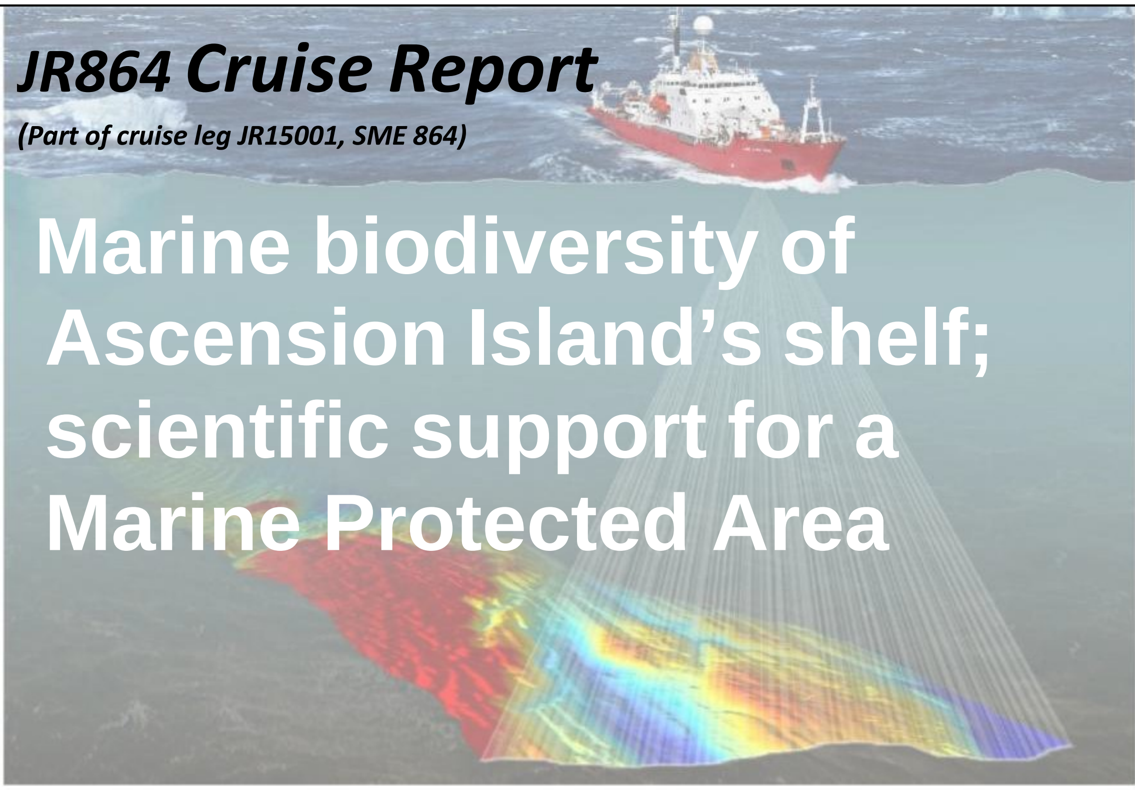
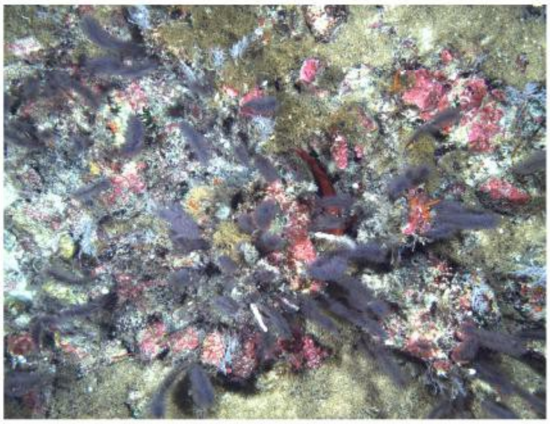


JR864 Cruise Report

(Part of cruise leg JR15001, SME 864)

Marine biodiversity of Ascension Island's shelf; scientific support for a Marine Protected Area



British Antarctic Survey, Natural Environment Research Council, Madingley Road, Cambridge, UK. This unpublished report contains initial observations and conclusions.

Report authors

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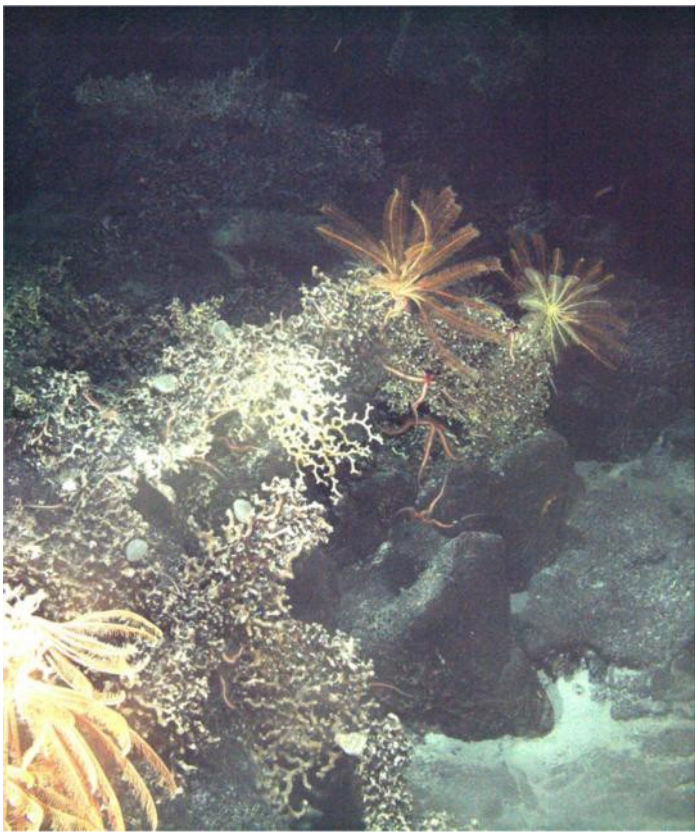

A deep biodiverse reef of corals, with basket stars and feather stars at 500 m

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1. Summary

Ascension Island is a young (~1my), mid-Atlantic island, administered as a UK Overseas Territory. There are small scale commercial and artisanal fisheries and the region is under consideration for designation of a Marine Protected Area. Comparatively little is known about the marine biodiversity surrounding the island, most research conducted to date concerns the turtle and seabird populations and shallow water assemblages (from diving). In 2014, The Ascension Island Government Conservation Department (AIG) in partnership with the South Atlantic Environmental Research Institute (SAERI) and the British Antarctic Survey (BAS) were awarded DEFRA funded Darwin-Initiative project to attempt to radically improve the state of marine biodiversity knowledge and understanding. The Blue Marine Foundation funded the continental shelf component of this which involved a science cruise, JR864 of the RRS James Clark Ross. The research planned, involving marine biologists from the partner institutes as well as Cefas and National Oceanography Centre brought a team of 11 specialists with expertise in multibeam seabed mapping, habitat profiling, benthic biodiversity, taxonomy and population genetics.

The oceanographic research ship RRS *James Clark Ross* attempted to physically and biologically characterise Ascension Island's shelf from 14th-18th October 2015. Multibeam sonar swath was used to generate the first open-access, high resolution mapping of Ascension Island's seabed between 100-1100m depth. These data was used to determine seabed profile and rugosity characteristics. Seabed substratum was investigated using a benthic camera lander (SUCS) and water column physico-chemistry was gained using CTD. The SUCS provided 500 photographs and video clips of benthos from 21 site/depth combinations, which showed a wide disparity in richness and density of biodiversity. These were ground-truthed by targeted Agassiz trawl samples to collect vouchers specimens for morphological and genetic identification. Specimens collected were photographed, fixed and then preserved in 96% ethanol for later genetic analyses. Preliminary analysis of the biodiversity captured was undertaken in the Conservation Department building, Georgetown, Ascension Island and indicated new records for the Island including first records of brachipods.

Analysis of the photographs by taxonomists on the voyage supported by collaborators elsewhere revealed 95 morphotypes, representing 25 classes and 13 phyla. Of these the most ubiquitous were Serpulid polychaetes, *Caryophyllia* cup corals, *Nematocarcinus* shrimps and *Ophiocantha* brittlestars. The latter were the most abundant of the macro- and megafauna. Total individual densities varied by more than three orders of magnitude from 1 to >300 ind.m^2; the highest densities were at ~500 m whereas highest richness occurred at 200-250 m depth. For a young and very isolated island, the average of >14 species m^2 (maximum of 24 species m^2) were surprisingly high. *Lophelia* corals and *Cidaris* sea urchins were typically the most important in terms of biomass, benthic carbon accumulation and provision of secondary space. We suggest that habitats at 200-500 m depth would be particularly important to include in any proposed Marine Protected Area. This is not just because biodiversity is typically richest and densest there but also because many species there are characteristic of Vulnerable Marine Environments (such as branching corals, cup corals, whip corals and erect sponges), and could be important in bentho-pelagic coupling (prey for fish) and seabed carbon accumulation.

2. List of personnel

2.1. Scientific and technical

DKA Barnes	BAS	PSO
CJ Sands	BAS	Molecular ecologist
S Morley	BAS	Physiologist
E Gowland	BAS	Polar Data Centre
P Enderlein	BAS	Marine engineer
OT Hogg	BAS	Biogeographer
J Brown	AIG	Fisheries biologist
K Downes	AIG	Marine biologist
E Nolan	AIG	Fisheries scientist
A Richardson	AIG	Marine ecologist
S Weber	AIG	Marine biologist
V Laptikhovsky	CEFAS	Marine biologist
T Smyth	PML	Oceanographer
G Tarran	PML	Oceanographer
S Thomas	AME	Electronics engineer
A England	BAS	IT engineer
C Cameron	NMF	Marine engineer

BAS = British Antarctic Survey, AIG = Ascension Island Government, Conservation Department, Cefas = Centre For Environment, Fisheries and Aquaculture Science, Lowestoft, UK, SMSG = Shallow Marine Surveys Group, Falkland Islands. PML = Plymouth Marine Laboratory, AME = Antarctic Marine Engineering, NMF = National Marine Facilities, Southampton.

2.2. Ship's complement

RA Stevens	Master
TS Page	Ch Off
AK White	2nd Off
GGJ Johnston	3rd Off
MEP Gloistein	ETO (Coms)
NC Macdonald	Ch Eng
G Behrmann	2nd Eng
M Laughlan	4th Eng
CGL Thomas	Deck Eng
SP Amner	ETO (Eng)
RJ Turner	Purser
TA Osborne	Doctor
DJ Peck	Bosun Sci Ops
AM Bowen	Bosun
GA Dale	Bosun's mate
FJ Hernandez	SG1
AS Howard	SG1
LS Pedersen	SG1
D Hale	SG2
GN Henry	MG1
J Pratt	Chief Cook
LJ Jones	Sr Stwd
NR Greenwood	Stwd
G Raworth	Stwd
R Morton	Stwd

3. Timetable of events

14th Oct	Departure RAF Brize Norton & JCR swath collection
15th Oct	Swath collection, mobilisation & site 1 sampling
16th Oct	Site 1-2 deployments
17th Oct	Site 3-4 deployments
18th Oct	Site 5 deployments, demobilisation
19th Oct	Sort and identify Agassiz trawl samples
20th Oct	Analysis of SUCS and multibeam swath data
21st Oct	Complete analyses, start cruise report write up
22nd Oct	Complete cruise report write up, pack up
23rd Oct	Transit north

4. Introduction

The UK Overseas Territory of Ascension Island is an important habitat for sea turtles and seabirds, but most of its known native biodiversity occurs on the seabed but has been studied very little. There are two small scale commercial sports fishing business on island and recreational fisheries are a key social activity for the small civilian population. A new Darwin-Initiative project – Ascension Island Marine Sustainability (AIMS) has attempted to collate existing biodiversity knowledge and greatly increase this through a concerted series of activities including use of SCUBA to survey the shallows.

During the Ascension Island expedition (JR864) a sampling protocol was adapted from previous continental shelf biodiversity survey expeditions (JR262 and JR287). Prior to the cruise, available literature was searched for bathymetric information, collated and assembled. Likewise biological literature and databases were searched for verified and geo-referenced taxon records and these were used to aid sample strategy planning. Prior to leaving UK a network of taxonomic authorities were established who could take specimens of various groups once collected and attempt to identify these using morphological characters. A stock of 96% ethanol was organised for RRS *James Clark Ross* so that the geneticists could fix and preserve material, allowing for complementary analyses to the morphological work. Contributing to the BAS core scientific programme 'Biodiversity, evolution and adaptations', the cruise JR864 aimed to investigate Ascension Island's continental shelf waters biodiversity. This fits into the wider context of previous Convention of Biological Diversity (CBD) science cruises undertaken by the same team exploring South Georgia and the South Orkney Islands (2011) and Gough and Tristan da Cunha Islands (2013). Establishing the baseline biodiversity status of Ascension Island's shelf should aid in 1) understanding potential links (bentho-pelagic coupling) with fish populations and fisheries, 2) mapping biodiversity hotspots (in endemism, rarities or fragile species), 3) highlight locations of particular biological value, including hotspots of carbon accumulation, and finally 4) assessment of threats and potential mitigation. The research cruise begins a new co-operative partnership between UK/Falkland Island Institutes and AIG – providing many opportunities in training and capacity building through information and skills transfer.

This report details the marine biodiversity background (section 5), political context (section 6.1), commitments of Ascension Island (section 6.2) and the development of critical environmental baseline information for future management of Ascension Island's marine biodiversity and the ecosystem services it provides (section 7). With this and the current

Darwin Initiative project AIMS as background context, the RRS *James Clark Ross* cruise JR864 used four key apparatus types (section 8) to optimize a sample regime (section 9). Then we attempted to map Ascension Island's seabed bathymetry and characterise its physical conditions (section 10) and biological assemblages (section 11). The aim was to provide maximum detail (within the cruise time scale) about Ascension Island's continental shelf biodiversity, hotspots of richness and density, key habitats, ecosystem services and prioritisation of the geography of protection (e.g. where should be considered for inclusion within a Marine Protected Area).

5. Ascension Island marine biodiversity background

Ascension Island is a small island situated in the tropical South Atlantic (7°56′S 14°25′W). Located approximately 1,500 km from the West African coast and 2,400 km from South America, the nearest landfall is St Helena, an island 1,130 km away. The island surface above sea-level was formed by volcanic activity approximately 1.5 million years ago. This makes Ascension Island relatively young in comparison to other Atlantic islands such as St Helena.

Being a small island ($97 km^2$) with no enclosed bays or sheltered lagoons the entire coastline of Ascension is subject to Atlantic swells. Many of the expected tropical coastal habitats such as mangroves, seagrass beds and coral reefs are absent, replaced only by a volcanic rocky substrate with infrequent and irregular beaches of coarse sand. Much of the rocky shore habitat on Ascension is formed from lava flows, fragmented to form ridges and slopes.

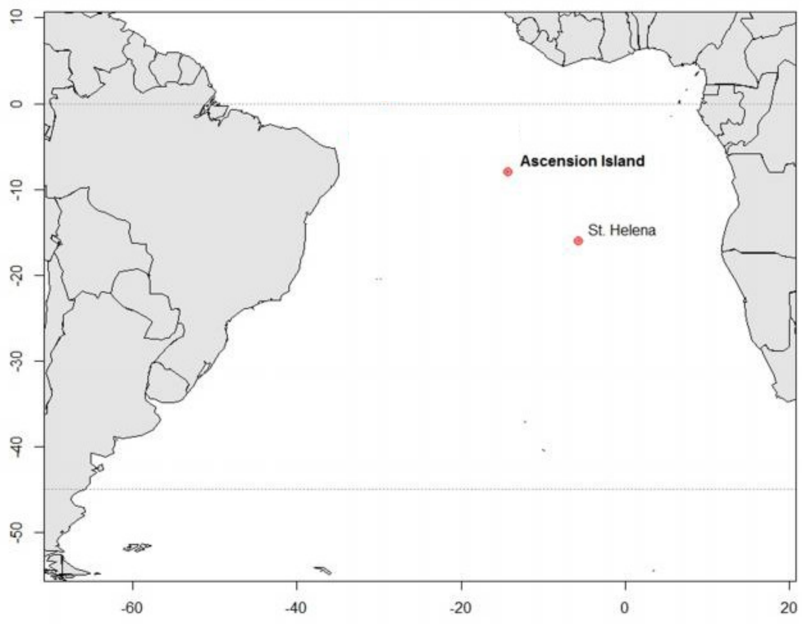


Figure 5.1 The position of Ascension and St Helena islands in the Atlantic Ocean

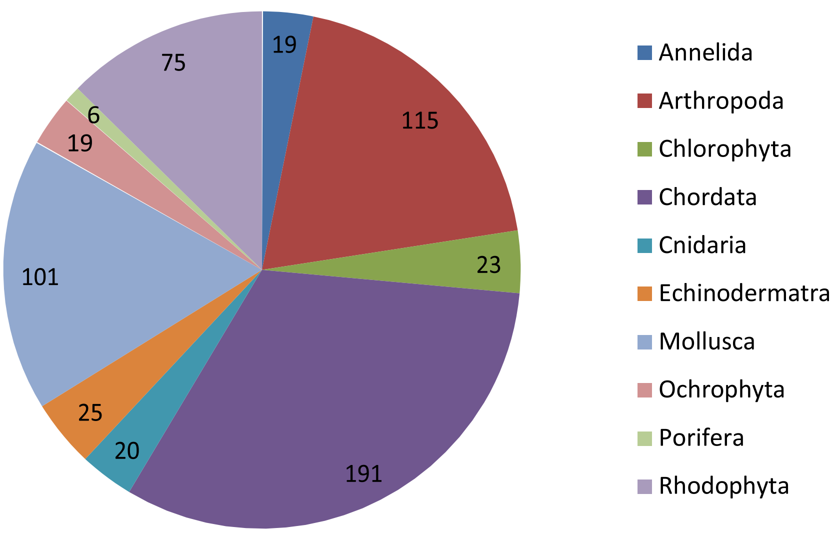
The intertidal and infralittoral fringe generally consists of stark, bare rock, interspersed with tide pools which show a pattern of zonation. Three sub-tidal habitat types are common around Ascension Island, rocky reef, sandy areas and rhodolith substrate. The physical structure of the rocky habitats varies around the island, often depending on the geological history.

The marine environment on Ascension is remarkably unexplored below a depth of 30m. HMS Challenger visited Ascension Island in March 1876, conducting 23 deep water soundings, 4 bottom dredges, 9 open water trawls and sea surface temperature observations. Previous to JCR 864, the HMS Challenger is the only known research vessel to have conducted similar investigations of deep water marine fauna, flora and seabed surrounding Ascension Island.

Due to both its isolation and position within ocean circulations, Ascension Island harbours a unique marine environment in that it represents assemblages from both the Eastern and Western Atlantic, including Caribbean, West African and Mediterranean fauna. Currently there are 35 endemic marine species known with several others awaiting description from shallow water collections.

To date a total of 594 marine species, have been recorded from Ascension Island, 138 of these are classified as common near-shore species and have been monitored since June 2014, on a monthly basis, during abundance & biodiversity SCUBA (>30m) surveys by the Ascension Island Marine Sustainability (AIMS) team. Of the 138 species included in the surveys, 63 of these are benthic species or predominantly associated with the benthos.

Figure 5.2 Number of marine species (by phylum) recorded from Ascension Island previous to JCR864



Ascension Island fish-community richness is low for a tropical island, only 174 species recorded. This has been attributed to the isolation and the poor diversity of habitats around the island mass. While the physical nature of the sub-tidal rocky reef habitat varies around the island, this habitat frequently holds the highest marine richness with an array of benthic and pelagic fish species being found there.

6. Political context and commitments of Ascension Island

5.1 Political context

Globally there is increasing awareness in the need to conserve marine ecosystems and this is reflected in a large political drive for marine protection within the UK. In their 2015 manifesto, the Conservative UK Government pledged to create "a Blue Belt around the UK's Overseas Territories", including "a protected area at Ascension Island, subject to the views of the local community". Ascension Island Government suspended commercial tuna long-lining in its waters in January 2014 and has spent the past 18 months considering in full the best way to manage its marine environment. Balancing the environmental value of protecting the marine environment alongside the economic driver to generate much needed income for Ascension Island, AIG is keen to ensure that informed decisions are made using appropriate scientific information. Whilst policy makers have considered a wide body of information on the marine environment it has also highlighted areas where information is lacking. Knowledge on the abundance and distribution of vulnerable species or habitats and the threats they may face is fundamental to designation of marine protected areas and therefore it is vital to gather biological data on which reasoned policy decisions can be made.

5.2 Local and international commitments for Ascension Island

Ascension Island has a 5 year strategic development plan with one of its ten core objectives being "to enhance the protection of the Island's terrestrial and marine biodiversity". Sub-objectives under the Environment section are:

(i) Establish a robust management, policy and legislative framework to regulate the impacts of development, pollution and resource use on natural systems, including licensing and management of fisheries;

(ii) Ensure the protection of Ascension's native and endemic marine and terrestrial biodiversity, including the restoration of degraded habitats to promote the recovery of threatened species;

(iii) Institute new, and continue long-term, research and development programs to further our knowledge and to better inform management decisions

(iv) Continue to raise awareness of Ascension's unique natural environment.

The strategic plan demonstrates Ascension Island Governments' commitment to conservation and their desire to underpin decisions with good scientific evidence. Ascension Island Government has ratified the Convention on Biological Diversity (CBD) and as such aims to contribute directly to Aichi Targets through conservation projects. Aichi target 11 states that "by 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes." Ascension Island Government and Councilors are in favour of marine protected areas where they are scientifically justified and financially viable.

Ascension Island Conservation Department has recently completed a Biodiversity Action Plan for the Island with key activities to be delivered being to "develop an Ascension Biodiversity Catalogue to host species inventories from all taxa"; to "Collate and review existing oceanographic and fisheries resources relating to Ascension Island's exclusive fishing zone and surrounding waters, integrating spatial datasets into GIS wherever possible."; to " Produce and ground truth a fine scale habitat map of Ascension Island's shallow marine environment and integrate into GIS as a basis for marine spatial planning." and to "Characterise spatial and temporal variation in community structure across all shallow marine habitat types using underwater visual census techniques and photo quadrats."

This current project inputs directly into several of these key activity areas in particular providing species and habitat data from 100-1,000m, beyond the depths available to be surveyed by the AIG Conservation dive team.

7. Developing critical environmental baselines for marine management on a tropical Atlantic Island

Prior to the current Darwin-funded AIMS project, a lack of baseline scientific data relating to the marine environment and a lack of capacity in marine and fisheries science on the island were major barriers to the effective management and conservation of the Island's marine resources.

A Darwin Challenge Award to the Shallow Marine Surveys Group (SMSG)/South Atlantic Environmental Research Institute (SAERI) in 2012 generated some much needed baseline data, resulting in 27 papers which will form a special issue in the Journal of the Marine Biological Association of the United Kingdom on Ascension Island's near shore flora and fauna.

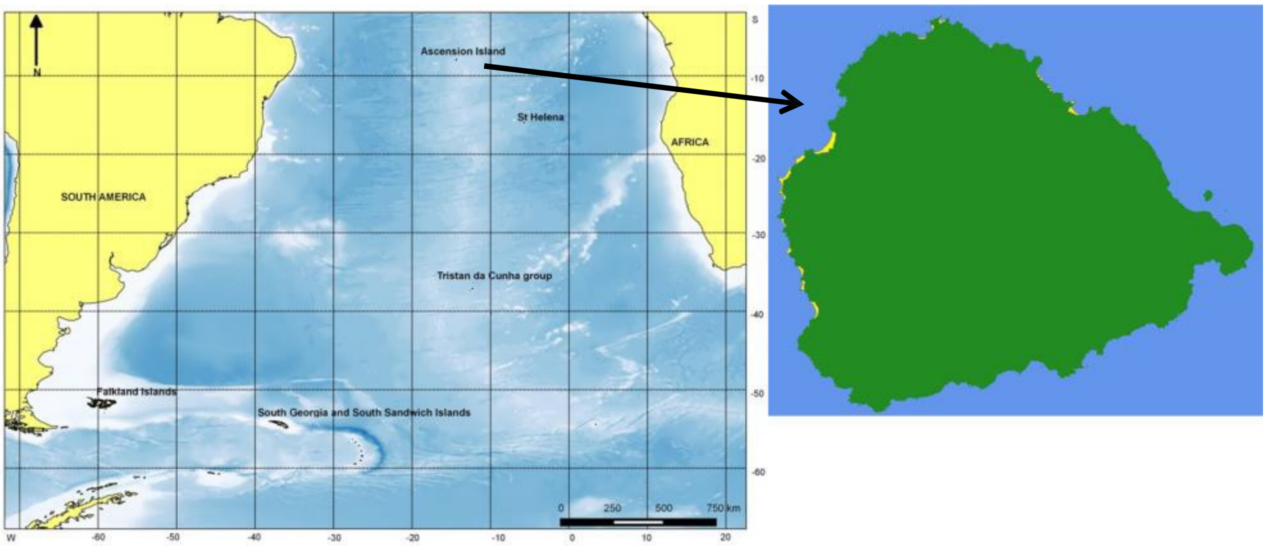


Figure 7.1 The position and shape of Ascension Island, Atlantic Ocean.

However, this project was limited in time and scope and spawned a more comprehensive marine biodiversity and conservation project in the form of the AIMS project

Funded by the Darwin Initiative, the AIMS Project is being delivered by drawing on existing expertise in marine and fisheries science from within the South Atlantic UKOTs (SAERI, British Antarctic Survey (BAS), SMSG), as well as the wider NGO community (Royal Society for the Protection of Birds (RSPB)). Due to be completed in June 2016, the project is helping to fill remaining knowledge gaps and build capacity and facilities at Ascension Island that will enable the sustainable management of marine resources beyond the lifespan of the AIMS project.

The AIMS project comprises three complementary work programmes:

1. Inshore (<30m) and offshore (>30m) marine biodiversity and habitat mapping.

This element is building on preliminary work conducted by SMSG/SAERI during a recent Darwin Challenge Award by filling temporal, spatial and bathymetric data gaps. Specifically, it is undertaking fine scale habitat classification and mapping; establishing a network of monitoring sites across habitat types to examine spatial and temporal changes in community structure, and is assessing the status and trends of endemic species; deploying settlement plates to monitor recruitment and invasive species; developing Habitat Action Plans (HAPs) and Species Action Plans (SAPs) for selected marine species within the NBAP framework; integrating data into a GIS platform as a basis for future marine spatial planning.

2. Inshore fisheries biology and management strategies. This component is building fisheries science capacity within the Territory by: setting up a marine fisheries laboratory with otolith saw, microtome, microscopes etc.; developing a strategy for conducting fisheries biology on a selection of commercial inshore species, including age, growth, reproductive biology etc.; training AIG Conservation Department staff in fisheries biology techniques; using underwater visual censuses to monitor abundances of commercial species at selected sites; working with the local community to build engagement in fisheries management and develop a reporting system that will collect catch and effort data from the line fishery, small vessel fishery and the charter boat fishery; developing a strategy for managing inshore line and vessel fisheries, including licensing and legislation if appropriate; deploying pop-up satellite archival tag (PSAT) on tuna to study their migration and behaviour. The latter will also contribute to an understanding of spatial and temporal distribution of fisheries resources in work programme 3.

3. **Reviewing offshore fisheries resources and by-catch.** This element deals with data collection and assimilation from ICCAT and other sources; it will review temporal and spatial changes in abundance of species in the offshore fishery utilising historic catch and effort data from ICCAT in conjunction with environmental data; it will conduct geospatial analyses to examine inter- and intra- annual distribution of species'

abundance; examine the potential for predictive models based on environmental proxies; conduct a by-catch risk assessment utilising existing data from tracked seabirds and turtles.

JR864, a 4 day survey on the *Royal Research Ship James Clark Ross* within Ascension Islands' Territorial waters, was undertaken as a core component of the AIMS project work programme 1

This area is likely to hold Ascension Island's greatest biological diversity. The survey included fine scale swath bathymetry, oceanography, drop down camera work, and Agassiz trawls. Utilising swath bathymetry (also referred to as multibeam echo sounding) enabled the cruise scientists to map the sea floor in 3 dimensions which allowed us to highlight areas of interest for further examination and will allow the survey team to create habitat maps. Drop down camera work and benthic Agassiz trawls enabled the team to assess the area's biological diversity. The cruise also allowed us to map and determine the distribution of rhodolith beds around the Island. Rhodoliths are free-living coralline algae (Rhodophyta, Corallinales) that are ecologically important for the functioning of marine environments. They are also important for carbon sequestration.

The success of the cruise is down to a combination of factors; notably the versitility of the JCR, its crew's 'can do' approach and importantly a team comprising individuals from 6 institutions (AIG, SAERI, BAS, SMSG, NOC and Cefas) that have successfully worked together in similar isolated and data poor regions.

The cruise has taken our marine biodiversity understanding of Ascension Island to a much needed new level which will be critical to informing the MPA debate currently ensueing in the United Kingdom and indeed on the Island. The cruise is an excellent model for future work; the JCR transits the equator twice a year, before the beginning and after the end of the Antarctic summer season, and because of this there are reduced mobilisation and de-mobilisation costs. This survey is therefore incredibly good value for money. Furthermore, with this cost effective model, the vessel could be used in the future to expand upon this survey and explore the waters in the wider region in order to bridge extensive environmental knowledge gaps.

8. Equipment used

8.1 Multibeam Swath sonar EM122

Background

The information about ocean depth and the topography of the sea floor around Ascension Island was relatively sparse before this cruise. The UK Hydrographic Office navigational chart of the area is constructed from data collected between 1826 (using leadline) and 1984 (singlebeam echosounder data). The area is also covered by the General Bathymetric Chart of the Ocean (GEBCO) which is a mix of satellite derived and ship collected data, which has data to 30 seconds of arc resolution, which is approximately 2km.

To enable the selection of sites for the underwater camera and trawling, it is necessary to have an accurate picture of the depth, structure and composition of the seafloor, on the scale of tens of metres and a multibeam survey can provide this information. Knowledge of the depth and topography of the sea floor can also aid habitat mapping.

The RRS James Clark Ross (JCR) is fitted with a Kongsberg EM122 multibeam system. This sends out a fan of acoustic beams to measure the depth of the seafloor in an area directly below the ship and up to 4 – 5 times the width of the water depth, depending on the settings used (see operational settings).

Operational Settings

The EM122 system is run through the Windows based SIS software provided by Kongsberg. Throughout the cruise the EM122 was run in external trigger mode with the ping rate calculated by the Kongsberg Synchronisation Unit (K-Sync). SIS creates 'on the fly' grids of the data as it is collected and these are displayed in the geographical window, and on the Helmsman machine which is displayed on the bridge. The creation of these grids requires that a grid size is defined for each new survey which cannot be changed once selected. During this cruise the number of cells in the processing grid was always set to 128*128 and the grid cell size was set to 50 metres. Angular coverage mode was set to manual and beam spacing to high density equidistant for the duration of the cruise. The max beam angle was varied from 50° to 75° depending on the sea state, water depth and bathymetry, often on the slope the uphill beam was extended much further than the downhill beam to try and maximize data capture. The max width kept constant at 20,000 m to port and starboard. Pitch stabilisation was set on, yaw stabilisation off, auto tilt off, along direction to 0° and heading filter to medium. Spike filter strength was set to medium, range gate to normal, phase ramp to normal and penetration filter strength to off. Slope and sector tracking were both switched on and the angle from nadir was set to 6°. Salinity was used as the absorption coefficient source with the default value of 35 ppm. Throughout the cruise the mammal protection power level was set to max with a startup ramp time of 0 mins. The real time data cleaning was set to auto 0.

System performance

The EM122 performed well during this cruise. There were a couple of minor issues with the SIS software not displaying all the data collected, and 2 crashes of the system, but these had little impact on the data collection. There were a couple of occasions where small areas of data were missed or incorrectly captured due to user error, these will be excluded or processed to correct the data before analysis.

The external trigger was controlled by the Kongsberg Synchronisation unit (K-Sync), so the singlebeam (EA600) and multibeam (EM122) were run in parallel. The bridge set the EA600 into passive mode with external trigger, and no interference on the EM122 was observed.

Data lines 0000 and 0037 from jr15001_b were excluded from the grids displayed in this report. Line 0000 is an approach line (which extends a long way outside the boundaries of the 6 nautical mile limit, and 0037 had incorrect parameters set initially so the data collected at the beginning of this line is incorrect.

There are some seemingly anomalous readings which appear as ridges in the shallow data following the cruise track which look like potential sound velocity issues (smile shaped). This could be because a deep water CTD profile was applied and then the top few hundred metres of water are different in the shallow water area. This affects parts of lines from survey jr15001_b (e.g. 0012, 0017, 0022). However, it could also be due to other factors such as wave / swell direction, or potentially these could be real features.

Next steps

The data will be processed, and the extra data collected after our disembarkation will be added to try and provide the complete picture from 100m depth to a distance of 6 nautical miles offshore. Once cleaned, the data will be provided to the UK Hydrographic Office for consideration of incorporation into the navigational charts. These data will be assessed to see if the backscatter is good enough to determine the bottom type (rock, sand, etc) to support habitat mapping.

8.2 Conductivity-Temperature-Depth CTD

A Conductivity-Temperature-Depth (CTD) unit was used to vertically profile the water column. During the cruise 5 casts were carried out in total.

An SBE32 carousel water sampler, holding 24 12-litre niskin bottles, an SBE9Plus CTD and an SBE11Plus deck unit were used. The SBE9Plus unit held dual SBE3Plus temperature and SBE4 conductivity sensors and a Paroscientific pressure sensor. An SBE35 Deep Ocean Standards Thermometer makes temperature measurements each time a bottle is fired, and time, bottle position and temperature are stored, allowing comparison of the SBE35 readings with the CTD and bottle data. Additional sensors included an altimeter, a fluorometer, an oxygen sensor, a photosynthetically active radiation (PAR) sensor and a transmissometer. The altimeter returns real time accurate measurements of height off the seabed within approximately 100m of the bottom. This allows more accurate determination of the position of the CTD with respect to the seabed than is possible with the Simrad EA600 system, which sometimes loses the bottom or reverts to default values (approximately multiples of 500m) and, in deep water, often returns depths that are several tens of metres different from the true bottom depth. A fin attached to the CTD frame reduced rotation of the package underwater. The CTD package was deployed from the mid-ships gantry on a cable connected to the CTD through a conducting swivel.

CTD data were collected at 24Hz and logged via the deck unit to a PC running Seasave Win32 (Sea-Bird Electronics, Inc.), which allows real-time viewing of the data. The procedure was to start data logging, deploy the CTD, then stop the instrument at 10m wireout, where the CTD package was left for at least two minutes to allow the seawater-activated pumps to switch on and the sensors to equilibrate with ambient conditions. The pumps consistently switched on 60 seconds after the instrument entered the water, as they should. After the 10m soak, the CTD was raised as close to the surface as sea conditions allowed and then lowered to within 10m of the seabed. No bottles were fired on the upcast as there was no need to collect water for further analysis**.**

8.3 Shelf Underwater Camera System

SUCS setup:

During summer 2014 the SUCS (shelf underwater camera system) was upgraded, replacing the pre-existing coax cable with a fibre-optic system. The main aim of this upgrade was to rectify an issue whereby the software frequently crashed as a result of sudden changes in tension on the data cable (caused mainly by landing the system on the sea bed or through the roll of the ship in rough weather). Additional benefits to the new cable also included an increase in the system's depth rating from 300m to 1000m, higher definition video, and a higher resolution, live colour feed.

The SUCS for the Ascension cruise comprises of three units:

1. The UIC unit consisting of (i) the PC with monitor, (ii) the cable metering sheave indicator and (iii) the deck box.
2. The deck unit consisting of (i) the winch, (ii) UW-cable, (ii) the deck monitor and (iii) the metering sheave on the mid-ships gantry.
3. The UW-unit consisting of the tripod holding the UW-housing including the camera, booster and power distribution board and the UW-light.

New components to the SUCS system since 2014 included 1000m of fibre-optic cable, fibre-optic connections at both the deck box and camera housing end, a new 1000m depth rated glass for the camera housing, and a slip-ring to accommodate separate power and fibre-optic cables.

The modification of the LabView code together with the fibre-optic upgrade enabled for the first time high-resolution photo stills (2448 x 2050) and video footage (2448 x 2050) to be taken simultaneously. Also the live feed is now in full colour and in HD (2448 x 2050).

Using SUCS during the Ascension cruise:

The SUCS can be used to estimate faunal density, biomass and species abundance of the benthos, which is otherwise difficult to achieve because of the selectivity and semi-quantitative nature of capture by the AGT. In addition it gives an overview of the conditions of the underwater landscape. Hence SUCS transects were performed to investigate the poorly known topography of the benthic environment around Ascension, below 100m. The SUCS and Agassiz gears, when both deployed at the same site, increase the value of the data obtained. This is because specimens trawled in the latter and identified by detailed morphological inspection or using molecular methods improve the likelihood and confidence of correct identifications of individuals seen in the SUCS images.

During the cruise over 400 high-resolution photo stills and about 100 video clips were taken during 21 deployments. The stand out benefits of the new system (vs. the old coax setup) was the rapid processing time for each photo and consequently the speed at which photo transects could be conducted, and the ability to simultaneously capture HD photo stills and video. During JR308 (December 14/15) the SUCS system was for the first time successfully deployed to 600m. During this cruise the system was for the first time successfully deployed to its full operational depth of 1000m. In contrast to the old system used during JR262, JR287 and

JRtri008 where the system suffered from software crashes, with the new fibre-optic and software upgrades the new system proved to be as stable and reliable as during JR308, with only a couple of software crashes, and none during any of the landings on the seabed.

8.4 Agassiz Trawl AGT

To ground truth the SUCS camera images an Agassiz trawl (AGT), was used to sample animals from ~1 cm and larger in length, which comprise the larger macro- and megafauna. The AGT was connected to the ships dredge wire via 2 shackles and a heavy duty swivel.

The Agassiz trawl used has a mesh size of 1 cm and a mouth width of 2 m. At each station the seabed topography was examined prior to trawl deployment using multibeam sonar (swath) and the SUCS camera system. The deployment protocol was standardised. While the AGT was lowered, the ship had to compensate for the wire lowering speed of max of 50 m/min by steaming at 0.3 knots until the AGT reached the seabed and at 0.5 knots until the full trawling wire length was put out. The full trawling cable length used was 1.5 times the water depth. The net was then trawled at 1 knot for 5 minutes. Afterwards, with the ship speed reduced to 0.3knots, the AGT was hauled at 30 m/min in order to avoid damaging the gear. When the AGT had left the seafloor, the hauling speed was increased to 45 m/min.

In total 7 deployments of the AGT where made. Due to the volcanic terrain the trawling was quite challenging. On two occasions the AGT became stuck on the sea bed at the swivel end, causing tension on the wire of up to 9 tonnes. After the second time the trawl was freed, because of the difficult terrain, the decision was made to concentrate on the SUCS camera work instead of risking the loss and/or major damage to the AGT for further ground truthing.

8.5 Analysis

ANOSIM (Analysis of Similarity) is a multivariate data analysis tool employed by ecologists to compare variation in faunal composition across sample sites in terms of a specific grouping factor or treatment (e.g. the effect of depth on biological assemblages).

Nonmetric multidimensional scaling (nMDS) is an ordination technique that enables the level of similarity, based on Bray Curtis distance, between samples to be visualised by scatterplot. The results are displayed on a 2-dimensional axis whereby increasing distance between points represents decreasing similarity. nMDS enables the inclusion of multiple grouping factors in the analysis. So, for example, when looking at species compositions in samples, environmental factors such as depth, temperature and substrate type can be included and visualised in the graphical output to assess whether they act as good predictors of species compositions. The effectiveness of rendering multiple variables in a 2-dimentional space is measured by a stress value which should be <0.2 in order for the output to be considered a reasonable representation of the data. If the stress factor falls around or above this value the number of grouping factors should be reduced.

9. Sample regime

The number of planned sampling sites was determined on the basis of the time scale available divided by the expected time taken for each deployment of each gear, taking into account team size, working shift times of scientists and crew, and the time taken to switch between apparatus. By using multiple apparatus we intended to investigate organisms across a range of habitat types, but focus on macro- and mega-fauna (animals large enough to see without the aid of microscope). Realised sample regimes (compared with planned ones) often omit sites, add others and use different suites of equipment due to limitations imposed by weather, equipment malfunction and changes to scheduling of other activities planned for the ship. Our plan was to collect multibeam swath data to map about 75% of the seabed at 100-1000m depth. From this, sites for more detailed sampling would be selected on the basis of contrasting bathymetry data (e.g. to visit as representative and wide a range of habitats as possible). The plan was then to sample five depths at each of three sites as follows;

- Shelf Underwater Camera System (SUCS): 20 photos of 0.25 m^2 per depth per site
- Agassiz trawl (AGT): 1 trawl at each of 5 depths at each site (where practicable, given steep and abrasive topography)
- Conductivity Temperature Depth (CTD): 3 across each site

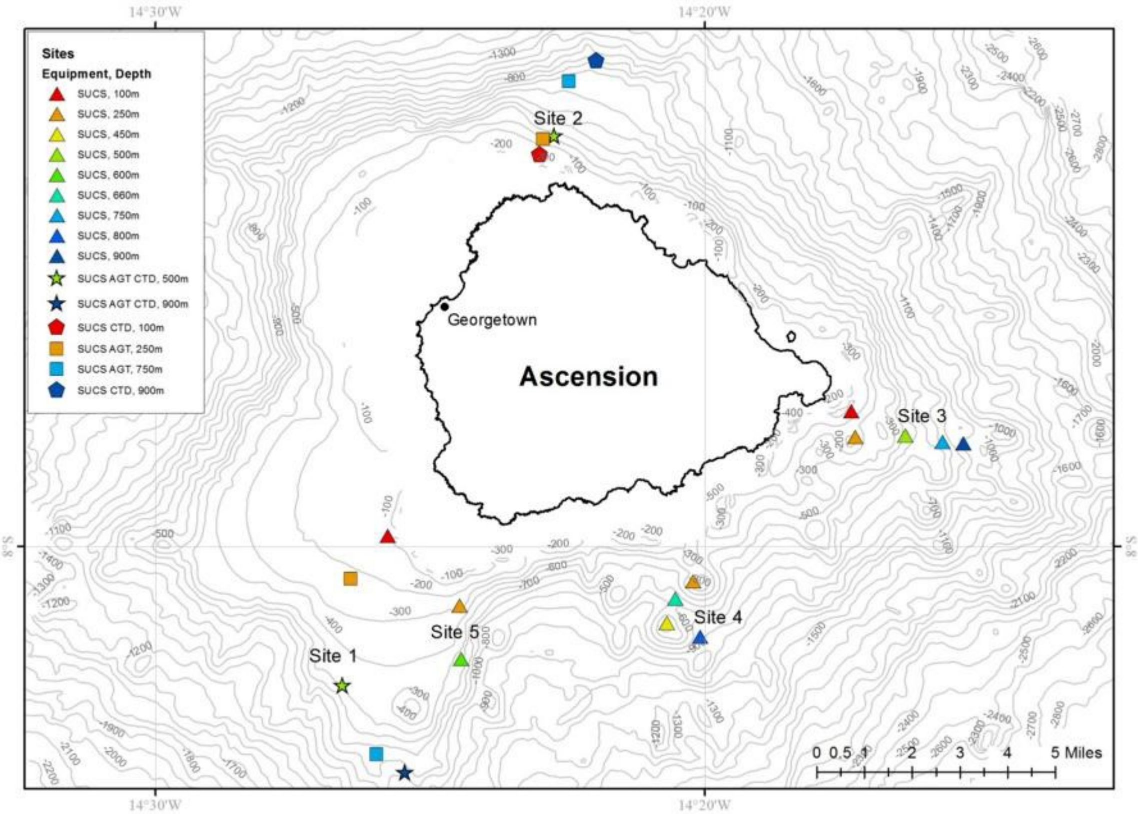


Figure 9.1 Sample locations of JR864, Ascension Island.

Our realised sample regime was a considerable improvement on our plan, largely thanks to the officers, crew and science staff of RRS James Clark Ross who arrived at Ascension early and collected a substantial quantity of multibeam bathymetry data for us prior to our embarkation. Mobilisation of equipment was efficient so we were able to rapidly make the first deployment.

10. Multibeam swath seabed mapping results

10.1 1 Multibeam swath mappings

Although the science party for JR864 did not join the JCR until 11am (GMT) on 15th October 2015 the multibeam data collection had begun earlier. Thanks to Captain Ralph Stevens & the officers of the JCR, Tim Smyth the AMT PSO and other AMT scientists, and the JCR ICT member Andy England, the data collection had already begun in the area (see survey table for details), and a large area had already been mapped (following the survey plan emailed through by the Ascension team in advance). This meant we had a massive head start on selection of sites for the underwater camera and trawling. This also enabled a much larger area to be surveyed than had been anticipated for the few days of cruise time available, resulting in nearly complete coverage from 100m depth out to 6 nautical miles from shore – an incredible achievement and an extremely valuable resource for the Ascension Island Government marine conservation team and (once processed) this will be provided to the UK Hydrographic Office to validate and update the navigational charts (if needed).

Due to the volume of data collected and amount of time on the cruise there was not time to process the data using MB-System (the normal method used in BAS), so all the work so far has been done on the raw data with limited editing using Fledermaus and ArcGIS software.

Table 10.1 – Multibeam Surveys

Survey	Start time	End time	Lines / Files
jr15001_b	14th October 2015 (JD287) 10:12:45	15th October 2015 (JD288) 17:33:45	0000 – 0039 (40 files)
jr150001_c*	16th October 2015 (JD289) 13:56:30	18th October 2015 (JD291) 09:59:01	0000 – 0022 (23 files)**

* This survey name contains a typo, and should read jr15001_c which will be used for the processed data.
**Please note that (again) due to the help of the crew, JCR ICT and AMT some multibeam data collection continued after the Ascension team disembarked (boat transfers around 10am GMT on 18th October 2015), so further data will be added to the survey jr150001_c.

Table 10.2 – Sound Velocity Profile

SVP	Date Time Applied
ASVP generated from AMT CTD48	14/10/2015 13:40:19
SVP from CTD JR15001_49	16/10/2015 13:30:00

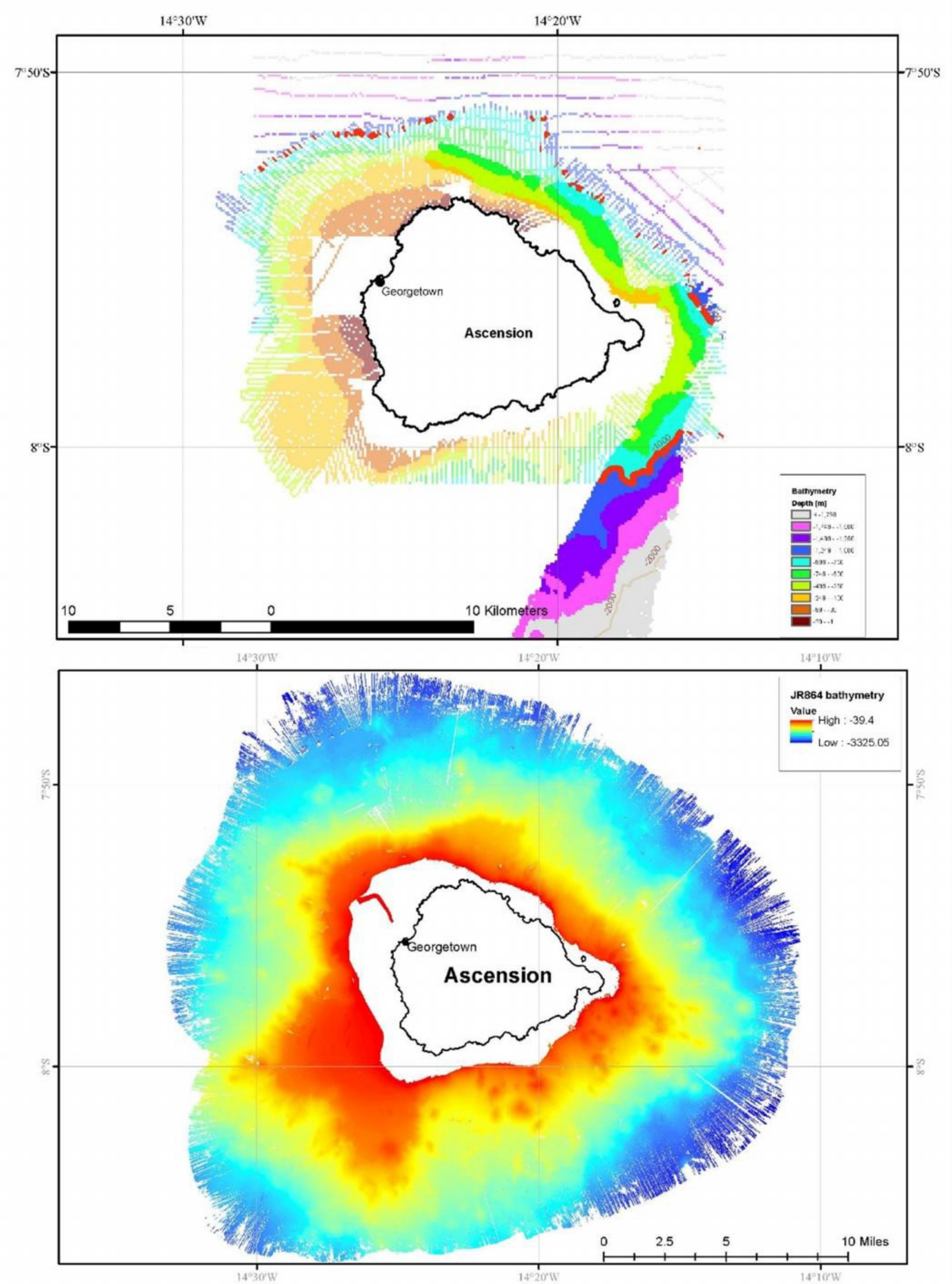


Figure 10 Comparison of bathymetric coverage before and after JR864

10.2 Seabed physical characteristics

Ascension Island has a narrow shelf which extends out from the island to a depth of ~450m (figure 10.2A). On the south-east and north-east of the island shelf area is much reduced with steep topography directly from the coastline. On the north-western and especially the south-western side, the seabed extends out in a large plateau which at its widest point extends 7km offshore. Beyond 450m the slope angle increases dramatically reaching depths in excess of 1000m within 1km from the island (figure 10.2B). This drop-off is most pronounced along the north-west coast of the island and to the east of the large south-eastern plateau where slope angle reach a near-vertical 78°. The slope around the island is punctuated by large topographic features rising from depth to, in places on the south coast, as shallow as 250m. This complexity in the topography creates regions of high rugosity over broad spatial scales (50m) (figure 10.2C) and large variable in Topographic Position Index (TPI) (figure 10.2D).

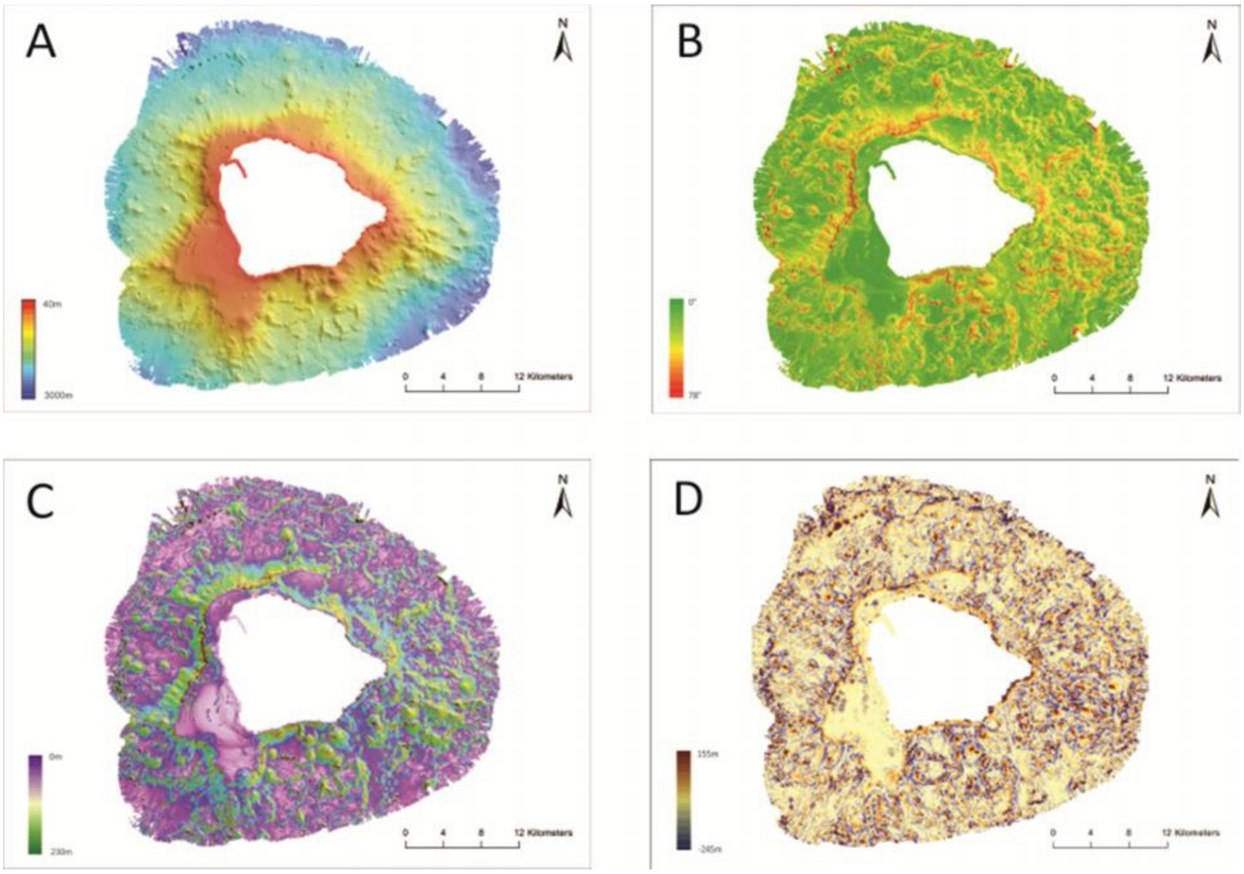


Figure 10.2 A: Bathymetry dataset gridded to 50m resolution. B: Slope is the measure in degrees (°) of the inclination of the seabed calculated using a roving window to compare each individual bathymetry point with its neighbours. Red regions denote steep slopes through to flatter regions in green. C: Terrain Ruggedness Index (TRI) is a measure of seabed rugosity.

It is calculated by comparing the 2-dimensional footprint area of the seabed versus the 3-dimensional area of the bathymetry dataset. A data point that differs in depth most from the mean depth of the surrounding cells will have the highest TRI. Purple regions denote low rugosity, whilst green regions denote high rugosity. D: Topographic position index (TPI) is a local elevation index which measures the relative topographic position of each bathymetric point in relation to its neighbours. TPI is a useful tool in identifying landscape features and topographic boundaries at different spatial resolutions. It provides an indication as to whether a site is located on a peak (red areas), in a valley (blue areas) or in a region of constant gradient (yellow areas).

Derivative bathymetry datasets such as slope angle, TPI and TRI are useful tools in understanding distribution patterns in biological assemblages because they allow us to quantify attributes of the physical environment beyond a simple measure of depth. By assessing slope angle and rugosity we can infer information about the substratum of the seabed. For example, regions of high rugosity and/or high slope angle could be assessed as hard or rocky substrate, whilst flat areas are more likely to be characterised by fine sediments of sand or mud. Likewise TPI can be used as a proxy for the relative exposure of an environment to help infer whether a habitat might support certain functional traits in fauna such as whether they are filter feeders, detritivores or suspension feeders. Through ground truthing with SUCS camera images and videos and AGT biological collection, if correlations can be drawn between the physical environment and the biological communities that inhabit them then geophysical datasets like these can be used to predict the distribution of regions of interest. These might include the presence of specific faunal assemblages, rare or endemic species or vulnerable marine environments (VMEs).

11. CTD results

Temperature and salinity profiles were recorded at two sites: site 1 to the south-west of Ascension at depths of 900 and 500 m, and site 2 to the north of the island at depths of 900, 300 and 100 metres.

Temperature profiles around Ascension were characterised by warm surface waters (24°C) with the top 80m of the water column falling in a narrow temperature range of 22-24°C. A sharp thermocline at 80m was identified at all sites, with temperatures rapidly dropping to 17°C and then continuing to drop to ~12°C by 200m. Below 200m water temperature continued to fall but at a reduced rate, falling to 10°C at 300m, 8°C at 500m and 5°C at 900m. At both sites temperatures stabilised at ~5°C below 800m.

Salinity was recorded at 36.2psu in the top 40m of water at all sites. All sites saw an increase in salinity between 50 and 60m peaking at ~36.5psu before dropping away sharply at first, then more gradually to ~35.0psu at 200m. Salinity stabilised at 34.5psu at depths over 600m.

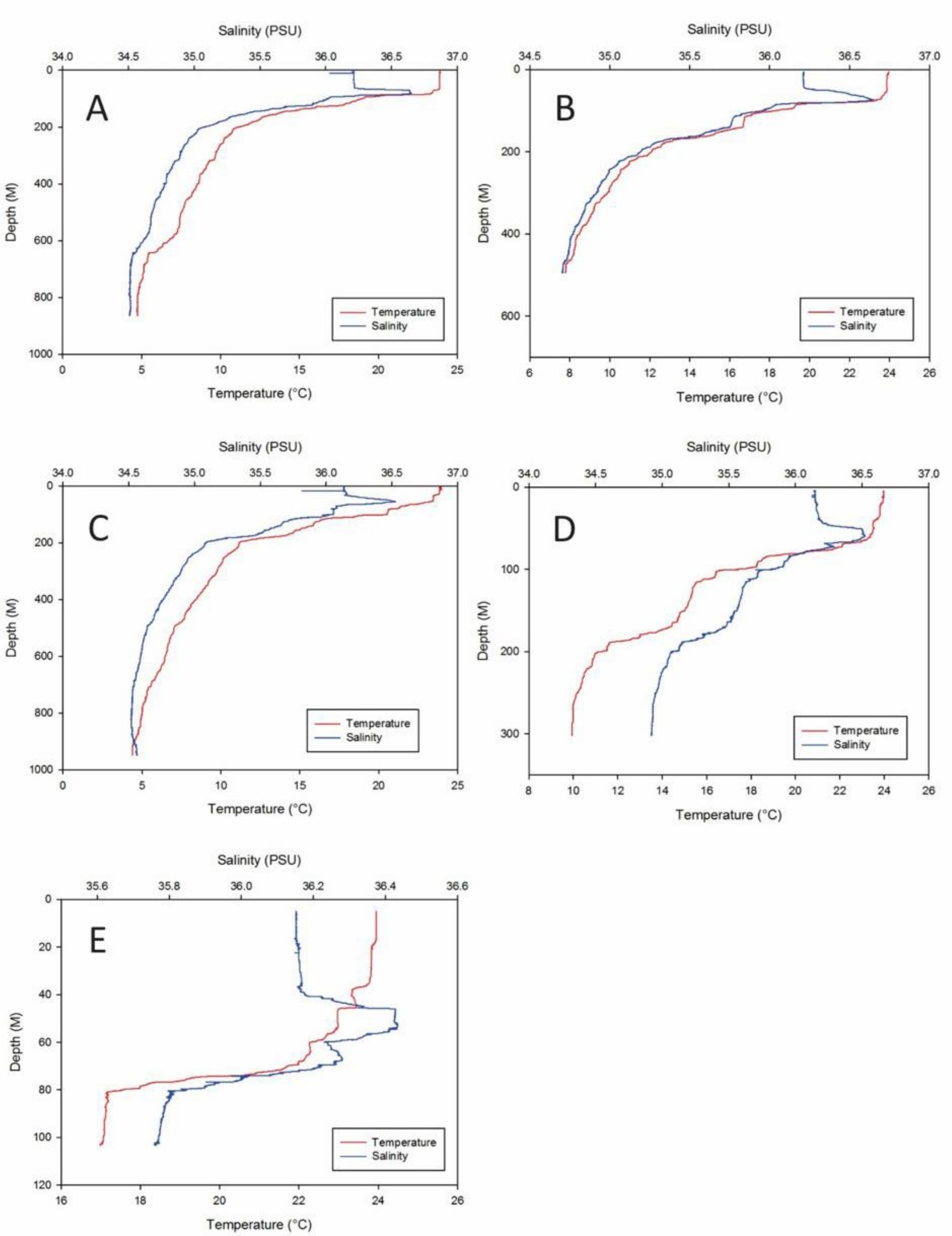
The temperature range across all sites and depths was 12.65°C and the salinity range across all sites and depths was 1.3psu (see table 11.1).

Table 11.1 Temperature and salinity at sample depth around Ascension Island.

Site	Temperature	Salinity
Site 1, 900m	4.7°C	34.5 psu
Site 1, 500m	8.1°C	34.7 psu
Site 2, 100m	17°C	35.8 psu
Site 2, 300m	10°C	35.0 psu
Site 2, 900m	4.35°C	34.5 psu

Figure 11.1

CTD derived temperature (red lines) and salinity (blue lines) profiles across depth. Data was collected at sites 1 and 2 at four depths: Site 1, 900 metres (A); Site 1, 500 m (B); Site 2, 900 m (C); Site 2, 300 metres (D); Site 2, 100 m (E)



12. Biological sampling results

12.1. SUCS

The SUCS was deployed across five sites around the coast of Ascension Island, the choice of which was primarily designed to capture habitat types on the basis of different seabed mapping signal. The bottom types were broadly bedrock, cobble-pebble matrix and coarse sand, though some photo-quadrats showed boulders within some of these habitats. Biological assemblages captured across 100-1000m at the five sites included 95 recognizable morphotypes, of which 57 could be preliminarily assigned to genus. These represented considerable higher taxonomic diversity of 25 classes and 13 phyla. Some of the species are characteristic of Vulnerable Marine Environments (such as branching corals eg. *Lophelia*, cup corals eg. *Caryophyllia*, whip corals eg. *Stichopathes* and erect sponges), and could be important in bioconstruction and seabed carbon accumulation.

The most ubiquitous morphotypes were *Serpula* (polychaete worm), *Caryophyllia* (cup coral), *Nematocarcinus* (shrimp, crustacean – see section 10.3) and *Ophiocantha* (brittlestar, Echinoderm). *Ophiocantha* brittlestars were the most abundant animals, reaching 400 ind.m^2 in places, forming a 'mesh' across the entire field of view of the camera. The major contributors to biomass, 3 dimensional habitat (bioconstruction) and benthic carbon accumulation were the coral *Lophelia* and the pencil urchin *Cidaris*.

This biodiversity contained new records for Ascension Island, such as the Grenadier fish *Malacocephalus laevis* (Fig. 12.1.1A) and *Ventrifossa* sp. (Fig. 12.1.1B).

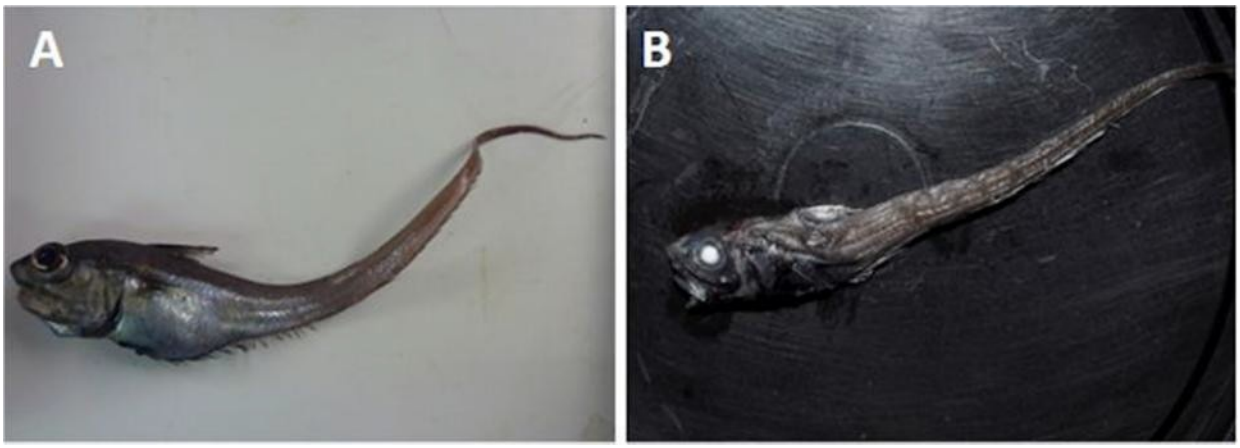
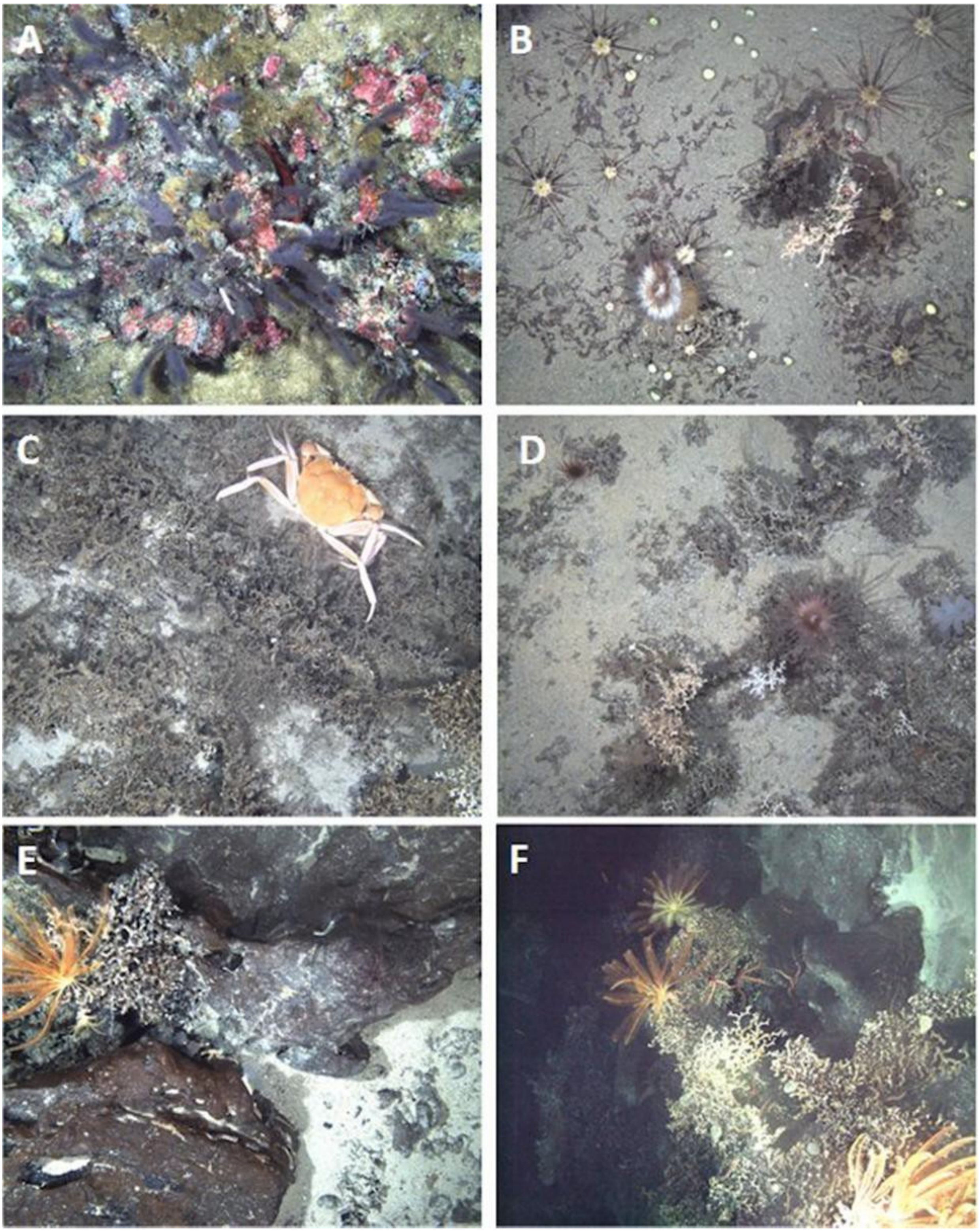


Figure 12.1.1 Grenadier fish Malacocephalus laevis (A) and Ventrifossa sp. (B)

Key habitats included Antipatharia (black coral) and encrusting algae dominated assemblages at 100m depth (Fig 12.1.2A), and fine sedimented substrates with abundant *Cidaris* (sea urchin) and *Caryopyllia* (cup coral) (Fig 12.1.2B). There were many areas with substantial biomass and a variety of errant (Fig. 12.1.2C) and sedentary animals (Fig 12.1.2D) but key to bioconstruction and carbon accumulation were the reefs of *Lophelia* (Fig. 12.1.2E,F) often with numerous crinoids.

Figure 12.1.2 Benthic habitats



12.2 Faunal composition from SUCS images

Trends in faunal composition within and across sites were analysed using non-metric multidimensional scaling (nMDS). Images from the SUCS were analysed for the presence and number of distinct faunal groups (identified to genus or species level where possible). In addition four physical environmental variables: depth, substrate type, rugosity and site location were included in the analysis. A stress-value of 0.14 indicated that the nMDS ordination represented a good representation of the data in 2-dimensional space (though not in itself an indication of a biological significant distribution).

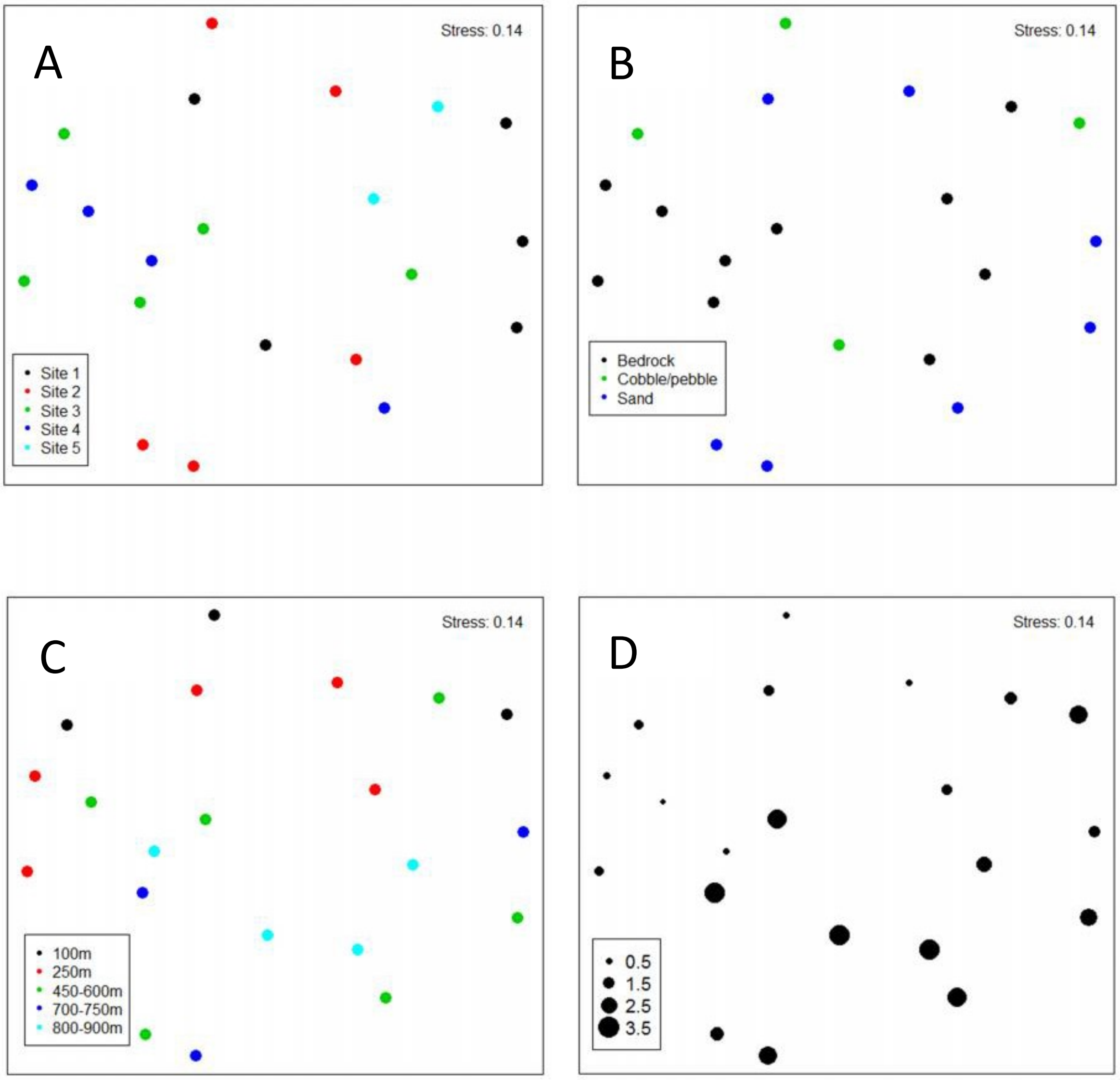
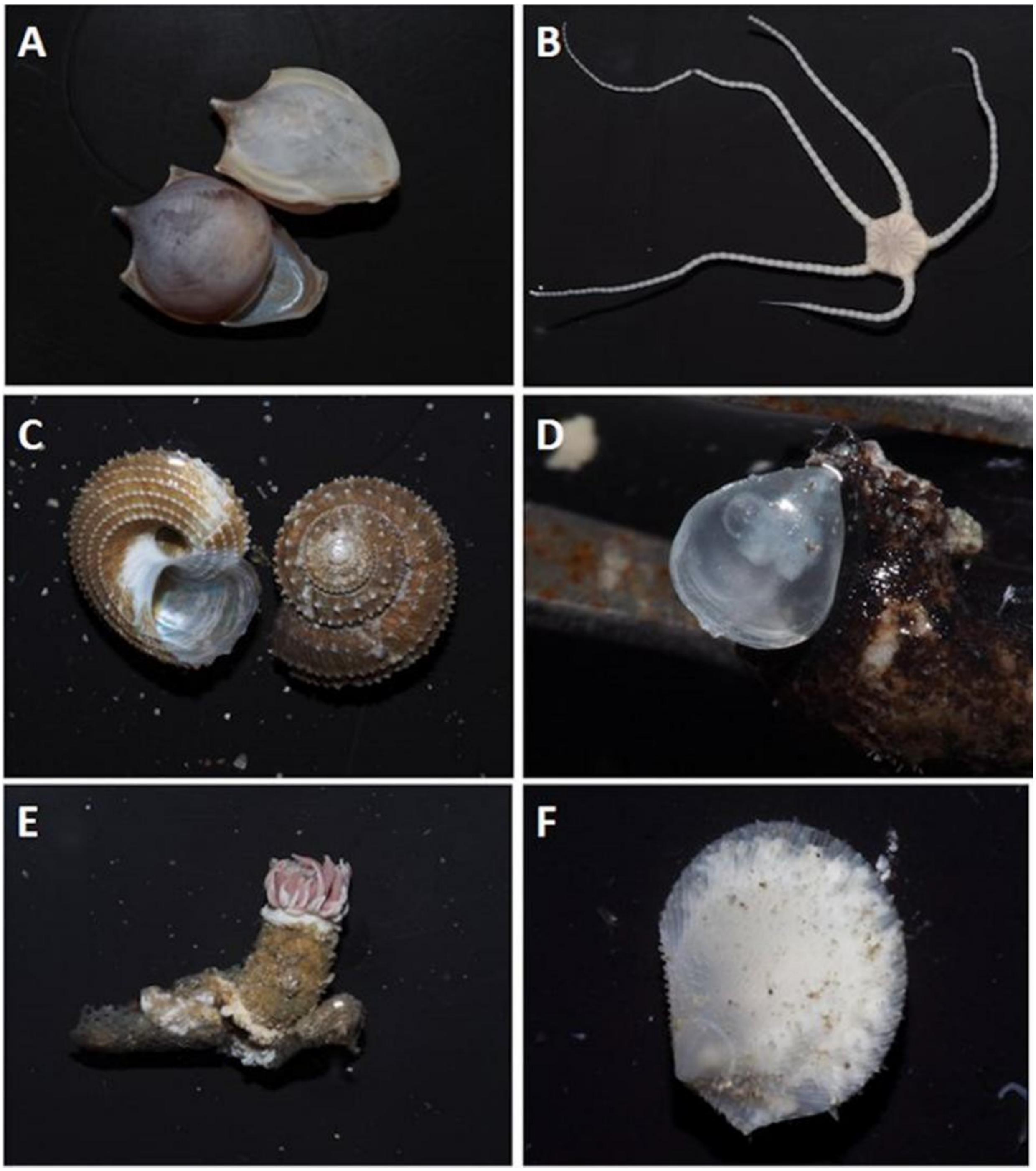


Figure 12.2.1: Nonmetric multidimensional scaling (nMDS) of faunal composition recorded from SUCS images and displayed by (A) Site location; (B) Substrate type; (C) Depth; (D) Rugosity (0=low; 3.5=high).

The nMDS analysis revealed a random distribution of points when displayed by site location demonstrating there was no clustering of sites with similar faunal assemblages by their geographical location (figure 12.2.1A). This indicated no significant difference in biological assemblage structure between site locations, an assessment supported by an analysis of similarity (ANOSIM ($R=0.214$, $P=0.064$)). Substrate type was categorised by three types: bedrock, cobbles/pebbles and sand. Clustering of points by substrate type showed that, though images dominated by sand, cobbles and pebbles were not shown to support similar biological assemblages, bedrock habitats that were sampled did broadly cluster together (figure B; ANOSIM: $R=0.2546$, $P<0.05$). Clustering by depth showed deep sites (700-900m) and shallow sites (100-250m) formed two distinct but loosely clustered groups (figure 12.2.1C). Mid-depth sites (450-600m) were randomly distributed. However there was no significant difference in biological assemblage structure between depths (ANOSIM: $R=0.1612$, $P=0.063$). Using SUCS images rugosity was recorded on the 1m scale and measured on a categorical scale of 0-5 with 0 representing homogenous flat environments (e.g. fine sand) through to 5 representing complex 3-dimensional environments (e.g. heavily crevassed rock and boulders). By this measure and averaged over each transect of 20 photos, rugosity was shown to be a significant factor in predicting faunal composition with nMDS showing a clear divide between sites of low (0.5-1.5) and high (2.5-3.5) rugosity (figure 12.2.1D; ANOSIM: $R=0.241$, $P<0.001$).

Though not included in this analysis rugosity was also measured at the cm scale (from SUCS photos), and 50m & 100m scale (derived from multibeam bathymetry [see section 10.2]). Analysis of this data will provide insight into the effect of rugosity over different spatial scales on biological community structure. The main finding of this analysis was that rugosity appeared to be the key determinant factor structuring benthic assemblages.

Fig.12.3.1 Examples of the variety of benthos caught by Agassiz trawl collections around Ascension Island. These are pteropod molluscs (A), brittlestar (B), gastropod (C), brachiopod (D), anemone (E) and bivalve mollusc (F).



12.3 Agassiz Trawl results

The Agassiz Trawl (AGT) used during the cruise was the same as has been used since JR144 (2006). It shows signs of wear on the frame, but still works perfectly well. The trawl is generally used on flat seabed as judged from Swath bathymetry profiles and other available

data such as SUCS images, to mitigate the risk of damaging the nets or getting the frame caught on rocks. During two consecutive deployments the shackles connecting the AGT frame to the cable swivel got caught on rocks requiring the ship to maneuver back and forth until the net came free. Whilst freeing the second trapped net there was a tension spike of over 8 t, which is over the recommended limit for the shackles. It was decided not to trawl at the 100 m site of transect one, or the 1000 and 100 m sites of transect two, as the SUCS photos showed a rocky bottom indicating that the risk of major damage was significant. This meant that on this cruise four trawls were completed on transect one and three trawls were completed on transect two.

In general the catches were small but clean as the substrate was sand or gravel. In all 215 specimens grouped into 60 morphotypes were collected and preserved in ethanol (see Table 12.3.1). At the time of report preparation the species have been separated into the following: Anthozoa (25), Bivalvia (3), Brachiopoda (2), Crinoidea (11), Crustacea (81), Echinoidea (7), Gastropoda (5), Hexactinalida (9), Hydrozoa (2), Ophiuridae (20), Pisces (9), Polychaetes (18), Scyphozoa (6), Sipunculida (2), Thaliacea (13). The brachipods represented the first records for the phylum at Ascension Island. All individuals have been identified to class or lower, sorted, photographed and both the photographs and the samples will be sent to taxonomic experts for formal identifications. Representative fauna from AGT catches are shown in Figure 12.3.1.

Table 12.3.1. AGT epibenthos sample identifications. The number of specimens captured ('No.' in table) is sample size, depth is given in metres.

Sediment type	Event	ID	Phylum	Class	Putative ID	No
soft	1_250	1	Echinoderm	Ophiuroidea	Amphiura sp	1
soft	1_250	2	Chordata	Piscies	Scorpaena sp	2
soft	1_250	3	Chordata	Piscies	Triglidae	1
soft	1_250	4	Chordata	Piscies	Flatfish sp1	1
soft	1_250	5	Chordata	Piscies	Flatfish sp2	2
soft	1_250	6	Annelida	Polychaete	Polychaete	1
soft	1_250	7	Crustacea	Malacostraca	Pagurus sp	1
soft	1_250	8	Chordata	Ascidiacea	Ascidiacea	10
soft	1_250	9	Echinodermata	Echinoidea	Cidaroida (urchin)	1
soft	1_250	10	Cnidaria	Anthozoa	Octocorallia (Alcyonium sp.?	1
soft	1_250	11	Cnidaria	Anthozoa	Hexacorallia (anemone)	5
soft	1_250	13	Cnidaria	Anthozoa	Octacoral sp 1	1
soft	1_250	14	Cnidaria	Anthozoa	Octacoral sp 2	2
soft	1_250	14_1	Echinodermata	Ophiuroidea	Ophiocten sp	1
soft	1_250	15	Annelida	Polychaete	Annelida	1
soft	1_250	17	Mollusca	Bivalvia	Bivalve	1
soft	1_250	18	Porifera	Hexactinellida	Sponge	1
soft	1_500	19	Chordata	Piscies	Malacocephalus laevis	1
soft	1_500	20	Crustacea	Malacostraca	Nematocarcinus gracilipes	10
soft	1_500	21	Crustacea	Malacostraca	Notostomus (gibbosus or elegans)	10
soft	1_500	22	Crustacea	Malacostraca	Pandalidae	20
soft	1_500	23	Echinodermata	Echinoidea	Cidaroida (urchin)	1
soft	1_500	23_1	Crustacea	Malacostraca	Megalasma annandelei	2
soft	1_500	24	Echinodermata	Echinoidea	Cidaroida (urchin)	1
soft	1_500	25	Echinodermata	Ophiuroidea	Ophiacantha sp 1	9
soft	1_500	26	Echinodermata	Echinoidea	Irregularia	1
soft	1_500	27	Cnidaria	Anthozoa	Actinaria	2
soft	1_500	28	Crustacea	Malacostraca	Phronima atlantica? Hyperiidae + salp body	1
soft	1_500	29	Porifera	Hexactinellida	Sponge	1
soft	1_500	30	Sipunculid	Sipunculida		2
soft	1_500	31	Porifera	Hexactinellida	Porifera	1
soft	1_750	32	Cnidaria	Scyphozoa	Cnidaria/medusa	5
soft	1_750	33	Cnidaria	Hydrozoa	Velella velella	1
soft	1_750	34	Echinodermata	Echinoidea	Echinodea	1
soft	1_750	35	Echinodermata	Echinoidea	Echinodea	1

soft	1_750	36	Crustacea	Malacostraca	Nematocarcinus tenuipes	5
soft	1_750	37	Crustacea	Malacostraca	Nematocarcinus gracilipes	2
soft	1_750	38	Crustacea	Malacostraca	Serestidae (Sergia?)	1
soft	1_750	39	Echinodermata	Crinoidea	Crinoid	1
soft	1_750	40	Echinodermata	Ophiuroidea	Ophiura sp. 1	1
soft	1_750	41	Crustacea	Malacostraca	Nematocarcinus gracilipes	1
hard	1_900	42	Echinodermata	Ophiuroidea	Ophiura sp. 1	7
hard	1_900	43	Crustacea	Malacostraca	Nematocarcinus gracilipes	13
hard	1_900	44	Cnidaria	Scyphozoa	Medusa	1
hard	1_900	45	Echinodermata	Echinoidea	Echinoid irregular	1
hard	1_900	46	Mollusca	Gastropoda	Cavolinia sp.	3
hard	1_900	47	Cnidaria	Anthozoa	Scleractinia	4
hard	1_900	48	Chordata	Piscies	Ventrifossa sp	1
hard	1_900	49	Mollusca	Gastropoda	Gastropoda	2
hard	1_900	50	Chordata	Ascidiacea	Ascidiacea	1
hard	1_900	51	Chordata	Piscies	flying fish	1
soft	2_750	52	Echinodermata	Ophiuroidea	Ophiacantha sp 2	1
soft	2_750	53	Crustacea	Malacostraca	Nematocarcinus gracilipes	7
soft	2_750	54	Mollusca	Bivalvia	Bivalve	1
soft	2_750	55	Brachiopoda	Articulata	brachiopod	1
soft	2_750	56	Brachiopoda	Articulata	brachiopod	1
soft	2_750	57	Crustacea	Malacostraca	Verruca sp	1
soft	2_750	58	Cnidaria	Anthozoa	Actinaria	1
soft	2_750	59	Echinodermata	Crinoidea	Crinoid	10
soft	2_750	60	Crustacea	Malacostraca	Gnathophausia zoea	1
soft	2_750	61	Chordata	Ascidiacea	Ascidiacea	1
soft	2_750	62	Cnidaria	Anthozoa	cnidaria/scleratina	1
soft	2_750	63	Annelida	Polychaete	Spirobids	3
soft	2_750	64	Chordata	Ascidiacea	Ascidiacea	1
soft	2_500	65	Crustacea	Malacostraca	Stylopandalus richardi	3
soft	2_500	66	Annelida	Polychaete	Polychaete	3
soft	2_500	67	Annelida	Polychaete	Polynoidae?	3
soft	2_500	68	Mollusca	Bivalvia	Bivalve	1
soft	2_500	69	Crustacea	Malacostraca	crustacea/crab sp1	1
soft	2_500	70	Crustacea	Malacostraca	crustacea/crab sp2	1
soft	2_500	71	Porifera	Hexactinellida	unidentified	1
soft	2_500	72	Cnidaria	Anthozoa	Actinaria	1
soft	2_500	73	Cnidaria	Anthozoa	Octocorallia	3
soft	2_500	74	Porifera	Hexactinellida	Sponge	3
soft	2_500	75	Annelida	Polychaete	Spirobids	1
soft	2_500	76	Annelida	Polychaete	worm house	2
soft	2_500	77	Cnidaria	Anthozoa	Scleractinia	3

Soft	2_250	78	Crustacea	Malacostraca	Stylopandalus richardi	1
Soft	2_250	79	Porifera	Hexactinellida	and tube things	1
Soft	2_250	80	Porifera	Hexactinellida	Sponge	1
Soft	2_250	81	Annelida	Polychaete	worm house	1
Soft	2_250	82	Annelida	Polychaete	tube	1
Soft	2_250	83	Annelida	Polychaete	Polychaete	1
Soft	2_250	84	Annelida	Polychaete	Annelida (tube worm)	1
Soft	2_250	85	Cnidaria	Anthozoa	Scleractinia	1

12.4 SUCS-Agassiz-SCUBA benthic faunal comparisons

We compared the fauna sampled from 0-1000m during the wider Ascension Island Darwin-Blue project which has used three different methodologies; SUCS, AGT and SCUBA. The proportion of flora and fauna identified into each taxonomic class using different benthic sampling methods on both hard (bedrock, boulders cobbles and pebbles) and soft substratum (sand). A, the SUCS, B, the AGT and C, surveys by SCUBA diver is shown in Fig. 12.3.1. SCUBA diving was conducted in depths shallower than 30m whilst SUCS deployments were conducted at depths between 100 and 900m and Agassiz trawls between 250 and 900m.

The communities measured on hard and soft substrata comprised different component fauna that varied between the 3 benthic survey techniques used in the Ascension Island study, the SUCS, the Agassiz trawl and SCUBA divers. The SUCS recorded significantly different communities on hard and soft substratum, with Anthozoa recorded as the dominant class on both hard and soft substratum. However, whilst polychaetes were also visible in many SUCS images taken on hard substratum there were very low numbers recorded on soft sediment. This is likely due to most of the polychaetes being infaunal and therefore not visible on the surface of soft sediment.

The AGT caught a higher proportion of Malacostraca than were recorded by the SUCS. They were the dominant component of the fauna on both hard and soft substrata. This potentially highlights the selective nature of the trawl.

Divers measured a considerably higher proportion of fish on both hard and soft substratum than the SUCS or the trawl. This may be because of different biases in the survey techniques; SUCS could disturb some fish during deployment or attract others to the lights, whereas SCUBA divers may selectively record fish over other faunal groups. Whilst each of the three survey methods was used over different depth ranges, this comparison shows how important it is to assess fauna using different survey methods to overcome any potential biases inherent in each technique.

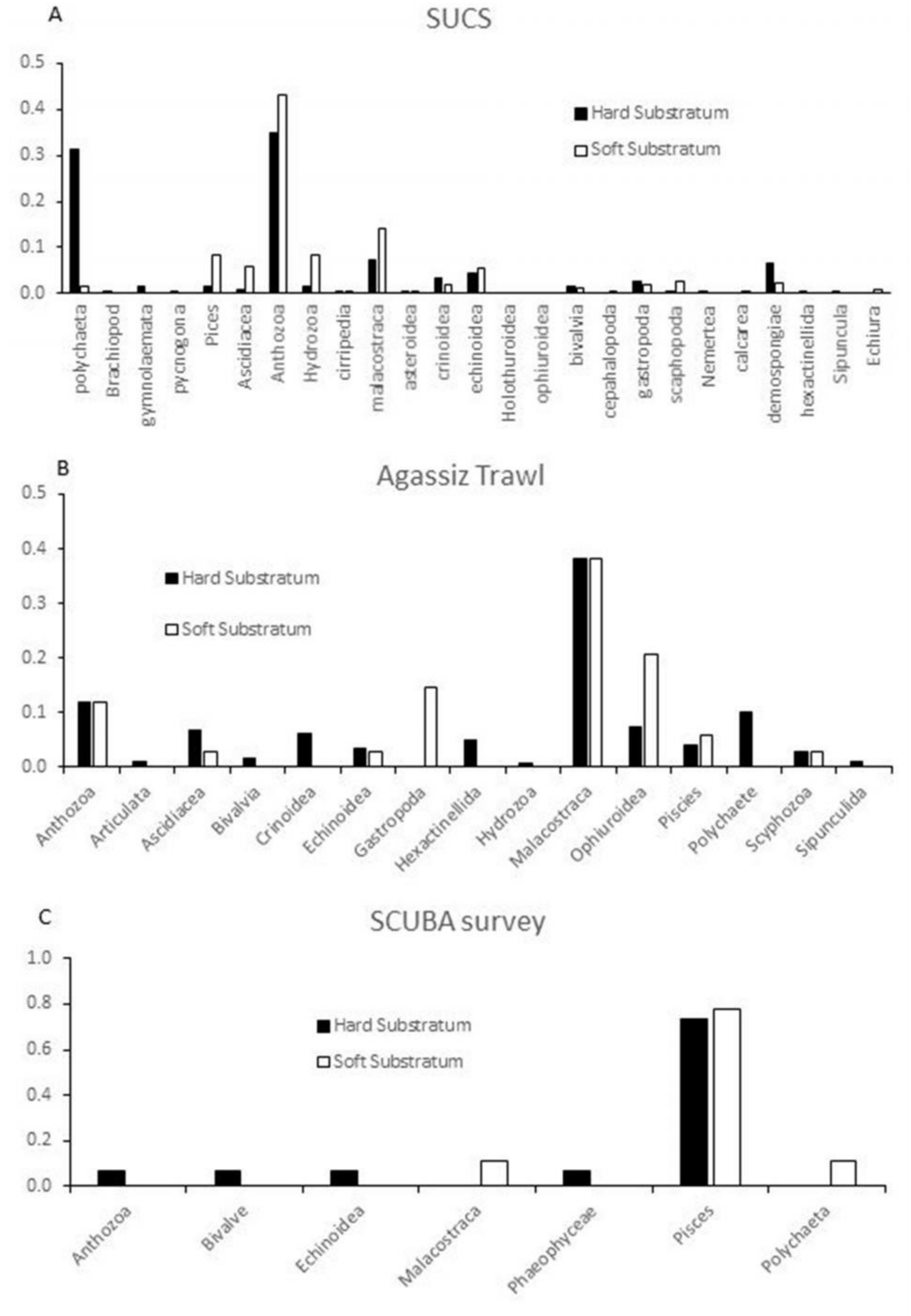


Fig.12.4.1 Benthic fauna sampled by differing methodologies.

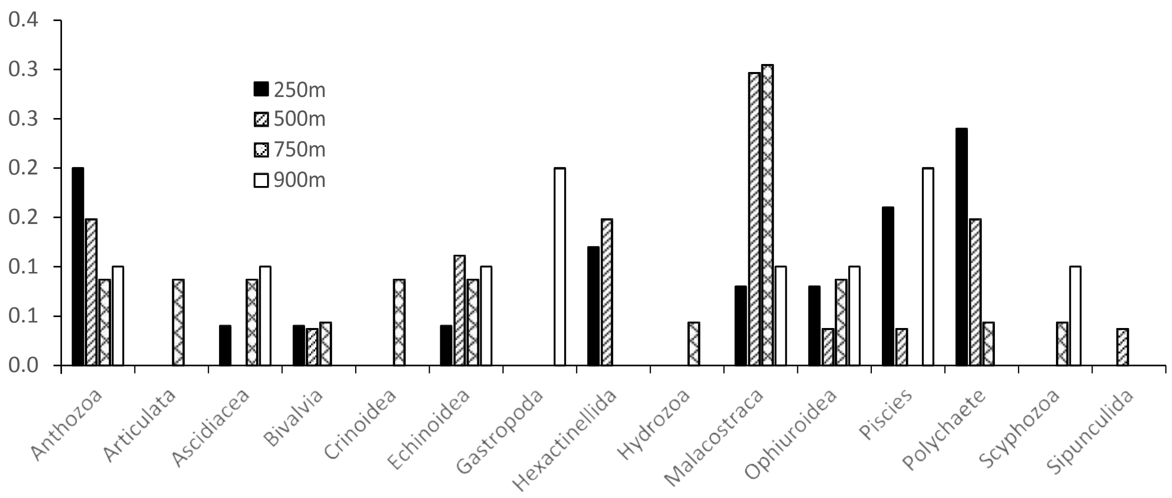


Figure 12.4.2. Proportion of each taxa identified from Agassiz trawls from different depths

There is considerable variation in the species caught in Agassiz trawls at different depths. The number of hauls at each depth was limited to 2 at 250, 500 and 750m and the only haul on hard substratum was at 900m (Table 12.3.1). It is therefore not easy to pick depth related patterns from the data.

12.5 Decapod crustaceans around Ascension Island

An abundant inhabitant of the deep-seas around Ascension Island between 500 and 1000 m were shrimps genus *Nematocarcinus*. Upon capture nearly all these shrimps were identified as *N. gracilipes* with some scarce records of *N. tenuipes*. Population of the depth 700-1000 m was represented mostly by adults, whereas at 500 m most of shrimps were juveniles. Other shrimp families also occurred at 500 m and shallower. A capture of one juvenile shrimp at ~250 m (Area 2 – 250 m) was the shallowest record known to science.

Representatives of the family are widely distributed in deep seas down to as deep as below 5,000 m, and its species are abundant in areas of high productivity of slope waters like in the zone of intensive allochthone production of detritus (in front of deltas of large rivers), in upwelling areas, and around hydrothermal vents. The identified species (*N. gracilipes*) is found in the Atlantic Ocean between Azores, north of Brazil and Ascension Island including the west Mediterranean Sea and off the east shores of South America from Peru to California (depth range 590-2000 m). Two other species are also known from this area. Distribution of *N. tenuipes* extends from Ascension Island into the South Atlantic and further into the South

Pacific and the Indian Ocean. The third species, *N. faxoni* is distributed on both sides of Panama isthmus with its Atlantic range extending eastward to Ascension Island. A representative of another nemacarcinid genus, a circumglobal *Nigmatullinus acanthitelsonis* was also collected near Ascension Island by RV "Challenger" at 3,385 m depth. Thus the studied area represents a zone of contact of several "regional" species, whose co-existence possibly is supported by high productivity of local waters.

As with other nematocarcinid shrimps, *N. gracilipes* fed on detritus, and due to its high abundance in the ecosystem of Ascension Island it may possibly be a staple food source for deep-sea fish. A similar situation was supposed for some other nematocarcinid shrimps in that areas of high production of detritus could represent a major part of the basement of the entire deep-sea food web. In areas of low productivity and thus low accumulation of detritus this position in sandy and gravel habitats might be occupied by shrimps of the different families. Other detritophagous crustaceans seen by SUCS in numbers on the continental slope included the squat lobster, likely to be *Munida microphtalma*, as well as a shrimp-like giant mysid *Gnathophausia zoea* and shrimps *Notostomus* sp (*gibbosus/elegans*).

Shrimp families Pandalidae (mostly *Stylopandalus richardi*) and Sergestidae (*Sergia* spp.) and possibly others as well as crabs *Chaceon* spp (Geryonidae) occurred regularly, mostly on rocky habitats between 100 and 500 m.

12.6 Cephalopod molluscs around Ascension Island

An oceanic squid *Sthenoteuthis pteropus* (Ommastrephidae) was regularly seen at night at the surface above depths > 200 m though never captured. Octopods recorded by SUCS could not be identified with any certainty as no information exists about their lifetime colouration patterns.

***Fig. 12.4.2 Crustaceans sampled by AGT; Nematocarcinus gracilipes* (A)*, spider crab* (B)*, Megalasma laevis* barnacle (C)*, Notostomus* sp. (D)*, Phronimia atlantica* amphipod (E)*, Gnathphausia zoea* Mysid (F).**

13 Preliminary conclusions

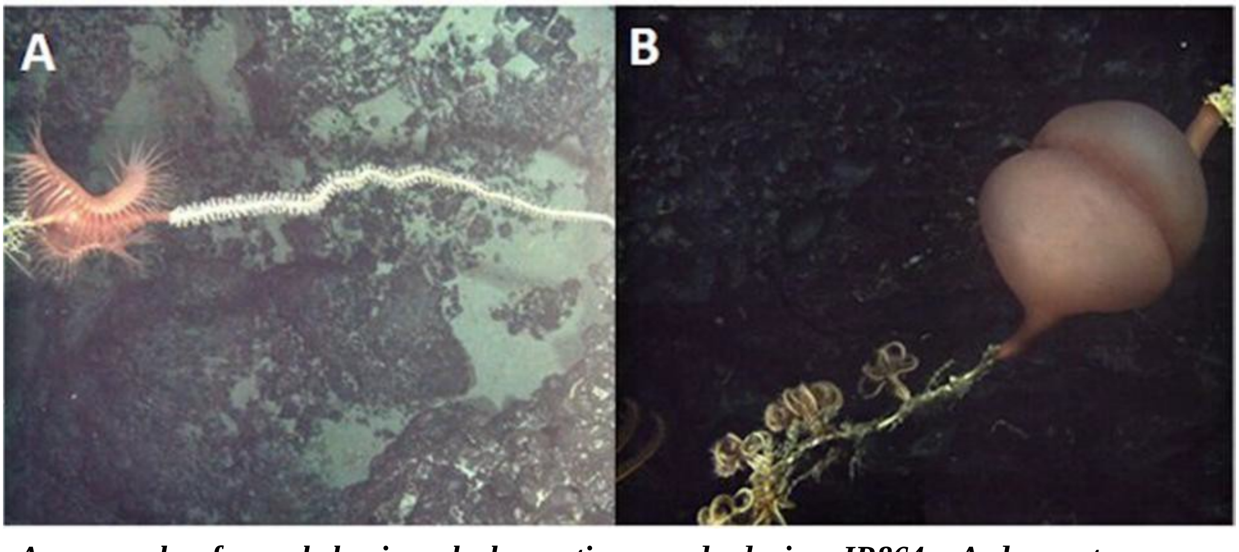
13.1 Benthic biodiversity on Ascension Islands' continental shelf

Biological richness of island regions generally increases with size, age and proximity to major continent shelves. For a small, young and very isolated island, the expectation of biodiversity measures is low (in the context of tropical waters and in the context of being the Atlantic Ocean). However at local scale (alpha diversity) richness was surprisingly high with up to 24 morphotypes (probably=species) per m^2, and a mean across all samples of 14.5 per m^2. Even with very preliminary analyses these have revealed new records for Ascension Island including the first ever record of Brachipods. The SUCS pictures show that biodiversity is strikingly patchy, many large areas have few species or individuals. However areas nearby can contain high richness, complex 3-dimensional bioconstructors, vulnerable marine ecosystem species and potentially high benthic carbon accumulation. Such habitats are likely to provide considerable ecosystem services in terms of being important habitat for benthic feeding fish, nurseries for juvenile fish, carbon drawdown and possibly hotspots for marine endemism. Key habitats with such characteristics mainly fell between 200 and 500m but did occur shallower and deeper than this. Analyses (nMDS) suggest the important environmental predictors of these hotspot areas are substratum rugosity (roughness), but this has only been measured at one spatial scale for this report (but the data collected will enable this to be undertaken at multiple spatial scales). The Agassiz trawl specimens will be dispatched to our network of expert taxonomists but the specimens seem to be in good condition and should add strong genetic component to future findings. Comparison of SUCS, AGT and SCUBA work really emphasized the value of using multiple techniques to sample, given the clear sampling bias of each apparatus. Given how little previous information was known about Ascension Islands' continental shelf life, except in the shallows, the science cruise JR864 already seems to have made a significant step in providing a baseline biodiversity standard. This is required for CBD compliance but is also a very useful tool to 1) provide context for Environmental Impact Assessments, 2) identify size and location of valuable areas for consideration of designation as Marine Protected Areas and 3) to monitor potential future direct anthropogenic impacts (eg. oil spill) or indirect anthropogenic impacts (such as climate change or non indigenous species establishment).

13.2 Recommendations for MPA designation.

It is clear that the continental shelf of Ascension Island contains some important benthic habitats and assemblages, and that some characteristics of multibeam swath data can be used to predict where these may occur and how extensive they are. This will require post-processing of multibeam data beyond the time scale of this report, but based on the biological data collected to date we would recommend that our study sites 2, 3 & 4 (ie from NNW of the Island clockwise to due South) be included in any realised protected status in particular at 200-500m depth. Thus if a Marine Protected Area is designated around Ascension Island, we think it should cover the East side of the Island encompassing the depth ranges 100-1000m (with respect to consideration of the continental shelf biodiversity alone). Further analyses during 2015 and 2016 of specimens and data already collected should greatly increase the resolution of the location of Ascension Island biodiversity hotspots and the nature of their ecosystem services.

Our study did not consider waters deeper than 1000m but we have planned a further research cruise onboard RRS James Clark Ross to sample some of the nearby seamounts and are currently in talks with potential funders to realize this further expedition.



An example of new behavioural observations made during JR864. A deepwater sea anemone, on a whip coral (A) catches a basket-star live on camera and swallows in (B).

Acknowledgements

We are extremely grateful to Charles Clover and the Blue Marine Foundation for funding that enabled this cruise to happen. We are also grateful to AIG for logistics, funding and critical participation. It is important to acknowledge the Darwin Initiative who fund the Ascension Island Marine Sustainability (AIMS) project which was the genesis for this cruise. We thank the Ascension Island Government, Conservation Department for their kind hospitality and assistance in Georgetown. Most of all we thank the master, officers and crew of RRS *James Clark Ross* for the skill, effort and kindness in making both a productive and enjoyable science cruise.

The JR864 science cruise participants

Appendices

Appendix 1. All deployments in chronological order

Event	Site	Equipment	Event name	Latitude	Longitude	Depth (m)
4	Site 1	SUCS	1_900	-8.06863	-14.42414	880
5	Site 1	SUCS	1_750	-8.06290	-14.43228	770
6	Site 1	SUCS	1_500	-8.04312	-14.44215	500
7	Site 1	SUCS	1_250	-8.01072	-14.43917	220
8	Site 1	SUCS	1_100	-7.99662	-14.42951	110
9	Site 1	AGT	1_250	-8.00864	-14.44232	210
10	Site 1	AGT	1_500	-8.04258	-14.44288	500
11	Site 1	AGT	1_750	-8.06320	-14.43360	770
12	Site 1	AGT	1_900	-8.06661	-14.42630	840
13	Site 1	CTD	1_900	-8.07042	-14.42232	880
14	Site 1	CTD	1_500	-8.04104	-14.44461	500
16	Site 2	CTD	2_900	-7.85150	-14.36572	960
17	Site 2	CTD	2_500	-7.87493	-14.37818	340
18	Site 2	CTD	2_100	-7.88045	-14.38340	120
19	Site 2	SUCS	2_100	-7.88041	-14.38336	120
20	Site 2	SUCS	2_250	-7.87584	-14.38308	260
21	Site 2	SUCS	2_500	-7.87464	-14.37855	340
22	Site 2	SUCS	2_750	-7.85806	-14.37374	750
23	Site 2	SUCS	2_900	-7.85244	-14.36671	890
24	Site 2	AGT	2_750	-7.85830	-14.37549	750
25	Site 2	AGT	2_500	-7.87483	-14.38003	330
26	Site 2	AGT	2_250	-7.87600	-14.38165	230
27	Site 3	SUCS	3_100	-7.95862	-14.28868	110
28	Site 3	SUCS	3_200	-7.96642	-14.28750	210
29	Site 3	SUCS	3_500	-7.96604	-14.27236	500
30	Site 3	SUCS	3_700	-7.96804	-14.26095	800
31	Site 3	SUCS	3_900	-7.96835	-14.25477	1020
32	Site 4	SUCS	4_250	-8.01039	-14.33673	280
33	Site 4	SUCS	4_600	-8.01574	-14.34216	670
34	Site 4	SUCS	4_450	-8.02304	-14.34470	480
35	Site 4	SUCS	4_800	-8.02727	-14.33457	850
36	Site 5	SUCS	5_280	-8.01773	-14.40765	280
37	Site 5	SUCS	5_500	-8.03400	-14.40719	590

Latitude and longitude indicate the start position of the deployment, in decimal degrees.

SUCS deployments

Event	Site	Event name	Latitude	Longitude	Depth (m)
8	Site 1	1_100	-7.99662	-14.42951	110
7	Site 1	1_250	-8.01072	-14.43917	220
6	Site 1	1_500	-8.04312	-14.44215	500
5	Site 1	1_750	-8.06290	-14.43228	770
4	Site 1	1_900	-8.06863	-14.42414	880
19	Site 2	2_100	-7.88041	-14.38336	120
20	Site 2	2_250	-7.87584	-14.38308	260
21	Site 2	2_500	-7.87464	-14.37855	340
22	Site 2	2_750	-7.85806	-14.37374	750
23	Site 2	2_900	-7.85244	-14.36671	890
27	Site 3	3_100	-7.95862	-14.28868	110
28	Site 3	3_200	-7.96642	-14.28750	210
29	Site 3	3_500	-7.96604	-14.27236	500
30	Site 3	3_700	-7.96804	-14.26095	800
31	Site 3	3_900	-7.96835	-14.25477	1020
32	Site 4	4_250	-8.01039	-14.33673	280
34	Site 4	4_450	-8.02304	-14.34470	480
33	Site 4	4_600	-8.01574	-14.34216	670
35	Site 4	4_800	-8.02727	-14.33457	850
36	Site 5	5_280	-8.01773	-14.40765	280
37	Site 5	5_500	-8.03400	-14.40719	590

AGT deployments

Event	Site	Event name	Latitude	Longitude	Depth (m)	Sample numbers
9	Site 1	1_250	-8.00864	-14.44232	210	1 – 18
10	Site 1	1_500	-8.04258	-14.44288	500	19 – 31
11	Site 1	1_750	-8.06320	-14.43360	770	32 – 41
12	Site 1	1_900	-8.06661	-14.42630	840	42 – 51
26	Site 2	2_250	-7.87600	-14.38165	230	78 – 85
25	Site 2	2_500	-7.87483	-14.38003	330	65 – 77
24	Site 2	2_750	-7.85830	-14.37549	750	52 – 64

CTD deployments

Event	Site	Event name	Latitude	Longitude	Depth (m)
14	Site 1	1_500	-8.04104	-14.44461	500
13	Site 1	1_900	-8.07042	-14.42232	880
18	Site 2	2_100	-7.88045	-14.38340	120
17	Site 2	2_500	-7.87493	-14.37818	340
16	Site 2	2_900	-7.85150	-14.36572	960