Cardno
Ecology Lab
Shaping the Future

Marine and Freshwater Studies

Ex-HMAS Adelaide Artificial Reef

Reef Community Monitoring

Survey 13

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Executive Summary

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

A comprehensive environmental assessment was previously 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 was that the NSW Department of Primary Industries –Lands, must implement the proposed Long Term Monitoring and Management Plan (LTMMP) prepared in March 2011.

This Progress Report outlines the methodology and findings of Reef Community Monitoring Survey 13 (**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 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 five reef community surveys have been completed in the interim. This Progress Report outlines the methodology and findings of Reef Community Survey 13 (Survey 13).

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 13 was carried out on 01 and 02 June 2016. Survey methods involved using divers to take photoquadrats and under water video Transects on vertically and horizontally oriented surfaces of the ship's deck, superstructure and hull. 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 13 did not indicate any significant change in the overall, ship-wide structure of encrusting assemblages since Survey 12. This is different to the pattern seen during most recent previous surveys, where significant differences between consecutive surveys were detected. It is possible that the absence of a ship-wide difference in assemblage structure between these two surveys could be indicative of a slowing in the rate of successional changes in assemblage structure. However, differences were detected between surveys at a local scale (i.e. between different surfaces of the vessel), which suggests changes are occurring at these scales, at least. Differences were also detected between ships surfaces within Survey 12 and Survey 13. Such differences are likely to be related to local scale variability in current and shade associated with the structure of the ship (e.g. relative location of masts and other deck structures). There also appeared to be consistent differences in the structure of encrusting assemblages between Aspects (port vs. starboard) of the ship. Larger scale differences such as these are more likely to be related to larger scale processes, such as prevailing current, swell and the relative orientation to the sun. Depth was not found to be a significant predictor of the structure of encrusting assemblages, possibly because the depth range utilised in this study is small.

The taxa / groups of taxa that contributed most to these differences tended also to be the most abundant (% cover) overall. The relatively large contribution these taxa made to the dissimilarity in assemblage structure between different ships surfaces could be due to variability in a range of factors that affect temporal changes in % cover, including stochastic processes such as recruitment, mortality and predation etc., which would also be affected by local and larger scale variability in current and other physical processes.

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. Thirty two species were observed in Survey 13, more than in Surveys 11 and 12 (Twenty eight) and in any previous survey. Two new species were observed in Survey 13 (beardie *(Lotella*

rhacina) and slender longtom (*Strongylura leiura*)) which have not previously been recorded during 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
Monitoring Survey 13	01 and 02 June 2016	5 years and 2 months post-scuttling

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Glossary

Artificial Reef	A structure or formation placed on the seabed for the purpose of increasing or concentrating populations of marine plants and animals or for the purpose of being used in human recreational activities
CPCe	Coral Point Count with Excel Extensions. A software package used to analyse cover of encrusting organisms and corals
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 sediment, structures etc.)
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) Pty Ltd, trading as Cardno Ecology Lab, was commissioned by the NSW Department of Primary Industries – Lands to undertake the post-scuttling environmental monitoring for the Ex-HMAS Adelaide artificial reef and dive site.

The Ex-HMAS Adelaide was gifted from the Australian 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 was that the NSW Department of Primary Industries – Lands must implement the proposed Long Term Monitoring and Management Plan (LTMMP) which was prepared in March 2011.

The LTMMP covers environmental and structural monitoring for the first five years post-scuttling and forms the basis for ongoing monitoring and maintenance over the operational life of the vessel as a dive site, which is estimated to be 40 years. The frequency of monitoring and the methodologies used will be reviewed periodically during the life of the 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 was 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 thirteenth reef community survey. Surveys have been carried out on a near quarterly basis since April 2011 and then an approximately 6-monthly basis since March 2014 (**Table 1**). This progress report (Survey 13) 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 water depth of approximately 32 m to 34 m 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 water 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 epifaunal reef communities on the ship 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 parts 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. Encrusting 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. Encrusting 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 / hydroid.

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 encrusting assemblages occurring on horizontally orientated (deck) surfaces were different in composition from the vertically orientated (hull) encrusting assemblages. Depth and Deck Position were also significant factors in structuring encrusting 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*).

1.3.13 Monitoring Survey 12

As was the case with Surveys 10 and 11, significant changes in the composition of sessile encrusting assemblages were detected between Surveys 11 and 12. Such differences would likely be explained, at least partly, by successional changes in community structure, as well as any seasonal variation between sampling times. The findings of Survey 12 suggest that the abundance of orange jewel anemones has increased, with this taxa observed to have grown over the layer of calcareous tubes and barnacles present on the vertically orientated parts of the ship. The absence of *E. radiata* (kelp) in Survey 12 (aside from occasional thali in the mid-deck video), which was previously in each survey since Survey 2, may be due to several reasons. These could include 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 were recorded in Survey 12, which is indicative of ongoing successional changes. Such changes likely reflect the continuing creation of secondary habitat and increase in habitat complexity which provides new niches for previously absent benthic invertebrates to occupy. The finding in previous surveys that the composition of assemblages on horizontally orientated (deck) surfaces differed from that of assemblages from the vertically orientated (hull) was also evident during Survey 12. This is possibly due to vertical surfaces being more shaded (which would favour ascidians and anemonies over algae) compared with horizontal surfaces and / or differences in water velocity (great current movement would improve the feeding rate of sessile suspension feeding fauna such as ascidians and anemones). 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.

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Monitoring Survey 13	01 and 02 June 2016	5 years and 2 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 encrusting 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).

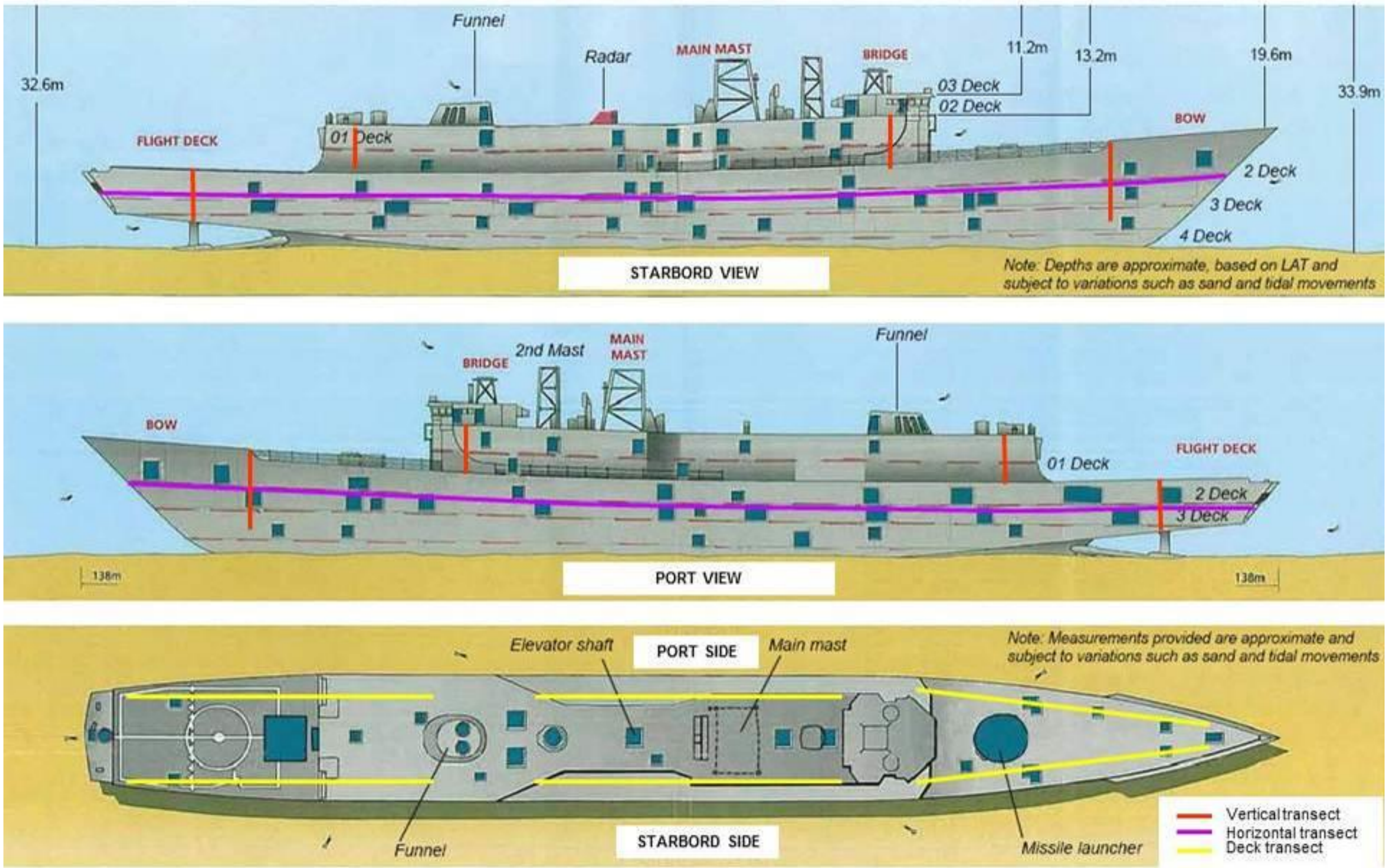


Figure 2: Plans of the Ex-HMAS Adelaide and positions of the reef assemblage survey sampling Transects.

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 encrusting 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.

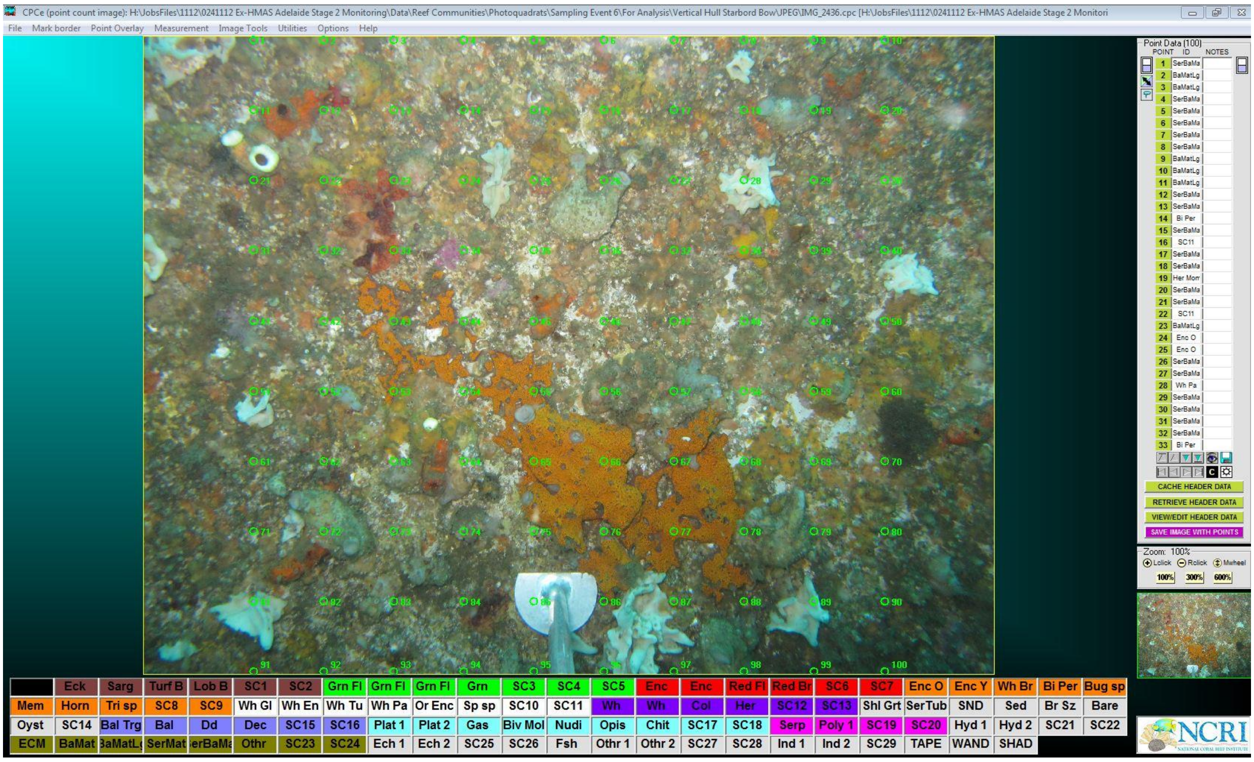


Figure 3: Screenshot of the CPCe Photoquadrat Analyses Frame with a Virtual 10 x 10 Grid Overlayed.

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 encrusting 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 12 and 13. 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 - 13): fixed, orthogonal;

This design compared reef assemblage structure among the 13 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 12/Survey 13): 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 12/Survey 13): 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 12/Survey 13): 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 13 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

It was noted during CPCE scoring of the photoquadrats that several ascidians appear to have recently become dislodged from the ship. This was indicated by roughly circular patches of un-colonised hull apparent in several photographs.

A total of 31 categories/groups of taxa were identified from the 82 photoquadrats examined during Survey 13 (**Appendix B**). The most abundant categories identified (total percentage cover) included a matrix of serpulid polychaete worms, barnacles and encrusting algae (30 %), brown filamentous algae / hydroid (20 %) a small orange anemone (*Corynactis* sp.) (16 %), a matrix of large barnacles, sediment and brown filamentous algae (11 %) and the ascidian *Herdmania momus* (6 %). These taxa / groups were also relatively abundant during Survey 12 (individual cover of 4 to 43 %). Five new taxa / groups were identified in Survey 13; a green filamentous alga (Chlorophyta), an encrusting red alga (Rhodophyta), an Echinoderm (Echinodermata), a pink colonial anemone (Actinaria) and new ascidian taxa (Ascidiacea). These occurred in relatively few photoquadrats and in low abundance.

A summary of all taxa and groups of taxa identified in the analyses of photoquadrats for Survey 13 is given in **Appendix B**.

Comparisons of photoquadrats from the Baseline and Monitoring Surveys 1-13 are presented in **Plates 1 – 16**.

3.1.2 Spatial and Temporal Variation in Reef Communities

All Times (Surveys 1-13)

PERMANOVA indicated a significant effect of Time, with assemblages from Survey 12 differing from those in Survey 13 (**Appendix C**). Pairwise tests indicated that all pairs of Times were significantly different, except from Survey 2 and 3, 4 and 7, 4 and 8, 5 and 6, 7 and 8, 9 and 10, and 12 and 13 (**Appendix D**). The SIMPER analysis was not considered appropriate in this instance as no significant difference was detected between Surveys 12 and 13.

The PCoA generally supported the findings of the PERMANOVA tests, with assemblages sampled during Surveys 12 and 13 tending to group together towards the bottom right of the PCoA. (**Figure 4**). There was also evidence to suggest assemblages from Surveys 4, 6, 8, 9 and 11 were less variable than those from the other surveys, with assemblages from these surveys tending to group relatively close together, compared with the other surveys. The global PERMDISP P = 0.001 indicated that differences detected between Surveys, when they occurred, were likely due to differences in the location and dispersion of the multivariate data (**Appendix F**).

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

PERMANOVA indicated a significant interactive effect of Time and Orientation, indicating the variation between Times depended on the Orientation considered, and / or vice versa (**Appendix C**). Pairwise tests (**Appendix D**) indicated that:

- The structure of encrusting assemblages in Survey 12 differed from those in Survey 13 on the horizontal hull and on the vertical deck; and
- The structure of encrusting assemblages on the deck differed from those on the hull during Survey 12 and during Survey 13.

The findings of the PERMANOVA tests are supported by the PCoA, with assemblages from the deck in Survey 12 tending to group at the top right, those from the deck in Survey 13 tending to group to the bottom right, those from the hull in Survey 12 tending to group towards the top left, and those from the hull in Survey 13 tending to group in the centre, of the PCoA (**Figure 5a**). Also, overall, assemblages from the deck group towards the right, while those from the hull group towards the left, of the PCoA.

SIMPER analyses indicated that the matrix of serpulid polychaete worms, barnacles and encrusting algae, small orange anemone (*Corynactis* sp.), the matrix of large barnacles, sediment and brown filamentous algae and brown filamentous algae / hydroid were, in general, the taxa and groups of taxa that contributed most to dissimilarity in the structure of encrusting assemblages (**Appendix E**). The results suggested that differences were, at least partly, due to a greater number of orange anemone and a smaller % cover of serpulid polychaete worms, barnacles and encrusting algae matrix and brown filamentous algae/hydroid on the hull, compared with the deck, during both surveys. They also suggested that differences between surveys on the hull were due to fewer orange anemone, a greater % cover of the large barnacles, sediment and brown filamentous algae matrix and a greater % cover of brown filamentous algae / hydroid in Survey 13, compared with Survey 12. Differences between surveys on the deck appeared to be due to a smaller % cover of serpulid polychaete worms, barnacles and encrusting algae matrix, and a greater % cover of brown filamentous algae / hydroid in Survey 13, compared with Survey 12.

PERMDISP P for the factor Time and Orientation was > 0.05, which suggested that, in general, differences between groups were due to the location, rather than dispersion, of the multivariate data (**Appendix F**).

PERMANOVA also detected a significant main effect of Aspect (**Appendix C**), though this was difficult to identify in the PCoA, with the assemblages from port and starboard tending to form a diffuse cloud along the axis utilised (**Figure 5b**). SIMPER analysis indicated that the matrix of serpulid polychaete worms, barnacles and encrusting algae, small orange anemone and brown filamentous algae and brown filamentous algae / hydroid contributed most to this dissimilarity (**Appendix E**). The analysis also suggested that this was due to a greater % cover of brown filamentous algae / hydroid and a smaller % cover of the matrix of serpulid polychaete worms, barnacles and encrusting algae on the starboard, compared with the port. PERMDISP P > 0.05 indicate that differences in the structure of the encrusting assemblages between Aspects were due likely to differences in the location, rather than dispersion, of the multivariate data (**Appendix F**).

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

PERMANOVA did not indicate a significant main effect or interactive effect of Depth. PERMANOVA indicated a significant interactive effect of Time and Transect (Depth x Aspect), indicating the variation between Transects (i.e. the bow transect vs. the stern transect) depended on the Survey considered, and / or vice versa (**Appendix C**). Pairwise tests indicated the following (**Appendix D**):

- The assemblage at the bow transect differed from that at the stern transect on the deep port and deep starboard surfaces during Survey 12;
- The assemblage at the bow transect differed from that at the stern transect on the deep port surface during Survey 13;
- Assemblages differed between Survey 12 and Survey 13 at the deep port bow transect, deep port stern transect and the deep starboard-stern transect;
- Assemblages differed between Surveys 12 and 13 at the shallow starboard-bow transect and shallow starboard-stern transect.

SIMPER analysis indicated that the taxa / groups of taxa contributing most to the dissimilarity in the structure of assemblages between Surveys at each Transect tended to be the matrix of large barnacles, sediment and brown filamentous algae, brown filamentous algae / hydroid, orange anemone and the matrix of serpulid polychaete worms, barnacles and encrusting algae (**Appendix E**). The results also indicated that orange anemone was the only taxa / group that displayed a potential consistent change in abundance between surveys, with some evidence to suggest a decrease in the abundance between surveys at these Transects.

Cursory examination of the SIMPER analyses involving pairs of the levels of the factor Transect (Depth and Aspect) suggest that differences in the structure of encrusting assemblages between bow and stern Transects during individual surveys were due primarily to variability in the serpulid polychaete worms, barnacles and encrusting algae matrix, *Herdmania momus* and orange anemone. Further examination of pairs of levels of the factor Transect (Depth x Aspect) were not considered appropriate, as Transect is a nested factor which provides a measure of background variability, rather than a fixed term of interest (i.e. the factors Time, Depth and Aspect).

PERMANOVA also indicted a significant main effect of Aspect when data were averaged across Time, Depth and Transect (Time and Depth). This indicates a difference in the structure of encrusting assemblages in vertical Transects between the port and starboard of the ship. The results of the PCoA support this finding of the PERMANOVA test, with assemblages from vertical Transects on the port tending to group to the left, and those from the starboard tending to group towards the right, of the PCoA, though some overlap of these points is evident (**Figure 6**). The results of the SIMPER analyses indicated that the taxa / groups contributing most to the difference in the structure of assemblages on the port and starboard included the serpulid polychaete worms, barnacles and encrusting algae matrix, orange anemone, *Herdmania momus* and the matrix of large barnacles, sediment and brown filamentous algae (**Appendix E**). The analyses also suggest that this may have been due an increase in the % cover of the serpulid polychaete worms, barnacles and encrusting algae matrix, and a reduction in the % cover other taxa / groups.

The PERMDISP P for the main effect of Aspect was > 0.05, indicating that the difference in the structure of encrusting assemblages between the port and starboard due likely to a difference in the location of the multivariate data, rather than dispersion (**Appendix F**). PERMDISP P for the interaction of Time and Transect (Depth x Aspect) was <0.01, suggesting that differences between Transects at the bow and stern during individual Surveys, and between consecutive surveys at each Transect location, were due likely to differences in the location and dispersion of the multivariate data.

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

PERMANOVA indicated a significant interactive effect of Time and Position, indicating that the variation between times depended on the Position considered and / or vice versa (**Appendix C**). Pairwise tests indicated the following:

- The assemblage at each position (bow, mid-ship, and stern) differed between Surveys 12 and 13:
- The assemblage at the bow differed from that at the mid-ship during Survey 12 and Survey 13.

The SIMPER analyses indicated that differences in the structure of macroinvertebrate assemblages were due primarily to variation in the % cover of the serpulid polychaete worms, barnacles and encrusting algae matrix and brown filamentous / hydroid, which together contributed over 70 % of the dissimilarity in assemblage structure (**Appendix E**). The results also suggest that differences were due to a greater % cover of these groups in Survey 13, compared with Survey 12. Differences between the bow and mid-ship appeared to be due, at least partly, to a greater, and smaller, % cover of the serpulid polychaete worms, barnacles and encrusting algae matrix and brown filamentous algae / hydroid, respectively, in Survey 12. Differences also appeared to be due to a smaller, and greater, % cover of the serpulid polychaete worms, barnacles and encrusting algae matrix and brown filamentous / hydroid, respectively, in Survey 13.

The PCoA for the interaction of Time and Position generally supports the finding of differences in assemblage structure between Surveys at each Position, with assemblages from Positions visited in Survey 12 tending to group towards the top left, and those from the same Positions visited in Survey 13 tending to group towards the bottom right, of the PCoA (**Figure 7a**). Differences in assemblages between the bow and mid-ship during each Survey were, however, more difficult to identify, with some overlap of the 'cloud' of assemblages evident in the PCoA. PERMDISP P for the interaction of Time and Position was > 0.05, indicating differences in the structure of encrusting assemblages between Times and Positions were due more likely to differences in the location, rather than dispersion, of the multivariate data (**Appendix F**).

PERMANOVA also indicated a significant main effect of Aspect (**Appendix C**). SIMPER analysis indicated that together, the serpulid polychaete worms, barnacles and encrusting algae matrix and brown filamentous / hydroid contributed 75 % to the dissimilarity in the assemblage structure between the port and starboard Aspects (**Appendix E**). The analysis also suggested that this was due, at least partly, to a smaller % cover of the serpulid polychaete worms, barnacles and encrusting algae matrix and greater % cover of brown filamentous algae / hydroid on the starboard, compared with the port. The results of the PCoA for Aspect are also somewhat supportive of the PERMANOVA, with assemblages from the port tending to group towards the right, and those from the starboard tending to group towards the left, of the PCoA (**Figure 7b**). PERMDISP P for the main effect of Aspect was > 0.05, indicating differences in the structure of assemblages between the two aspects were more likely due to the location of the multivariate data, rather than dispersion (**Appendix F**).

Summary

The results of the PERMANOVA analyses are summarised as follows:

- Overall, no significant difference in the structure of encrusting assemblages was detected between Survey 12 and Survey 13. Differences were detected between surveys at a local scale (i.e. at the scale of Orientations (i.e. deck and hull), Positions on the deck (bow, mid-ship and stern) and individual Transects);

- There were significant differences in the structure of assemblages between the horizontal deck and the vertical hull, in Surveys 12 and 13 (i.e. an effect of Orientation);
- No significant difference in the structure of assemblages was detected between shallow and deep vertical Transects (i.e. no effect of Depth);
- There was a significant difference in the structure of assemblages between the bow and the mid-ship Positions during Survey 12 and during Survey 13 (i.e. an effect of Position); and
- There was a significant difference in the structure of assemblages between the port and starboard Aspects, averaged across all other factors, for each of the analyses undertaken (i.e. a main effect of Aspect).

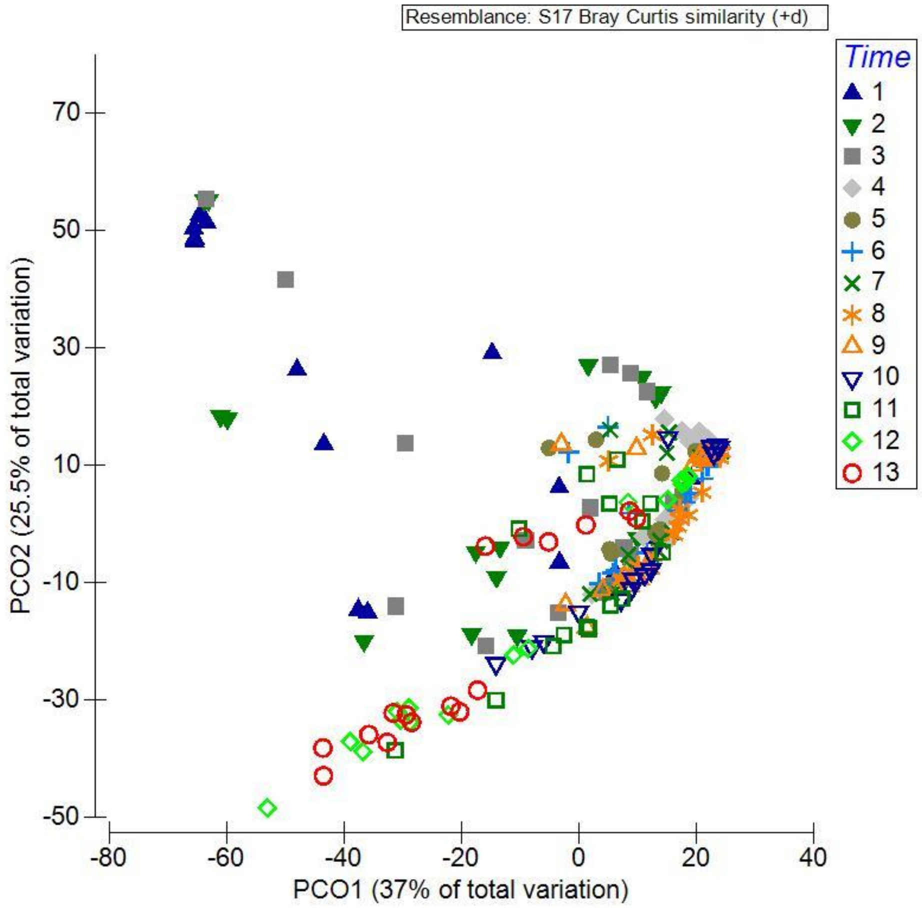
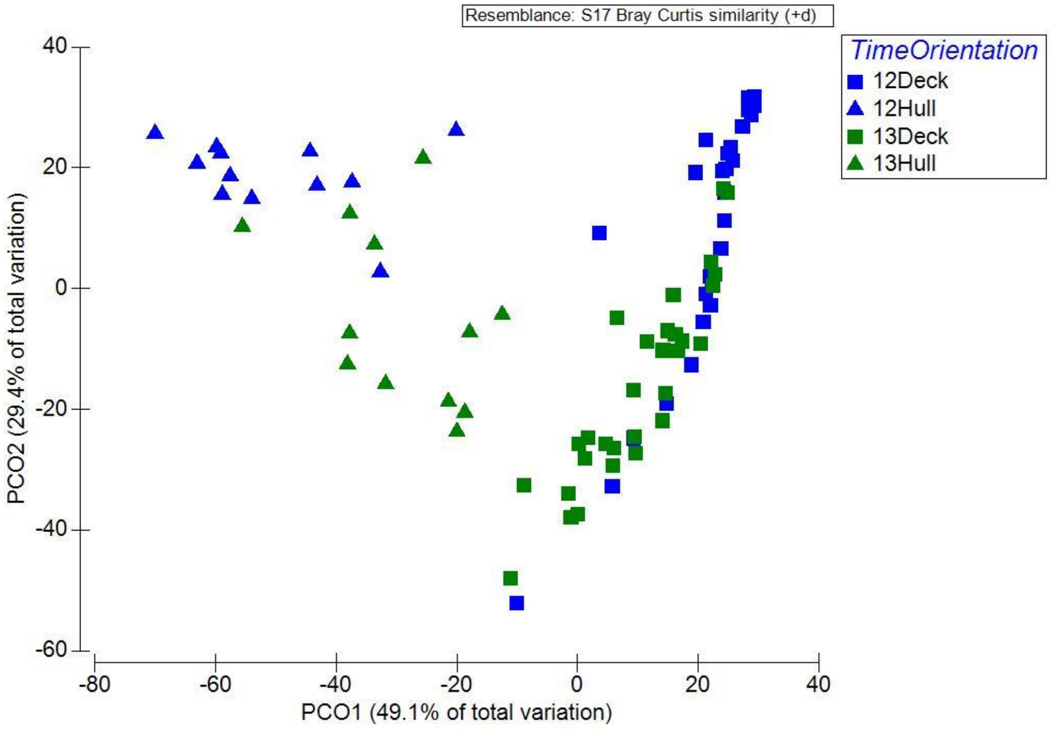


Figure 4: Principal Coordinates Analyses (PCoA) of Percent Cover of Encrusting assemblages from Transects Taken at all Positions on the Ex-HMAS Adelaide for Surveys 1 to 13

a)



b)

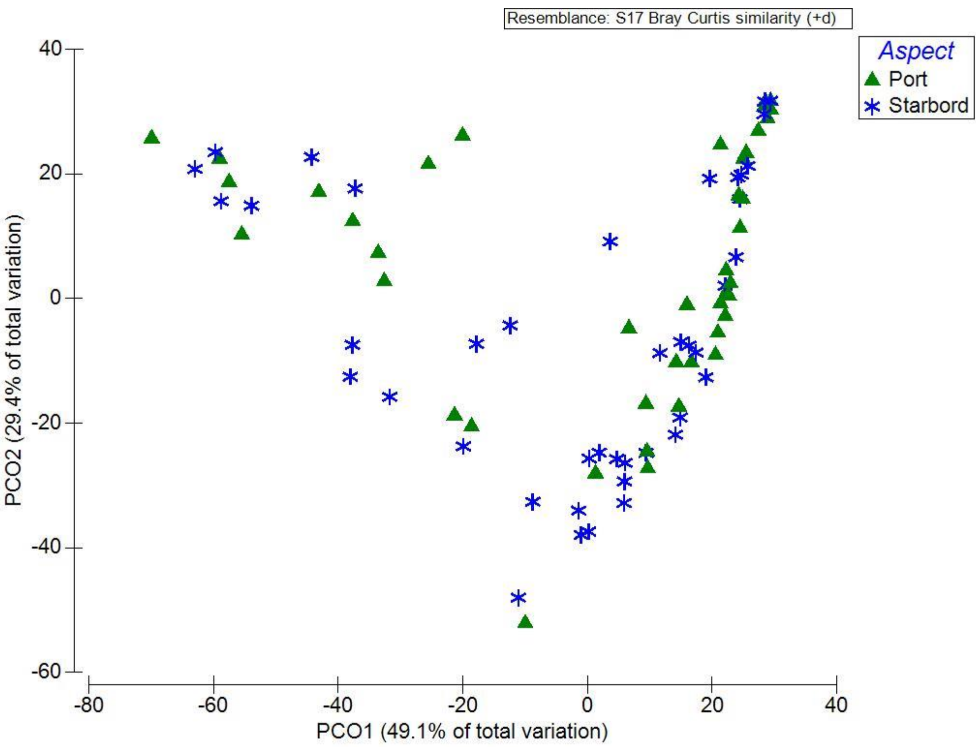


Figure 5: Principal Coordinates Analyses (PCoA) of Percent Cover Encrusting assemblages from Transects a) Taken on Hull and Deck Surfaces and b) on different Aspects of the Ex-HMAS Adelaide for Surveys 12 and 13

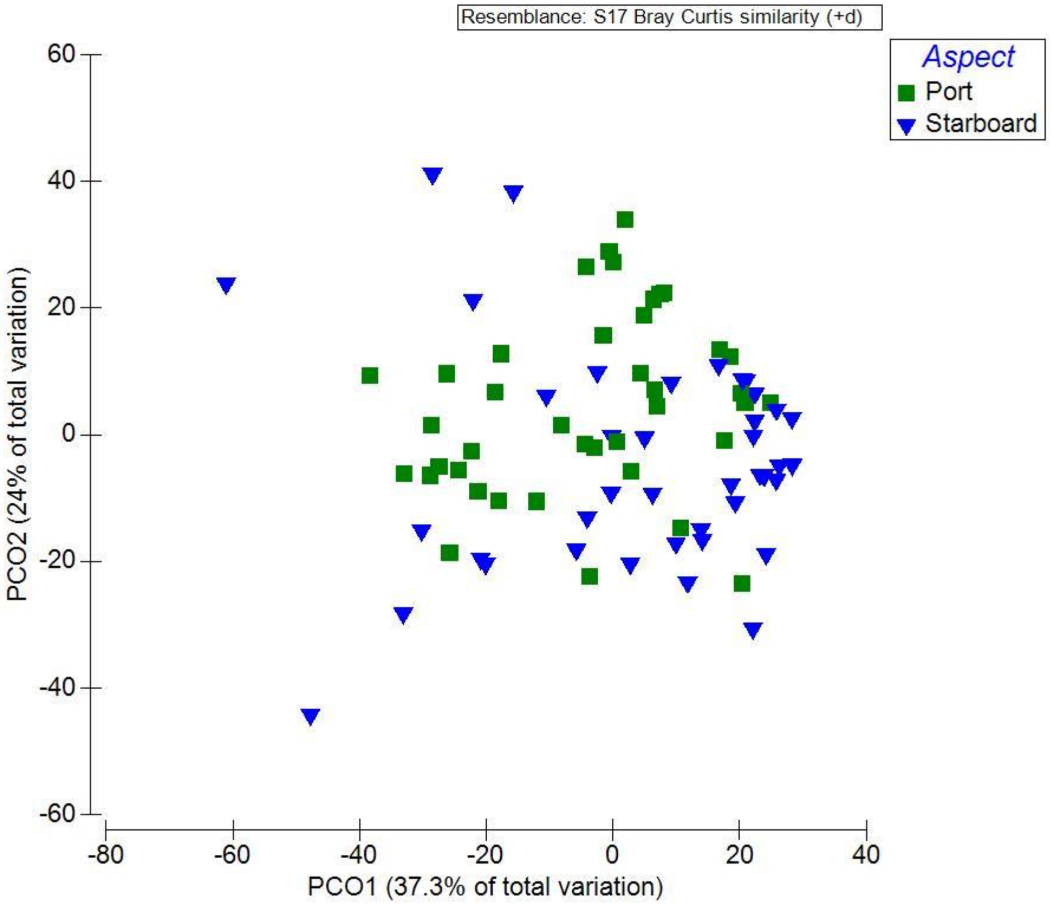
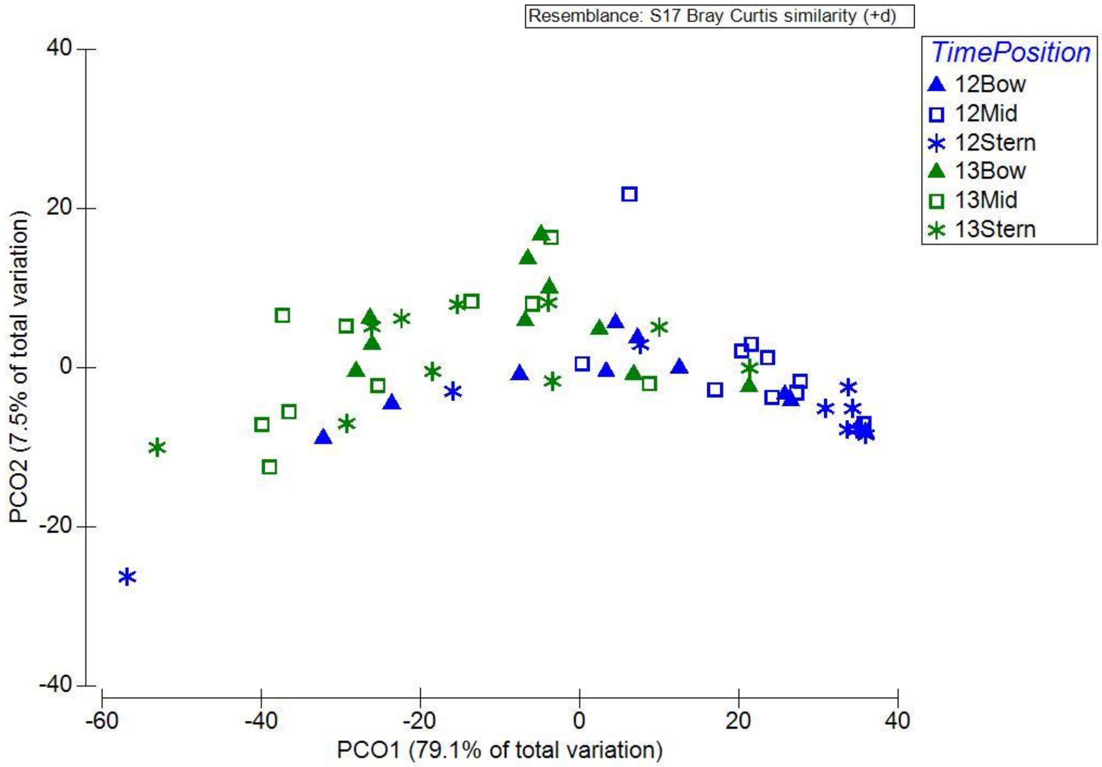


Figure 6: Principal Coordinates Analyses (PCoA) of Percent Cover of Encrusting Assemblages from Transects at Different Depths and Aspect on the Ex-HMAS Adelaide for Surveys 12 and 13

a)



b)

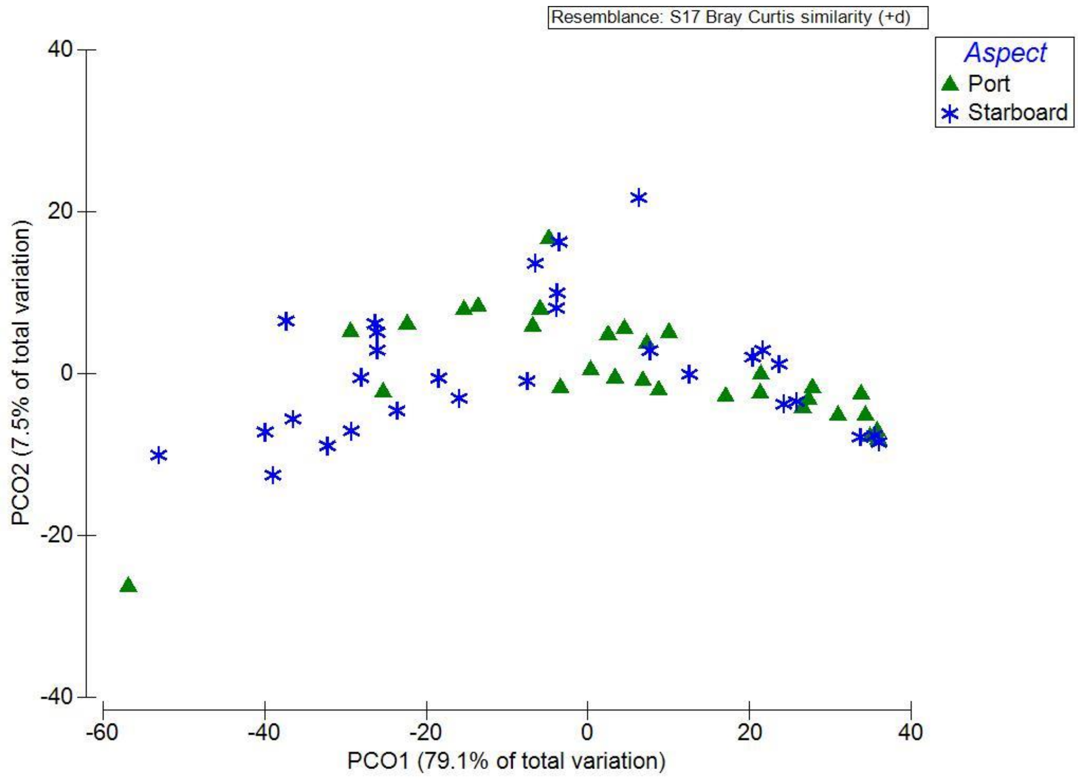


Figure 7: Principal Coordinates Analyses (PCoA) of Percent Cover of Encrusting assemblages at a) different Positions and Surveys and b) different Aspects on the Deck Ex-HMAS Adelaide for Surveys 12 and 13

3.2 Fixed Photographs

Photographs taken from fixed locations are presented in **Appendix A**. The encrusting assemblage in Survey 13 primarily consists of a thick encrusting layer over more complex structures such as ladders, railings and masts and to a lesser extent on deck surfaces. A visual assessment of the assemblage in the fixed photos indicates that it does not appeared to have changed significantly over the past 14 months between Surveys 12 and 13.

3.3 Video Transects

The results of observations made from video Transects are summarised in **Table 2**. All fish species observed during previous surveys and the current monitoring survey (Survey 13) are listed in **Table 3**. Species of recreational, commercial or conservation value are also indicated. More species of fish (a total of 32 species) were recorded in Survey 13 than for any of the previous surveys, including two species (beardie (Lotella rhacina) and blender longtom (Strongylura leiura)) 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, serpulid tubes and fine filamentous algae. Tubular solitary sponges, white papillate encrusting sponges and yellow encrusting sponge were also conspicuous. Tarwhine (*Rhabdosargus sarba*), eastern hulafish (*Trachinops taeniatus*)and sweep (*Scorpis lineolatus*) were all observed.
Deck Port Mid	Unlike some previous surveys no kelp (*Ecklonia radiata*) was observed in this area. The majority of the deck was otherwise heavily encrusted with barnacles, serpulid tubes, encrusting red algae and fine filamentous algae. Patches of encrusting yellow/orange and white sponge was observed on the deck as were many small bare patches. Tarwhine were common and rock cale (*Crinodus lophodon*) were abundant on the deck.
Deck Port Stern	The deck was predominantly covered in serpulid tubes, barnacles and fine filamentous algae. Large tubular and papillate sponges were conspicuous on the deck surface.
Deck Starboard Bow	As with previous surveys, encrusting growth included barnacles, serpulid tubes and tufing algae with patches of tubular, papillate and encrusting sponges. Solitary, tubular, red, pink and white sponges were observed on the deck. Schools of eastern hulafish and sweep were observed as well as some banded parma (*Parma polylepis*) and white ear (*Parma microlepis*).
Deck Starboard Mid	As per previous surveys, the majority of the deck was encrusted with barnacles, encrusting algae, and fine red filamentous algae. Tubular solitary sponges, white papillate and orange encrusting sponges and serpulid tubes were conspicuous on the deck surface. Unlike some previous surveys no kelp (*Ecklonia radiata*) was observed. Fish observed included schools of one-spot puller (*Chromis hypsilepis*), eastern hulafish and mado (*Atypicthys strigatus*) as well as tarwhine, sweep, wirrah (*Acanthistius ocellatus*), snapper (*Pagrus auratus*), rock cale and girdled parma.
Deck Starboard Stern	The deck was predominantly covered in serpulid tubes, barnacles and fine filamentous algae. Large tubular and papillate sponges were conspicuous on the deck surface. Fish observed included, tarwhine, one-spot puller and eastern red scorpioncod (*Scorpaena cardinalis*).
Horizontal Hull Port and Starboard	Similar to the previous survey, the hull, particularly the upper rim, remains densely 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. Similar to the previous survey, 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. There are very few bare patches on the hull apart from small areas where solitary ascidians have probably recently become detached. Species of fish observed included: tarwhine, eastern hulafish, eastern red scorpioncod, sweep, silver trevally (*Pseudocaranx dentex*), rock cale and a beardie (*Lotella rhacina*), which has not been observed previously in the program.
Vertical Hull Bow	Large ascidians such as *Herdmania momus*, barnacles and tiny orange and bright purple jewel anemones (*Corynactis* sp.) were the most prevalent encrusting biota on the vertical bow of the ship. As for the horizontal hull areas, the upper rim of the vertical bow areas had the thickest cover of invertebrates. 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 areas 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 and sweep were observed near the top of the hull.
Vertical Hull Superstructure	The superstructure surface was covered with large ascidians and barnacles (*Balanus* sp.), bryozoans, barnacles, encrusting white and orange sponge, fine filamentous algae and a dense covering of tiny orange jewel anemones. Tarwhine, eastern hulafish, crimson banded wrasse (*Notolabrus gymnogenis*) and sweep 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)	Survey 13 (June 2016)
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 leweni*	Longfinned pike	263		•			•					•				•
Carangidae	*Pseudocaranx dentex*	Silver trevally	292				•	•	•		•	•	•	•	•	•	•
Carangidae	*Trachurus novaezelandiae*	Yellowtail scad+	294		•			•				•					
Carangidae	*Seriola lalandi*	Yellowtail kingfish*	298			•	•		•	•	•	•	•	•	•	•	•
Carangidae	*Seriola hippos*	Samson Fish*	300									•					
Carangidae	*Elagatis bipinnulata*	Rainbow runner	303									•					
Sparidae	*Pagrus auratus*	Snapper (juv)*+	310		•	•	•		•	•	•				•	•	•
Sparidae	*Rhabdosargus sarba*	Tarwhine*	311			•	•	•	•	•	•	•	•	•	•	•	•
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	*Cirritichthys aprinus*	Blotched hawkfish	406						•	•	•	•	•	•		•	
Chironemidae	*Chironemus marmoratus*	Eastern kelpfish	411						•						•		
Aplodactylidae	*Crinodus lophodon*	Rock cale	415						•		•	•	•	•	•	•	•
Cheilodactylidae	*Cheilodactylus fuscus*	Red morwong*	416		•	•	•	•	•	•	•	•	•	•	•	•	•
Cheilodactylidae	*Nemadactylus douglasii*	Blue morwong*	424		•	•				•	•		•	•	•	•	•
Cheilodactylidae	*Cheilodactylus vestitus*	Magpie morwong	421								•		•		•		•
Latrididae	*Latridopsis forsteri*	Bastard trumpeter	427		•				•	•	•	•	•		•		•
Labridae	*Achoerodus viridis*	Eastern blue groper	438		•	•	•	•	•	•	•		•	•	•	•	•
Labridae	*Coris picta*	Comb wrasse	446						•								
Labridae	*Notolabrus gymnogenis*	Crimson banded wrasse	481				•		•	•			•	•	•	•	•
Labridae	*Notolabrus parilus*	Brown spotted wrasse	483				•							•	•		
Labridae	*Psuedolabrus luculentus*	Luculentus wrasse	487								•	•		•			
Labridae	*Thalassoma lunare*	Moon wrasse	505									•					
Blenniidae	*Petroscirtes lupus*	Brown sabretooth blenny	532	•						•							
Blenniidae	*Parablennius intermedius*	Horned blenny	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							•							
Monacanthidae	*Eubalichthys bucephalus*	Black reef leatherjacket	649											•	•	•	•
Monacanthidae	*Meuschenia spp.*	Unidentified leatherjackets	x				•	•	•								•
Tetraodonitdae	*Dicotlichthys punctulatus*	Three-bar porcupinefish	682		•				•	•				•	•	•	
Sepiidae	*Sepia* sp.	Cuttlefish	x										•				
Moridae	*Lotella rhacina*	Beardie	112														•
Belonidae	*Strongylura leiura*	Slender longtom	127														•
Total Number of Taxa				**3**	**17**	**14**	**19**	**13**	**23**	**19**	**26**	**26**	**26**	**25**	**28**	**28**	**32**

4 Discussion

4.1 Encrusting Biota

There was no evidence of an overall change in the ship-wide assemblage structure between Surveys 12 and 13. In most recent previous surveys, ship-wide differences have been detected. Results of Survey 12 showed significant changes in the composition of the sessile reef assemblage over the previous six months following Survey 11 (September 2014); this was similar to previous consecutive surveys (10 and 11) which also differed in assemblage structure. Differences between surveys may partly be due to successional changes as well as seasonal conditions which would potentially influence current patterns and recruitment, all of which would be expected to influence the abundance and composition of encrusting assemblages. It is possible that the absence of a detectable difference in the ship-wide assemblage between the most two most recent surveys may be indicative of a slowing in the rate of successional change. However, differences between surveys were still apparent at different surfaces on the ship, which suggests that changes are still occurring.

Differences between surveys were detected at a more local scale at different surfaces on the ship (i.e. Orientation - horizontal deck Transects and vertical hull Transects, Position – bow, mid-ship and stern and Transect). Also, as has often been the case in previous surveys, significant differences in assemblage structure were detected between Orientations (i.e. horizontal deck vs. vertical hull) during Surveys 12 and 13. As discussed previously, it is likely that suspension / filter feeders such as ascidians and anemones (particularly *Corynactis* sp., which was often found to contribute to a relatively large proportion of the dissimilarity between assemblages) tend to proliferate on more shaded (i.e. vertical) portions of the ship (for example, where competition for space from algae would be expected to be lower) or possibly where there is more current which would be expected to improve feeding efficiency. There is also some evidence to suggest a substantial, overall increase in the abundance of this taxon in recent surveys, however, there was also some evidence to suggest a reduction in the cover of this taxon between Surveys 12 and 13 at some individual Transects. *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. Algae would be expected to be are more abundant on upper horizontal surfaces where light availability is optimal.

As well as significant differences in the structure of assemblages associated with Orientation, differences were detected between some Positions on the deck (bow and mid-ship). Differences were also detected between Aspects (port and starboard) for each of the analyses involving this factor. Differences among Positions are likely to be related to local scale differences in current and shade associated with the structure of the ship (e.g. relative location of masts and other deck structures). Larger scale differences between Aspect are more likely to be related to larger scale processes, such as prevailing current, swell and the relative orientation to the sun. The absence of detectable difference in structure of assemblages from different depths was also noted in recent previous Surveys 11 and 12. It is possible that the depth ranges examined in this study are too similar to expect consistent variability associated with this predictor, which would otherwise be expected to strongly influence the occurrence and abundance of most, if not all species. Depth influences a variety of abiotic and biotic resources, including light, food, and other physical and chemical variables.

The apparent reduction in the cover of *E. radiata* in photoquadrats noted in Survey 12 appears to have continued in Survey 13. Although the occasional kelp thalli were observed by divers or in videos, this alga was not identified in any of the photo quadrats during Surveys 12 and 13. This potential reduction in percent cover of *E. radiata* at the mid ship of the deck is likely to have affected the outcome of Surveys 12 and 13, as this has previously been a factor in distinguishing the mid ship area of the deck from the bow and stern of the ship. As was the case in 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. The apparent loss of some ascidians from the ships surface (indicated by the roughly circular patches of bare ship hull in photoquadrats) in Survey 13 could also be due to flaking of the ship’s hull and / or dislodgement due to strong currents / swell during storms.

In addition to *Corynactis* sp., taxa / groups of taxa that were found to contribute most to differences in the structure of assemblages tended, overall, to be the most abundant taxa / groups present. These include the matrix of serpulid polychaete worms, barnacles and encrusting algae, the matrix of large barnacles, sediment and brown filamentous algae and brown filamentous algae / hydroids. The relatively large contribution these taxa make to the dissimilarity in assemblage structure between Aspects, Orientations and Positions etc. could be due to a relatively high turnover, particularly if they are removed regularly due to feeding / grazing by other marine biota. This could result in frequent and relatively substantial changes in their occurrence and abundance, which would explain why they consistently contribute a relatively large proportion of the difference between assemblages.

The continual occurrence of new species, albeit in a small number of quadrats and small % cover, such as this is indicative that successional changes are continuing through time. Likely related to the creation of new secondary habitat by other species and increased habitat complexity for other benthic invertebrates to occupy.

4.2 Fish

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. Thirty two species were observed in Survey 13, more than in Surveys 11 and 12 (Twenty eight) and in any previous survey. Two new species were observed in Survey 13 (beardie *(Lotella rhacina*) and blender longtom (*Strongylura leiura*)) which have not previously been recorded during the monitoring program. Beardie is a benthic species often found in caves along the south, south-east and south-west coast of Australia. Slender longtom is a somewhat tropical species of needle fish that inhabits coastal waters and estuaries.

5 References

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6 Plates

Deck, Port Bow

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

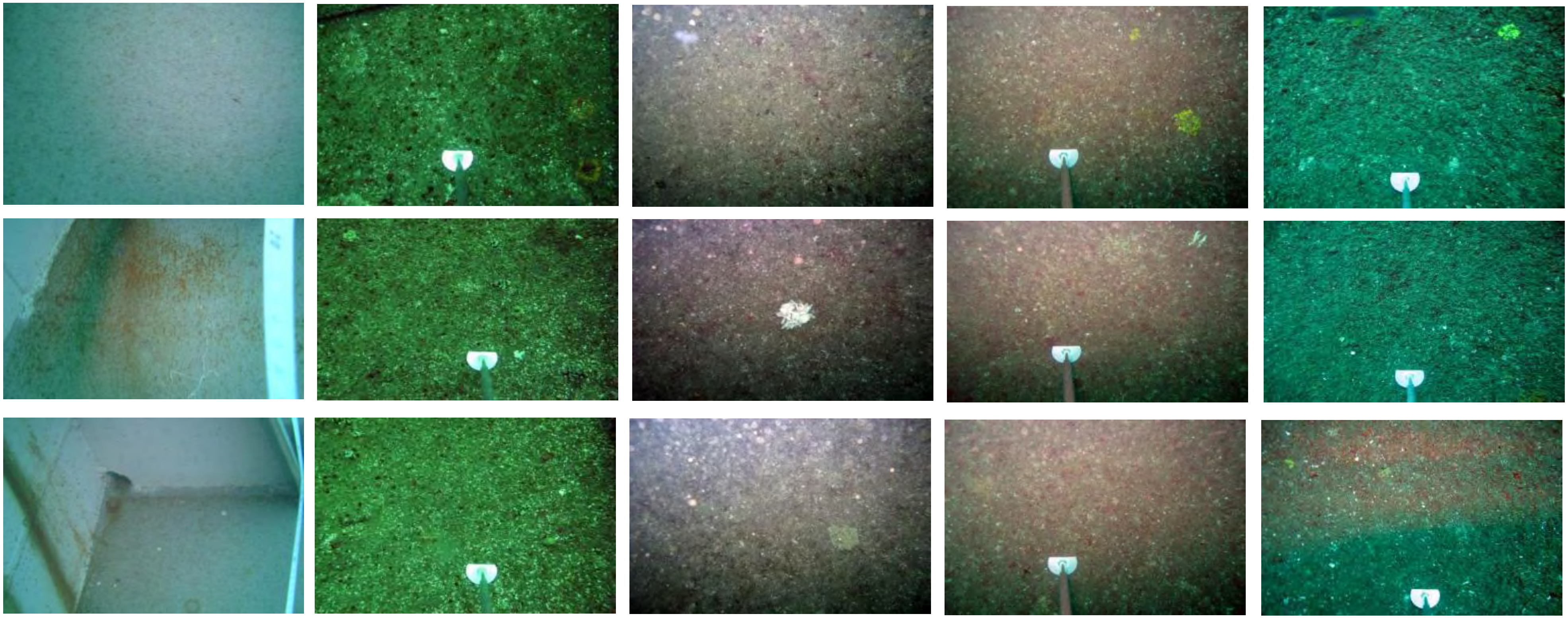


Plate 1: Deck port bow

Deck, Port Bow

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

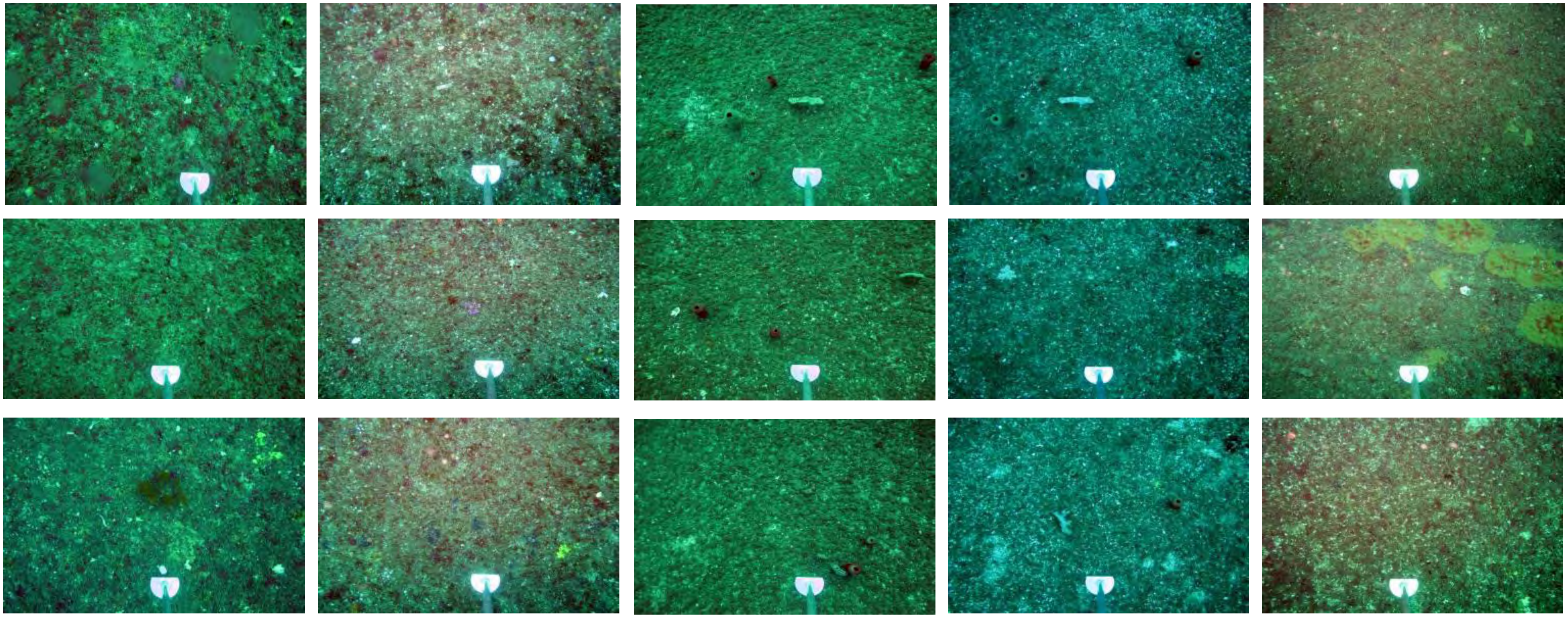
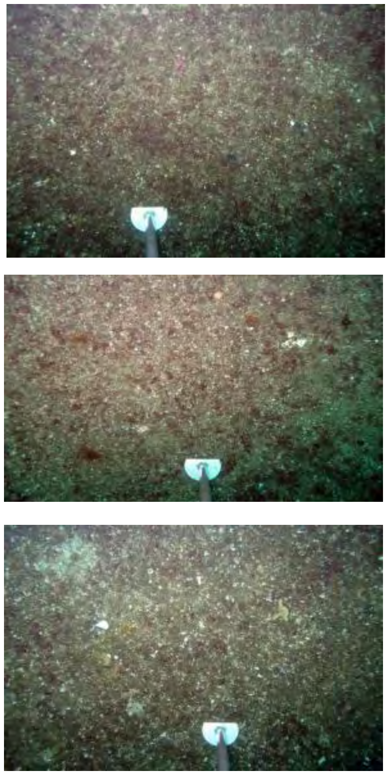


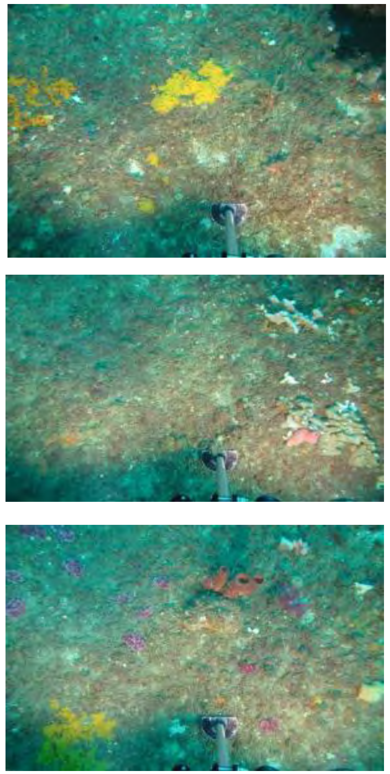
Plate 1 Continued: Deck port bow

Deck, Port Bow

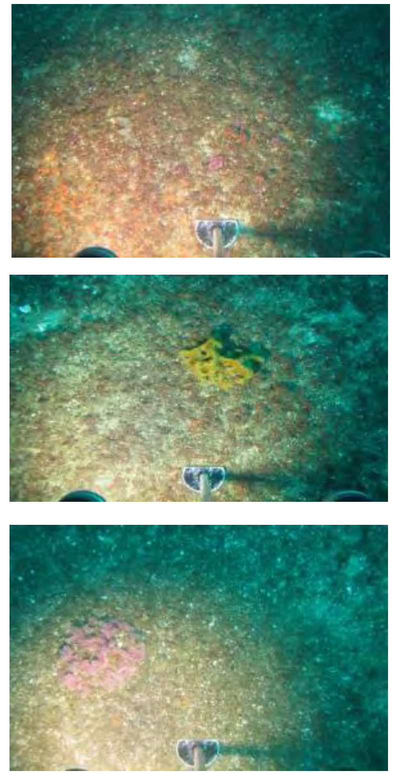
Monitoring Survey 10 (March 2014)



Monitoring Survey 11 (October 2014)



Monitoring Survey 12 (March 2015)



Monitoring Survey 13 (June 2016)

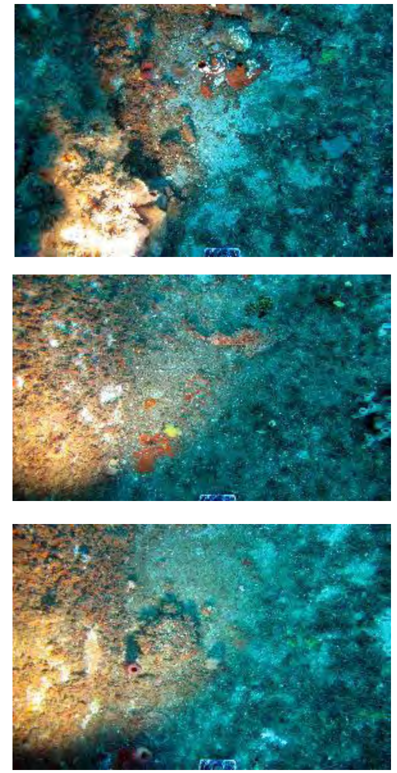


Plate 1 Continued: Deck port bow

Deck, Port Mid

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

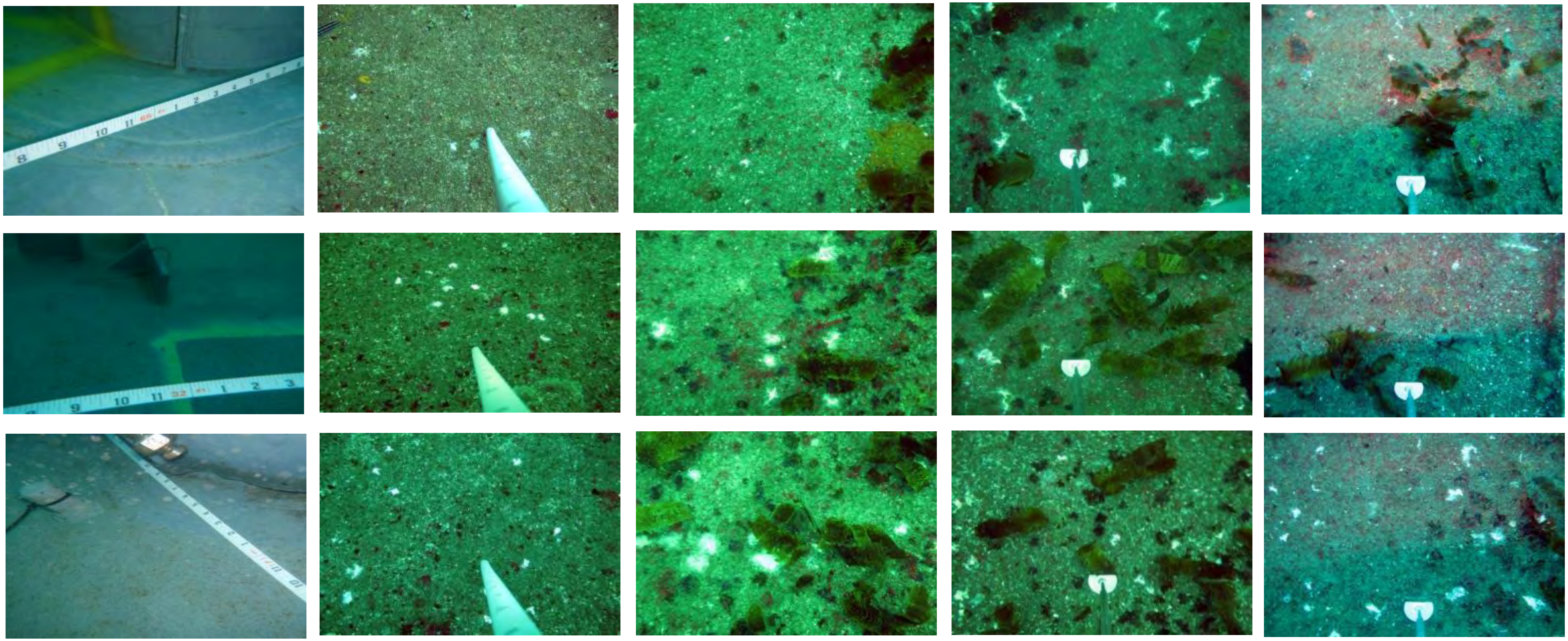


Plate 2: Deck Port Mid

Deck, Port Mid

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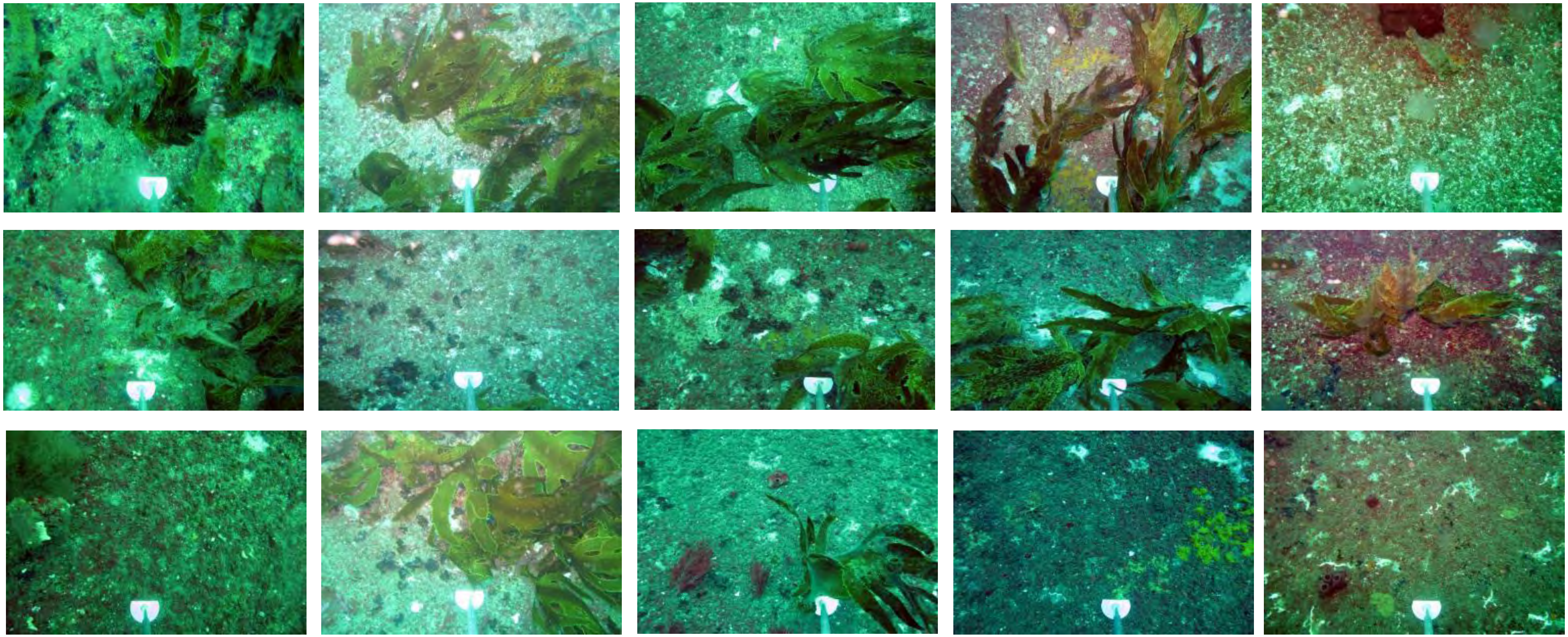


Plate 2 Continued: Deck Port Mid

Deck, Port Mid

Monitoring Survey 10 (March 2014)	Monitoring Survey 11 (October 2014)	Monitoring Survey 12 (March 2015)	Monitoring Survey 13 (June 2016)

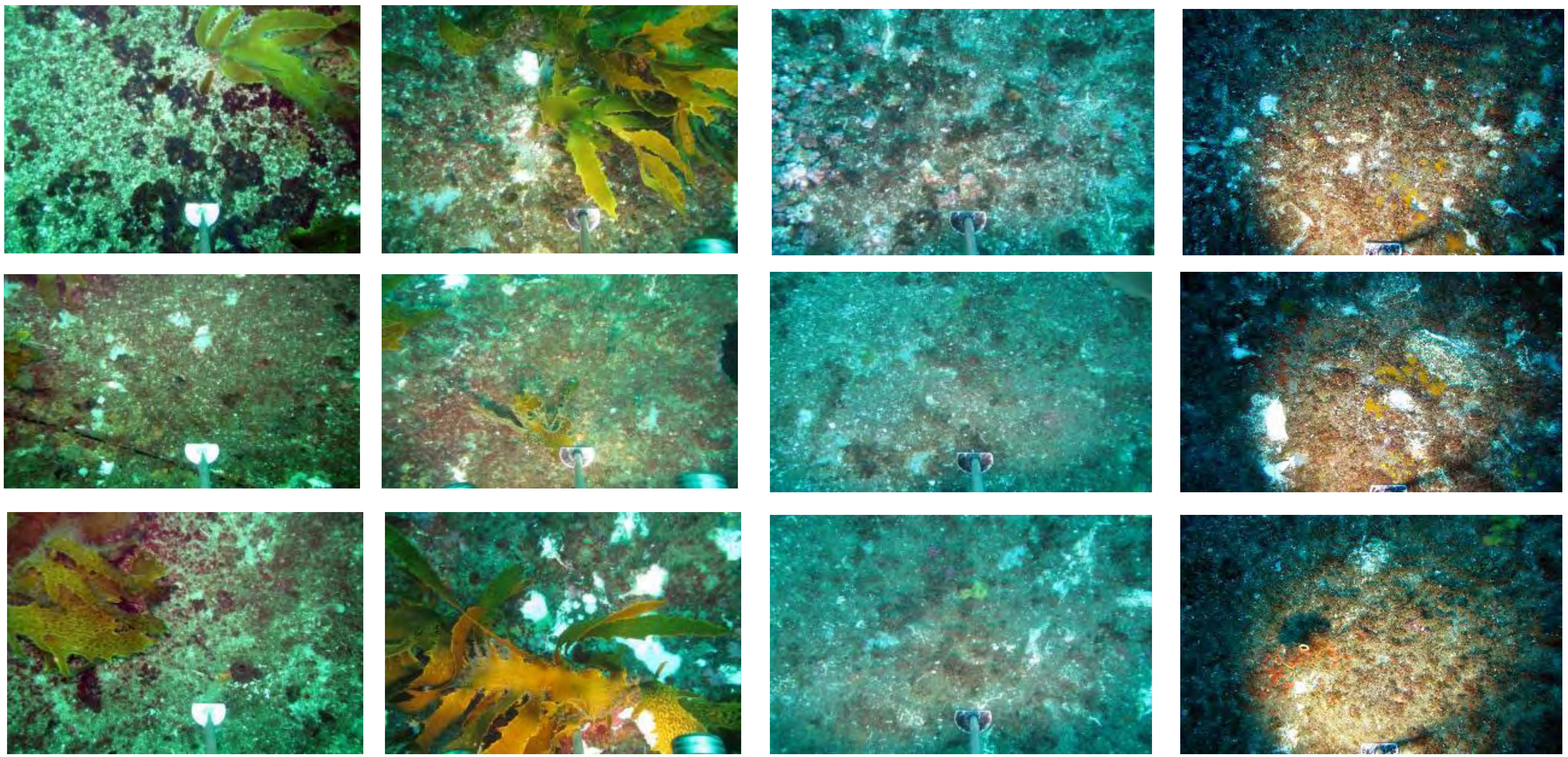


Plate 2 Continued: Deck Port Mid

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)

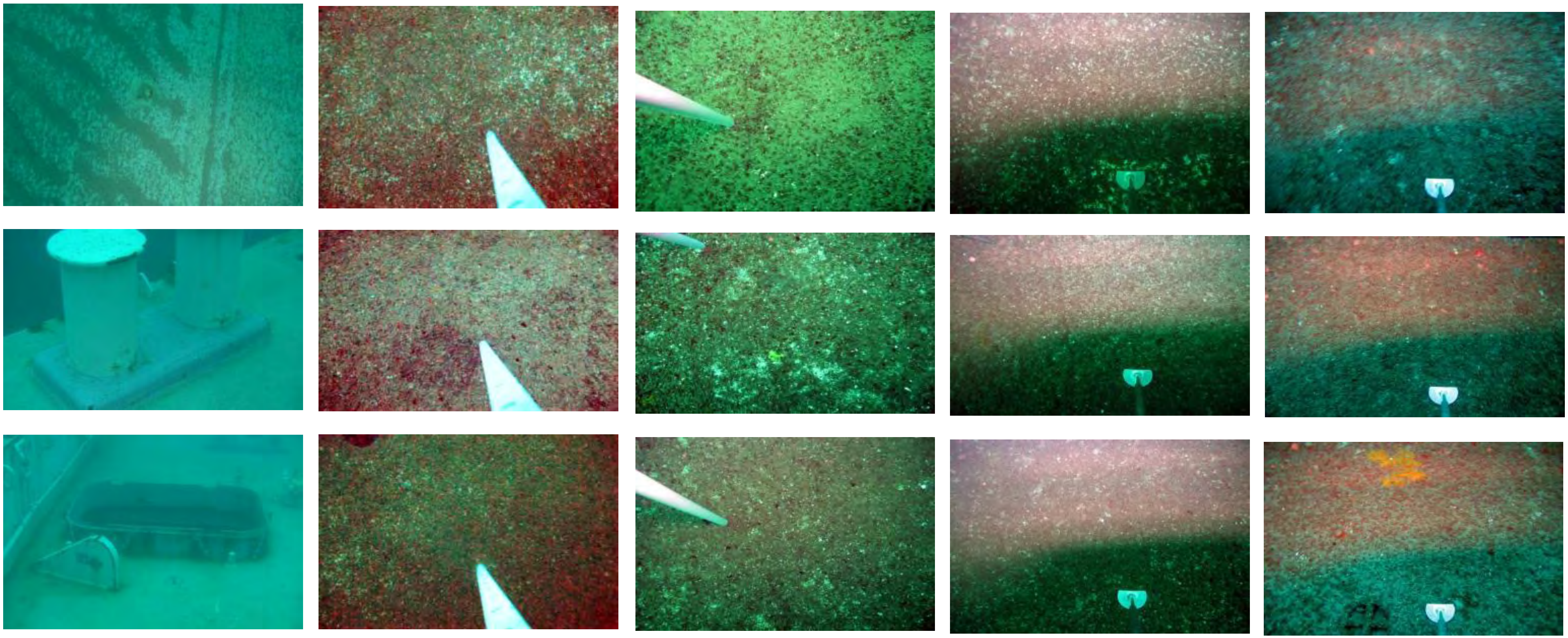


Plate 3: Deck Port Stern

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)

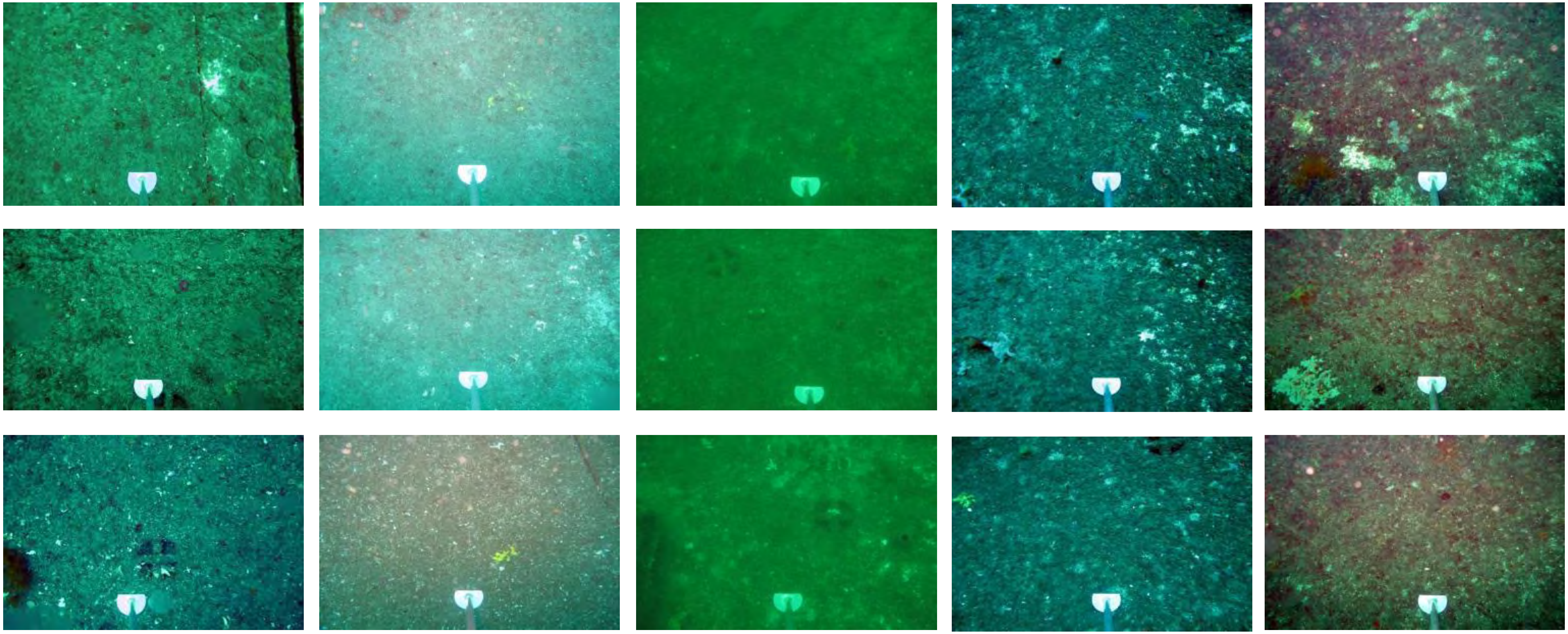


Plate 3 Continued: Deck Port Stern

Deck, Port, Stern

Monitoring Survey 10 (March 2014)	Monitoring Survey 11 (October 2014)	Monitoring Survey 12 (March 2015)	Monitoring Survey 13 (June 2016)

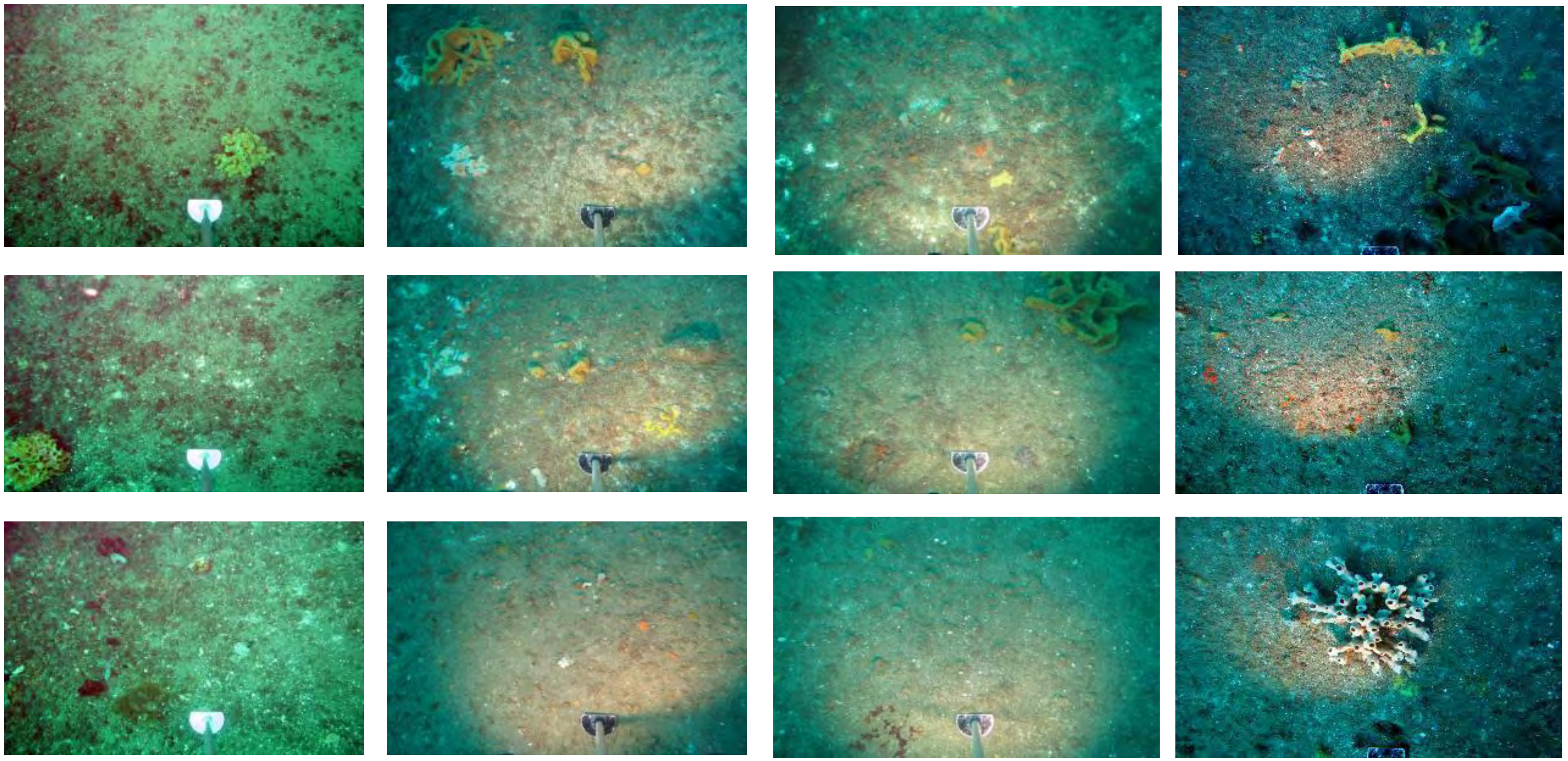


Plate 3 Continued: Deck Port Stern

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)

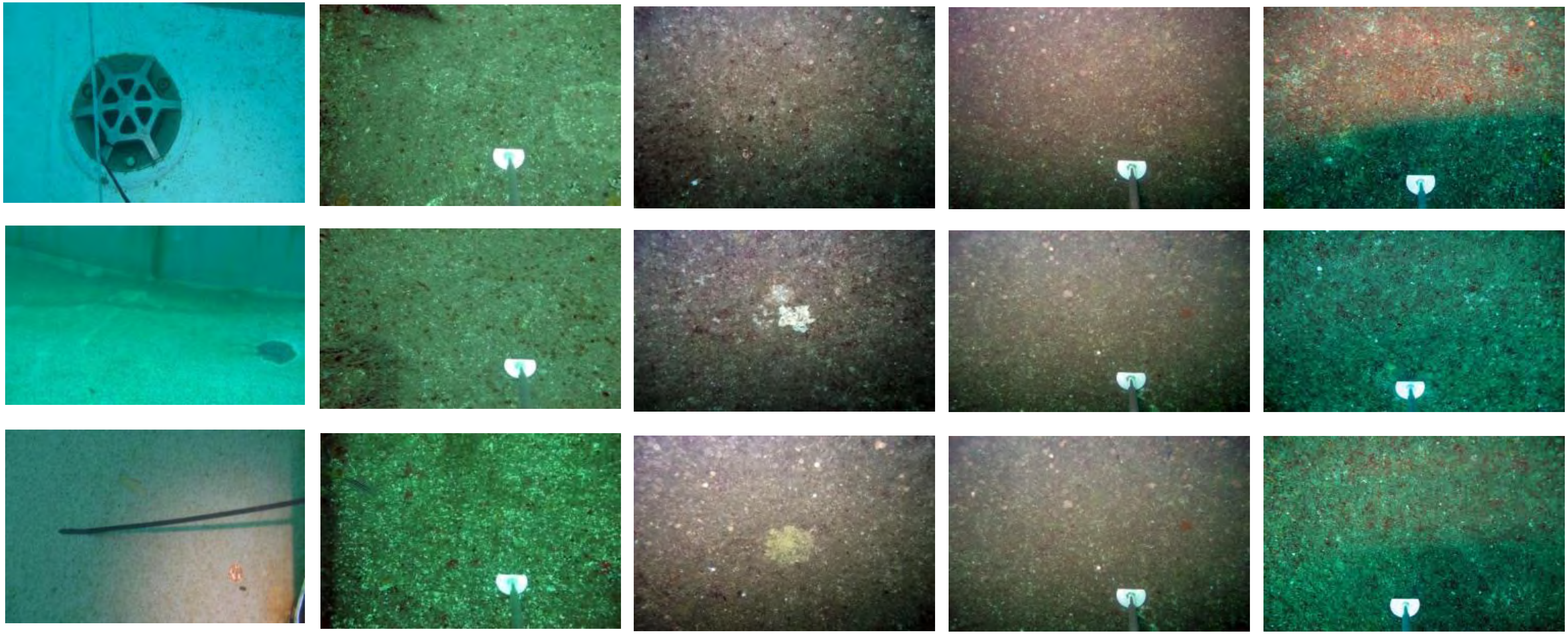


Plate 4: Deck Starbord Bow

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)

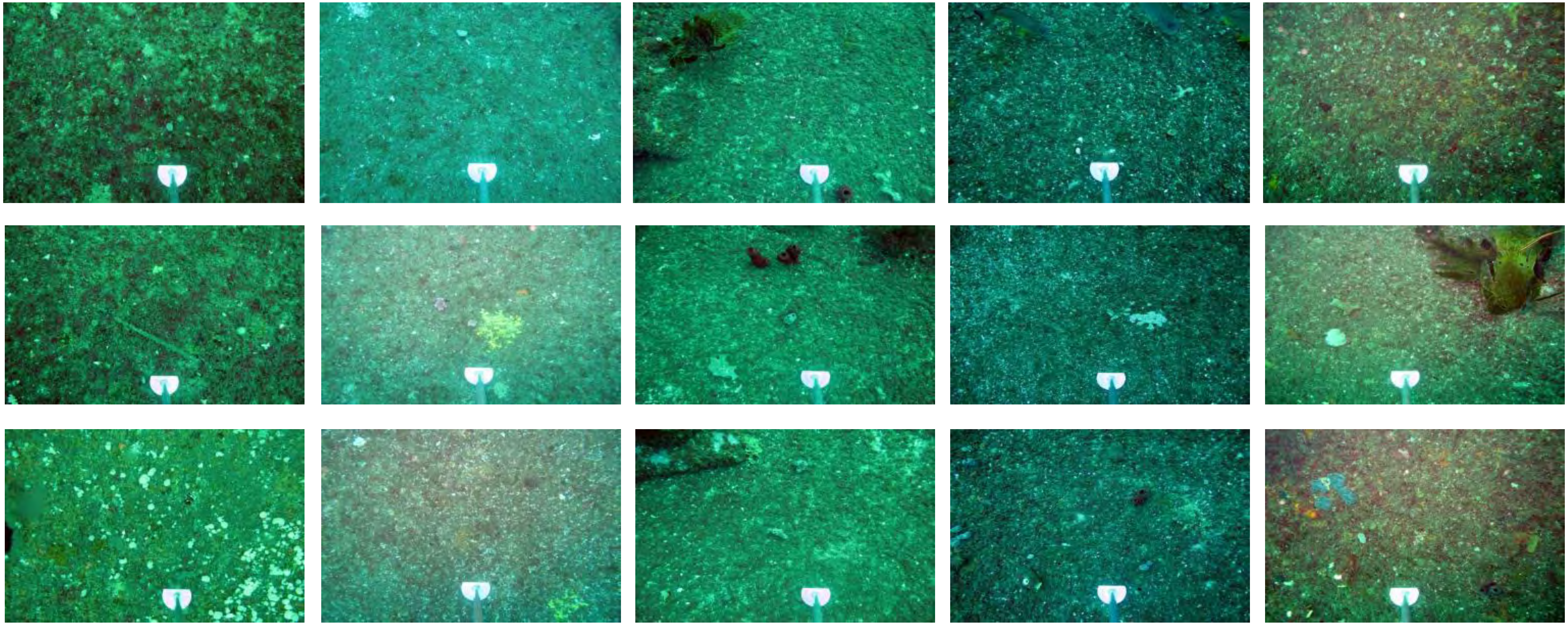


Plate 4 Continued: Deck Starbord Bow

Deck, Starbord, Bow

Monitoring Survey 10 (March 2014) | **Monitoring Survey 11 (October 2014)** | **Monitoring Survey 12 (March 2015)** | **Monitoring Survey 13 (June 2016)**

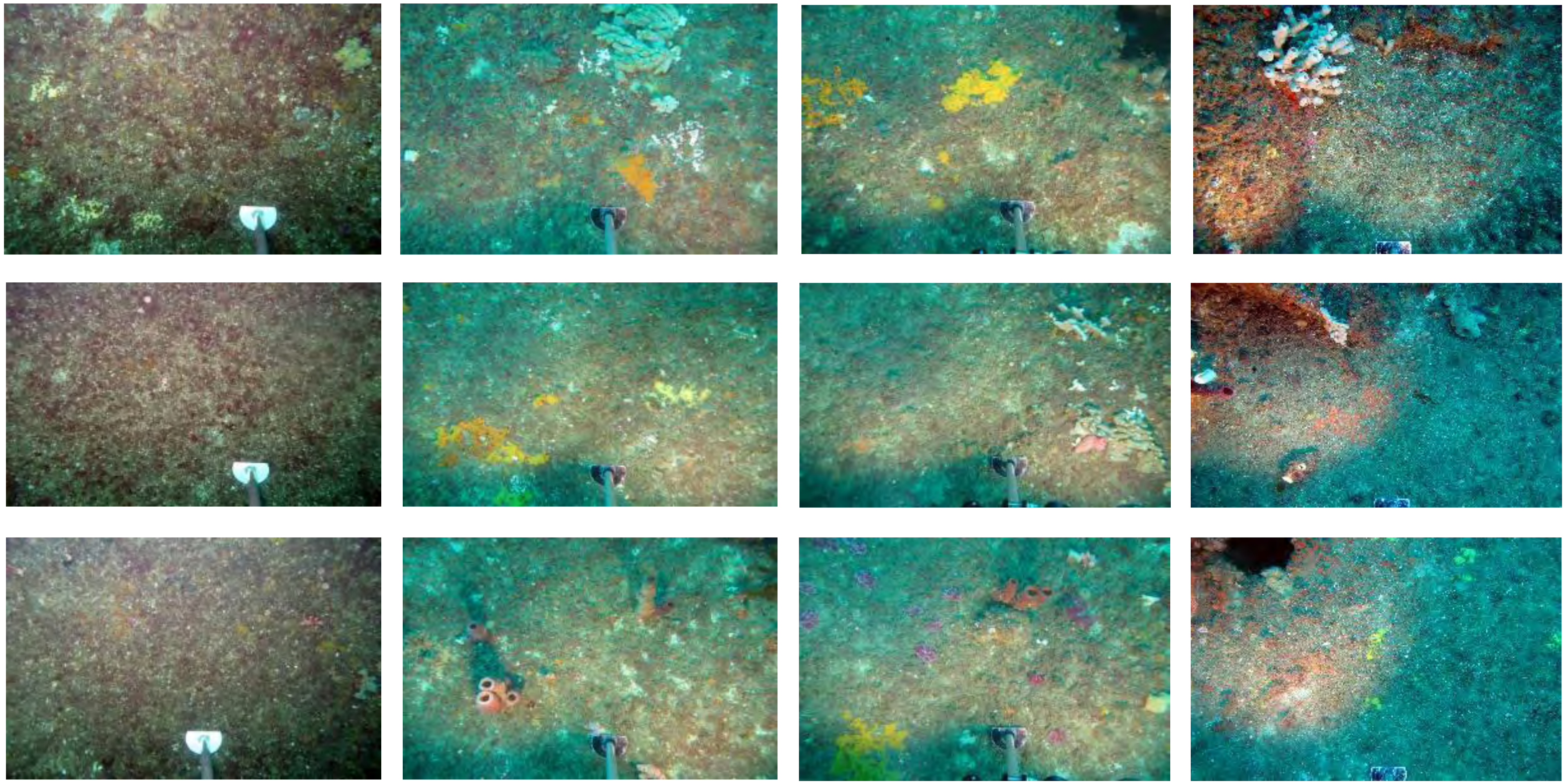


Plate 4 Continued: Deck Starbord Bow

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)

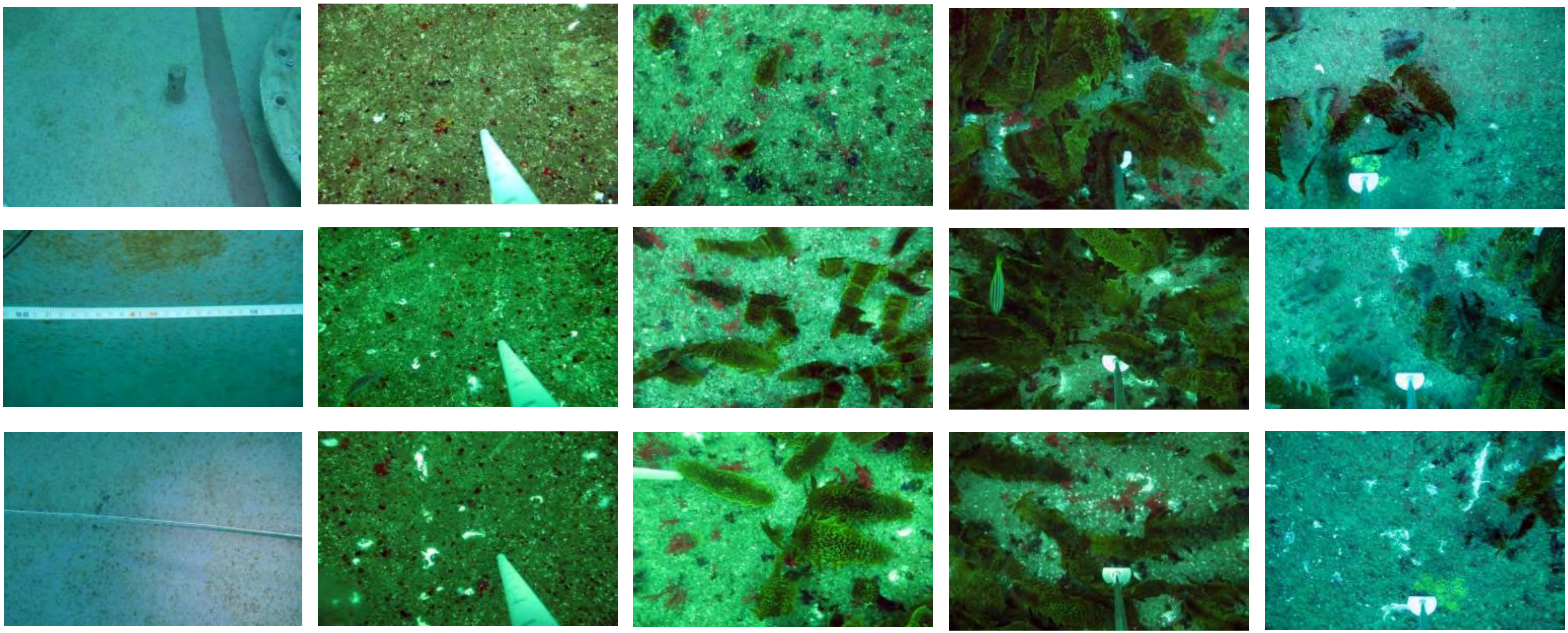


Plate 5: Deck Starbord Mid

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)**

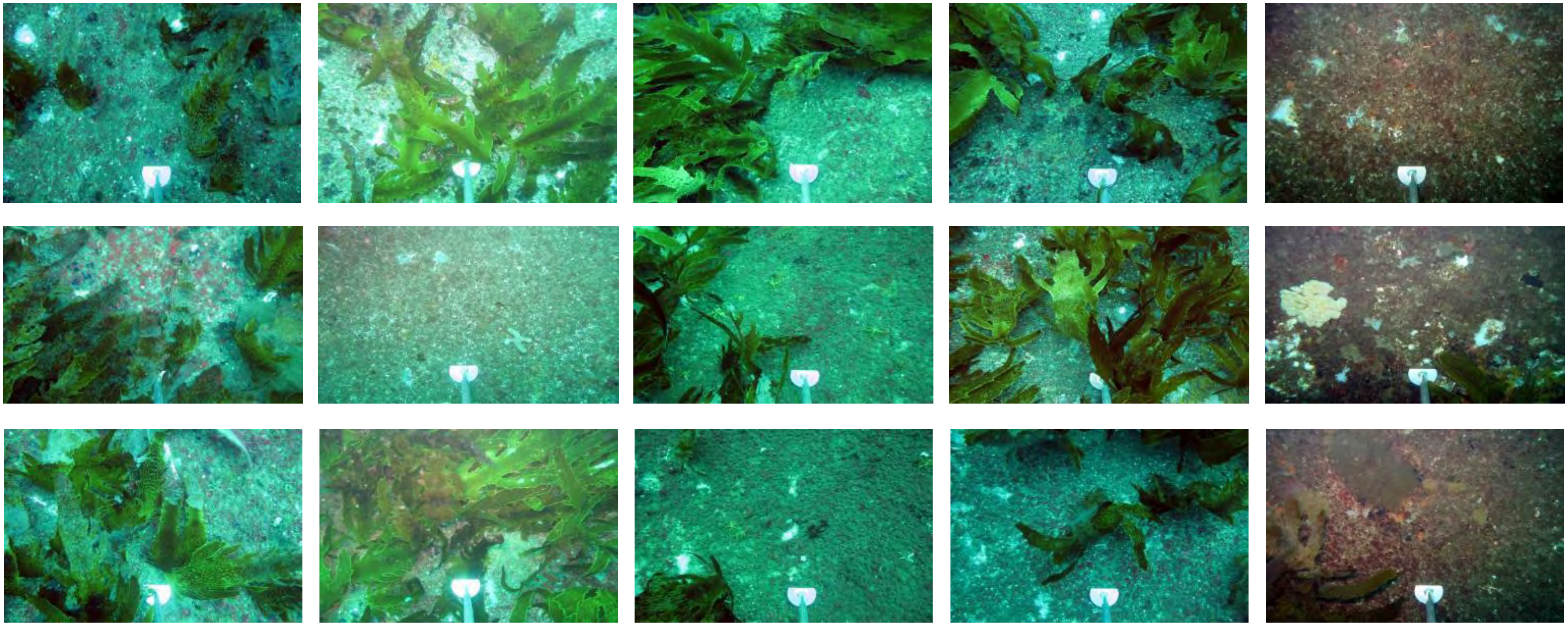


Plate 5 Continued: Deck Starbord Mid

Deck, Starbord, Mid

Monitoring Survey 10 (March 2014)	Monitoring Survey 11 (October 2014)	Monitoring Survey 12 (March 2015)	Monitoring Survey 13 (June 2016)

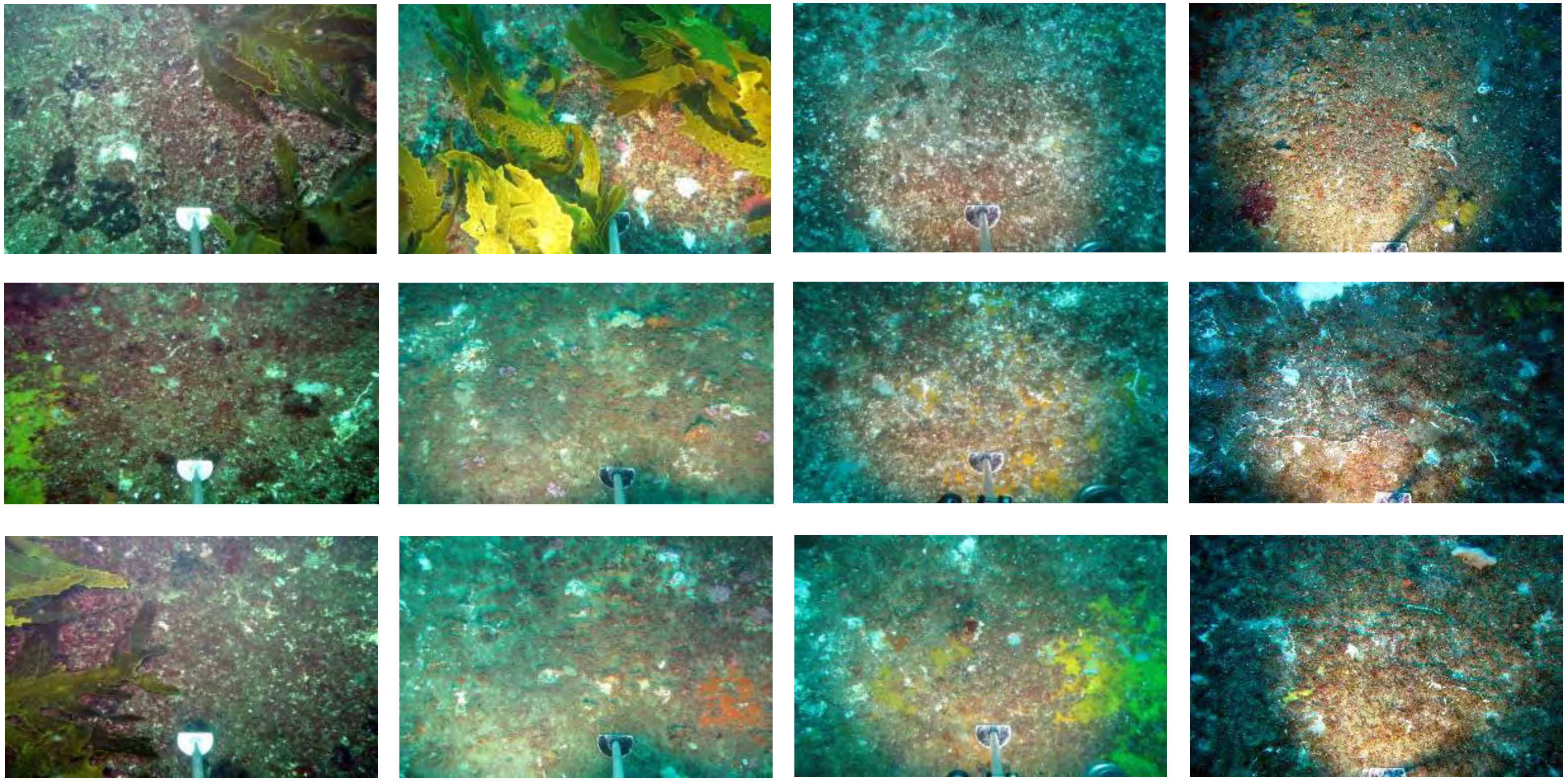


Plate 5 Continued: Deck Starbord Mid

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)

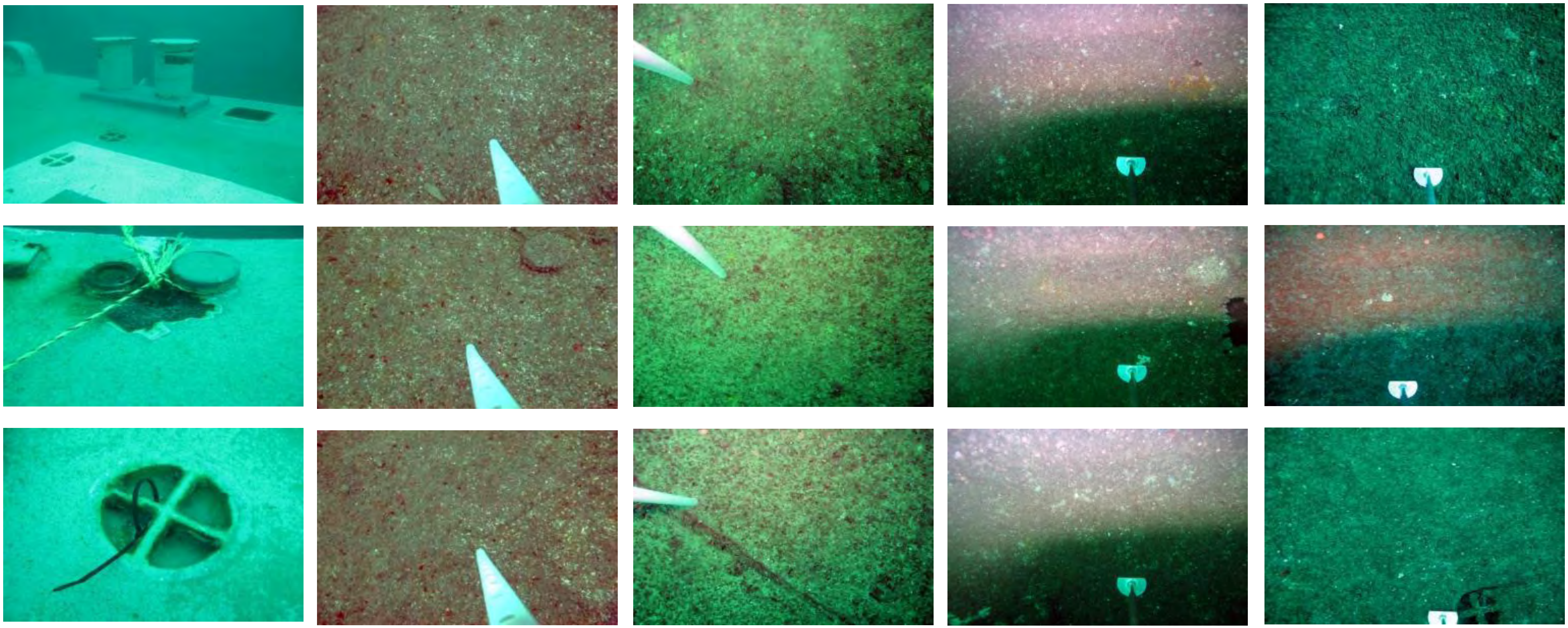


Plate 6: Deck Starbord Stern

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)

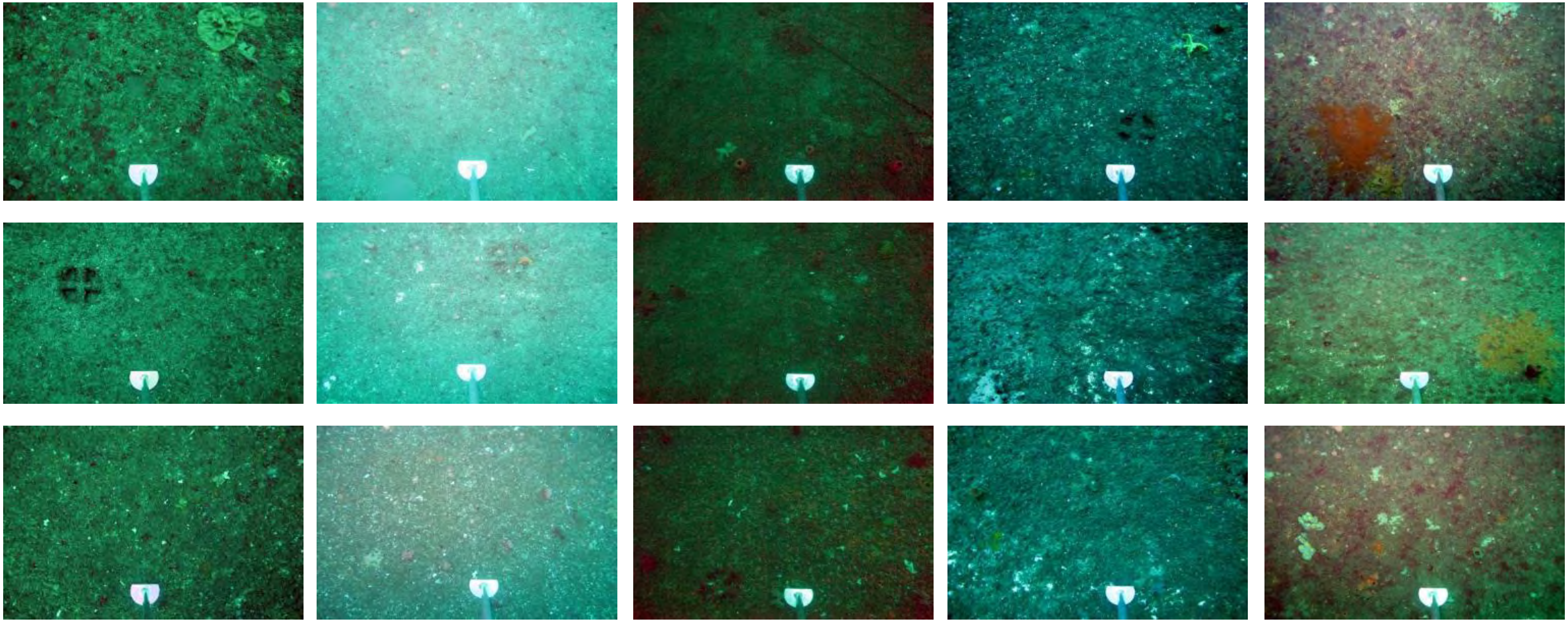


Plate 6 Continued: Deck Starbord Stern

Deck, Starbord, Stern

Monitoring Survey 10 (March 2014)	Monitoring Survey 11 (October 2014)	Monitoring Survey 12 (March 2015)	Monitoring Survey 13 (June 2016)

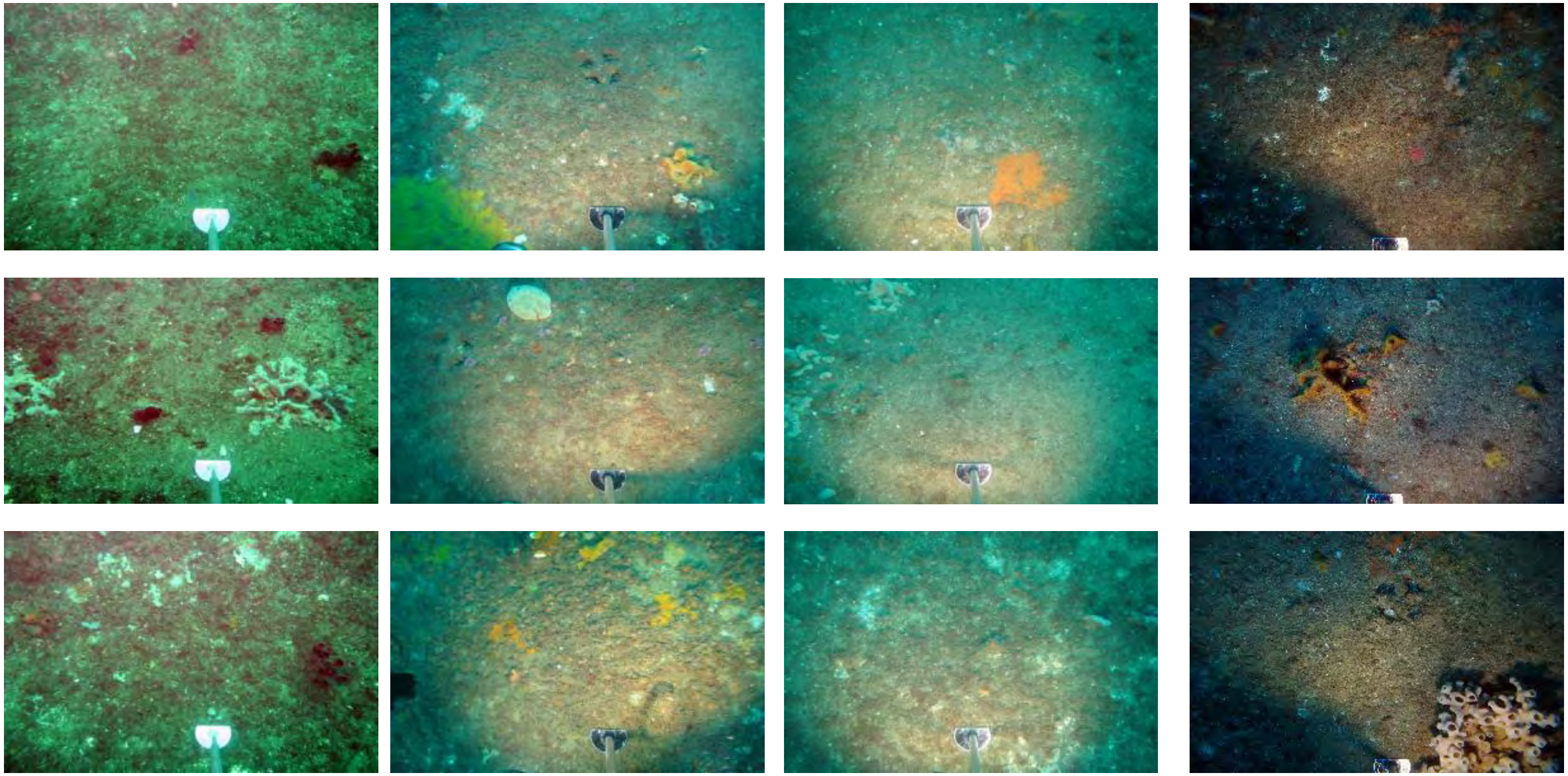


Plate 6 Continued: Deck Starbord Stern

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)**

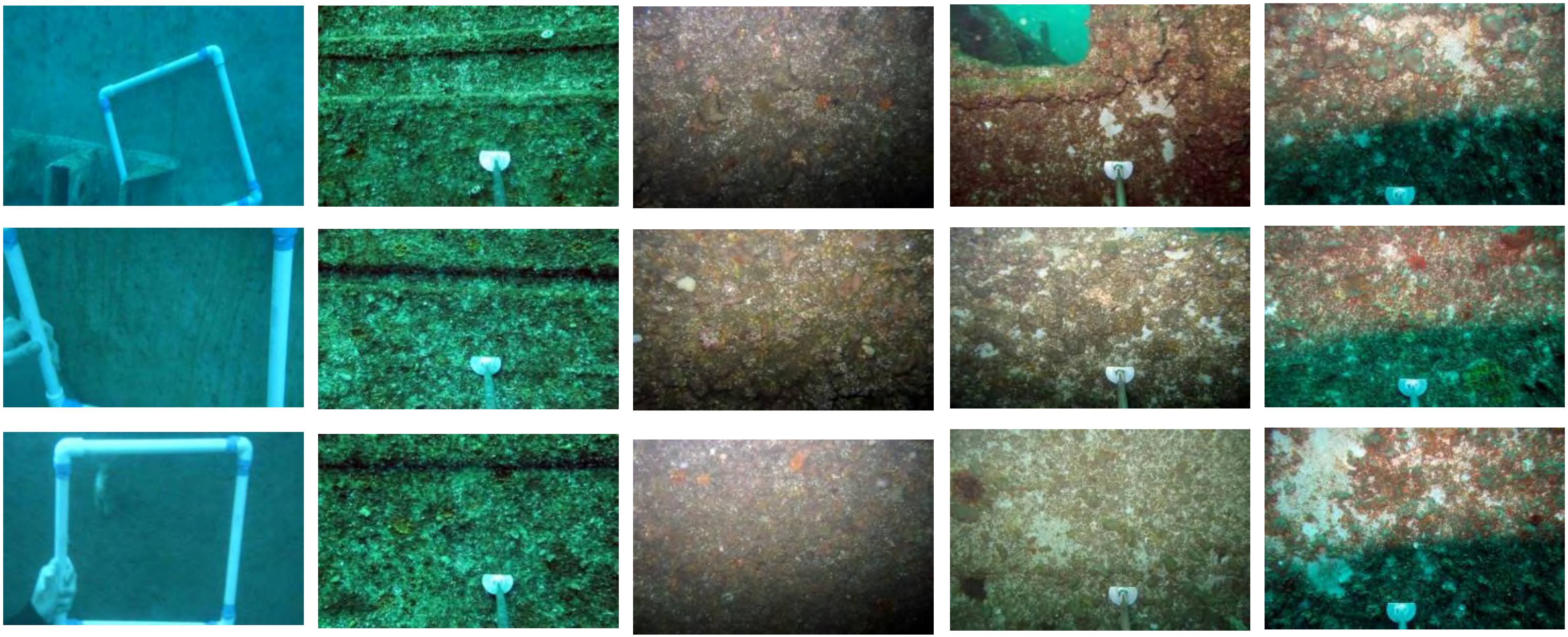


Plate 7: Horizontal Hull Port

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)

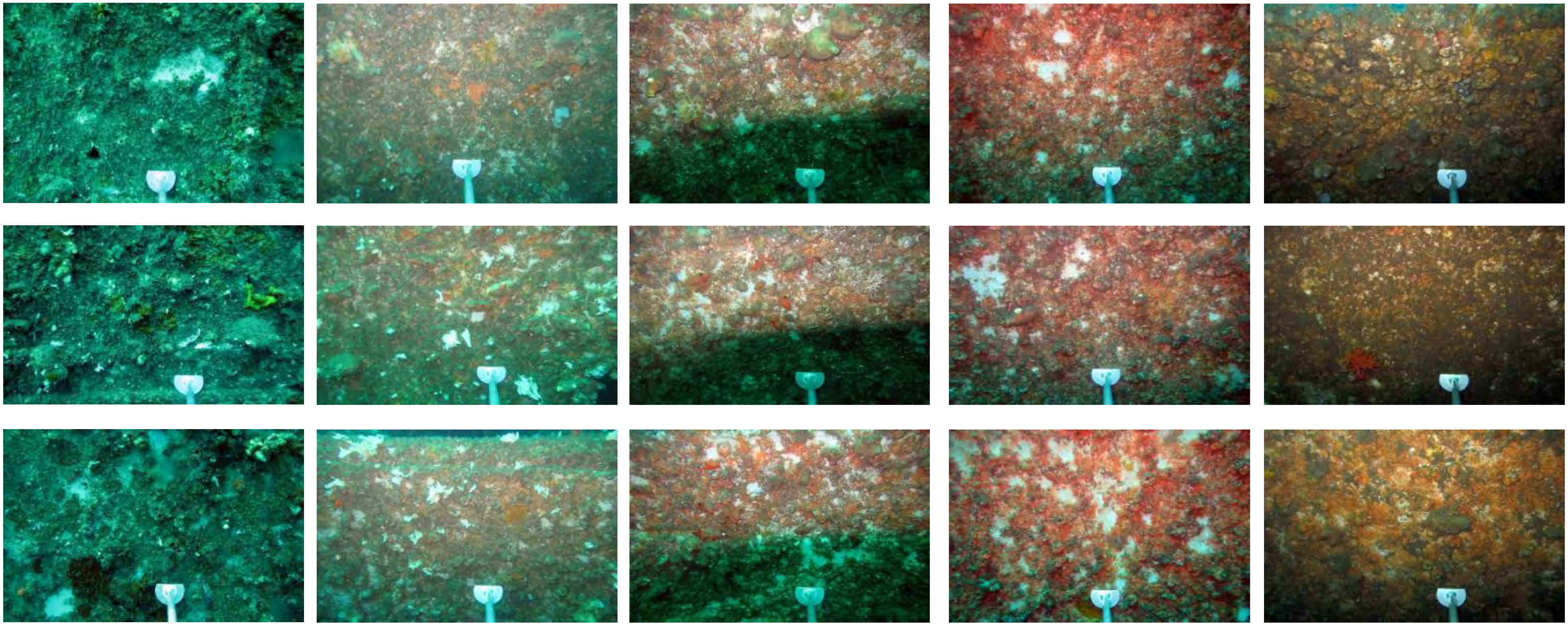


Plate 7 Continued: Horizontal Hull Port

Horizontal Hull Port

Monitoring Survey 10 (March 2014)	Monitoring Survey 11 (October 2014)	Monitoring Survey 12 (March 2015)	Monitoring Survey 13 (June 2016)

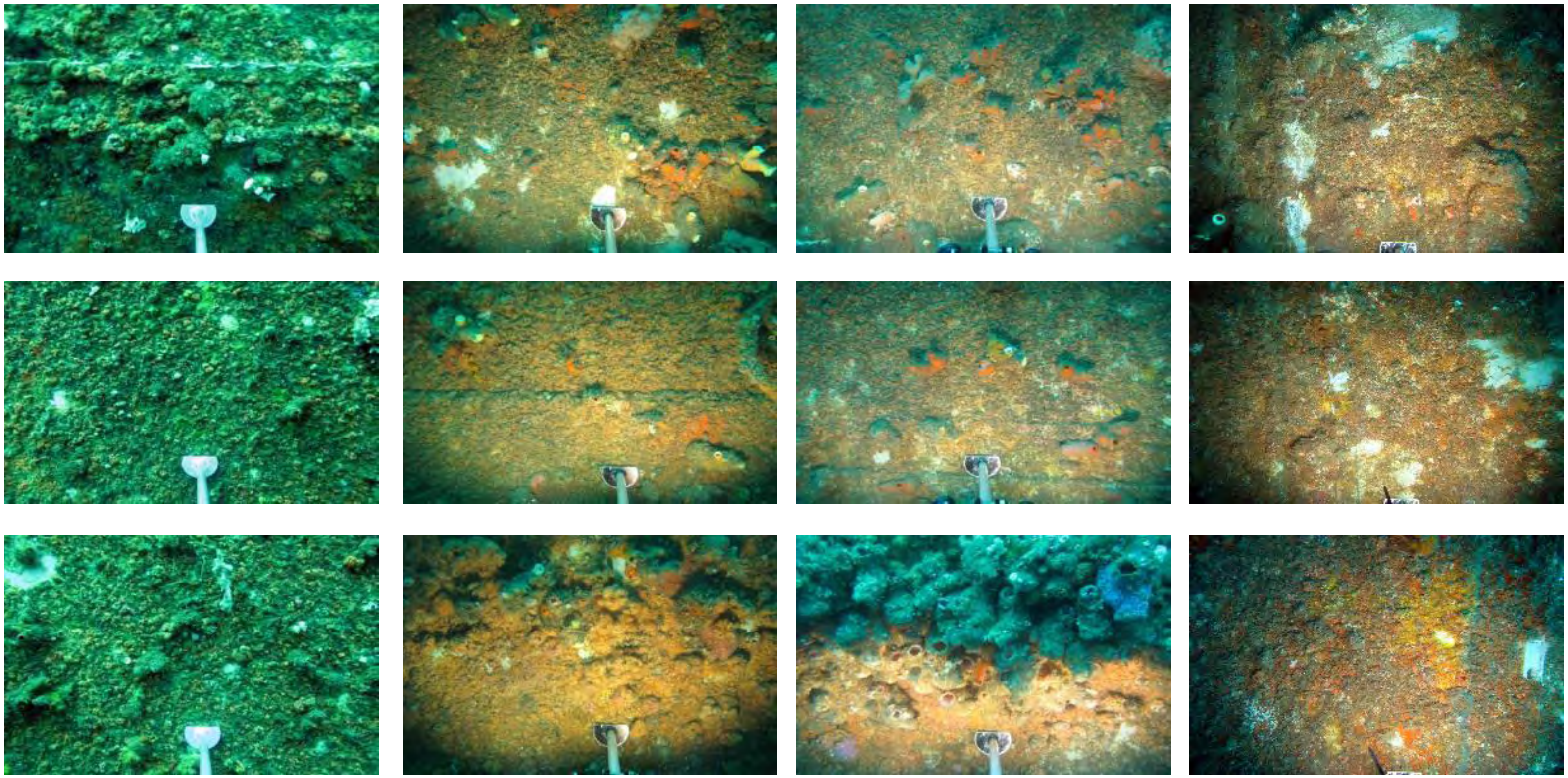


Plate 7 Continued: Horizontal Hull Port

Horizontal Hull Starbord

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

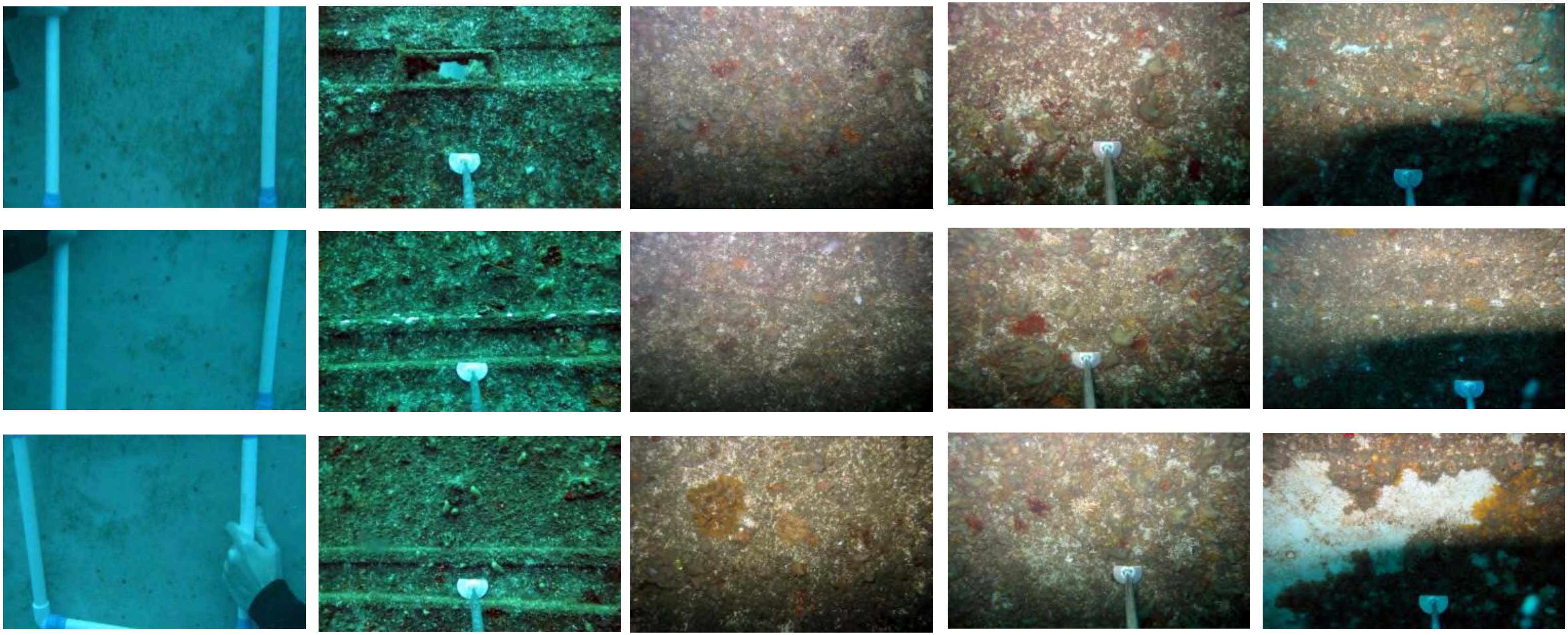
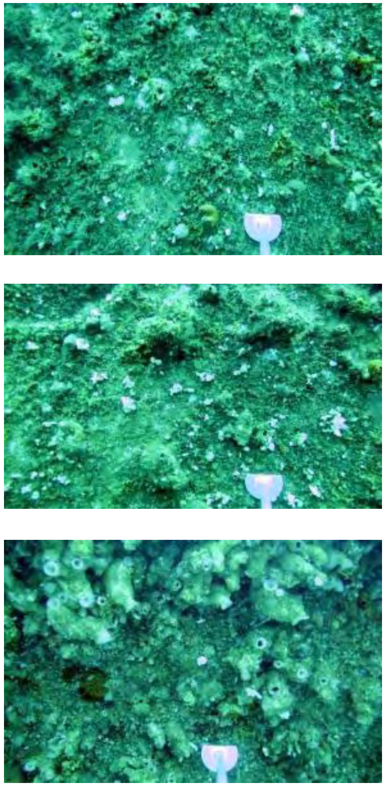


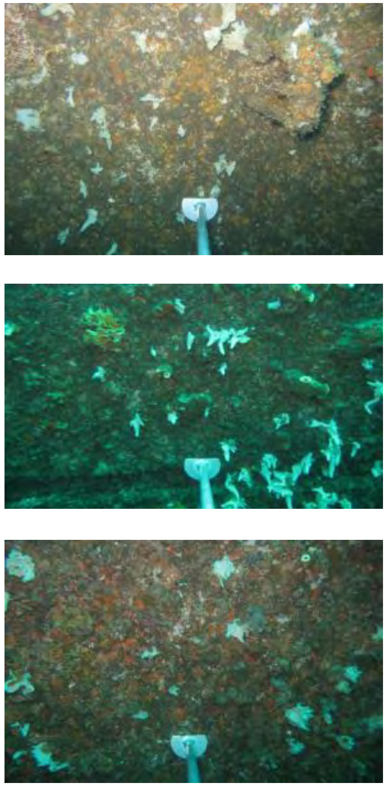
Plate 8: Horizontal Hull Starbord

Horizontal Hull Starbord

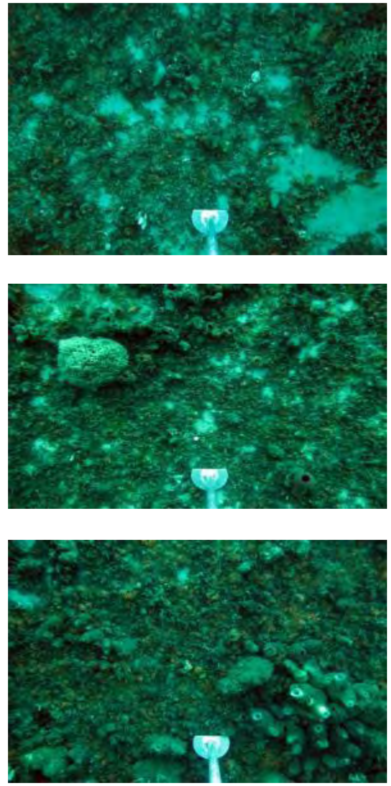
Monitoring Survey 5 (October/November 2012)



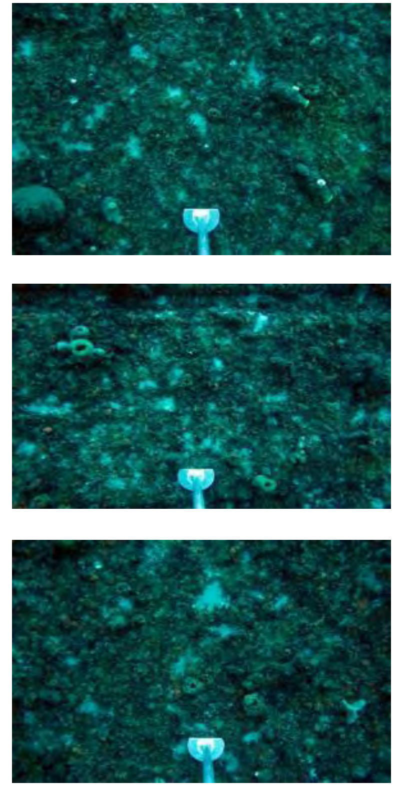
Monitoring Survey 6 (January 2013)



Monitoring Survey 7 (April 2013)



Monitoring Survey 8 (July 2013)



Monitoring Survey 9 (October 2013)

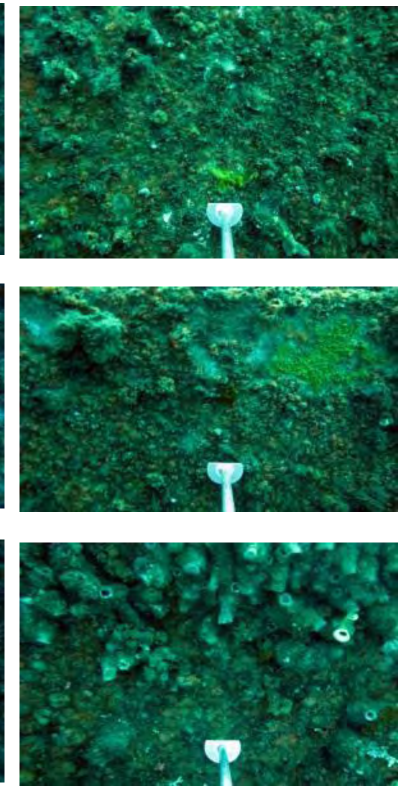


Plate 8 Continued: Horizontal Hull Starbord

Horizontal Hull Starbord

Monitoring Survey 10 (March 2014)	Monitoring Survey 11 (October 2014)	Monitoring Survey 12 (March 2015)	Monitoring Survey 13 (June 2016)

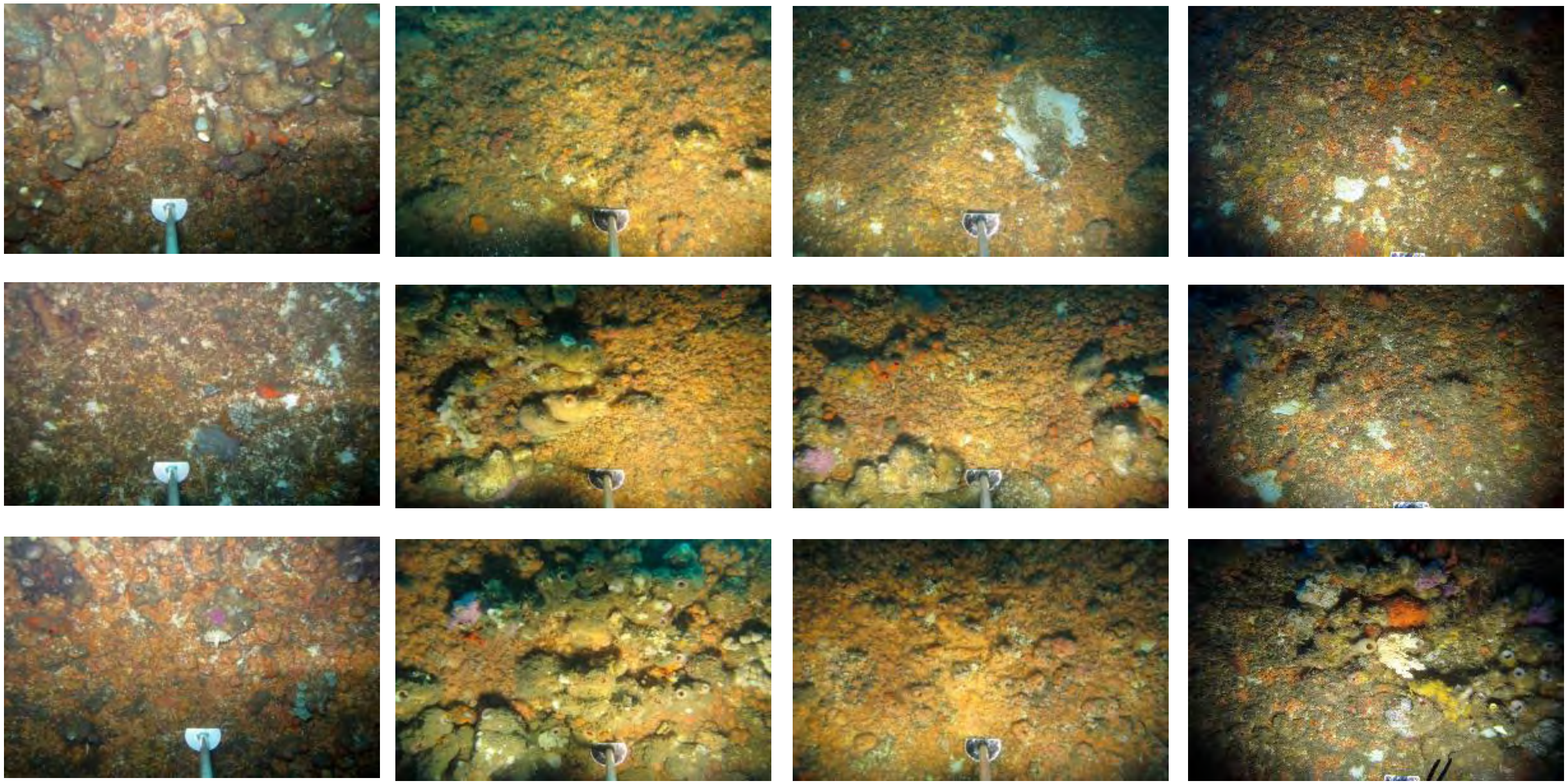


Plate 8 Continued: Horizontal Hull Starbord

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)**

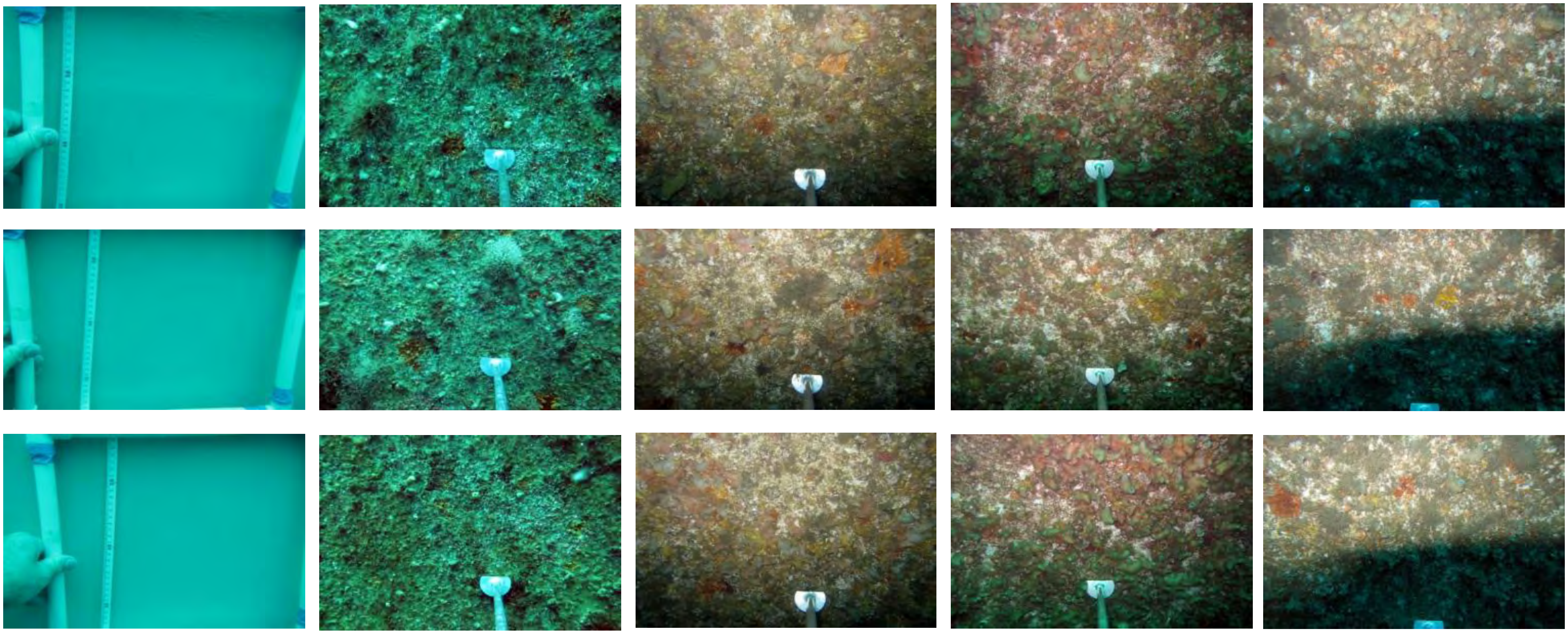


Plate 9: Vertical Hull Port Bow

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)

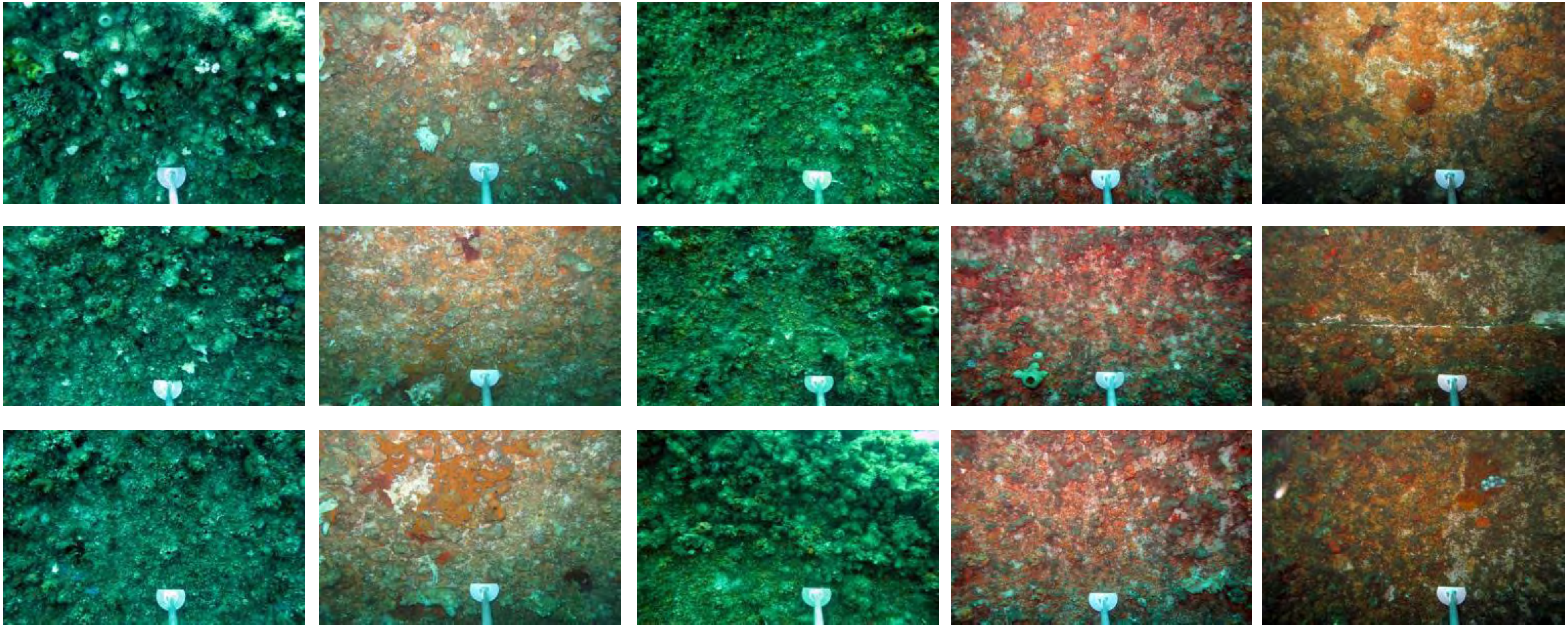


Plate 9 Continued: Vertical Hull Port Bow

Vertical Hull Port Bow

Monitoring Survey 10 (March 2014) | **Monitoring Survey 11 (October 2014)** | **Monitoring Survey 12 (March 2015)** | **Monitoring Survey 13 (June 2016)**

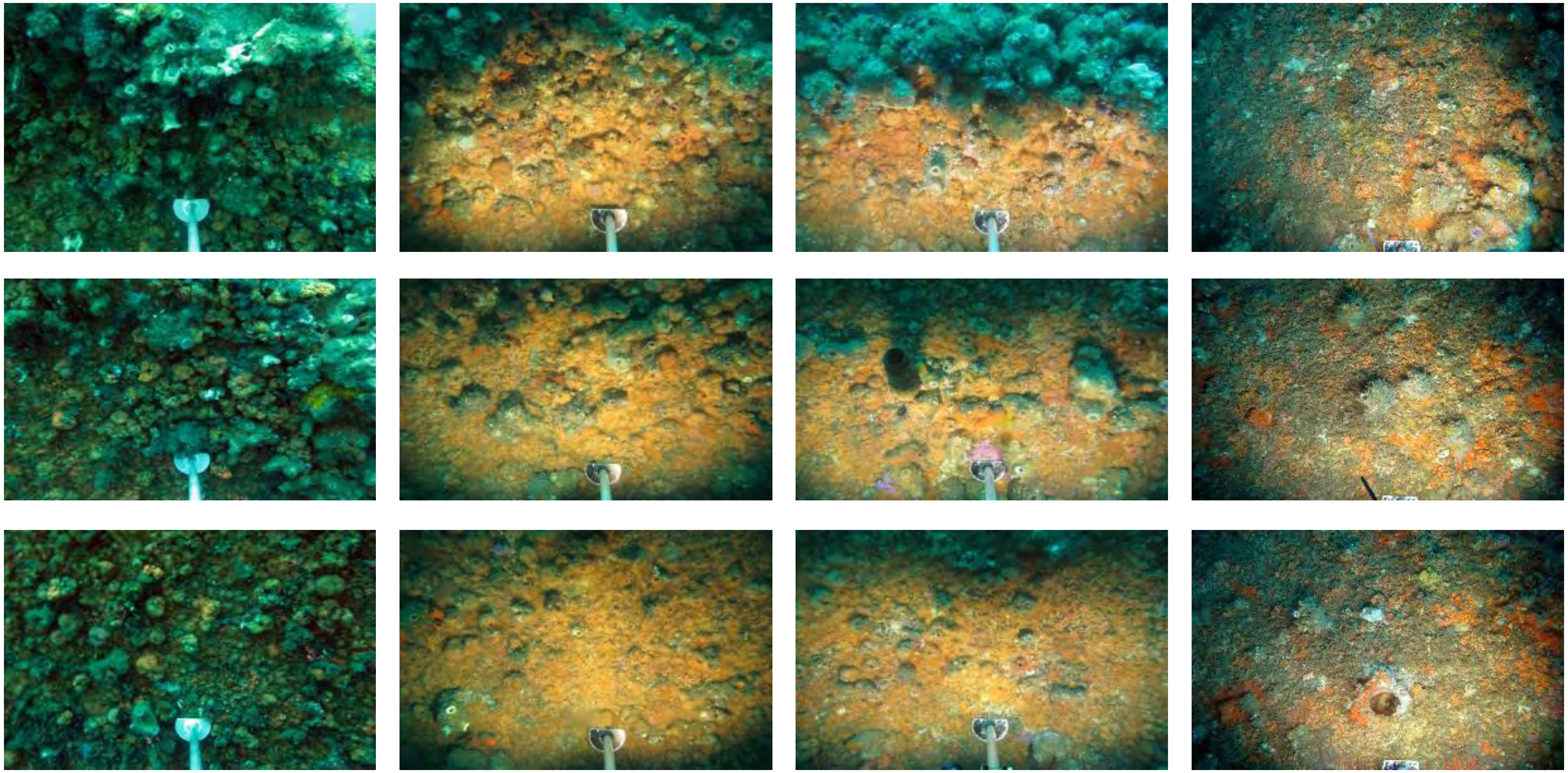


Plate 9 Continued: Vertical Hull Port Bow

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)**

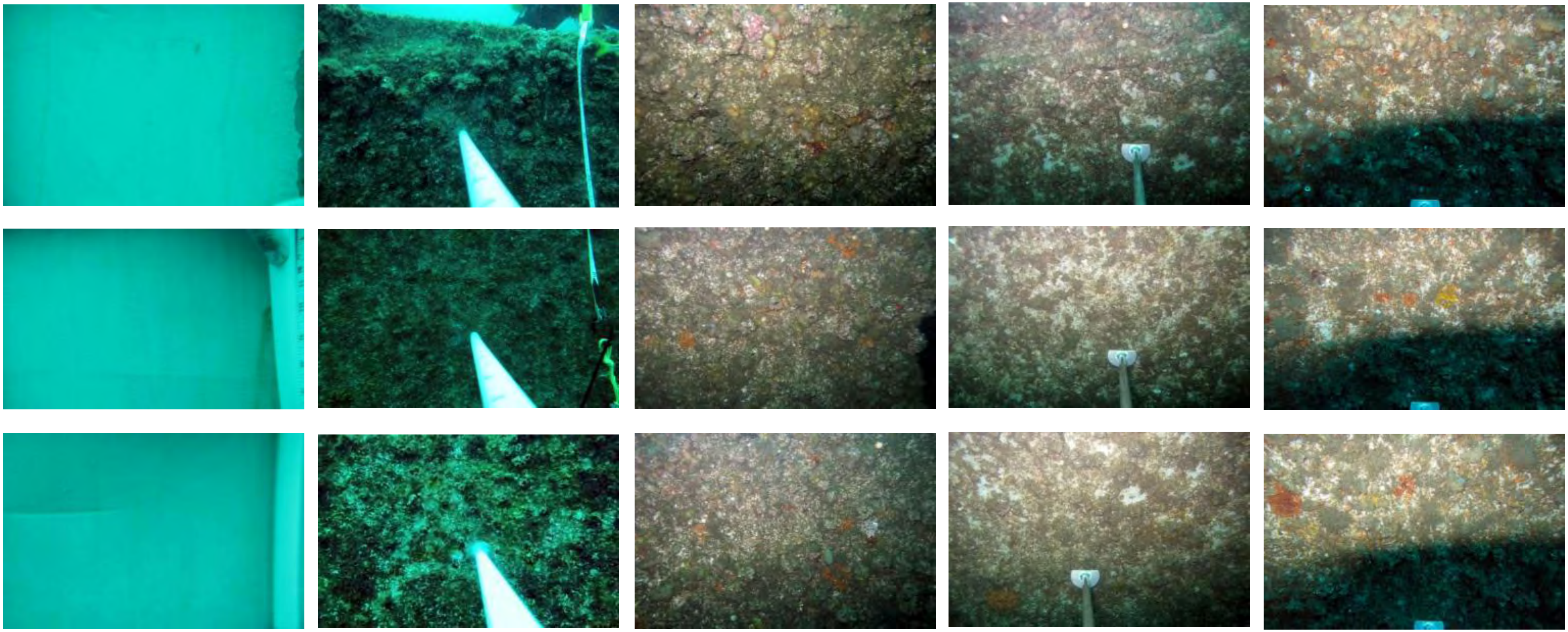


Plate 10: Vertical Hull Port Stern

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)

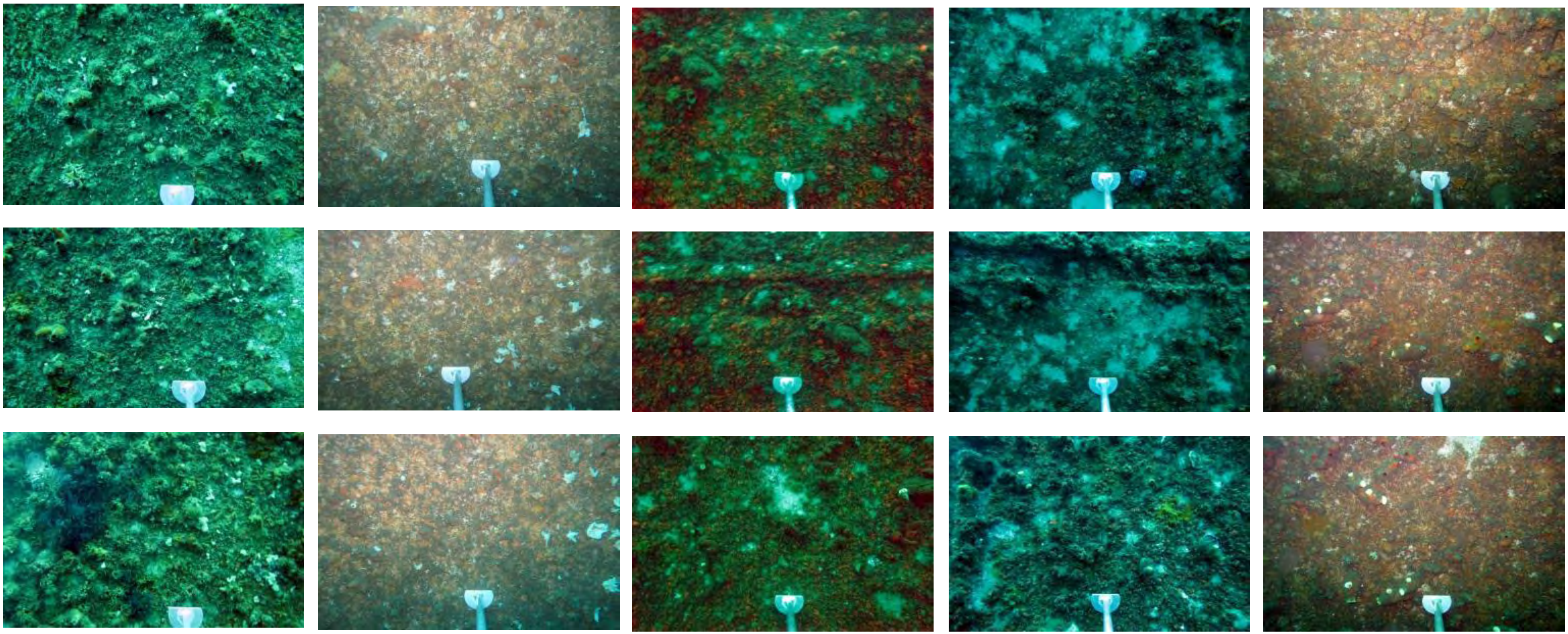


Plate 10 Continued: Vertical Hull Port Stern

Vertical Hull Port Stern

Monitoring Survey 10 (March 2014) | **Monitoring Survey 11 (October 2014)** | **Monitoring Survey 12 (March 2015)** | **Monitoring Survey 13 (June 2016)**

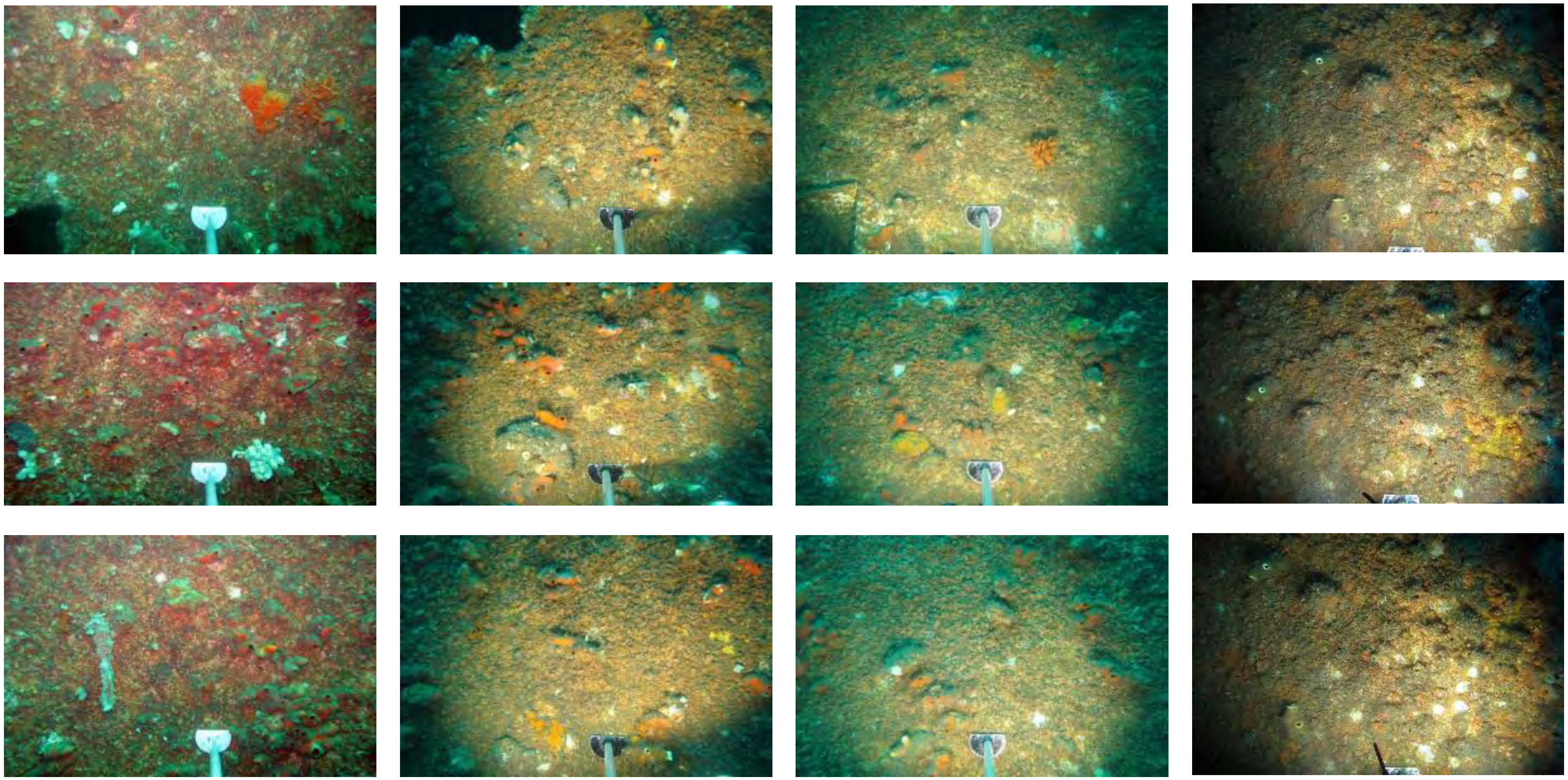


Plate 10 Continued: Vertical Hull Port Stern

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)

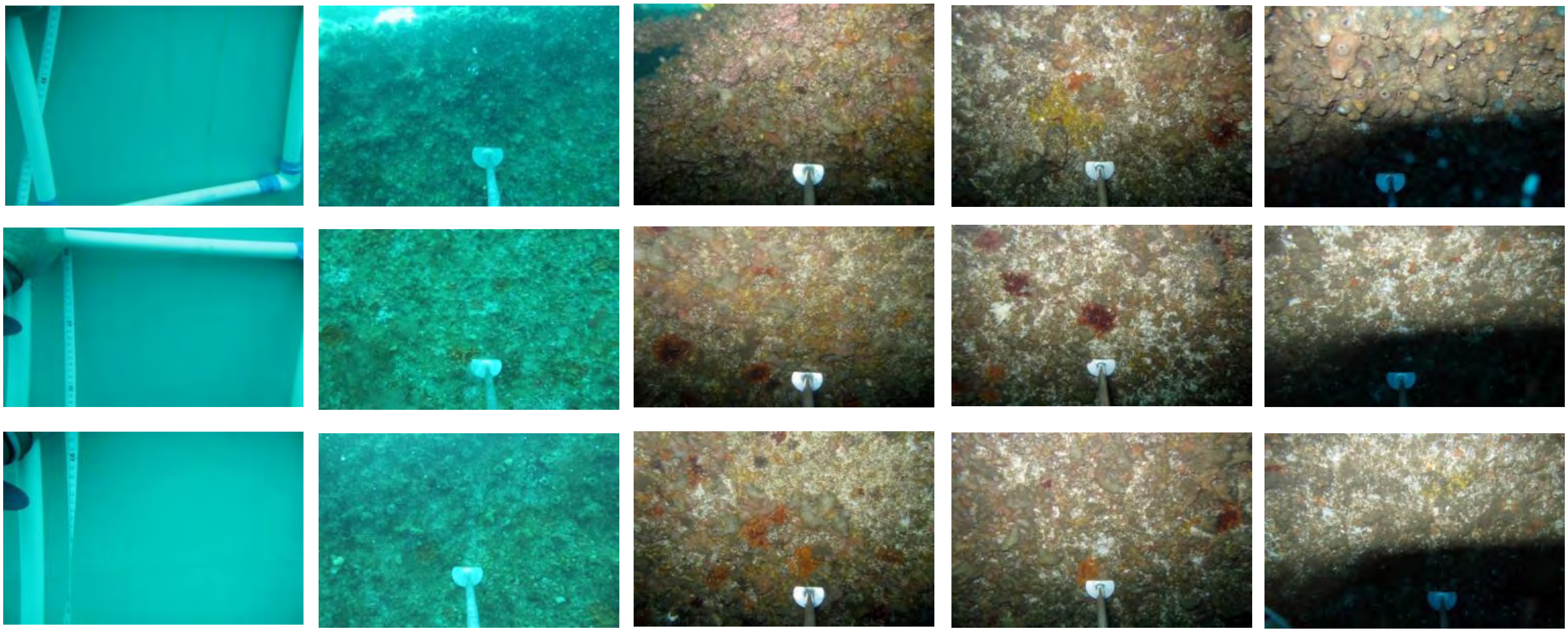


Plate 11: Vertical Hull Starbord Bow

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)

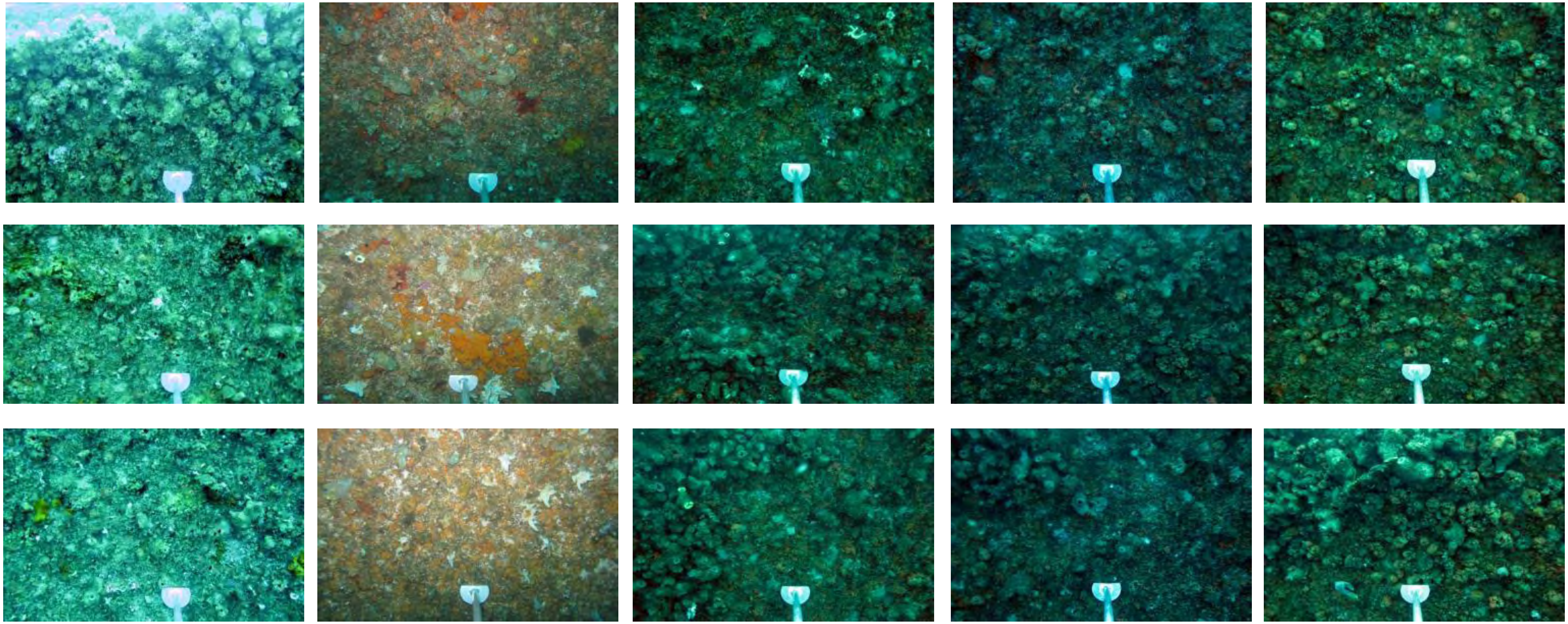


Plate 11 Continued: Vertical Hull Starbord Bow

Vertical Hull Starbord Bow

Monitoring Survey 10 (March 2014) | **Monitoring Survey 11 (October 2014)** | **Monitoring Survey 12 (March 2015)** | **Monitoring Survey 13 (June 2016)**

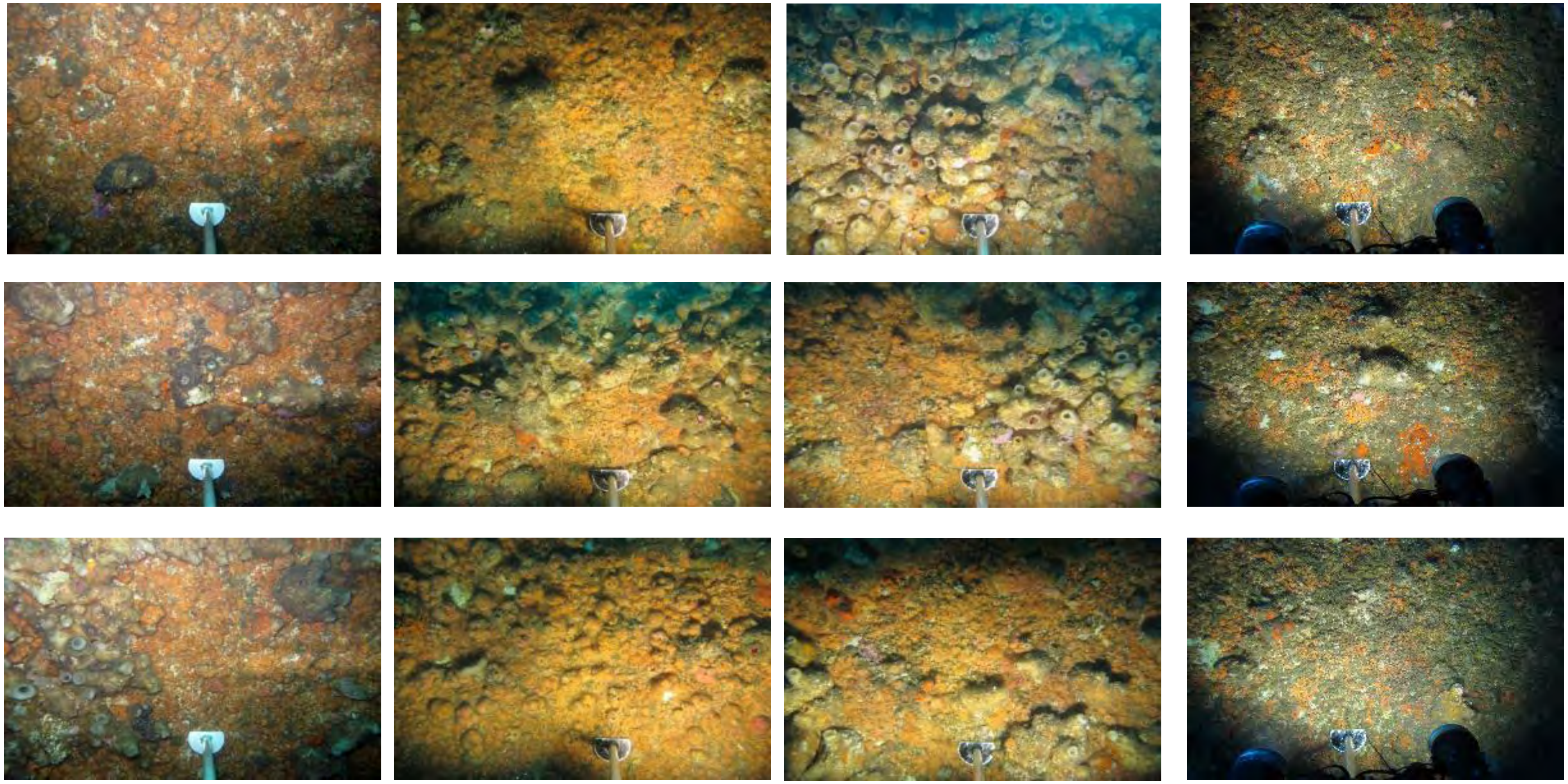


Plate 11 Continued: Vertical Hull Starbord Bow

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)

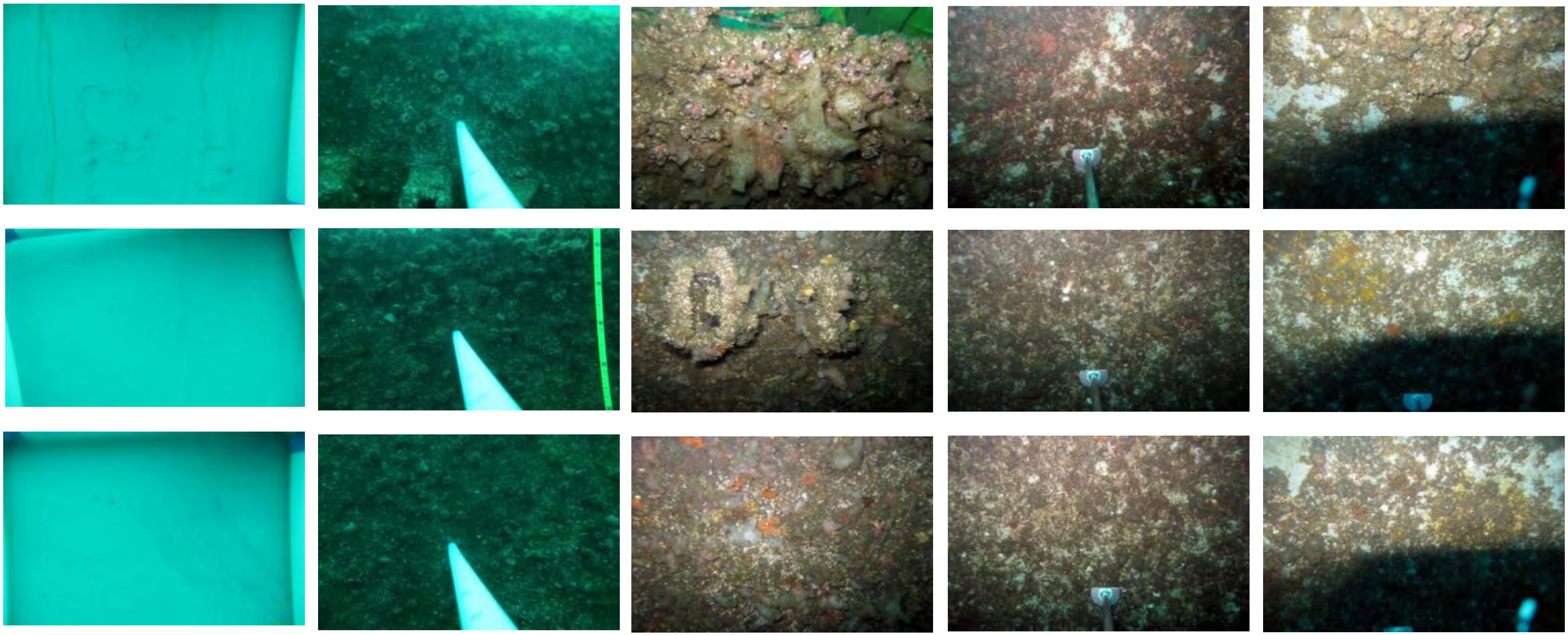


Plate 12: Vertical Hull Starbord Stern

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)

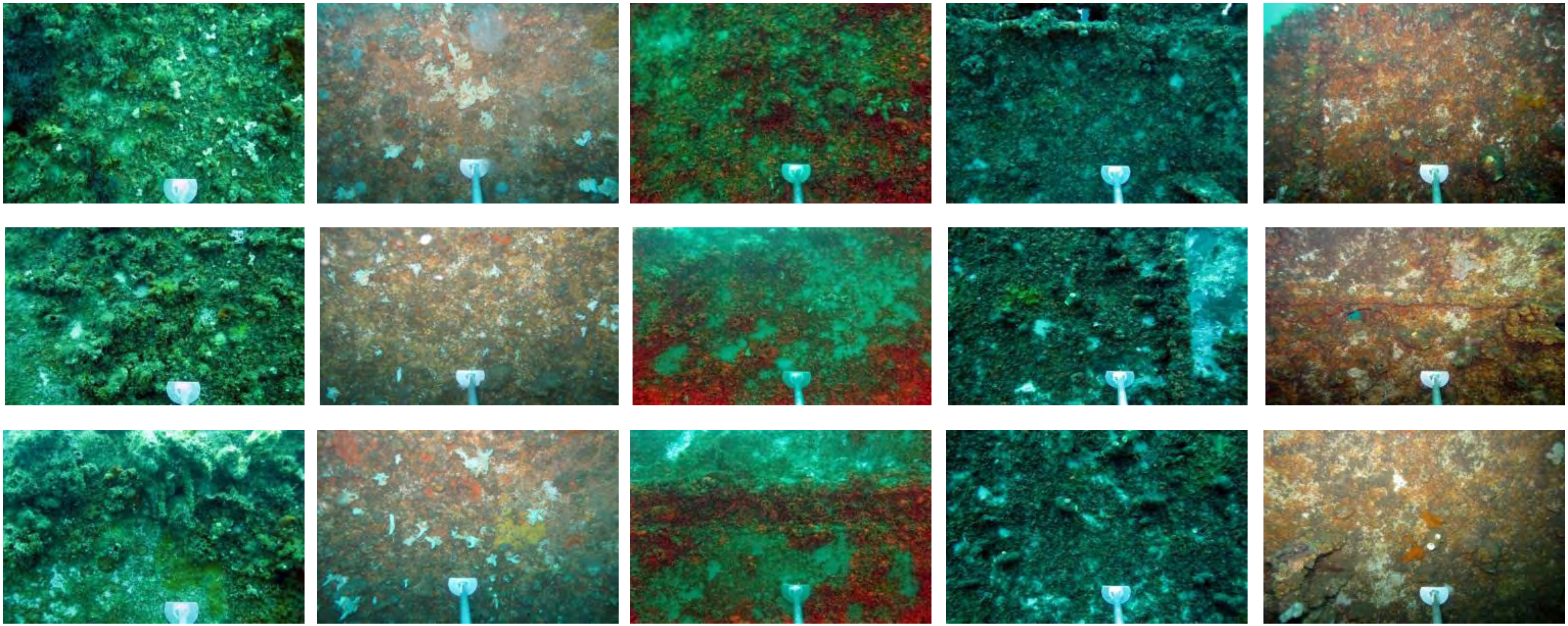


Plate 12 Continued: Vertical Hull Starbord Stern

Vertical Hull Starbord Stern

Monitoring Survey 10 (March 2014)	Monitoring Survey 11 (October 2014)	Monitoring Survey 12 (March 2015)	Monitoring Survey 13 (June 2016)

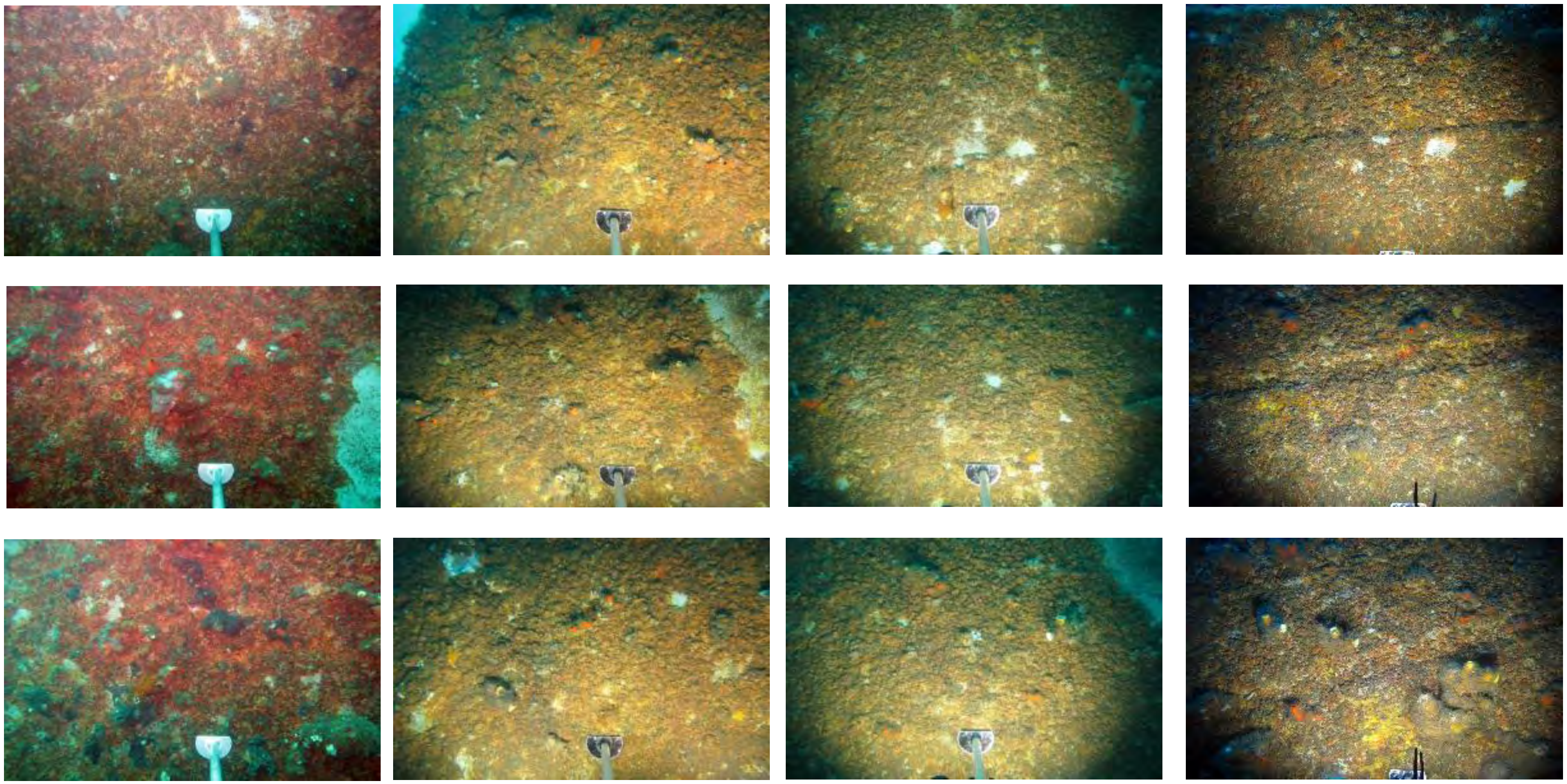


Plate 12 Continued: Vertical Hull Starbord Stern

Vertical Superstructure Port Bow

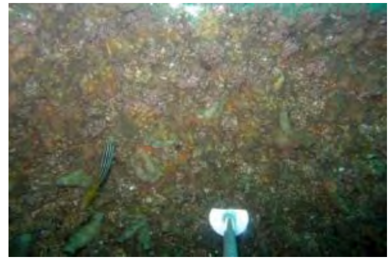
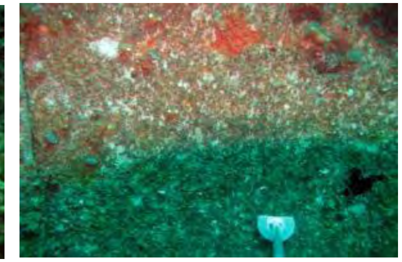
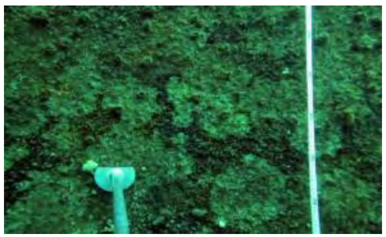
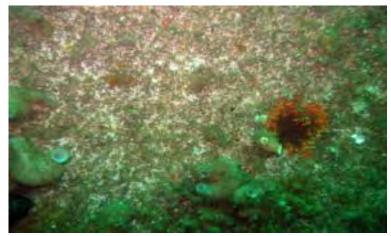
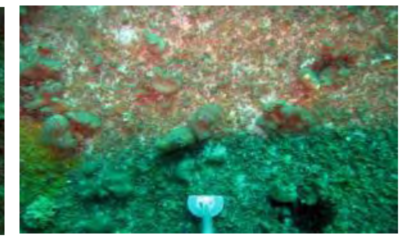
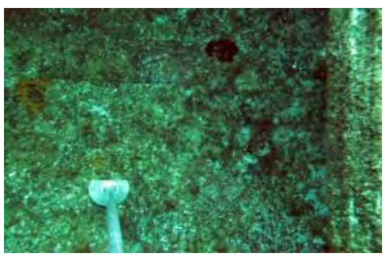
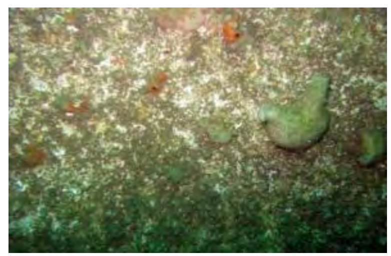
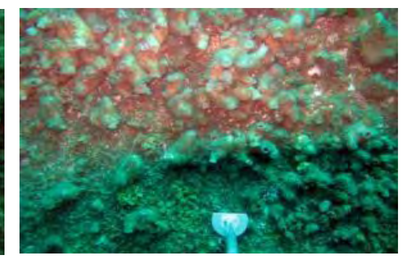
Baseline Survey (April/May 2011)	Monitoring Survey 1 (October 2011)	Monitoring Survey 2 (February 2012)	Monitoring Survey 3 (May 2012)	Monitoring Survey 4 (August 2012)
Not Sampled				
Not Sampled				
Not Sampled				

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)

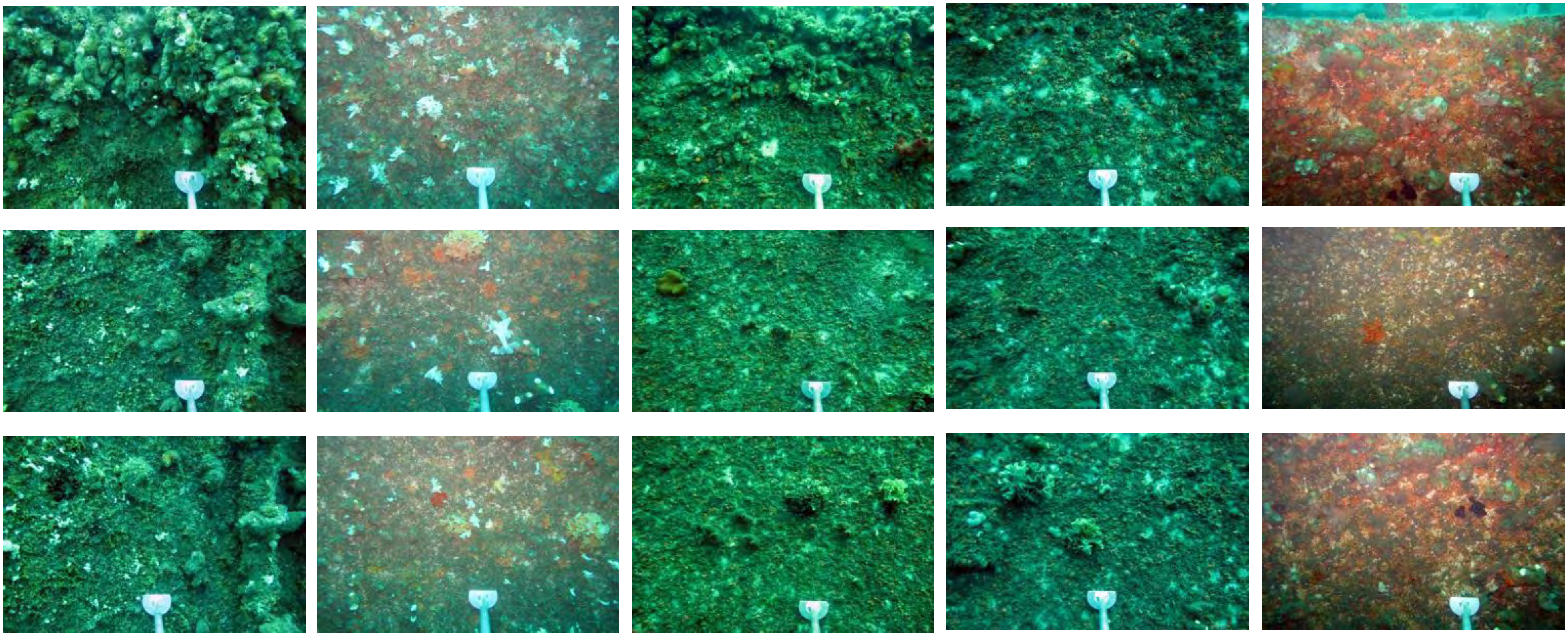


Plate 13 Continued: Vertical Superstructure Port Bow

Vertical Superstructure Port Bow

Monitoring Survey 10 (March 2014)	Monitoring Survey 11 (October 2014)	Monitoring Survey 12 (March 2015)	Monitoring Survey 13 (June 2016)

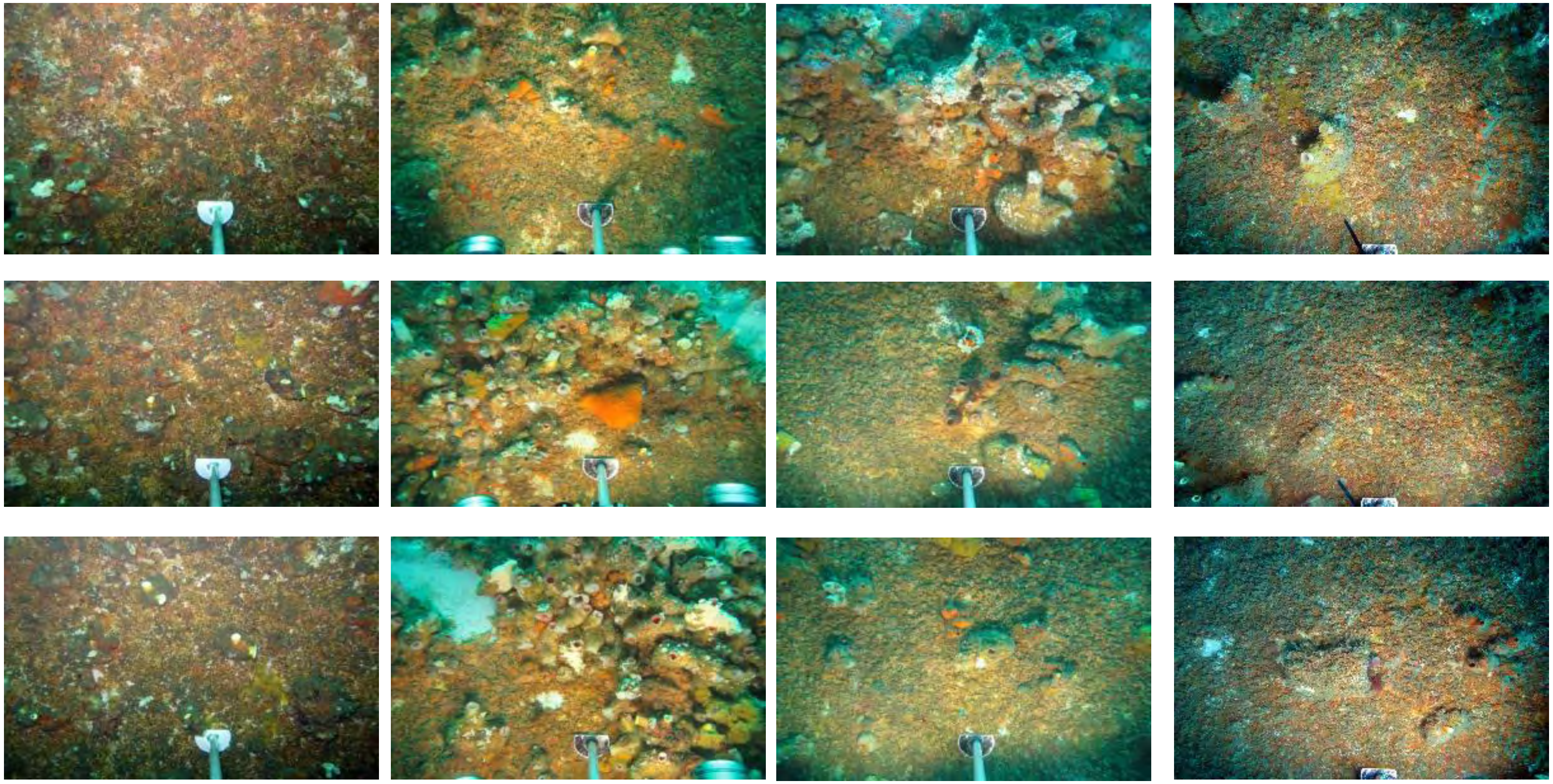


Plate 13 Continued: Vertical Superstructure Port Bow

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)**

Baseline Survey:

Not Sampled

Not Sampled

Not Sampled

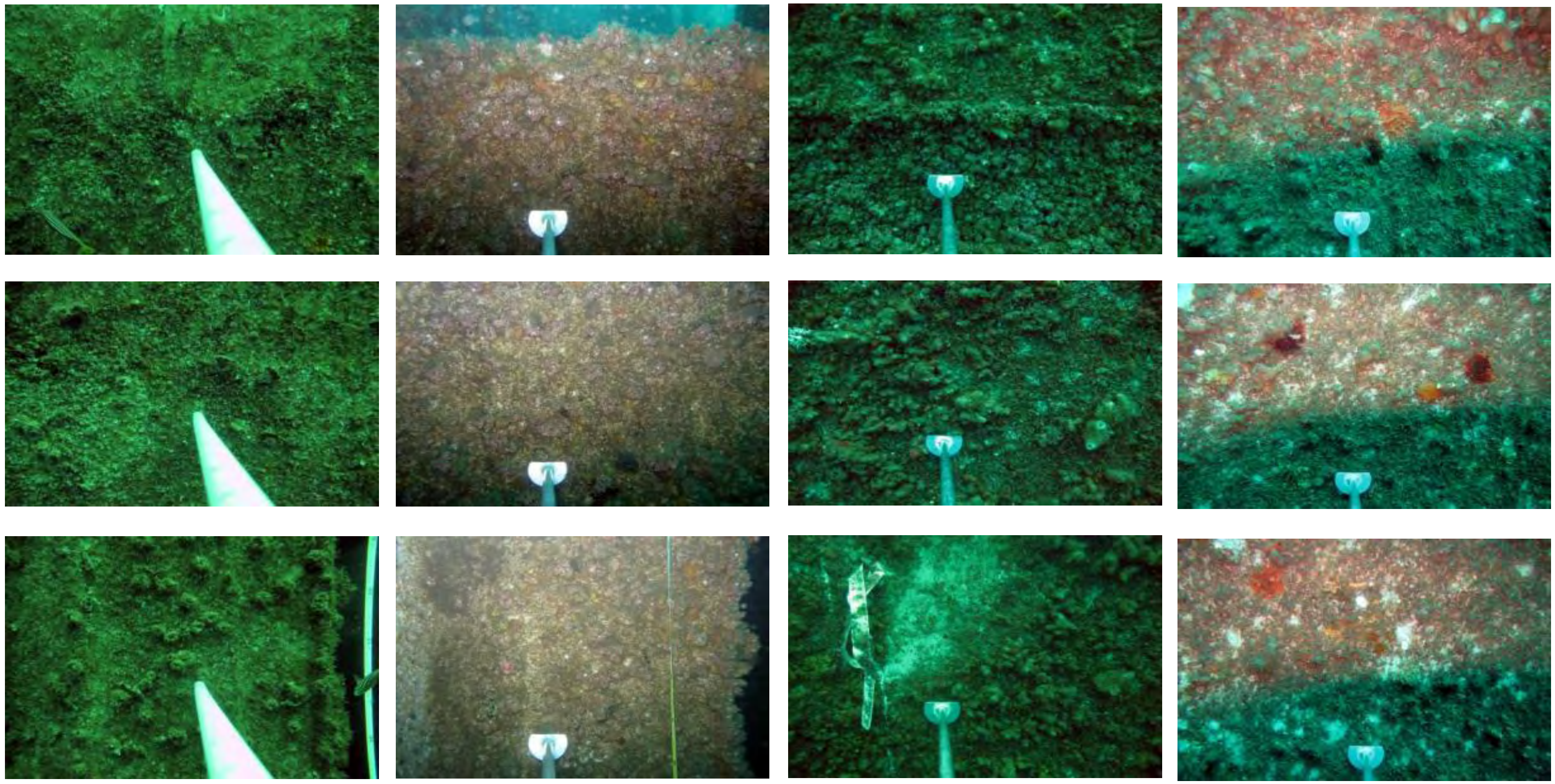


Plate 14: Vertical Superstructure Port Stern

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)

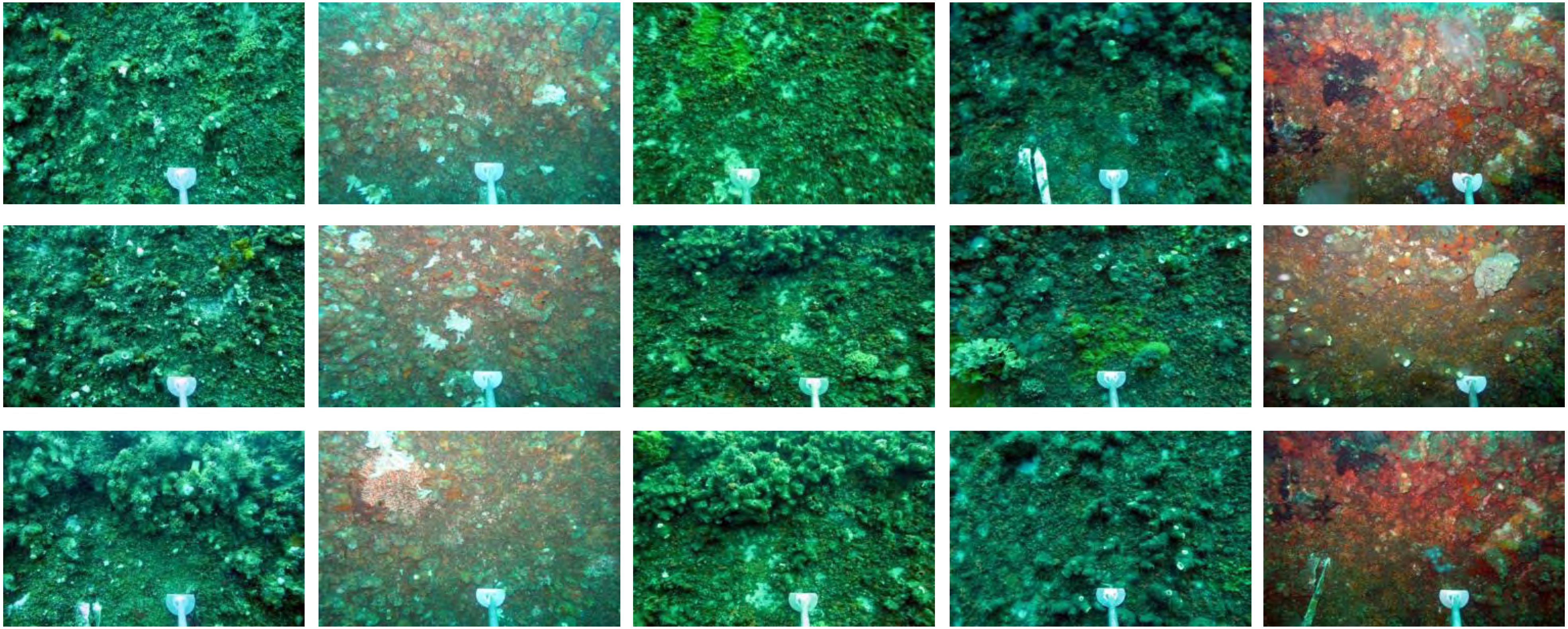


Plate 14 Continued: Vertical Superstructure Port Stern

Vertical Superstructure Port Stern

Monitoring Survey 10 (March 2014)	Monitoring Survey 11 (October 2014)	Monitoring Survey 12 (March 2015)	Monitoring Survey 13 (June 2016)

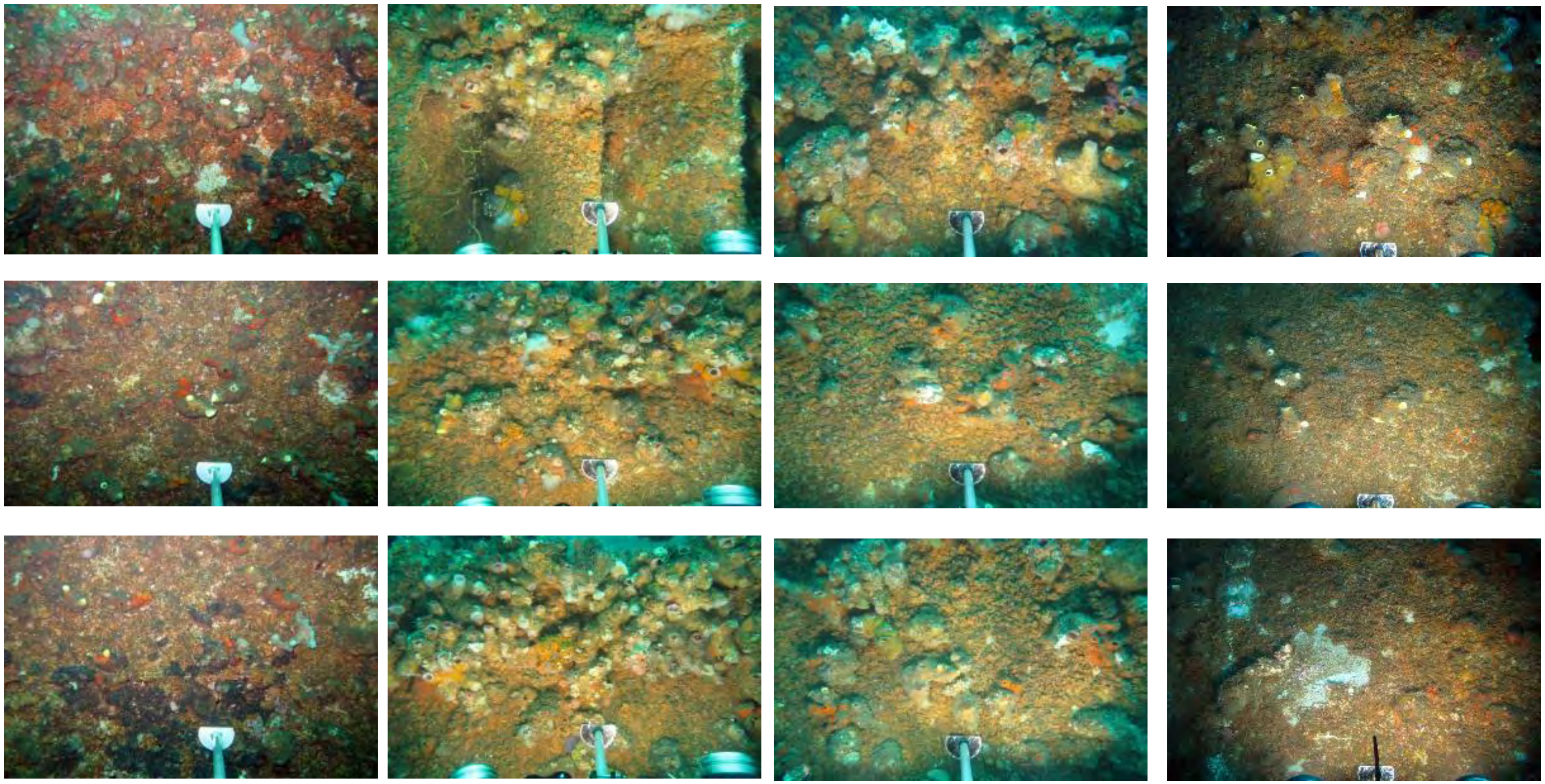


Plate 14 Continued: Vertical Superstructure Port Stern

Vertical Superstructure 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)
Not Sampled				
Not Sampled				
Not Sampled				

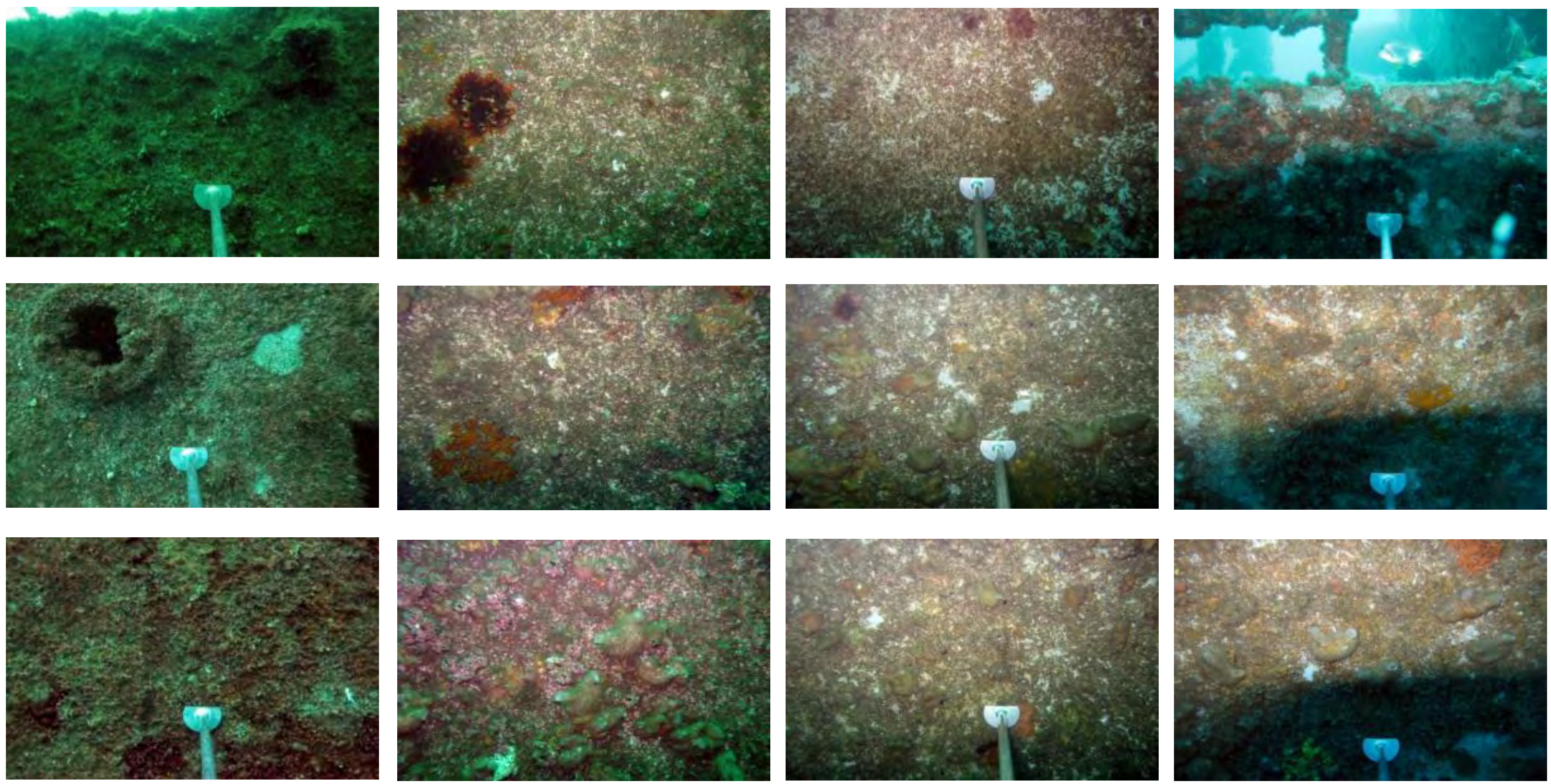


Plate 15: Vertical Superstructure Starbord Bow

Vertical Superstructure 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)**

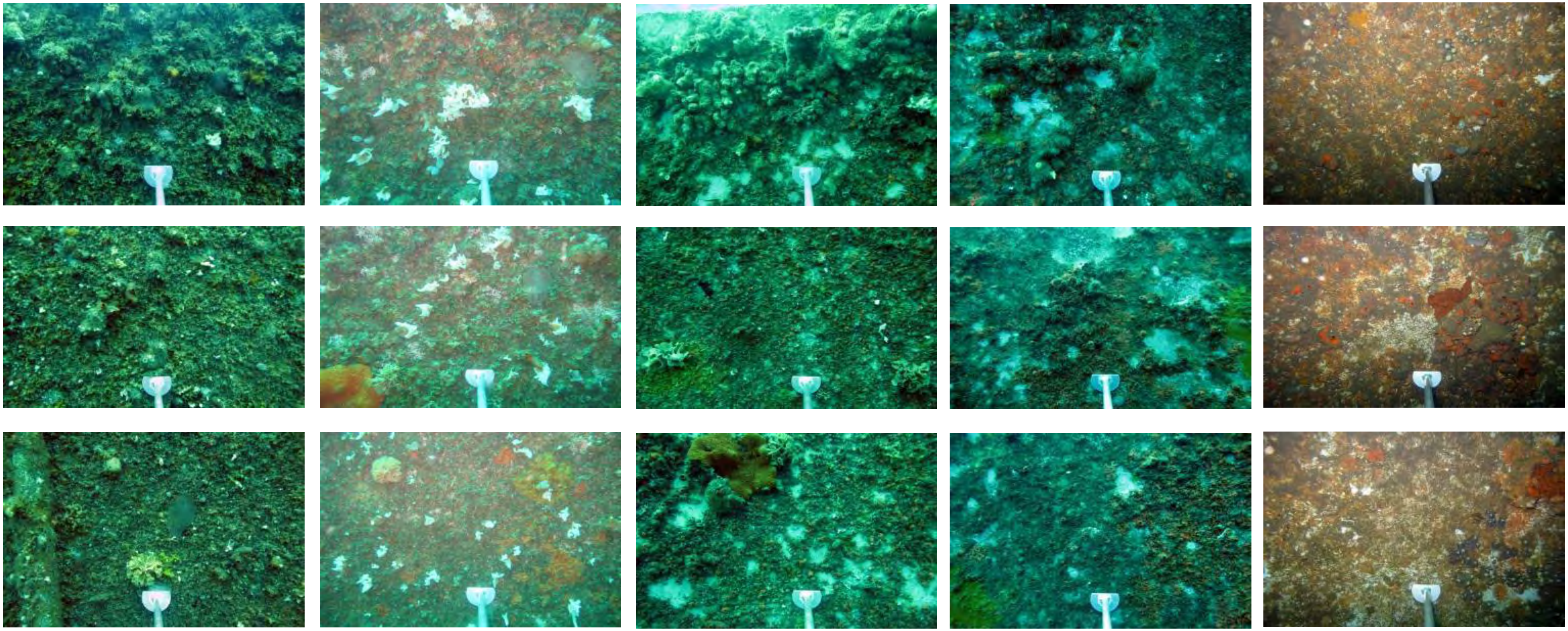


Plate 15 Continued: Vertical Superstructure Starbord Bow

Vertical Superstructure Starbord Bow

Monitoring Survey 10 (March 2014) | **Monitoring Survey 11 (October 2014)** | **Monitoring Survey 12 (March 2015)** | **Monitoring Survey 13 (June 2016)**

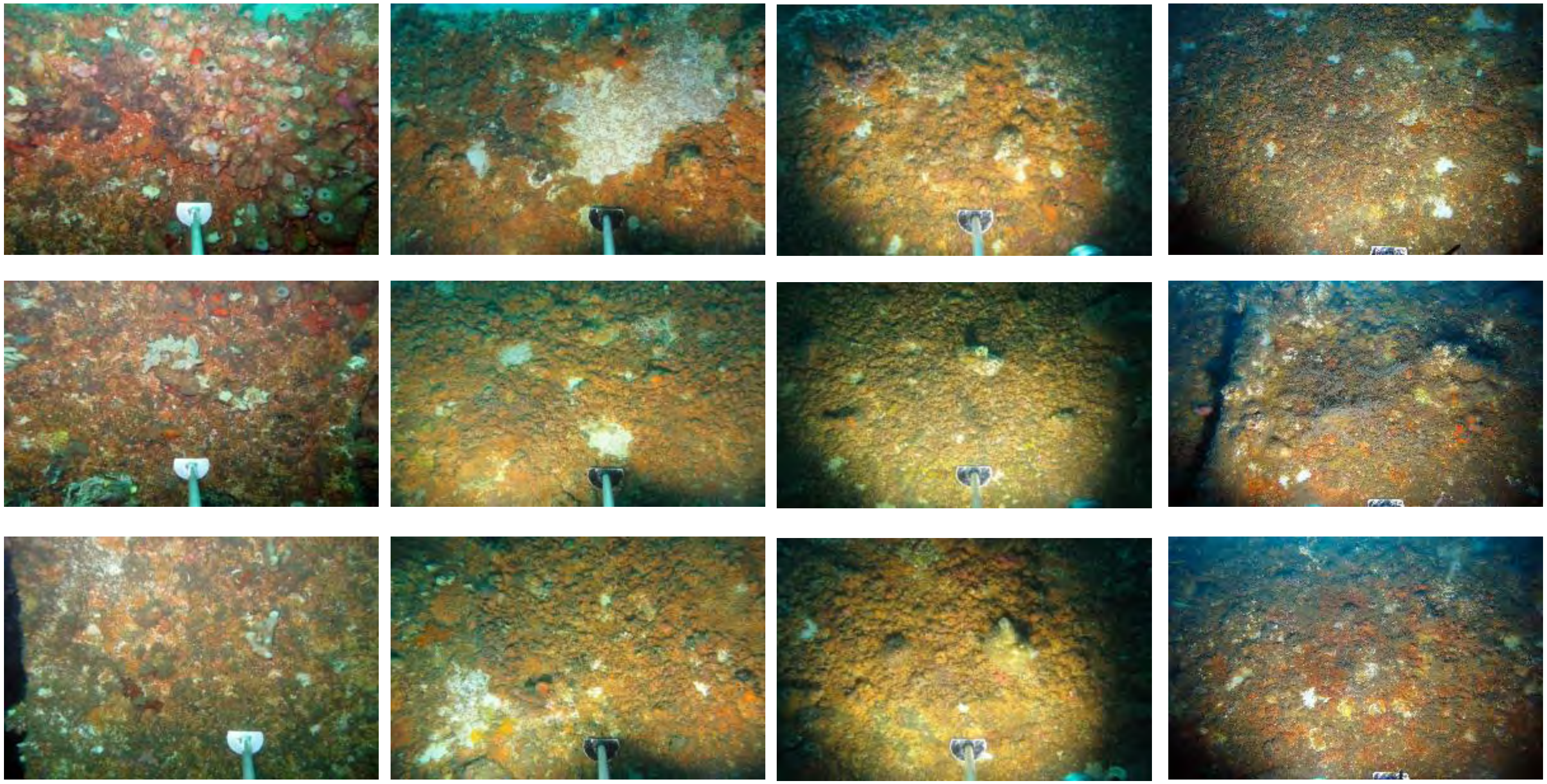


Plate 15 Continued: Vertical Superstructure Starbord Bow

Vertical Superstructure 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)
Not Sampled				
Not Sampled				
Not Sampled				

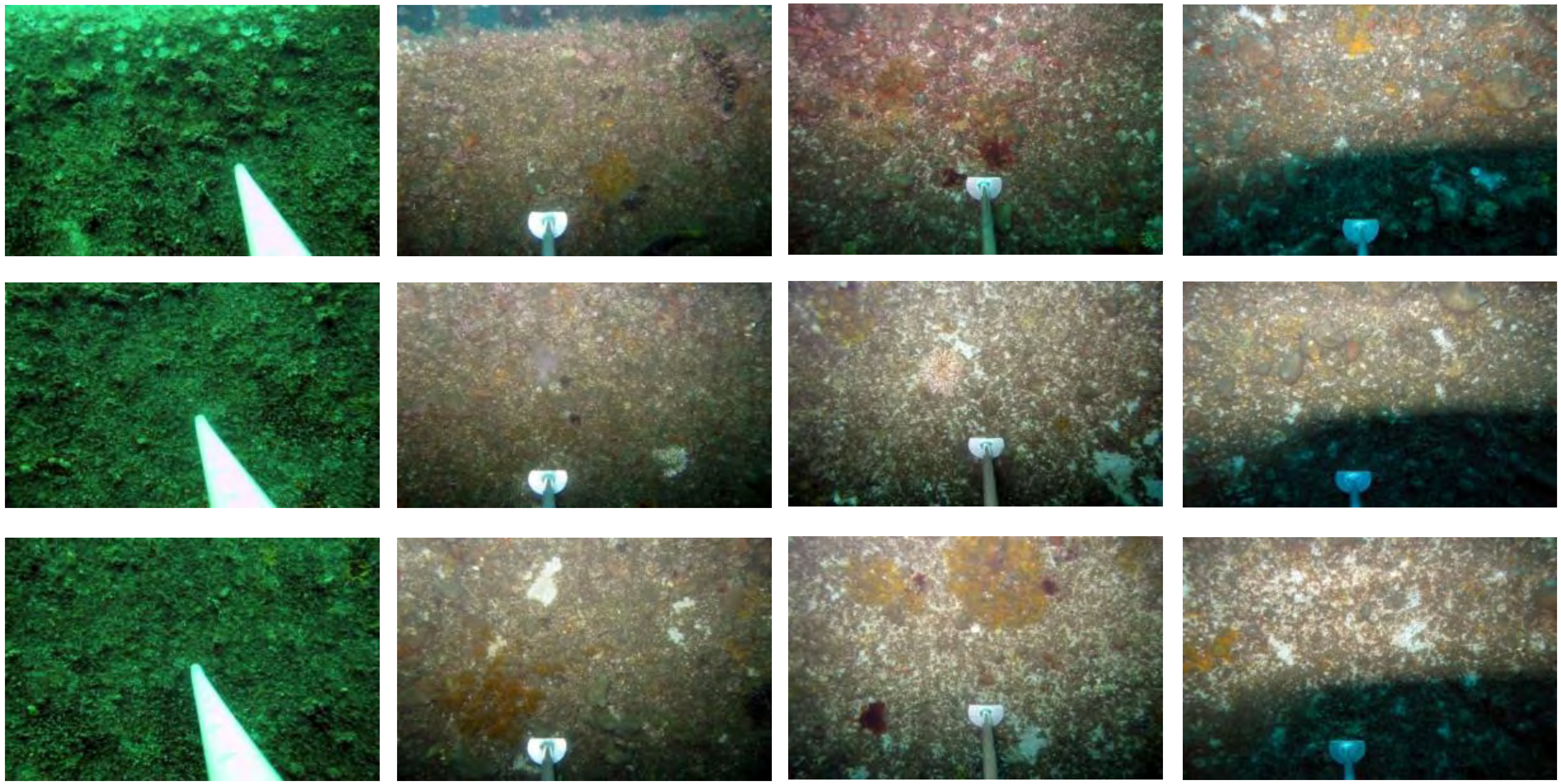


Plate 16: Vertical Superstructure Starbord Stern

Vertical Superstructure 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)**

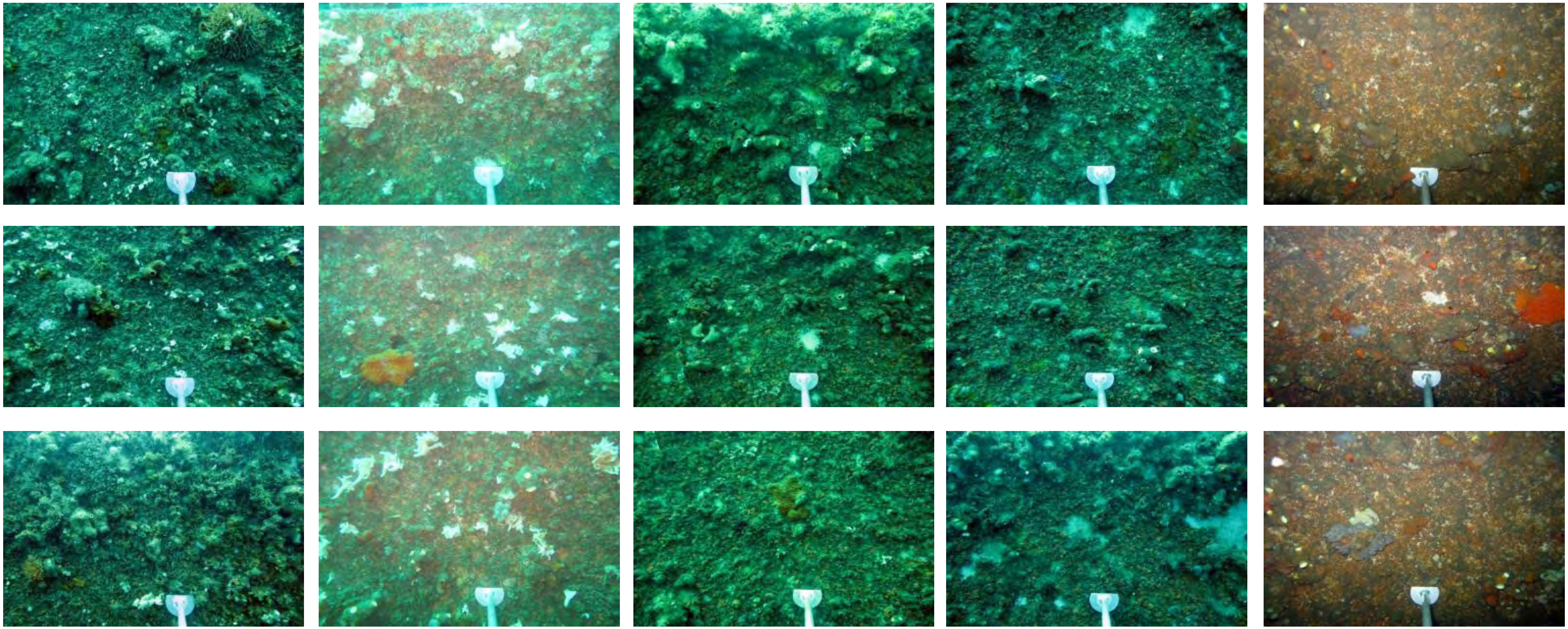


Plate 16 Continued: Vertical Superstructure Starbord Stern

Vertical Superstructure Starbord Stern

Monitoring Survey 10 (March 2014)

Monitoring Survey 11 (October 2014)

Monitoring Survey 12 (March 2015)

Monitoring Survey 13 (June 2016)

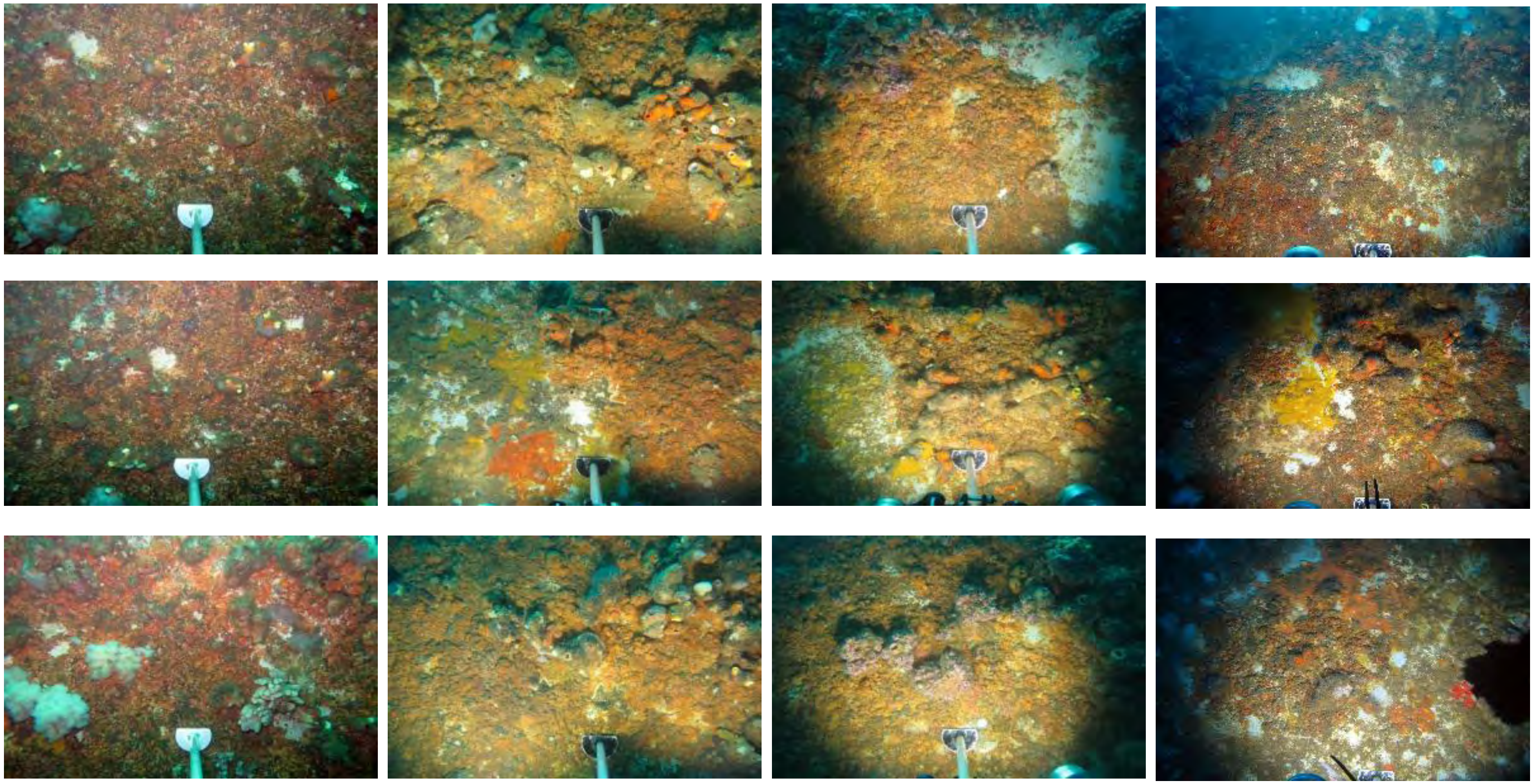


Plate 16 Continued: Vertical Superstructure Starbord Stern

7 Appendices

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

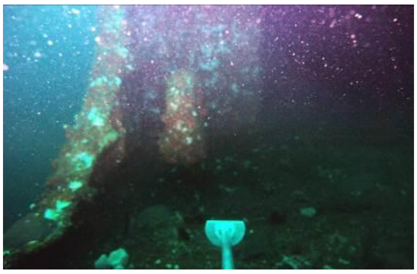
Survey 6

Survey 7

Survey 8

Survey 9

Survey 10



Survey 11

Survey 12

Survey 13

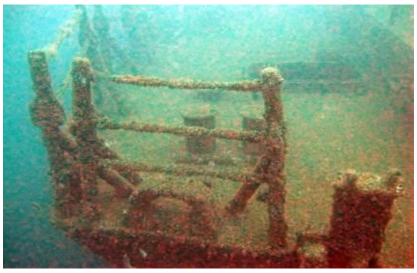
Appendix A: (Continued).

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

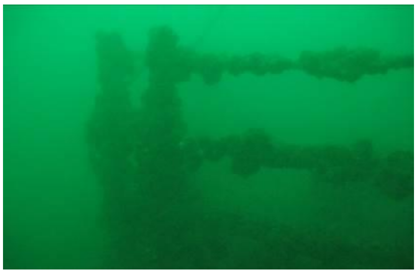
Survey 4

Survey 5

No Data

Survey 6

Survey 7



Survey 8

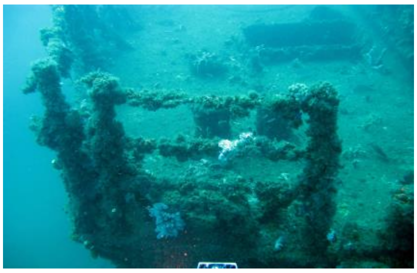
Survey 9

Survey 10

Survey 11

Survey 12

Survey 13



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

Survey 13

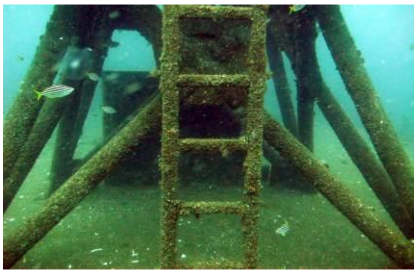
Appendix A: (Continued).

Fixed Photo: 4

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

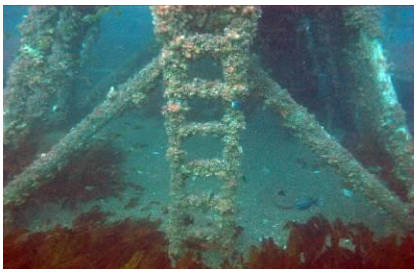
Depth: Approximately 23 m

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

Survey 13

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

Survey 13

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

Survey 13

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

Survey 13

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

Survey 13

Appendix A: (Continued).

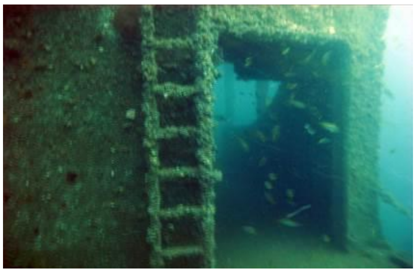
Fixed Photo: 9

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

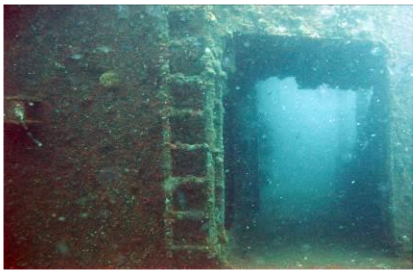
Survey 5

Survey 6

Survey 7

Survey 8

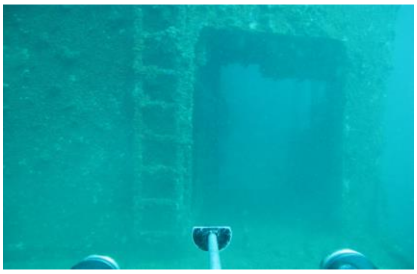
Survey 9



Survey 10

Survey 11

Survey 12



Survey 13

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

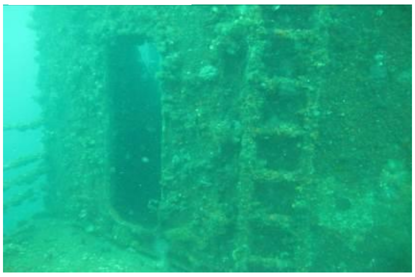
Survey 5

Survey 6

Survey 7

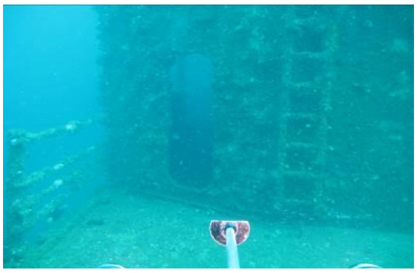
Survey 8

Survey 9



Survey 10

Survey 11



Survey 12

Survey 13

Appendix B

	Deck Port Bow		Deck Port Mid		Deck Port Stern		Deck Starbord Bow		Deck Starbord Mid		Deck Starbord Stern		Horizontal Hull Port	
Taxon Name	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
Brown filamentous algae/hydroid	25.61	3.53	38.23	5.06	30.43	6.17	40.71	5.02	50.91	7.90	50.91	7.51	14.61	7.30
Lobed brown algae (Lobophora sp.)	0.20	0.20	0.00	0.00	0.61	0.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Red encrusting algae	0.40	0.40	0.20	0.20	0.00	0.00	1.21	0.81	0.61	0.40	1.21	0.49	0.17	0.18
Red filamentous/branching algae	0.00	0.00	0.20	0.20	0.00	0.00	2.83	1.41	1.82	0.81	0.20	0.20	0.00	0.00
Orange/yellow encrusting bryozoan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hornera sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.25	0.00	0.00	0.00	0.00	0.00	0.00
White Encrusting Sponge	0.20	0.20	1.21	1.21	2.59	1.08	2.07	1.20	2.42	1.93	1.82	0.81	1.70	0.59
White Globular Sponge	0.00	0.00	0.20	0.20	1.63	1.63	1.41	1.18	0.00	0.00	2.63	2.63	0.00	0.00
White Papillate Sponge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Orange Encrusting Sponge	1.02	0.32	2.83	1.41	1.01	0.55	2.65	0.93	4.24	1.61	1.82	0.81	0.00	0.00
Yellow Encrusting Sponge	0.82	0.82	2.42	0.82	4.81	2.15	1.24	0.61	1.82	1.12	2.63	0.76	2.72	1.29
Purple encrusting sponge	0.41	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.00	0.00	0.00	0.00
Solitary ascidian (Herdmania momus/)	2.69	1.70	1.21	0.98	0.00	0.00	1.82	0.74	0.00	0.00	0.20	0.20	3.30	1.24
Botryloides spp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Orange colonial ascidian	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pink spikey sponge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bare ships surface	1.44	0.78	2.23	0.67	0.00	0.00	0.20	0.20	1.01	0.45	0.81	0.59	0.85	0.72
Anthothoe albocincta	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.40	0.00	0.00
Early colonising matrix	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.23	1.70	0.81	0.59	1.04	0.54
Large barnacle,sediment,brown fil	0.42	0.42	0.20	0.20	0.20	0.20	0.40	0.25	0.00	0.00	0.00	0.00	34.61	6.61
Serpulid, barnacle and encrusting algae matrix	62.45	5.72	47.21	6.90	57.70	7.61	40.96	4.15	28.08	5.41	34.75	7.75	21.26	2.71
Serpulid matrix	0.62	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.00	0.00	0.34	0.37
Fish in frame	1.03	0.65	0.00	0.00	0.00	0.00	0.61	0.61	0.00	0.00	0.20	0.20	0.00	0.00
Unknown white material	0.41	0.25	3.84	2.13	0.00	0.00	0.00	0.00	4.65	2.27	0.61	0.61	0.69	0.37
Tiny orange anemone	1.85	0.82	0.00	0.00	1.01	1.01	3.27	0.87	0.61	0.61	1.01	0.45	18.38	2.63
White encrusting solitary ascidian	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.37
Encrusting Coralline (ENC COR)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Green Filamentous (GRN FL)	0.20	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Echinoderm 1 (ECH 1)	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.00	0.00	0.00	0.00	0.00	0.00
Pink Colonial Anemone	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ascidian - Spare Category 6 (SC6)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Taxon Name	Horizontal Hull Starbord Mean	Horizontal Hull Starbord S.E.	Vertical Hull Port Bow Mean	Vertical Hull Port Bow S.E.	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.
Brown filamentous algae/hydroid	26.92	3.18	12.32	5.37	1.71	0.61	3.04	1.55	0.96	0.46
Lobed brown algae (Lobophora sp.)	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.25	0.00	0.00
Red encrusting algae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Red filamentous/branching algae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Orange/yellow encrusting bryozoan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hornera sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
White Encrusting Sponge	0.17	0.19	0.43	0.43	0.00	0.00	0.00	0.00	0.00	0.00
White Globular Sponge	0.17	0.19	0.43	0.26	0.75	0.31	0.00	0.00	0.48	0.48
White Papillate Sponge	0.00	0.00	0.00	0.00	0.00	0.00	0.78	0.78	1.43	0.58
Orange Encrusting Sponge	0.18	0.00	1.75	0.89	1.48	0.60	1.92	1.04	0.00	0.00
Yellow Encrusting Sponge	2.23	0.96	1.74	1.02	4.44	0.91	2.32	1.39	8.72	2.58
Purple encrusting sponge	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.26	0.00	0.00
Solitary ascidian (Herdmania momus/)	6.30	4.61	6.18	1.68	13.78	2.40	14.61	12.34	6.07	4.97
Botryloides spp.	0.18	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Orange colonial ascidian	0.52	0.23	0.22	0.22	0.00	0.00	0.00	0.00	0.00	0.00
Pink spikey sponge	0.00	0.00	0.00	0.00	0.25	0.25	0.00	0.00	0.00	0.00
Bare ships surface	4.70	3.29	0.00	0.00	3.07	1.47	1.85	0.71	3.38	0.73
Anthothoe albocincta	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Early colonising matrix	8.86	5.94	10.16	1.80	5.21	1.41	4.42	2.03	4.79	1.77
Large barnacle,sediment,brown fil	11.76	5.03	22.56	3.84	32.33	2.61	14.97	3.09	5.44	2.14
Serpulid, barnacle and encrusting algae matrix	20.79	5.06	9.55	2.79	9.37	1.58	32.35	9.10	33.85	5.96
Serpulid matrix	0.00	0.00	1.95	0.87	0.51	0.31	0.76	0.50	0.25	0.25
Fish in frame	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unknown white material	0.86	0.54	2.56	1.07	0.76	0.31	0.00	0.00	0.25	0.25
Tiny orange anemone	16.37	2.52	29.50	3.55	26.10	1.95	19.78	4.37	34.40	1.41
White encrusting solitary ascidian	0.00	0.00	0.44	0.44	0.00	0.00	0.00	0.00	0.00	0.00
Encrusting Coralline (ENC COR)	0.00	0.00	0.21	0.21	0.00	0.00	0.00	0.00	0.00	0.00
Green Filamentous (GRN FL)	0.00	0.00	0.00	0.00	0.24	0.24	0.00	0.00	0.00	0.00
Echinoderm 1 (ECH 1)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pink Colonial Anemone	0.00	0.00	0.00	0.00	0.00	0.00	2.43	0.92	0.00	0.00
Ascidian - Spare Category 6 (SC6)	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.28	0.00	0.00

Taxon Name	Vertical Super Port Bow Mean	Vertical Super Port Bow SE	Vertical Super Port Stern Mean	Vertical Super Port Stern S.E.	Vertical Super Starbord Bow Mean	Vertical Super Starbord Bow S.E.	Vertical Super Starbord Stern Mean	Vertical Super Starbord Stern S.E.
Brown filamentous algae/hydroid	13.01	3.58	3.88	2.12	0.00	0.00	0.00	0.00
Lobed brown algae (Lobophora sp.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Red encrusting algae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Red filamentous/branching algae	0.00	0.00	0.00	0.00	4.37	2.50	0.24	0.24
Orange/yellow encrusting bryozoan	0.89	0.89	0.00	0.00	0.00	0.00	0.00	0.00
Hornera sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
White Encrusting Sponge	0.21	0.21	0.00	0.00	0.00	0.00	1.75	1.16
White Globular Sponge	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.24
White Papillate Sponge	0.83	0.83	2.59	1.11	2.63	1.12	0.71	0.47
Orange Encrusting Sponge	1.10	0.86	1.32	0.81	0.64	0.43	2.97	1.51
Yellow Encrusting Sponge	3.02	1.58	3.04	1.05	7.58	2.64	5.79	1.99
Purple encrusting sponge	0.21	0.21	0.00	0.00	0.00	0.00	0.24	0.24
Solitary ascidian (Herdmania momus/)	10.09	2.60	16.55	5.65	6.86	2.56	8.24	5.62
Botryloides spp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Orange colonial ascidian	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pink spikey sponge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bare ships surface	3.18	0.88	8.63	1.84	5.12	1.28	12.78	1.89
Anthothoe albocincta	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Early colonising matrix	8.70	4.43	13.12	2.34	11.50	2.93	15.16	5.12
Large barnacle,sediment,brown fil	3.63	2.35	1.51	1.51	16.53	7.26	20.10	7.59
Serpulid, barnacle and encrusting algae matrix	14.41	6.85	21.85	3.32	28.18	8.81	16.13	4.35
Serpulid matrix	0.42	0.26	0.22	0.22	0.00	0.00	0.00	0.00
Fish in frame	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unknown white material	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.26
Tiny orange anemone	40.31	6.89	27.09	6.67	16.11	2.56	15.39	4.26
White encrusting solitary ascidian	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Encrusting Coralline (ENC COR)	0.00	0.00	0.22	0.22	0.00	0.00	0.00	0.00
Green Filamentous (GRN FL)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Echinoderm 1 (ECH 1)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pink Colonial Anemone	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ascidian - Spare Category 6 (SC6)	0.00	0.00	0.00	0.00	0.47	0.47	0.00	0.00

Appendix C: Permutational Analysis of Variance of Percent Cover of Encrusting assemblages Sampled in Reef Monitoring Surveys 12 and 13. *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)	perms
Ti	**12**	**108730**	**9061**	**9.1565**	**0.0001**	**9854**
Res	195	192970	989.58			
Total	207	301700				

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

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Ti	1	15441	15441	23.906	RED	9950
Or	1	54782	54782	84.814	RED	9957
As	**1**	**2700**	**2700**	**4.179**	**0.0095**	**9953**
TixOr	**1**	**7902**	**7902**	**12.234**	**0.0001**	**9951**
TixAs	1	931	931	1.442	0.2144	9961
OrxAs	1	1572	1572	2.434	0.0629	9946
TixOrxAs	1	1128	1128	1.747	0.1473	9943
Res	76	49089	646			
Total	83	134970				

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

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Ti	1	9842	9842	5.671	RED	9949
De	1	3441	3441	1.415	0.293	315
As	1	6891	6891	2.834	**0.041**	315
TixDe	1	1760	1760	1.014	0.421	9950
TixAs	1	779	779	0.449	0.798	9947
DexAs	1	6226	6226	2.561	0.054	315
Tr(DexAs)	4	9726	2432	3.802	RED	9918
TixDexAs	1	1530	1530	0.881	0.499	9946
TixTr(DexAs)	**4**	**6942**	**1736**	**2.714**	**0.000**	**9901**
Res	64	40928	640			
Total	79	88064				

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

Source	df	SS	MS	Pseudo-F	P(perm)	Unique perms
Ti	1	13049	13049	25.212	RED	9941
Po	2	1296	648	1.252	RED	9944
As	**1**	**3138**	**3138**	**6.064**	**0.010**	**9947**
TixPo	**2**	**3189**	**1595**	**3.081**	**0.032**	**9948**
TixAs	1	1017	1017	1.964	0.138	9949
PoxAs	2	664	332	0.641	0.591	9941
TixPoxAs	2	727	364	0.702	0.549	9940
Res	48	24843	518			
Total	59	47923				

Appendix D: Pairwise tests of encrusting 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**	**0.0236**	**9954**
1, 3	**2.2409**	**0.0086**	**9954**
1, 4	**4.3128**	**0.0001**	**9954**
1, 5	**3.8913**	**0.0001**	**9945**
1, 6	**4.0002**	**0.0001**	**9946**
1, 7	**4.0715**	**0.0001**	**9942**
1, 8	**4.2386**	**0.0001**	**9948**
1, 9	**3.9414**	**0.0001**	**9944**
1, 10	**3.9944**	**0.0001**	**9939**
1, 11	**3.8569**	**0.0001**	**9954**
1, 12	**3.4838**	**0.0001**	**9933**
1, 13	**3.654**	**0.0001**	**9953**
2, 3	1.0401	0.3488	9936
2, 4	**3.2352**	**0.0001**	**9957**
2, 5	**2.7874**	**0.0001**	**9955**
2, 6	**2.9683**	**0.0001**	**9953**
2, 7	**3.1645**	**0.0001**	**9949**
2, 8	**3.4435**	**0.0001**	**9943**
2, 9	**3.023**	**0.0001**	**9941**
2, 10	**2.8985**	**0.0001**	**9954**
2, 11	**2.6461**	**0.0002**	**9957**
2, 12	**2.6441**	**0.0005**	**9962**
2, 13	**2.9387**	**0.0001**	**9939**
3, 4	**2.3061**	**0.0003**	**9944**
3, 5	**1.998**	**0.002**	**9949**
3, 6	**2.1216**	**0.0006**	**9941**
3, 7	**2.1354**	**0.0002**	**9956**
3, 8	**2.3774**	**0.0002**	**9947**
3, 9	**2.1324**	**0.0001**	**9938**
3, 10	**2.0363**	**0.0005**	**9942**
3, 11	**2.3781**	**0.0001**	**9932**
3, 12	**2.5589**	**0.001**	**9955**
3, 13	**3.1784**	**0.0001**	**9943**
4, 5	**1.7909**	**0.0093**	**9951**
4, 6	**1.5849**	**0.0353**	**9939**
4, 7	1.3004	0.1407	9940
4, 8	1.2995	0.1407	9939
4, 9	**2.0158**	**0.005**	**9939**
4, 10	**1.8018**	**0.0342**	**9942**
4, 11	**3.4478**	**0.0001**	**9949**
4, 12	**3.7796**	**0.0001**	**9956**
4, 13	**5.0211**	**0.0001**	**9953**

Term 'Ti' Groups	t	P(perm)	Unique perms
5, 6	1.1947	0.2046	9942
5, 7	**1.6529**	**0.0217**	**9944**
5, 8	**1.8101**	**0.0083**	**9939**
5, 9	**1.6509**	**0.0168**	**9938**
5, 10	**1.6265**	**0.0308**	**9950**
5, 11	**2.5963**	**0.0001**	**9951**
5, 12	**3.3196**	**0.0003**	**9946**
5, 13	**4.3323**	**0.0001**	**9956**
6, 7	**1.7059**	**0.0208**	**9949**
6, 8	**1.62**	**0.0353**	**9939**
6, 9	**1.759**	**0.0096**	**9939**
6, 10	**1.7066**	**0.0277**	**9938**
6, 11	**2.8491**	**0.0001**	**9949**
6, 12	**3.4724**	**0.0001**	**9938**
6, 13	**4.5683**	**0.0001**	**9936**
7, 8	0.88275	0.5224	9946
7, 9	**1.7415**	**0.0119**	**9944**
7, 10	**1.7011**	**0.0368**	**9946**
7, 11	**3.037**	**0.0001**	**9946**
7, 12	**3.626**	**0.0005**	**9946**
7, 13	**4.6554**	**0.0001**	**9951**
8, 9	**1.6928**	**0.0188**	**9936**
8, 10	**1.7087**	**0.034**	**9945**
8, 11	**3.136**	**0.0001**	**9945**
8, 12	**3.6642**	**0.0003**	**9961**
8, 13	**4.7493**	**0.0001**	**9956**
9, 10	0.91456	0.4975	9947
9, 11	**1.997**	**0.0035**	**9954**
9, 12	**2.8031**	**0.0016**	**9940**
9, 13	**3.8794**	**0.0001**	**9953**
10, 11	**2.028**	**0.0086**	**9953**
10, 12	**2.6549**	**0.005**	**9930**
10, 13	**3.8883**	**0.0001**	**9959**
11, 12	**1.8626**	**0.0391**	**9940**
11, 13	**2.3241**	**0.0043**	**9926**
12, 13	1.6156	0.0741	9945

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
12, 13	**4.8773**	**0.0001**	**9937**

Within level 'Hull' of factor 'Orientation'

Groups	t	P(perm)	Unique perms
12, 13	**3.4795**	**0.0001**	**9946**

3. Time x Orientation (for factor Orientation)

Within level '12' of factor 'Time'

Groups	t	P(perm)	Unique perms
Deck, Hull	**7.8112**	**0.0001**	**9954**

Within level '13' of factor 'Time'

Groups	t	P(perm)	Unique perms
Deck, Hull	**5.5977**	**0.0001**	**9945**

4. Time x Transect (Depth x Aspect) Pairs of levels of factor Time

Term 'TixTr(DexAs)' for pairs of levels of factor 'Time'

Within level 'Deep' of factor 'Depth'
Within level 'Port' of factor 'Aspect'
Within level 'Bow' of factor 'Transect'

Groups	t	P(perm)	Unique perms
12, 13	**1.9431**	**0.0064**	**126**

Within level 'Deep' of factor 'Depth'
Within level 'Port' of factor 'Aspect'
Within level 'Stern' of factor 'Transect'

Groups	t	P(perm)	Unique perms
12, 13	**3.856**	**0.008**	**126**

Continued

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

Groups	t	P(perm)	Unique perms
12, 13	1.5262	0.126	126

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

Groups	t	P(perm)	Unique perms
12, 13	**1.6693**	**0.0394**	**126**

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

Groups	t	P(perm)	Unique perms
12, 13	1.254	0.2128	126

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

Groups	t	P(perm)	Unique perms
12, 13	1.4766	0.1314	126

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

Groups	t	P(perm)	Unique perms
12, 13	**2.5701**	**0.0084**	**126**

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

Groups	t	P(perm)	Unique perms
12, 13	**2.2779**	**0.0092**	**126**

5. Time x Transect (Depth x Aspect) Pairs of levels of factor Transect

Term 'TixTr(DexAs)' for pairs of levels of factor 'Transect'

Within level '12' of factor 'Time'
Within level 'Deep' of factor 'Depth'
Within level 'Port' of factor 'Aspect'

Groups	t	P(perm)	Unique perms
Bow, Stern	**3.7093**	**0.008**	**126**

Within level '12' of factor 'Time'
Within level 'Deep' of factor 'Depth'
Within level 'Starboard' of factor 'Aspect'

Groups	t	P(perm)	Unique perms
Bow, Stern	**2.9042**	**0.0092**	**126**

Within level '12' of factor 'Time'
Within level 'Shallow' of factor 'Depth'
Within level 'Port' of factor 'Aspect'

Groups	t	P(perm)	Unique perms
Bow, Stern	0.84855	0.5782	126

Within level '12' of factor 'Time'
Within level 'Shallow' of factor 'Depth'
Within level 'Starboard' of factor 'Aspect'

Groups	t	P(perm)	Unique perms
Bow, Stern	1.3985	0.1432	126

Within level '13' of factor 'Time'
Within level 'Deep' of factor 'Depth'
Within level 'Port' of factor 'Aspect'

Groups	t	P(perm)	Unique perms
Bow, Stern	**1.7507**	**0.0066**	**126**

Within level '13' of factor 'Time'
Within level 'Deep' of factor 'Depth'
Within level 'Starboard' of factor 'Aspect'

Groups	t	P(perm)	Unique perms
Bow, Stern	1.4339	0.0702	126

Within level '13' of factor 'Time'
Within level 'Shallow' of factor 'Depth'
Within level 'Port' of factor 'Aspect'

Groups	t	P(perm)	Unique perms
Bow, Stern	1.2865	0.1568	126

Continued

Within level '13' of factor 'Time'
Within level 'Shallow' of factor 'Depth'
Within level 'Starboard' of factor 'Aspect'

Groups	t	P(perm)	Unique perms
Bow, Stern	0.87947	0.5888	126

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
12, 13	**1.9444**	**0.045**	**9931**

Within level 'Mid' of factor 'Position'

Groups	t	P(perm)	Unique perms
12, 13	**5.1005**	**0.0001**	**9955**

Within level 'Stern' of factor 'Position'

Groups	t	P(perm)	Unique perms
12, 13	**2.5573**	**0.0146**	**9940**

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

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

Within level '12' of factor 'Time'

Groups	t	P(perm)	Unique perms
Bow, Mid	**2.0722**	**0.0294**	**9954**
Bow, Stern	1.1482	0.2715	9955
Mid, Stern	0.9955	0.3906	9934

Within level '13' of factor 'Time'

Groups	t	P(perm)	Unique perms
Bow, Mid	**2.1991**	**0.0129**	**9939**
Bow, Stern	1.4474	0.1214	9939
Mid, Stern	1.346	0.1542	9938

Appendix E: Results of SIMPER analyses of encrusting assemblages sampled in The Ex-HMAS Adelaide Artificial Reef Community Surveys 12 and 13. Cut off for percentage contribution is 90%. Note that only relevant SIMPER results have been included.

1. All Times (Surveys 1 – 12)

N/A

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

Groups Deck12 & Hull12

Average dissimilarity = 82.35

	Group Deck12	Group Hull12				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	72.37	13	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	10.8	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	3.8	0.98	4.62	91.11

Groups Deck13 & Hull13

Average dissimilarity = 56.54

	Group Deck13	Group Hull13				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	45.19	21.03	13.19	1.46	23.32	23.32
Large barnacle,sediment,brown fil	0.2	23.19	11.5	1.23	20.34	43.66
Brown filamentous algae/hydroid	39.47	20.76	11.07	1.36	19.57	63.23
Tiny orange anemone	1.29	17.37	8.04	2.86	14.23	77.46

Groups Hull12 & Hull13
Average dissimilarity = 59.40

Species	Group Hull12 Av.Abund	Group Hull13 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Tiny orange anemone	48.17	17.37	16.06	2.04	27.03	27.03
Large barnacle,sediment,brown fil	6.5	23.19	11.3	1.23	19.02	46.05
Brown filamentous algae/hydroid	3.67	20.76	9.69	1.57	16.31	62.36
Serpulid, barnacle and encrusting algae matrix	13	21.03	7.8	1.47	13.14	75.5
Solitary ascidian (Herdmania momus/)	9.75	4.8	5.28	0.65	8.89	84.4
Early colonising matrix	7.33	4.95	4.4	0.95	7.4	91.8

Groups Deck12 & Deck13
Average dissimilarity = 41.33

Species	Group Deck12 Av.Abund	Group Deck13 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	72.37	45.19	16.99	1.66	41.11	41.11
Brown filamentous algae/hydroid	18.13	39.47	14.76	1.66	35.7	76.82
Yellow encrusting sponge	1.13	2.29	1.32	0.92	3.18	80.00
Orange encrusting sponge	1	2.26	1.2	1.05	2.91	82.92
White encrusting sponge	0.17	1.72	0.88	0.71	2.12	85.04
Tiny orange anemone	0.53	1.29	0.8	0.74	1.95	86.99
Unknown white material	0	1.58	0.8	0.49	1.94	88.93
Red encrusting algae	1.2	0.61	0.72	0.71	1.74	90.67

Aspect - Groups Port & Starbord
Average dissimilarity = 52.37

Species	Group Port Av.Abund	Group Starbord Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	52.32	41.37	17.35	1.44	33.14	33.14
Brown filamentous algae/hydroid	19.67	28.46	12.21	1.3	23.32	56.46
Tiny orange anemone	9.54	10.49	8.08	0.79	15.43	71.89
Large barnacle,sediment,brown fil	6.4	2.42	4.05	0.54	7.74	79.63
Solitary ascidian (Herdmania momus/)	2.77	2.14	2.19	0.42	4.18	83.81
Early colonising matrix	0.86	3.29	1.91	0.54	3.65	87.46
Yellow encrusting sponge	1.78	1.42	1.18	0.84	2.25	89.7
Orange encrusting sponge	0.98	1.56	0.99	0.86	1.88	91.58

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

Groups Port and Starboard

Species	Group Port Av.Abund	Group Starboard Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	15.27	30.06	10.59	1.45	22.61	22.61
Tiny orange anemone	36.85	27.81	8.66	1.36	18.5	41.11
Solitary ascidian (Herdmania momus/)	13.23	11.55	7.62	0.96	16.26	57.37
Large barnacle,sediment,brown fil	12.38	8.46	7.17	1.08	15.31	72.68
Early colonising matrix	7.6	6.73	3.51	1.16	7.5	80.18
Brown filamentous algae/hydroid	4.91	1.15	2.43	0.73	5.18	85.36
Bare ships surface	2.23	3.42	1.93	0.94	4.12	89.48
Yellow encrusting sponge	1.85	3.3	1.85	0.93	3.96	93.44

Groups 12BowDeepPort & 13BowDeepPort
Average dissimilarity = 34.54

Species	Group 12BowDeepPort Av.Abund	Group 13BowDeepPort Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Large barnacle,sediment,brown fil	34.2	22.56	6.74	1.39	19.52	19.52
Brown filamentous algae/hydroid	1.6	12.32	5.63	0.97	16.29	35.82
Serpulid, barnacle and encrusting algae matrix	0.6	9.55	4.83	1.72	13.97	49.79
Tiny orange anemone	32.6	29.5	4.66	1.19	13.5	63.29
Solitary ascidian (Herdmania momus/)	14	6.18	4.44	1.23	12.86	76.15
Early colonising matrix	6	10.16	2.95	1.46	8.53	84.68
Unknown white material	0	2.56	1.34	1.17	3.89	88.57
Serpulid matrix	0	1.95	1.02	1.09	2.97	91.53

Groups 12SternDeepPort & 13SternDeepPort
Average dissimilarity = 48.43

Species	Group 12SternDeepPort Av.Abund	Group 13SternDeepPort Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Large barnacle,sediment,brown fil	2.8	32.33	14.98	4.13	30.93	30.93
Tiny orange anemone	47.4	26.1	10.8	3.9	22.3	53.24
Serpulid, barnacle and encrusting algae matrix	22	9.37	8.31	2.02	17.15	70.39
Solitary ascidian (Herdmania momus/)	8.8	13.78	3.86	1.52	7.97	78.36
Early colonising matrix	9.2	5.21	3.5	1.13	7.22	85.58
Yellow encrusting sponge	0.6	4.44	1.95	2	4.02	89.6
Brown filamentous algae/hydroid	4.2	1.71	1.45	1.23	3	92.6

Groups 12SternDeepStarboard & 13SternDeepStarboard
Average dissimilarity = 29.46

Species	Group 12SternDeepStarboard Av.Abund	Group 13SternDeepStarboard Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	42.2	33.85	8.06	1.51	27.36	27.36
Yellow encrusting sponge	0	8.72	4.5	1.66	15.27	42.63
Tiny orange anemone	36.4	34.4	4.29	1.47	14.56	57.18
Solitary ascidian (Herdmania momus/)	1	6.07	3.24	0.67	10.99	68.18
Large barnacle,sediment,brown fil	0.2	5.44	2.7	1.19	9.16	77.34
Early colonising matrix	7.8	4.79	2.48	1.44	8.43	85.77
Brown filamentous algae/hydroid	3.4	0.96	1.41	0.95	4.8	90.57

Groups 12BowShallowStarboard & 13BowShallowStarboard
Average dissimilarity = 50.41

Species	Group 12BowShallowStarboard Av.Abund	Group 13BowShallowStarboard Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Tiny orange anemone	43	16.11	14.01	2.05	27.8	27.8
Serpulid, barnacle and encrusting algae matrix	39	28.18	10.3	1.61	20.42	48.22
Large barnacle,sediment,brown fil	0.4	16.53	8.61	1.14	17.07	65.29
Early colonising matrix	3.8	11.5	4.12	1.34	8.18	73.47
Yellow encrusting sponge	0.4	7.58	3.79	1.35	7.52	80.99
Solitary ascidian (Herdmania momus/)	3.6	6.86	2.77	1.5	5.49	86.48
Bare ships surface	0.6	5.12	2.36	1.7	4.68	91.16

Groups 12SternShallowStarboard & 13SternShallowStarboard
Average dissimilarity = 51.30

Species	Group 12SternShallowStarboard Av.Abund	Group 13SternShallowStarboard Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Tiny orange anemone	34.2	15.39	10.08	1.76	19.65	19.65
Large barnacle,sediment,brown fil	6	20.1	9.28	1.28	18.09	37.74
Serpulid, barnacle and encrusting algae matrix	28.2	16.13	7.48	1.54	14.58	52.32
Bare ships surface	1.4	12.78	6.02	2.75	11.73	64.05
Early colonising matrix	6	15.16	5.72	1.14	11.15	75.2
Solitary ascidian (Herdmania momus/)	8.4	8.24	5.34	1.22	10.41	85.61
Yellow encrusting sponge	1.2	5.79	2.68	1.36	5.22	90.83

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

Groups 12Bow & 13Bow

Average dissimilarity = 30.07

	Group 12Bow	Group 13Bow				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	64.7	51.71	11.57	1.46	38.48	38.48
Brown filamentous algae/hydroid	26.5	33.16	9.57	1.46	31.84	70.32
Tiny orange anemone	0.2	2.56	1.27	1.39	4.21	74.53
Solitary ascidian (Herdmania momus/)	0.1	2.26	1.13	0.84	3.77	78.3
Orange encrusting sponge	0.6	1.84	1.06	1.17	3.51	81.81
Red encrusting algae	2	0.81	0.97	1.28	3.23	85.04
Yellow encrusting sponge	0.9	1.03	0.75	0.89	2.49	87.53
Red filamentous/branching algae	0	1.41	0.72	0.58	2.4	89.93
White encrusting sponge	0.3	1.14	0.61	0.66	2.03	91.96

Groups 12Mid & 13Mid

Average dissimilarity = 48.72

	Group 12Mid	Group 13Mid				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	75	37.65	19.33	2.06	39.67	39.67
Brown filamentous algae/hydroid	10.7	44.57	17.36	2.11	35.64	75.31
Unknown white material	0	4.24	2.16	0.96	4.43	79.74
Orange encrusting sponge	1.4	3.54	1.71	1.22	3.5	83.24
Yellow encrusting sponge	1.4	2.12	1.34	1.05	2.76	86
Early colonising matrix	0.7	1.62	0.98	0.72	2	88
White encrusting sponge	0.1	1.82	0.94	0.57	1.92	89.92
Red encrusting algae	1.5	0.41	0.83	0.57	1.7	91.63

Groups 12Stern & 13Stern

Average dissimilarity = 46.94

	Group 12Stern	Group 13Stern				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	77.4	46.22	20.89	1.91	44.52	44.52
Brown filamentous algae/hydroid	17.2	40.67	18.4	1.88	39.21	83.73
Yellow encrusting sponge	1.1	3.72	1.89	1.11	4.02	87.75
White globular sponge	0.2	2.13	1.13	0.52	2.41	90.16

Groups 12Bow & 12Mid

Average dissimilarity = 28.19

	Group 12Bow	Group 12Mid				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	64.7	75	10.52	1.39	37.33	37.33
Brown filamentous algae/hydroid	26.5	10.7	10.34	1.25	36.67	74
Red encrusting algae	2	1.5	1.27	1.01	4.5	78.5
Yellow encrusting sponge	0.9	1.4	0.99	0.67	3.51	82.01
Orange encrusting sponge	0.6	1.4	0.91	0.75	3.22	85.23
Tiny orange anemone	0.2	1.3	0.73	0.48	2.59	87.82
Lobed brown algae (Lobophora sp.)	0	1.4	0.72	0.69	2.55	90.37

Groups 13Bow & 13Mid

Average dissimilarity = 32.33

	Group 13Bow	Group 13Mid				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	51.71	37.65	10.54	1.43	32.6	32.6
Brown filamentous algae/hydroid	33.16	44.57	8.93	1.4	27.61	60.21
Unknown white material	0.2	4.24	2.06	0.94	6.38	66.59
Orange encrusting sponge	1.84	3.54	1.57	1.35	4.85	71.44
Tiny orange anemone	2.56	0.3	1.23	1.36	3.81	75.25
Solitary ascidian (Herdmania momus/)	2.26	0.61	1.18	0.92	3.65	78.9
White encrusting sponge	1.14	1.82	1.17	0.75	3.63	82.53
Yellow encrusting sponge	1.03	2.12	1.04	1.19	3.21	85.74
Red filamentous/branching algae	1.41	1.01	0.94	0.87	2.91	88.64
Early colonising matrix	0	1.62	0.81	0.55	2.5	91.15

Aspect

Groups Port & Starboard
Average dissimilarity = 37.00

Species	Group Port Av.Abund	Group Starboard Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Serpulid, barnacle and encrusting algae matrix	65.96	51.6	14.91	1.47	40.3	40.3
Brown filamentous algae/hydroid	23.84	33.75	12.88	1.39	34.8	75.1
Yellow encrusting sponge	1.88	1.55	1.23	0.85	3.32	78.43
Orange encrusting sponge	1.38	1.88	1.13	0.99	3.06	81.49
White encrusting sponge	0.73	1.15	0.79	0.68	2.13	83.62
Tiny orange anemone	0.51	1.31	0.78	0.7	2.1	85.72
Red encrusting algae	0.53	1.27	0.74	0.73	1.99	87.71
Unknown white material	0.71	0.88	0.72	0.46	1.95	89.66
Bare ships surface	0.74	0.64	0.53	0.81	1.44	91.1

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: 14.217 df1: 12 df2: 195

P(perm): **0.001**

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

Group factor: Time x Orientation

DEVIATIONS FROM CENTROID

F: 2.1223 1 df1: 3 df2: 80

P(perm): 0.1637

Group factor: Aspect

DEVIATIONS FROM CENTROID

F: 0.03 1 df1: 1 df2: 82

P(perm): 0.891

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

Group factor: Aspect

DEVIATIONS FROM CENTROID

F: 0.541 df1: 1 df2: 78

P(perm): 0.527

Group factor: Transect (Depth x Aspect)

DEVIATIONS FROM CENTROID

F: 4.011 df1: 7 df2: 72

P(perm): 0.005

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

Group factor: Aspect

DEVIATIONS FROM CENTROID

F: 3.1374 df1: 1 df2: 58

P(perm): 0.081

Group factor: Time x Position

DEVIATIONS FROM CENTROID

F: 1.088 df1: 5 df2: 54

P(perm): 0.591