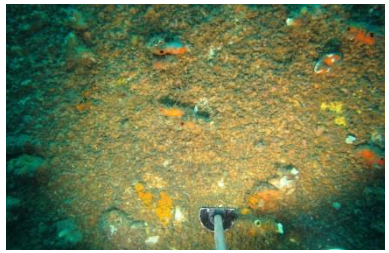
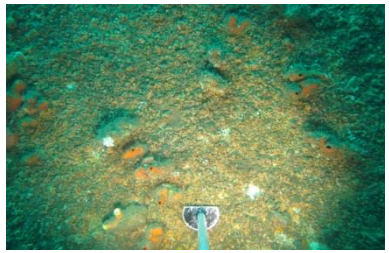
Monitoring Survey 10 (March 2014)	Monitoring Survey 11 (October 2014)	Monitoring Survey 12 (March 2015)
		
		
		

Plate 10 Continued: Vertical Hull Port Stern

Vertical Hull Starbord Bow

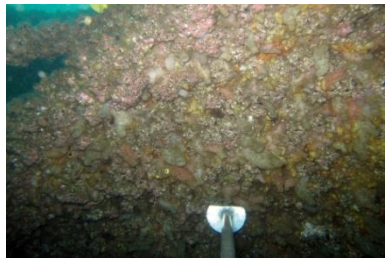
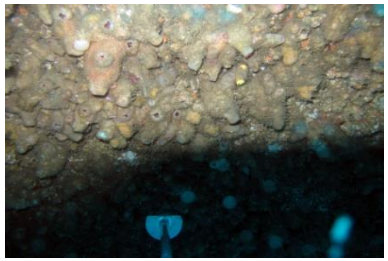
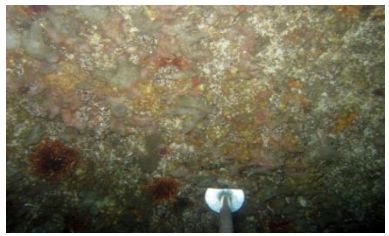
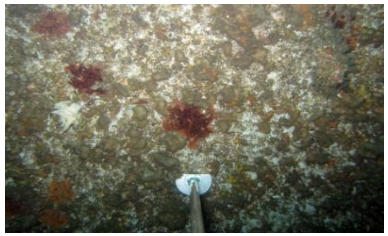
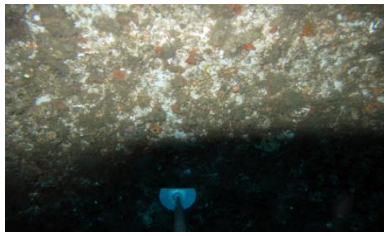
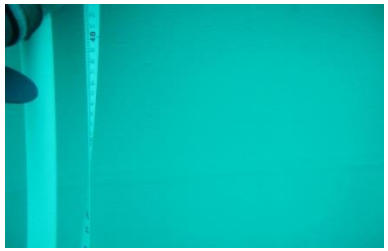
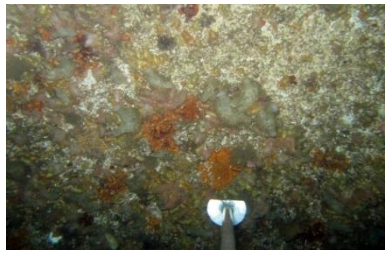
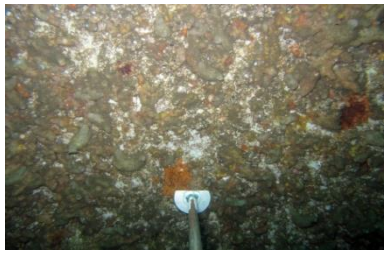
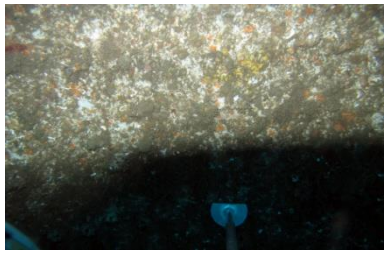
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 11: Vertical Hull Starbord Bow

Vertical Hull Starbord Bow

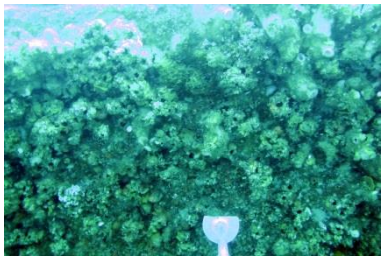
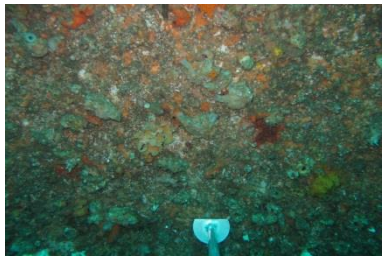
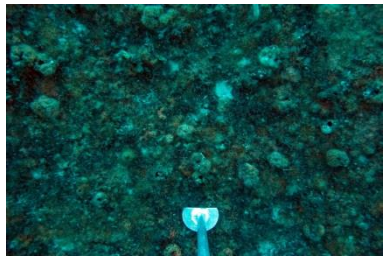
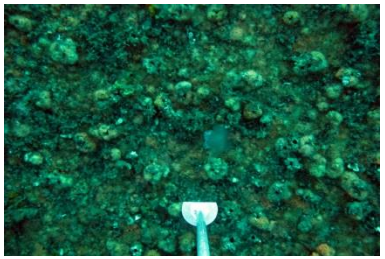
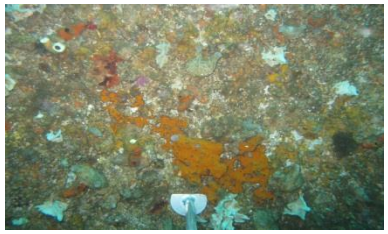
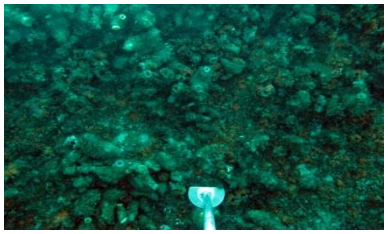
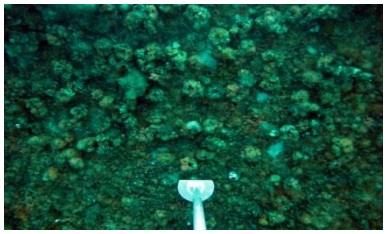
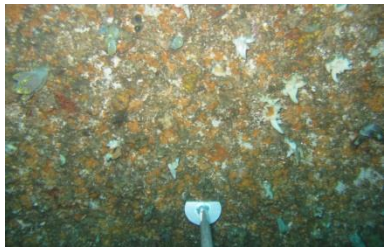
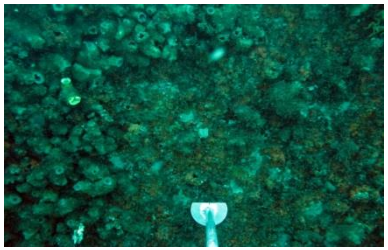
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)	Monitoring Survey 9 (October 2013)
				
				
				

Plate 11 Continued: Vertical Hull Starbord Bow

Vertical Hull Starbord Bow

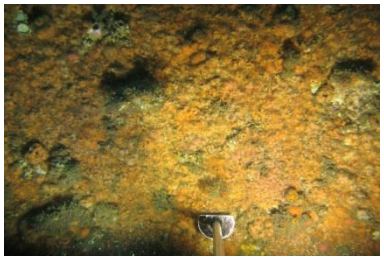
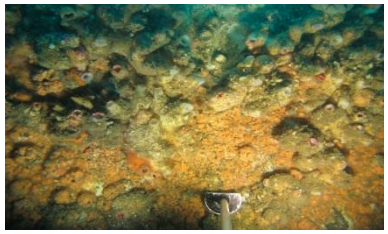
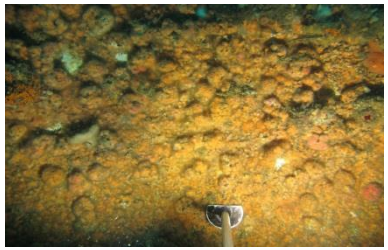
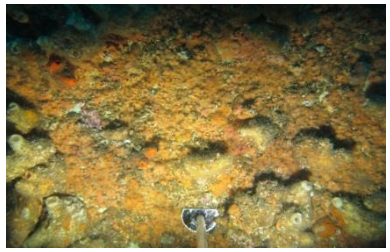
Monitoring Survey 10 (March 2014)	Monitoring Survey 11 (October 2014)	Monitoring Survey 12 (March 2015)
		
		
		

Plate 11 Continued: Vertical Hull Starbord Bow

Vertical Hull Starbord Stern

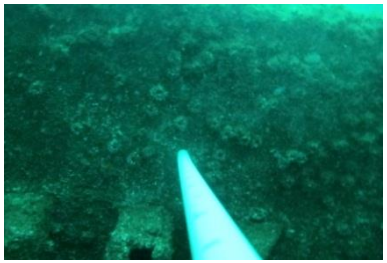
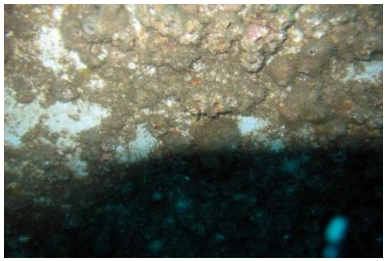
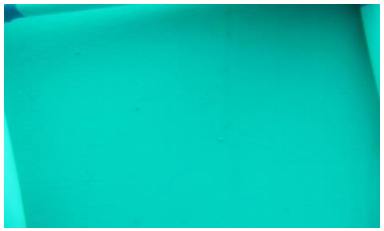
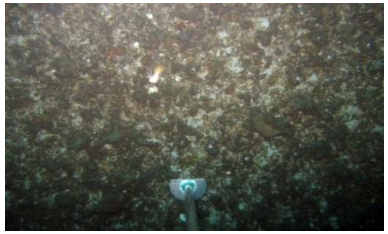
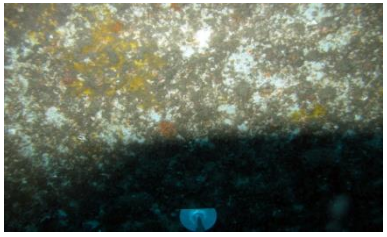
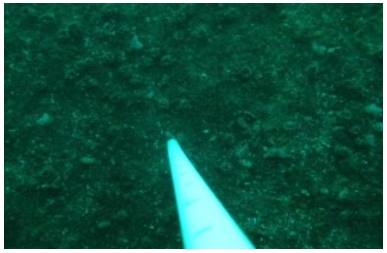
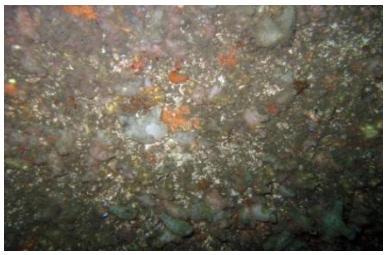
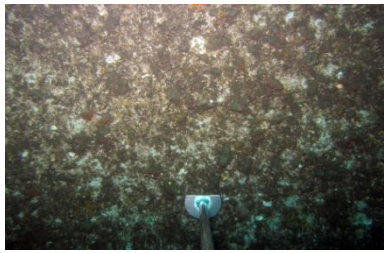
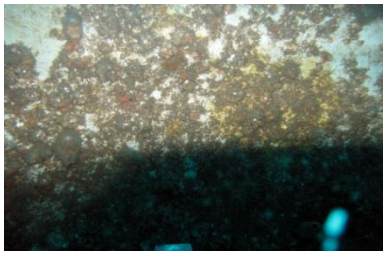
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
				
				
				

Plate 12: Vertical Hull Starbord Stern

Vertical Hull Starbord Stern

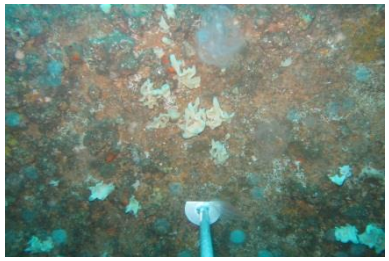
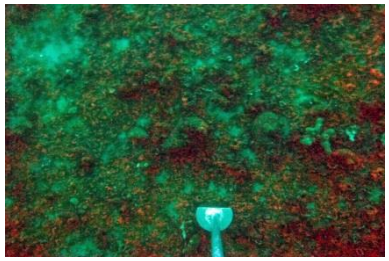
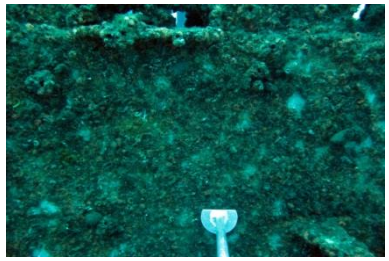
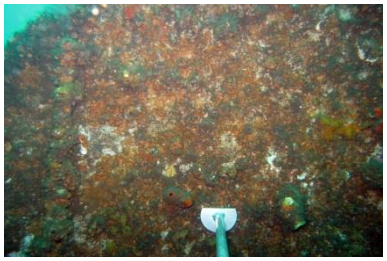
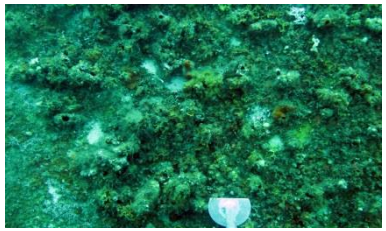
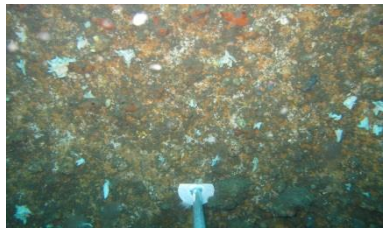
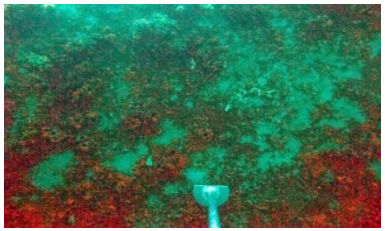
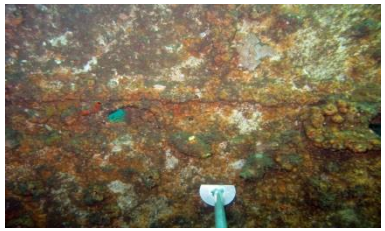
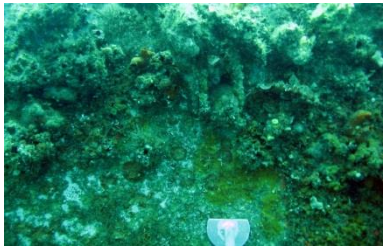
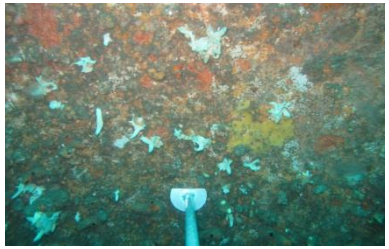
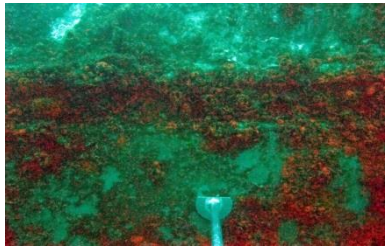
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)	Monitoring Survey 9 (October 2013)
				
				
				

Plate 12 Continued: Vertical Hull Starbord Stern

Vertical Hull Starbord Stern

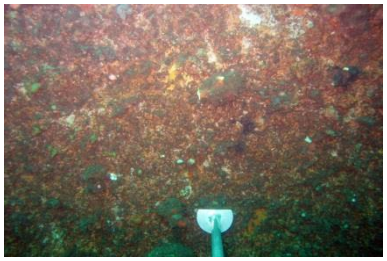
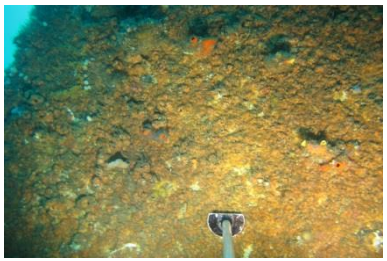
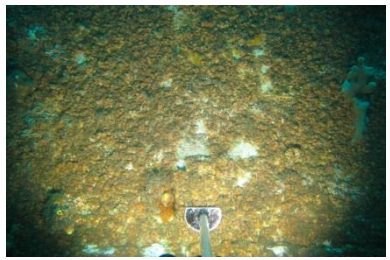
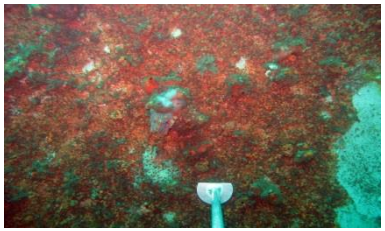
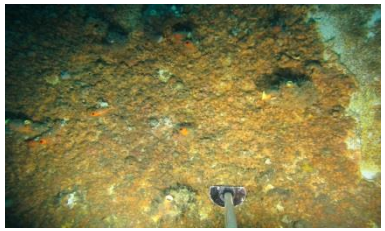
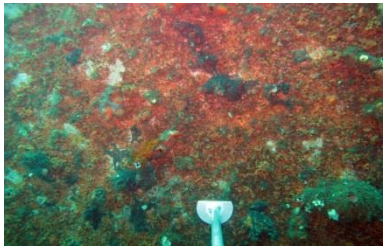
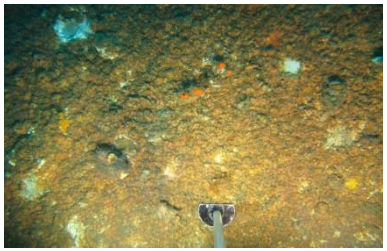
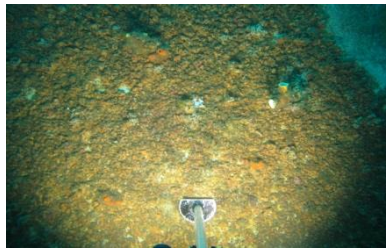
Monitoring Survey 10 (March 2014)	Monitoring Survey 11 (October 2014)	Monitoring Survey 12 (March 2015)
		
		
		

Plate 12 Continued: Vertical Hull Starbord Stern

Vertical Superstructure Port Bow

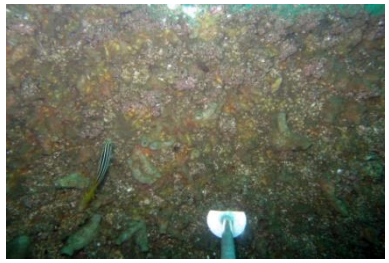
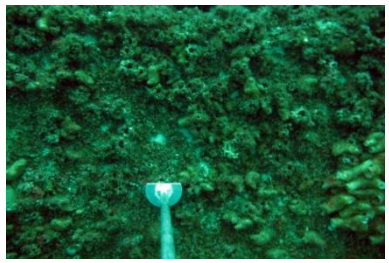
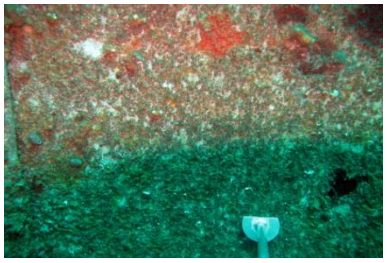
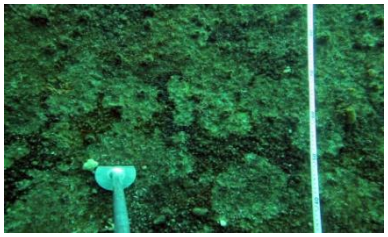
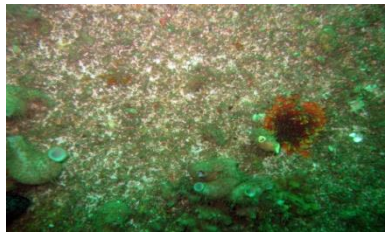
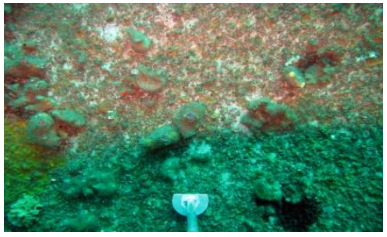
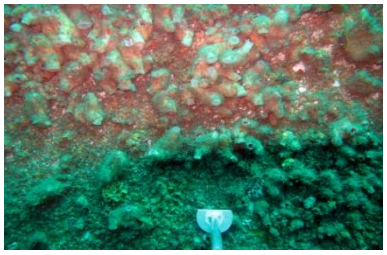
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
Not Sampled				
Not Sampled				
Not Sampled				

Plate 13: Vertical Superstructure Port Bow

Vertical Superstructure Port Bow

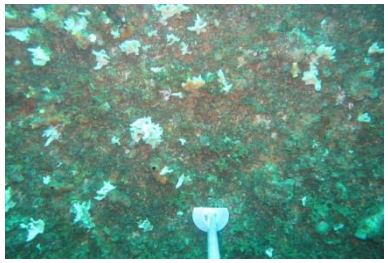
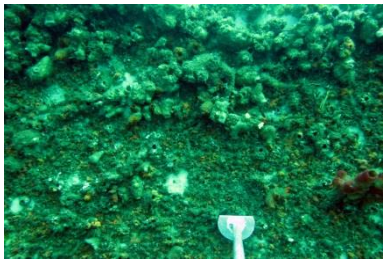
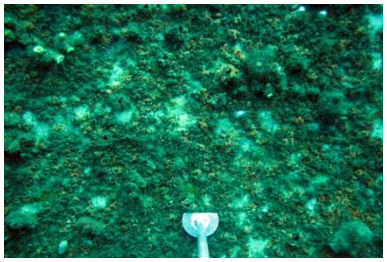
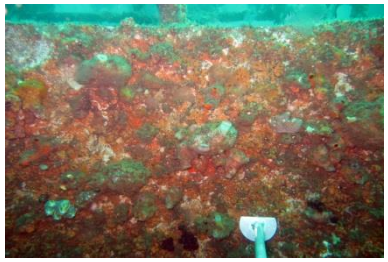
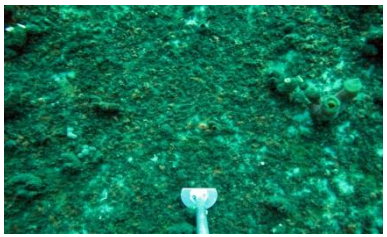
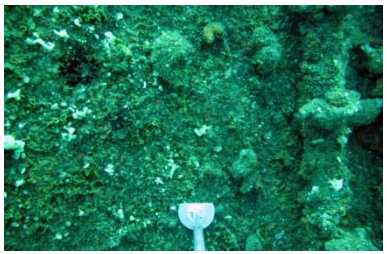
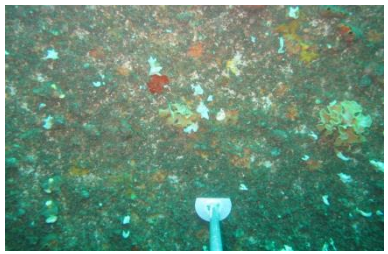
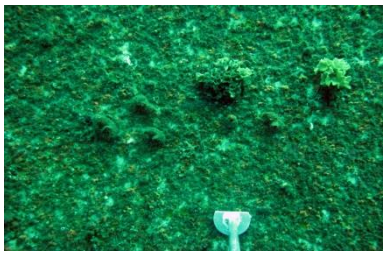
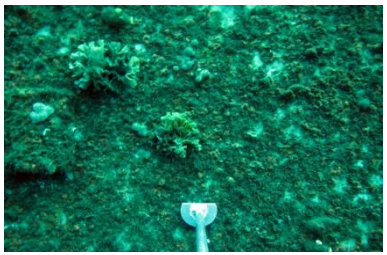
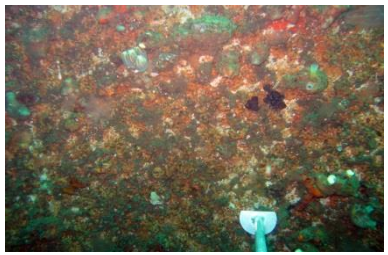
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)	Monitoring Survey 9 (October 2013)
				
				
				

Plate 13 Continued: Vertical Superstructure Port Bow

Vertical Superstructure Port Bow

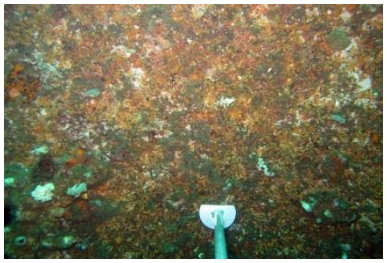
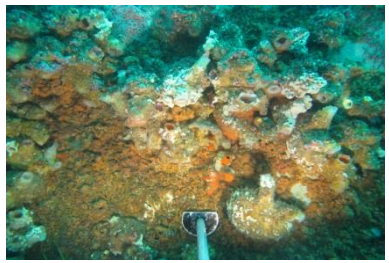
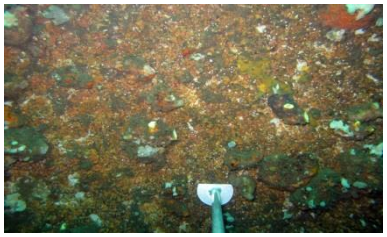
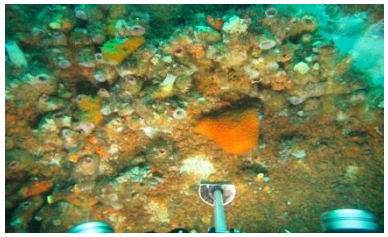
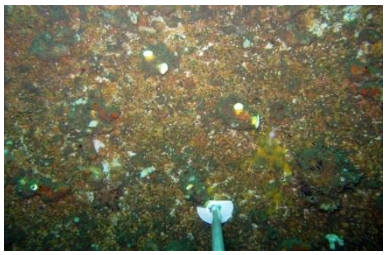
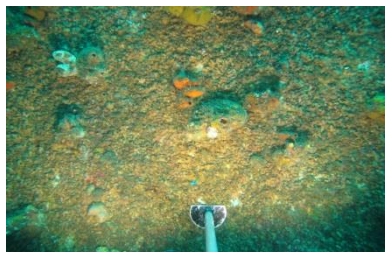
Monitoring Survey 10 (March 2014)	Monitoring Survey 11 (October 2014)	Monitoring Survey 12 (March 2015)
		
		
		

Plate 13 Continued: Vertical Superstructure Port Bow

Vertical Superstructure Port Stern

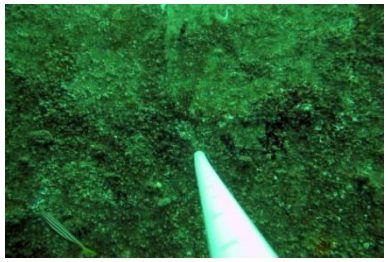
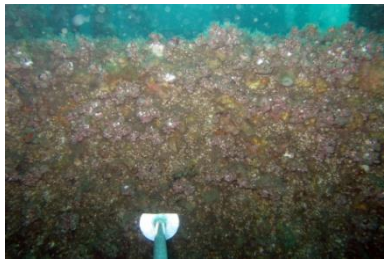
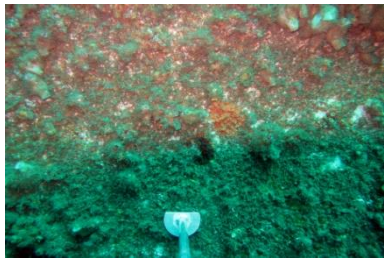
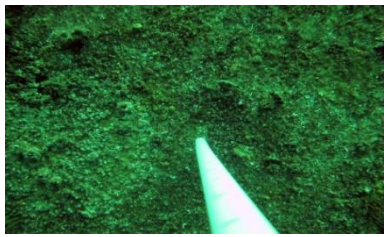
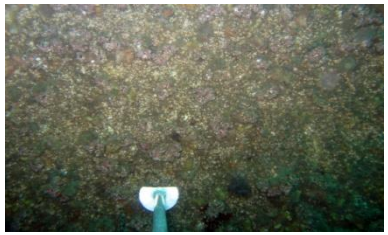
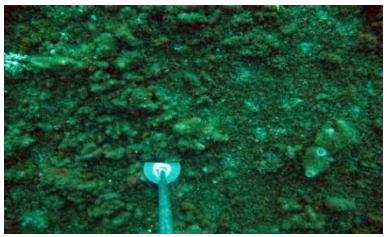
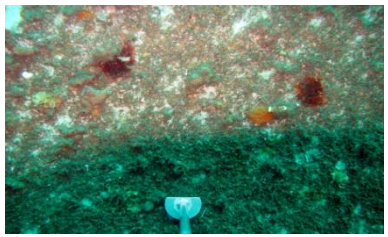
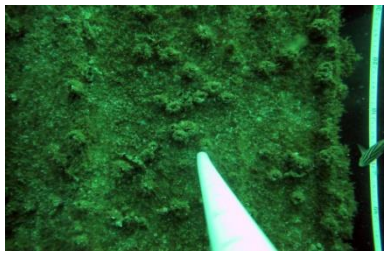
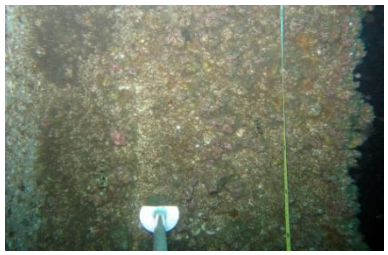
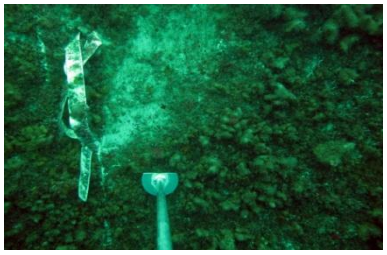
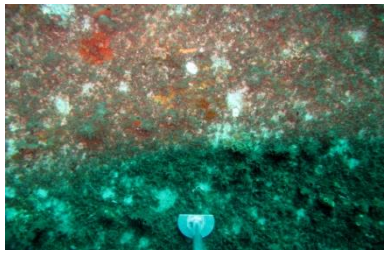
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
Not Sampled				
Not Sampled				
Not Sampled				

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)

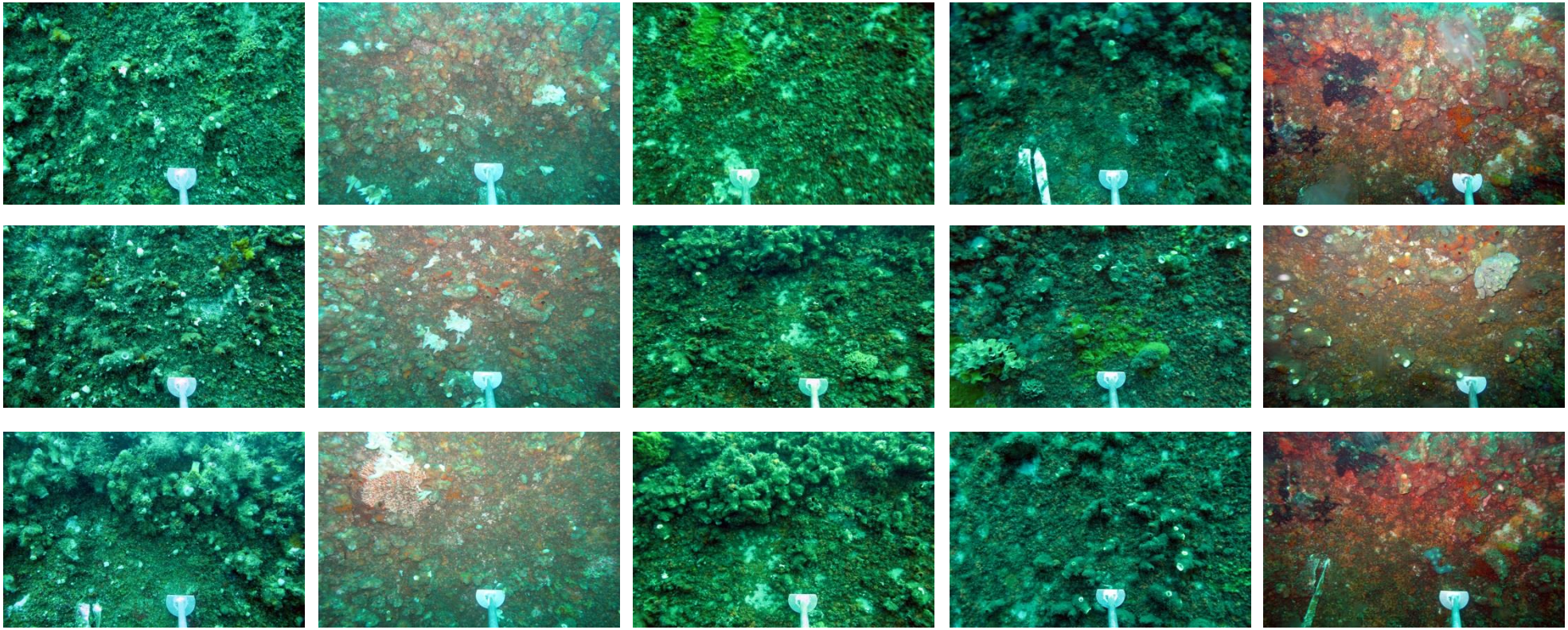


Plate 14 Continued: Vertical Superstructure Port Stern

Vertical Superstructure Port Stern

Monitoring Survey 10 (March 2014)	Monitoring Survey 11 (October 2014)	Monitoring Survey 12 (March 2015)

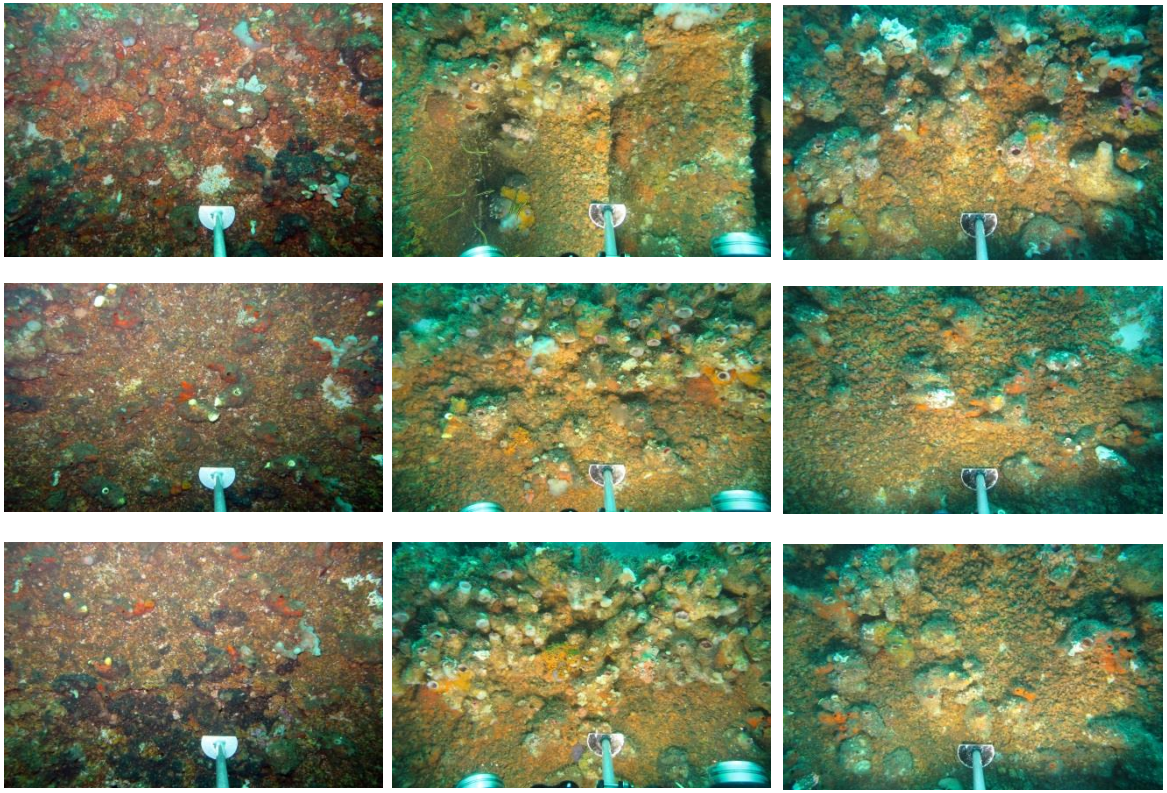


Plate 14 Continued: Vertical Superstructure Port Stern

Vertical Superstructure Starboard Bow

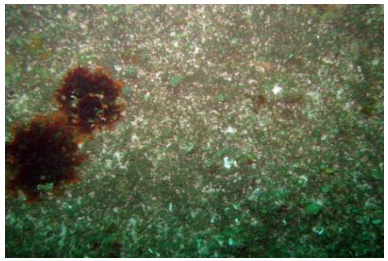
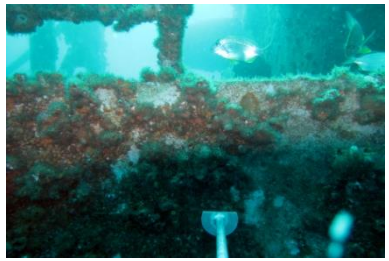
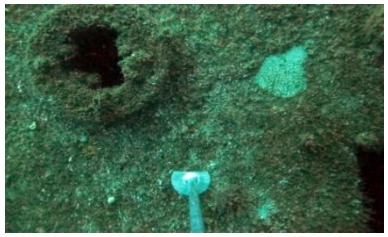
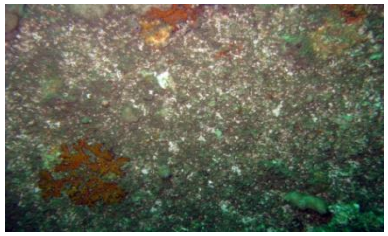
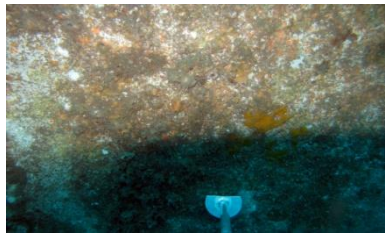
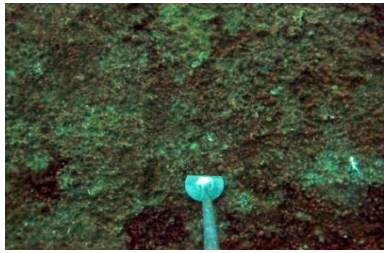
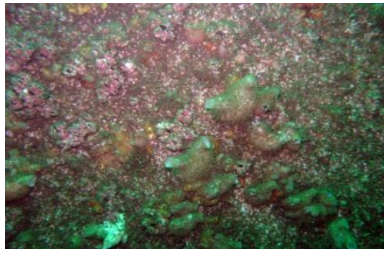
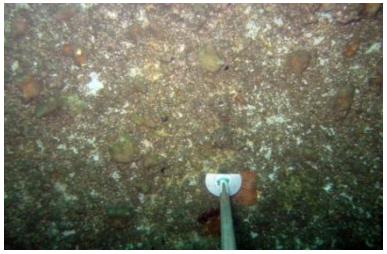
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
Not Sampled				
Not Sampled				
Not Sampled				

Plate 15: Vertical Superstructure Starbord Bow

Vertical Superstructure Starboard Bow

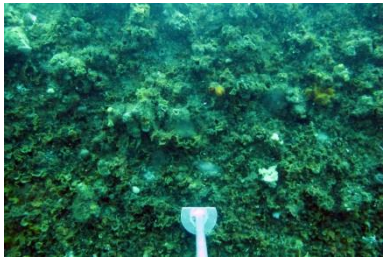
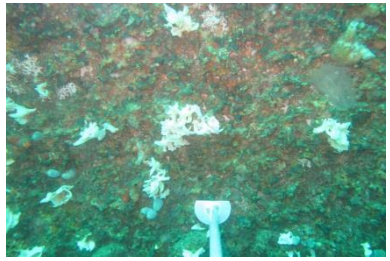
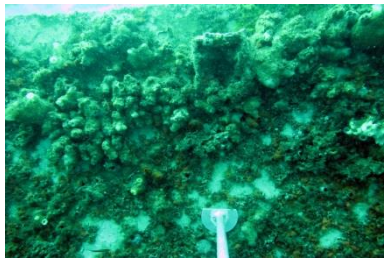
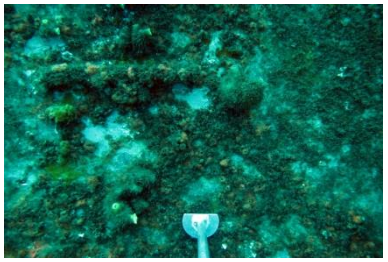
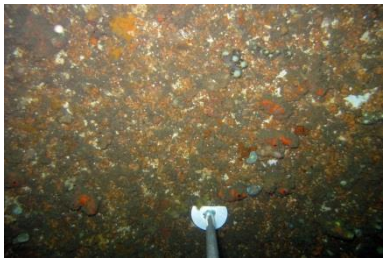
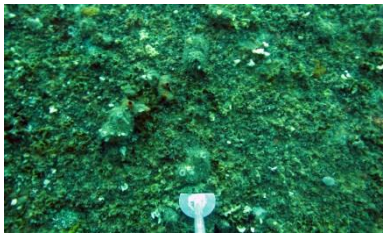
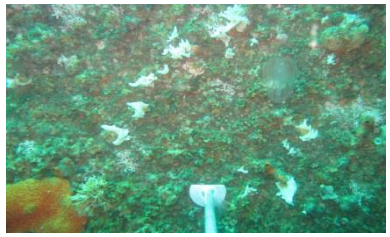
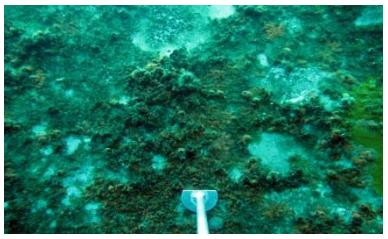
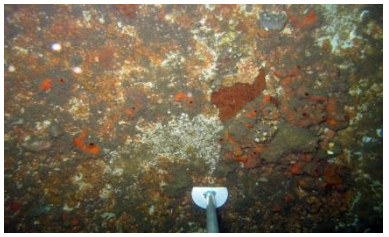
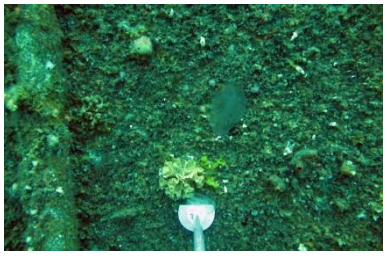
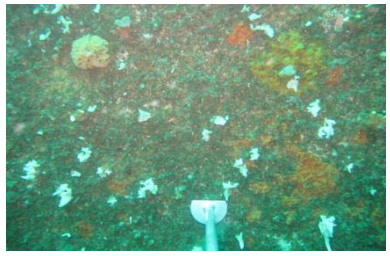
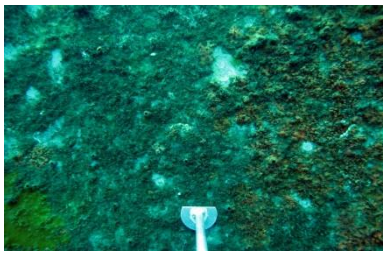
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)	Monitoring Survey 9 (October 2013)
				
				
				

Plate 15 Continued: Vertical Superstructure Starboard Bow

Vertical Superstructure Starboard Bow

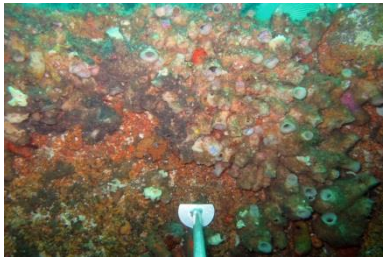
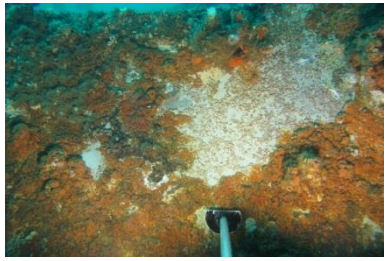
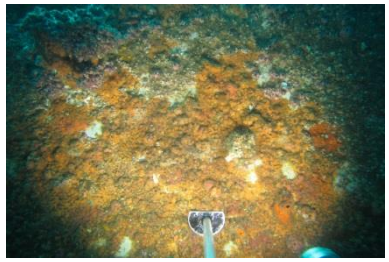
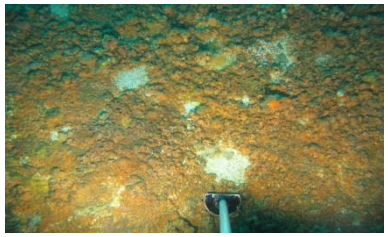
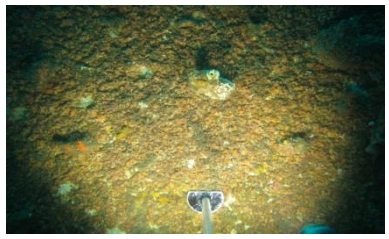
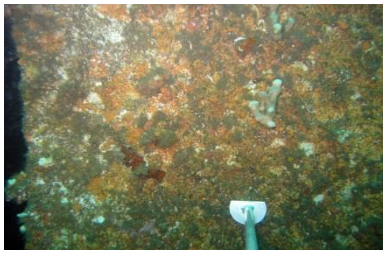
Monitoring Survey 10 (March 2014)	Monitoring Survey 11 (October 2014)	Monitoring Survey 12 (March 2015)
		
		
		

Plate 15 Continued: Vertical Superstructure Starbord Bow

Vertical Superstructure Starboard Stern

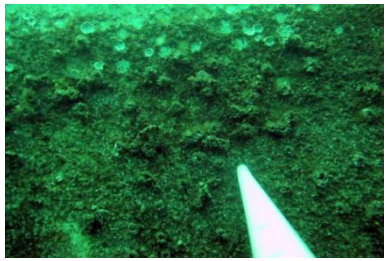
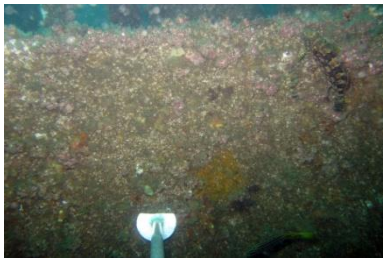
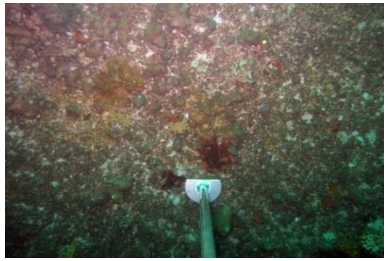
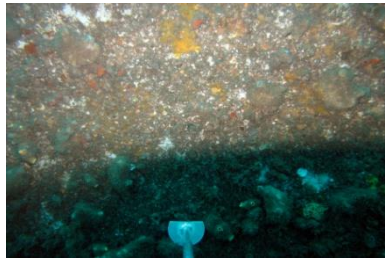
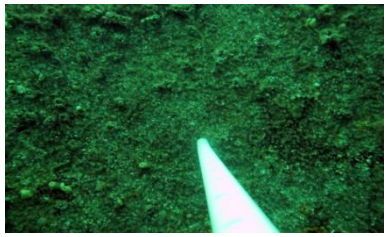
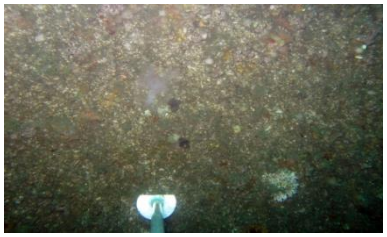
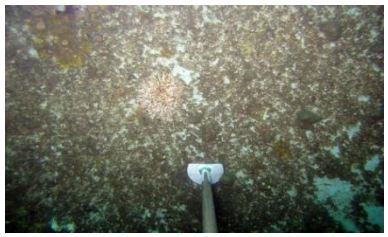
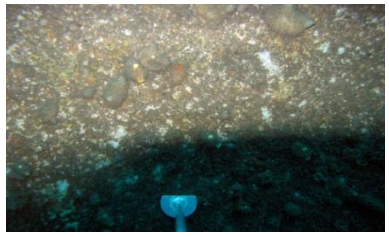
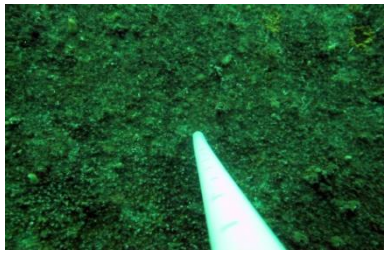
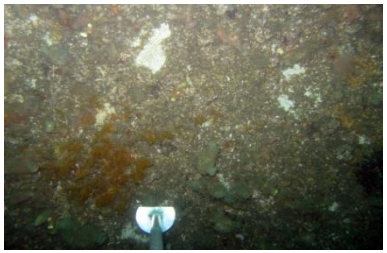
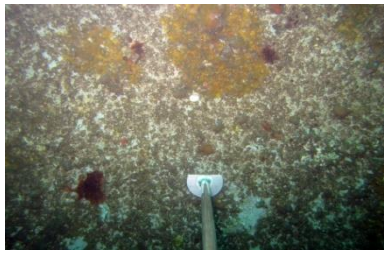
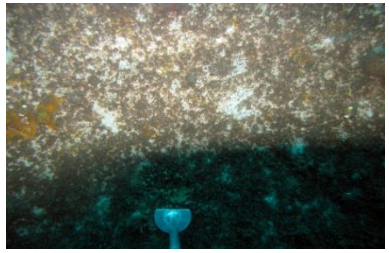
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
Not Sampled				
Not Sampled				
Not Sampled				

Plate 16: Vertical Superstructure Starboard Stern

Vertical Superstructure Starboard Stern

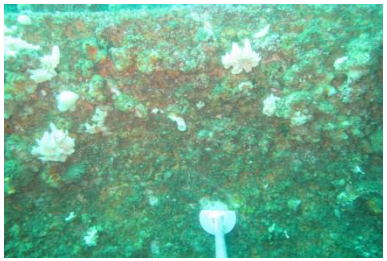
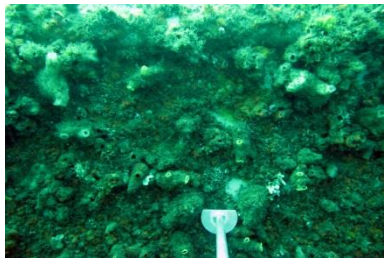
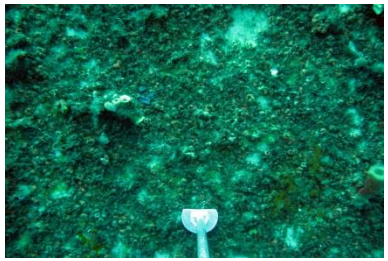
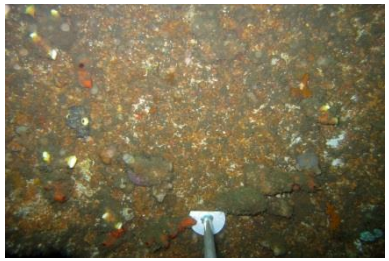
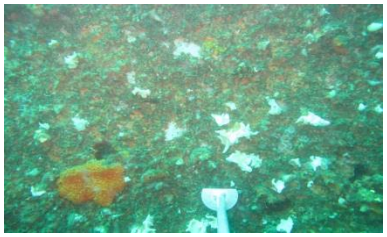
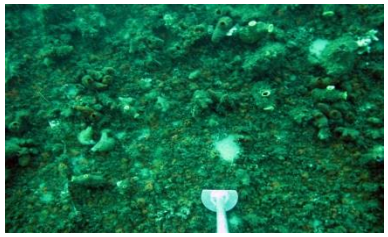
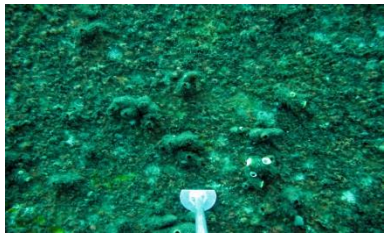
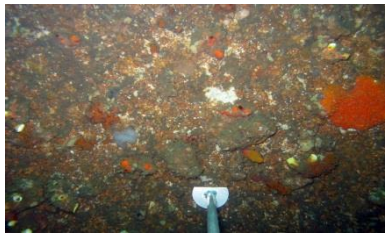
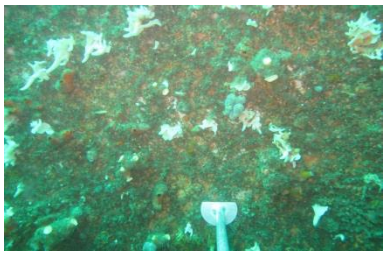
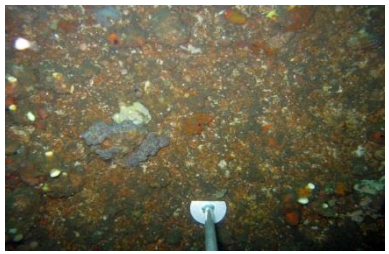
Monitoring Survey 5 (October/November 2012)	Monitoring Survey 6 (January 2013)	Monitoring Survey 7 (April 2013)	Monitoring Survey 8 (July 2013)	Monitoring Survey 9 (October 2013)
				
				
				

Plate 16 Continued: Vertical Superstructure Starboard Stern

Vertical Superstructure Starboard Stern

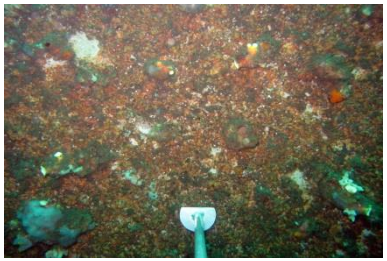
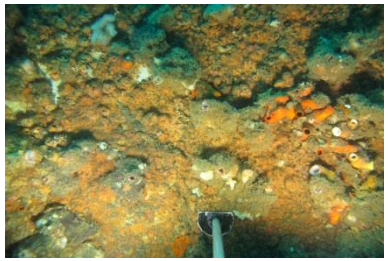
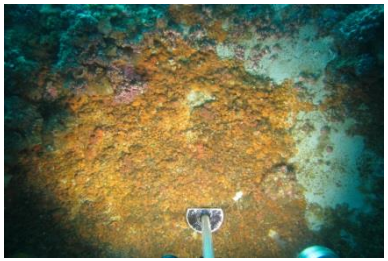
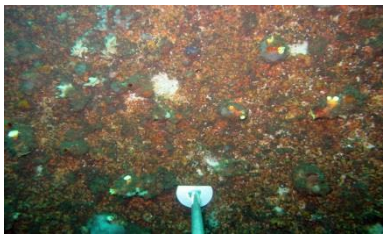
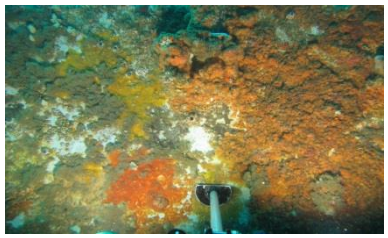
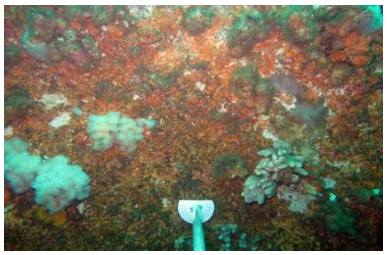
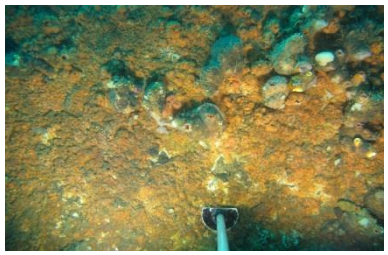
Monitoring Survey 10 (March 2014)	Monitoring Survey 11 (October 2014)	Monitoring Survey 12 (March 2015)
		
		
		

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

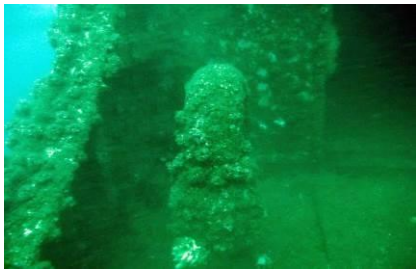
Fixed Photo: 1

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

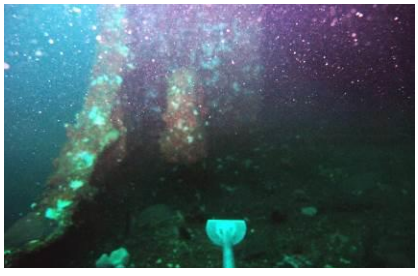
Survey 6

Survey 7

Survey 8

Survey 9

Survey 10



Survey 11

Survey 12

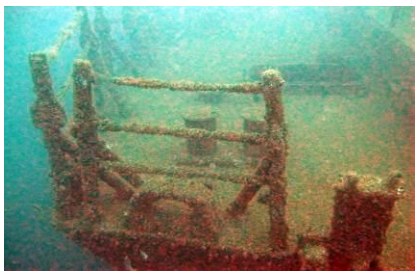
Appendix A: (Continued).

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

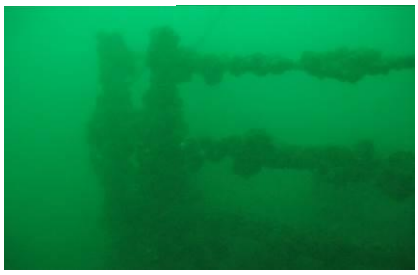
Survey 4

Survey 5

No Data

Survey 6

Survey 7



Survey 8

Survey 9

Survey 10

Survey 11

Survey 12

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

Survey 10

Survey 11

Survey 12

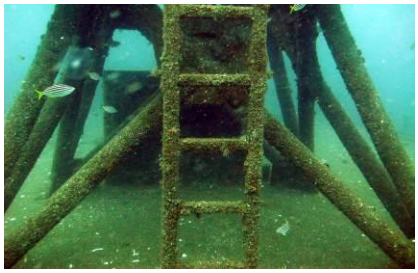
Appendix A: (Continued).

Fixed Photo: 4

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

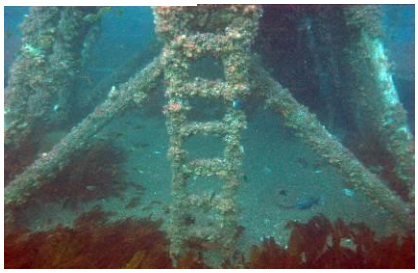
Depth: Approximately 23 m

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

Survey 10

No Data

Survey 11

No Data

Survey 12

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

Survey 10

Survey 11

Survey 12

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

Survey 10

Survey 11

Survey 12

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

Survey 10

Survey 11

Survey 12

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

Survey 10

Survey 11

Survey 12

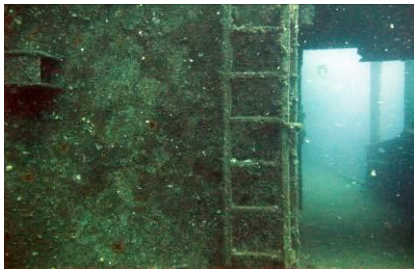
Appendix A: (Continued).

Fixed Photo: 9

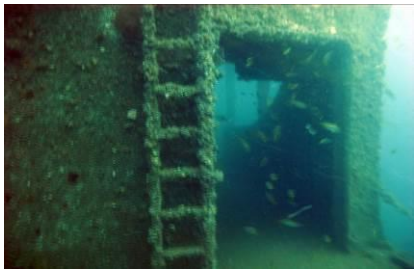
Location: Wall below the bridge on the starboard side. Photo taken standing on front deck 2 m in front of the ladder.

Depth: Approximately 26 m.

Survey 1



Survey 2



Survey 3

Survey 4

Survey 5

Survey 6

Survey 7

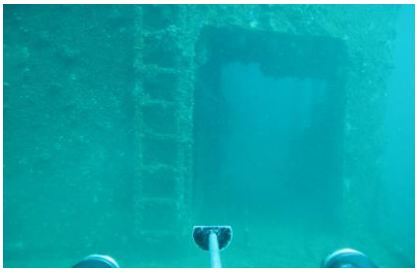
Survey 8

Survey 9

Survey 10

Survey 11

Survey 12



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

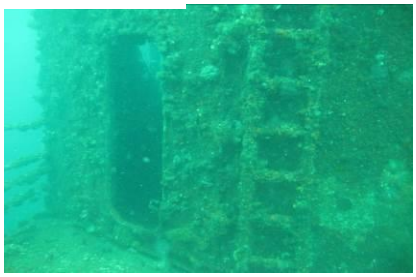
Survey 5

Survey 6

Survey 7

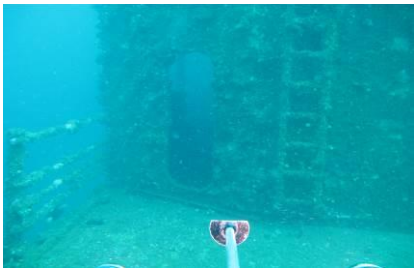
Survey 8

Survey 9



Survey 10

Survey 11



Survey 12

Taxon Name	Deck Port Bow		Deck Port Mid		Deck Port Stern	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
PHAEOPHYTA (PH)						
Lobed Brown Algae (LOB B)	0.00	0.00	2.20	1.24	0.00	0.00
Orange Filamentous (O FIL)	0.00	0.00	0.00	0.00	0.00	0.00
Turfing Brown Algae (TURF B)	17.00	5.39	12.00	5.49	19.80	18.56
RHODOPHYTA (RH)						
Encrusting Coralline (ENC COR)	0.00	0.00	0.20	0.20	0.00	0.00
Encrusting Red Algae (ENC RED)	2.20	0.97	0.20	0.20	0.00	0.00
Red Filamentous (RED FL)	0.00	0.00	0.60	0.24	0.00	0.00
SPONGE (SP)						
Orange Encrusting Sponge (OR ENC)	1.20	1.20	1.00	0.63	1.20	0.80
Purple Sponge (PURP SP)	0.00	0.00	0.00	0.00	0.00	0.00
White Encrusting Sponge (WH EN)	0.40	0.24	0.00	0.00	0.00	0.00
White Globular Sponge (WH GL)	0.00	0.00	0.00	0.00	0.20	0.20
White Papillate Sponge (WH PA)	0.00	0.00	0.00	0.00	0.00	0.00
White Tubular Sponge (WH TU)	0.00	0.00	0.00	0.00	0.00	0.00
Yellow Encrusting Sponge (YEL ENC)	1.00	1.00	0.20	0.20	2.00	1.76
Halopsamma laminaefavosa (SC9)	0.00	0.00	0.00	0.00	0.20	0.20
ASCIDIAN (AS)						
Botryloides magnicoecum (BOT MAG)	0.00	0.00	0.00	0.00	0.20	0.20
Herdmania momus (HER MOM)	0.20	0.20	0.00	0.00	0.00	0.00
Orange Colonial Ascidian (ORGE COL ASC)	0.00	0.00	0.00	0.00	0.00	0.00
Pink Spikey Solitary Ascidian (PINK SOL)	0.80	0.80	0.00	0.00	0.00	0.00
Red Solitary Ascidian (RED SOL)	0.00	0.00	0.00	0.00	0.00	0.00
White Tubular Solitary Ascidian (WH TASC)	0.00	0.00	0.00	0.00	0.00	0.00
ABIOTIC (AB)						
Bare Ships Surface (BARE)	0.00	0.00	0.60	0.24	0.20	0.20
sediment (SED)	0.00	0.00	0.00	0.00	0.20	0.20
CRUSTACEAN (CRUST)						
Balanus sp. (BAL SP1)	0.00	0.00	1.60	1.12	0.00	0.00
CNIDARIAN (CNI)						
Anthothoe albocincta (ANTH ALB)	0.00	0.00	0.00	0.00	0.00	0.00
Tiny orange anemone (SC11)	0.00	0.00	0.20	0.20	0.00	0.00
MATRIX (MAT)						
Barnacle,Sediment,Brown Fil (BAMAT)	0.00	0.00	0.00	0.00	0.00	0.00
Early Colonising Matrix (ECM)	0.00	0.00	0.00	0.00	0.00	0.00
Large Barnacle,Sediment,Brown Fil (BAMATLG)	0.00	0.00	0.00	0.00	0.00	0.00
Serpulid Barnacle and Encrusting Algae Matrix (SERBAMAT)	74.20	6.78	79.20	5.74	74.80	17.98
Serpulid Matrix (SERMAT)	0.00	0.00	0.00	0.00	0.00	0.00
FISH MOBILE (FSH)						
Fish Mobile (FSH MOB)	0.00	0.00	0.20	0.20	0.00	0.00
TAPE, WAND, SHADOW (TWS)						
Shadow (SHAD)	1.20	0.37	0.00	0.00	0.20	0.20
Wand (WAND)	1.80	0.37	1.60	0.24	1.00	0.32

Taxon Name	Deck Starbord Bow		Deck Starbord Mid		Deck Starbord Stern	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
PHAEOPHYTA (PH)						
Lobed Brown Algae (LOB B)	0.00	0.00	0.60	0.40	0.00	0.00
Orange Filamentous (O FIL)	0.00	0.00	0.20	0.20	0.00	0.00
Turfing Brown Algae (TURF B)	36.00	9.78	9.20	0.58	14.60	9.41
RHODOPHYTA (RH)						
Encrusting Coralline (ENC COR)	0.20	0.20	0.00	0.00	0.00	0.00
Encrusting Red Algae (ENC RED)	1.60	0.68	2.60	1.94	0.20	0.20
Red Filamentous (RED FL)	0.00	0.00	0.40	0.40	0.40	0.24
SPONGE (SP)						
Orange Encrusting Sponge (OR ENC)	0.00	0.00	1.80	1.32	0.80	0.80
Purple Sponge (PURP SP)	0.40	0.40	0.00	0.00	0.00	0.00
White Encrusting Sponge (WH EN)	0.20	0.20	0.20	0.20	0.20	0.20
White Globular Sponge (WH GL)	0.00	0.00	0.20	0.20	0.20	0.20
White Papillate Sponge (WH PA)	0.00	0.00	0.00	0.00	1.60	0.68
White Tubular Sponge (WH TU)	0.00	0.00	0.00	0.00	0.00	0.00
Yellow Encrusting Sponge (YEL ENC)	0.80	0.58	2.60	1.89	0.20	0.20
Halopsamma laminaefavosa (SC9)	0.40	0.40	0.00	0.00	0.00	0.00
ASCIDIAN (AS)						
Botryloides magnicoecum (BOT MAG)	0.00	0.00	0.00	0.00	0.00	0.00
Herdmania momus (HER MOM)	0.00	0.00	0.00	0.00	0.20	0.20
Orange Colonial Ascidian (ORGE COL ASC)	0.00	0.00	0.00	0.00	0.00	0.00
Pink Spikey Solitary Ascidian (PINK SOL)	0.00	0.00	0.00	0.00	0.00	0.00
Red Solitary Ascidian (RED SOL)	0.00	0.00	0.00	0.00	0.00	0.00
White Tubular Solitary Ascidian (WH TASC)	0.00	0.00	0.00	0.00	0.00	0.00
ABIOTIC (AB)						
Bare Ships Surface (BARE)	0.00	0.00	1.80	0.86	0.00	0.00
sediment (SED)	0.00	0.00	0.00	0.00	0.00	0.00
CRUSTACEAN (CRUST)						
Balanus sp. (BAL SP1)	0.00	0.00	0.00	0.00	0.00	0.00
CNIDARIAN (CNI)						
Anthothoe albocincta (ANTH ALB)	0.00	0.00	0.00	0.00	0.20	0.20
Tiny orange anemone (SC11)	0.40	0.40	2.40	1.94	0.20	0.20
MATRIX (MAT)						
Barnacle,Sediment,Brown Fil (BAMAT)	0.00	0.00	0.00	0.00	0.00	0.00
Early Colonising Matrix (ECM)	0.00	0.00	1.40	0.68	0.00	0.00
Large Barnacle,Sediment,Brown Fil (BAMATLG)	0.00	0.00	0.00	0.00	0.00	0.00
Serpulid Barnacle and Encrusting Algae Matrix (SERBAMAT)	55.20	9.72	70.80	5.65	79.80	10.03
Serpulid Matrix (SERMAT)	0.00	0.00	1.20	0.97	0.20	0.20
FISH MOBILE (FSH)						
Fish Mobile (FSH MOB)	0.00	0.00	0.00	0.00	0.40	0.40
TAPE, WAND, SHADOW (TWS)						
Shadow (SHAD)	3.40	0.93	3.40	1.03	0.00	0.00
Wand (WAND)	1.40	0.51	1.00	0.00	0.80	0.20

Taxon Name	Horizontal Hull Port		Horizontal Hull Starbord		Vertical Hull Port Bow	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
PHAEOPHYTA (PH)						
Lobed Brown Algae (LOB B)	0.00	0.00	0.00	0.00	0.00	0.00
Orange Filamentous (O FIL)	0.00	0.00	0.00	0.00	0.00	0.00
Turfing Brown Algae (TURF B)	3.83	2.15	3.50	1.48	1.60	0.68
RHODOPHYTA (RH)						
Encrusting Coralline (ENC COR)	0.00	0.00	0.00	0.00	0.00	0.00
Encrusting Red Algae (ENC RED)	0.00	0.00	0.00	0.00	0.00	0.00
Red Filamentous (RED FL)	0.00	0.00	0.00	0.00	0.00	0.00
SPONGE (SP)						
Orange Encrusting Sponge (OR ENC)	0.00	0.00	1.33	0.88	0.60	0.40
Purple Sponge (PURP SP)	0.17	0.17	0.00	0.00	0.00	0.00
White Encrusting Sponge (WH EN)	0.33	0.21	0.00	0.00	0.00	0.00
White Globular Sponge (WH GL)	0.33	0.21	0.17	0.17	0.00	0.00
White Papillate Sponge (WH PA)	0.00	0.00	0.00	0.00	0.00	0.00
White Tubular Sponge (WH TU)	0.50	0.34	0.00	0.00	0.00	0.00
Yellow Encrusting Sponge (YEL ENC)	0.33	0.21	0.00	0.00	0.40	0.40
Halopsamma laminaefavosa (SC9)	0.00	0.00	0.00	0.00	0.00	0.00
ASCIDIAN (AS)						
Botryloides magnicoecum (BOT MAG)	0.00	0.00	0.00	0.00	0.00	0.00
Herdmania momus (HER MOM)	12.67	9.91	6.83	3.09	14.00	3.32
Orange Colonial Ascidian (ORGE COL ASC)	0.00	0.00	0.00	0.00	0.00	0.00
Pink Spikey Solitary Ascidian (PINK SOL)	0.00	0.00	0.00	0.00	0.00	0.00
Red Solitary Ascidian (RED SOL)	0.17	0.17	0.00	0.00	0.40	0.40
White Tubular Solitary Ascidian (WH TASC)	0.00	0.00	0.00	0.00	0.00	0.00
ABIOTIC (AB)						
Bare Ships Surface (BARE)	0.00	0.00	0.67	0.33	0.00	0.00
sediment (SED)	0.00	0.00	0.00	0.00	0.00	0.00
CRUSTACEAN (CRUST)						
Balanus sp. (BAL SP1)	0.00	0.00	0.00	0.00	1.20	1.20
CNIDARIAN (CNI)						
Anthothoe albocincta (ANTH ALB)	0.00	0.00	0.00	0.00	0.00	0.00
Tiny orange anemone (SC11)	45.83	7.58	50.50	5.13	32.60	4.23
MATRIX (MAT)						
Barnacle,Sediment,Brown Fil (BAMAT)	0.00	0.00	0.00	0.00	10.20	2.13
Early Colonising Matrix (ECM)	5.00	2.25	9.67	3.92	6.00	1.95
Large Barnacle,Sediment,Brown Fil (BAMATLG)	8.17	5.98	4.83	4.44	22.80	3.10
Serpulid Barnacle and Encrusting Algae Matrix (SERBAMAT)	15.17	6.13	10.83	4.03	0.60	0.40
Serpulid Matrix (SERMAT)	0.00	0.00	0.00	0.00	0.00	0.00
FISH MOBILE (FSH)						
Fish Mobile (FSH MOB)	0.17	0.17	0.00	0.00	0.00	0.00
TAPE, WAND, SHADOW (TWS)						
Shadow (SHAD)	5.67	2.91	10.00	2.42	7.60	0.51
Wand (WAND)	1.33	0.33	1.33	0.21	1.80	0.20

Taxon Name	Vertical Hull Port Stern Mean	Vertical Hull Port Stern S.E.	Vertical Hull Starbord Bow Mean	Vertical Hull Starbord Bow S.E.	Vertical Hull Starbord Stern Mean	Vertical Hull Starbord Stern S.E.
PHAEOPHYTA (PH)						
Lobed Brown Algae (LOB B)	0.00	0.00	0.00	0.00	0.00	0.00
Orange Filamentous (O FIL)	0.00	0.00	0.00	0.00	0.00	0.00
Turfing Brown Algae (TURF B)	4.20	1.20	0.20	0.20	3.40	1.50
RHODOPHYTA (RH)						
Encrusting Coralline (ENC COR)	0.00	0.00	0.00	0.00	0.00	0.00
Encrusting Red Algae (ENC RED)	0.00	0.00	0.00	0.00	0.00	0.00
Red Filamentous (RED FL)	0.00	0.00	0.00	0.00	0.00	0.00
SPONGE (SP)						
Orange Encrusting Sponge (OR ENC)	0.20	0.20	0.20	0.20	0.20	0.20
Purple Sponge (PURP SP)	0.00	0.00	0.00	0.00	0.00	0.00
White Encrusting Sponge (WH EN)	0.20	0.20	0.00	0.00	0.80	0.37
White Globular Sponge (WH GL)	0.00	0.00	0.00	0.00	0.00	0.00
White Papillate Sponge (WH PA)	0.00	0.00	0.00	0.00	0.00	0.00
White Tubular Sponge (WH TU)	0.00	0.00	0.00	0.00	0.00	0.00
Yellow Encrusting Sponge (YEL ENC)	0.60	0.24	0.40	0.40	0.00	0.00
Halopsamma laminaefavosa (SC9)	0.00	0.00	0.00	0.00	0.00	0.00
ASCIDIAN (AS)						
Botryloides magnicoecum (BOT MAG)	0.00	0.00	0.00	0.00	0.00	0.00
Herdmania momus (HER MOM)	8.80	2.94	43.60	12.99	1.00	0.32
Orange Colonial Ascidian (ORGE COL ASC)	0.20	0.20	0.20	0.20	0.00	0.00
Pink Spikey Solitary Ascidian (PINK SOL)	0.00	0.00	0.00	0.00	0.00	0.00
Red Solitary Ascidian (RED SOL)	0.00	0.00	0.00	0.00	0.00	0.00
White Tubular Solitary Ascidian (WH TASC)	0.00	0.00	0.00	0.00	0.00	0.00
ABIOTIC (AB)						
Bare Ships Surface (BARE)	1.60	0.81	0.20	0.20	2.00	0.63
sediment (SED)	0.00	0.00	0.00	0.00	0.00	0.00
CRUSTACEAN (CRUST)						
Balanus sp. (BAL SP1)	0.00	0.00	0.00	0.00	0.00	0.00
CNIDARIAN (CNI)						
Anthothoe albocincta (ANTH ALB)	0.00	0.00	0.00	0.00	0.00	0.00
Tiny orange anemone (SC11)	47.40	2.03	23.20	6.94	36.40	4.62
MATRIX (MAT)						
Barnacle,Sediment,Brown Fil (BAMAT)	2.00	1.76	0.00	0.00	0.00	0.00
Early Colonising Matrix (ECM)	9.20	3.87	0.40	0.40	7.80	1.80
Large Barnacle,Sediment,Brown Fil (BAMATLG)	0.80	0.58	4.00	2.35	0.20	0.20
Serpulid Barnacle and Encrusting Algae Matrix (SERBAMAT)	22.00	6.36	20.60	8.04	42.20	5.91
Serpulid Matrix (SERMAT)	0.00	0.00	0.00	0.00	0.00	0.00
FISH MOBILE (FSH)						
Fish Mobile (FSH MOB)	0.00	0.00	0.00	0.00	0.00	0.00
TAPE, WAND, SHADOW (TWS)						
Shadow (SHAD)	2.00	0.32	5.00	2.24	3.40	1.66
Wand (WAND)	0.40	0.24	1.80	0.20	2.60	1.12

Taxon Name	Vertical Super Port Bow Mean	Vertical Super Port Bow S.E.	Vertical Super Port Stern Mean	Vertical Super Port Stern S.E.	Vertical Super Starbord Bow Mean	Vertical Super Starbord Bow S.E.
PHAEOPHYTA (PH)						
Lobed Brown Algae (LOB B)	0.00	0.00	0.00	0.00	0.00	0.00
Orange Filamentous (O FIL)	0.00	0.00	0.00	0.00	0.00	0.00
Turfing Brown Algae (TURF B)	1.20	0.37	1.40	0.75	0.00	0.00
RHODOPHYTA (RH)						
Encrusting Coralline (ENC COR)	0.00	0.00	0.00	0.00	0.00	0.00
Encrusting Red Algae (ENC RED)	0.00	0.00	0.00	0.00	0.00	0.00
Red Filamentous (RED FL)	0.00	0.00	0.00	0.00	0.00	0.00
SPONGE (SP)						
Orange Encrusting Sponge (OR ENC)	0.20	0.20	0.00	0.00	0.00	0.00
Purple Sponge (PURP SP)	0.00	0.00	0.00	0.00	0.00	0.00
White Encrusting Sponge (WH EN)	0.60	0.40	0.80	0.58	0.40	0.24
White Globular Sponge (WH GL)	0.40	0.40	0.00	0.00	0.00	0.00
White Papillate Sponge (WH PA)	0.80	0.58	0.60	0.60	0.00	0.00
White Tubular Sponge (WH TU)	0.20	0.20	0.00	0.00	0.00	0.00
Yellow Encrusting Sponge (YEL ENC)	0.20	0.20	1.40	0.93	0.40	0.40
Halopsamma laminaefavosa (SC9)	0.00	0.00	0.00	0.00	0.00	0.00
ASCIDIAN (AS)						
Botryloides magnicoecum (BOT MAG)	0.00	0.00	0.00	0.00	0.00	0.00
Herdmania momus (HER MOM)	12.80	5.27	23.40	6.67	3.60	0.93
Orange Colonial Ascidian (ORGE COL ASC)	0.00	0.00	0.00	0.00	0.00	0.00
Pink Spikey Solitary Ascidian (PINK SOL)	0.00	0.00	0.20	0.20	0.00	0.00
Red Solitary Ascidian (RED SOL)	0.60	0.60	0.00	0.00	0.00	0.00
White Tubular Solitary Ascidian (WH TASC)	0.20	0.20	0.00	0.00	0.00	0.00
ABIOTIC (AB)						
Bare Ships Surface (BARE)	0.60	0.40	0.80	0.49	0.60	0.24
sediment (SED)	0.00	0.00	0.00	0.00	0.00	0.00
CRUSTACEAN (CRUST)						
Balanus sp. (BAL SP1)	0.00	0.00	0.20	0.20	0.00	0.00
CNIDARIAN (CNI)						
Anthothoe albocincta (ANTH ALB)	0.00	0.00	0.00	0.00	0.00	0.00
Tiny orange anemone (SC11)	51.80	3.56	40.00	7.60	43.00	5.97
MATRIX (MAT)						
Barnacle,Sediment,Brown Fil (BAMAT)	0.00	0.00	0.00	0.00	0.00	0.00
Early Colonising Matrix (ECM)	4.60	0.93	3.80	2.31	3.80	0.58
Large Barnacle,Sediment,Brown Fil (BAMATLG)	0.20	0.20	1.60	0.51	0.40	0.40
Serpulid Barnacle and Encrusting Algae Matrix (SERBAMAT)	22.40	3.39	22.00	8.03	39.00	5.02
Serpulid Matrix (SERMAT)	0.00	0.00	0.20	0.20	0.00	0.00
FISH MOBILE (FSH)						
Fish Mobile (FSH MOB)	0.00	0.00	0.00	0.00	0.00	0.00
TAPE, WAND, SHADOW (TWS)						
Shadow (SHAD)	2.00	1.55	2.20	0.73	5.80	1.53
Wand (WAND)	1.20	0.37	1.20	0.37	3.00	0.45

Taxon Name	Vertical Super Starbord Stern Mean	S.E.
PHAEOPHYTA (PH)		
Lobed Brown Algae (LOB B)	0.00	0.00
Orange Filamentous (O FIL)	0.00	0.00
Turfing Brown Algae (TURF B)	1.60	0.93
RHODOPHYTA (RH)		
Encrusting Coralline (ENC COR)	0.00	0.00
Encrusting Red Algae (ENC RED)	0.00	0.00
Red Filamentous (RED FL)	0.00	0.00
SPONGE (SP)		
Orange Encrusting Sponge (OR ENC)	0.00	0.00
Purple Sponge (PURP SP)	0.00	0.00
White Encrusting Sponge (WH EN)	2.00	1.05
White Globular Sponge (WH GL)	0.20	0.20
White Papillate Sponge (WH PA)	0.00	0.00
White Tubular Sponge (WH TU)	0.20	0.20
Yellow Encrusting Sponge (YEL ENC)	1.20	0.80
Halopsamma laminaefavosa (SC9)	0.00	0.00
ASCIDIAN (AS)		
Botryloides magnicoecum (BOT MAG)	0.00	0.00
Herdmania momus (HER MOM)	8.40	3.22
Orange Colonial Ascidian (ORGE COL ASC)	0.00	0.00
Pink Spikey Solitary Ascidian (PINK SOL)	0.00	0.00
Red Solitary Ascidian (RED SOL)	0.00	0.00
White Tubular Solitary Ascidian (WH TASC)	0.00	0.00
ABIOTIC (AB)		
Bare Ships Surface (BARE)	1.40	0.68
sediment (SED)	0.00	0.00
CRUSTACEAN (CRUST)		
Balanus sp. (BAL SP1)	3.80	2.33
CNIDARIAN (CNI)		
Anthothoe albocincta (ANTH ALB)	0.00	0.00
Tiny orange anemone (SC11)	34.20	3.81
MATRIX (MAT)		
Barnacle,Sediment,Brown Fil (BAMAT)	1.80	1.11
Early Colonising Matrix (ECM)	6.00	1.95
Large Barnacle,Sediment,Brown Fil (BAMATLG)	0.40	0.40
Serpulid Barnacle and Encrusting Algae Matrix (SERBAMAT)	28.20	3.81
Serpulid Matrix (SERMAT)	0.00	0.00
FISH MOBILE (FSH)		
Fish Mobile (FSH MOB)	0.00	0.00
TAPE, WAND, SHADOW (TWS)		
Shadow (SHAD)	6.00	0.84
Wand (WAND)	4.60	1.21

Appendix C: Permutational Analysis of Variance of Percent Cover of Reef Assemblages Sampled in Reef Monitoring Surveys 11 and 12. *P*-values highlighted in bold are significant. RED = Redundant term. A term becomes redundant if a lower order interaction including that term is significant. Res = Residual. This term is a measure of the variation in the data not explained by the variation attributed to the main factors in the experimental model (i.e. Time, Orientation etc. and their associated interactions).

1. All Times (Surveys 1-12)

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Ti	11	87257	7932.5	8.2154	**0.0001**	9854
Res	180	1.738E5	965.56			
Total	191	2.6106E5				

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

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Ti	1	5451.6	5451.6	5.7165	RED	9946
Or	1	49002	49002	51.383	RED	9945
As	1	547.05	547.05	0.57362	0.6558	9944
TixOr	1	11013	11013	11.548	**0.0001**	9939
TixAs	1	1043.6	1043.6	1.0943	0.3335	9949
OrxAs	1	1350.1	1350.1	1.4157	0.2139	9933
TixOrxAs	1	1694.4	1694.4	1.7767	0.1358	9940
Res	76	72479	953.67			
Total	83	1.4072E5				

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

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Ti	1	29760	29760	38.316	**0.0001**	9959
De	1	2689.9	2689.9	3.4632	RED	9958
As	1	4972.6	4972.6	6.4021	RED	9950
TixDe	1	616.43	616.43	0.79365	0.5052	9949
TixAs	1	449.79	449.79	0.5791	0.6508	9958
DexAs	1	2951.9	2951.9	3.8005	**0.0117**	9944
TixDexAs	1	855.04	855.04	1.1008	0.3398	9945
Res	72	55923	776.71			
Total	79	98219				

4. Time, Position (bow, mid ship, stern) and Aspect (port and starboard)

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Ti	1	5236.8	5236.8	6.6018	RED	9963
Po	2	5645.9	2823	3.5588	RED	9947
As	1	536.89	536.89	0.67684	0.5283	9950
TixPo	2	3859.1	1929.6	2.4325	**0.0445**	9957
TixAs	1	1680.2	1680.2	2.1182	0.108	9952
PoxAs	2	2094.7	1047.4	1.3204	0.2465	9946
TixPoxAs	2	2378.9	1189.4	1.4995	0.19	9925
Res	48	38075	793.23			
Total	59	59508				

Appendix D: Pairwise tests of reef assemblages for significant terms. Only significant pairwise results for the relevant terms are presented. Significant results in bold.

1. All Times (Surveys 1-12)

Term 'Ti'

Groups	t	P(perm)	Unique perms
1, 2	1.902	**0.0265**	9937
1, 3	2.2409	**0.0114**	9948
1, 4	4.3128	**0.0001**	9950
1, 5	3.8913	**0.0001**	9944
1, 6	4.0002	**0.0001**	9943
1, 7	4.0715	**0.0001**	9949
1, 8	4.2386	**0.0001**	9934
1, 9	3.9414	**0.0001**	9945
1, 10	3.9944	**0.0001**	9939
1, 11	3.8569	**0.0001**	9954
1, 12	3.4838	**0.0001**	9949
2, 3	1.0401	0.3411	9940
2, 4	3.2352	**0.0001**	9947
2, 5	2.7874	**0.0001**	9954
2, 6	2.9683	**0.0001**	9963
2, 7	3.1645	**0.0001**	9956
2, 8	3.4435	**0.0001**	9948
2, 9	3.023	**0.0001**	9946
2, 10	2.8985	**0.0001**	9949
2, 11	2.6461	**0.0001**	9946
2, 12	2.6441	**0.0001**	9960
3, 4	2.3061	**0.0001**	9957
3, 5	1.998	**0.0019**	9956
3, 6	2.1216	**0.0006**	9948
3, 7	2.1354	**0.0003**	9957
3, 8	2.3774	**0.0002**	9945
3, 9	2.1324	**0.0001**	9945
3, 10	2.0363	**0.0017**	9942
3, 11	2.3781	**0.0001**	9942
3, 12	2.5589	**0.0004**	9943
4, 5	1.7909	**0.0088**	9947
4, 6	1.5849	**0.0379**	9930
4, 7	1.3004	0.1533	9946
4, 8	1.2995	0.1484	9949
4, 9	2.0158	**0.0044**	9928
4, 10	1.8018	**0.036**	9937

4, 11	3.4478	**0.0001**	9965
4, 12	3.7796	**0.0002**	9944
5, 6	1.1947	0.2071	9956
5, 7	1.6529	**0.0194**	9941
5, 8	1.8101	**0.0077**	9946
5, 9	1.6509	**0.0163**	9944
5, 10	1.6265	**0.038**	9942
5, 11	2.5963	**0.0001**	9943
5, 12	3.3196	**0.0003**	9948
6, 7	1.7059	**0.0188**	9962
6, 8	1.62	**0.039**	9938
6, 9	1.759	**0.009**	9939
6, 10	1.7066	**0.0273**	9953
6, 11	2.8491	**0.0001**	9955
6, 12	3.4724	**0.0005**	9954
7, 8	0.88275	0.516	9956
7, 9	1.7415	**0.0123**	9949
7, 10	1.7011	**0.0393**	9944
7, 11	3.037	**0.0001**	9947
7, 12	3.626	**0.0001**	9949
8, 9	1.6928	**0.0175**	9941
8, 10	1.7087	**0.034**	9954
8, 11	3.136	**0.0001**	9944
8, 12	3.6642	**0.0002**	9928
9, 10	0.91456	0.4921	9952
9, 11	1.997	**0.0033**	9930
9, 12	2.8031	**0.0019**	9954
10, 11	2.028	**0.0072**	9952
10, 12	2.6549	**0.0047**	9948
11, 12	1.8626	**0.0389**	9951

2. Time x Orientation (for factor Time)

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

Groups	t	P(perm)	Unique perms
11, 12	2.3736	**0.0047**	9942

Within level 'Hull' of factor 'Orientation'

Groups	t	P(perm)	Unique perms
11, 12	3.0388	**0.0002**	9954

3. Time x Orientation (for factor Orientation)

Term 'TixOr' for pairs of levels of factor 'Orientation'
Within level '11' of factor 'Time'

Groups	t	P(perm)	Unique perms
Deck, Hull	3.5203	**0.0001**	9956

Within level '12' of factor 'Time'

Groups	t	P(perm)	Unique perms
Deck, Hull	7.8112	**0.0001**	9943

4. Depth x Aspect (Depth)

Term 'DexAs' for pairs of levels of factor 'Depth'
Within level 'Port' of factor 'Aspect'

Groups	t	P(perm)	Unique perms
Deep, Shallow	2.317	**0.003**	9947

Within level 'Starboard' of factor 'Aspect'

Groups	t	P(perm)	Unique perms
Deep, Shallow	1.3197	0.1407	9947

5. Depth x Aspect (Aspect)

Term 'DexAs' for pairs of levels of factor 'Aspect'
Within level 'Deep' of factor 'Depth'

Groups	t	P(perm)	Unique perms
Port, Starboard	2.404	**0.002**	9955

Within level 'Shallow' of factor 'Depth'

Groups	t	P(perm)	Unique perms
Port, Starboard	2.0146	**0.0117**	9953

6. Time x Deck Position (for factor Time)

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

Groups	t	P(perm)	Unique perms
11, 12	1.1725	0.245	9945

Within level 'Mid' of factor 'Position'

Groups	t	P(perm)	Unique perms
11, 12	2.0074	**0.0111**	9947

Within level 'Stern' of factor 'Position'

Groups	t	P(perm)	Unique perms
11, 12	2.1897	**0.0365**	9923

7. Time x Deck Position (for factor Deck Position)

Term 'TixPo' for pairs of levels of factor 'Position'
Within level '11' of factor 'Time'

Groups	t	P(perm)	Unique perms
Bow, Mid	1.608	0.0552	9946
Bow, Stern	1.7583	0.0789	9946
Mid, Stern	2.3035	**0.0043**	9951

Within level '12' of factor 'Time'

Groups	t	P(perm)	Unique perms
Bow, Mid	2.0722	**0.0298**	9949
Bow, Stern	1.1482	0.2694	9942
Mid, Stern	0.9955	0.3795	9936

Appendix E: Results of SIMPER analyses of reef assemblages sampled in The Ex-HMAS Adelaide Artificial Reef Community Surveys 11 and 12. Cut off for percentage contribution is 90%. Note that only relevant SIMPER results have been included in this Appendix.

1. All Times (Surveys 1 – 12)

Groups 11 & 12
Average dissimilarity = 48.62

Species	Group 11 Av.Abund	Group 12 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	53.40	41.08	14.21	1.70	29.22	29.22
Tiny orange anemone	7.93	25.51	12.01	1.51	24.71	53.93
Brown filamentous algae/hydroid	13.35	8.11	6.58	0.87	13.54	67.47
Solitary ascidian (Herdmania momus/)	6.44	8.48	4.71	0.97	9.68	77.15
Large barnacle,sediment,brown fil	5.65	4.01	3.73	0.76	7.68	84.83
Early colonising matrix	4.31	3.60	2.31	1.25	4.75	89.58
Ecklonia radiata	2.01	0.00	1.03	0.38	2.12	91.70

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

Groups 11Deck & 11Hull
Average dissimilarity = 59.40

Species	Group 11Deck Av.Abund	Group 11Hull Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	52.64	47.95	15.08	1.42	25.39	25.39
Brown filamentous algae/hydroid	28.36	4.04	12.85	1.00	21.64	47.03
Tiny orange anemone	1.16	19.66	9.45	1.74	15.90	62.93
Large barnacle,sediment,brown fil	0.00	9.43	4.71	0.72	7.93	70.87
Solitary ascidian (Herdmania momus/)	0.05	9.44	4.70	0.89	7.91	78.78
Early colonising matrix	0.16	5.66	2.78	0.79	4.68	83.46
Ecklonia radiata	5.35	0.00	2.68	0.37	4.51	87.96
Red encrusting algae	4.64	0.14	2.30	0.71	3.87	91.83

Groups 11Deck & 12Deck
Average dissimilarity = 40.64

Species	Group 11Deck Av.Abund	Group 12Deck Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	52.64	72.37	15.82	1.38	38.92	38.92
Brown filamentous algae/hydroid	28.36	18.13	13.27	1.08	32.64	71.56
Ecklonia radiata	5.35	0.00	2.71	0.37	6.68	78.24
Red encrusting algae	4.64	1.20	2.32	0.75	5.72	83.95
Yellow encrusting sponge	1.80	1.13	1.23	0.65	3.03	86.98
Orange encrusting sponge	1.65	1.00	0.98	1.00	2.41	89.40
Tiny orange anemone	1.16	0.53	0.82	0.37	2.01	91.41

Groups 11Hull & 12Hull
Average dissimilarity = 57.15

Species	Group 11Hull Av.Abund	Group 12Hull Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	47.95	13.00	19.86	1.50	34.75	34.75
Tiny orange anemone	19.66	48.17	15.37	1.83	26.90	61.65
Solitary ascidian (Herdmania momus/)	9.44	9.75	6.47	0.82	11.32	72.96
Large barnacle,sediment,brown fil	9.43	6.50	6.33	0.91	11.08	84.04
Early colonising matrix	5.66	7.33	3.92	1.04	6.87	90.91

Groups 12Deck & 12Hull
Average dissimilarity = 82.35

Species	Group 12Deck Av.Abund	Group 12Hull Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	72.37	13.00	31.98	2.66	38.83	38.83
Tiny orange anemone	0.53	48.17	25.25	3.41	30.66	69.49
Brown filamentous algae/hydroid	18.13	3.67	8.89	0.82	10.80	80.28
Solitary ascidian (Herdmania momus/)	0.07	9.75	5.11	0.59	6.21	86.49
Early colonising matrix	0.23	7.33	3.80	0.98	4.62	91.11

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

Groups 11 & 12

Average dissimilarity = 54.94

Species	Group 11 Av.Abund	Group 12 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	55.34	24.63	17.97	1.61	32.71	32.71
Tiny orange anemone	10.07	38.58	14.97	2.23	27.24	59.96
Solitary ascidian (Herdmania momus/)	10.48	14.48	7.56	0.92	13.75	73.71
Large barnacle,sediment,brown fil	8.94	6.20	5.87	0.82	10.69	84.40
Early colonising matrix	7.09	5.20	3.66	1.01	6.67	91.06

Groups DeepPort & DeepStarboard

Average dissimilarity = 52.02

Species	Group DeepPort Av.Abund	Group DeepStarboard Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	27.75	48.87	17.65	1.47	33.92	33.92
Tiny orange anemone	27.14	18.47	9.62	1.40	18.50	52.42
Solitary ascidian (Herdmania momus/)	13.23	13.68	9.01	0.94	17.32	69.74
Large barnacle,sediment,brown fil	17.38	6.30	9.00	1.07	17.30	87.04
Early colonising matrix	6.11	5.02	3.49	1.03	6.71	93.75

Groups DeepPort & ShallowPort

Average dissimilarity = 49.30

Species	Group DeepPort Av.Abund	Group ShallowPort Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	27.75	39.91	15.62	1.38	31.68	31.68
Tiny orange anemone	27.14	28.61	10.49	1.40	21.29	52.96
Large barnacle,sediment,brown fil	17.38	1.33	8.56	0.95	17.37	70.33
Solitary ascidian (Herdmania momus/)	13.23	16.56	7.26	1.17	14.72	85.05
Early colonising matrix	6.11	5.39	3.14	1.10	6.38	91.43

Groups ShallowPort & ShallowStarboard
Average dissimilarity = 43.82

Species	Group ShallowPort Av.Abund	Group ShallowStarboard Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	39.91	43.40	13.04	1.53	29.77	29.77
Tiny orange anemone	28.61	23.07	11.34	1.37	25.88	55.65
Solitary ascidian (Herdmania momus/)	16.56	6.44	6.98	1.09	15.92	71.57
Early colonising matrix	5.39	8.06	3.74	0.99	8.54	80.10
Large barnacle,sediment,brown fil	1.33	5.28	2.66	0.84	6.07	86.18
Brown filamentous algae/hydroid	2.13	4.04	2.21	0.75	5.03	91.21

4. Time, Position (bow, mid ship, stern) and Aspect (port and starboard)
Groups 11Mid & 11Stern
Average dissimilarity = 54.76

Species	Group 11Mid Av.Abund	Group 11Stern Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Brown filamentous algae/hydroid	12.91	45.52	19.76	1.37	36.09	36.09
Serpulid, barnacle and encrusting algae matrix	52.52	48.15	16.20	1.48	29.59	65.68
Ecklonia radiata	15.90	0.00	7.95	0.75	14.52	80.20
Red encrusting algae	8.63	0.16	4.25	0.94	7.76	87.96
Yellow encrusting sponge	3.19	2.06	1.93	0.83	3.53	91.49

Groups 11Mid & 12Mid
Average dissimilarity = 43.91

Species	Group 11Mid Av.Abund	Group 12Mid Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	52.52	75.00	16.25	1.67	37.01	37.01
Ecklonia radiata	15.90	0.00	8.08	0.75	18.40	55.41
Brown filamentous algae/hydroid	12.91	10.70	7.08	0.76	16.13	71.54
Red encrusting algae	8.63	1.50	4.12	0.93	9.39	80.93
Yellow encrusting sponge	3.19	1.40	1.85	0.73	4.22	85.14
Unknown white material	2.06	0.00	1.05	0.56	2.39	87.53
Orange encrusting sponge	1.11	1.40	0.87	0.94	1.97	89.50
Bare ships surface	0.80	1.20	0.73	0.96	1.66	91.17

Groups 12Bow & 12Mid
Average dissimilarity = 28.19

Species	Group 12Bow Av.Abund	Group 12Mid Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	64.70	75.00	10.52	1.39	37.33	37.33
Brown filamentous algae/hydroid	26.50	10.70	10.34	1.25	36.67	74.00
Red encrusting algae	2.00	1.50	1.27	1.01	4.50	78.50
Yellow encrusting sponge	0.90	1.40	0.99	0.67	3.51	82.01
Orange encrusting sponge	0.60	1.40	0.91	0.75	3.22	85.23
Tiny orange anemone	0.20	1.30	0.73	0.48	2.59	87.82
Lobed brown algae (Lobophora sp.)	0.00	1.40	0.72	0.69	2.55	90.37

Groups 11Stern & 12Stern
Average dissimilarity = 46.28

Species	Group 11Stern Av.Abund	Group 12Stern Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	48.15	77.40	20.83	1.49	45.00	45.00
Brown filamentous algae/hydroid	45.52	17.20	20.75	1.42	44.84	89.84
Yellow encrusting sponge	2.06	1.10	1.30	0.78	2.81	92.65

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

1. All Times (Surveys 1 -12)

Group factor: Time

DEVIATIONS FROM CENTROID

F: 14.274 df1: 11 df2: 180

P(perm): **0.001**

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

Group factor: Time x Orientation

DEVIATIONS FROM CENTROID

F: 2.7481 df1: 3 df2: 80

P(perm): 0.1194

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

Group factor: Time

DEVIATIONS FROM CENTROID

F: 2.3734E-2 df1: 1 df2: 78

P(perm): 0.9005

Group factor: Depth x Aspect

DEVIATIONS FROM CENTROID

F: 2.2664 df1: 3 df2: 76

P(perm): 0.1133

4. Time, Position (bow, mid ship, stern) and Aspect (port and starboard)

Group factor: Time

DEVIATIONS FROM CENTROID

F: 5.8993 df1: 1 df2: 58

P(perm): 0.05

Group factor: Time x Position

DEVIATIONS FROM CENTROID

F: 3.227 df1: 5 df2: 54

P(perm): 0.0809