Natural England Commissioned Report NECR160

Isles of Scilly Complex SAC: Reef Feature Condition Assessment

Kelp forest communities and vertical rock: 2013 baseline dive survey

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NATURAL ENGLAND

Foreword

Natural England commission a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England.

Background

Natural England commissioned this work as part of the ongoing condition assessment of the Annex I reef feature within the Isles of Scilly Complex Special Area of Conservation (SAC). It focuses on the sub-features:

- vertical rock; and
- kelp forest communities.

The survey builds on a partially-completed survey from 2011 to provide a set of baseline data for the attributes of these sub-features against which condition assessment monitoring can be carried out in future monitoring cycles.

This survey establishes a suitable survey methodology, and series of 12 repeat monitoring locations around the islands.

For kelp forest communities – the survey has established densities and relative proportions of the various kelp species at each location, as well as the characterising red algae species (with measures of abundance).

For vertical rock sites – the composite characterising species have been established, along with abundances.

The results and analysis in the final report set this baseline as well as providing current information to contribute towards condition assessment of the reef feature of the site. Condition assessment for these sub-features will be possible in future monitoring surveys as long as the methodologies outlined in the final report are followed, to allow comparison.

This report should be cited as:

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Keywords - Isles of Scilly, condition assessment, monitoring, reefs, kelp forest communities, vertical rock, Special Area of Conservation (SAC), European Marine Site (EMS)

Further information
This report can be downloaded from the Natural England website: **www.naturalengland.org.uk**. For information on Natural England publications contact the Natural England Enquiry Service on 0845 600 3078 or e-mail **enquiries@naturalengland.org.uk**.

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SeaStar Survey

Asterias rubens

Summary

Background

Natural England contracted Seastar Survey Ltd to undertake survey work in order to assess the condition of part of the Isles of Scilly Complex SAC reef features.

The main survey aim was to develop a baseline dataset and assess the condition of the Isles of Scilly SAC complex, focusing on the following Annex I subtidal reef sub-features:

- Kelp forest communities
- Vertical rock

The aim was to study the species composition of the characteristic biotopes within the kelp forest and vertical rock sub-features by analysing the presence and abundance of composite species, using *in-situ* observations as well as still and video photography. The subtidal monitoring initiated in 2011 provided a baseline for a long-term monitoring programme under the Habitats Directive. The current survey follow on from the 2011 survey work (Irving and Northen, 2012) attempting to improve the existing baseline and gather data from new areas to enable significant changes to be detected, which will inform the site managers as to any adaptations to the SAC management that may need to be made in the future.

Main findings

The dive surveys on the Isles of Scilly were completed successfully between 12th and 17th May and 21st and 26th July in 2013 with a total of 130 person-dives (64 in May and 66 in July). The effort and results of these surveys are summarised as follows:

- A total of 12 different scuba-divers were used. All divers were qualified to a minimum of CMAS 3-star.
- The scuba-diving quadrat survey methodology as detailed in Axelsson *et al*. (2013) was used for the 2013 Isles of Scilly dive surveys.
- The dive surveys involved laying a ground line, filming the line and carrying out quadrat based survey work at 30 random locations along the ground line to generate quantitative data on species composition of the community.
- For the kelp forest community sub-feature six kelp species were recorded: *Laminaria hyperborea*, *Laminaria ochroleuca*, *Saccharina latissima* (formerly *Laminaria saccharina*), *Saccorhiza polyschides*, *Laminaria digitata* and *Alaria esculenta.*
- For the kelp understory community nine red algal species were recorded: *Kallymenia reniformis, Delesseria sanguinea, Membranoptera alata* (particularly on kelp stipes)*, Phycodrys rubens* (particularly on kelp stipes)*, Heterosiphonia plumosa, Pterosiphonia parasitica, Sphaerococcus coronopifolius, Dilsea carnosa, Halurus equisetifolius*.
- 22 faunal species were regarded as characteristic and therefore selected for the vertical rock assessments including *Corynactis viridis, Caryophyllia smithii, Alcyonium digitatum, Alcyonium glomeratum, Leptopsammia pruvoti, Hemimycale columella* and *Haliclona viscosa*.
- A total of 13 dive locations were surveyed during the 2013 survey resulting in 12 monitoring locations spread geographically across the Isles of Scilly. Six locations were kelp forest communities and six were vertical rock communities but one kelp forest community location (Frenchman's Rock) was surveyed twice (May and July).

One subtidal faunal turf community location was also surveyed before this sub-feature was removed as a survey target for this project (see section 3.2 for further information).

- The six kelp forest community monitoring locations were established at Frenchman's Rock (St. Mary's), Porth Hellick (St. Mary's), Lizard Rock (St. Agnes), Carn Morval (St. Mary's), Cromwell's Castle (Tresco Channel) and Porth Morran (White Island).
- The six vertical rock monitoring locations were established at JS Wall (St. Mary's), Newfoundland Point (St. Mary's), Menawethan (Menawethan), Men-a-vaur (St. Helen's), John Thomas Ledge (St. Martin's) and East Withan (White Island).
- Site descriptions were completed for all the monitoring locations surveyed in 2013 to allow re-location of the survey lines and future monitoring.
- The highest overall kelp density (12.8 plants/m^2) was found at Frenchman's Rock (July 2013 survey) followed by Porth Hellick (11.0 plants/m^2) and Lizard Rock (10.5 plants/m^2). The lowest kelp density was found at Porth Morran (7.0 plants/m^2).
- *Laminaria hyperborea* was the dominant kelp species at Frenchman's Rock and Porth Hellick. There was a significant difference (comparing *L. hyperborea* and *L. ochroleuca*) in median kelp abundance at Frenchman's Rock (in May and July).
- *Laminaria ochroleuca* was the dominant kelp species at Lizard Rock, Carn Morval, Tresco Channel and Porth Morran. There was a significant difference (comparing *L. hyperborea* and *L. ochroleuca*) in median kelp abundance at Carn Morval, Cromwell's Castle (Tresco Channel) and Porth Morran.
- Based on the available data (collected in 2013) all kelp community stations were tentatively classified as IR.LIR.K.LhypLoch.
- There appears to be a biogeographical divide in the distributions of both kelp and red algal species across the Isles of Scilly.
- *L. hyperborea* was the dominant kelp taxon along the Eastern Isles whilst *L. ochroleuca* was dominant everywhere else.
- The most abundant species on the vertical rock was the jewel anemone (*Corynactis viridis*), which was recorded at all locations and in 177 of the 180 analysed quadrats across the survey locations.
- *Hemimycale columella, Caryophyllia smithii, Haliclona viscosa* and *Marthasterias glacialis* were relatively frequently recorded on the vertical rock walls at 45, 32, 29 and 24 records respectively out of the 180 quadrats analysed.
- There were subtle differences in the vertical rock communities at different locations across the Isles of Scilly, the aspect, geographical location and level of exposure may explain these differences. However, based on the current data it was not possible to distinguish between these communities and the sites have all been classified as CR.HCR.XFa.SpAnVt.
- The recommendations based on the 2013 survey include the need for photographic expertise and high level of red algae species identification skills among the divers, a flexible approach regarding survey times to allow for good weather conditions and a re-assessment of the list of red algal species to be used for future monitoring. The potential for including red algal management (true) indicator species, as well as other species indicators of environmental change should be explored and the final selection should allow easy and fast *in-situ* identification.

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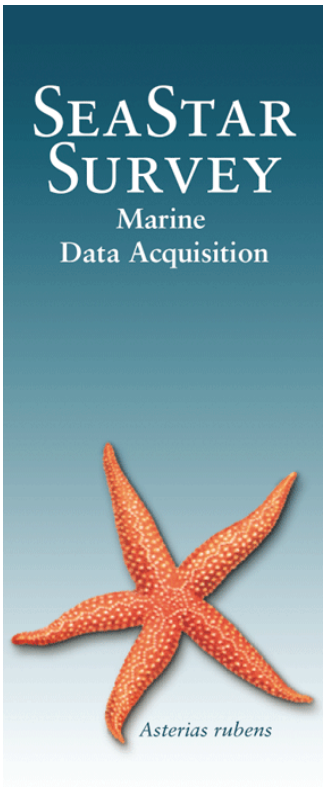
PROJECT PERSONNEL

This report and the survey detailed within was undertaken by Seastar Survey Ltd. for Natural England. All of the Seastar Survey Ltd. personnel involved in the project are listed below together with the Natural England divers in May and July 2013.

Project Tendering	Steven Dewey
Survey Team	
HSE Dive Contractor	Steven Dewey
Project Manager	Steven Dewey Magnus Axelsson
Survey team members	Magnus Axelsson Juliet Wilson Holger Anlauf
Data Analysis	
Video and photo analysis	Magnus Axelsson Juliet Wilson
GIS processing	Chris Allen
Report Writing	
Lead author	Magnus Axelsson



Natural England Divers

May 2013	Jen Ashworth John Bleach Kathryn Dawson Holly Latham Fiona Tibbitt
July 2013	Kevan Cook Tom Hardy Ross Bullimore Holly Latham Ian Saunders

1 INTRODUCTION

In 2013 Natural England contracted Seastar Survey Ltd to undertake survey work to establish a baseline in order to assess the condition of the Isles of Scilly Complex SAC interest features. The Condition Assessment is based on the Favourable Condition table given in Natural England's advice under Regulation 33(2) of the Conservation (Natural Habitats and c.) Regulations 1994 and informs a 6 year cycle of conservation status reporting under the Habitats Directive undertaken through JNCC.

In the summer of 2011 Natural England commissioned a similar Condition Assessment survey (Irving and Northen, 2012). However, due to adverse weather conditions relatively few sites were surveyed and therefore a complete Condition Assessment for the Reef feature could not be made. The data collected in 2011 (Irving and Northen, 2012) provide a useful partial baseline for future comparisons but the 2013 diving work was to be considered as an entirely separate survey building on the earlier work.

The sites surveyed previously by Irving and Northen (2012) were to be surveyed again in 2013, wherever possible, and the data previously gathered used for comparison but the intention of the 2013 survey was to gain wider spatial coverage and ensure a robust data set was obtained for all attributes. Particular attention should be paid to sites to the north and west of the SAC that are representative of the sub-features, in order to achieve a geographically representative suite of sites.

The 2013 survey work consisted of two field work periods, in May and July 2013, of six diving days each.

1.1 Survey location

The Isles of Scilly are the most south-westerly part of Britain, located 45 km west of Land's End at a latitude of 49°55'06 N and a longitude of 06°20'35 W (Figure 1.1). The Isles are a collection of over 200 granite islands and rocks, covering an area of 26850.95 hectares and represent Britain's only oceanic archipelago (JNCC, 2013).

The Isles hold a number of important national and international designations due to the unique mix of marine communities. These have derived from variations in exposure to Atlantic storms and currents as well as the south-westerly position of the Isles which has led to the presence of some warm water species living at the northern extremes of their range. The area therefore has a rich biodiversity and has been selected as a Special Area of Conservation (SAC) under the EU Habitats Directive for a number of Annex I habitats and Annex II species present (JNCC, 2013).

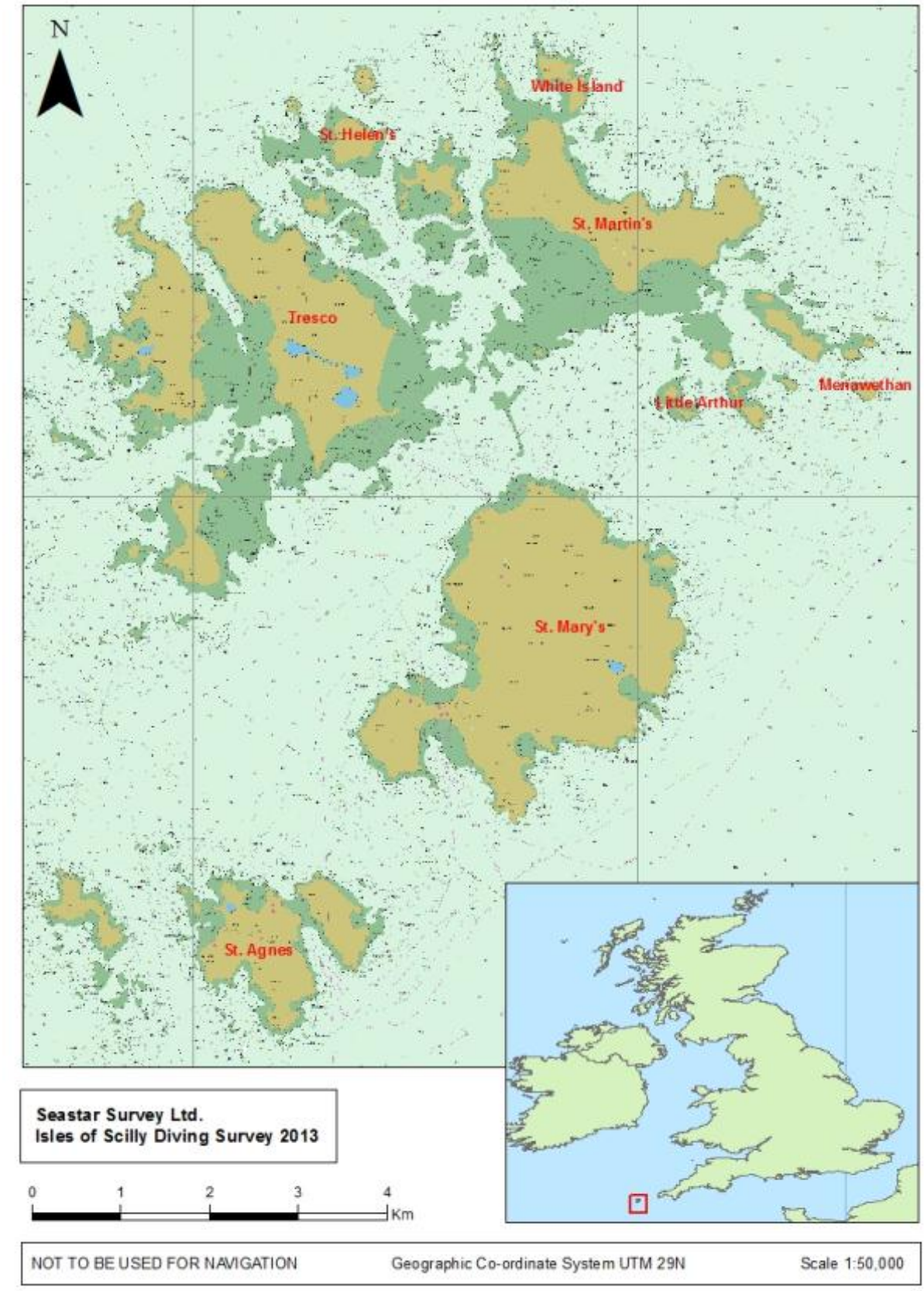


Figure 1.1. The Isles of Scilly.

1.2 Isles of Scilly SAC

The Isles of Scilly were designated a Special Area of Conservation (SAC) in 2000 under the 1994 Habitat Regulations (JNCC, 2013). Figure 1.2 shows the SAC boundary in blue with other designations marked according to the key. The reasons for the SAC designation are the presence of the following Annex I habitats:

- 1110 Sand banks which are slightly covered by seawater all the time
- 1140 Mudflats and sand banks not covered by seawater at low tide
- 1170 Reefs

The following Annex II qualifying species are also present in the SAC:

- 1441 Shore dock *Rumex rupestris*
- 1364 Grey seals *Halichoerus grypus*

Within the Isles of Scilly SAC there are many nationally rare and scarce marine species, such as the sponges *Axinella damicornis* and *Desmacidon fruticosum*, the Weymouth carpet coral *Hoplangia durotrix* and the cup coral *Caryophyllia inornata* (Barne *et al.*, 1996).

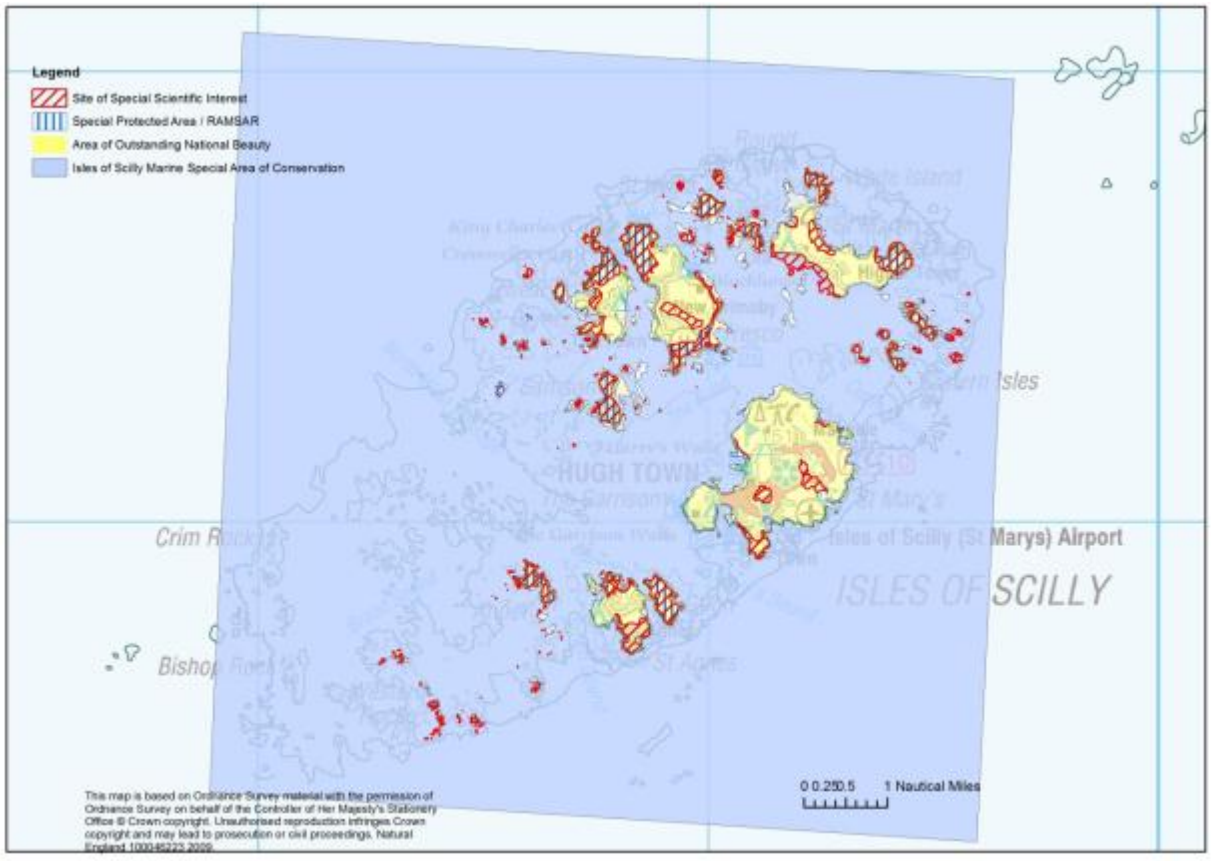


Figure 1.2. Isles of Scilly with SAC (NE, 2012).

1.3 Aims and objectives

The original main survey aim was to develop a baseline dataset and assess the condition (see Table 1.1 for the relevant Favourable Conditions) of the Isles of Scilly SAC complex, focusing on the following Annex I subtidal reef sub-features:

- Kelp forest communities
- Vertical rock
- Subtidal bedrock and boulder communities
- Subtidal faunal turf communities

The latter two sub-features were merged by Natural England following the update of the Marine Habitat Classification System and the large overlap of the habitat types. After discussions with Natural England representatives and managers it was decided not to include these two faunal turf communities in the 2013 survey. The main reasons for excluding these habitats were: 1) these habitats are generally found at depths (>30 m) limiting the amount of non-decompression diving time available to successfully complete the required analysis and data recording; 2) these habitats are found at depths exceeding safe diving depths according to the HSE "Science and Archaeological Diving Projects" Approved Code of Practice (ACOP); and 3) other more cost-effective methods (e.g. drop-down camera) are available to survey these sub-features. Subtidal faunal turf communities on bedrock and boulders were to be assessed under a separate drop-down video survey with NE, Cefas and the Cornwall IFCA. The two sub-features assessed during the 2013 Isles of Scilly scuba-diving survey were therefore:

- Kelp forest communities
- Vertical rock

The aim was to study the species composition of the characteristic biotopes within the kelp forest and vertical rock sub-features by analysing the presence and abundance of composite species, using *in-situ* observations as well as still and video photography.

The subtidal monitoring initiated in 2011 provided a baseline for a long-term monitoring programme under the Habitats Directive. The current survey follows on from the 2011 survey work (Irving and Northen, 2012) attempting to improve the existing baseline and gather data from new areas to enable significant changes to be detected, which will inform the site managers as to any adaptations to the SAC management that may need to be made in the future. The main objectives of the 2013 project were to:

- Design and plan a dive survey in the Isles of Scilly
- Develop simple, repeatable and statistically robust survey methodologies
- Collect new baseline data at new locations for the selected sub-features
- Collect sub-feature monitoring data from some locations surveyed in 2011
- Analyse the data and compare with historic data where possible

The design of the 2013 survey was based on the methodologies, locations and data collected in 2011. Whilst the design of the dive methodology in terms of data collection was altered (now based on Seastar Survey monitoring methodology; see Axelsson *et al*., 2013), the selection of species to be used for monitoring was based on the 2011 survey work (Irving and Northen, 2012) and the subsequent methodology review process (Highfield *et al*., 2013). The site selection was also based on the 2011 survey work but new locations were selected after discussions with the local advisors to achieve a large geographic spread as well as different levels and aspects of exposure, depths and tidal strengths.

Table 1.1. Favourable condition table for the post-moderated feature of 'Reefs', with recommended measures and attributes (from Table 9.3.2, Isles of Scilly SAC Management Scheme, 2010; Irving and Northen, 2012).

Main / Sub-features	Attribute	Measure	Target	Monitoring Programme Identified / or ongoing
Kelp forest communities (sub-feature)	Characteristic species - *Laminaria hyperborea* & *L. ochroleuca* population size within kelp forest community	Densities and relative proportions of kelp species (particularly *L. hyperborea* and *L. ochroleuca*), measured during summer, twice during reporting cycle.	Maintain the kelp community structure of the site, allowing for natural succession or known cyclical change.	Survey work to identify areas of kelp forest, particularly displaying a range of wave exposure and tidal streams.
	Species composition of characteristic biotopes	Monitoring the diversity of red algal species (sp. list in FCT), Measured during summer, once during reporting cycle.	Presence and abundance of composite species should not deviate significantly from an established baseline, subject to natural change.	Survey work to identify areas of kelp forest, red algal species, and their species composition.
Vertical Rock (sub-feature)	Species composition of characteristic biotopes	Presence and abundance of composite species. Measured during summer, twice during reporting cycle.	Presence and abundance of composite species should not deviate significantly from the established baseline, subject to natural change.	Search for examples of, and survey, species compositions on vertical rock surface. The Isles of Scilly Marine Countdown project will go some way to highlighting example sites, and collection of information on notable species – some of which overlap as BAP species.

1.4 The environment

1.4.1 Geology and sedimentary environment

The Isles of Scilly are low-lying islands composed of granite. The islands form part of an almost continuous granite batholith that continues at depth and extends to Dartmoor (Barne *et al.*, 1996). Surrounding the granite is metamorphosed sediment (killas), which is exposed off St. Martin's on White Island. Granite erosion has formed the white sand present on the beaches and subtidal sandy sediment (Barne *et al.*, 1996). The seabed environment is predominantly granite outcrops around the coastline. Further offshore in the northwest of the

SAC (90 m depth) the seabed is mainly sediment covered bedrock with rock exposed in some places (Eggleton and Meadows, 2012).

1.4.2 Physical conditions

The bathymetry around the Isles of Scilly quickly drops to depths of 60-90 m within a few kilometres of the coast (Eggleton and Meadows, 2012). The bedrock topography is typically steeply sloping and irregular, with many gullies and ledges. Boulder areas are present on the slopes and there are ledges at depths around 50 m, some of which are cut by sediment filled gullies. Eggleton and Meadows (2012) found extensive sediment banks (East Bank and West Bank) to the north-west and south-east of the Isles, which are covered with sand waves and megaripples.

The predominant winds in the area are from the south-west. As a result of the Isles' offshore location the winds can be strong, with gales occurring on an average of 24 days a year (Met Office, 2011). The Isles of Scilly are also very exposed to waves from all directions. The prevailing westerly winds combined with the long fetch across the Atlantic Ocean can create large waves from the west, but the east and south-east also experience significant wave energy (Barne *et al.*, 1996)). The annual 10% exceedance wave height is around 3.0-3.5 m (Cornwall Council for CISCAG, 2009).

Exposure to wave action varies greatly around the islands, from very exposed to sheltered, due to the direction of the prevailing wind. Sites on the east of the Isles are generally more sheltered whereas those on the west are more exposed, resulting in a great diversity of marine communities (Barne *et al.*, 1996).

Tidal currents in the area are generally only around 0.75 m/s, but greater velocities occur in the narrows between the islands (Cornwall Council for CISCAG, 2009). The tidal currents can also reach over 2 knots in the channel between the Isles of Scilly and the mainland (Barne *et al.*, 1996). The tidal range is around 4.7 m (Buttress and Towler, 2013).

The surface water temperature ranges from around 10°C to 17°C (Global Sea Temperature, 2013). The seawater around the Isles of Scilly is 0.5-1.0°C warmer than on the adjacent mainland during winter due to the south-westerly location (Barne *et al.*, 1996). This has led to the presence of several warm water species on the Isles of Scilly that are not found on mainland Britain. The waters surrounding the islands are fully saline and have little coastal influence so siltation is minimal (JNCC, 2013).

1.4.3 Ecology

The Isles of Scilly support a unique and highly diverse range of marine communities. The high diversity results from the variations in exposure around the Isles, the south-westerly location, and lack of coastal influence leading to clear waters (Natural England, 2010). Some warm water species are present at the northern extreme of their range, such as the sunset cup coral *Leptopsammia pruvoti*, pink sea fans *Eunicella verrucosa*, and Weymouth carpet coral *Hoplangia durotrix*. *Eunicella verrucosa* is generally rare but is common at a few sites, including Hoe Point and the wrecks of Plympton and Hathor off St. Agnes (Seasearch, 2006). In 2010 Seasearch dives recorded *Eunicella verrucosa* at nine sites around the Isles and *Leptopsammia pruvoti* at Wingletang (Seasearch, 2010), both of which are Biodiversity Action Plan (BAP) species. The rare sea fan anemone *Amphianthus dohrnii* has also been recorded several times at Flat Ledge and North Chapel Rock off St. Martin's (Seasearch, 2004, 2006, 2007).

The Isles also have international importance for marine conservation. The rare shore dock *Rumex rupestris*, an Annex II species under the EU Habitats Directive and one of Europe's most threatened endemic vascular plants, is present on four of the islands (JNCC, 2013). The population of *R. rupestris* on the Isles is now estimated to be fewer than 100 plants (JNCC, 2013). There is also an important colony of grey seals, *Halichoerus grypus*, which are another Annex II species (JNCC, 2013). Significant populations of breeding seabirds, such as European shags, great black-backed gull, European storm petrels and Manx shearwaters, are found throughout the Islands (Barne *et al.*, 1996).

The reefs and rocky islets surrounding the Isles of Scilly support a zonation of benthic communities of flora and fauna. Rocky reefs can appear robust and resilient, but the communities which live on them can be delicate (Irving and Northen, 2012). Kelp forests of *Laminaria hyperborea* and *Laminaria ochroleuca* are found in varying proportions across the islands. Below the kelp forests the rocks are typically covered by anemones, sponges and hydroids, such as jewel anemones *Corynactis viridis* and dead man's fingers *Alcyonium digitatum* (Irving and Northen, 2012).

The extensive sublittoral sand banks are characterised by a low silt content and fully marine salinity, providing a habitat for a rich diversity of species, including tanaid crustaceans, echinoderms and a variety of polychaetes (JNCC, 2013). Seagrass beds colonise these shallow sediments, creating the most extensive *Zostera marina* beds in southern England (Hocking and Tompsett, 2001). For example at Tean Sound, between the islands of St. Martin's and Tean, the seagrass is considered to be in good health (Seasearch, 2010; Cook, 2013). The *Z. marina* beds are associated with a diverse community of algae, fish, hydroids, molluscs and sea anemones (JNCC, 2013).

The Isles also have extensive areas of intertidal sandflats. The outer reaches of the *Zostera marina* beds in the sublittoral extend onto the intertidal sandflats, which support exceptionally species-rich communities of anemones, polychaetes, bivalves and burrowing echinoderms such as *Echinocardium cordatum*, as well as different seaweeds and fish (JNCC, 2013). The isolated nature of the Isles and the flow of oceanic water mean that there is little mud or siltation. Southern species such as the hermit crab *Cestopagurus timidus* and the spiny cockle *Acanthocardia aculeata*, rarely found in the UK, are also present on these intertidal sandflats (JNCC, 2013).

1.5 Seabed species and habitats of conservation interest

1.5.1 Annex I habitat: Reefs

The Isles of Scilly are surrounded by reefs, which are an Annex I habitat. These reefs extend from the shallow sublittoral into depths below 50 m. The prevailing westerly wind coming across the Atlantic Ocean means that the reefs (Figure 1.3) on the west of the archipelago are very exposed whereas those on the east side are much more sheltered (JNCC, 2013).

The reef habitat is described as:

"Submarine, or exposed at low tide, rocky substrates and biogenic concretions, which arise from the seafloor in the sublittoral zone but may extend into the littoral zone where there is an uninterrupted zonation of benthic communities of algae and animal species including concretions, encrustations and corallogenic concretions. These reefs generally support a zonation of benthic (bottom-living) communities of algae and animals. Although rocky reefs can appear robust and resilient, the communities which live on them can be delicate, particularly in areas which are sheltered from strong wave action." (Isles of Scilly Management Scheme, 2010).

The reefs Annex I habitat is divided into the following sub-features (Isles of Scilly Management Scheme, 2010):

- Rocky shore communities
- Kelp forest communities
- Vertical rock
- Subtidal bedrock and boulder communities
- Subtidal faunal turf communities

Of these sub-features only two (kelp forest communities and vertical rock) are relevant to this survey. The sub-features are described in more detail below together with the recommended measures and attributes as detailed in the Favourable Condition table (Table 1.1).

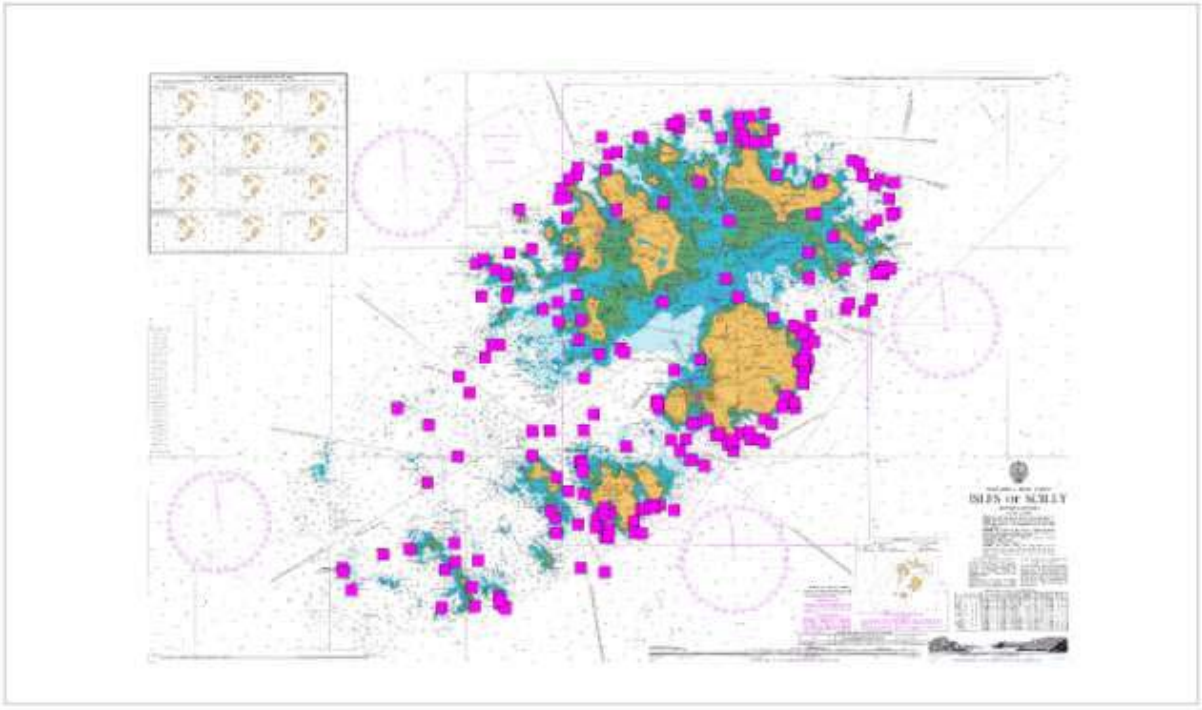


Figure 1.3. The locations of all 'subtidal rock' sites from Isles of Scilly historic data entered onto Marine Recorder (filtered as "infralittoral rock" and "circalittoral rock") (Irving and Northen, 2012).

1.5.1.1 Kelp forest communities

Infralittoral rock surfaces in shallow water are dominated by kelps (Figure 1.4). Characteristic species are *Laminaria hyperborea* and *Laminaria ochroleuca*, though *Saccharina latissima*, *Saccorhiza polyschides*, *Laminaria digitata* and *Alaria esculenta* are also commonly found (Irving and Northen, 2012). This sub-feature is likely to include the following biotopes (Connor *et al.*, 2004):

- **IR.HIR.KFaR.LhypR.Loch** (Mixed *Laminaria hyperborea* and *Laminaria ochroleuca* forest on exposed infralittoral rock);
- **IR.LIR.K.LhypLoch** (Mixed *Laminaria hyperborea* and *Laminaria ochroleuca* forest on moderately exposed or sheltered infralittoral rock).

A diverse range of species can be found attached to the stipe of *Laminaria hyperborea*, and a variety of macroalgal species, especially red algae, are found underneath *L. hyperborea*

forest (Irving and Northen, 2012). These red algal species include *Kallymenia reniformis*, *Delesseria sanguinea* and *Heterosiphonia plumosa* amongst others, some of which occur in exposed conditions and others that occur in sheltered kelp forests (Irving and Northen, 2012). However, the stipe of *Laminaria ochroleuca* is much smoother and very few epiphytic red algae attach.

The kelps can survive at greater depths than in mainland coastal waters because of the clear water around the Isles, with *Laminaria ochroleuca* occurring at depths up to 30 m (Barne *et al.*, 1996). The relative abundances of the two species may change with depth. On the parts of the British mainland where both species exist the kelp forest tends to be composed of *L. hyperborea* above 10 m depth, then below this the forest is mixed *L. hyperborea* and *L. ochroleuca*, and at depths below 16 m only *L. ochroleuca* is found (Dipper, 1981). Although just an indication of the vertical distribution of the two kelp species, these depths give an idea of the vertical change in species distribution on the Isles of Scilly but further research is required to establish the actual depth limits for the two species.

Around most of the UK *Laminaria hyperborea* dominates in kelp forests, but in the Isles of Scilly *Laminaria ochroleuca* has been found in higher abundances, for example at Menglow and Melledgan in the southwest of the area (Seasearch, 2010). Since *L. ochroleuca* is a warmer water species its abundance is likely to increase with climate change and the proportion of *L. hyperborea* is likely to decrease in the Isles of Scilly (Highfield *et al.*, 2013).

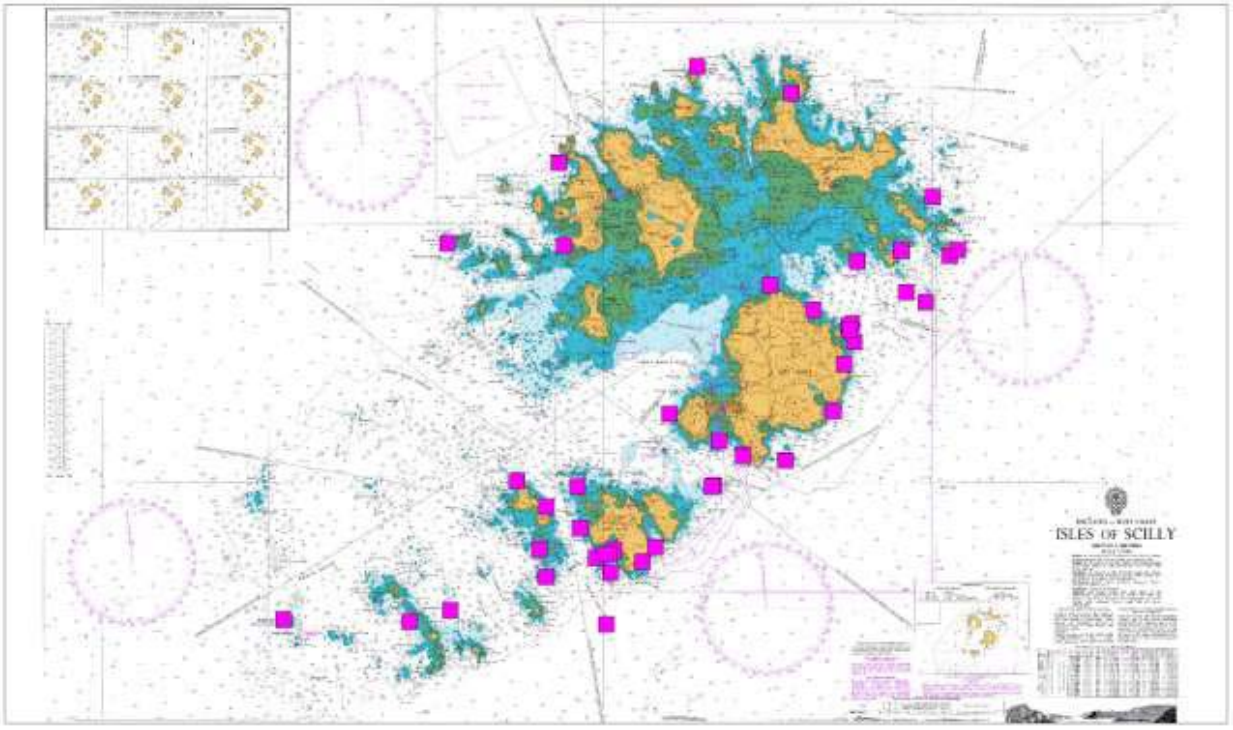


Figure 1.4. GIS plot of all historical sites featuring the kelp biotopes: IR.HIR.KFaR.LhypR.Loch and IR.LIR.K.LhypLoch (from Irving and Northen, 2012).

1.5.1.2 Vertical rock

Vertical rock faces in the circalittoral zone supporting a variety of species, including erect sponges, cup corals and anthozoans (Figure 1.5). In particular in the Isles of Scilly jewel anemones *Corynactis viridis*, sunset cup corals *Leptopsammia pruvoti* and dead man's fingers *Alcyonium digitatum* are characteristic of this sub-feature (Irving and Northen, 2012). Elegant anemones *Sagartia elegans* and plumose anemones *Metridium senile* are also often found on rocky walls, such as at Trenemene Wall and Ridge High Corner at the Eastern Isles (Seasearch, 2007, 2010). The biotopes may include (Connor *et al.*, 2004):

- **CR.HCR.XFa.SpAnVt** (Sponges and anemones on vertical circalittoral bedrock);
- **CR.HCR.XFa.CvirCri** (*Corynactis viridis* and a mixed turf of crisiids, *Bugula*, *Scrupocellaria* and *Cellaria* on moderately tide-swept exposed circalittoral rock);
- **CR.MCR.EcCr.CarSp** (*Caryophyllia smithii*, sponges and crustose communities on wave-exposed circalittoral rock);
- **CR.FCR.Cv.SpCup** (Sponges, cup corals and anthozoans on shaded or overhanging circalittoral rock).

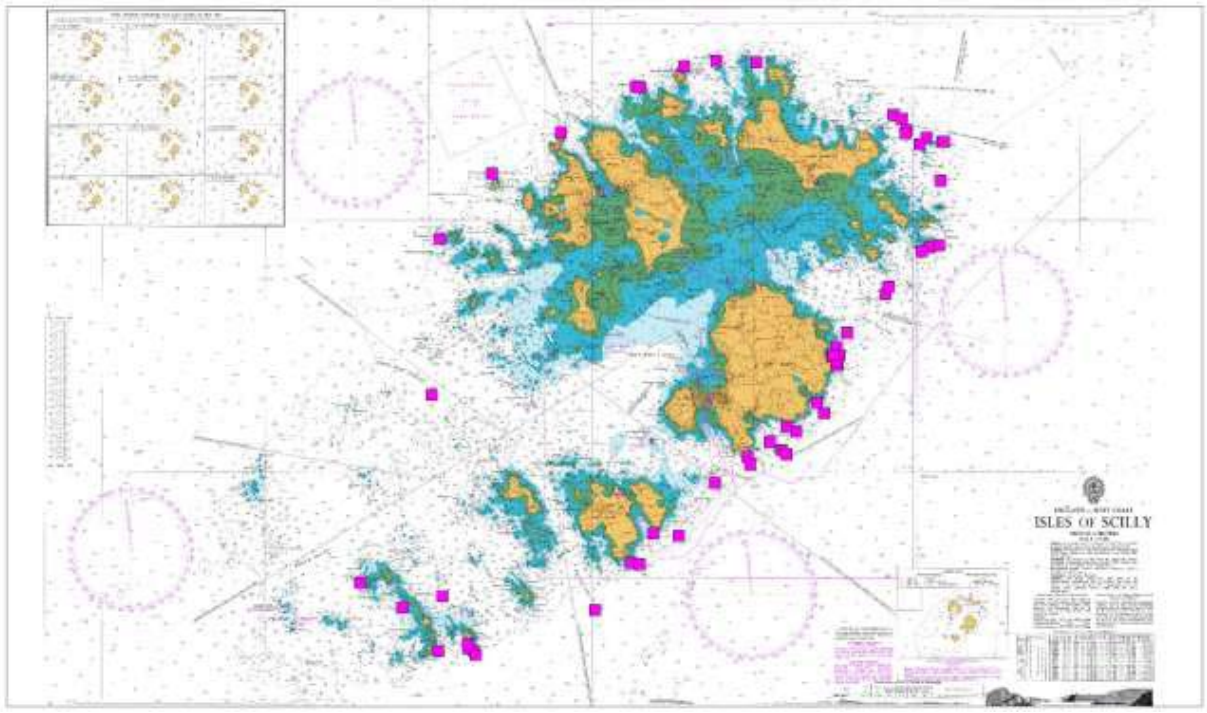


Figure 1.5. GIS plot of all historical sites featuring the four biotopes associated with circalittoral vertical rock: CR.HCR.XFa.SpAnVt, CR.HCR.XFa.CvirCri, CR.MCR.EcCr.CarSp and CR.FCR.Cv.SpCup (from Irving and Northen, 2012).

2 METHODOLOGY

2.1 Target flora and fauna

The 2013 target flora and fauna were largely based on the selection by Irving and Northen (2012), which in turn were largely based on the main characterising species of biotopes, representing kelp forests and vertical rock, found on the Isles of Scilly. The detailed rationale behind the species selection has been given in Irving and Northen (2012) but can be summarised as follows:

Kelp forest communities:

- *In-situ* identification of the kelp species is relatively easy;
- The proportion of *Laminaria ochroleuca* to *L. hyperborea* is a potential condition indicator of increasing water temperatures;
- Recording these taxa provide a simple comparison of baseline to monitoring ratio (Loch ; Lhyp) data;
- The condition indicator ratio data are also comparable to other studies.

Red algae:

- The range of the selected red algal species occur in exposed, moderately sheltered and sheltered conditions;
- Some of the red algae are limited to the south-west region of the UK whilst others have a wider distribution;
- The selected red algal species are distinct in terms of shape and form.

Vertical rock:

- The selected species are distinct and *in-situ* identification is relatively easy;
- The taxa are conspicuous;
- The selection provides examples from across the main benthic taxa represented within the sub-feature.

The rationale behind the 2013 species selection was largely to allow comparisons with the data collected in 2011 as well as those collected in subsequent years of monitoring but also as most of the flora and fauna allow *in-situ* identification (see Irving and Northen, 2012).

2.2 Site selection

All survey sites were chosen to be in water depths of less than 30 m; had safe access; were repeatable by future surveys; and were representative of the particular sub-feature being surveyed.

Sites were selected using local advisors to cover the full geographic spread of the SAC as far as conditions allowed, with a particular focus given to the north and west of the survey area. The selected sites were also meant to offer a certain amount of redundancy to ensure the survey could be adapted based on the weather conditions at the time of the fieldwork. The habitat surveyed in 2011 at Frenchman's Rock was also surveyed again in 2013.

2.3 Dates and activities

The first field work was completed between 10th and 19th May with a total of six potential diving days from 12th to 17th May. The breakdown of the first survey period was as follows:

- Friday 10th May – travel to Penzance, dive team rendezvous.
- Saturday 11th May – ferry to St. Mary's with onwards journey to St. Martins.
- Sunday 12th May to Friday 17th May – diving survey work.
- Saturday 18th May – demobilise all kit from dive vessel and return to Penzance.
- Sunday 19th May – travel home.

The second field work was completed between 19th and 28th July with a total of six potential diving days from 21st to 26th July. The breakdown of the second survey period was as follows:

- Friday 19th July – travel to Penzance, dive team rendezvous.
- Saturday 20th July – ferry to St. Mary's.
- Sunday 21stJuly to Friday 26th July – diving survey work.
- Saturday 27th July – demobilise all kit from dive vessel and return to Penzance.
- Sunday 28th July – travel home.

2.4 Vessels

Diving operations during May were conducted from the hardboat '*Morvoren*', an Offshore 105 licenced to carry 12 divers, which was skippered by Tim Allsop (St. Martin's Dive Services). Tim Allsop also provided expert local knowledge about dive sites and diving conditions during the survey. During the survey in July, the hardboat '*Tiburon*' skippered by Dave McBride was used. This boat was also licenced to carry 12 divers and was appropriately MCA coded. Both vessels were licenced to drop divers at any location within the SAC. Note that neither vessel carried survey management systems (e.g. Hypack), limiting any depth records to below sea level (BSL) rather than below chart datum (BCD).

2.5 Scuba-diving team

All diving work was undertaken in accordance with the HSE "Science and Archaeological Diving Projects" Approved Code of Practice (ACOP).

The dive team for the work included:

1. HSE diving contractor / project manager
2. Dedicated dive supervisor (HSE Part 1 diver and experienced dive supervisor)
3. Vessel skipper
4. Two Seastar scientific divers in May, three Seastar Survey scientific divers in July (CMAS 3* equivalent)
5. Five Natural England divers during each survey period (May and July)

For each dive site 2 or 3 buddy pairs were diving at any one time (depending on survey requirements) with 1 standby diver and the dive supervisor remaining on the vessel.

There were therefore a total of seven scientific divers for the May 2013 survey (Table 2.1) and eight scientific divers for the July 2013 survey (Table 2.2). All were qualified to CMAS 3-star, or equivalent, as a minimum.

Table 2.1. Scientific dive team in May 2013.

Name of diver	Organisation	Diving qualifications
Magnus Axelsson (MA)	Seastar Survey	CMAS 3-star (advanced diver)
Holger Anlauf (HA)	Seastar Survey	NAUI Assistant SCUBA Instructor, European Scientific Diver
Jen Ashworth (JA)	Natural England	PADI Divemaster
John Bleach (JB)	Natural England	HSE Part IV, BSAC Advanced Diver and OWI
Kathryn Dawson (KD)	Natural England	PADI Divemaster
Holly Latham (HL)	Natural England	HSE Commercial SCUBA (Part IV), PADI Open Water SCUBA Instructor and Speciality Instructor
Fiona Tibbitt (FT)	Natural England	HSE Professional SCUBA

Table 2.2. Scientific dive team in July 2013.

Name of diver	Organisation	Diving qualifications
Magnus Axelsson (MA)	Seastar Survey	CMAS 3-star (advanced diver)
Juliet Wilson (JW)	Seastar Survey	PADI Divemaster
Holger Anlauf (HA)	Seastar Survey	NAUI Assistant SCUBA Instructor, European Scientific Diver
Kevan Cook (KC)	Natural England	HSE Part IV, BSAC Advanced Instructor
Tom Hardy (TH)	Natural England	HSE Part IV, PADI Divemaster
Ross Bullimore (RB)	Natural England	HSE Part IV, PADI Divemaster
Holly Latham (HL)	Natural England	HSE Part IV, PADI Open Water SCUBA Instructor and Speciality Instructor
Ian Saunders (IS)	Natural England	BSAC Advanced Diver, BSAC Open Water Instructor

2.6 Scuba-diving survey methodology

The survey approach followed the recommendations given in the Isles of Scilly Dive Method Review (Highfield *et al*., 2013) as instructed by Natural England at the outset of the project. The actual scuba-diving methodology was changed from the 2011 survey (Irving and Northen, 2012) and specifically designed to acquire as much high-quality data as possible in the given survey period.

Two sub-features were assessed during this survey – kelp forest communities and vertical rock. The methodology differed for the two sub-features assessed, but essentially followed Seastar Survey's Standard Survey Methodology (SSM) - scuba-diving quadrat survey methodology - as detailed in Axelsson *et al*. (2013). The survey involved laying a ground line (the transect), filming along the transect and carry out quadrat based survey work at random locations along the transect. Summary methodologies for each sub-feature are given below, with a full survey methodology statement provided in Appendix 01 with the associated recording forms in Appendix 02 and a summary of the flora and fauna assessed in Appendix 03.

It is rarely possible to obtain measures of the entire population for an area or a feature. A sub-set sample of observations or units is therefore collected. The sample should represent

the population from which it was drawn but to be truly representative the units or observations of the sample must be drawn randomly, i.e. free from bias (see Fowler and Cohen, 1992). The true representation of the samples taken will increase with an increased number of observations made but Fowler and Cohen (1992) reported that 30 observations would give reliable estimates of the measured parameters. The detailed statistical imitations and advantages of using this number of samples are beyond the scope of this report but are given in, among other texts, Fowler and Cohen (1992) and Sokal and Rohlf (1995).

2.6.1 Random sampling

Random locations were generated prior to each survey day, and applied to the different methodologies used for the sub-features. A grid was created around each ground line consisting of 80 cells. From these 80 cells, 30 cells (37.5 %) were selected by the use of a random number generator prior to each dive. The locations of the 30 selected cells were then transcribed onto dive slates.

For the kelp forest feature, quadrat analysis was based on using 1 m^2 quadrats whilst the red algal component was based on 0.25 m^2 quadrats. A 20 m ground line was used and an area 2 m either side of the line was to be analysed, creating 80 x 1 m^2 cells in the sampling grid. The kelp component was assessed using this grid whilst the red algal component was assessed by randomly selecting a quarter of the 1 m^2 cells (i.e. 0.25 m^2) generated prior to the dive commencing.

For the vertical rock sub-feature, a 5 m high wall was selected for analysis. Analysis was based on 25 x 25 cm quadrats (0.0625 m^2). Within an area 0.5 m either side of the 5 m long transect, 20 x 0.25 m^2 quadrats could be laid. These quadrats were then further divided into 4 x 0.0625 m^2 cells, resulting in a total of 80 cells (each covering 0.0625 m^2) in the sample grid along the entire 5 m long vertical transect.

2.6.2 Summary of the kelp and red algae survey methodology

The kelp forest survey had two components; kelp ratio assessments and red algae assessments (see further detail in Appendix 01). The randomly generated locations within the 80 cell grid (covering 2 m on both sides of the line) were used for both components simultaneously. However, the kelp ratio was assessed using a 1.0 m^2 quadrat, whilst the red algae assessment was carried out in a 0.25 m^2 area in one corner of the 1 m^2 quadrat.

Sites were selected within the upper infralittoral zone (i.e. the kelp forest). The first task was to assess the kelp species ratio. Using a three-sided 1 m^2 quadrat, the numbers of individuals from six kelp species were counted at each quadrat location. The six kelp species were: *Laminaria hyperborea*, *Laminaria ochroleuca*, *Saccharina latissima* (formerly *Laminaria saccharina*), *Saccorhiza polyschides*, *Laminaria digitata* and *Alaria esculenta* (after Irving and Northen, 2012).

The second component involved the red algae assessment. In a 0.25 m^2 area within the 1 m^2 quadrat presence/absence records were made of the following nine characteristic species: *Kallymenia reniformis, Delesseria sanguinea, Membranoptera alata* (particularly on kelp stipes)*, Phycodrys rubens* (particularly on kelp stipes)*, Heterosiphonia plumosa, Pterosiphonia parasitica, Sphaerococcus coronopifolius, Dilsea carnosa, Halurus equisetifolius* (after Irving and Northen, 2012).

The required tasks were divided between the divers as follows:

Dive Pair 1: Based on local advice select the location for the transect. Lay the 20 m ground-rope (marked at 1 m intervals) for the transect, ensuring the depth of the line remained within the minimum and maximum for the kelp forest biotope. Film along the transect attempting to cover the 4 m width if possible. Produce a site description using methodology similar to Seasearch (2013). Complete the kelp community assessment and presence/absence of the 9 characteristic red algal species at 6 quadrat locations, using the randomly generated positions.

Dive Pair 2 and 3: Firstly, use the randomly generated and pre-selected 12 quadrat positions (cells) along the transect line to complete the kelp community assessment. Secondly, using one corner of the 1 m^2 quadrat in an area of 0.25 m^2 record the presence/absence of 9 characteristic red algal species, both on the rock surface and on the kelp stipes, on a pre-prepared recording form. *In-situ* recording was made as far as possible, but samples were collected for later identification and verification.

Still photographs of each quadrat were taken or a short video film taken if the quality of the still photographs was not sufficient. The identification and abundance data were recorded on pre-prepared recording forms together with the depth of the quadrat.

The opportunity for sampling repeatability of the kelp forest community locations should be high using the site descriptions given for each station (positional data, drawings, descriptions and photographs). However, the survey aims to assess the habitat, not the exact location (NB. random sampling), so as long as the depth limits are adhered to, future survey transects can be at slightly different positions to the original without affecting the overall assessment and any subsequent comparisons.

2.6.3 Summary of the vertical rock survey methodology

A detailed description of the vertical rock assessment methodology is given in Appendix 01. As part of the process developing the methodology it was decided that the aim would be to find circalittoral vertical walls of 5 m in height. This was to restrict the diving depths (most walls are found from 17 m and below) required for the assessments, and therefore allow longer underwater analysis time.

The local advisor identified suitable vertical rock locations in collaboration with the project managers from Seastar Survey Ltd. The vertical rock feature had to be around 5 m in height, as near vertical as possible (180°), as smooth as possible, found at depths of 30 m, or less, and allow repeatability in terms of shelter and access.

Once at a location and the vertical wall face was located, a piton was hammered into the wall, and a pre-marked guide rope (1 m intervals) was reeled out from the top to the bottom of the feature, forming a mid-line of the transect. The depth at the start and end of the transect was noted and the wall was filmed (video) to form a permanent record. Due to the limited time underwater at the depths where the vertical transects were present, half of the quadrats were completed in one dive. During the second dive at the same location, dive pairs 1 to 3 would complete 6 quadrats per pair, and therefore complete the assessment of the 30 cells for the sub-feature. On completion of the assessment pair 3 would recover the guide rope and return it to the vessel.

Of note is that the pitons were marked with orange strips of material to allow repeatability of sites. The strips of material may deteriorate or vanish over time but the pitons are permanent markers for future surveys and together with the site descriptions should allow for future repeatability of sites.

The required tasks to be completed by the divers can be summarised as follows:

Dive Pair 1: Site selection and description (Seasearch methodology; Seasearch, 2013), attach piton, attach 5 m vertical guide rope and video the transect. On the second visit to the site complete 6 quadrats, photographing quadrat and assessing percentage cover/counts of selected taxa in each quarter (generated randomly).

Dive Pair 2: 6 quadrats (at top of wall if appropriate), photograph quadrat, assess percentage cover/counts of selected taxa in each quarter (generated randomly). Repeat the procedure for the second dive.

Dive Pair 3: 6 quadrats (at bottom of wall if appropriate), photograph quadrat, assess percentage cover/counts of selected taxa in each quarter (generated randomly). Repeat the procedure for the second dive and retrieve guide rope after dive two.

As the divers arrived at the wall one of the dive buddies in each of the two dive pairs identified the location of the cells to be analysed and held the 0.25 m^2 quadrat against the wall at each of the pre-selected cells in the grid. The quarter (0.0625 m^2) to be analysed was photographed and then assessed. The divers recorded the number of individuals, or the percentage cover for colonial species, for 22 characteristic species at 30 quadrat locations along the line.

The 22 species regarded as being 'characteristic' of circalittoral vertical rock, from exposed to sheltered (wave action) and exposed to semi-exposed (tidal streams), and were selected from Hiscock (1983). The dive recording forms list all the species and how these were recorded, but the taxa were as follows:

Porifera
Axinella dissimilis
Tethya citrina
Cliona celata
Hemimycale columella
Dysidea fragilis
Haliclona viscosa

Cnidaria
Alcyonium digitatum
Alcyonium glomeratum
Corynactis viridis
Actinothoe sphyrodeta
Sagartia elegans
Leptopsammia pruvoti
Caryophyllia smithii

Cnidaria
Hoplangia durotrix
Parazoanthus axinellae
Parazoanthus anguicomus

Echinodermata
Echinus esculentus
Marthasterias glacialis
Holothuria forskali
Antedon bifida

Tunicata
Clavelina lepadiformis
Stolonica socialis

2.7 Algae pressing

Samples of red algae were collected at some of the sites in order to verify identification, since some of the red algal species were difficult to identify *in situ.* The samples were retained, identified and pressed to be kept as a permanent record. This herbarium has been submitted as a digital record of algae specimens (see Appendix 05) to Natural England.

2.8 Data analysis

On completion of the field work the field logs, still photographs and video were assessed for quality and usability. A quality control (QC) process of the data collected was also completed where all the stills and video were re-analysed to ensure similar assessments of the quantitative data as far as possible. The fauna and flora recorded during this survey were identified with reference to WoRMS (WoRMS Editorial Board, 2014) for species nomenclature. The fauna and flora were recorded using a variety of methods including counts, percentage cover, presence/absence (see Appendix 02) and the SACFOR scale (Connor *et al*., 2004).

Site descriptions were completed for each survey location (kelp forest and vertical rock communities) with information about positions, depths, the fauna and flora were noted together with drawings to illustrate the habitat and allow future surveys to re-locate the survey transect lines.

2.8.1 Analysis of kelp data

The kelp forest community data were analysed by calculating and illustrating (in graphs) the total abundance and the mean density for the different kelp species, the juveniles and the total at each site. The ratio between *Laminaria hyperborea* and *Laminaria ochroleuca* was also calculated for each site to assess any differences in the characteristic kelp species at the different locations.

The Wilcoxan's matched pair test (T) was used to assess (see Fowler and Cohen, 1992) any significant differences in the median abundance of *Laminaria hyperborea* and *Laminaria ochroleuca* for all the 2013 kelp forest community locations as well as the data collected from Frenchman's Rock in 2011. The Null Hypothesis given for each location was that "there was no difference in median abundance between *Laminaria hyperborea* and *Laminaria ochroleuca*".

2.8.2 Analysis of red algae data

Recording red algae *in-situ* is a very challenging task but it is also difficult to assess the red algae parameter in a sensible manner as the cover is extremely difficult to estimate. Presence / absence records therefore become the only sensible recording option. These records can be assessed by completing a community assessment in, for example, PRIMER, followed by a SIMPER analysis to verify which species have the biggest influence on the community structure in each group, area or location. By recording the occurrence frequency across a survey location the community structure, the most important taxa and the frequency at which these taxa are found can then be used to assess any future change. The percentage frequency of specific species can then be compared between years and locations (e.g. pair-wise tests or frequency homogeneity tests) to assess whether any changes are significant or not.

In the 2013 study the percentage frequency of the occurrence (the percentage of the number quadrats with species records in relation to the total number of quadrats analysed) of the characteristic species have therefore been used to assess the community structure at the different dive locations. The community structure was assessed by multivariate analysis using cluster analysis followed by a SIMPER analysis procedure in PRIMER. The cluster analysis was completed on untreated data (no standardisation or transformation). The resultant groups were subsequently assessed for any detailed patterns.

2.8.3 Analysis of vertical rock data

The vertical rock faunal data were summarised in tables of frequencies and percentages of the different species recorded in the analysed quadrats. The number of quadrats (frequency n) and the percentage of quadrats (frequency %) were calculated as well as the mean percentage cover (and standard deviation) for each taxon. The former two results illustrate how widespread the different taxa are across the site and the latter the relative abundance of the different taxa at the site.

The multivariate analysis was undertaken using PRIMER (Plymouth Routines in Multivariate Ecological Research) v 6 (Clarke and Warwick, 2001). To assess any patterns in the different communities across the sites, the percentage of quadrat (frequency %) data were used as it was more representative across the sites compared to mean or median percentage cover. With small values across most of the taxa the mean percentage cover data furthermore had the potential of distorting the results as some fauna were present only in one quadrat of the 30 analysed.

There were no pre-treatments of the data prior to the multivariate analyses as percentage values were used for the analyses. Therefore neither standardisation nor transformations were completed. The multivariate analysis of species data involved cluster analysis using the Bray-Curtis similarly coefficient where the sites were group-averaged and the resultant dendrogram plotted to illustrate the similarities between communities. To assess any differences in community structure between the cluster groups, a SIMPER analysis was completed (based on frequency % data) with a cut-off of 97 %.

3 RESULTS

3.1 Scuba diving effort

In order to comply with the ACOP the plan was for each diver to complete two dives each per day (morning and afternoon) with a minimum of 2 hours surface interval between dives. This resulted in a potential of 12 person-dives per day and a total of 72 person dives in each of the six day periods on the Isles of Scilly in May and July 2013.

During the dive survey in May 2013 (Table 2.1) poor weather conditions (Beaufort Force 9 on 14th May 2013) and some logistical issues (12th May 2013) resulted in a total of 64 person dives (Table 3.1).

A total of 66 person dives were completed in July 2013 (Table 3.2). The success and high efficiency of the dive operations meant there was no need to utilise the afternoon of the final day (contingency dive) despite the fact that one member of the NE staff was unable to dive on 23rd July (reducing the dive effort to 4 person-dives in the morning) due to other Natural England work commitments (see also Table 2.2).

Table 3.1. Total number of dives in May 2013 (see Table 2.1. Scientific dive team in May 2013. for diver names in full).

Date	Target	Dive No	Dives	Divers
12/05/13	Faunal turf community	1	4	KD, JA, JB, FT
12/05/13	Kelp forest / red algae	2	6	MA, HA, FT, HL, KD, JA
13/05/13	Vertical rock	3	6	MA, HA, HL, KD, JB, FT
13/05/13	Kelp forest / red algae	4	6	MA, HA, HL, KD, JB, FT
14/05/13	Vertical rock	5	6	MA, HA, JB, FT, HL, JA
15/05/13	Vertical rock	6	6	MA, HA, JB, KD, HL, JA
15/05/13	Kelp forest / red algae	7	6	MA, HA, JB, KD, HL, JA
16/05/13	Vertical rock	8	6	MA, HA, FT, HL, KD, JA
16/05/13	Kelp forest / red algae	9	6	MA, HA, KD, JB, HL, FT
17/05/13	Vertical rock	10	6	MA, HA, HL, FT, JB, KD
17/05/13	Vertical rock	11	6	MA, HA, FT, HL, KD, JA
Total	**64**			

Table 3.2. Total number of dives in July 2013 (see Table 2.2. Scientific dive team in July 2013. for diver names in full).

Date	Target	Dive No	Dives	Divers
21/07/13	Kelp forest / red algae	12	6	HA, TH, HL, IS, RB, KC
21/07/13	Kelp forest / red algae	13	6	JW, TH, HL, IS, RB, KC
22/07/13	Vertical rock	14	6	HA, TH, HL, IS, RB, KC
22/07/13	Kelp forest / red algae	15	6	HA, JW, HL, IS, RB, TH
23/07/13	Vertical rock	16	4	TH, KC, HA, JW
23/07/13	Kelp forest / red algae	17	6	HA, JW, HL, TH, RB, KC
24/07/13	Vertical rock	18	6	MA, HA, KC, RB, HL, IS
24/07/13	Vertical rock	19	6	MA, HA, KC, RB, HL, IS
25/07/13	Vertical rock	20	6	MA, KC, HL, IS, JW, TH
25/07/13	Kelp forest / red algae	21	6	MA, KC, RB, HL, JW, TH
26/07/13	Vertical rock	22	6	TH, HL, RB, IS, JW, HA
26/07/13	Vertical rock	23	2	MA, KC
Total	**66**			

3.2 Survey locations and habitats

A total of 13 dive locations were surveyed during the entire survey (Table 3.3 and Figure 3.1). Out of these locations one was a faunal turf community, six were kelp forest communities and six were vertical rock communities (Tables 3.4-3.7) with the assessment of the sub-features completed in one, two or three dives (see further detail in Appendix 04). One location, Frenchman's Rock (kelp forest community) was surveyed twice, once in May 2013 and once in July 2013.

The sites were spread geographically over several different islands (Figure 3.1), including St. Mary's, St. Martin's, St. Agnes, White Island, Men-a-vaur, Tresco, Little Arthur and Menawethan (Figures 3.2-3.5) over different days and times (for tidal height data see Tables 3.6 and 3.7; from BODC, 2014).

Table 3.3. Summary of the dive site locations.

Station Name	**Island**	**Target (sub-feature)**
Frenchman's Rock	Little Arthur	Kelp forest / red algae
Porth Hellick	St Mary's	Kelp forest / red algae
Lizard Rock	St Agnes	Kelp forest / red algae
Carn Morval	St. Mary's	Kelp forest / red algae
Tresco Channel, Cromwell's Castle	Tresco/Bryher	Kelp forest / red algae
Porth Morran	White Island	Kelp forest / red algae
JS Wall	St Mary's	Vertical rock
Newfoundland Point	St Mary's	Vertical rock
Menawethan	Menawethan	Vertical rock
Men-a-vaur	St. Helen's	Vertical rock
John Thomas Ledge	St. Martin's	Vertical rock
East Withan	White Island	Vertical rock
JS Wall	St Mary's	Faunal turf community

The faunal turf community dive in May 2013 was a 'shake-down' dive to test the equipment, get used to the local conditions and the dive vessel. It furthermore allowed the divers to get familiar with the survey methodologies, equipment (buddy pair and survey) and the fauna present. Of most importance, however, was the opportunity to assess whether surveying faunal turfs (sub-features "Subtidal bedrock and boulder communities" and "Subtidal faunal turf communities") on the Isles of Scilly using scuba-diving was appropriate considering the depths at which these features are found.

The conclusion from these sets of dives was that these features simply are found at depths in excess of those appropriate and safe to allow sufficient survey time even over two dives (for six pairs of divers) to allow all of the tasks to be completed to a satisfactory standard. As mentioned in the introduction, discussions with Natural England representatives and managers resulted in the decision not to survey the faunal turf communities during the scuba-diving surveys in 2013 and focus on the kelp forest community and vertical rock sub-feature. The faunal turf communities will therefore not be described further in this report other than included in the survey logs and other basic records.

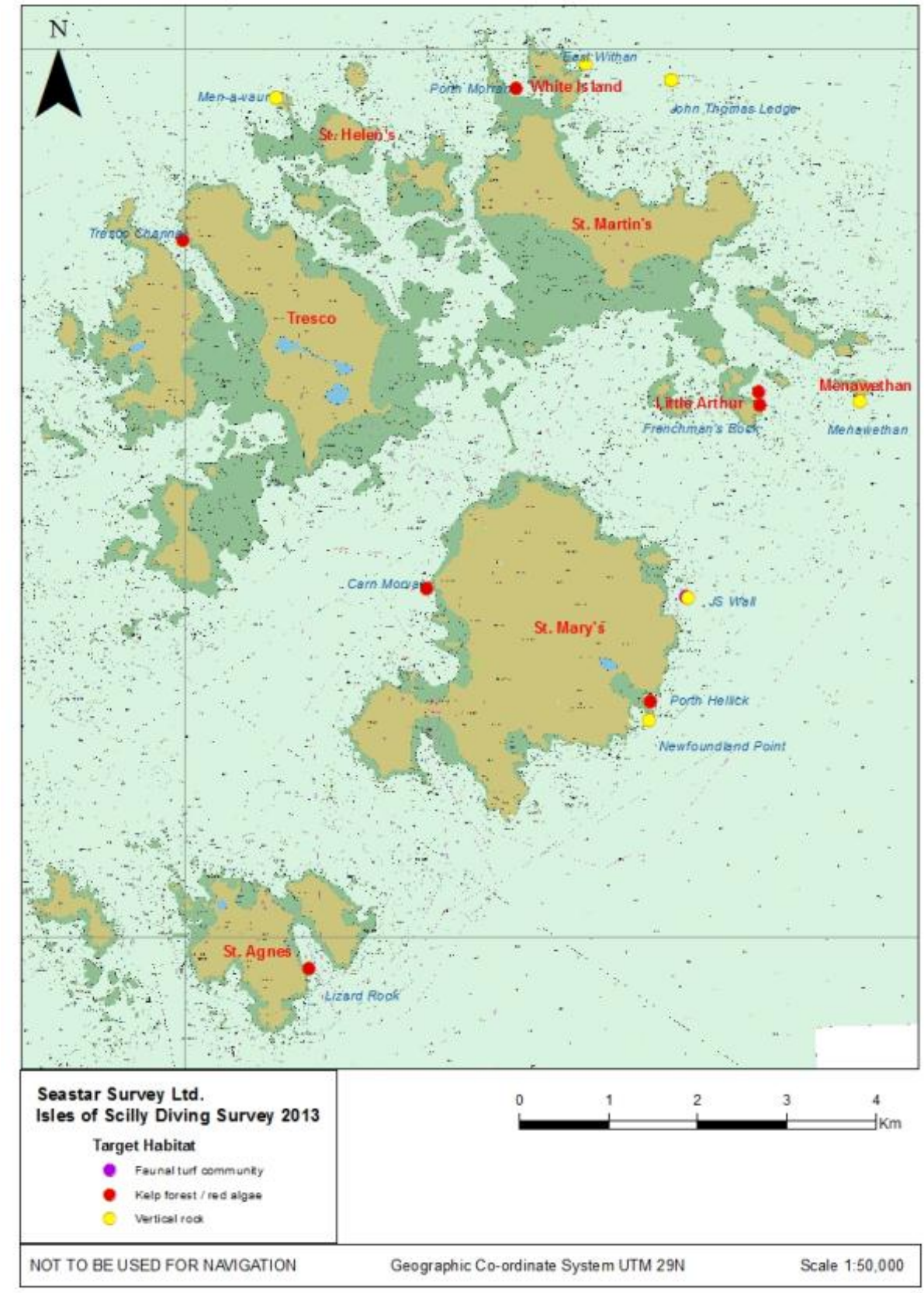


Figure 3.1. Map of survey locations.

Table 3.4. Summary of the dive locations surveyed in May 2013 (depth: below sea level (BSL) depth at the GPS position; positions in WGS84).

Dive Number	Target	Site Name	Island	Station Number	Date	Time	Latitude N (decimal minutes)	Longitude W (decimal minutes)	Depth (m)
1	Faunal turf community	JS Wall	St Mary's	349-01	12/05/2013	10:16	49° 55.490’	06° 16.458’	26
2	Kelp forest / red algae	Frenchman’s Rock	Little Arthur	349-02	12/05/2013	13:40	49° 56.634’	06° 15.691’	12
3	Vertical rock	JS Wall	St Mary's	349-03	13/05/2013	11:00	49° 55.481’	06° 16.429’	17
4	Kelp forest / red algae	Porth Hellick	St Mary's	349-04	13/05/2013	13:45	49° 54.864’	06° 16.816’	6
5	Vertical rock	JS Wall	St Mary's	349-05	14/05/2013	10:20	49° 55.481’	06° 16.429’	18
6	Vertical rock	Newfoundland Point	St Mary's	349-06	15/05/2013	10:45	49° 54.745’	06° 16.840’	15
7	Kelp forest / red algae	Porth Hellick	St Mary's	349-07	15/05/2013	13:10	49° 54.864’	06° 16.816’	7
8	Vertical rock	Newfoundland Point	St Mary's	349-08	16/05/2013	08:00	49° 54.745’	06° 16.840’	15
9	Kelp forest / red algae	Lizard Rock	St Agnes	349-09	16/05/2013	10:30	49° 53.315’	06° 20.118’	9
10	Vertical rock	Menawethan	Menawethan	349-10	17/05/2013	09:20	49° 56.634’	06° 14.746’	16
11	Vertical rock	Menawethan	Menawethan	349-11	17/05/2013	12:10	49° 56.634’	06° 14.746’	16

Table 3.5. Summary of the dive locations surveyed in July 2013 (depth: below sea level (BSL) depth at the GPS position; positions in WGS84).

Dive Number	Target	Site Name	Island	Station Number	Date	Time	Latitude N (decimal minutes)	Longitude W (decimal minutes)	Depth (m)
12	Kelp forest / red algae	Carn Morval	St. Mary’s	349_12	21/07/13	09:30	49° 55.594’	06° 18.882’	7
13	Kelp forest / red algae	Carn Morval	St. Mary’s	349_13	21/07/13	12:44	49° 55.594’	06° 18.882’	8
14	Vertical rock	Men-a-vaur	St. Helen’s	349_14	22/07/13	09:12	49° 58.606’	06° 20.137’	19
15	Kelp forest / red algae	Cromwell’s Castle, Tresco Channel	Tresco/ Bryher	349_15	22/07/13	12:53	49° 57.761’	06° 21.052’	8
16	Vertical rock	Men-a-vaur	St. Helen’s	349_16	23/07/13	08:54	49° 58.606’	06° 20.137’	19
17	Kelp forest / red algae	Porth Morran	White Island	349_17	23/07/13	12:44	49° 58.610’	06° 17.877’	8
18	Vertical rock	John Thomas Ledge	St. Martin’s	349_18	24/07/13	10:23	49° 58.628’	06° 16.404’	17
19	Vertical rock	East Withan	White Island	349_19	24/07/13	13:05	49° 58.742’	06° 17.216’	15
20	Vertical rock	John Thomas Ledge	St. Martin’s	349_20	25/07/13	11:18	49° 58.628’	06° 16.404’	17
21	Kelp forest / red algae	Frenchman’s Rock	Little Arthur	349_21	25/07/13	14:25	49° 56.713’	06° 15.695’	12
22	Vertical rock	East Withan	White Island	349_22	26/07/13	09:18	49° 58.742’	06° 17.216’	21
23	Vertical rock	John Thomas Ledge	St. Martin’s	349_23	26/07/13	12:24	49° 58.628’	06° 16.404’	26

*Table 3.6. Summary of the data collected in May 2013 with tidal heights for St. Mary's (*maximum depth by divers; tide data for St. Mary's in Greenwich Mean Time, GMT).*

Dive Number	Max Depth (m)*	Transect videos	Still photographs (total)	Usable photographs	Quadrat Videos (total)	High water (time and height)	Low water (time and height)
1	25.0	N/A	41	41	0	05:50 / 5.1 m	12:10 / 1.0 m
2	11.4	Yes	82	25	0	05:50 / 5.1 m	12:10 / 1.0 m
3	24.0	Yes	33	24	0	06:25 / 4.9 m	12:45 / 1.1 m
4	11.5	Yes	53	12 (+13 videos)	19	06:25 / 4.9 m	12:45 / 1.1 m
5	25.0	(yes #03)	99	47	2	07:00 / 5.0 m	13:15 / 1.5 m
6	24.1	Yes	52	34	0	07:35 / 4.7 m	13:55 / 1.5 m
7	11.5	(yes #04)	18	11 (+ videos)	22	07:35 / 4.7 m	13:55 / 1.5 m
8	24.1	(yes #06)	85	56	3 (labels only)	08:15 / 4.6 m	14:35 / 1.8 m
9	11.8	Yes	17	12 (+ videos)	32	08:15 / 4.6 m	14:35 / 1.8 m
10	24.2	Yes	46	28	0	09:05 / 4.3 m	15:25 / 1.9 m
11	22.3	(yes as #10)	97	63	0	09:05 / 4.3 m	15:25 / 1.9 m

*Table 3.7. Summary of the data collected in July 2013 with tidal heights for St. Mary's (*maximum depth by divers; tide data for St. Mary's in GMT).*

Dive Number	Max Depth (m)*	Transect videos	Still photographs (total)	Useable photographs	Quadrat videos (total)	Low water (time and height)	High water (time and height)
12	6.8	2	57	35	0	09:25 / 1.0 m	15:25 / 5.5 m
13	10.2	0	172	127	3	09:25 / 1.0 m	15:25 / 5.5 m
14	25.0	2	31	31	0	10:15 / 0.7 m	16:15 / 5.8 m
15	11.5	1	24	5	40	10:15 / 0.7 m	16:15 / 5.8 m
16	22.0	0	65	59	0	11:05 / 0.5 m	17:05 / 6.0 m
17	9.2	1	31	26	38	11:05 / 0.5 m	17:05 / 6.0 m
18	23.9	1	57	45	1	11:55 / 0.4 m	17:50 / 6.1 m
19	21.1	1	41	38	0	11:55 / 0.4 m	17:50 / 6.1 m
20	24.5	1	67	57	0	12:40 / 0.4 m	18:35 / 6.0 m
21	13.5	1	93	93	29	12:40 / 0.4 m	18:35 / 6.0 m
22	25.8	2	87	84	0	13:25 / 0.6 m	19:20 / 5.7 m
23	25.0	1	40	40	0	13:25 / 0.6 m	19:20 / 5.7 m

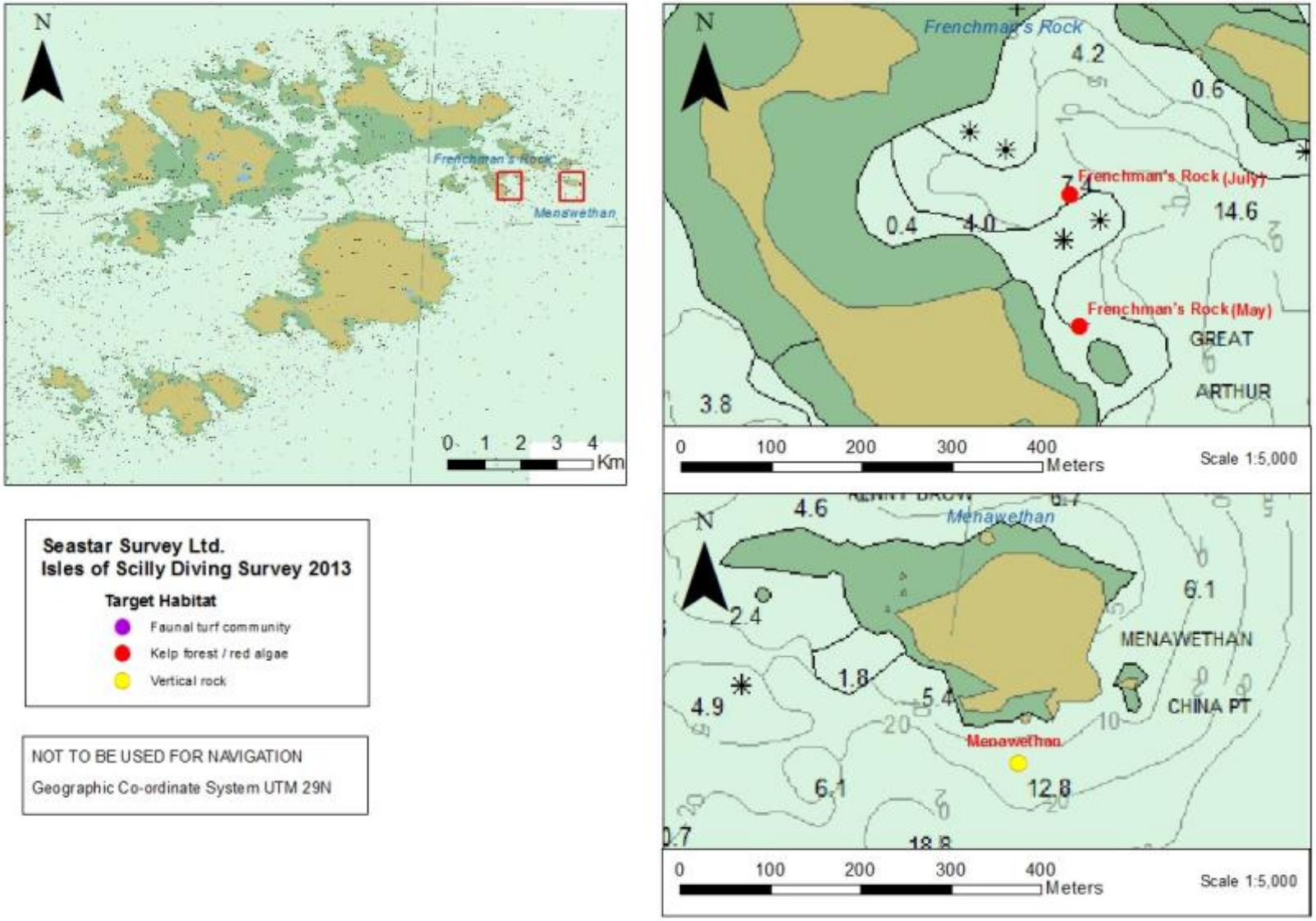


Figure 3.2. Dive sites Frenchman's Rock and Menawethan.

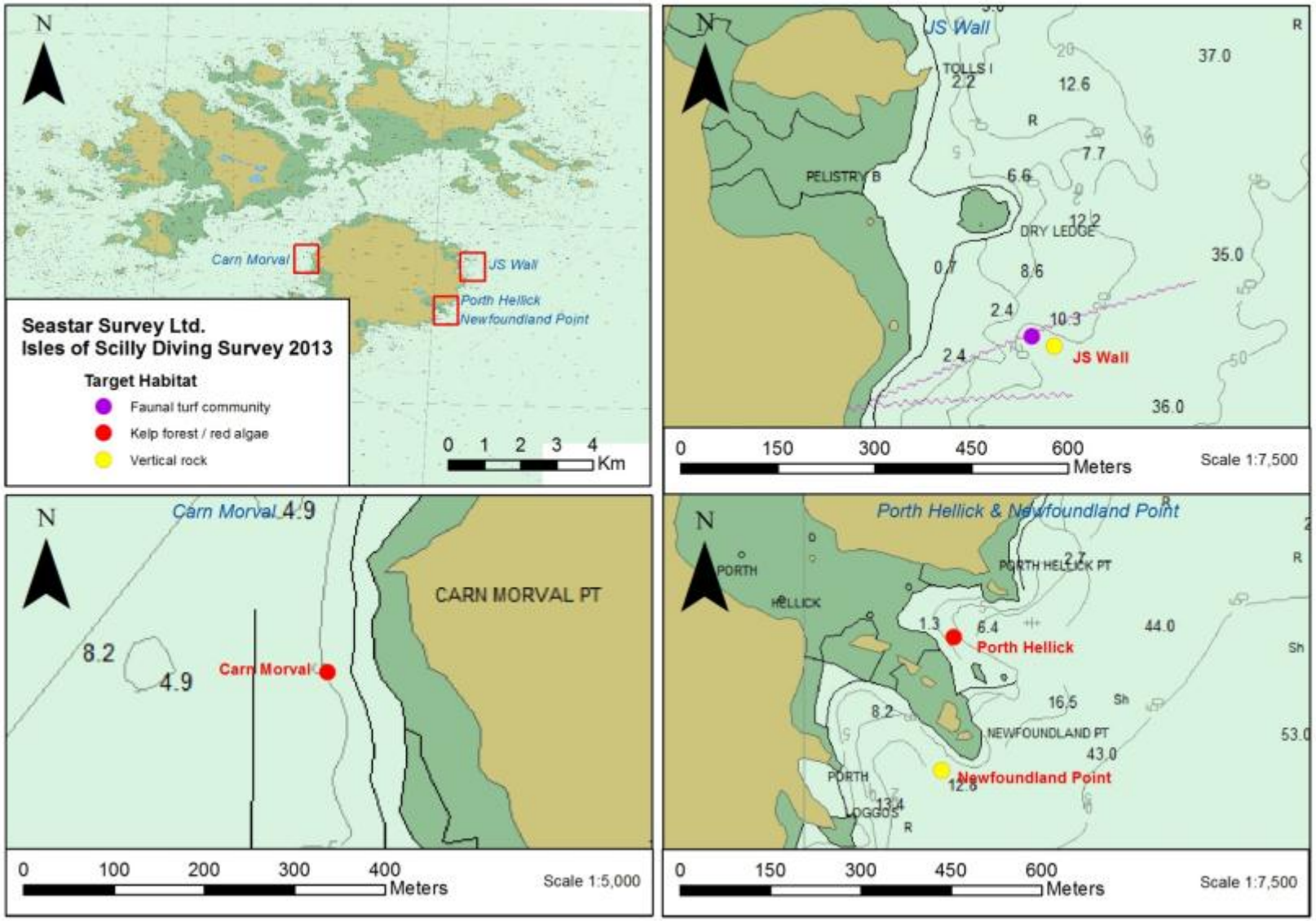


Figure 3.3. Dive sites J S Wall, Carn Morval, Porth Hellick and Newfoundland Point.

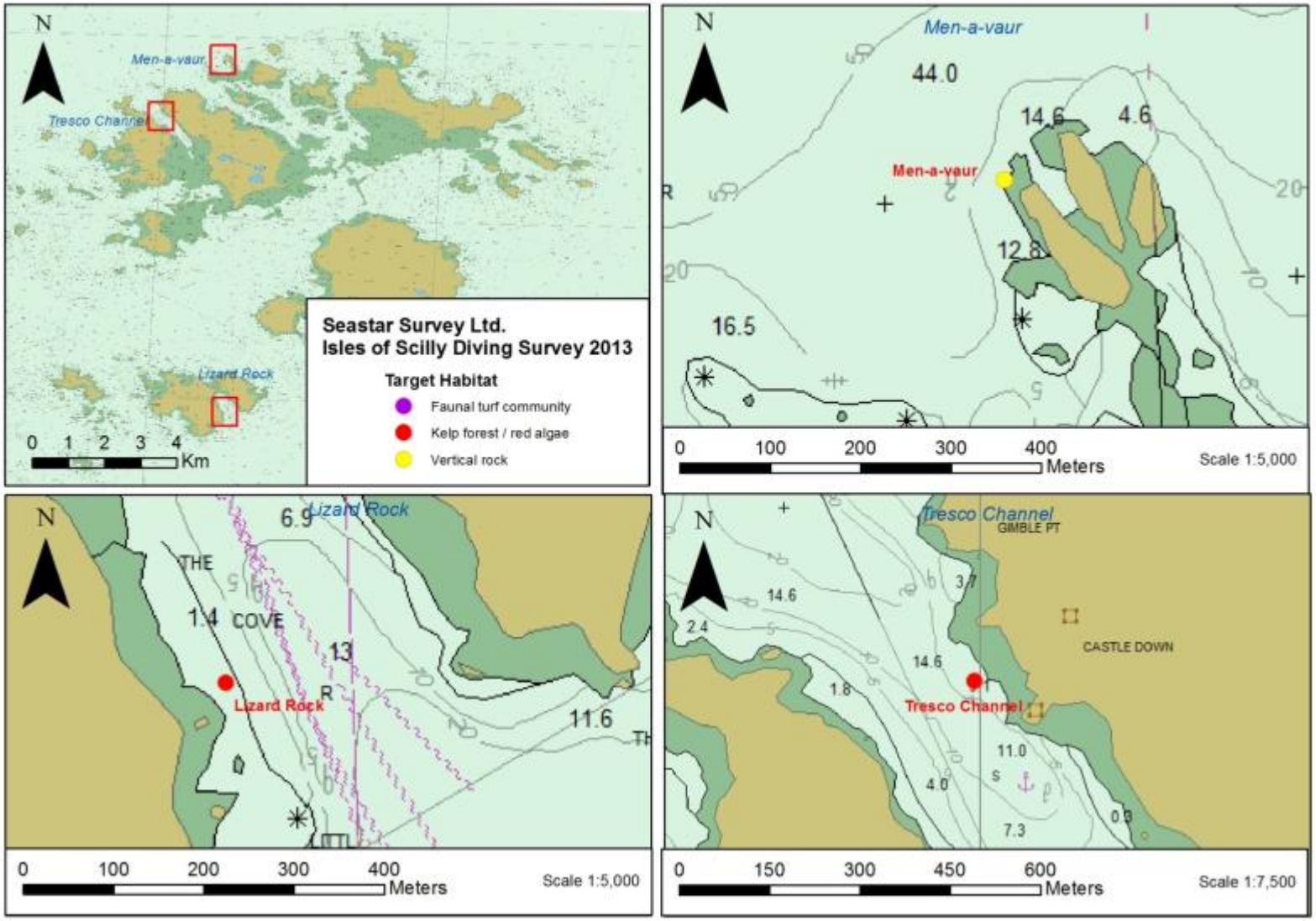


Figure 3.4. Dive sites Men-a-Vaur, Lizard Rock and Tresco Channel.

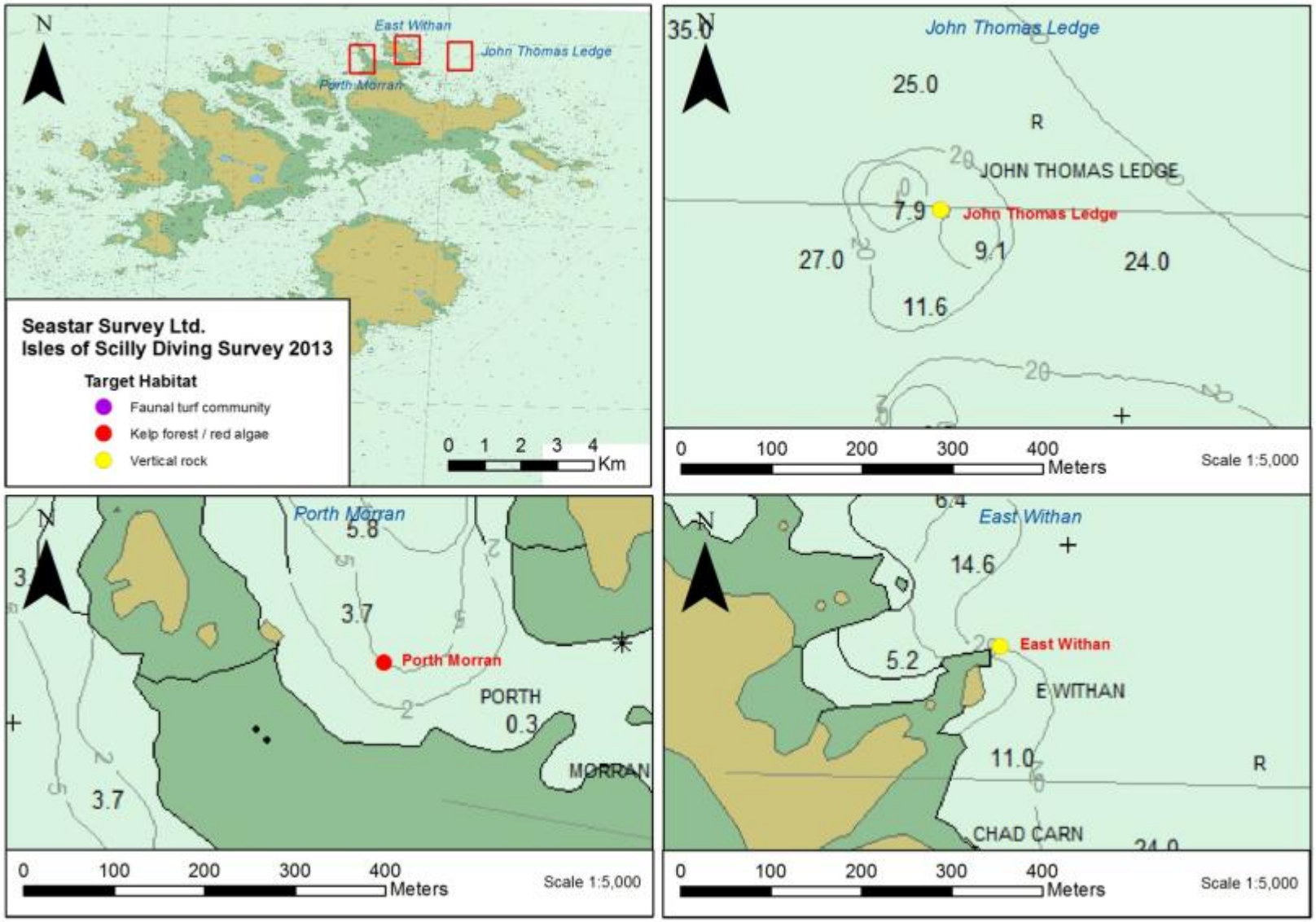


Figure 3.5. Dive sites John Thomas Ledge, Porth Morran and East Withan.

3.3 Kelp forest communities

Out of the six kelp forest community dive locations surveyed in 2013 three were completed in May 2013 (Frenchman's Rock, Porth Hellick and Lizard Rock; see Tables 3.4-3.7 with additional detail in Appendix 04) and four kelp forest community sub-feature sites were completed in July 2013 (Carn Morval, Tresco Channel, Morran Porth and a repeat survey of Frenchman's Rock; see Tables 3.4-3.7).

The first kelp forest community assessment in May was the second dive of the week. The divers were therefore familiar with the survey methodology which allowed a complete focus on the survey targets. The first kelp forest community site in July (with a new dive team) was a 'shake-down' dive to test the equipment, get used to the local conditions and the dive vessel. It furthermore allowed the divers to get familiar with the survey methodologies, equipment (buddy pair and survey) and the fauna and flora present. Therefore both dives on the first day during the July survey were carried out at the first kelp forest community site, with half of the quadrats being completed during each dive.

Both in May and July the identification and abundance assessment of the kelp species was completed without any particular difficulties but the red algae assessment was the most challenging aspect of the survey work. Several other factors also contributed to the challenges but the three main areas of difficulty were: 1) swell and surge movements at these shallow sites (caused by high wind speeds during May 2013 survey period in particular); 2) completing all tasks in three buddy pair dives; and 3) *in-situ* red algae identification.

The difficulties with the swell and, in particular, the surge in the shallow kelp forest community bays at the Isles of Scilly could be overcome by avoiding periods of high wind speeds at the islands. However, flexibility in the survey planning and timing would be required. Sites were selected with care to avoid exposed areas but also allow some flexibility to allow for changeable weather conditions.

The kelp forest community dives are typically the second dives of the day as the vertical rock habitats are found at greater depths and therefore have to be completed first. Despite the relatively shallow depths at which these features are found, the large number of tasks required for the assessment (the original plan was to complete 15 quadrats for each dive pair) resulted in the need to change the survey methodology and reduce the number quadrats to be assessed during each dive to approximately 5-8 quadrats per pair per dive. This level of assessment allows for a more careful assessment of the flora present, therefore increasing the potential for correct identification of the plants.

The final, and main challenge was the identification of some of the red algae. The small size, the similarity between different species (e.g. *H. plumosa* and *P. parasitica*) and the large number of plants present in these communities resulted in this task being particularly challenging. However, the collection of samples greatly aided the process and allowed verification of *in-situ* identification.

Each of the survey locations have been described below with maps of the site locations given in each site description drawing. There is a site description with figures together with the kelp species ratio and red algae assessments for each location.

3.3.1 Frenchman's Rock (May)

3.3.1.1 Site description

Little Arthur is one of the islands within the Eastern Isles complex and is situated northeast of St. Mary's (Figure 3.1). The island and the area around Frenchman's Rock are only exposed to the south-east (Figures 3.2 and 3.6) creating a sheltered survey location from the prevailing winds.

The shotline was placed at a depth (BSL) of 10 m (Figure 3.7) and the transect start of line was found 3-4 m north-northwest of this position. The transect line was placed within the bay running northwest from the SOL at 10 m to the EOL at a depth of 7 m (Figure 3.8).

A kelp forest consisting of *Laminaria ochroleuca*, *Laminaria hyperborea, Saccorhiza polyschides* and a red algal understorey was present (Figure 3.7). The seabed comprised of boulders and cobbles with occasional large boulders but no sediment patches. *Echinus esculentus, Marthasterias glacialis* and *Holothuria forskali* were also found at this site.

Figure 3.6. Frenchman's Rock site location.

Figure 3.7. Seabed images from Frenchman's Rock (in May 2013).

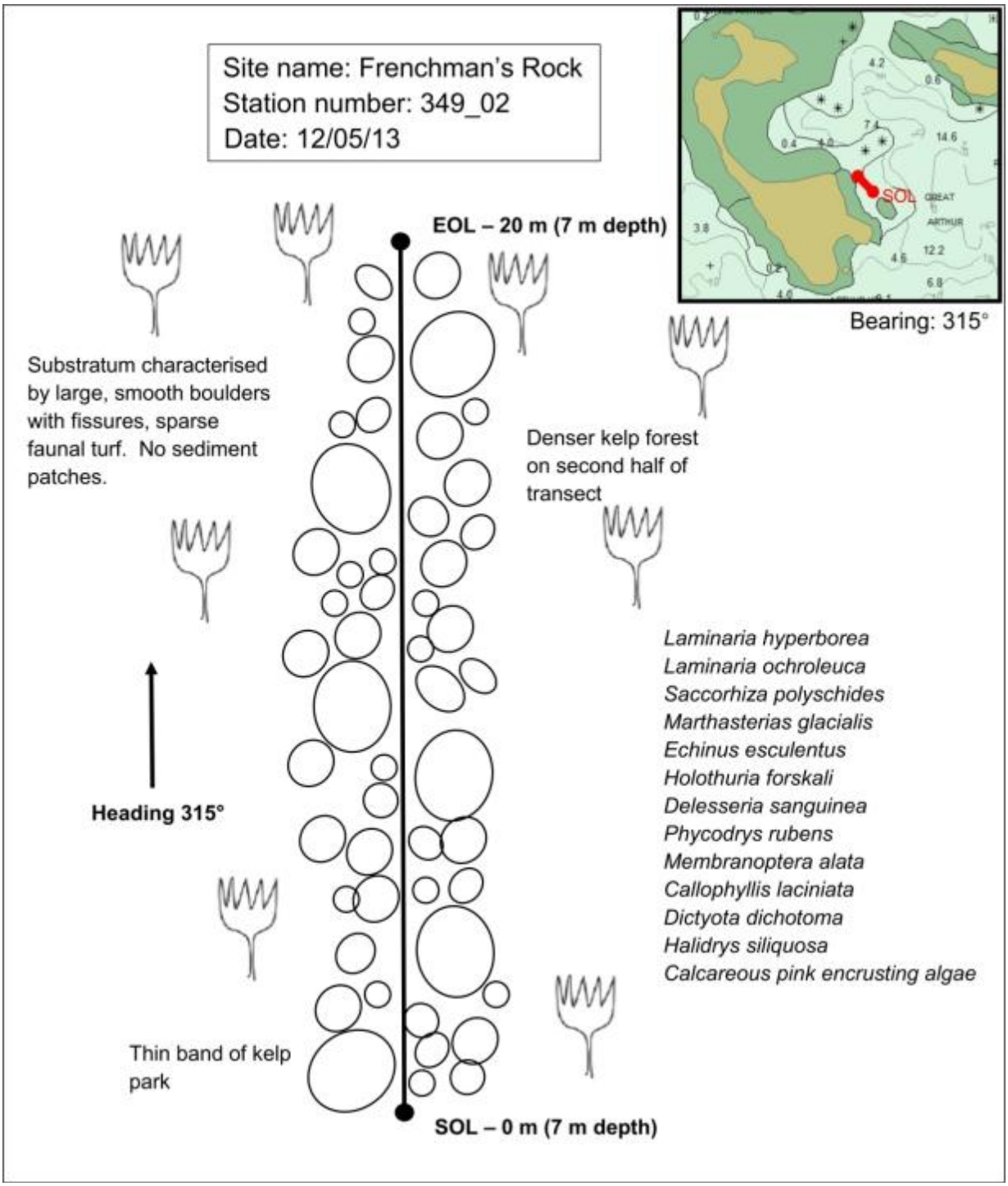


Figure 3.8. Frenchman's Rock kelp site description.

3.3.1.2 Kelp forest assessment

The survey at Frenchman's Rock was completed at depths ranging from c.7 m to 10 m (BSL) and a total of 25 quadrats were analysed (Table 3.8). The kelp forest community was characterised by *Laminaria hyperborea* (Lhyp) but *Laminaria ochroleuca* (Loch) and *Saccorhiza polyschides* were also recorded. A total of 172 kelp plants were recorded in the assessed quadrats along the transect resulting in a mean density of *L. hyperborea* of 5.6 plants/m^2 and *L. ochroleuca* of 0.6 plants/m^2. The ratio between the two kelp species was 8.75:1 (Lhyp: Loch).

Table 3.8. Kelp forest community data for Frenchman's' Rock (12 May 2013; SOL position in WGS84; depth: below sea level).

Frenchman's Rock (May) (Little Arthur)			Latitude Longitude	49° 56.634' N 06° 15.691' W	Date Depth range (m) Quadrats analysed Area (m^2) analysed		12/05/13 6.8 – 9.8 25 25	
Kelp species	*Laminaria hyperborea*	*Laminaria ochroleuca*	*Saccorhiza polyschides*	*Saccharina latissima*	*Alaria esculenta*	*Laminaria digitata*	Kelp juv.	**Total**
Total number of plants	140	16	3	0	0	0	13	172
Mean density (plants/m^2)	5.60	0.64	0.12	0.00	0.00	0.00	0.52	6.9
Ratio Lhyp:Loch	8.75							

3.3.1.3 Red algae assessment

The red algal assessment resulted in records of four of the nine species (Table 3.9). The most widespread taxa were *Phycodrys rubens* and *Kallymenia reniformis* with individuals found at 56 % and 40 % respectively of the 25 quadrats analysed. Only one individual of *Pterosiphonia parasitica* was found with four records of *Delesseria sanguinea*.

Table 3.9. Red algal community data for Frenchman's Rock (12 May 2013; SOL position in WGS84; depth: below sea level).

Frenchman's Rock (May) (Little Arthur)				Latitude Longitude	49° 56.634' N 06° 15.691' W	Date Depth range (m) Quadrats analysed Area (m^2) analysed		12/05/13 6.8 – 9.8 25 6.25	
Red algal species	*Kallymenia reniformis*	*Delesseria sanguinea*	*Membranoptera alata*	*Phycodrys rubens*	*Heterosiphonia plumosa*	*Pterosiphonia parasitica*	*Sphaerococcus coronopifolius*	*Dilsea carnosa*	*Halurus equisetifolius*
Number of quadrats with algal record	10	4	0	14	0	1	0	0	0
Percentage of quadrats with algal records	40.0	16.0	0.0	56.0	0.0	4.0	0.0	0.0	0.0

3.3.2 Porth Hellick

3.3.2.1 Site description

Porth Hellick was a kelp forest community site located in the Porth Hellick Bay on the eastern side of St. Mary's (Figure 3.1). The site is exposed to the east and southeast but is sheltered from all other directions including the prevailing south-westerly winds.

Wreck debris was found at the SOL at a depth of 10.9 m and the transect ran along a bearing of 270° to the EOL at a depth of 8.3 m (Figures 3.9 and 3.11). The GPS position recorded is the location of the EOL. To the east of the transect line more wreck debris could be seen and there were several large boulders around the EOL.

The substratum comprised of boulders and cobbles with coarse sand in between and in the rock crevices (Figure 3.10). A mixed kelp forest of *Laminaria hyperborea* and *Laminaria ochroleuca* dominated, with red algae (*Kallymenia reniformis*, *Delesseria sanguinea* and *Phycodrys rubens*) and *Ulva* sp. also present. The fauna consisted mainly of *Echinus esculentus* and *Marthasterias glacialis*.

Figure 3.9. Porth Hellick kelp site location.

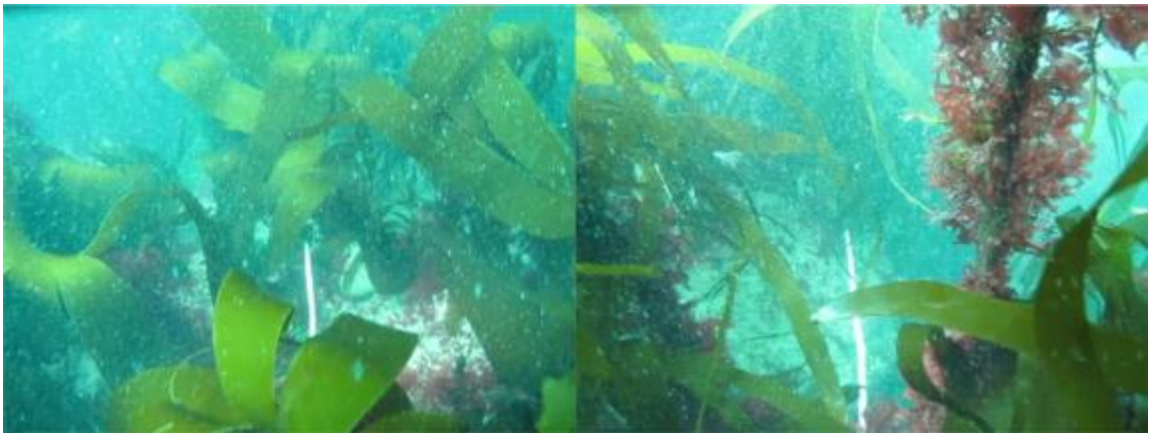


Figure 3.10. Seabed images from Porth Hellick (in May 2013).

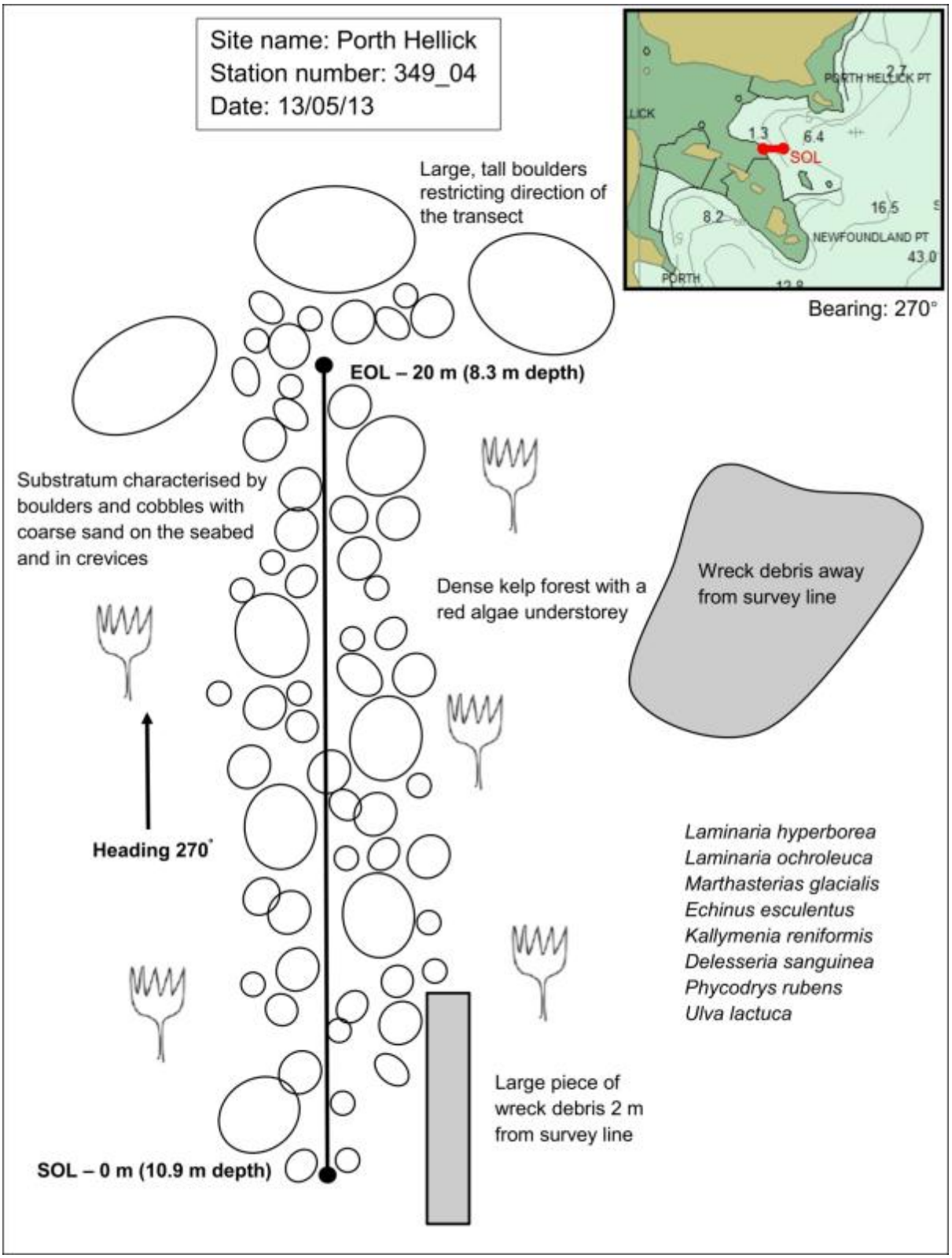


Figure 3.11. Porth Hellick kelp site description.

3.3.2.2 Kelp forest assessment

A total of 30 quadrats (1 m^2) were analysed at Porth Hellick as part of the kelp forest community assessment (Table 3.10). *Laminaria hyperborea* (6.4 plants/m^2) was the most abundant kelp taxon recorded but *Laminaria ochroleuca* (3.8 plants/m^2) was also relatively abundant. There was only one individual of *Saccorhiza polyschides* recorded but 25 juvenile kelp species were also noted. The kelp ratio was 1.70:1 (Lhyp: Loch).

Table 3.10. Kelp forest community data for Porth Hellick (13 May 2013; EOL position in WGS84; depth: below sea level).

Porth Hellick (St. Mary's)			Latitude	49° 54.864' N	Date	13/05/13		
			Longitude	06° 16.816' W	Depth range (m)	8.4 – 11.1		
					Quadrats analysed	30		
					Area (m^2) analysed	30		
Kelp species	*Laminaria hyperborea*	*Laminaria ochroleuca*	*Saccorhiza polyschides*	*Saccharina latissima*	*Alaria esculenta*	*Laminaria digitata*	Kelp juv.	**Total**
Total number of plants	192	113	1	0	0	0	25	331
Mean density (plants/m^2)	6.40	3.77	0.03	0.00	0.00	0.00	0.83	11.0
Ratio Lhyp:Loch	1.70							

3.3.2.3 Red algae assessment

The red algal assessment resulted in recording all (Table 3.11) but one of the nine red algae selected (by Irving and Northen, 2012). *Kallymenia reniformis* (at 66.7 % of quadrats) was the most widespread red algal species followed by *Delesseria sanguinea* (50 % of the quadrats) and *Phycodrys rubens* (47 % of the quadrats). There was only one record each of *Dilsea carnosa*, *Halurus equisetifolius* and *Membranoptera alata*. The only taxon not recorded was *Sphaerococcus coronopifolius.*

Table 3.11. Red algal community data for Porth Hellick (13 May 2013; EOL position in WGS84; depth: below sea level).

Porth Hellick (St. Mary's)				Latitude	49° 54.864' N	Date	13/05/13		
				Longitude	06° 16.816' W	Depth range (m)	8.4 – 11.1		
						Quadrats analysed	30		
						Area (m^2) analysed	7.5		
Red algal species	*Kallymenia reniformis*	*Delesseria sanguinea*	*Membranoptera alata*	*Phycodrys rubens*	*Heterosiphonia plumosa*	*Pterosiphonia parasitica*	*Sphaerococcus coronopifolius*	*Dilsea carnosa*	*Halurus equisetifolius*
Number of quadrats with algal record	20	15	1	14	12	6	0	1	1
Percentage of quadrats with algal records	66.67	50.00	3.33	46.67	40.00	20.00	0.00	3.33	3.33

3.3.3 Lizard Rock

3.3.3.1 Site description

Lizard Rock was a kelp forest community site situated in a bay on St. Agnes, which is situated in the southeast of the Isles of Scilly (Figures 3.1 and 3.12). The site is located half-way into The Cove bay close to the Higher Town area and therefore sheltered from all wind directions apart from the south-east.

The transect ran from the SOL at 11.5 m on a bearing of 280° to the EOL at a depth of 8.0 m (Figure 3.14). The SOL was approximately 20 m east of the shotline position (bearing 300°), to ensure safe working conditions away from the dive vessel (N.B. as the habitat as a whole was assessed rather than a particular point, any slight difference in relocation of the position will not affect future monitoring results).

The seabed was composed of boulders and cobbles surrounded by coarse sand, and at the SOL was a large boulder. A dense kelp forest covered the seabed, both *Laminaria hyperborea* and *Laminaria ochroleuca* (Figure 3.13). Other species present included *Halidrys siliquosa*, *Ulva* sp. and an understorey of red algae. *Holothuria forskali* and *Echinus esculentus* were found grazing at this site.

Figure 3.12. Lizard Rock kelp site location.

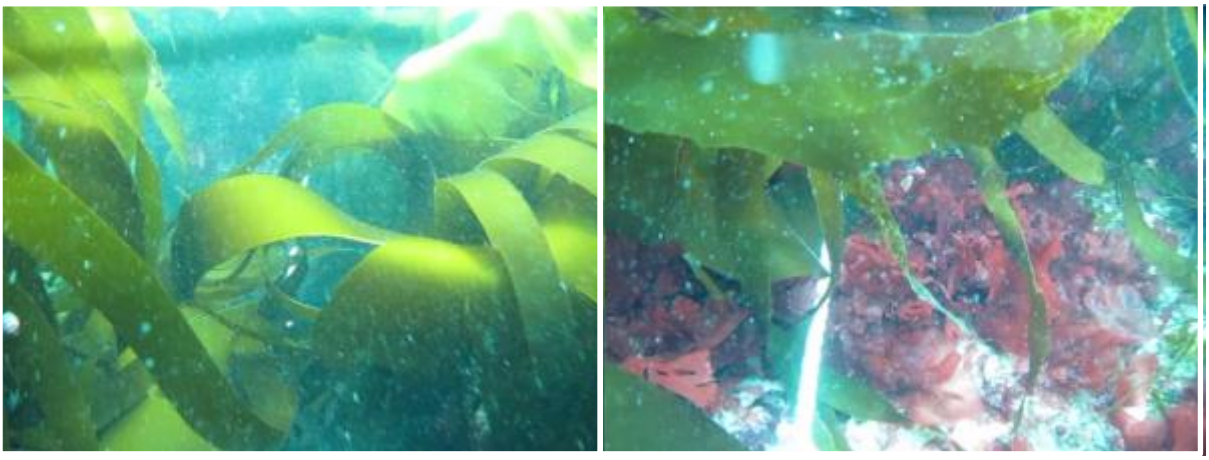


Figure 3.13. Seabed images from Lizard Rock (in May 2013).

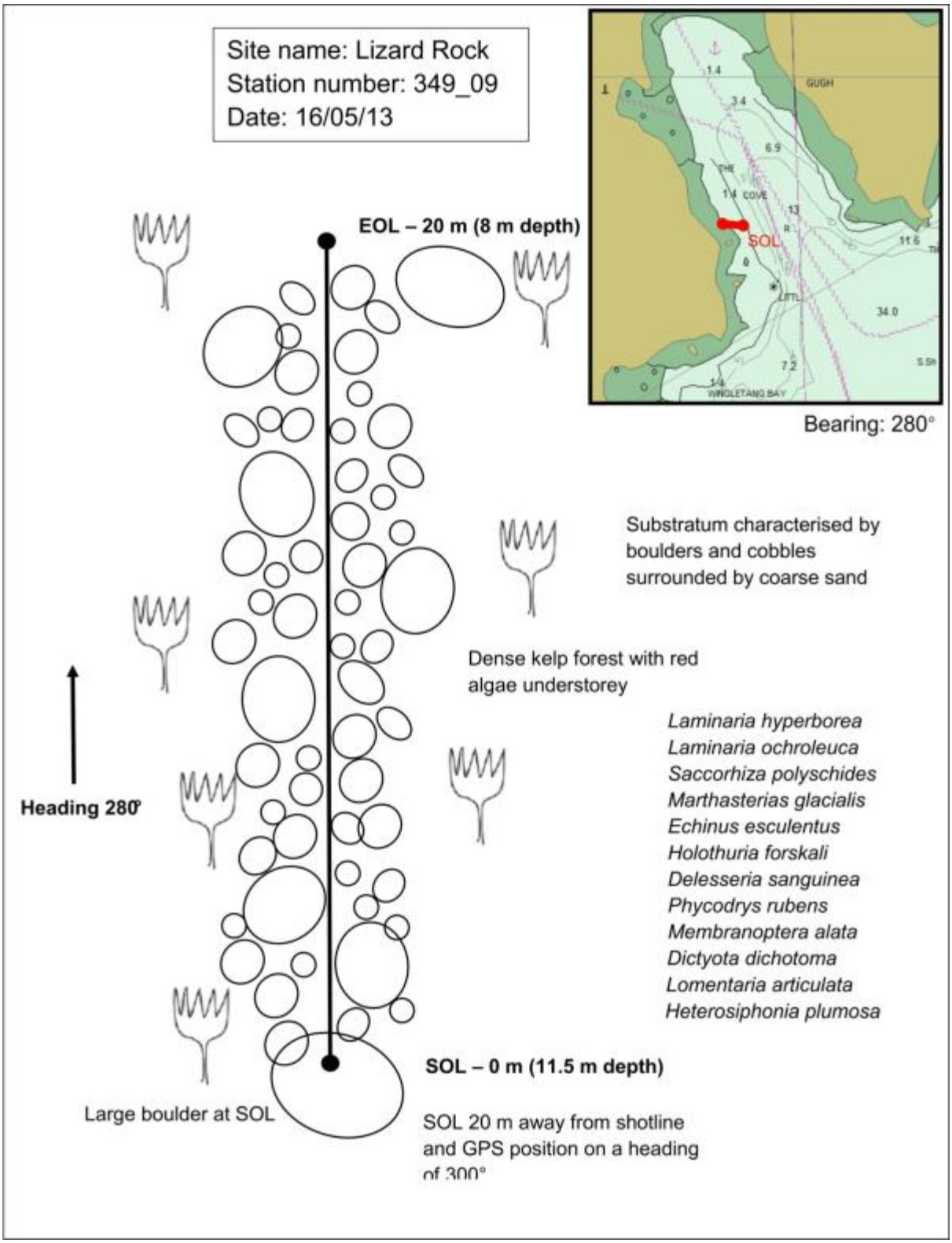


Figure 3.14. Lizard Rock kelp site description.

3.3.3.2 Kelp forest assessment

The depth recorded by the divers at Lizard Rock ranged between 7.1 m and 9.8 m (Table 3.12). The most abundant kelp taxon was *Laminaria ochroleuca* with a total of 154 individuals recorded and a density of 5.1 plants/m^2. The density of *Laminaria hyperborea* was 3.5 plants/m^2. *Saccorhiza polyschides* and *Saccharina latissima* were also recorded together with 48 juvenile kelp individuals. The kelp ratio was 0.69:1 (Lhyp: Loch).

Table 3.12. Kelp forest community data for Lizard Rock (16 May 2013; SOL position in WGS84; depth: below sea level).

Lizard Rock (St. Agnes)			Latitude	49° 53.315' N	Date	16/05/13		
			Longitude	06° 20.118' W	Depth range (m)	7.1 – 9.8		
					Quadrats analysed	30		
					Area (m^2) analysed	30		
Kelp species	*Laminaria hyperborea*	*Laminaria ochroleuca*	*Saccorhiza polyschides*	*Saccharina latissima*	*Alaria esculenta*	*Laminaria digitata*	Kelp juv.	**Total**
Total number of plants	106	154	7	1	0	0	48	316
Mean density (plants/m^2)	3.5	5.1	0.2	0.1	0.0	0.0	1.6	10.5
Ratio Lhyp:Loch	0.69							

3.3.3.3 Red algae assessment

At Lizard Rock *Kallymenia reniformis* was ubiquitous across the transect survey line (Table 3.13) and the most abundant red algal species, found in 22 of the 30 analysed quadrats. Six other species (*Delesseria sanguinea, Membranoptera alata, Phycodrys rubens, Heterosiphonia plumosa, Pterosiphonia parasitica* and *Sphaerococcus coronopifolius*) displayed at patchy distribution across the site and could be considered as common across the site. There were no records of *Dilsea carnosa* or *Halurus equisetifolius.*

Table 3.13. Red algal community data for Lizard Rock (16 May 2013; SOL position in WGS84; depth: below sea level).

Lizard Rock (St. Agnes)				Latitude	49° 53.315' N	Date	16/05/13		
				Longitude	06° 20.118' W	Depth range (m)	7.1 – 9.8		
						Quadrats analysed	30		
						Area (m^2) analysed	7.5		
Red algal species	*Kallymenia reniformis*	*Delesseria sanguinea*	*Membranoptera alata*	*Phycodrys rubens*	*Heterosiphonia plumosa*	*Pterosiphonia parasitica*	*Sphaerococcus coronopifolius*	*Dilsea carnosa*	*Halurus equisetifolius*
Number of quadrats with algal record	22	5	7	13	7	13	9	0	0
Percentage of quadrats with algal records	73.33	16.67	23.33	43.33	23.33	43.33	30.00	0.00	0.00

3.3.4 Carn Morval

3.3.4.1 Site description

The Carn Morval kelp forest community site was situated along the north-western coastal fringe of St. Mary's, immediately south of the Carn Morval peninsula (Figures 3.1 and 3.15). On leaving St. Mary's harbour the survey location was found by following the northern coastline past Newford Island and Taylor's Island towards the Carn Morval peninsula.

This site is exposed to the south and south-west but is sheltered from any easterly winds. The transect ran in a northerly direction on a bearing of 0° from the start of line (SOL) at 6.3 m depth to the end of line (EOL) at 5.5 m depth (Figure 3.16).

The kelp community consisted of *Laminaria ochroleuca*, *L. hyperborea* and *Saccorhiza polyschides* with an understorey of red algal species (Figure 3.15). The kelp forest was approximately 2 m high and very dense apart from two sandy patches. The substratum was predominantly boulders and cobbles interspersed with patches of sand. The fauna present included *Echinus esculentus*, *Asterias rubens* and *Cliona celata*.

Figure 3.15. Seabed images from Carn Morval (in July 2013).

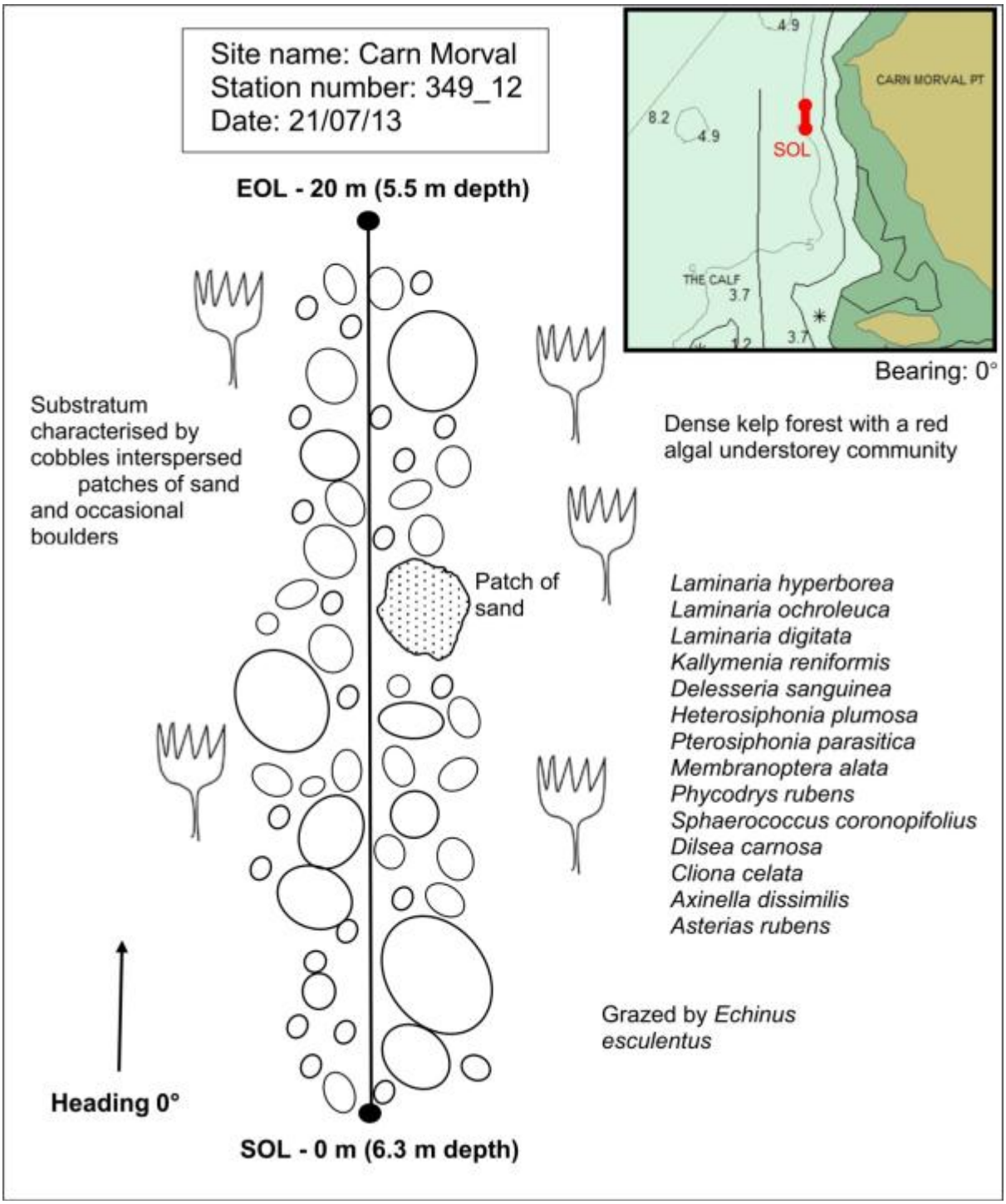


Figure 3.16. Carn Morval kelp site description.

3.3.4.2 Kelp forest assessment

The kelp forest community was characterised by *Laminaria ochroleuca*, which was recorded at a density of 5.1 plants/m^2 (Table 3.14). The second most abundant kelp species was *Saccorhiza polyschides* at 1.7 plants/m^2 followed by *Laminaria hyperborea* at 0.9 plants/m^2. *Saccharina latissima* and *Laminaria digitata* were also recorded whilst *Alaria esculenta* was not. The kelp ratio was 0.18:1 (Lhyp: Loch).

Table 3.14. Kelp forest community data for Carn Morval (21 July 2013; SOL position in WGS84; depth: below sea level).

Carn Morval (St. Mary's)			Latitude	49° 55.594' N	Date	21/07/13		
			Longitude	06° 18.882' W	Depth range (m)	6.0 – 10.2		
					Quadrats analysed	30		
					Area (m^2) analysed	30		
Kelp species	*Laminaria hyperborea*	*Laminaria ochroleuca*	*Saccorhiza polyschides*	*Saccharina latissima*	*Alaria esculenta*	*Laminaria digitata*	Kelp juv.	**Total**
Total number of plants	28	152	50	6	0	1	3	240
Mean density (plants/m^2)	0.93	5.07	1.67	0.20	0.00	0.03	0.10	8.0
Ratio Lhyp:Loch	0.18							

3.3.4.3 Red algae assessment

All the characterising species, as selected by Irving and Northen (2012) were recorded at Carn Morval (Table 3.15). *Heterosiphonia plumosa* and *Delesseria sanguinea* were the most widespread red algae taxa across this location. *Sphaerococcus coronopifolius, Kallymenia reniformis, Phycodrys rubens* and *Dilsea carnosa* were patchily distributed at Carn Morval whilst only one record each of *Membranoptera alata* and *Halurus equisetifolius* was made.

Table 3.15. Red algal community data for Carn Morval (21 July 2013; SOL position in WGS84; depth: below sea level).

Carn Morval (St. Mary's)				Latitude	49° 55.594' N	Date	21/07/13		
				Longitude	06° 18.882' W	Depth range (m)	6.0 – 10.2		
						Quadrats analysed	30		
						Area (m^2) analysed	7.5		
Red algal species	*Kallymenia reniformis*	*Delesseria sanguinea*	*Membranoptera alata*	*Phycodrys rubens*	*Heterosiphonia plumosa*	*Pterosiphonia parasitica*	*Sphaerococcus coronopifolius*	*Dilsea carnosa*	*Halurus equisetifolius*
Number of quadrats with algal record	10	23	1	9	24	1	15	8	1
Percentage of quadrats with algal records	33.33	76.67	3.33	30.00	80.00	3.33	50.00	26.67	3.33

3.3.5 Cromwell's Castle, Tresco Channel

3.3.5.1 Site description

The kelp forest community site in the Tresco Channel, between the islands of Tresco and Bryher, was located along the western shoreline of Tresco (Figure 3.1) immediately to the north-west of Cromwell's Castle (Figures 3.17 and 3.18). The transect line ran along the shoreline from south to north at a bearing of 330° from the SOL at 7.5 m depth to the EOL at 7.9 m (Figure 3.19). The seabed was mostly boulders with gravel or coarse sand interspersed, but there were a few sand patches where the kelp was less dense. There was also a very large boulder with a vertical side just to the left of the transect near the SOL.

The Tresco Channel was described by Seasearch (2005) as a channel characterised by sand and gravel with mixed brown, red and green seaweeds, including large sugar kelps (*Saccharina latissima*). The eastern side of the channel had a dense eel grass bed with snakelock anemones (*Anemonia viridis*), red-specked pimplets (*Anthopleura ballii*), and a variety of tube worms (Seasearch 2008).

The current survey found a kelp forest community comprised of a dense forest of kelp (*Laminaria hyperborea, L. ochroleuca, Saccorhiza polyschides and Saccharina latissima*) with a rich red algal understorey community. The fauna included *Marthasterias glacialis, Echinus esculentus, Anemonia viridis* and *Labrus bergylta*.

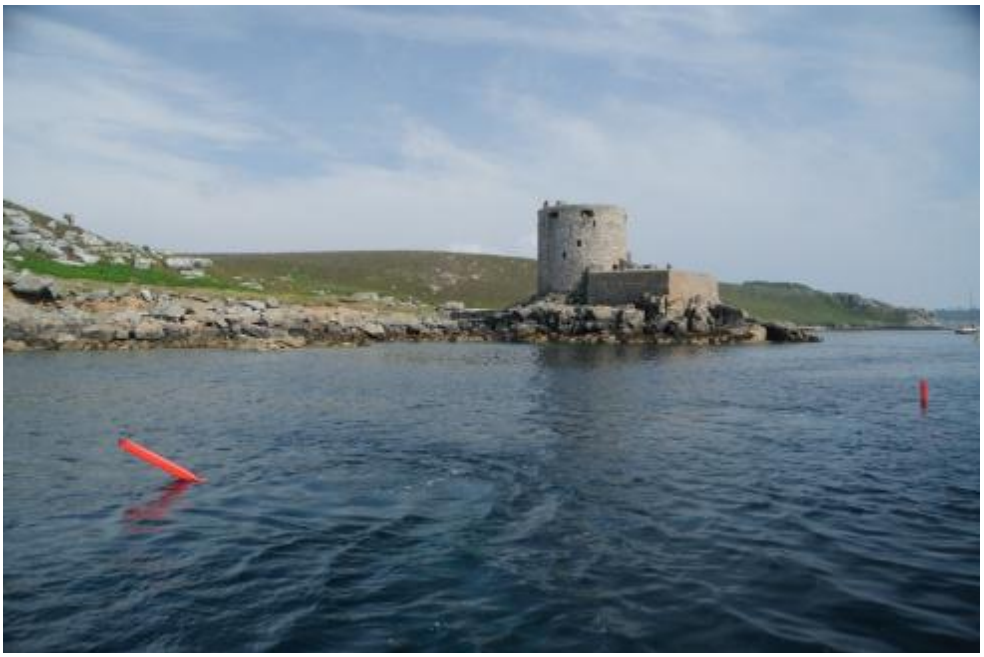


Figure 3.17. Kelp site location by Cromwell's Castle in the Tresco Channel.

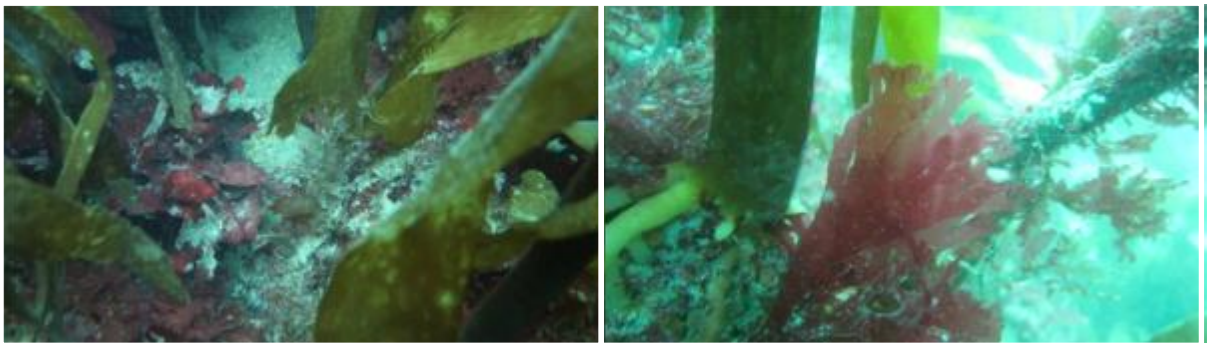


Figure 3.18. Seabed images from Cromwell's Castle in the Tresco Channel (in July 2013).

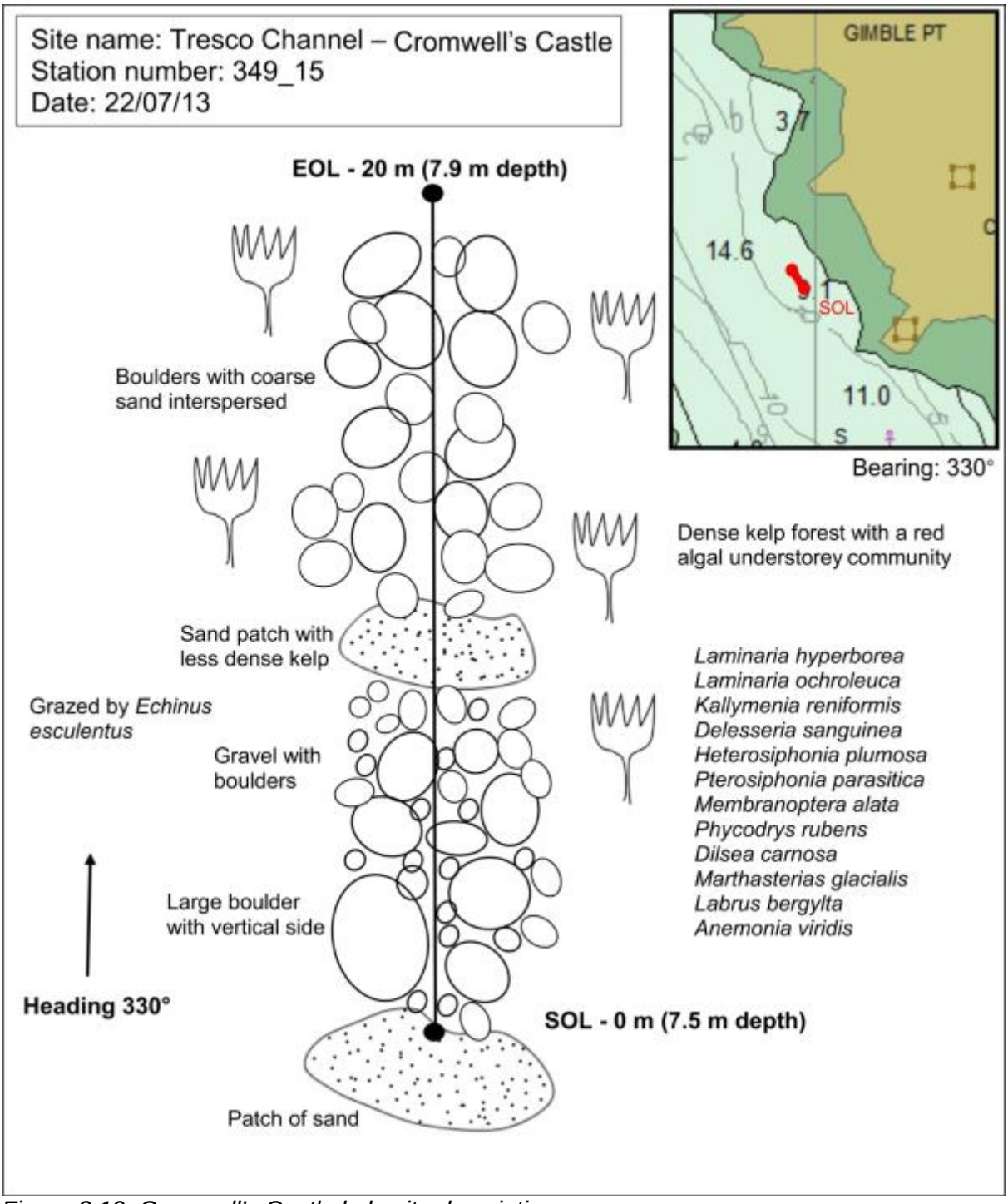


Figure 3.19. Cromwell's Castle kelp site description.

3.3.5.2 Kelp forest assessment

The kelp forest community at Cromwell's Castle was characterised by *Laminaria ochroleuca* with a density of 6.9 plants/m^2 (Table 3.16). Three other species, *Laminaria hyperborea, Saccorhiza polyschides* and *Saccharina latissima* were also present but at much lower densities (1.0 plants/m^2, 0.6 1.0 plants/m^2 and <0.1 1.0 plants/m^2 respectively). A few juvenile kelp species were also recorded. The total kelp density across the site was 8.6 plants/m^2 with the kelp ratio calculated to be 0.15:1 (Lhyp: Loch).

Table 3.16. Kelp forest community data for Cromwell's Castle (22 July 2013; SOL position in WGS84; depth: below sea level).

Cromwell's Castle (Tresco / Bryher)			Latitude	49° 57.761' N	Date	22/07/13		
			Longitude	06° 21.052' W	Depth range (m)	8.0 – 11.0		
					Quadrats analysed	30		
					Area (m^2) analysed	30		
Kelp species	*Laminaria hyperborea*	*Laminaria ochroleuca*	*Saccorhiza polyschides*	*Saccharina latissima*	*Alaria esculenta*	*Laminaria digitata*	Kelp juv.	**Total**
Total number of plants	30	206	17	1	0	0	4	258
Mean density (plants/m^2)	1.00	6.87	0.57	0.03	0.00	0.00	0.13	8.6
Ratio Lhyp:Loch	0.15							

3.3.5.3 Red algae assessment

At Cromwell's Castle all but one (*Halurus* equisetifolius) of the red algal taxa were recorded (Table 3.17). *Delesseria sanguinea, Heterosiphonia plumosa* and *Kallymenia reniformis* were recorded at 28, 24 and 15 quadrats (out of 30 analysed) with the former two species therefore considered ubiquitous to this survey location. *Dilsea carnosa* was recorded in 7 quadrats with the remaining taxa were found in 4 quadrats or less, apart from *Halurus equisetifolius* which was not recorded at all along this transect.

Table 3.17. Red algal community data for Cromwell's Castle (22 July 2013; SOL position in WGS84; depth: below sea level).

Cromwell's Castle (Tresco / Bryher)				Latitude	49° 57.761' N	Date	22/07/13			
				Longitude	06° 21.052' W	Depth range (m)	8.0 – 11.0			
						Quadrats analysed	30			
						Area (m^2) analysed	7.5			
Red algal species	*Kallymenia reniformis*	*Delesseria sanguinea*	*Membranoptera alata*	*Phycodrys rubens*	*Heterosiphonia plumosa*	*Pterosiphonia parasitica*	*Sphaerococcus coronopifolius*	*Dilsea carnosa*	*Halurus equisetifolius*
Number of quadrats with algal record	15	28	2	1	24	2	4	7	0
Percentage of quadrats with algal records	50.00	93.33	6.67	3.33	80.00	6.67	13.33	23.33	0.00

3.3.6 Porth Morran

3.3.6.1 Site description

The Porth Morran kelp forest community site was situated to the west of White Island, north of St. Martin's (Figures 3.1 and 3.20). The transect line was laid on a bearing of 020° from the SOL at 7.2 m depth to the EOL at 8.2 m within the bay (Figure 3.21).

The kelp forest at the site was mixed *Laminaria hyperborea* and *L. ochroleuca*. Red algal species, including *Kallymenia reniformis*, *Heterosiphonia plumosa* and *Sphaerococcus coronopifolius* were present beneath the kelp forest canopy and on the stipes of *L. hyperborea*.

The substratum was comprised of boulders and cobbles with sand between. Occasional patches of sand were present where there were clearings in the kelp, which were characterised by the presence of *Halidrys siliquosa*. *Marthasterias glacialis* and *Labrus bergylta* were also found at this site.

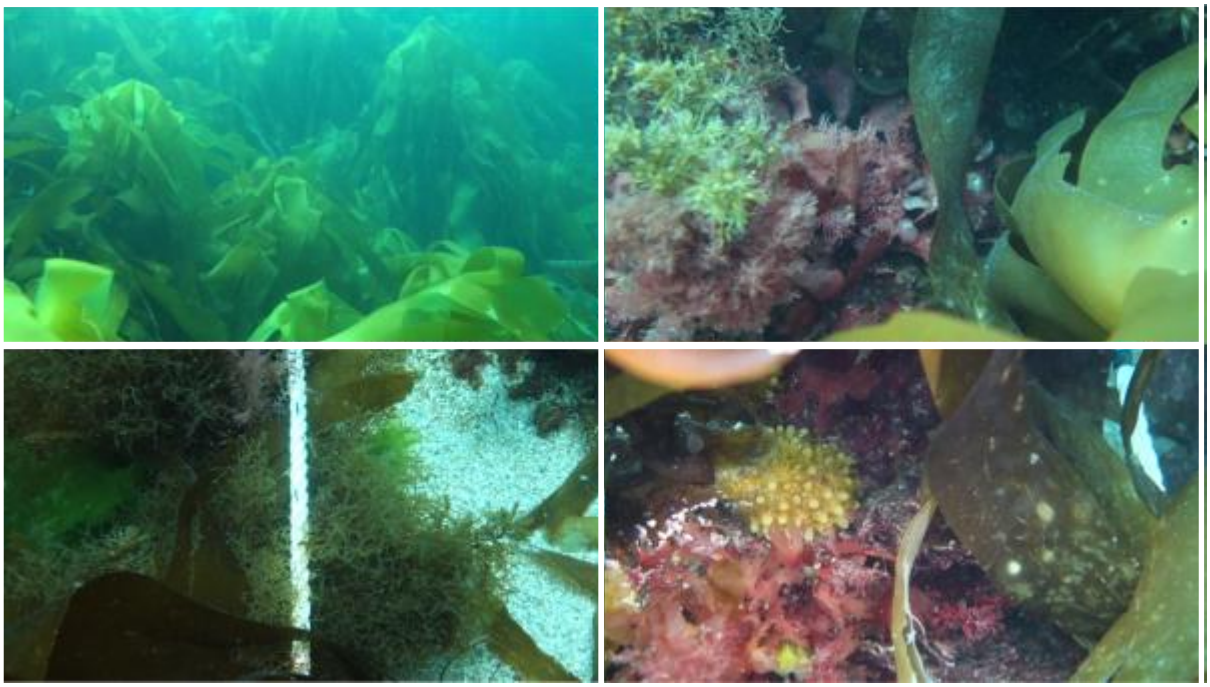


Figure 3.20. Seabed images from Porth Morran (in July 2013).

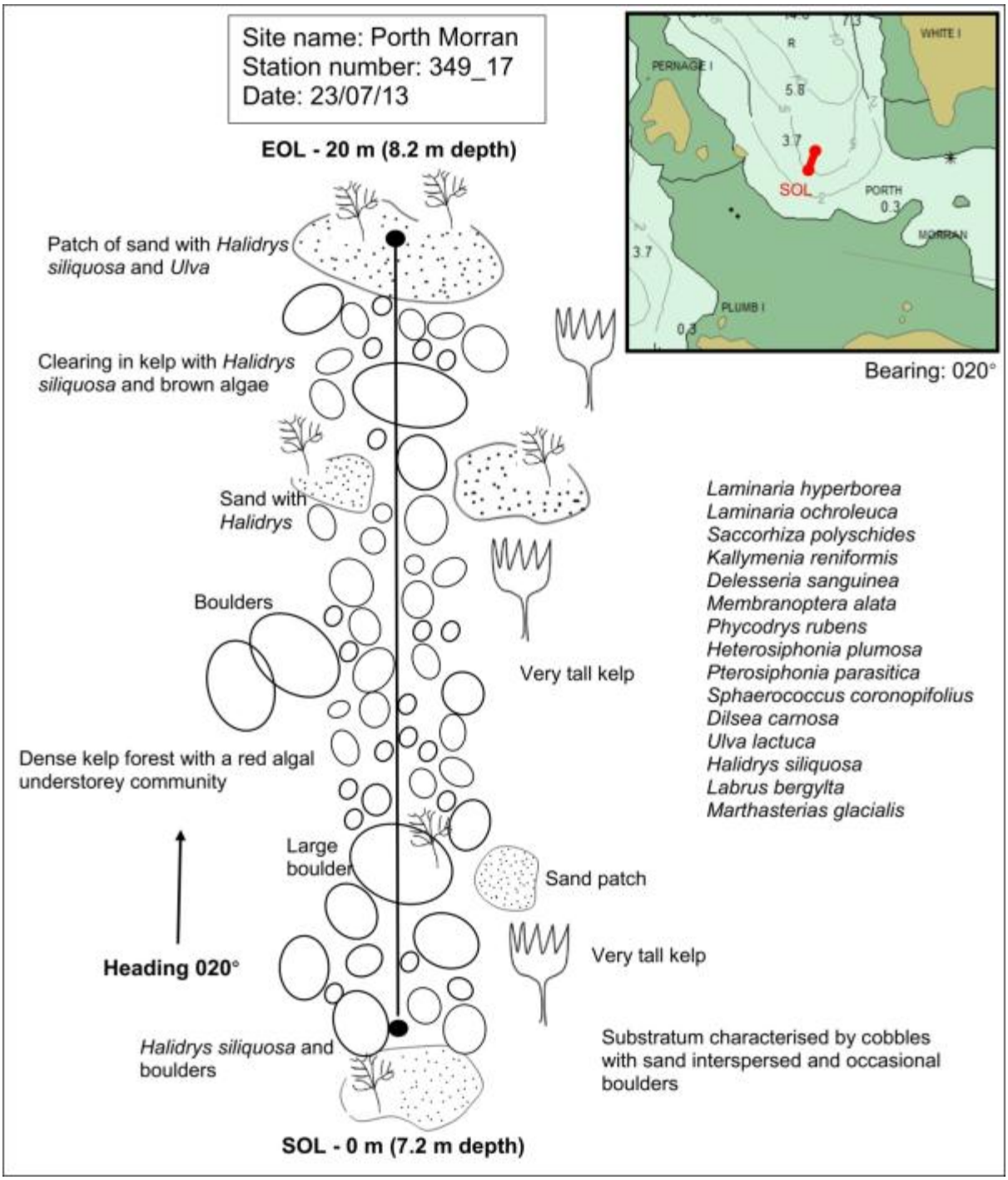


Figure 3.21. Porth Morran kelp site description.

3.3.6.2 Kelp forest assessment

The mean kelp density at Porth Morran was 7 plants/m^2 (Table 3.18) with *Laminaria ochroleuca* the most abundant kelp species at 5 plants/m^2. *Laminaria hyperborea* was also relatively abundant at 1.7 plants/m^2. *Saccorhiza polyschides* and *Alaria esculenta* were present but only at low densities. At Porth Morran the *L. hyperborea* : *L. ochroleuca* kelp ratio was calculated to be 0.34:1.

Table 3.18. Kelp forest community data for Porth Morran (23 July 2013; SOL position in WGS84; depth: below sea level).

Porth Morran (White Island)			Latitude	49° 58.610' N	Date	23/07/13		
			Longitude	06° 17.877' W	Depth range (m)	7.3 – 9.2		
					Quadrats analysed	30		
					Area (m^2) analysed	30		
Kelp species	*Laminaria hyperborea*	*Laminaria ochroleuca*	*Saccorhiza polyschides*	*Saccharina latissima*	*Alaria esculenta*	*Laminaria digitata*	Kelp juv.	**Total**
Total number of plants	51	151	5	0	2	0	2	211
Mean density (plants/m^2)	1.70	5.03	0.17	0.00	0.07	0.00	0.07	7.0
Ratio Lhyp:Loch	0.34							

3.3.6.3 Red algae assessment

The red algal component of the kelp understory was composed of all the characterising species (Table 3.19) selected for this study. *Heterosiphonia plumosa* was the most widespread red algal taxon, followed by *Sphaerococcus coronopifolius* and *Kallymenia reniformis*.

Delesseria sanguinea and *Pterosiphonia parasitica* were recorded at around 30 % of the quadrats whilst *Dilsea carnosa* was recorded at 5 of the 30 quadrats. These taxa were therefore considered to have a patchy distribution across the station. *Membranoptera alata, Phycodrys rubens* and *Halurus equisetifolius* had a limited distribution across the station.

Table 3.19. Red algal community data for Porth Morran (23 July 2013; SOL position in WGS84; depth: below sea level).

Porth Morran (White Island)				Latitude	49° 58.610' N	Date	23/07/13		
				Longitude	06° 17.877' W	Depth range (m)	7.3 – 9.2		
						Quadrats analysed	30		
						Area (m^2) analysed	7.5		
Red algal species	*Kallymenia reniformis*	*Delesseria sanguinea*	*Membranoptera alata*	*Phycodrys rubens*	*Heterosiphonia plumosa*	*Pterosiphonia parasitica*	*Sphaerococcus coronopifolius*	*Dilsea carnosa*	*Halurus equisetifolius*
Number of quadrats with algal record	17	9	2	2	26	8	18	5	1
Percentage of quadrats with algal records	56.67	30.00	6.67	6.67	86.67	26.67	60.00	16.67	3.33

3.3.7 Frenchman's Rock (July)

3.3.7.1 Site description

A kelp forest community site at Frenchman's Rock on Little Arthur was surveyed in 2011 (Irving and Northen, 2012). It was decided to complete a repeat assessment at the same position in 2013. The GPS position recorded in the 2011 survey was used to locate the site, but the lack of an original detailed site description (e.g. start of line and end of line positions or bearing) meant it was unclear whether the 2013 transect line was in exactly the same position as in 2011. However, the original site position allowed for a repeat survey of the habitat and community present within the bay. This site was surveyed in May 2013 but as there were some concerns about the quality of the red algae identification, this site was re-visited in July 2013.

Little Arthur is one of the islands within the Eastern Isles complex and is situated northeast of St. Mary's (Figure 3.1). The island and the area around Frenchman's Rock are only exposed to the south-east (Figure 3.1) creating a sheltered survey location. The transect line was placed within the bay at a bearing of 180° from the SOL at 6.5 m depth to the EOL at 4.0 m (Figure 3.23). A kelp forest community consisting of *Laminaria ochroleuca* and *L. hyperborea* and a red algal understorey was present (Figure 3.22). The seabed comprised of boulders and cobbles with occasional large boulders. *Labrus bergylta* and *Echinus esculentus* were found grazing at this site, but there were very few other faunal species.

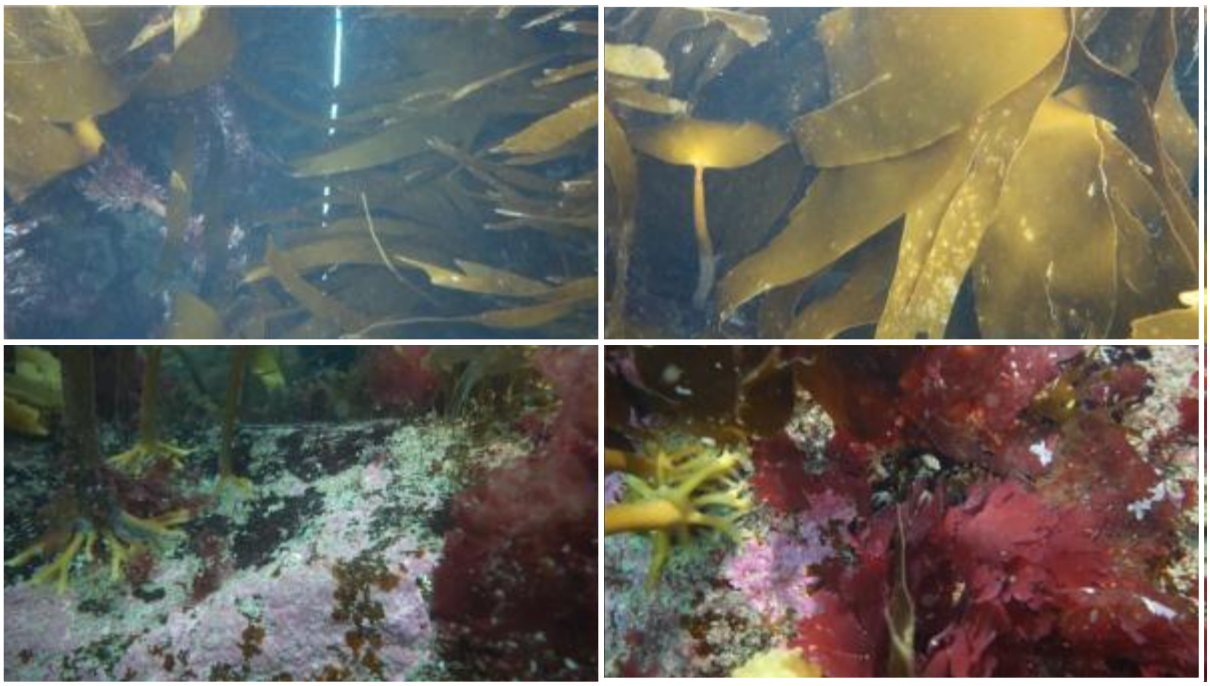


Figure 3.22. Seabed images from Frenchman's Rock (in July 2013).

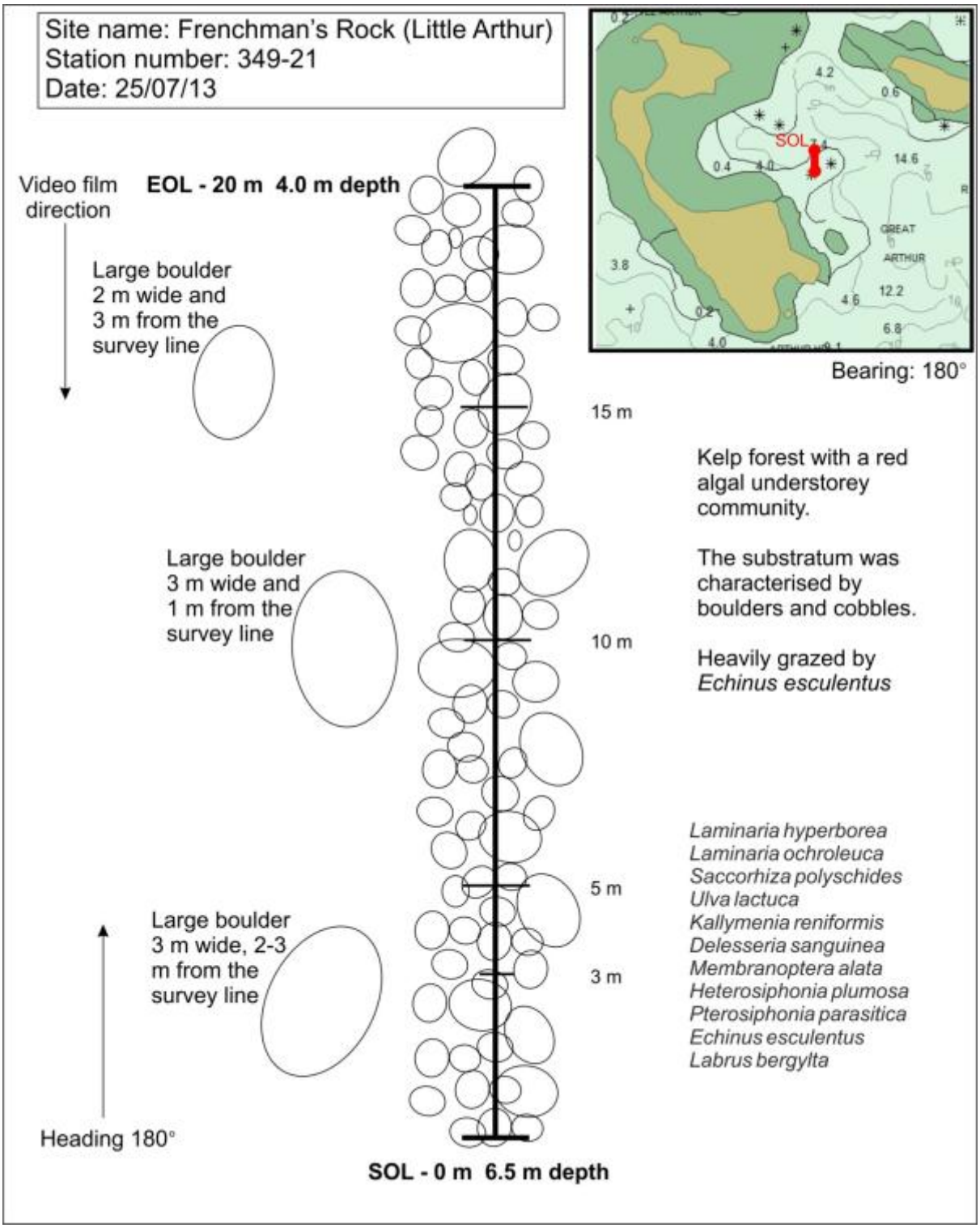


Figure 3.23. Frenchman's Rock site description.

3.3.7.2 Kelp forest assessment

The vast majority of plants recorded at Frenchman's Rock in July 2013 were *Laminaria hyperborea* (Table 3.20). The density of this taxon was 11.2 plants/m2, which is higher than the density recorded in May 2013 at 5.60 plants/m^2 (Table 3.8). However, the ratio between the two kelp species was similar with 8.75:1 (Lhyp: Loch) in May compared to 8.62 in July. In addition to *L. hyperborea, Laminaria ochroleuca* and *Saccorhiza polyschides* were also recorded in July 2013 together with some unidentified juvenile kelp plants.
The location in July was not exactly in the same position as the site in May 2013 and the depth range was also slightly different (May: 6.8-9.8 m; and July: 3.8-7.5 m) although as the BSL depths were recorded due to the vessel used, the BCD depths remain unknown. However, as the survey aimed to assess the habitat and it was completed using random quadrat positions along the ground line the transect position does not have to be exactly the same as long as the same depth range is used and the same kelp habitat is assessed.

Table 3.20. Kelp forest community data for Frenchman's Rock (25 July 2013; SOL position in WGS84; depth: below sea level).

Frenchman's Rock (July) (Little Arthur)			Latitude Longitude	49° 56.713' N 06° 15.695' W	Date Depth range (m) Quadrats analysed Area (m^2) analysed		25/07/13 3.8 – 7.5 30 30	
Kelp species	*Laminaria hyperborea*	*Laminaria ochroleuca*	*Saccorhiza polyschides*	*Saccharina latissima*	*Alaria esculenta*	*Laminaria digitata*	Kelp juv.	**Total**
Total number of plants	336	39	3	0	0	0	6	384
Mean density (plants/m^2)	11.20	1.30	0.10	0.00	0.00	0.00	0.20	12.8
Ratio Lhyp:Loch	8.62							

3.3.7.3 Red algae assessment

The most widely distributed red algal species at Frenchman's Rock in July 2013 was *Phycodrys rubens*. *Delesseria sanguinea, Kallymenia reniformis* and *Membranoptera alata* were also relatively abundant and recorded at between 40 % and 47 % of the analysed quadrats (Table 3.21). *Heterosiphonia plumosa, Pterosiphonia parasitica* and *Sphaerococcus coronopifolius* were patchily distributed whilst *Dilsea carnosa* and *Halurus equisetifolius* were not recorded at all.

Table 3.21. Red algal community data for Frenchman's Rock (25 July 2013; SOL position in WGS84; depth: below sea level).

Frenchman's Rock (July) (Little Arthur)				Latitude Longitude	49° 56.713' N 06° 15.695' W	Date Depth range (m) Quadrats analysed Area (m^2) analysed		25/07/13 3.8 – 7.5 30 7.5	
Red algal species	*Kallymenia reniformis*	*Delesseria sanguinea*	*Membranoptera alata*	*Phycodrys rubens*	*Heterosiphonia plumosa*	*Pterosiphonia parasitica*	*Sphaerococcus coronopifolius*	*Dilsea carnosa*	*Halurus equisetifolius*
Number of quadrats with algal record	12	14	12	25	2	4	1	0	0
Percentage of quadrats with algal records	40.00	46.67	40.00	83.33	6.67	13.33	3.33	0.00	0.00

3.4 Vertical rock

There were three vertical rock sites completed in May 2013 and another three completed in July 2013 (Figures 3.2-3.5; Tables 3.4-3.7 with additional detail in Appendix 04). The assessments of these vertical rock habitats were all successful. The main challenge was the available bottom time for the divers to ensure the tasks were completed to a satisfactory level. However, splitting each site into two dives allowed the necessary bottom time to complete all the tasks required.

The site selection was a potentially difficult challenge but the use of a local skipper (Tim Allsop) with extremely good knowledge of the habitats present meant that at least the vertical rock habitat was located. The second part of the site selection therefore became much easier but the suitable vertical rock (criteria given in Appendix 01) still had to be found.

The vertical rock habitat typically occurs on wave-exposed vertical or steep circalittoral bedrock or large boulders. The habitat is usually subject to moderate and strong tidal streams. The fauna is characterised by the anemone *Corynactis viridis* and cup-coral *Caryophyllia smithii* but sponges (such as *Cliona celata* and *Dysidea fragilis*), bryozoans (*Crisia* spp., *Bugula* spp. and *Cellaria* spp.), soft corals (e.g. *Alcyonium digitatum*) and echinoderms (*Marthasterias glacialis, Asterias rubens* and *Echinus esculentus*) are also found in this habitat (for further detail see Connor *et al.*, 2004).

Relocating the sites in future monitoring surveys should be possible with the positioning data, site descriptions and the pitons attached to the walls (pitons had orange markers but these may deteriorate or disappear with time). The use of Tim Allsop would also be most useful as it makes the process of finding the sites much easier but even without local knowledge it should be possible to relocate these sites.

With two divers working together one diver would hold the quadrat up and stay buoyant immediately above the quadrat (holding onto the quadrat) whilst the second diver would have space for photographic work below. The roles could then be swapped for the analysis stage or simply carried out in the positions already assumed. Both systems work well and all the tasks can be completed without difficulty assuming the divers are skilled at taking underwater still photographs and/or video.

3.4.1 JS Wall

3.4.1.1 Site description

JS wall is situated on the eastern (northeast) seashore of St. Mary's (Figures 3.1, 3.3 and 3.24) and the area consists of walls, ledges and gullies. Exposed to the east this moderate to high-energy environment was sheltered from the prevailing winds (southwest).

The shotline was positioned on a large ledge at about 18 m depth. The piton was put in place at the top of a south-easterly facing vertical wall 10-15 m west of the shotline position at a depth of 17 m, and to reach it the divers had to swim past a rock pinnacle to a series of vertical walls (Figure 3.26). Below the transect line was a ledge at a depth of 25 m.

In terms of the habitats present a kelp forest community was found on the flat areas above and along the top of the vertical wall whilst *Corynactis viridis* dominated the habitat on the vertical rock (Figure 3.25). A variety of other species were also present across the site including *Caryophyllia smithii*, *Alcyonium digitatum*, *Alcyonium glomeratum* and sponges (*Hemimycale columella* and *Haliclona viscosa*). *Marthasterias glacialis*, *Echinus esculentus* and *Holothuria forskali* were also found.

Figure 3.24. JS Wall site location.

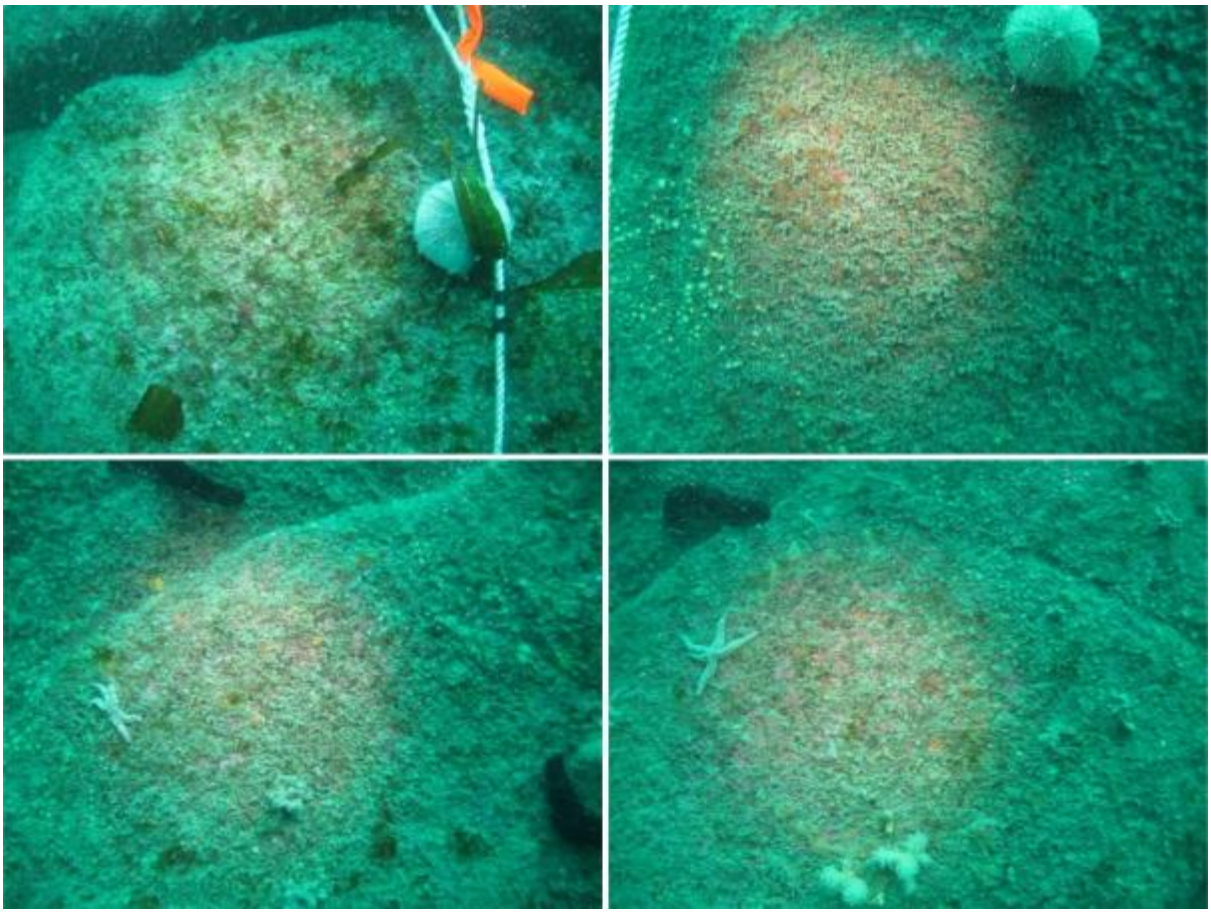


Figure 3.25. Seabed images from JS Wall (in May 2013) with the orange material marking the piton visible in the top-left image.

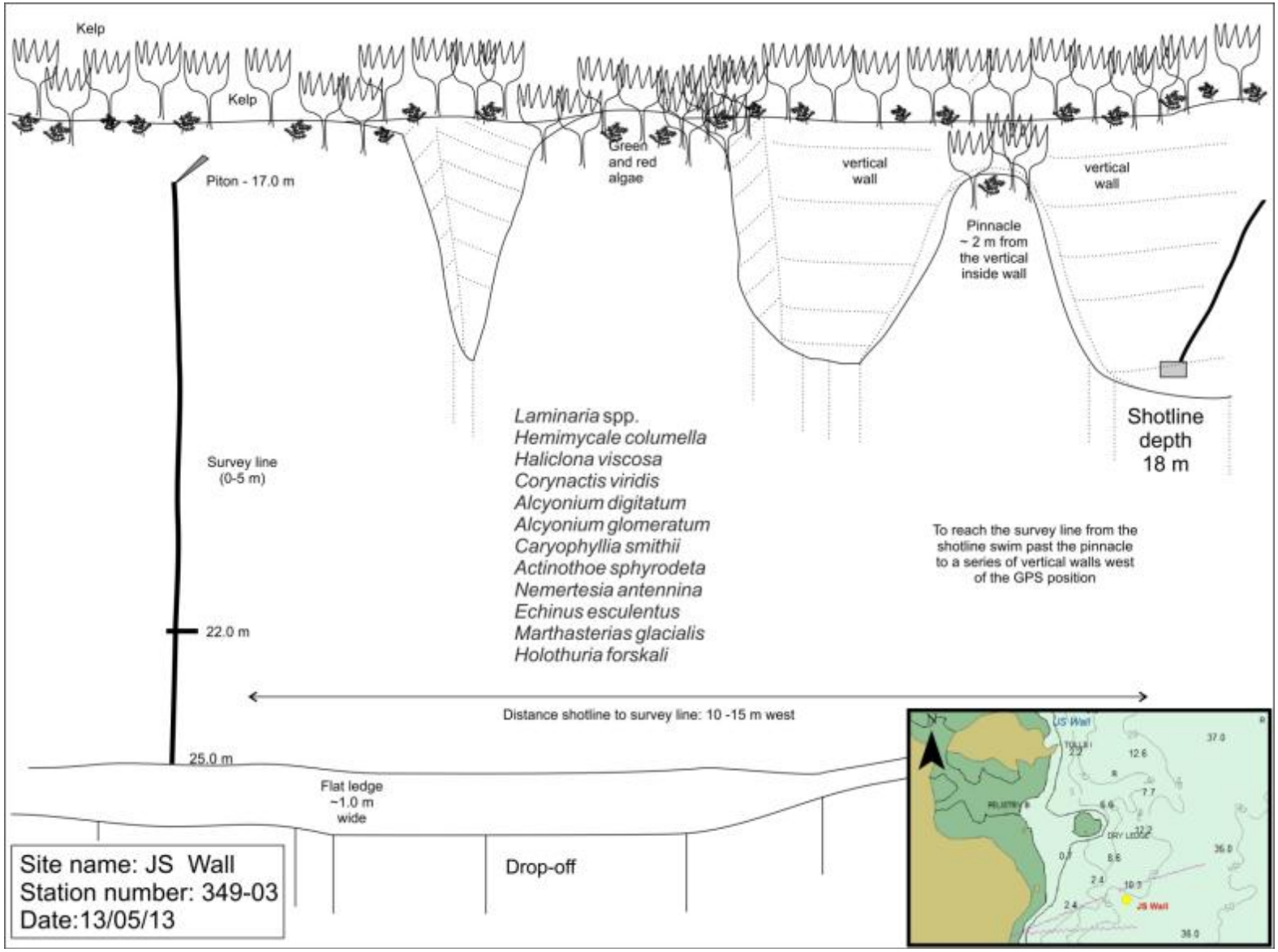


Figure 3.26. JS Wall site description.

3.4.1.2 Faunal assessment

The jewel anemone (*Corynactis viridis*) was ubiquitous and the most characteristic taxon along the JS Wall vertical rock survey line (see Figure 3.26 and Table 3.22). The percentage cover ranged between 5 % and 40 % with an overall mean percentage cover of 23 % but it was present in all of the analysed quadrats (quadrat frequency of 100 %).

Other relatively widespread fauna included *Caryophyllia smithii, Hemimycale columella* and *Haliclona viscosa,* present at 56.7 %, 53.3 % and 46.7 % of the analysed quadrats. Larger taxa, such as *Marthasterias glacialis, Echinus esculentus* and *Holothuria forskali*, were also found across the site but with a patchy distribution (recorded in 4, 1 and 2 quadrats along the line respectively) as expected.

Of note was the presence of *Alcyonium glomeratum* and *Leptopsammia pruvoti. A. glomeratum* was recorded in six of the 30 quadrats but the size of these individuals was generally small, covering 1 – 5 % of the 0.0625 m^2 quadrat. *L. pruvoti* was recorded only once along this wall and with a quadrat coverage of 1 % (Appendix 04) it may only have been one individual. *L. pruvoti* is a UK Biodiversity Action Plan (BAP) species (Gall, 2011) with a limited distribution found primarily in the south-west of England (Wood, 2013).

Table 3.22. Fauna recorded at JS Wall (St. Mary's) on 13 May 2013 (frequency (n); refers to the number of quadrats with a faunal record; frequency (%): refers to the percentage of quadrats with a faunal record; depth: below sea level; coordinates: position of shotline).

JS Wall (St. Mary's)	Latitude	49° 55.481' N	Date	13/05/13
	Longitude	06° 16.429' W	Depth range (m)	17 – 23
			Quadrats analysed	30
			Area (m^2) analysed	1.875
Species	**Mean % cover**	**±S.D.**	**Frequency (n)**	**Frequency (%)**
Axinella dissimilis (count)	-	-	-	-
Tethya citrina (count)	-	-	-	-
Cliona celata (%)	-	-	-	-
Hemimycale columella (%)	3.53	±5.0	16	53.3
Dysidea fragilis (%)	-	-	-	-
Haliclona viscosa (%)	1.30	±1.8	14	46.7
Alcyonium digitatum (%)	0.27	±1.0	3	10.0
Alcyonium glomeratum (%)	0.77	±1.7	6	20.0
Corynactis viridis (%)	23.33	±8.1	30	100.0
Actinothoe sphyrodeta (%)	-	-	-	-
Sagartia elegans (%)	-	-	-	-
Leptopsammia pruvoti (%)	0.03	±0.2	1	3.3
Caryophyllia smithii (%)	1.20	±1.9	17	56.7
Hoplangia durotrix (%)	-	-	-	-
Parazoanthus axinellae (%)	-	-	-	-
Parazoanthus anguicomus (%)	-	-	-	-
Echinus esculentus (%)	0.33	±1.8	1	3.3
Marthasterias glacialis (%)	1.00	±2.8	4	13.3
Holothuria forskali (%)	1.00	±4.6	2	6.7
Antedon bifida (%)	-	-	-	-
Clavelina lepadiformis (%)	0.63	±2.1	4	13.3
Stolonica socialis (%)	0.17	±0.9	1	3.3

3.4.2 Newfoundland Point

3.4.2.1 Site description

Newfoundland Point was a south-easterly facing vertical rock site on the southeast side of St. Mary's (Figures 3.1 and 3.3). Exposed to the east and south this moderate to high-energy environment was partly sheltered from the prevailing south-westerly winds.

The shotline was on a large ledge at about 18 m depth. The upper parts of the wall were dominated by kelp (forest and park). The vertical walls started at and just below the kelp line. The shotline weight was positioned on a small ledge at about 17 m. The piton was located at a depth of 17 m, approximately 2 m north-northeast of the shotline position (Figure 3.27).

The survey transect line ran vertically alongside a vertical crevice (Figure 3.28) 1-2 m north of the line. Immediately below the survey line was a ledge at a depth of 24.1 m (diver gauge depth). The ledge was 2 m wide with cobbles and small boulders scattered across it. Beyond the ledge was another vertical drop off.

The wall was dominated by *Corynactis viridis*, but *Alcyonium digitatum*, *Alcyonium glomeratum*, *Marthasterias glacialis* and *Caryophyllia smithii* as well as the sponges *Hemimycale columella* and a large *Cliona celata* were also present. In the crevice were *Corynactis viridis*, *Leptopsammia pruvoti* and *Eunicella verrucosa*. Kelp could in places also be found at the upper parts of the wall. Seasearch (2007) recorded *Sagartia elegans* as being abundant and *Caryophyllia smithii* and *Corynactis viridis* as being superabundant.

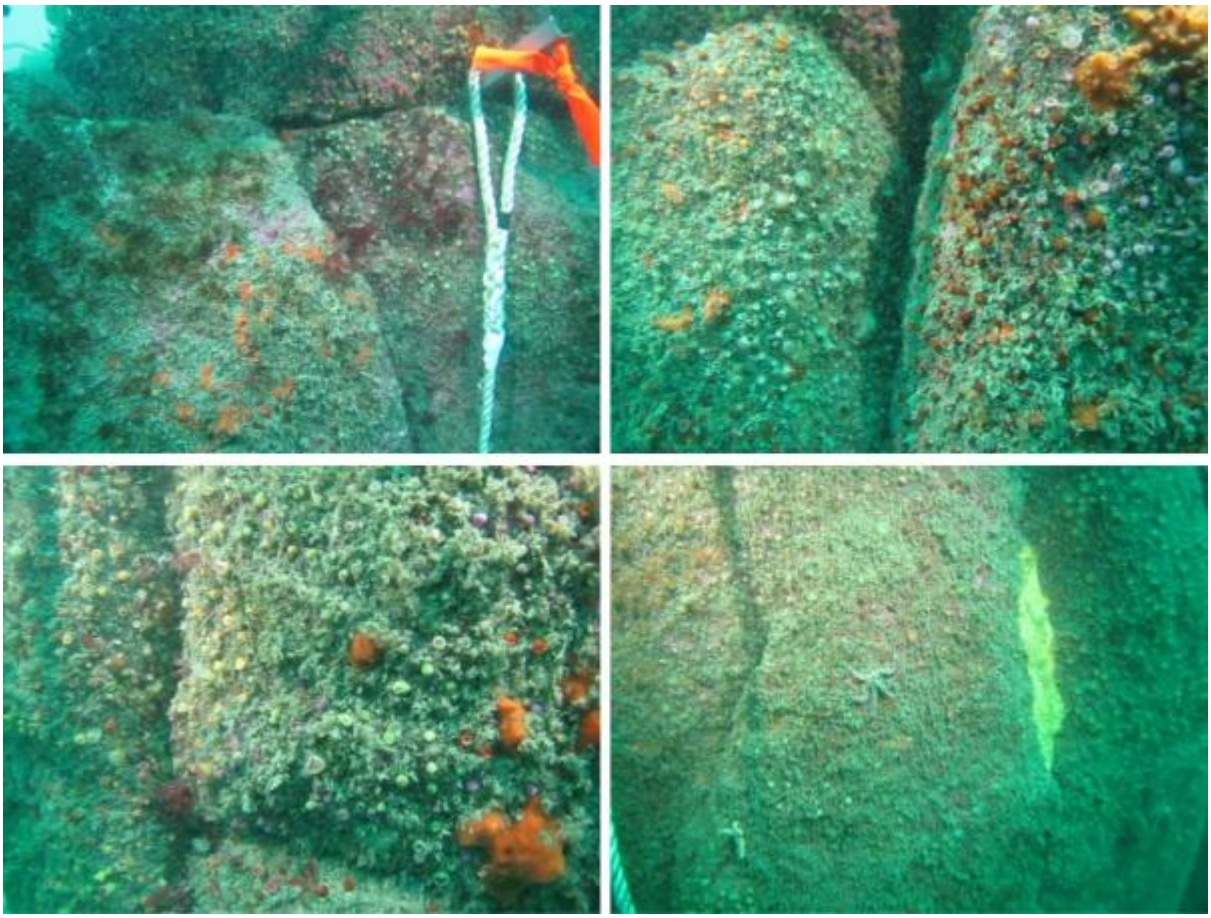


Figure 3.27. Seabed images from Newfoundland Point (in May 2013).

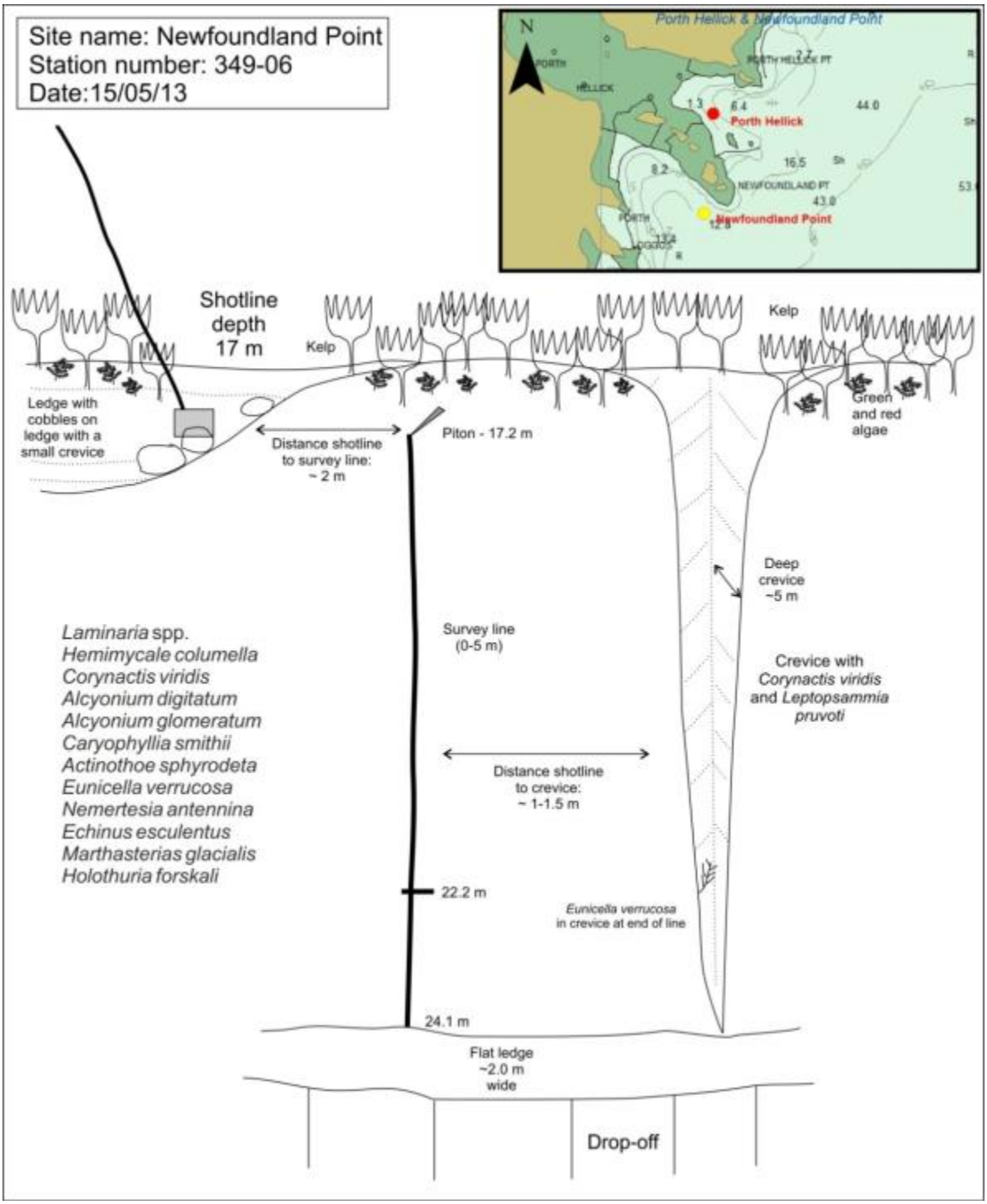


Figure 3.28. Newfoundland Point site description.

3.4.2.2 Faunal assessment

At Newfoundland Point the jewel anemone (*Corynactis viridis*) was ubiquitous and characteristic of the vertical rock community (Table 3.23) but there was an influence of several floral taxa at the top of the survey line (as well as above it). Jewel anemones were recorded in all the analysed quadrats and the cover ranged from 20 % to 80 % with the mean percentage cover calculated to be 44 %. The highest cover was found at mid-depths (2.5-3.75 m) along the survey line with the lowest coverage found at the top and the bottom of the line.

A total of nine other taxa were recorded at this location (Table 3.23). *Hemimycale columella* was recorded at 50 % of the randomly selected quadrats whilst *Marthasterias glacialis* was recorded at 1/3 of the quadrats with *Caryophyllia smithii* and *Haliclona viscosa* were found in 20 % of the samples. Of particular note was the presence of *Alcyonium glomeratum* as it is considered to be nationally scarce (Gall, 2011). It was only recorded in one quadrat but at 10 % cover.

Table 3.23. Fauna recorded at Newfoundland Point (St. Mary's) on 15 May 2013 (frequency (n); refers to the number of quadrats with a faunal record; frequency (%): refers to the percentage of quadrats with a faunal record; depth: below sea level; coordinates: position of shotline).

Newfoundland Point (St. Mary's)	Latitude Longitude	49° 54.745' N 06° 16.840' W	Date Depth range (m) Quadrats analysed Area (m^2) analysed	15/05/13 17 – 22 30 1.875
Species	**Mean % cover**	**± S.D.**	**Frequency (n)**	**Frequency (%)**
Axinella dissimilis (count)	-	-	-	-
Tethya citrina (count)	-	-	-	-
Cliona celata (%)	0.07	±0.4	1.0	3.3
Hemimycale columella (%)	2.67	±3.6	15.0	50.0
Dysidea fragilis (%)	0.27	±0.8	3.0	10.0
Haliclona viscosa (%)	0.77	±1.7	6.0	20.0
Alcyonium digitatum (%)	0.10	±0.4	2.0	6.7
Alcyonium glomeratum (%)	0.33	±1.8	1.0	3.3
Corynactis viridis (%)	44.00	±17.8	30.0	100.0
Actinothoe sphyrodeta (%)	-	-	-	-
Sagartia elegans (%)	-	-	-	-
Leptopsammia pruvoti (%)	-	-	-	-
Caryophyllia smithii (%)	0.30	±0.7	6.0	20.0
Hoplangia durotrix (%)	-	-	-	-
Parazoanthus axinellae (%)	-	-	-	-
Parazoanthus anguicomus (%)	-	-	-	-
Echinus esculentus (%)	-	-	-	-
Marthasterias glacialis (%)	1.60	±2.6	10.0	33.3
Holothuria forskali (%)	-	-	-	-
Antedon bifida (%)	-	-	-	-
Clavelina lepadiformis (%)	0.17	±0.9	1.0	3.3
Stolonica socialis (%)	-	-	-	-

3.4.3 Menawethan

3.4.3.1 Site description

The Menawethan vertical rock site was situated on the island of Menawethan (Figures 3.1 and 3.2), along the eastern margin of the Eastern Isles, and was exposed to the southeast (Figure 3.29). It consisted of short vertical walls, steeply sloping faces and upward-facing surfaces (Figure 3.30). The shotline was positioned at the top of the walls on a ledge at a depth of approximately 18 m. The piton (with an orange marker) could be found at a depth of 18 m approximately 8 m south-southwest of the GPS position along the wall. To reach the survey line the divers had to swim past a small perpendicular wall about 2 m wide, which in 2013 had a piton placed at the top, to reach the survey line piton next to a second large (5 m wide) perpendicular wall (Figure 3.31). The perpendicular wall was immediately beyond the survey transect line location. A ledge with boulders and cobbles was found at a depth of 25 m, approximately 2 m below the transect line.

The southerly facing vertical wall was dominated by *Corynactis viridis*, but other fauna included *Alcyonium digitatum*, *Cliona celata*, *Echinus esculentus*, *Holothuria forskali*, *Marthasterias glacialis*, *Nemertesia antennina* and *Nemertesia ramosa*. A dense kelp forest (*Laminaria hyperborea* and *Laminaria ochroleuca*) was present at the top of the walls. Seasearch dives between 2004 and 2008 recorded the presence of the nationally scarce scarlet and gold cup coral *Balanophyllia regia*, as well as Atlantic grey seals and 30 other species (Seasearch, 2004; Seasearch, 2006, Seasearch, 2007; Seasearch, 2008).

Figure 3.29. Menawethan wall site location.

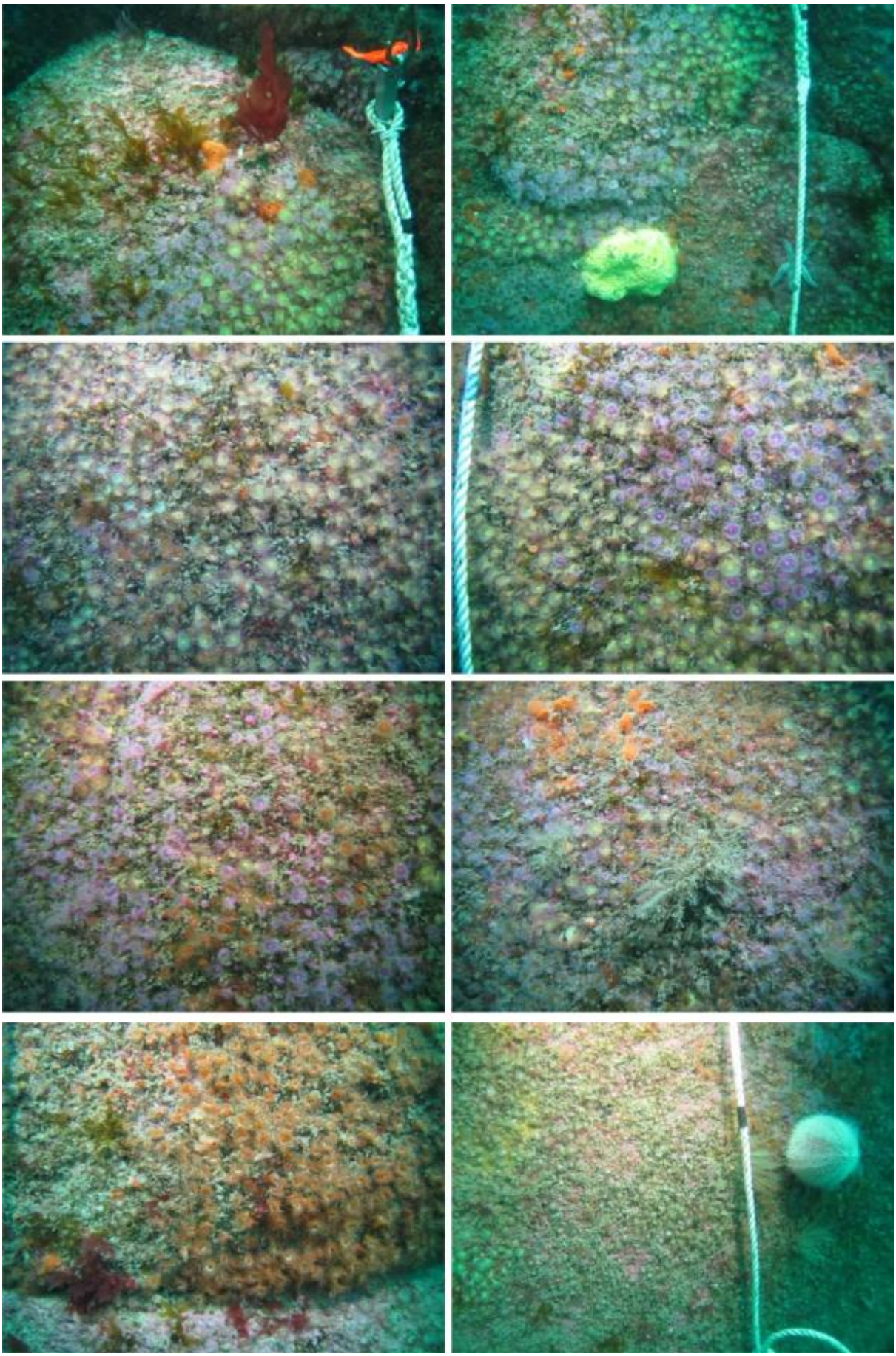


Figure 3.30. Seabed images from Menawethan (in May 2013).

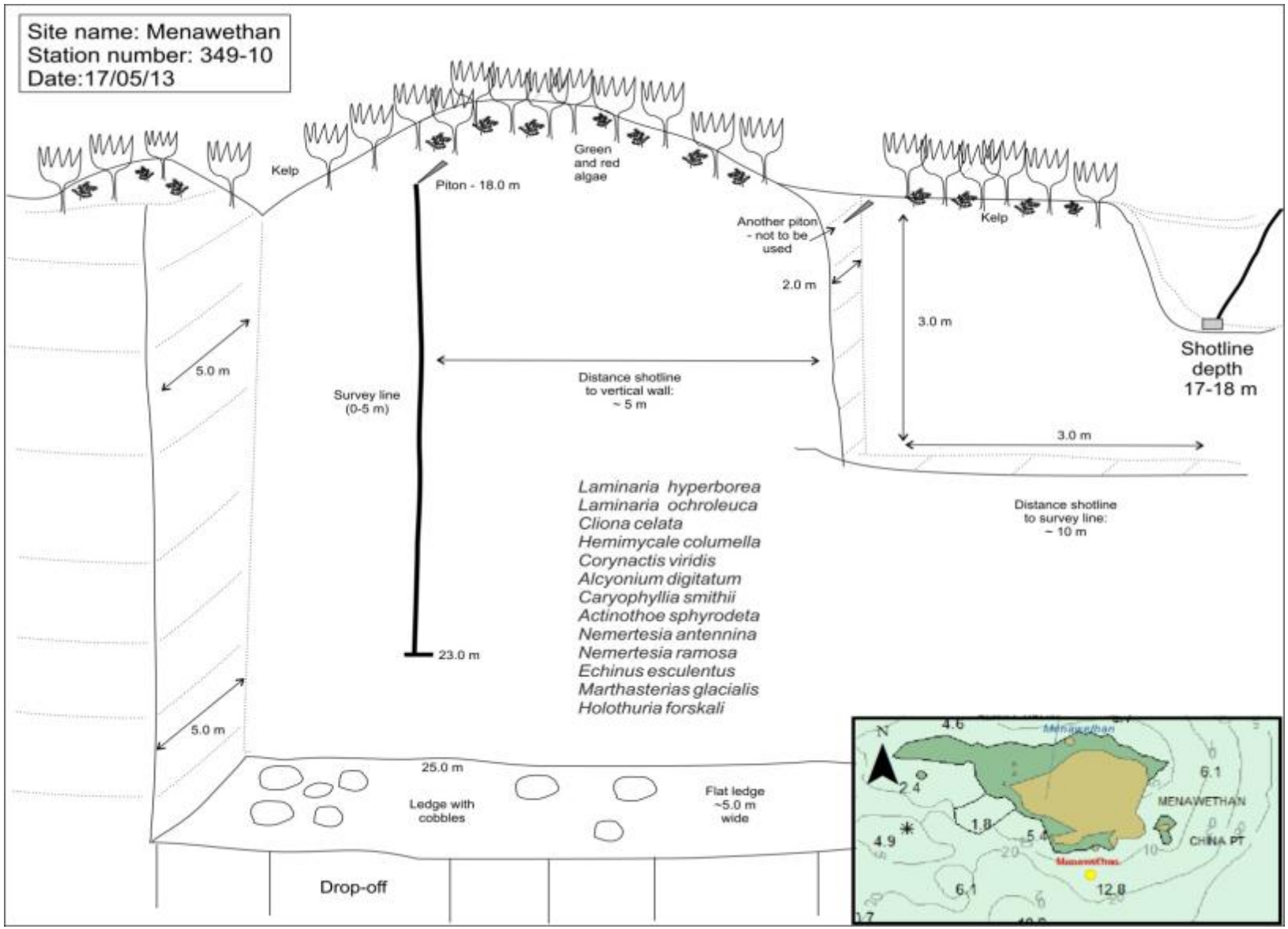


Figure 3.31. Menawethan wall site description.

3.4.3.2 Faunal assessment

The Menawethan vertical rock site had relatively few records (Table 3.24) and was relatively species poor compared to the other two sites surveyed in May. Eight species were recorded in the randomly selected grid cells along the survey line with the jewel anemone (*Corynactis viridis*) being the most abundant and essentially ubiquitous across the site with a mean percentage cover of 52 %.

Hemimycale columella and *Marthasterias glacialis* were at 16.7 % of the quadrats with *Haliclona viscosa* present at 10 % of sites. *Cliona celata, Alcyonium digitatum, Antedon bifida* and *Stolonica socialis* were also recorded but only at a small number of quadrats along the line. *Alcyonium glomeratum* was not recorded at Menawethan.

Table 3.24. Fauna recorded at Menawethan (Menawethan) on 17 May 2013 (frequency (n); refers to the number of quadrats with a faunal record; frequency (%): refers to the percentage of quadrats with a faunal record; depth: below sea level; coordinates: position of shotline).

Menawethan (Menawethan)	Latitude Longitude	49° 56.634' N 06° 14.746' W	Date Depth range (m) Quadrats analysed Area (m^2) analysed	17/05/13 18 – 23 30 1.875
Species	**Mean % cover**	**± S.D.**	**Frequency (n)**	**Frequency (%)**
Axinella dissimilis (count)	-	-	-	-
Tethya citrina (count)	-	-	-	-
Cliona celata (%)	0.33	±1.8	1.0	3.3
Hemimycale columella (%)	1.00	±2.4	5.0	16.7
Dysidea fragilis (%)	-	-	-	-
Haliclona viscosa (%)	0.50	±1.5	3.0	10.0
Alcyonium digitatum (%)	0.17	±0.9	1.0	3.3
Alcyonium glomeratum (%)	-	-	-	-
Corynactis viridis (%)	52.17	±14.9	30.0	100.0
Actinothoe sphyrodeta (%)	-	-	-	-
Sagartia elegans (%)	-	-	-	-
Leptopsammia pruvoti (%)	-	-	-	-
Caryophyllia smithii (%)	-	-	-	-
Hoplangia durotrix (%)	-	-	-	-
Parazoanthus axinellae (%)	-	-	-	-
Parazoanthus anguicomus (%)	-	-	-	-
Echinus esculentus (%)	-	-	-	-
Marthasterias glacialis (%)	1.00	±2.4	5.0	16.7
Holothuria forskali (%)	-	-	-	-
Antedon bifida (%)	0.07	±0.4	1.0	3.3
Clavelina lepadiformis (%)	-	-	-	-
Stolonica socialis (%)	0.17	±0.9	1.0	3.3

3.4.4 Men-a-vaur

3.4.4.1 Site description

This site was a steep sided rock wall situated off the Men-a-vaur island, in the north/north-western part of the Scilly Isles (Figures 3.1, 3.4 and 3.32). The island is exposed to the north, west and southwest, and therefore exposed to the prevailing winds. Tidal currents were moderate.

The shotline was located in 18-19 m water depth to the east of the piton at around 10-15 m. The site can be found by first locating the prominent ledge at 18.5 m depth, then swimming west as far as possible. On reaching the corner of the ledge there was a fissure running vertically. The piton (with a yellow marker) is 20 cm to the right of this at a depth of 14.7 m (Figure 3.33*).* The south-westerly facing vertical rock is just short of 5 m in length.

Near the end (bottom) of transect line was a 1 m wide ledge (18.5 m depth), which intersected the transect line, with the last 0.5 m of the transect continuing below the ledge (Figure 3.33). Below the transect line (at 19 m) were large boulders, which prevented the transect from being placed any deeper.

Both *Laminaria* spp. and red algae were present at the top of the wall above the piton but red algae was also present along the transect line, even reaching the boulders below. The community along the transect itself predominantly consisted of red algae (high cover), sponges (*Hemimycale columella*, *Cliona celata* and *Haliclona viscosa*) and *Corynactis viridis* (the most common taxon on the wall). *Actinothoe sphyrodeta* was found on the upper section of the wall with *Marthasterias glacialis*, *Alcyonium digitatum* and *Echinus esculentus* also present (Figure 3.32). Seasearch (2006) recorded 14 species of sponge, the starfish *Henricia oculata* and the cushion star *Asterina phylactica* at this site.

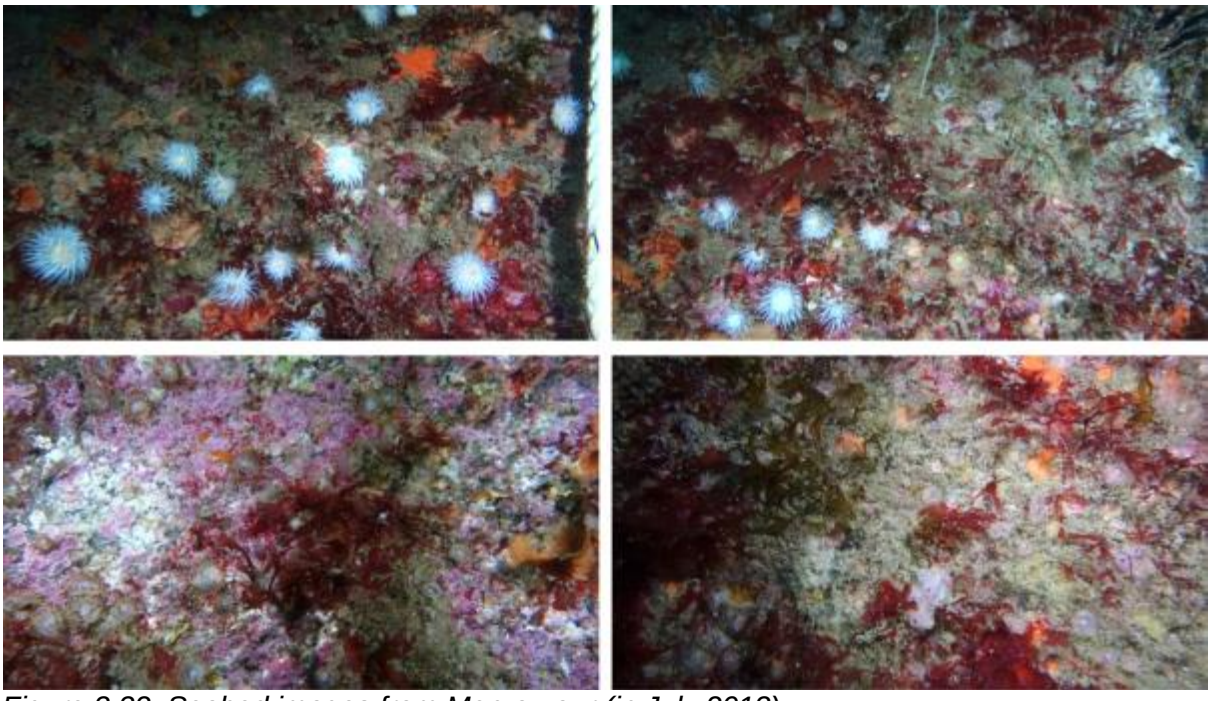


Figure 3.32. Seabed images from Men-a-vaur (in July 2013).

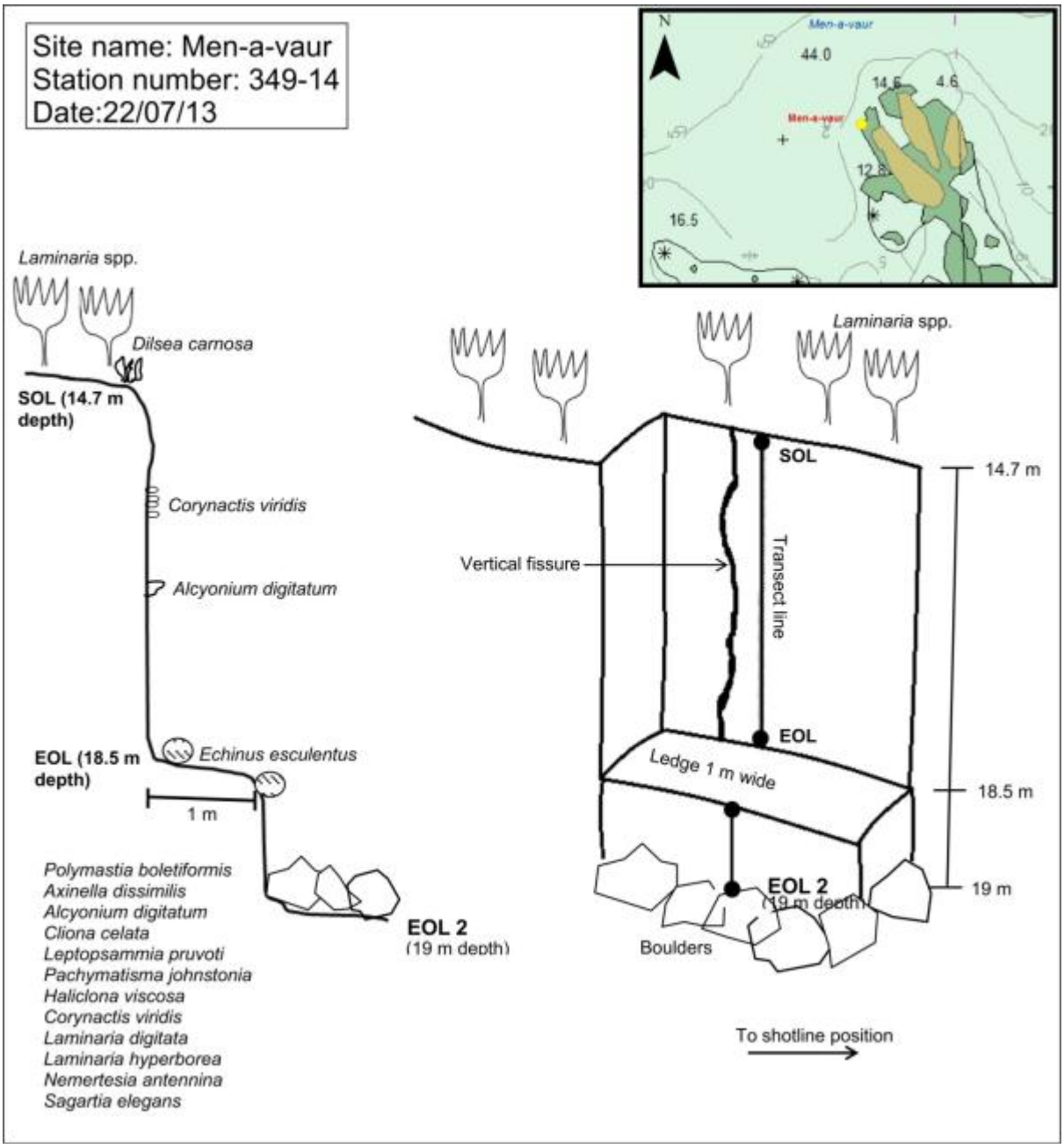


Figure 3.33. Men-a-vaur wall site description.

3.4.4.2 Faunal assessment

There was a considerable algal component at Men-a-vaur all along the survey line. The algae were particularly notable at the top and at the bottom of the line but essentially present all along the line. However, the jewel anemone (*Corynactis viridis*) was the most abundant and widespread taxa along this survey line. This species was recorded at 27 of the 30 quadrats analysed and where recorded ranging in cover from 10 % to 75 % with a mean percentage cover of c. 37 % (Figure 3.25).

The secondly most recorded species was *Actinothoe sphyrodeta* at 30 % of the quadrats. Most of the individuals were found at the shallow end of the line with a cover of up to 10 % in each quadrat. Of note is that *Sagartia elegans* was also recorded at this site.

Unlike the other survey locations *Dysidea fragilis* was relatively frequently recorded at Menawethan. Initially some of the records were uncertain but after the quality control process these records were confirmed.

Alcyonium glomeratum was recorded at Menawethan. There was only one record near the top of the survey line (0.25 m below the piton) but the recorded 10 % cover suggested the individual was of reasonable size.

Table 3.25. Fauna recorded at Men-a-vaur (St. Helen's) on 22 July 2013 (frequency (n); refers to the number of quadrats with a faunal record; frequency (%): refers to the percentage of quadrats with a faunal record; depth: below sea level; coordinates: position of shotline).

Men-a-vaur (St. Helen's)	Latitude Longitude	49° 58.606' N 06° 20.137' W	Date Depth range (m) Quadrats analysed Area (m^2) analysed	22/07/13 15 – 20 30 1.875
Species	**Mean % cover**	**± S.D.**	**Frequency (n)**	**Frequency (%)**
Axinella dissimilis (count)	-	-	-	-
Tethya citrina (count)	-	-	-	-
Cliona celata (%)	-	-	-	-
Hemimycale columella (%)	0.67	±1.6	6.0	20.0
Dysidea fragilis (%)	0.43	±1.3	4.0	13.3
Haliclona viscosa (%)	2.33	±9.7	2.0	6.7
Alcyonium digitatum (%)	0.17	±0.9	1.0	3.3
Alcyonium glomeratum (%)	0.33	±1.8	1.0	3.3
Corynactis viridis (%)	36.83	±21.1	27.0	90.0
Actinothoe sphyrodeta (%)	1.73	±3.5	9.0	30.0
Sagartia elegans (%)	0.87	±4.6	2.0	6.7
Leptopsammia pruvoti (%)	-	-	-	-
Caryophyllia smithii (%)	0.03	±0.2	1.0	3.3
Hoplangia durotrix (%)	-	-	-	-
Parazoanthus axinellae (%)	-	-	-	-
Parazoanthus anguicomus (%)	-	-	-	-
Echinus esculentus (%)	-	-	-	-
Marthasterias glacialis (%)	-	-	-	-
Holothuria forskali (%)	-	-	-	-
Antedon bifida (%)	-	-	-	-
Clavelina lepadiformis (%)	-	-	-	-
Stolonica socialis (%)	-	-	-	-

3.4.5 John Thomas Ledge wall

3.4.5.1 Site description

The John Thomas Ledge is a large, flat plateau situated to the northeast of St. Martins (Figures 3.1, 3.5, 3.34 and 3.35). This location is exposed to the north, northeast and southeast, but is relatively sheltered from all other directions. The survey location was a northeast-facing wall on a rocky reef situated toward the outer reaches of the ledge. The depth on the ledge was approximately 25 m with the shallowest point on the rocky reef being 9 m. Of note are the relatively strong tidal currents restricting diving to the slack water around low or high water.

The shallower sections (9-18 m) of the rocky reef were covered in kelp (*Laminaria hyperborea, L. ochroleuca* and *Saccharina polyschides*) with an understorey of green, red and brown algae (e.g. *Dictyopteris polypodioides* and *Dictyota dichotoma*). Beyond the edge of the flat reef, in a north-easterly direction, there were a number of vertical walls of various sizes and heights. The fauna at depths below ~18 m were dominated by *Corynactis viridis* with other fauna including *Cliona celata, Hemimycale columella, Alcyonium digitatum, A. glomeratum, Caryophyllia smithii, Actinothoe sphyrodeta, Echinus esculentus, Holothuria forskali* and *Marthasterias glacialis* (Figure 3.34).

The shotline position was situated at the edge of the ledge at a depth of approximately 15-16 m (Figure 3.35). This area was characterised by a dense kelp forest community. To reach the wall the divers left the shotline swimming approximately 15 m in a northerly direction. The piton (with an orange marker) was attached at a depth of 19 m on the wall immediately beyond a vertical ledge. There was a large, sloping ledge roughly half way down the wall. The 5 m survey line was therefore split into two sections, the first between 19 – 22 m depth (0-3 m) and one between 23-25 m (3-5 m) to avoid the flat section of the ledge. Of particular note was the presence of a large rock boring sponge (*Cliona celata*) immediately beyond the survey line, a feature which should aid relocating the line in future years.

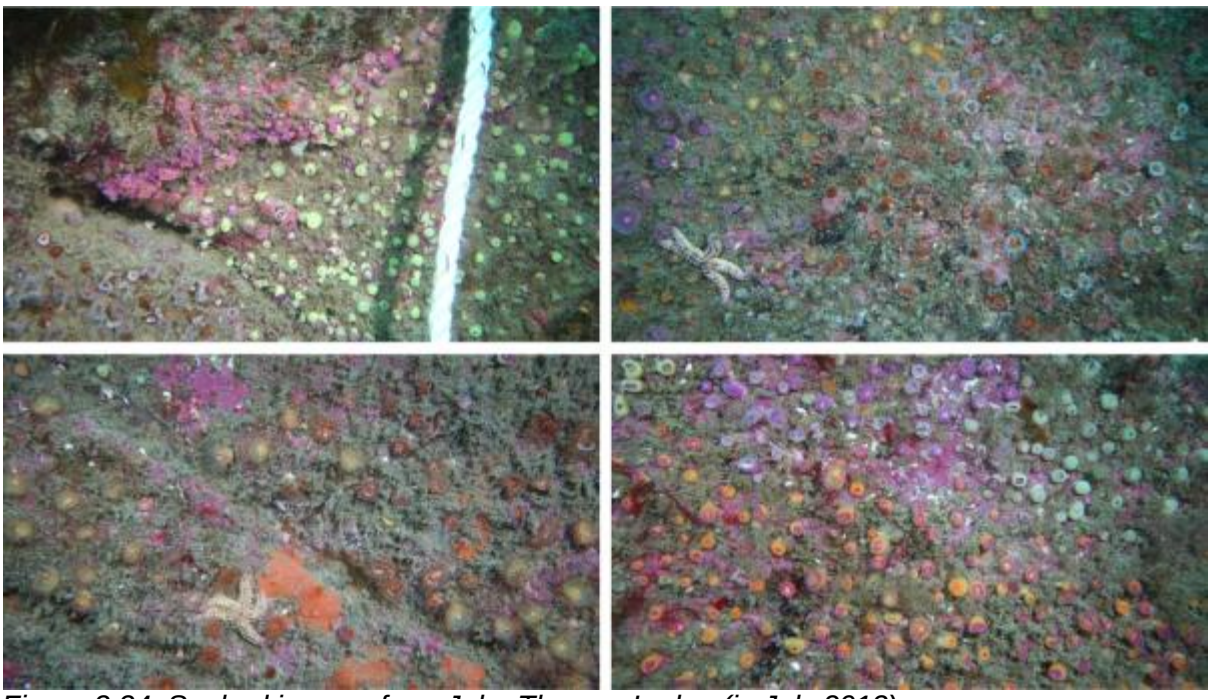


Figure 3.34. Seabed images from John Thomas Ledge (in July 2013).

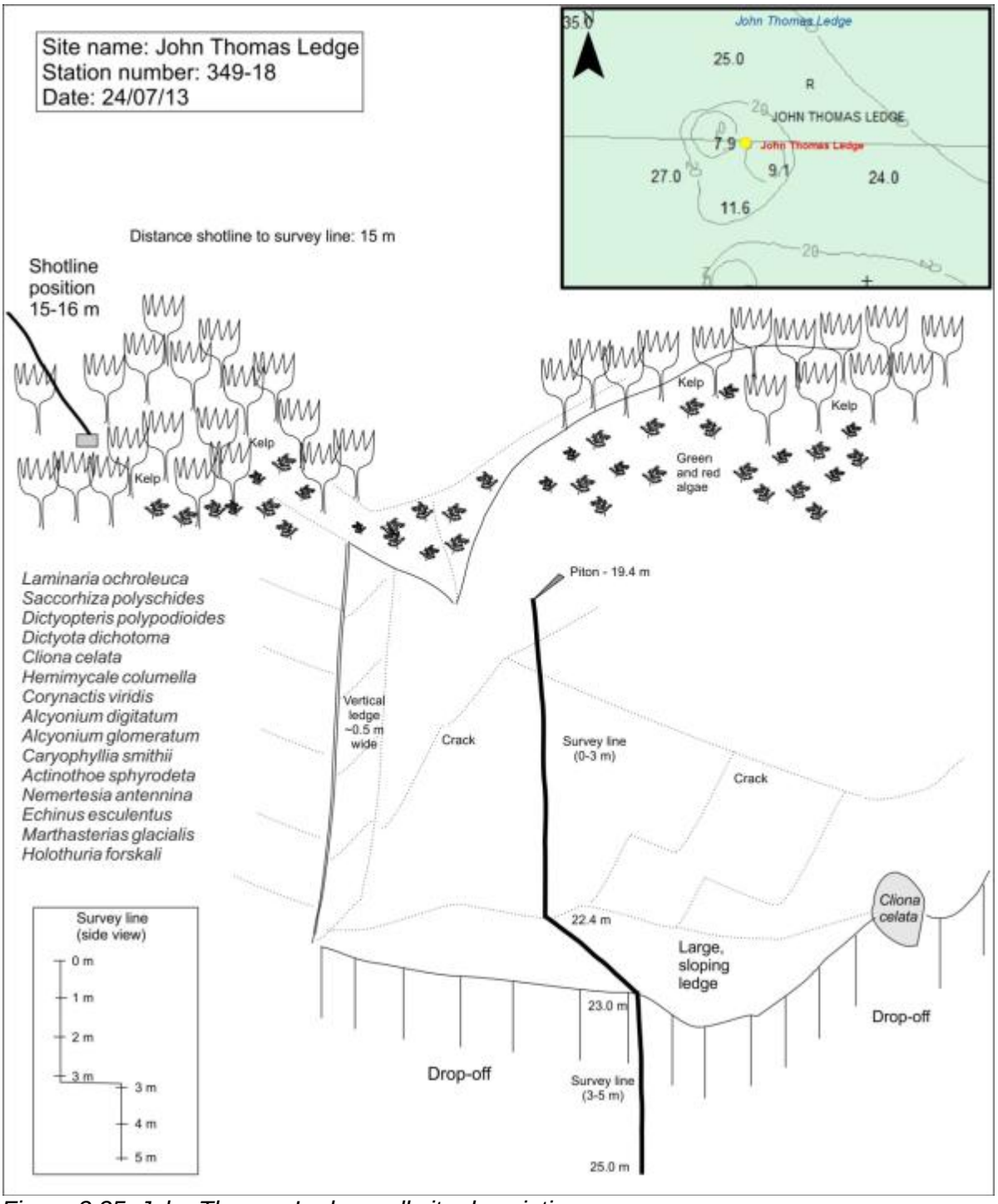


Figure 3.35. John Thomas Ledge wall site description.

3.4.5.2 Faunal assessment

The percentage cover of jewel anemones (*Corynactis viridis*) on the John Thomas Ledge wall was high (see Appendix 04). The frequency records vary between 20 % and 80 % but most of the records are >50 %. Furthermore, *C. viridis* was recorded in 30 of the 30 quadrats (100 %) analysed (see Table 3.26) further illustrating how widely distributed this taxon was in July 2013. The mean percentage cover is high relative to the other stations in the 2013 survey at c. 55 %.

Out of the remaining fauna recorded at John Thomas Ledge *Alcyonium digitatum* and *Marthasterias glacialis* were the most abundant but the distribution of these taxa can only be described as patchy as the frequency of counts was only 13.3 %. The same can be said for *Caryophyllia smithii* with records only noted in 10 % of quadrats. *Hemimycale columella, Haliclona viscosa, Actinothoe sphyrodeta, Clavelina lepadiformis* and *Holothuria forskali* were infrequently recorded suggesting low abundances of these taxa along the wall.

Of particular note was the presence of the UK Biodiversity Action Plan (BAP) species *Leptopsammia pruvoti* (Gall, 2011). The sunset cup coral is the largest and one of the rarest of the cup corals (Wood, 2013). It has only been recorded from a few sites in south-west of England including the Isles of Scilly (Gall, 2011; Wood, 2013).

Table 3.26. Fauna recorded at John Thomas Ledge (St. Martin's) on 24 July 2013 (frequency (n); refers to the number of quadrats with a faunal record; frequency (%): refers to the percentage of quadrats with a faunal record; depth: below sea level).

***John Thomas Ledge* (St. Martin's)**	Latitude Longitude	49° 58.628' N 06° 16.404' W	Date Depth range (m) Quadrats analysed Area (m^2) analysed	24/07/13 19 – 25 30 1.875
Species	**Mean % cover**	**± S.D.**	**Frequency (n)**	**Frequency (%)**
Axinella dissimilis (count)	-	-	-	-
Tethya citrina (count)	-	-	-	-
Cliona celata (%)	-	-	-	-
Hemimycale columella (%)	0.33	±1.8	1.0	3.3
Dysidea fragilis (%)	-	-	-	-
Haliclona viscosa (%)	0.17	±0.9	1.0	3.3
Alcyonium digitatum (%)	0.27	±0.9	4.0	13.3
Alcyonium glomeratum (%)	-	-	-	-
Corynactis viridis (%)	54.67	±16.6	30.0	100.0
Actinothoe sphyrodeta (%)	0.03	±0.2	1.0	3.3
Sagartia elegans (%)	-	-	-	-
Leptopsammia pruvoti (%)	0.17	±0.9	1.0	3.3
Caryophyllia smithii (%)	0.10	±0.3	3.0	10.0
Hoplangia durotrix (%)	-	-	-	-
Parazoanthus axinellae (%)	-	-	-	-
Parazoanthus anguicomus (%)	-	-	-	-
Echinus esculentus (%)	-	-	-	-
Marthasterias glacialis (%)	1.00	±2.8	4.0	13.3
Holothuria forskali (%)	1.00	±4.0	2.0	6.7
Antedon bifida (%)	-	-	-	-
Clavelina lepadiformis (%)	0.43	±1.9	2.0	6.7
Stolonica socialis (%)	-	-	-	-

3.4.6 East Withan

3.4.6.1 Site description

East Withan was a steep stepped bedrock reef/wall situated at the east of White Island, north of St. Martin's (Figures 3.1, 3.5 and 3.36). It consisted of vertical faces of 2-4 m height with 2-3 m wide stepped plateaus down to 25 m depth. This location was found in moderate to high energy conditions with a moderate to strong tidal current running beyond the vertical rock face. However, the survey transect is largely protected from the current flow.

The shotline was dropped on the ledge (21 m) at the base and immediately to the north of the wall where the transect line was laid. The piton (with an orange marker) was found by swimming south from the shotline to the base of the vertical rock and then ascending along the rock to a depth of 16.5 m. The piton can be found c.1 m above a deep crevice in the wall (Figures 3.37 and 3.38) just as the wall starts to level off.

The north-north-easterly vertical faces (Figure 3.37) were dominated by dense *Corynactis viridis*, with occasional *Caryophyllia smithii*, encrusting sponges and pink encrusting algae (*Lithothamnium* sp.). The horizontal faces, ledges and small overhangs were grazed by *Echinus esculentus*, *Marthasterias glacialis* and *Holothuria forskali*. Some algae were present at 23 m. *Alcyonium digitatum* and *A. glomeratum* were also present on smaller ledges and slight overhangs.

Figure 3.36. East Withan wall location off St. Martin's.

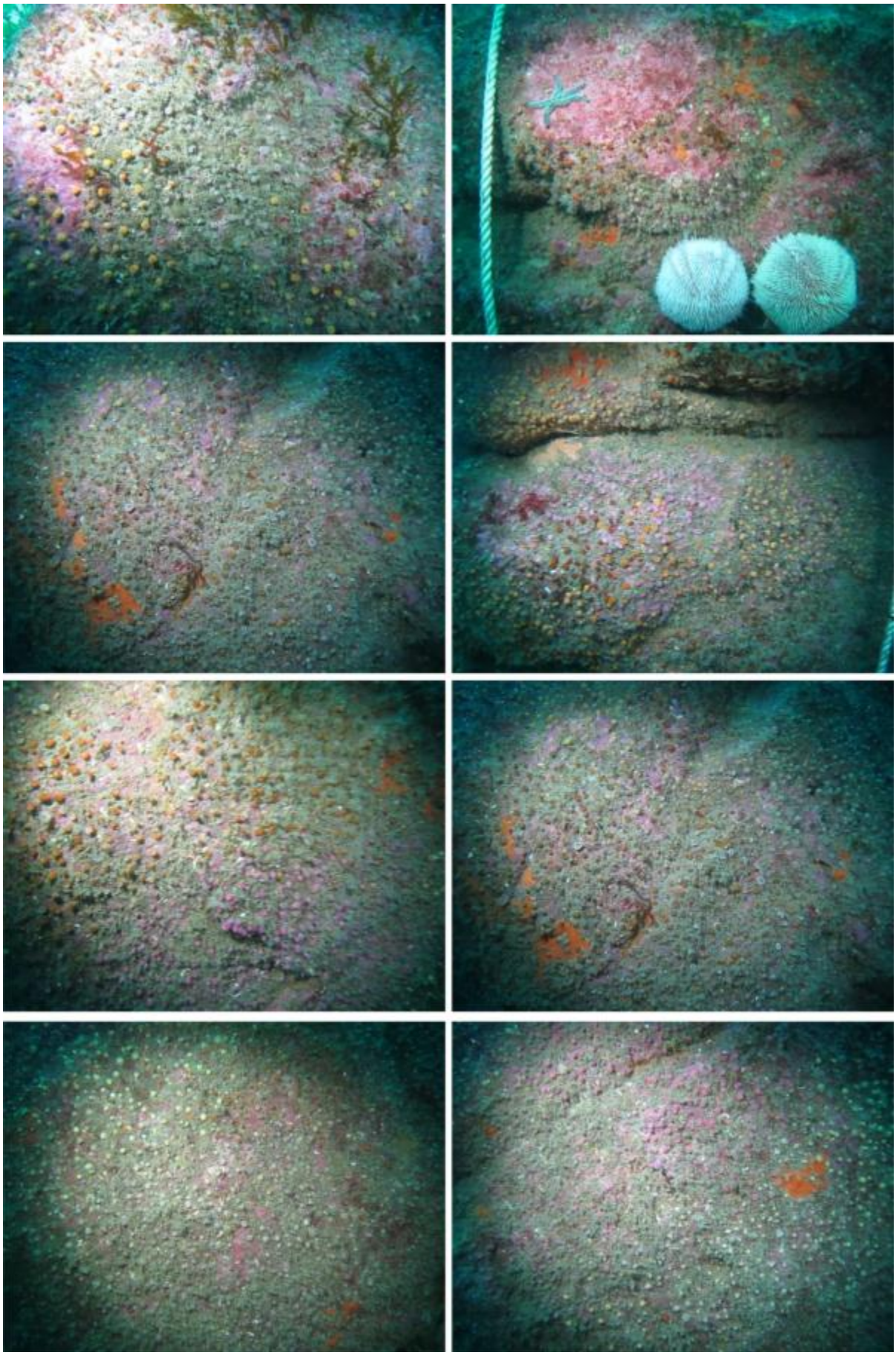


Figure 3.37. Seabed images from East Withan (in July 2013).

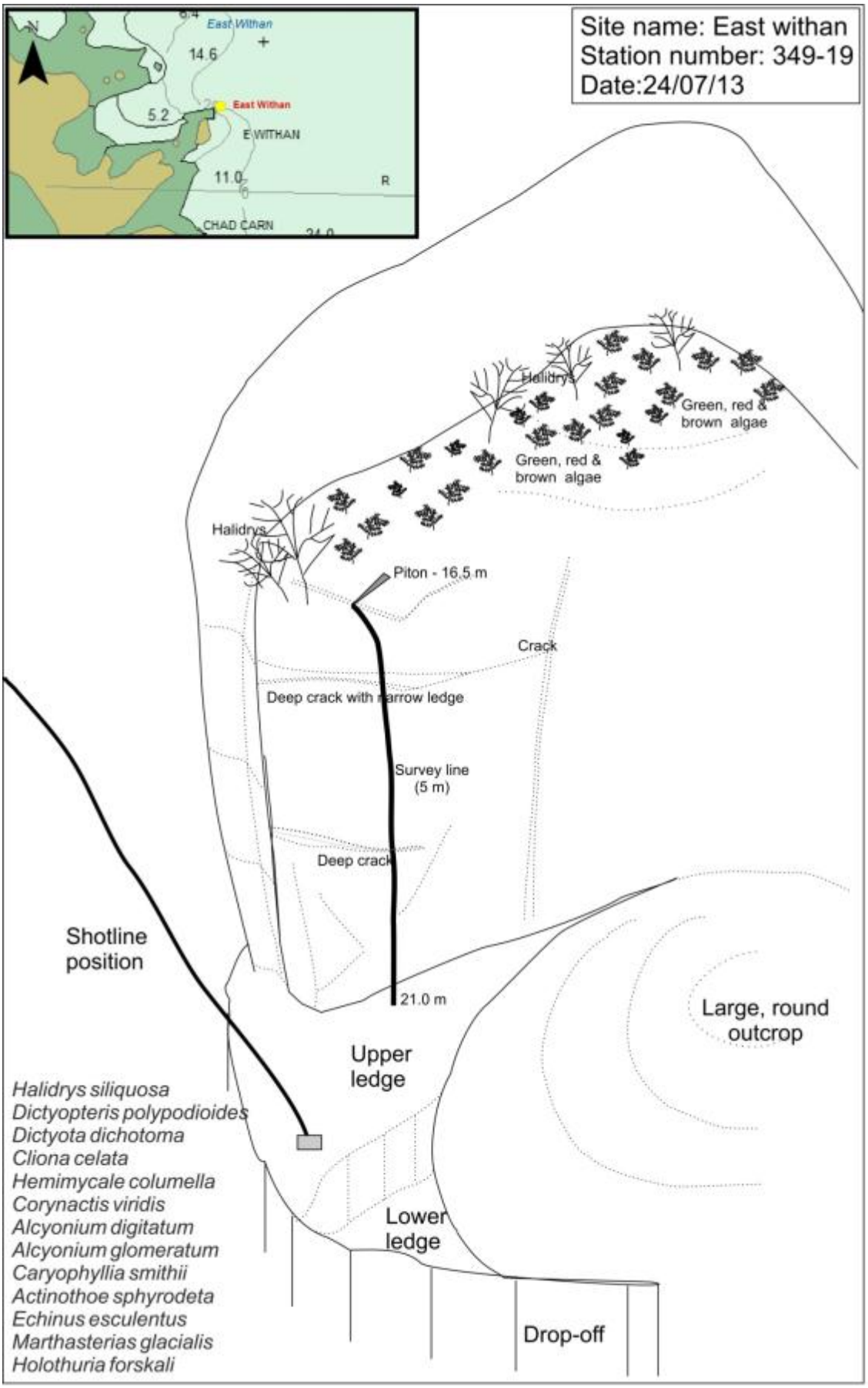


Figure 3.38. East Withan wall site description.

3.4.6.2 Faunal assessment

As with all the vertical rock locations selected for this survey East Withan was characterised by the jewel anemone (Table 3.27). The frequency records ranged in percentage from 15% to 90% but most of the records were >50% (Appendix 04). The lowest frequency of 15-25% was found at the shallower depths (0-1 m). However, below 1 m along the transect all records but one were >50%. The mean percentage cover across the entire line was 60 %, the highest value recorded for this taxon in the 2013 study.

The abundance of the remaining fauna was low with the most frequently recorded species being *Haliclona viscosa* and *Caryophyllia smithii. Hemimycale columella, Actinothoe sphyrodeta* and *Alcyonium digitatum* were also recorded but at low abundances overall.

Table 3.27. Fauna recorded at East Withan (White Island) on 24 July 2013 (frequency (n); refers to the number of quadrats with a faunal record; frequency (%): refers to the percentage of quadrats with a faunal record; depth: below sea level; coordinates: position of shotline).

East Withan (White Island)	Latitude Longitude	49° 58.606' N 06° 20.137' W	Date Depth range (m) Quadrats analysed Area (m^2) analysed	24/07/13 16 – 24 30 1.875
Species	**Mean % cover**	**± S.D.**	**Frequency (n)**	**Frequency (%)**
Axinella dissimilis (count)	-	-	-	-
Tethya citrina (count)	-	-	-	-
Cliona celata (%)	-	-	-	-
Hemimycale columella (%)	0.50	±2.0	2.0	6.7
Dysidea fragilis (%)	-	-	-	-
Haliclona viscosa (%)	1.00	±3.8	3.0	10.0
Alcyonium digitatum (%)	0.03	±0.2	1.0	3.3
Alcyonium glomeratum (%)	-	-	-	-
Corynactis viridis (%)	60.00	±24.1	30.0	100.0
Actinothoe sphyrodeta (%)	0.17	±0.9	1.0	3.3
Sagartia elegans (%)	-	-	-	-
Leptopsammia pruvoti (%)	-	-	-	-
Caryophyllia smithii (%)	0.83	±2.9	5.0	16.7
Hoplangia durotrix (%)	-	-	-	-
Parazoanthus axinellae (%)	-	-	-	-
Parazoanthus anguicomus (%)	-	-	-	-
Echinus esculentus (%)	-	-	-	-
Marthasterias glacialis (%)	0.17	±0.9	1.0	3.3
Holothuria forskali (%)	-	-	-	-
Antedon bifida (%)	-	-	-	-
Clavelina lepadiformis (%)	-	-	-	-
Stolonica socialis (%)	-	-	-	-

3.5 Comparisons of kelp forest communities during 2013

3.5.1 Kelp species assessment

The kelp forest dive surveys revealed some differences in the communities present across the various locations on the Isles of Scilly (see a summary of the results of the kelp plant densities in Table 3.28 illustrated in Figures 3.39 and 3.40). The highest overall kelp density (12.8 plants/m^2) was found at Frenchman's Rock (July 2013 survey) followed by Porth Hellick and Lizard Rock. The lowest kelp density was found at Porth Morran.

Of note is the similarity in kelp ratio at Frenchman's Rock in May and July 2013 despite the difference in relative plant density. The two surveys were completed at two slightly different locations suggesting slight variations in density across the bay but similar ratios in the relative abundance of the two species.

Most of the survey locations are characterised primarily by one kelp species, a statement illustrated by the plant ratios in Table 3.28. At Frenchman's Rock and Porth Hellick *Laminaria hyperborea* was the dominant kelp species whilst at Lizard Rock, Carn Morval, Tresco Channel and Porth Morran *Laminaria ochroleuca* was the dominant kelp species. At Porth Hellick the kelp ratio is relatively small (1.70) suggesting an equal distribution between the two species.

Table 3.28. Kelp plants densities (plants/m^2) at the different survey locations in 2013.

Site	*Laminaria hyperborea*	*Laminaria ochroleuca*	Other kelp taxa	Total	Lhyp: Loch ratio
Frenchman's Rock (May)	5.6	0.6	0.6	6.9	8.75
Porth Hellick	6.4	3.8	0.0	11.0	1.70
Lizard Rock	3.5	5.1	1.9	10.5	0.69
Carn Morval	0.9	5.1	2.0	8.0	0.18
Cromwell's Castle, Tresco Channel	1.0	6.9	0.7	8.6	0.15
Porth Morran	1.7	5.0	0.3	7.0	0.34
Frenchman's Rock (July)	11.2	1.3	0.3	12.8	8.62

The results illustrated in Figure 3.39 suggest a biogeographic boundary in the distribution of the two kelp species *Laminaria hyperborea* and *L. ochroleuca*. Whilst *L. hyperborea* was characteristic at locations in the Eastern Isles with high plant densities, *L. ochroleuca* was characteristic of locations in the south, west and north. Therefore locations exposed to the prevailing south-westerly winds and waves are dominated by *L. ochroleuca* whilst locations less exposed to these conditions and with a certain degree of protection, are dominated by *L. hyperborea*. Other factors such as the relative current speeds, siltation levels (therefore light) and temperature may also have an influence on this apparent pattern. Future surveys and additional data will aid in explaining this potential pattern but the additional sites across the islands should also be considered to further explore this apparent kelp distribution.

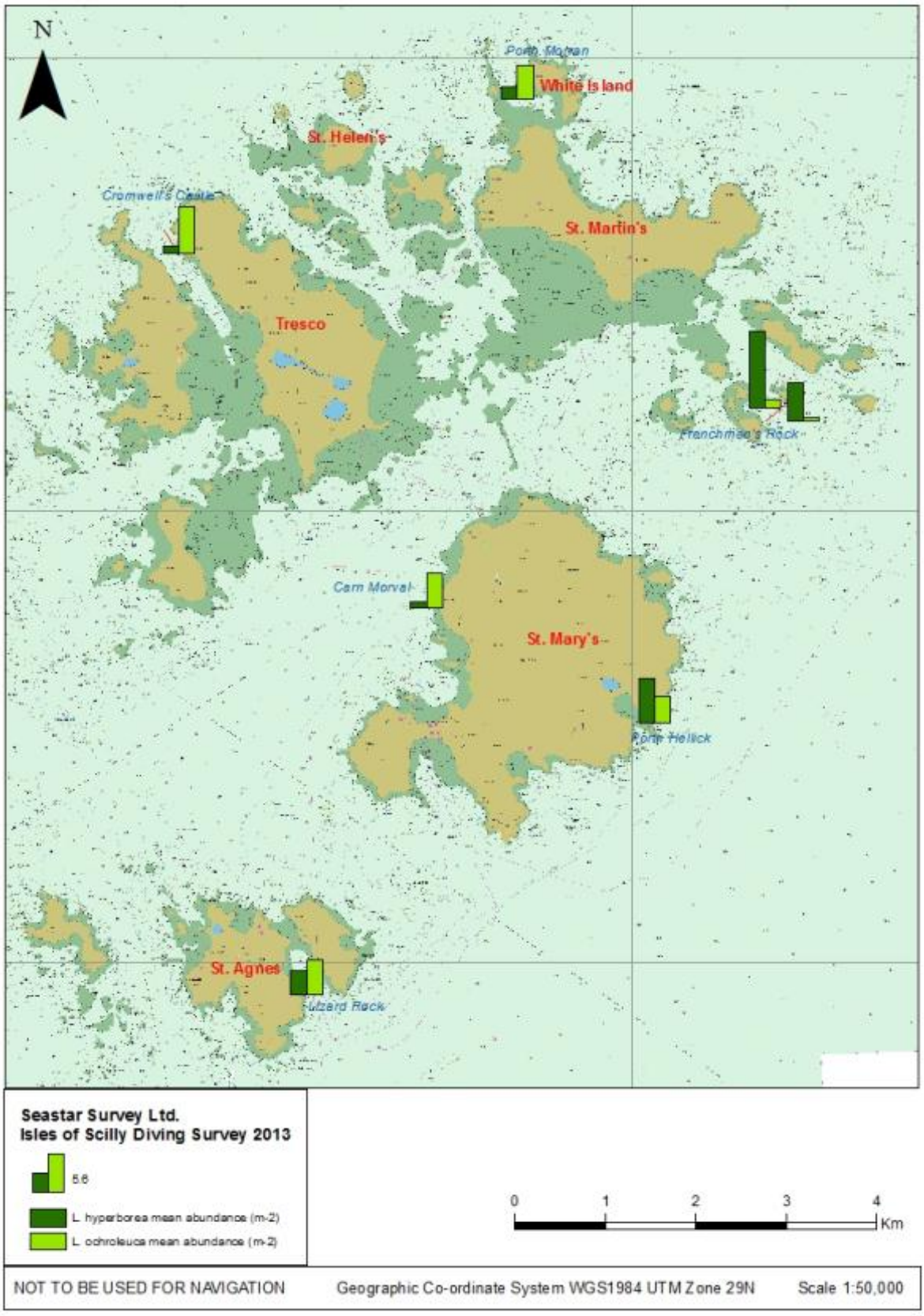


Figure 3.39. Kelp plants densities (plants/m^2) at the different survey locations in 2013.

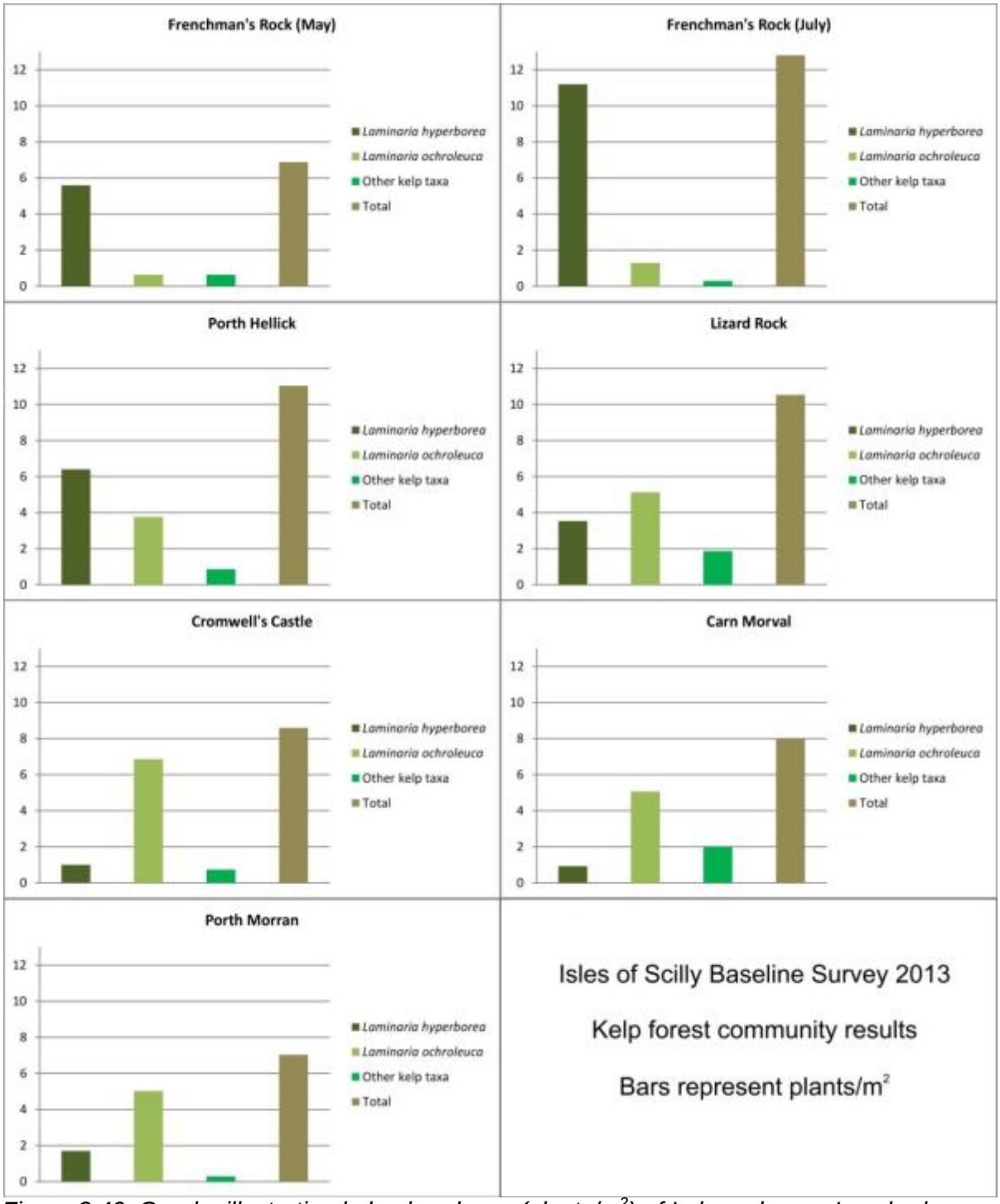


Figure 3.40. Graphs illustrating kelp abundance (plants/m^2) of L. hyperborea, L. ochroleuca and 'other kelp taxa' (Saccorhiza polyschides, Saccharina latissima, Alaria esculentus, Laminaria digitata and juvenile kelp species) at the different locations in the Isles of Scilly.

To test the kelp abundance statistically the Wilcoxan's test for matched pairs was completed for all the kelp forest community locations (Table 3.29). The Null Hypothesis given for each location was that "there was no difference in median abundance between *Laminaria hyperborea* and *Laminaria ochroleuca*".

The results (Table 3.29) show no statistical difference in the relative abundance of *L. hyperborea* and *L. ochroleuca* at Porth Hellick and Lizard Rock. However, the abundance of

L. ochroleuca was significantly greater than *L. hyperborea* at Carn Morval, Cromwell's Castle (Tresco Channel) and Porth Morran whilst the abundance of *L. hyperborea* was significantly greater than *L. ochroleuca* at Frenchman's Rock both in May and July 2013.

Table 3.29. Wilcoxan's matched pairs test results for kelp forest communities at various locations in the Isles of Scilly in 2013 (T=Wilcoxan's test statistic; n=number of quadrats for which d ≠ 0; p=probability - level of significance; ns=not significant).

Site	T	n	p	Species
Frenchman's Rock (May)	10.5	19	p<0.002	*L. hyperborea*
Porth Hellick	104.5	26	ns	-
Lizard Rock	148.5	30	ns	-
Carn Morval	9	27	p<0.002	*L. ochroleuca*
Cromwell's Castle, Tresco Channel	0	30	p<0.002	*L. ochroleuca*
Porth Morran	10	29	p<0.002	*L. ochroleuca*
Frenchman's Rock (July)	16.5	29	p<0.002	*L. hyperborea*

3.5.2 Red algae assessment

The results of the red algae dive assessment present at the different 2013 survey locations are given in Table 3.30. Two of the 7 survey locations (Carn Morval and Porth Morran) resulted in records of all nine characteristic red algal species. The first Frenchman's Rock survey (in May 2013) recorded the lowest total number of characteristic species. This was most likely a result of it being the shake-down dive and the first kelp forest community assessment dive. The dive team had to get used to the dive methodology as well as the challenge of identifying the red algae present.

To assess any underlying community structure a cluster analysis was completed (Figure 3.41). The analysis resulted in two main clusters (A and B) with survey locations in the west of the islands (cluster A) being separated from those in the east (cluster B). There was a second division of the survey locations in the east (cluster B) with one group containing the Frenchman's Rock samples (cluster B2) and one with the other two (Lizard Rock and Porth Hellick) in cluster B.

Of particular interest was that these clusters agree well with the results of the kelp analysis described above. The dominant kelp species at Frenchman's Rock was *Laminaria hyperborea* (red algal cluster B2) with a significant difference in the median abundance of *L. hyperborea* compared to *L. ochroleuca*. The survey locations at Cromwell's Castle, Carn Morval and Porth Morran (red algal cluster A) were dominated by *L. ochroleuca* and there was a significant difference in the abundance of *L. ochroleuca* over *L. hyperborea*. The remaining stations, Lizard Rock and Porth Hellick (red algal cluster B1), had a more equal distribution of the two species of kelp and there was no significant difference in the median abundance of the two species.

To test these patterns further a SIMPER analysis of the clusters was completed (Table 3.31). The results illustrated that *Heterosiphonia plumosa* (average abundance was 82 %) was a dominant species in cluster A (*L. ochroleuca* dominated), but it was far less important in terms of the community structure in cluster B (average *H. plumosa* abundance 17.5 %). *Phycodrys rubens* conversely was important in cluster B (average abundance of 57 %), which was characterised by *L. hyperborea*, whilst much less so in cluster A (average *P. rubens* abundance of 13 %).

The red algal species *Kallymenia reniformis* differed little in terms of average abundance (47 % versus 55 %) in the two kelp communities (*L. ochroleuca* versus *L. hyperborea*

communities respectively) but there was a difference in the relative community contribution (17 % versus 33 % respectively).

The difference between the two sub-clusters (B1 and B2) appeared to be minor overall, some of which may simply be a result of recorder differences. Additional data will be required to assess these potential differences further.

In terms of biotope designations there were only subtle differences between clusters in relation to the kelp and red algae composition. All but one of the stations (Carn Morval), were in sheltered locations with little tidal current and wave exposure. Carn Morval was exposed to the south-westerly winds and waves. However, the shallow water to the southwest of the site would most likely limit the level of wave exposure.

The occurrence of both *Laminaria hyperborea* and *L. ochroleuca* at all stations resulted in a choice of only two potential biotopes available in the classification system by Connor *et al.* (2004; IR.LIR.K.LhypLoch - mixed *L. hyperborea* and *L. ochroleuca* forest on moderately exposed or sheltered infralittoral rock and IR.HIR.KFaR.LhypR.Loch - mixed *L. hyperborea* and *L. ochroleuca* forest on exposed infralittoral rock). These biotopes are very similar with only subtle differences in composition but considering the overall red algal composition (see Table 3.30) across the stations, the similarity in depth range (shallow water in the range 4-11 m) and the sheltered nature of the locations (the only possible exception being Carn Morval) all the stations have tentatively been classified as IR.LIR.K.LhypLoch.

Table 3.30. Red algal species recorded at the 2013 dive survey locations (values are % frequency: the percentage of quadrats with a record of the specific taxon).

Species	**Frenchman's Rock (May)**	**Porth Hellick**	**Lizard Rock**	**Carn Morval**	**Tresco Channel**	**Porth Morran**	**Frenchman's Rock (July)**
Kallymenia reniformis	40.0	66.67	73.33	33.33	50.00	56.67	40.00
Delesseria sanguinea	16.0	50.00	16.67	76.67	93.33	30.00	46.67
Membranoptera alata	-	3.33	23.33	3.33	6.67	6.67	40.00
Phycodrys rubens	56.0	46.67	43.33	30.00	3.33	6.67	83.33
Heterosiphonia plumosa	-	40.00	23.33	80.00	80.00	86.67	6.67
Pterosiphonia parasitica	4.0	20.00	43.33	3.33	6.67	26.67	13.33
Sphaerococcus coronopifolius	-	-	30.00	50.00	13.33	60.00	3.33
Dilsea carnosa	-	3.33	-	26.67	23.33	16.67	-
Halurus equisetifolius	-	3.33	-	3.33	-	3.33	-
Total number of species recorded	4	8	7	9	8	9	7
Total number of analysed quadrats	25	30	30	30	30	30	30

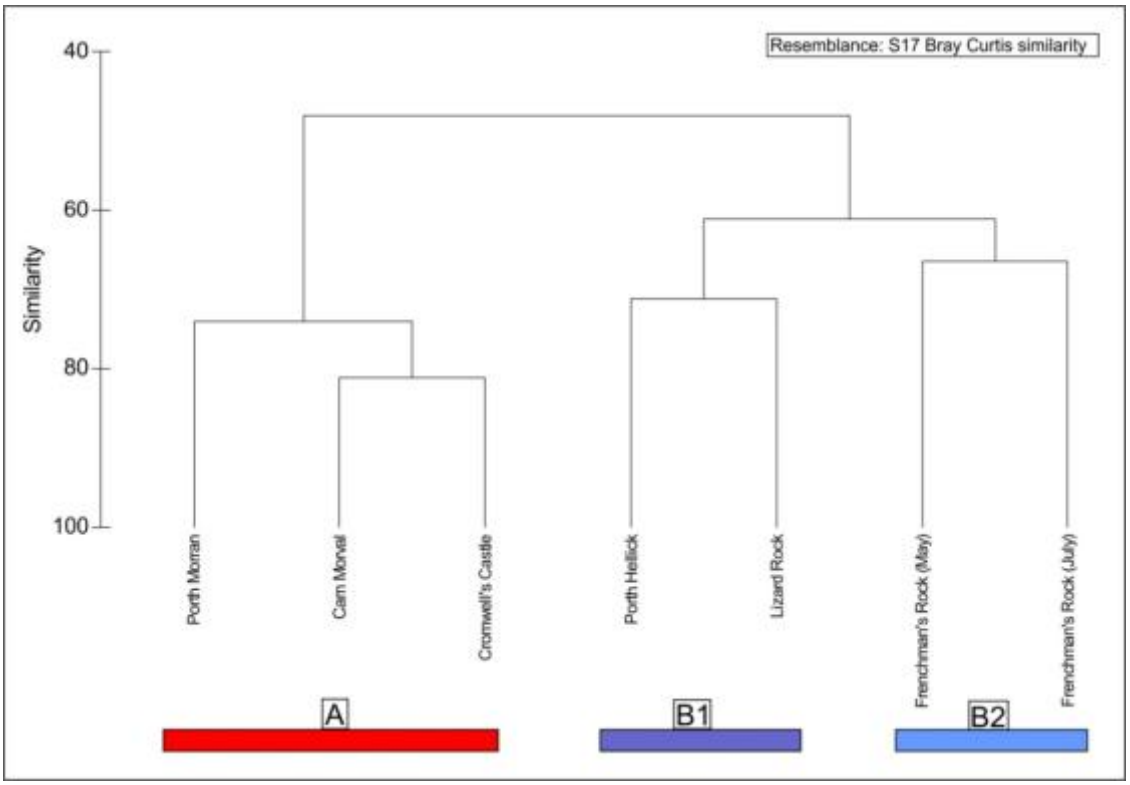


Figure 3.41. Cluster analysis of the 2013 red algae species data (based on % frequency).

Table 3.31. SIMPER analysis results of the 2013 red algae cluster groups (based on % frequency data).

Cluster	SIMPER analysis	
	Species	**Contribution (%)**
A	*Heterosiphonia plumosa*	35.9
	Delesseria sanguinea	20.4
	Kallymenia reniformis	17.5
	Sphaerococcus coronopifolius	11.3
	Dilsea carnosa	8.5
	Membranoptera alata	2.0
	Pterosiphonia parasitica	2.0
	Phycodrys rubens	2.0
B	*Phycodrys rubens*	36.1
	Kallymenia reniformis	33.6
	Delesseria sanguinea	15.9
	Pterosiphonia parasitica	6.9
	Heterosiphonia plumosa	4.0
	Membranoptera alata	3.2
	Sphaerococcus coronopifolius	0.4
B1	*Phycodrys rubens*	48.3
	Kallymenia reniformis	34.5
	Delesseria sanguinea	13.8
	Pterosiphonia parasitica	3.5
B2	*Kallymenia reniformis*	38.5
	Phycodrys rubens	25.0
	Heterosiphonia plumosa	13.5
	Pterosiphonia parasitica	11.5
	Delesseria sanguinea	9.6
	Membranoptera alata	1.9

3.6 Comparisons of vertical rock communities in 2013

A summary of all the vertical rock data from all the 2013 survey locations has been given in Tables 3.32 and 3.33. The most abundant species overall was the jewel anemone (*Corynactis viridis*), which was recorded at all locations and in 177 of the 180 analysed quadrats across the survey (see Appendix 04 for more detail). The mean cover varied across the sites from 23 % to 60 %. In terms of SACFOR abundance *C. viridis* would be recorded as Common at JS Wall and Men-a-vaur and Abundant at the other four sites.

To illustrate this further frequency distribution graphs for *C. viridis* have been plotted for each survey location (Figure 3.42). The relatively high frequency of low percentage covers at JS Wall becomes apparent but it also illustrates the high frequencies of high percentage cover at East Withan and John Thomas Ledge. Of note (pers. comm.) is that the jewel anemones observed on the vertical rocks at JS Wall and Newfoundland Point had contracted tentacles whilst the individuals at the other sites on the whole did not. This may have affected the diver assessments and therefore the results, particularly regarding the mean percentage cover values.

Table 3.32. Vertical rock transect data, with the values representing the number of quadrats along each vertical transect line with a species record, collected at six locations on the Isles of Scilly in 2013 (30 quadrats surveyed at each location resulting in an area of 1.875 m^2 surveyed along each line).

Species	JS Wall	Newfoundland Point	Menawethan	Men-a-vaur	John Thomas Ledge	East Withan	Total
Axinella dissimilis	-	-	-	-	-	-	-
Tethya citrina	-	-	-	-	-	-	-
Cliona celata	-	1	1	-	-	-	2
Hemimycale columella	16	15	5	6	1	2	45
Dysidea fragilis	-	3	-	4	-	-	7
Haliclona viscosa	14	6	3	2	1	3	29
Alcyonium digitatum	3	2	1	1	4	1	12
Alcyonium glomeratum	6	1	-	1	-	-	8
Corynactis viridis	30	30	30	27	30	30	177
Actinothoe sphyrodeta	-	-	-	9	1	1	11
Sagartia elegans	-	-	-	2	-	-	2
Leptopsammia pruvoti	1	-	-	-	1	-	2
Caryophyllia smithii	17	6	-	1	3	5	32
Hoplangia durotrix	-	-	-	-	-	-	-
Parazoanthus axinellae	-	-	-	-	-	-	-
Parazoanthus anguicomus	-	-	-	-	-	-	-
Echinus esculentus	1	-	-	-	-	-	1
Marthasterias glacialis	4	10	5	-	4	1	24
Holothuria forskali	2	-	-	-	2	-	4
Antedon bifida	-	-	1	-	-	-	1
Clavelina lepadiformis	4	1	-	-	2	-	7
Stolonica socialis	1	-	1	-	-	-	2
Total number of species recorded	12	10	8	9	10	7	17

Of the remaining fauna *Hemimycale columella, Caryophyllia smithii, Haliclona viscosa* and *Marthasterias glacialis* were relatively frequently recorded with 45, 32, 29 and 24 records respectively out of the 180 quadrats analysed.

Out of the 22 selected species (from Irving and Northen, 2012), a total of 17 were recorded within the quadrats surveyed in 2013. Five species were therefore not recorded at all in the analysed quadrats assessed in 2013. These were *Axinella dissimilis, Tethya citrina, Hoplangia durotrix, Parazoanthus axinellae* and *Parazoanthus anguicomus*.

Of note is that some species were clearly patchily distributed whilst other larger fauna, although observed on the vertical rock, were on occasion immediately outside the survey transect line. For example, *Axinella dissimilis* and *Tethya citrina* were observed (pers. comm.) during the dive operations but not recorded along the survey transect lines. However, *Hoplangia durotrix, Parazoanthus axinellae* and *Parazoanthus anguicomus* were not seen during the dive operations in May or July 2013 but may have been present elsewhere or simply not noticed.

Table 3.33. Vertical rock transect data, with the values representing the mean percentage cover (see site description tables above for all the standard deviation values) of the fauna recorded in the quadrats along each vertical transect line, collected at six locations on the Isles of Scilly in 2013 (30 quadrats surveyed at each location resulting in an area of 1.875 m^2 surveyed along each line).

Species	**JS Wall**	**Newfoundland Point**	**Menawethan**	**Men-a-vaur**	**John Thomas Ledge**	**East Withan**
Axinella dissimilis	-	-	-	-	-	-
Tethya citrina	-	-	-	-	-	-
Cliona celata	-	0.07	0.33	-	-	-
Hemimycale columella	3.53	2.67	1.00	0.67	0.33	0.50
Dysidea fragilis	-	0.27	-	0.43	-	-
Haliclona viscosa	1.30	0.77	0.50	2.33	0.17	1.00
Alcyonium digitatum	0.27	0.10	0.17	0.17	0.27	0.03
Alcyonium glomeratum	0.77	0.33	-	0.33	-	-
Corynactis viridis	23.33	44.00	52.17	36.83	54.67	60.00
Actinothoe sphyrodeta	-	-	-	1.73	-	0.17
Sagartia elegans	-	-	-	0.87	-	-
Leptopsammia pruvoti	-	-	-	-	0.17	-
Caryophyllia smithii	1.20	0.30	-	-	0.10	0.83
Hoplangia durotrix	-	-	-	-	-	-
Parazoanthus axinellae	-	-	-	-	-	-
Parazoanthus anguicomus	-	-	-	-	-	-
Echinus esculentus	0.33	-	-	-	-	-
Marthasterias glacialis	1.00	1.60	1.00	-	1.00	0.17
Holothuria forskali	1.00	-	-	-	1.00	-
Antedon bifida	-	-	0.07	-	-	-
Clavelina lepadiformis	0.63	0.17	0.00	-	0.43	-
Stolonica socialis	0.17	-	0.17	-	-	-
Total number of species recorded	12	10	8	9	10	7

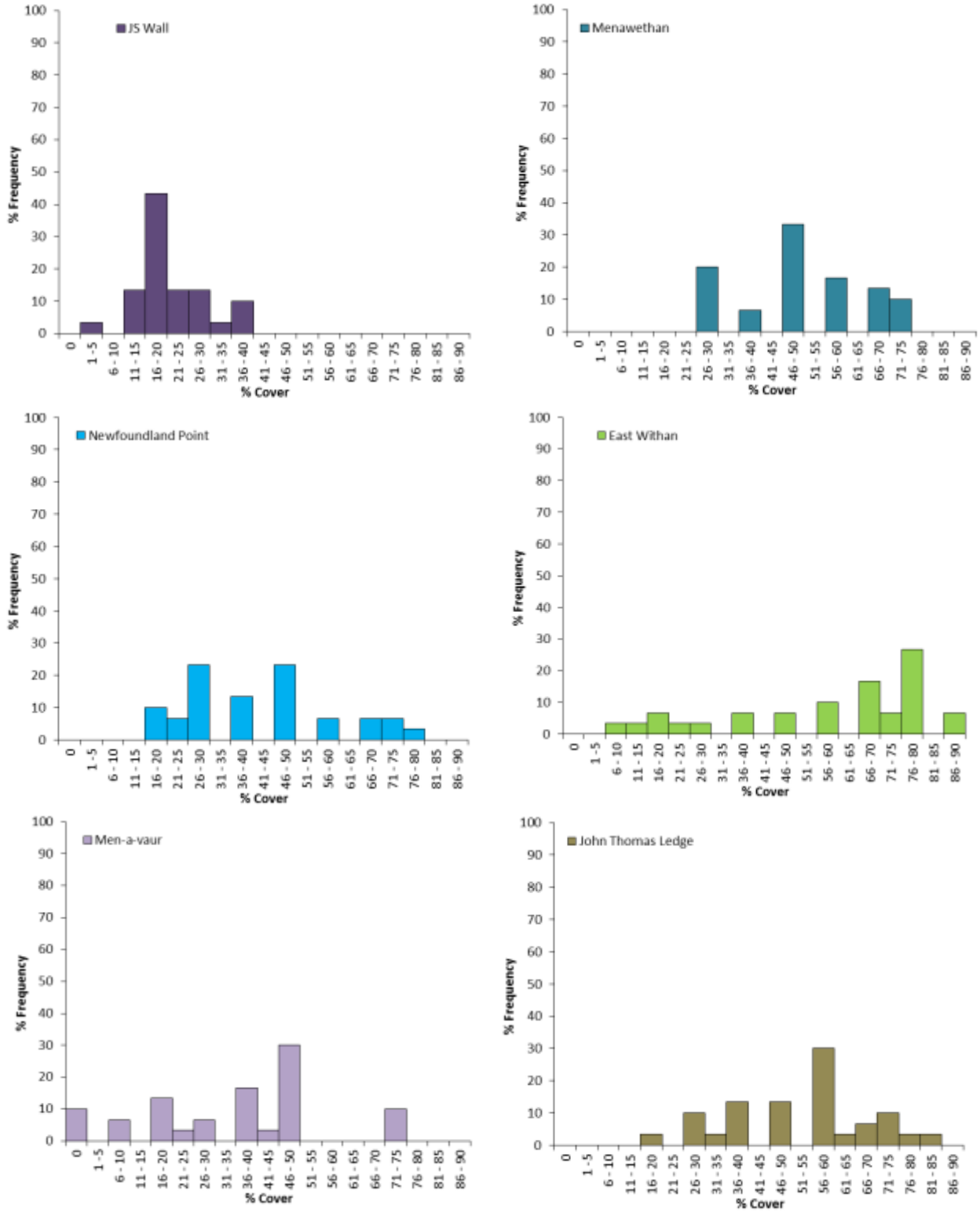


Figure 3.42. Illustrating the Corynactis viridis frequency distribution size groups across the six vertical rock survey areas.

In order to assess any similarities between the different survey locations a cluster analysis was completed (Figure 3.43). The results suggested some faunal similarities between JS Wall and Newfoundland Point as these have been clustered together. There is a further clustering of John Thomas Ledge, East Withan and Menawethan. Whilst there are similarities between Men-a-vaur and these three latter sites, Men-a-vaur is clustered separately. Of note is the overall high levels of similarity between the stations, suggesting that the communities at the six different sites are similar overall and therefore that the selected species list is representative of the vertical rock habitat.

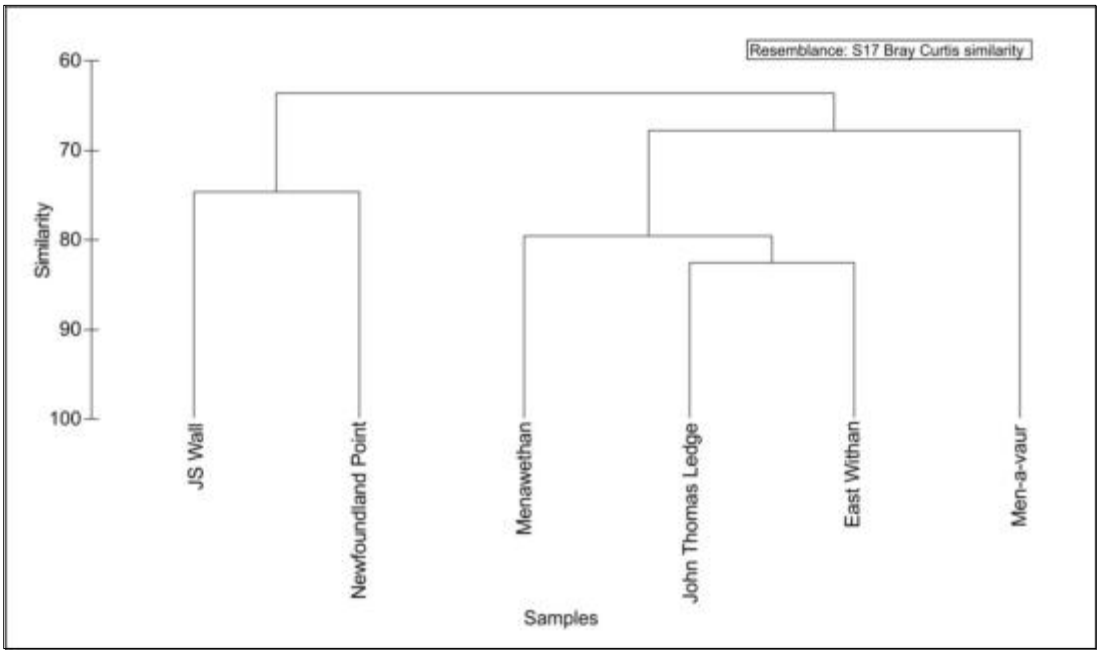


Figure 3.43. Cluster analysis of the 2013 vertical rock species data (based on % frequency).

To assess these groups further a SIMPER analysis was carried out (Table 3.34). As expected from the high similarities between the groups in the cluster analysis, the fauna present in the different clusters were similar and only subtle differences in the relative contribution of the different taxa to the clusters appeared to decide the sites in each group.

The main differences between the two communities were the relative contribution of *Corynactis viridis* between the two clusters and the relative high importance of *Hemimycale columella* to the community structure at JS Wall and Newfoundland Point compared to the other sites. *Haliclona viscosa* was also more important at JS Wall and Newfoundland Point compared to the sites in the other cluster. However, the subtle differences in species composition do not justify classifying these as different biotopes and based on the 2013 data all the vertical rock sites have therefore been designated as the biotope CR.HCR.XFa.SpAnVt (sponges and anemones on vertical circalittoral bedrock).

All the vertical rock locations have similar environmental conditions. For example, the walls are within similar depth ranges (15 m and 25 m), in areas of tidal current flow, in moderate to high levels of energy exposure and all the walls are vertical. There is therefore little apparent environmental difference between the survey locations. However, there are differences in exposure depending on the aspect of the survey locations and the direction in which the vertical walls are facing (Table 3.35 and Figure 3.1). With this in mind, there is a potential link between the cluster results and the direction as well as the level of exposure of the sites.

JS Wall and Newfoundland Point are situated along the east coastal fringe of St. Mary's. Both sites are exposed to the east/south-east and both walls have a south-easterly aspect. The faunal communities are therefore likely to be very similar.

Table 3.34. SIMPER analysis results of the 2013 cluster groups (based on % frequency data; Men-a-vaur not included as this site was considered an outlier).

Clusters and dive site locations	SIMPER analysis	
	Species	**Contribution (%)**
JS Wall **Newfoundland Point**	*Corynactis viridis* *Hemimycale columella* *Haliclona viscosa* *Caryophyllia smithii* *Marthasterias gracilis* *Alcyonium digitatum*	46.2 23.1 9.2 9.2 6.2 3.1
East Withan **John Thomas Ledge** **Menawethan**	*Corynactis viridis* *Marthasterias gracilis* *Haliclona viscosa* *Hemimycale columella* *Caryophyllia smithii*	80.4 5.3 4.5 3.6 2.7

Table 3.35. Aspect and exposure conditions at the vertical rock survey locations (energy: M – moderate, H – High; Location exposure: the directions from which the site is exposed; Wall aspect: the direction in which the wall is facing).

Station name	Location on Isles of Scilly	Location exposure	Wall aspect	Wave exposure	Tidal streams
JS Wall	E/SE	NE/E/SE	SE	M	M-H
Newfoundland Point	SE	S/SE/E	SE	M-H	M-H
Menawethan	E	S/SE/E	S	M-H	M-H
Men-a-vaur	NW	N/SW/W	SW	H	M-H
John Thomas Ledge	NE	N/E	NE	M-H	H
East Withan	NE	N/NE/E	N/NE	M	M-H

The environmental conditions at East Withan (White Island), John Thomas Ledge (St. Martins) and Menawethan (Menawethan island) are slightly different but the largest combining factor may be the relative positions of these sites on the Isles of Scilly. All of the sites are situated in the north-east of the Isles of Scilly and whilst Menawethan is located along the eastern coastline of the islands, all three sites are essentially protected from the prevailing south-westerly winds. The slight differences in the communities may be related to differences in tidal current strength, fetch and exposure. John Thomas Ledge offers protection from the prevailing south-westerly winds. However, this ledge is approximately 1 nm from St. Martin's Bay and the tidal currents along the John Thomas Ledge were particularly strong (pers. comm.). East Withan is entirely protected from the prevailing winds and the tidal streams are moderate to high. Menawethan is largely protected for the south-westerly winds but there is a fetch of c. 2 nm partly exposing this site to the prevailing winds.

Men-a-vaur is situated in the north-western corner of the Isles of Scilly. Men-a-vaur is a highly exposed site open to the prevailing south-westerly winds and waves. The vertical rock assessed is also facing the south-west. The algal cover was high at Men-a-vaur, to such an extent that there was high cover of red algal on the boulders found at a depth of 19 m (the bottom of the transect and wall). The abundance of *Actinothoe sphyrodeta* (found at exposed sites; Picton and Morrow, 2014) was furthermore relatively high at Men-a-vaur and *Sagartia elegans* was also recorded, a taxon not recorded at the other sites.
Whether these differences in aspect and exposure are significant remains uncertain, however, these factors may explain some of, what are essentially minor, differences in the fauna recorded at the various survey locations.

3.7 Survey limitations

3.7.1 Weather conditions

The weather during the survey period in May 2013 was poor with strong winds and wave heights of over 1 m on several occasions. On 14 May 2013 the morning dive was completed successfully but the afternoon dive was abandoned due to poor weather.

3.7.2 Tidal currents

The vertical rock sites were all exposed to moderate-high tidal current streams. Of particular note were JS Wall and John Thomas Ledge where the tidal streams were particularly strong during the flood. Survey work was therefore limited to the slack water period at these two sites. The slack water period at John Thomas Ledge was furthermore relatively short resulting in a need for efficient use of time whilst diving at this location and limiting the amount of time between dive pairs. In fact, time was limited to such an extent that to allow sufficient dive time at this site the second and third dive pairs entered the water immediately after receiving the signal from the first pair that the vertical ground line had been established.

3.7.3 Quality of photographs

It is important to obtain some permanent records of the survey transect lines and quadrats in the form of video or still photographic data. To acquire such data requires skills in underwater photography and video operations with familiarity with the equipment, the use of lights and strobes and the ability to control buoyancy whilst under water. The quality of the underwater photographs acquired in 2013 was unfortunately of moderate quality and using these for retrospective re-analysis or quality control proved problematic.

3.7.4 Diving time

The faunal turfs and vertical rock habitats are found at great depths in the Isles of Scilly. Whilst vertical rock habitats are found at depths ranging from 16 m to 25 m the faunal turfs are typically found at depths in excess of 28 m (Tim Allsop, pers. comm.). Diving at depths below 25 m limits the time available for survey work. Considering the amount of work required to assess a sub-feature such as faunal turf communities it is unrealistic to include these in a dive survey of this nature. This sub-feature was therefore not included in the 2013 baseline survey.

3.7.5 Dive vessel hire

At the beginning of the May survey week the dive vessel was on ‘day charter’. ‘Day charter’ meant that the vessel was hired for two dives per day but it essentially meant that the vessel could be available for other divers for parts of the day and therefore not on hire for the entire day. This limited the use of the vessel for the first two days. To ensure efficient use of time, divers and the dive vessel / skipper, the dive vessel was hired for entire days after day two.

3.7.6 Red algae identification

The *in-situ* identification of red algae was a challenging task. It is not possible to ascertain whether all the taxa selected as characterising species were recorded along the different survey lines. However, considering the difficulties in identifying specifically *Pterosiphonia parasitica* (largely due to small size), these records in particular may be underestimates.

4 DISCUSSION

4.1 Previous studies

Monitoring studies took place each year around the Isles of Scilly between 1984 and 1991, using photographic records to look at certain species of conservation interest. These species included the sunset cup coral *Leptopsammia pruvoti*, the yellow cluster anemone *Parazoanthus axinellae*, red sea fingers *Alcyonium glomeratum* and some branching sponges (Hiscock, 1985; Irving, 1987). These studies were reviewed by Fowler and Pilley (1992). A vertical circalittoral rock site at Gap Point, on the east side of St Mary's, was previously monitored using photography in the 1980s (Fowler and Pilley, 1992) and Hiscock (2011) studied this site again with a dive survey to monitor the sunset cup corals. Irving and Northen (2012) also surveyed this wall taking permanent photographic records of the vertical rock as part of the 2011 baseline study. The Isles of Scilly Biodiversity Audit (Lewis *et al.*, 2008; Gall, 2011) contains descriptions of the marine species and habitats in the archipelago.

Acoustic data and ground-truthing samples were collected by Munro and Nunny (1998) in order to map the seabed habitats around the Isles of Scilly. In 2011 Natural England undertook further surveys using acoustic methods and ground truthing to assess the extent and condition of the reefs in the SAC (Eggleton and Meadows, 2012).

A number of other surveys have been conducted around the Isles. These have mostly focused on the description of seabed habitats and the presence and abundance of associated species (e.g. Dipper, 1981; Hiscock, 1983). Seasearch dives have been carried out by volunteers all around the SAC since 2004 (Seasearch, 2004 - 2008, 2010), recording all the species found at many different sites around the Isles. Some have focused on a specific habitat or species, such as pink sea fans *Eunicella verrucosa*. In 2007 bryozoans were looked at in particular detail (Seasearch, 2007). The results from these dives were entered into the JNCC Marine Recorder database, enabling the construction of sub-feature distribution maps.

As mentioned in the introduction, a Condition Assessment Survey of the reef feature in the Isles of Scilly SAC (Figure 4.1) was carried out by Natural England in 2011 (Irving and Northen, 2012), but adverse weather conditions meant that not enough vertical rock sites were surveyed to make the results statistically robust (Highfield *et al.*, 2013). However, the kelp sites were surveyed more rigorously and the 2011 vertical rock survey is still a useful partial baseline for future surveys and some comparisons between the 2011 and the 2013 kelp forest community and vertical rock data have been made below.

Out of all these studies the most appropriate study to be used for any comparisons is the study completed in 2011 (Irving and Northen, 2012), a study set out to collect baseline data for the SAC sub-features. The data collected from the current study used different survey methodologies (Axelsson *et al*., 2013) but did adopt the selected species lists selected in 2011 to allow direct comparisons as far as possible.

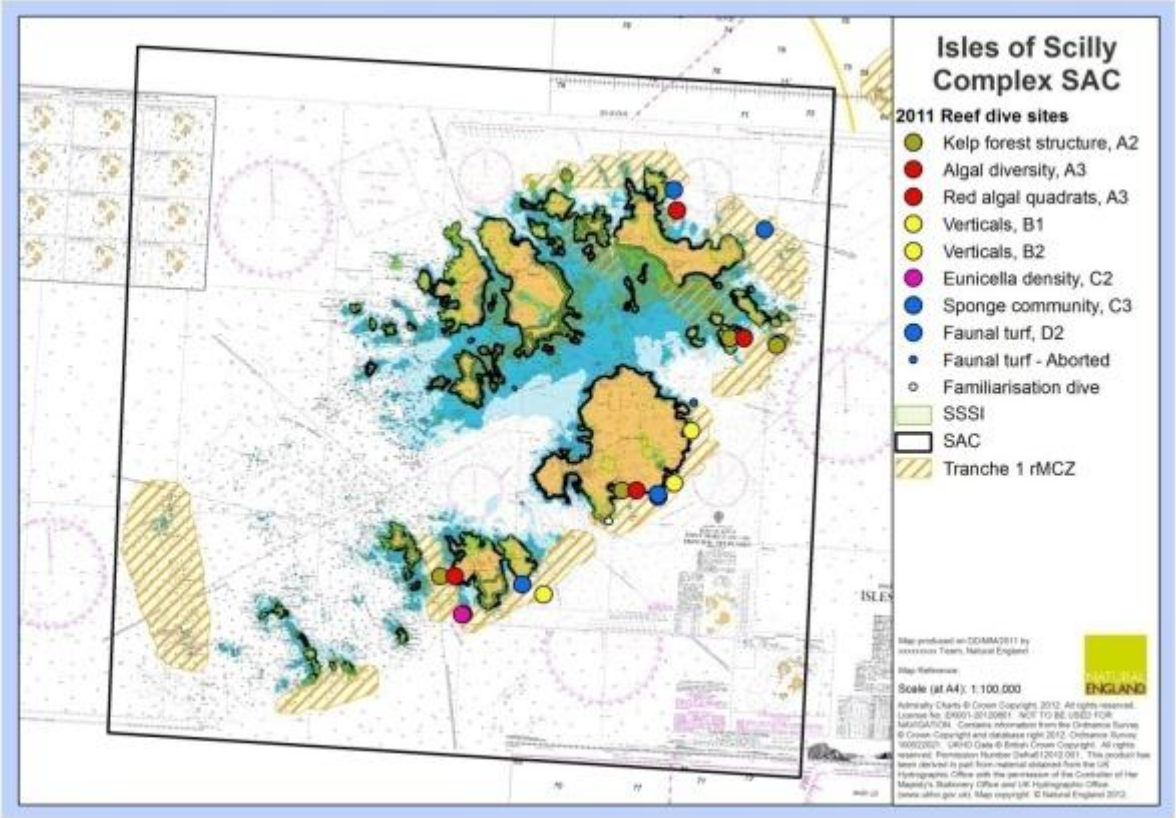


Figure 4.1. Reef survey sites in 2011 (from Irving and Northen, 2012).

4.2 Kelp forest communities

Irving and Northen (2012) summarised the kelp forest community survey results in a number of tables and figures, some of which have been included below (Table 4.1 and Figure 4.2). The 2011 results showed *Laminaria ochroleuca* to be the dominant kelp species at Menglow whilst *Laminaria hyperborea* was the dominant kelp species at Brodfield, Menawethan and Little Arthur (Frenchman's Rock).

Whilst the 2013 survey locations were spread across the Isles of Scilly the only location with directly comparable data between 2011 and 2013 is Frenchman's Rock (Little Arthur). Both sets of data support the notation that *L. hyperborea* is the dominant kelp species. The plant densities are similar (2011: 5.1 plants/m^2 compared to 2013: 5.6 plants/m^2 in May and 11.2 plants/m^2 in July) although the density recorded in July 2013 was higher. This could be explained by the fact that the survey locations were in slightly different locations but also as the depth ranges were different (the depth range at Frenchman's Rock in 2011 was 6.7-9.7 m, in May 2013 it was 6.8-9.8 m and in July the depth range was 3.8-7.5 m).

The data collected in 2013 were statistically tested to assess any significance in the median abundance of *L. hyperborea* and *L. ochroleuca*. At Frenchman's Rock there was a significant difference ($p<0.002$) found in median abundance between the two kelp species both in May and July in 2013. Whether there was a statistically significant difference between the two species in 2011 at this location remains unknown as it was not assessed but the data (Table 4.1) suggest there might be as there was a considerable difference between the densities of the two species. Of note is that, although *L. hyperborea* was the characteristic kelp species in both 2011 and 2013, the ratio was lower in 2011 (5.5:1) compared to the 2013 results (8.75:1 and 8.62:1). Whether this result is statistically significant or not remains unknown as

it was not possible to complete any tests due to the lack of raw data from 2011 in the 2012 report.

Table 4.1. Mean kelp plant densities at the four monitoring sites surveyed in 2011 and 2013 (2011 data from Irving and Northen (2012); depth range: from dive gauge readings; significant results: from Wilcoxan's matched pair test data).

Site	Dominant kelp	Significant result	Depth range (m)	*Laminaria hyperborea*	*Laminaria ochroleuca*	Lhyp:Loch ratio
Frenchman's Rock (May)	Lhyp	Yes	6.8-9.7	5.6	0.6	8.75:1
Porth Hellick	Lhyp	No	8.4-11.1	6.4	3.8	1.70:1
Lizard Rock	Loch	No	7.1-9.8	3.5	5.1	0.69:1
Carn Morval	Loch	Yes	6.0-10.2	0.9	5.1	0.18:1
Cromwell's Castle	Loch	Yes	8.0-11.0	1.0	6.9	0.15:1
Porth Morran	Loch	Yes	7.3-9.2	1.7	5.0	0.34:1
Frenchman's Rock (July)	Lhyp	Yes	3.8-7.5	11.2	1.3	8.62:1
Menawethan, 2011	Lhyp	-	3.2-10.8	12.1	0.2	58.50:1
Frenchman's Rock, 2011	Lhyp	-	6.7-9.7	5.1	0.9	5.46:1
Brodfield, 2011	Lhyp	-	9.0-11.0	4.1	1.9	2.17:1
Menglow, 2011	Loch	-	9.1-13.0	1.2	3.1	0.38:1

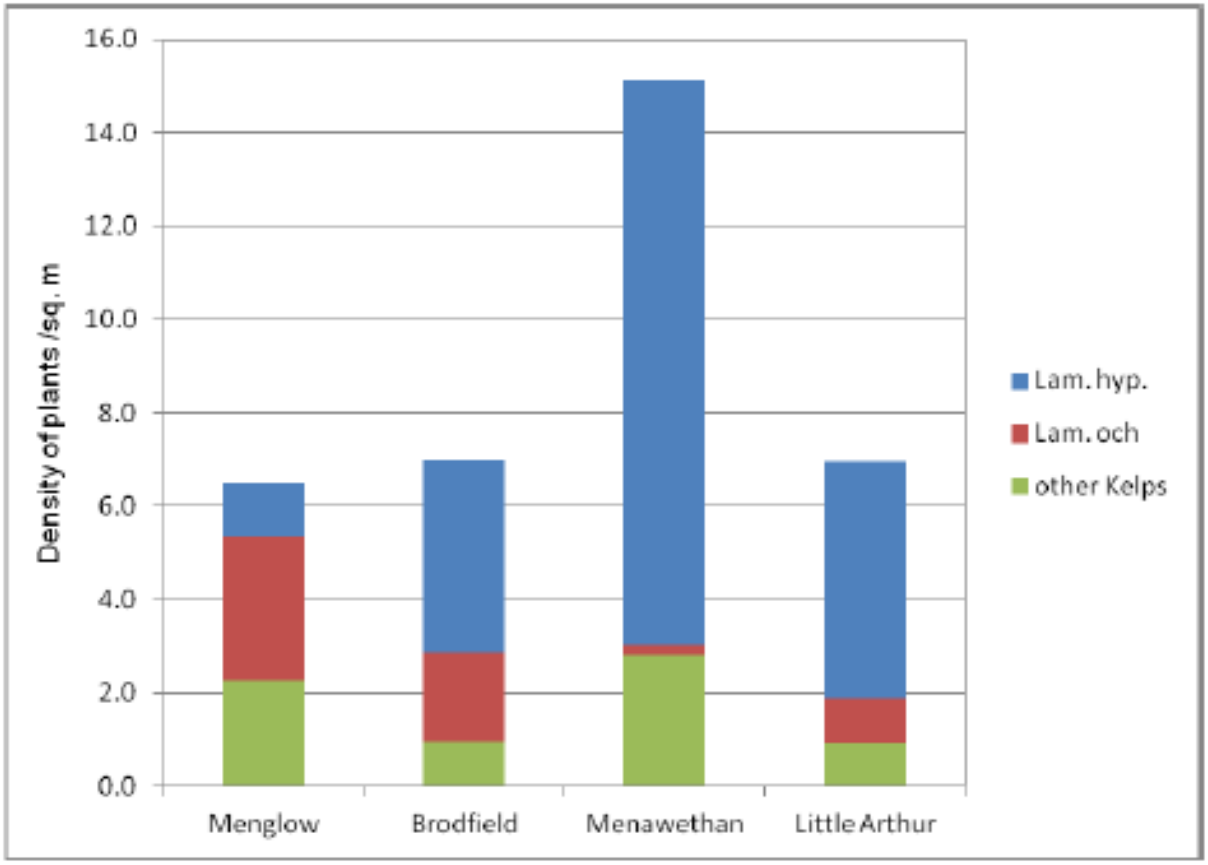


Figure 4.2. Mean kelp plant densities at the four monitoring sites surveyed in 2011 (from Irving and Northen, 2012).

As noted by Irving and Northen (2012), *L. hyperborea* is a northern species whilst *L. ochroleuca* is a southern species with a northern extent limit at Lundy. Both species are found on the Isles of Scilly but whether there is a difference in the distribution and extent across the islands remains uncertain. Other than Frenchman's Rock further direct kelp density or ratio comparisons between the 2011 and 2013 data were not possible as the locations in 2011 were different to those in 2013. However, the data in Table 4.1 and Figure 4.3, suggest a biogeographic boundary between *L. hyperborea* and *L. ochroleuca* where the former is the dominant species along the eastern extent of the Isles of Scilly whilst the latter is dominant in the north, west and south of the islands. Considering the relative densities and ratios at the different kelp forest community locations across the islands (Figure 4.3) a biogeographic boundary may potentially be linked to the relative exposure to the south-westerly prevailing winds. This can not only be exemplified by the overall pattern but also at St. Agnes where the ratio of *L. hyperborea* to *L. ochroleuca* is higher on the eastern margin of St. Agnes compared to the western margin.

Additional data will be required to assess this further but explanations for this potential biogeographic boundary could include geological factors (type of rock), scouring effects, depth range, wave action, temperature differences, current flow, light levels, ecological factors (e.g. epiphytes, grazing) and aspect/exposure.

The Isles of Scilly are low, flat-topped islands formed of granite (Barne *et al.*, 1996; IoS Museum, 2014) with eroded granite forming the white sand present on the beaches and subtidal sandy sediment (Barne *et al.*, 1996). Considering the change in depth, the complex physiography of the islands and the difference in tidal currents across the islands, the effects of sediment suspension, smothering and scouring is likely to vary depending on location within the islands. However, although smothering is a threat to kelp and scouring effects the levels of epiphytes on *L. hyperborea*, it has been speculated that increased light attenuation and turbidity as part of increased siltation may be more important in limiting kelp density and distribution (John 1969; Tyler-Walters, 2007). It has also been noted that *Laminaria hyperborea* is unable to survive where wave action is extreme because of its large frond area attached to a stiff stipe which is liable to snap (Tyler-Walters, 2007). Whether wave action affects *L. ochroleuca* in the same manner is unknown but if not, it is a possible explanation for the difference in kelp species distribution seen.

In attempting to explain the different kelp ratios and respective densities Irving and Northen (2012) considered several factors including temperature, ecological factors and light but depth range appeared to be one of the most an important factors. It has for example been speculated that *L. ochroleuca* becomes more dominant with depth (Dipper, 1981) but considering the depth range and the overlapping ranges where both kelp species are present, as noted during both the surveys in 2011 and 2013, there is still no clear indication of what has the biggest influence on the distribution of the two kelp species across the Isles of Scilly. Additional data, particularly on the distribution of kelp species at different locations and depths across the islands, but also current flow and water temperature data, will be required to assess the potential boundary in the distribution of kelp across the Isles of Scilly further. There also needs to be additional research effort focusing on the ecology of *L. ochroleuca* and *L. hyperborea* to assess the factors limiting the distributions, densities and geographic extents.

In terms of the biotope designations Irving and Northen (2012) identified two biotopes among the kelp communities (IR.HIR.KFaR.LhypR.Loch and IR.LIR.K.LhypLoch). In the current study, however, it was not possible to clearly distinguish the sites into separate biotopes largely as a result of the lack of distinct community structure. This can in part be attributed to the fact that only a sub-set of species were recorded in the survey and other biotope diagnostic species may not have been recorded. Based on the available data, the sheltered nature (sheltered to moderate exposure) of the survey locations, the presence of all four kelp

species at many locations, the red algae composition (similar across sites) and the depth ranges (4-11 m) at the stations resulted in tentatively designating all sites surveyed in 2013 as IR.LIR.K.LhypLoch.

In terms of exposure the Carn Morval site is exposed to the south-westerly winds and waves. However, the shallow water to the southwest of the site is believed to reduce the level of wave exposure, possibly resulting in a level of exposure more akin to LIR or MIR rather than HIR. In fact, for the Isles of Scilly there may be a need for a new biotope at level 3, and introducing a biotope within the IR.MIR main habitat level. However, this is beyond the scope of the current study.

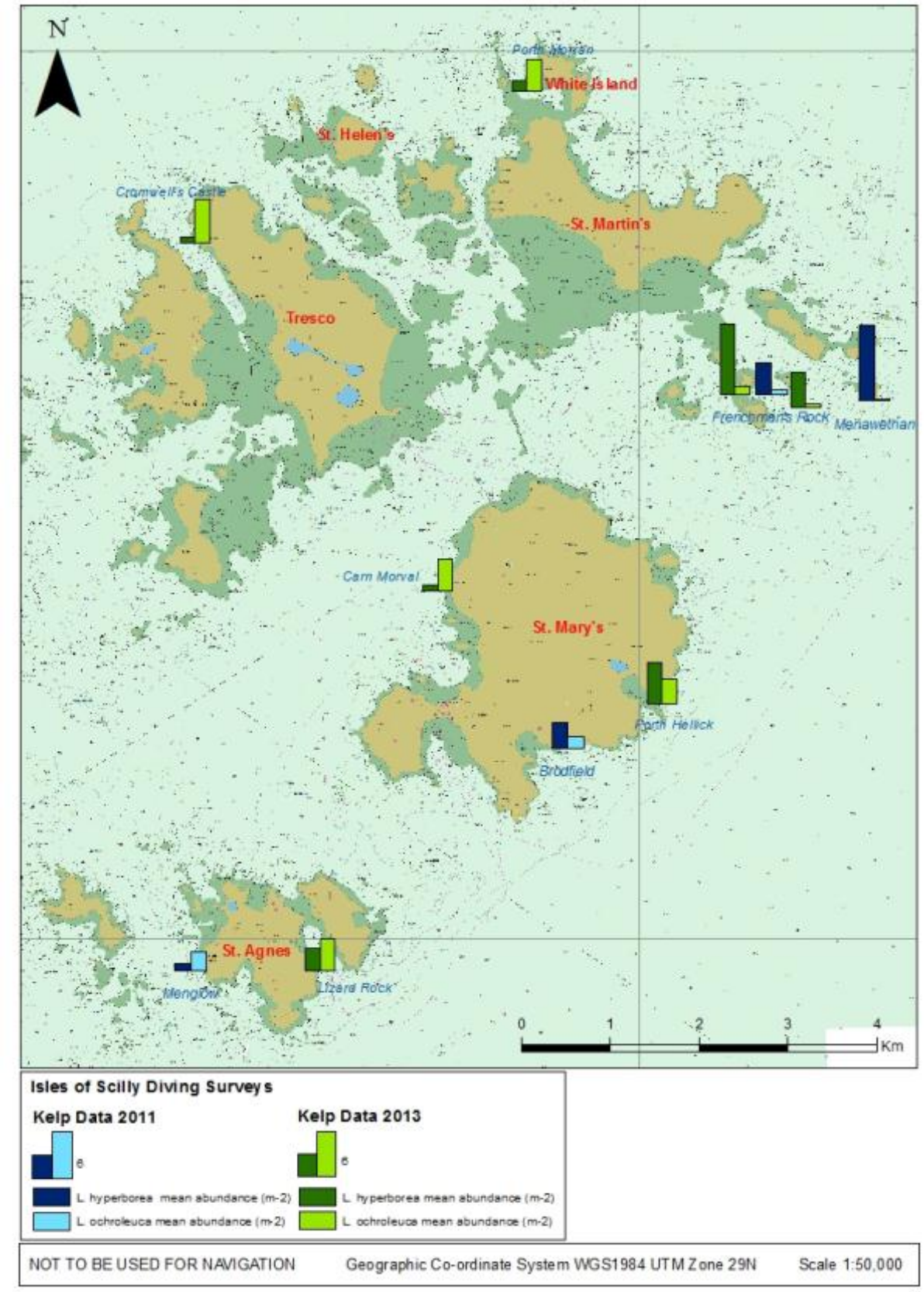


Figure 4.3. Dominant kelp species at the different survey locations in 2011 and 2013.

4.3 Vertical rock

The vertical rock assessments in 2011 were completed at Gap Point, Gugh Reef and Newfoundland Point (see Irving and Northern, 2012). The only directly comparable data with the current study are therefore the 2011 data from Newfoundland Point, where two transects were analysed (2011:1 and 2011:2), but the other data can be used for overall assessments of the vertical rock habitats across the Isles of Scilly.

The Newfoundland Point data from 2011 and 2013 are summarised in Table 4.2. Of note is that the survey methodology was different between 2011 and 2013. Apart from the overall methodology, the size and the number of quadrats assessed were also different but some of the results are comparable. In particular, it is of note that the dominance of jewel anemones (*Corynactis viridis*) was apparent across the three surveys with 100 % presence in the analysed quadrats. *Caryophyllia smithii* and *Alcyonium digitatum* were also frequently recorded and found during all three surveys. Overall the fauna were similar across the three surveys but the total number of species recorded was higher in 2013 compared to the 2011 surveys. This may be a result of the difference in methodology used but it could also be attributed to other factors, including small-scale variability, patchiness, and different sample size.

The relative positions of the two 2011 survey transects are unknown but Newfoundland Point 2011:2 was a shorter wall than 2011:1. It furthermore appeared to be along the inside of a perpendicular wall near the pinnacle at this site (see site description above). This may explain the slight differences between these two sets of data. There may also be slight differences as a result of patchiness along the two positions of the 2011:1 and 2013 vertical transect lines. Re-locating the exact survey line in future years will therefore be crucial to allow a re-assessment of the same location.

In terms of the communities present a cluster analysis was completed and illustrated in Figure 4.4. The patterns seen in the results of the 2013 analysis remain, with high similarities between the different communities (70 % for all but the Men-a-vaur site). Of note is that the 2011 site NP 2011:2 has been clustered (cluster A) with the JS Wall and Newfoundland Point communities whilst NP 2011:1 was clustered (cluster B) with the north-eastern 2013 sites (East Withan, John Thomas Ledge and Menawethan).

Whilst the similarity between the 2013 north-eastern sites in cluster B was high (80 %), the link and similarity with NP 2011:1 was relatively low (c. 68 %). Overall the communities at all of the sites are similar and a small difference in faunal coverage or presence / absence can therefore have a large impact on the clustering result.

To assess these differences further the SIMPER analysis procedure in PRIMER was completed (on 100 % of taxa present) and given in Table 4.3. The main difference between the two clusters was the relative importance of *Corynactis viridis* but also the relative contribution of some particular taxa. In cluster A *C. viridis* and *Hemimycale columella* were the two most important taxa of the community with a combined contribution of 75 % whilst *C. viridis* was the most important species in cluster B, contributing 79 % to the community structure. Of additional note is that whilst *Alcyonium digitatum, Clavelina lepadiformis* and *Haliclona viscosa* contributed similarly to the community in the two clusters, the relative contributions of *H. columella* and *Caryophyllia smithii* were quite different.

Table 4.2. Vertical rock transect data (numbers represent the number of quadrats along each vertical transect line with a species record) collected at Newfoundland Point on the Isles of Scilly in 2011 (two surveys; from Irving and Northern, 2012) and 2013 (current survey); frequency (n): number of quadrats with fauna record; frequency (%): percentage of quadrats with faunal record).

Species	Newfoundland Point 2013 (from 30 (0.0625 m^2) samples)		Newfoundland Point 2011:1 (from 18 (0.05 m^2) samples)		Newfoundland Point 2011:2 (from 16 (0.05 m^2) samples)	
	Frequency (n)	Frequency (%)	Frequency (n)	Frequency (%)	Frequency (n)	Frequency (%)
Axinella dissimilis	-	-	-	-	2	12.5
Tethya citrina	-	-	-	-	-	-
Cliona celata	1	3.3	-	-	-	-
Hemimycale columella	15	50.0	-	-	8	50.0
Dysidea fragilis	3	10.0	-	-	5	31.3
Haliclona viscosa	6	20.0	-	-	-	-
Alcyonium digitatum	2	6.7	5	27.8	2	12.5
Alcyonium glomeratum	1	3.3	1	5.6	-	-
Corynactis viridis	30	100.0	18	100.0	16	100.0
Actinothoe sphyrodeta	-	-	-	-	-	-
Sagartia elegans	-	-	-	-	-	-
Leptopsammia pruvoti	-	-	-	-	-	-
Caryophyllia smithii	6	20.0	6	33.3	4	25.0
Hoplangia durotrix	-	-	-	-	-	-
Parazoanthus axinellae	-	-	-	-	-	-
Parazoanthus anguicomus	-	-	-	-	-	-
Echinus esculentus	-	-	2	11.1	1	6.3
Marthasterias glacialis	10	33.3	3	16.7		
Holothuria forskali	-	-	-	-	1	6.3
Antedon bifida	-	-	-	-	-	-
Clavelina lepadiformis	1	3.3	4	22.2	-	-
Stolonica socialis	-	-	-	-	-	-

Finally, four species (*Dysidea fragilis, Alcyonium glomeratum, Holothuria forskali* and *Echinus esculentus*) were recorded in cluster A but not in cluster B whilst *Actinothoe sphyrodeta* was recorded in cluster B but not in cluster A.

Prior to analysing the 2011 and 2013 data together the two 2011 sites would have been expected to be clustered with the 2013 JS Wall and Newfoundland Point data. The reasons for the clustering of NP 2011:1 with the 2013 north-eastern sites remains uncertain, particularly as NP 2011:1 was located in a similar position to the 2013 site with the same aspect and exposure. The clustering with the stations in cluster B was most likely a result of minor differences in the community, especially as the overall similarity between the two main clusters was high (65 %).

The final deduction therefore has to be that the vertical rock communities were similar across the different Isles of Scilly survey locations (CR.HCR.XFa.SpAnVt) but with subtle differences in the finer structure at the various sites. It suggests that the selection of characteristic species for this sub-feature was correct as the main taxa were present at all of the sites but it also suggests that any large changes in the community at different locations across the islands should be detectable.

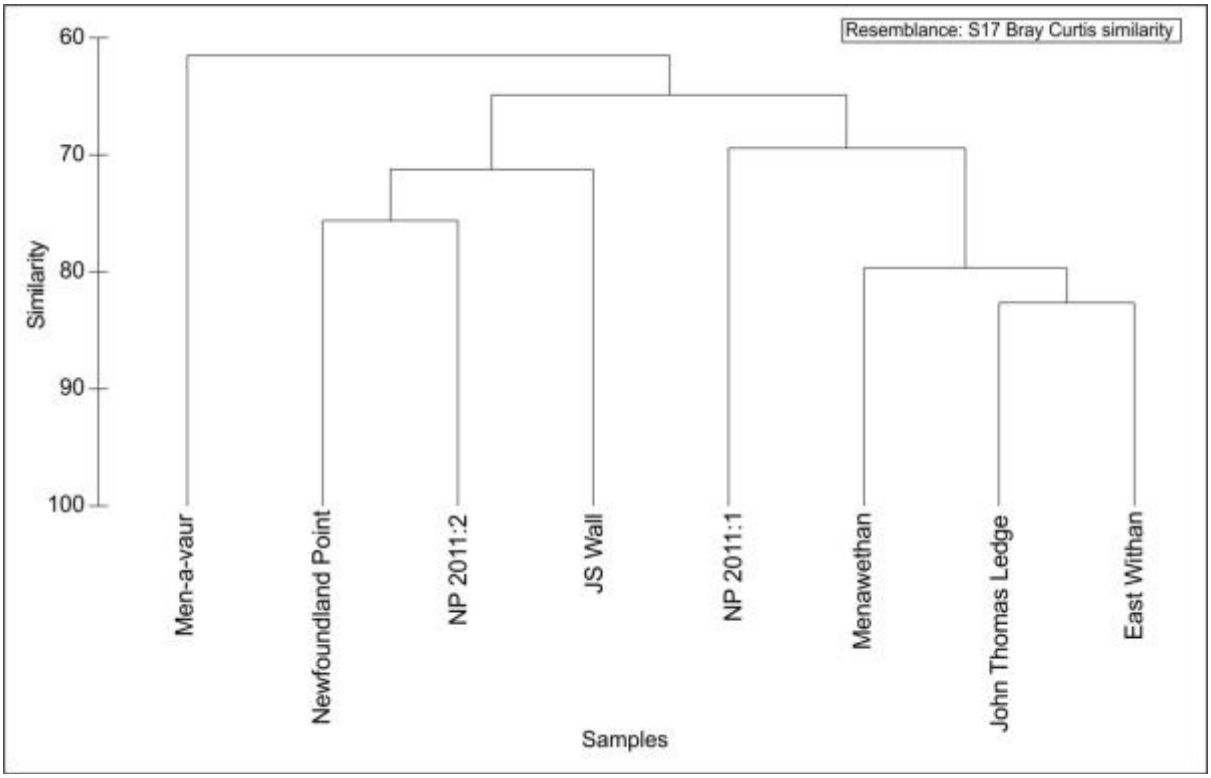


Figure 4.4. Cluster analysis of the 2011 and 2013 vertical rock species data (based on % frequency).

Table 4.3. SIMPER analysis of the 2011 and 2013 vertical rock data.

Clusters and dive site locations	**SIMPER analysis**	
	Species	**Contribution (%)**
CLUSTER A JS Wall Newfoundland Point NP 2011:2	*Corynactis viridis*	50.4
	Hemimycale columella	25.2
	Caryophyllia smithii	10.9
	Alcyonium digitatum	3.9
	Haliclona viscosa	3.2
	Marthasterias gracilis	2.1
	Dysidea fragilis	1.9
	Holothuria forskali	1.0
	Echinus esculentus	0.5
	Alcyonium glomeratum	0.5
	Clavelina lepadiformis	0.5
CLUSTER B East Withan John Thomas Ledge Menawethan NP 2011:1	*Corynactis viridis*	79.1
	Marthasterias gracilis	6.8
	Caryophyllia smithii	4.7
	Alcyonium digitatum	3.8
	Haliclona viscosa	2.4
	Hemimycale columella	1.9
	Clavelina lepadiformis	0.8
	Actinothoe sphyrodeta	0.5

4.4 Condition Assessment

The 2013 survey established the baseline (all raw data given in Appendix 04) for the two sub-features. Condition assessments using statistical hypothesis testing should therefore be possible in future monitoring surveys as long as the methodologies used in 2013 are followed.

The recording of the common fauna and flora established the baseline for these communities and any shift or change in the environment which changes the habitat significantly should be detectable in the community structure. This could be tested using the frequency occurrence of the species across the site as well as the mean coverage and any abundance measures. In a quadrat survey both measures will most likely be required to assess change. The use of the list of characterising species was validated as the selected fauna and flora were ubiquitous across the selected sites.

The results and achievements in relation to the condition assessment after the 2013 field surveys are given in Table 4.4. Some recommendations for future monitoring surveys have also been added. The main recommendations are 1) increased number of samples collected from all sub-features (>30 quadrats per site) to increase the robustness of the data (achievable by diving twice at each site using three buddy pairs and assessing >6 quadrats per pair per dive); 2) assess potential management indicator species in addition to the characterising species included in the current study; 3) zonation studies on the kelp forest communities to establish the potential influence of depth on kelp (*L. hyperborea* versus *L. ochroleuca*) and red algae community structure. The main reason for this is to eliminate potential errors by sampling a particular depth (i.e. are the communities at shallow or moderate depths different to those at the limit of the kelp extents). This was outside the 2013 remit but it should arguably be part of the baseline for the habitat as it would make the measure of densities more accurate (the density measure being one of the attribute measures for kelp forest communities) and allow comparisons against this measure during the monitoring stage.

Essentially the 2013 survey has become the new baseline hence the lack of any monitoring results given in Table 4.4. However, there were two sets of comparable monitoring results acquired in 2013, one at Frenchman's Rock (kelp forest community) and one at Newfoundland Point (vertical rock).

The data collected in 2013 were statistically tested and at Frenchman's Rock there was a significant difference ($p<0.002$) found in median abundance of *L. hyperborea* and *L. ochroleuca* both in May and July in 2013. Whether there was a statistically significant difference between the two species in 2011 at this location remains unknown as it was not assessed but the data (Table 4.1) suggested that there might be as there was a considerable difference between the densities of the two species. In addition, although *L. hyperborea* was the characteristic kelp species in both 2011 and 2013, the ratio was lower in 2011 (5.5:1) compared to the 2013 results (8.75:1 and 8.62:1). Whether this result is statistically significant or not remains unknown as it was not possible to complete any tests due to the lack of raw data from 2011 in the 2012 report.

There was furthermore a community test between the 2011 and 2013 data at Newfoundland Point. The results showed similarities between the communities seen in both surveys with similar characterising species and similar occurrence frequencies. Again statistical tests were not possible as the raw data collected in 2011 were not available in the 2012 report.

Table 4.4. Favourable condition assessment table for the post-moderated feature of 'Reefs', with recommended measures and attributes post-2013 survey (from Table 9.3.2, Isles of Scilly SAC Management Scheme, 2010).

Main / Sub-features	Attribute	Measure	Target	Monitoring Programme Identified / or ongoing	2013 survey results / achievements	Recommendations (2013)
Kelp forest communities (sub-feature)	Characteristic species - *Laminaria hyperborea* & *L. ochroleuca* population size within kelp forest community	Densities and relative proportions of kelp species (particularly *L. hyperborea* and *L. ochroleuca*), measured during summer, twice during reporting cycle.	Maintain the kelp community structure of the site, allowing for natural succession or known cyclical change.	Survey work to identify areas of kelp forest, particularly displaying a range of wave exposure and tidal streams.	- Condition Assessment not assessed due to lack of historic data. -Six monitoring survey areas have been established with geographic spread across the Isles of Scilly (six kelp forest community sites). - The densities and relative proportions of the kelp species have been established (incl. *L. hyperborea* and *L ochroleuca*).	- Future surveys to set aim of collecting >30 samples along each survey transect. - Establish the vertical extent of the community to assess zonation and kelp species composition with depth.
	Species composition of characteristic biotopes	Monitoring the diversity of red algal species (sp. list in FCT), Measured during summer, once during reporting cycle.	Presence and abundance of composite species should not deviate significantly from an established baseline, subject to natural change.	Survey work to identify areas of kelp forest, red algal species, and their species composition.	- Condition Assessment not assessed due to lack of historic data. - Six monitoring survey areas have been established with geographic spread across the Isles of Scilly. - The composite characterising red algal species present have been established. - The abundance expressed as occurrence frequency values has been established.	- Future surveys to set aim of collecting >30 samples along each survey transect. - Establish the vertical extent of the community to assess zonation and red algal species composition with depth. - Identify management (true) indicator species, which need to be easily identifiable, to be added to the current list of characterising species.

Main / Sub-features	Attribute	Measure	Target	Monitoring Programme Identified / or ongoing	2013 survey results / achievements	Recommendations (2013)
Vertical Rock (sub-feature)	Species composition of characteristic biotopes	Presence and abundance of composite species. Measured during summer, twice during reporting cycle.	Presence and abundance of composite species should not deviate significantly from the established baseline, subject to natural change.	Search for examples of, and survey, species compositions on vertical rock surface. The Isles of Scilly Marine Countdown project will go some way to highlighting example sites, and collection of information on notable species – some of which overlap as BAP species.	- Condition Assessment not assessed due to lack of historic data. - Six monitoring survey areas have been established with geographic spread across the Isles of Scilly (vertical rock). - The composite characterising vertical rock community species present have been established. - The abundance of the composite characterising species has been established.	- Future surveys to set aim of collecting >30 samples along each survey transect. - Identify management (true) indicator species, which need to be easily identifiable, to be added to the current list of characterising species.

4.5 Future survey recommendations

4.5.1 Weather conditions

The weather in May 2013 was poor on several occasions. Difficult weather conditions not only hamper the survey work but also have the potential of making diving unsafe. During the baseline survey there were flexibility and redundancy in the dive sites available for survey as the sites were selected as part of the baseline collection process. However, during future monitoring surveys the choice will be limited to those already surveyed. Planning the survey work with some potential flexibility in the survey timing is therefore recommended. Accommodation and vessel access are associated problems. It is therefore recommended that future surveys consider the potential of live-aboard vessels or other survey vessels as diving platforms with the potential for a more flexible approach. Alternatively accommodation might be more easily available during periods outside the school summer holidays.

4.5.2 Tidal currents

Some of the survey locations were located in areas of relatively strong currents limiting the time of survey to periods around slack water. Overall this was not a significant problem but at, for example, JS Wall and John Thomas Ledge the tide and the time of slack water have to be considered.

4.5.3 Wave exposure

All the vertical rock sites are found in fairly exposed locations but whilst some are found in areas protected from the prevailing south-westerly winds (e.g. JS Wall, East Withan) others are not. Men-a-vaur is particularly exposed to the south-west and this site needs careful consideration during the planning stage of future monitoring surveys.

4.5.4 Photographic skills

The assessments of the sub-features require some *in-situ* identification skills. However, it is also important to obtain some permanent records of the quadrats in the form of video or still photographic data. To acquire such data requires skills in underwater photography and video operations with familiarity with the equipment, the use of lights and strobes and the ability to control buoyancy whilst under water. During the planning stage of future surveys it is of utmost importance that the divers are selected based on these skills or are trained sufficiently prior to commencement of the project.

4.5.5 Video recording versus still photography

The collection of permanent records is an important part of the baseline and future monitoring surveys. Filming of the transect survey lines using video recording over still photography is therefore recommended as these records allow a good understanding of the habitat. It is furthermore recommended to use video recording of the quadrats assessed as part of the kelp forest community surveys over still photography as the video footage provided better data (for quality control and additional assessments) and permanent records. Video recording of the vertical rock quadrats should also be considered in case the still photographs are of poor quality.

4.5.6 Faunal turfs

The faunal turfs are typically found at depths in excess of 28 m (Tim Allsop, pers. comm.). Diving at depths below 25 m limits the time available for survey work and considering the amount of work required to assess a feature it is unrealistic to be able to complete a faunal turf dive even in two mornings (i.e. 12 person dives) using the current robust methodology. The use of time and effort therefore becomes inefficient. The use of a drop-down camera system with the capability of collecting semi- and quantitative data would therefore be more appropriate.

4.5.7 Red algae identification

The identification of red algae was probably the most challenging task during this survey. The basis for the survey methodology was simplicity and repeatability whilst allowing statistically robust data to be collected. Whilst all other aspects of the survey complied with these principles the red algae identification was the most difficult and the methodology perhaps needs some adjustment. Other even more easily identifiable taxa might need to be selected and added to the current selection but also the use of management (true) indicator species should be considered (see below).

4.5.8 Management (true) indicator species

The red algal species were selected partly as a result of being characteristic of the biotopes found rather than being species particularly useful as indicators of environmental change. There might therefore be a need to assess the suitability of other species to be used as true (management) indicators (*sensu* Hiscock *et al.*, 2004; Hiscock *et al.*, 2005; Dean, 2008) but also as other species might be easier to identify *in-situ*. In particular, *H. plumosa* and *P. parasitica* are difficult to identify under water but even small specimens of *Membranoptera alata* and *Sphaerococcus coronopifolius* can be difficult to identify with certainty.

Whilst the current methodology is workable some effort in trying to address this issue is recommended. The subject of true indicator species (a tested species against a particular stressor; biotic, abiotic or a particular environmental condition) sensitive to specific environmental conditions is large and perhaps future work could include assessing other species suitable for inclusion in the monitoring surveys once the sites have been analysed and assessed fully using the current data. One of the tasks would be establishing the types of potential environmental change these indicator species should be assessing. Once these types have been selected the management indicator species can also be selected to ensure any environmental change can be detected.

4.5.9 Species list

In addition to a re-assessment of the species selected as management species, the species selected for the assessment should also be re-assessed. For example, it would be sensible to consider removing *Hoplangia durotrix* from the list as it was not recorded and it is found primarily in caves and crevices in the shade (Peckett, 2007).

4.5.10 Vessel charter

The need for vessel charter may be re-assessed for future survey work. However, if any of the local dive vessels are to be used it is recommended that the vessels are hired on a full days' use basis rather than on a dive charter basis (which restricts the use to two dives per day and potentially allows other divers use of the vessel) to allow flexibility in planning, efficiency in getting the monitoring sites completed and content charter vessel owners.

5 CONCLUSIONS

The dive surveys on the Isles of Scilly were completed successfully between 12 and 17 May and 21 and 26 July in 2013 with a total of 130 person-dives (64 in May and 66 in July). The effort and results of these surveys are summarised as follows:

- A total of 12 different scuba-divers were used. All divers were qualified to a minimum of CMAS 3-star.
- The scuba-diving quadrat survey methodology as detailed in Axelsson *et al*. (2013) was used for the 2013 Isles of Scilly dive surveys.
- The dive surveys involved laying a ground line, filming the line and carrying out quadrat based survey work at 30 random locations along the ground line to generate quantitative data on species composition of the community.
- For the kelp forest community sub-feature six kelp species were recorded: *Laminaria hyperborea*, *Laminaria ochroleuca*, *Saccharina latissima* (formerly *Laminaria saccharina*), *Saccorhiza polyschides*, *Laminaria digitata* and *Alaria esculenta.*
- For the kelp understory community nine red algal species were recorded: *Kallymenia reniformis, Delesseria sanguinea, Membranoptera alata* (particularly on kelp stipes)*, Phycodrys rubens* (particularly on kelp stipes)*, Heterosiphonia plumosa, Pterosiphonia parasitica, Sphaerococcus coronopifolius, Dilsea carnosa, Halurus equisetifolius*.
- 22 faunal species were regarded as characteristic and therefore selected for the vertical rock assessments including *Corynactis viridis, Caryophyllia smithii, Alcyonium digitatum, Alcyonium glomeratum, Leptopsammia pruvoti, Hemimycale columella* and *Haliclona viscosa*.
- A total of 13 dive locations were surveyed during the 2013 survey resulting in 12 monitoring locations spread geographically across the Isles of Scilly. Six locations were kelp forest communities and six were vertical rock communities but one kelp forest community location (Frenchman's Rock) was surveyed twice (May and July). One subtidal faunal turf community location was also surveyed before this sub-feature was removed as a survey target for this project (see section 3.2 for further information).
- The six kelp forest community monitoring locations were established at Frenchman's Rock (St. Mary's), Porth Hellick (St. Mary's), Lizard Rock (St. Agnes), Carn Morval (St. Mary's), Cromwell's Castle (Tresco Channel) and Porth Morran (White Island).
- The six vertical rock monitoring locations were established at JS Wall (St. Mary's), Newfoundland Point (St. Mary's), Menawethan (Menawethan), Men-a-vaur (St. Helen's), John Thomas Ledge (St. Martin's) and East Withan (White Island).
- Site descriptions were completed for all the monitoring locations surveyed in 2013 to allow re-location of the survey lines and future monitoring.
- The highest overall kelp density (12.8 plants/m^2) was found at Frenchman's Rock (July 2013 survey) followed by Porth Hellick (11.0 plants/m^2) and Lizard Rock (10.5 plants/m^2). The lowest kelp density was found at Porth Morran (7.0 plants/m^2).
- *Laminaria hyperborea* was the dominant kelp species at Frenchman's Rock and Porth Hellick. There was a significant difference (comparing *L. hyperborea* and *L. ochroleuca*) in median kelp abundance at Frenchman's Rock (in May and July).
- *Laminaria ochroleuca* was the dominant kelp species at Lizard Rock, Carn Morval, Tresco Channel and Porth Morran. There was a significant difference (comparing *L.*

hyperborea and *L. ochroleuca*) in median kelp abundance at Carn Morval, Cromwell's Castle (Tresco Channel) and Porth Morran.

- Based on the available data (collected in 2013) all kelp community stations were tentatively classified as IR.LIR.K.LhypLoch.
- There appears to be a biogeographical divide in the distributions of both kelp and red algal species across the Isles of Scilly.
- *L. hyperborea* was the dominant kelp taxon along the Eastern Isles whilst *L. ochroleuca* was dominant everywhere else.
- The most abundant species on the vertical rock was the jewel anemone (*Corynactis viridis*), which was recorded at all locations and in 177 of the 180 analysed quadrats across the survey locations.
- *Hemimycale columella, Caryophyllia smithii, Haliclona viscosa* and *Marthasterias glacialis* were relatively frequently recorded on the vertical rock walls at 45, 32, 29 and 24 records respectively out of the 180 quadrats analysed.
- There were subtle differences in the vertical rock communities at different locations across the Isles of Scilly, the aspect, geographical location and level of exposure may explain these differences. However, based on the current data it was not possible to distinguish between these communities and the sites have all been classified as CR.HCR.XFa.SpAnVt.
- The recommendations based on the 2013 survey include the need for photographic expertise and high level of red algae species identification skills among the divers, a flexible approach regarding survey times to allow for good weather conditions and a re-assessment of the list of red algal species to be used for future monitoring. The potential for including red algal management (true) indicator species, as well as other species indicators of environmental change should be explored and the final selection should allow easy and fast *in-situ* identification.

6 REFERENCES

Axelsson, M., Dewey, S. and Allen, C. 2013. Standard Survey Methodology – Scientific Scuba-diving Quadrat Survey Methodology version 01. 11 pages.

Barne, J.H., Robson, C.F., Kaznowska, S.S., Doody, J.P., Davidson, N.C., and Buck, A.L., *eds*. 1996. *Coasts and seas of the United Kingdom. Region 11 The Western Approaches: Falmouth Bay to Kenfig.* Peterborough, Joint Nature Conservation Committee. (Coastal Directories Series).

BODC. 2014. British Oceanographic Data Centre. Historic tidal data. Available at http://www.bodc.ac.uk/ (Accessed May 2014).

Buttress, R. and Towler, P. (eds.) 2013. Reeds Nautical Almanac 2013. Published by Adlard Coles Nautical 2012. 1032 pages.

Connor, D.W., Allen, J.H., Golding, N., Howell, K.L., Lieberknecht, L.M., Northen, K.O. and Reker, J.B. 2004. The Marine Habitat Classification for Britain and Ireland Version 04.05. JNCC, Peterborough. ISBN 1 861 07561 8 (internet version) www.jncc.defra.gov.uk/MarineHabitatClassification (Accessed April 2013).

Cook, K.J. 2011. *Report on 2011 Isles of Scilly Zostera marina survey*. Natural England Commissioned Reports, Number 124.

Cornwall Council for CISCAG (Cornwall and Isles of Scilly Coastal Advisory Group). 2009. Cornwall and Isles of Scilly SMP2 Review of Coastal Processes and Geomorphology, Draft Report 9T8801.

Dean. H.K. 2008. The use of polychaetes (Annelida) as indicator species of marine pollution: a review Revista de Biología Tropical, vol. 56, núm. 4, -diciembre, 2008, pp. 11-38, Universidad de Costa Rica, Costa Rica.

Dipper, F. 1981. Sublittoral Survey of the Scilly Isles and South Cornwall by the Underwater Conservation Society. Unpublished report to the Nature Conservancy Council.

Eggleton, J.D. and Meadows, W. 2012. Offshore Monitoring of Annex 1 reef habitat present within the Isles of Scilly Special Area of Conservation (SAC). Natural England Commissioned Report. Natural England Commissioned Report, Number 125.

Fowler, J. and Cohen, L. 1992. Practical statistics for field biology. John Wiley & Sons.

Fowler, S.L. and Pilley, G.M. 1992. Report on the Lundy and Isles of Scilly marine monitoring programmes 1984 and 1991. Unpublished report to English Nature from The Nature Conservation Bureau Ltd.

Gall, A. 2011. Marine Biodiversity Action Plan habitats and species of the Isles of Scilly. An update to the Isles of Scilly Biodiversity Audit 2008. Available online: An update to the Isles of Scilly Biodiversity Audit 2008 (accessed January 2014).

Global Sea Temperature. 2013. http://www.seatemperature.org/europe/united-kingdom/isles-of-scilly-august.htm (Accessed April 2013).

Highfield, J., Black, G. and Pirie, C. 2013. Review of dive survey methodologies employed in the 2011 Isles of Scilly subtidal reef condition assessment. Natural England unpublished file note.

Hiscock, K. 1983. South-west Britain Sublittoral Survey. Unpublished report to the Nature Conservancy Council by the Field Studies Council Oil Pollution Research Unit, Orielton, Pembrokeshire.

Hiscock, K. 1985. Littoral and Sublittoral Monitoring in the Isles of Scilly, September 22nd and 29th, 1984. Unpublished report to the Nature Conservancy Council from the Field Studies Council Oil Pollution Research Unit, Orielton, Pembrokeshire.

Hiscock, K., Langmead, O. & Warwick, R. 2004. Identification of seabed indicator species from time-series and other studies to support implementation of the EU Habitats and Water Framework Directives. *Report to the Joint Nature Conservation Committee and the Environment Agency from the Marine Biological Association.* Plymouth: Marine Biological Association. JNCC Contract F90-01-705. 109 pp.

Hiscock, K., Langmead, O., Warwick, R. & Smith, A. 2005. Identification of seabed indicator species to support implementation of the EU Habitats and Water Framework Directives. Second edition. *Report to the Joint Nature Conservation Committee and the Environment Agency from the Marine Biological Association.* Plymouth: Marine Biological Association. JNCC Contract F90-01-705. 77 pp.

Hiscock, K. 2011. Census of Sunset Corals, *Leptopsammia pruvoti,* at Gap Point, Isles of Scilly, September 2010. Newsletter of the Porcupine Marine Natural History Society, Issue 29, page 16.

Hocking, S. and Tompsett, P. 2001. The Location and Conservation of Eelgrass Beds in Cornwall and the Isles of Scilly. Volume I - Report. Environmental Records Centre for Cornwall and the Isles of Scilly. Project Series No. 5.

IoS Museum. 2014. Geology tour of the Isles of Scilly. Isle of Scilly Museum. Available online: http://naturalhistoryofscilly.info/scillygeology/Map_and_guide.html (Accessed January 2014).

Irving, R.A. 1987. Sublittoral monitoring in the Isles of Scilly 1985 and 1986. Unpublished report to the Nature Conservancy Council.

Irving, R.A. and Northen, K.O. 2012. *Isles of Scilly SAC Diving Monitoring Studies, 2011*. Natural England Commissioned Reports, Number 104.

JNCC. 2013. Isles of Scilly Complex 2013. Joint Nature Conservation Committee (JNCC). Available online: http://jncc.defra.gov.uk/protectedsites/sacselection/sac.asp?EUCode=UK0013694 (Accessed April 2013).

John, D.M. 1969. An ecological study on *Laminaria ochroleuca*. *Journal of the Marine Biological Association of the United Kingdom*, 49, 175-187.

Lewis, G., Parslow, R., Gall, A. and McCartney, P. 2008. Isles of Scilly Biodiversity Audit. Report published by Natural England with the support of the Isles of Scilly Environmental Trust, Cornwall Wildlife Trust and the Environmental Records Centre for Cornwall and the Isles of Scilly. Funded by the Aggregates Levy Sustainability Fund http://www.cornwallwildlifetrust.org.uk/Resources/Cornwall%20Wildlife%20Trust/PDF%20Documents/Isles_of_Scilly_Biodiversity_Audit_2008.pdf. (Accessed April 2013).

Munro, C. and Nunny, R. 1998. Isles of Scilly habitat and biotope mapping survey. English Nature Research Reports No. 276.

Natural England. 2010. Inshore Special Area of Conservation (SAC): Land's End and Cape Bank SAC Selection Assessment, Version 2.3, Available online at: http://publications.naturalengland.org.uk/file/3262325 (Accessed October 2014).

Natural England. 2012. Isles of Scilly Complex SAC map. Available online: http://publications.naturalengland.org.uk/publication/3084503 (Accessed October 2014).

Peckett, F. 2007. *Hoplangia durotrix*. Weymouth carpet coral. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available from: http://www.marlin.ac.uk/speciesinformation.php?speciesID=3521.

Picton, B.E. and Morrow, C.C. 2014. *Actinothoe sphyrodeta.* Encyclopedia of Marine Life of Britain and Ireland. Available online: http://www.habitas.org.uk/marinelife/index.html (Accessed April 2014).

Seasearch. 2004. Seasearch dives the Scilly Isles 2004. Isles of Scilly Survey September 2004 – Summary report. Available online: http://www.seasearch.co.uk/achievements.htm (Accessed July 2013).

Seasearch. 2005. Seasearch dives the Scilly Isles 2005. Isles of Scilly Survey May 2005 – Summary report. Available online: http://www.seasearch.co.uk/achievements.htm (Accessed July 2013).

Seasearch. 2006. Seasearch dives the Scilly Isles 2006. Isles of Scilly Survey May 2006 – Summary report. Available online: http://www.seasearch.co.uk/achievements.htm (Accessed July 2013).

Seasearch. 2007. Seasearch dives the Scilly Isles 2007. Isles of Scilly Survey May 2007 – Summary report. Available online: http://www.seasearch.co.uk/achievements.htm (Accessed July 2013).

Seasearch. 2008. Seasearch dives the Scilly Isles 2008. Isles of Scilly Survey September 2008 – Summary report. Available online: http://www.seasearch.co.uk/achievements.htm (Accessed July 2013).

Seasearch. 2010. Seasearch dives the Scilly Isles 2010. Isles of Scilly 2010 summary report. Available online: http://www.seasearch.org.uk/downloads/Scilly2010summary.pdf (Accessed May 2013).

Seasearch. 2013. Seasearch Recording. Seasearch scuba-diving recording methodology and forms. Available online: http://www.seasearch.org.uk/recording.htm (Accessed May 2013).

Sokal, R.R. and Rohlf, F.J. 1995. Biometry. The principles and practice of statistics in biological research. W.H. Freeman and Company.

Tyler-Walters, H. 2007. *Laminaria hyperborea*. Tangle or cuvie. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available online: http://www.marlin.ac.uk/speciesbenchmarks.php?speciesID=3614 (Accessed January 2014).

Wood, C. 2013. Sea anemones and corals of Britain and Ireland (2nd edition). Seasearch. Wild Nature Press, 160 pages.

WoRMS Editorial Board. 2014. World Register of Marine Species. Available online http://www.marinespecies.org at VLIZ. (Accessed from May 2013 to March 2014).

APPENDIX 1 METHODOLOGY

KELP FOREST COMMUNITIES

Equipment

- Ground rope (marked at 1 m intervals) 20 m in length
- Video camera
- 2x Still photography camera (with strobes)
- Dive slates (with clips), pencils and recording paper (log sheets)
- Quadrat 1m^2
- Quadrat 0.25m^2
- Sample collection bags

Summary of feature, rationale and methodology

Kelp communities

***Sub-feature*: (A)**	**Kelp Forest Communities**
***Attribute*: (A2)**	**Characteristic species - *Laminaria hyperborea* and *L. ochroleuca* population size within the kelp forest community**
Target:	Presence and abundance of composite species should not deviate significantly from an established baseline, subject to natural change.
Baseline:	Measured at Little Arthur but not at other locations before using this proposed methodology. Some records exist of the relative abundance of these two kelp species using MNCR Phase 2 methodology.
Comment:	Likely to include the biotopes (Connor *et al*., 2004): IR.HIR.KFaR.LhypR.Loch (Mixed *Laminaria hyperborea* and *Laminaria ochroleuca* forest on exposed infralittoral rock); IR.LIR.K.LhypLoch (Mixed *Laminaria hyperborea* and *Laminaria ochroleuca* forest on moderately exposed or sheltered infralittoral rock)
Survey size:	20 m long transect, survey 2 m on both sides of the transect, creating a grid of 80 cells of 1 m^2. Number grid cells from 1 – 80 and select 30 quadrats randomly for assessment (additional cells to be randomly selected in case additional work can be completed, up to a total of 40 cells).

77	78	79	80
..	..	..	..
13	14	15	……
9	10	11	12
5	6	7	8
1	2	3	4

Summary of Method:	Sites chosen within the upper infralittoral, i.e. the kelp forest. Quadrat size: 1 m^2 (3-sided). Survey entire cell for each sample. Using a three-sided 1 m^2 quadrat, the number of individuals for each of six kelp species was counted at each quadrat location by one pair of divers. The six kelp species (from Irving and Northen, 2012) were: *Laminaria hyperborea*, *Laminaria ochroleuca*, *Saccharina latissima* (formerly *Laminaria saccharina*), *Saccorhiza polyschides*, *Laminaria digitata* and *Alaria esculenta*. Dive Pair 1: Based on local advice selected the location for the transect. Laid the 20 m transect line (ground-rope marked at 1 m intervals), with the depth of the line remaining within the minimum and maximum for the kelp forest biotope. Filmed along the transect attempting to cover the 4 m width if possible. Produced a site description using methodology similar to Seasearch and survey 6 of the quadrats. Dive Pair 2 and 3: Used the randomly generated and pre-selected 30 quadrat positions (cells) along the transect line and to carry out the kelp community assessment to complete 12 quadrats per pair. A still photograph or video recording of each quadrat was taken. The identification and abundance data was recorded on pre-prepared recording forms together with the depth of the quadrat. This method was repeated for all the different sites, in a range of different exposures and geographical locations across the SAC (St. Agnes, St. Mary's (west and east coastal fringes), St. Martins and in the Tresco Channel). Avoided geographic extremities as these are likely to be more exposed to variation caused by natural cycles.
Rationale:	The northern kelp *Laminaria hyperborea* supports a diverse understorey of macroalgae (particularly species of red algae), with several species attached to the stipes of the kelp. The southern kelp *Laminaria ochroleuca* also supports a rich understorey of macroalgae, but on the other hand has a much smoother stipe with few if any epiphytic red algae managing to attach to it. The proportion of *L. ochroleuca* to *L. hyperborea* in the Isles of Scilly is likely to increase as the surrounding waters gradually warm as a result of climate change, thus altering the biotope composition. This method provides a simple comparison of baseline ratios (*L. hyperborea*: *L. ochroleuca*. The ratio measure will provide the condition indicator for this particular attribute. The data obtained are comparable to similar recent studies undertaken elsewhere in the south-west, such as at Lundy (Irving, 2011).

Red algae communities

<table>
<tr><td>Sub-feature: (A)</td><td>Kelp Forest Communities</td></tr>
<tr><td>Attribute: (A3)</td><td>Species composition of characteristic biotopes within kelp forests: monitoring the diversity of red algal species.</td></tr>
<tr><td>Target:</td><td>Presence and abundance of composite species should not deviate significantly from an established baseline, subject to natural change.</td></tr>
<tr><td>Baseline:</td><td>The diversity of algal species within kelp forests was recorded by Hiscock (1983). The species recorded for the Algal Diversity task were selected from Hiscock's (1983) initial list.</td></tr>
<tr><td>Survey size:</td><td>20 m long transect, surveyed 2 m on both sides of the transect, creating a grid of 80 cells of 1 m^2 grid. Survey to assess 0.25 m^2 within each 1 m^2 cell randomly. Numbered grid cells from 1 – 80 and selected 30 quadrats randomly for assessment (additional cells randomly selected in case additional work can be completed, up to a total of 40 cells).
<table>
<tr><td>77</td><td>78</td><td>79</td><td>80</td></tr>
<tr><td>..</td><td>..</td><td>..</td><td>..</td></tr>
<tr><td>13</td><td>14</td><td>15</td><td>……</td></tr>
<tr><td>9</td><td>10</td><td>11</td><td>12</td></tr>
<tr><td>5</td><td>6</td><td>7</td><td>8</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td></tr>
</table>
</td></tr>
<tr><td>Summary of Method:</td><td>A3 was carried out at the same sites and at the same time as A2, where kelp dominates. The same 20 m transect line as A2 was used.
Randomly generated distances along the transect line and up to 2 m either side of the line were pre-selected for 30 quadrat positions (additional cells were randomly selected in case additional work could be completed).
<u>Dive Pair 1, 2 & 3:</u> Pair 1 completed 6 quadrats whilst pairs 2 and 3 completed 12 quadrats each. Using a three-sided 0.25 m^2 quadrat presence/absence of 9 characteristic red algal species, both on the rock surface and on the kelp stipes, was recorded on a pre-prepared recording form. In-situ recording was made as far as possible but samples were collected for later identification and verification.
A still photograph or video recording of each quadrat was taken as a permanent record and potentially allow for percentage cover to be analysed (in addition to the presence/absence data).</td></tr>
</table>

	The nine characteristic species (from Irving and Northen, 2012) recorded were: *Kallymenia reniformis, Delesseria sanguinea, Membranoptera alata* (particularly on kelp stipes)*, Phycodrys rubens* (particularly on kelp stipes)*, Heterosiphonia plumosa, Pterosiphonia parasitica, Sphaerococcus coronopifolius, Dilsea carnosa, Halurus equisetifolius*. This method was repeated for all the different sites, in a range of different exposures and geographical locations across the SAC but geographic extremities were avoided as these are likely to be exposed to variation by natural cycles.
Rationale:	Some of the red algal species occur in exposed kelp forests, while others occur in moderately sheltered or sheltered conditions. Some have distributions limited to the SW, while others have wider distributions which cover the much of Britain and Ireland. Most are fairly distinct in terms of their shape and form.

VERTICAL ROCK

Equipment

- Guide rope (for vertical use), marked every 1 m
- Mechanism to attach rope to side of wall (piton)
- Video camera
- 2x Stills photography camera with strobe
- Quadrat 0.25 m^2 with further divisions making four 0.0625 m^2 cells (marked differently)
- Slates, pens and pre-prepared log sheets
- Identification photographs for species identification (used primarily on the vessel)

Summary of feature, rationale and methodology

Vertical Rock

***Sub-feature*: (B)**	**Vertical Rock**
***Attribute*: (B1)**	**Species composition of characteristic biotopes on vertical rock: Presence and abundance of notable species of erect sponges, cup corals, and anthozoan communities.**
Target:	Presence and abundance of composite species should not deviate significantly from the established baseline, subject to natural change.
Baseline:	None (to our knowledge) using this technique. However, a vertical circalittoral rock site at Gap Point, east side of St Mary's, was established as a photographic monitoring site in the 1980s (see Fowler and Pilley 1992), and a number of sites surveyed in 2011 (Irving and Northen, 2012).
Comment:	Following on the criteria set out in Irving and Northen (2012) only vertical rock communities within the circalittoral zone were targeted for this study. This reflected the described biotopes (see below). CR.HCR.Xfa.SpAnVt (Sponges /anemones on vertical circalittoral bedrock); CR.HCR.Xfa.CvirCri (*Corynactis viridis* and a mixed turf of crisiids, *Bugula*, *Scrupocellaria* and *Cellaria* on moderately tide-swept exposed circalittoral rock); CR.MCR.EcCr.CarSp (*Caryophyllia smithii*, sponges and crustose communities on wave-exposed circalittoral rock); CR.FCR.Cv.SpCup (Sponges, cup corals and anthozoans on shaded or overhanging circalittoral rock)
Vertical rock wall criteria	The main criteria were therefore: 5 m long vertical rock face with an angle near as possible to 180°, found at depths of 30 m, or less, and with smooth walls (if possible) without overhangs but split walls (above and below a ledge) were considered suitable as the walls above and below could both be assessed. Repeatability in terms of access and shelter was

<table>
<tr><td></td><td>also an important selection criterion.</td></tr>
<tr><td>Survey size:</td><td>Target 5 m high walls to achieve a grid of 80 quarters 0.25 m^2 quadrats covering of 0.0625m^2 cells each (i.e. a sample is a quarter of a 0.25 m^2 quadrat). By placing the guide rope along the wall and placing quadrats along one side of the rope 80 cells are available between the top and the bottom of the line at 5 m.
Grid:
<table><tr><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td>5</td><td>6</td><td>7</td><td>8</td></tr><tr><td>9</td><td>10</td><td>11</td><td>12</td></tr><tr><td>..</td><td>..</td><td>..</td><td>..</td></tr><tr><td>77</td><td>78</td><td>79</td><td>80</td></tr></table></td></tr>
<tr><td>Summary of Method:</td><td>Circalittoral vertical rock exposures need to be between 5 m and 10 m high to be suitable (5 m for assessment). Once a suitable vertical face was located, a piton was hammered into the wall (the re-locatable point), a pre-marked guide rope (1 m intervals) was reeled out from the top to the bottom of the feature, forming a mid-line of the transect. The depth at the start and end of the transect were noted and the wall was filmed (video) to form a permanent record. Since there was a limited underwater time at the depths where the walls were found, each site required two dives to ensure completion of all the 30 quadrats.
With two divers working together one diver would hold the quadrat (0.25m^2) up and stay buoyant immediately above the quadrat (holding onto the quadrat) whilst the second diver would have space for photographic work below. The roles could then be swapped for the analysis stage (analysis of a quarter of a quadrat; 0.0625 m^2) or simply carried out in the positions already assumed. Both systems work well and all the tasks can be completed without difficulty assuming the divers are skilled at taking underwater still photographs and/or video.
A total of six vertical rock sites were surveyed in the two survey periods.
The required tasks to be completed by the divers were as follows:
<u>Dive Pair 1:</u> Site selection and description (Seasearch methodology), attach piton, attach 5 m vertical guide rope and video the transect. On the second dive at the same site, photograph and assess 6 quadrats.
<u>Dive Pair 2:</u> 6 quadrats (at top of wall if appropriate), photograph quadrat, assess percentage cover/counts of selected taxa in each quarter (generated randomly). Same assessment for the two dives.</td></tr>
</table>

	Dive Pair 3: 6 quadrats (at bottom of wall if appropriate), photograph quadrat, assess percentage cover/counts of selected taxa in each quarter (generated randomly). Same assessment for the two dives. Retrieve the ground line on completion of the assessment. The assessment was completed by holding the quadrat against the wall at pre-selected cells in the grid. The quarter (0.0625 m^2) was photographed and then assessed. The number of individuals, or the percentage cover for colonial species, was recorded at 30 quadrat locations for 22 characteristic species by two pairs of divers. The number of quarters of analysed in each 1m interval may need increasing or decreasing depending on the size of the wall. Aim to cover similar percentage of this feature to the other features (c. 37.5%) in the survey. The data were recorded on a pre-prepared recording form with the depth of the quadrat. A still photograph of each quadrat was taken and a video of the transect line was recorded. This method was repeated for all the sites with different exposures and at different geographical locations across the SAC. Avoid geographic extremities as these are likely to be more exposed to variation caused by natural cycles. Only the presence of those species listed on the recording form was noted. Finally, the distance on the tape at the top end of the transect was noted, together with the depth. The video film to be used for QA checks made at some later stage of the *in situ* species recording. 22 species regarded as being 'characteristic' of circalittoral vertical rock, from exposed to sheltered (wave action) and exposed to semi-exposed (tidal streams), were included on the recording form (selected from Hiscock, 1983): *Axinella dissimilis* *Tethya citrina* *Cliona celata* *Hemimycale columella* *Dysidea fragilis* *Haliclona viscosa* *Alcyonium digitatum* *Alcyonium glomeratum* *Corynactis viridis* *Actinothoe sphyrodeta* *Sagartia elegans* *Leptopsammia pruvoti* *Caryophyllia smithii* *Hoplangia durotrix* *Parazoanthus axinellae* *Parazoanthus anguicomus* *Echinus esculentus* *Marthasterias glacialis* *Holothuria forskali* *Antedon bifida* *Clavelina lepadiformis* *Stolonica socialis*

Rationale:	This method provides a straightforward means of being able to assess, with reasonable accuracy, the abundance of various 'characterising' species from this sub-feature. Clearly, the more cells that can be recorded, the more accurate the assessment will be. The species have been selected for ease of identification and conspicuousness. Together they provide examples from across the main benthic taxa represented within this sub-feature. The above list of species should be used as a 'core' list. Additional species *may* be added to it in future if thought necessary, though this will restrict the use of historical comparisons.
Note:	Prior to the survey work commencing it was decided that a circalittoral vertical rock between 5 m and 10 m high was required. After the first dive it was decided to aim at finding 5 m walls to restrict the diving depths (most walls are found from 17 m and below) required for the assessments and therefore allow longer underwater analysis time but also as 10 m long vertical walls are relatively rare.

APPENDIX 2 RECORDING FORMS

Kelp Forest Communities (A2)			Date:		Site Name:				
Divers:					Station Number:				
Depth: (ES)					Latitude:				
Notes:					Longitude:				
			L. hyperborea	L. ochroleuca	Saccorhiza polyschides	Saccharina latissima	Alaria esculenta	L. digitata	Kelp juv.
Quadrat No	Grid Cell	Depth	Rough stipe with epiphytes. Round in X-section.	Smooth stipe with no epiphytes (though possibly encrusting bryozoans). Golden patch at base of blade.	Massive lobose base with small projections. Flat stipe with wavy edges, partic. at base.	Single undivided ribbon-like blade with crinkly edge. Short thin stipe.	Narrow, slightly crinkly blade with midrib. Club-like repro. bodies on short stipe.	Smooth stipe, oval in shape, flexible (just below blade), Smooth and shiny brown	
Q1									
Q2									
Q3									
Q4									
Q5									
Q6									
Q7									
Q8									
Q9									
Q10									
Q11									
Q12									
Q13									
Q14									
Q15									

Kelp Forest Communities (A2)			Date:		Site Name:				
Divers:					Station Number:				
Depth: (ES)					Latitude:				
Notes:					Longitude:				
			L. hyperborea	L. ochroleuca	Saccorhiza polyschides	Saccharina latissima	Alaria esculenta	L. digitata	Kelp juv.
Quadrat No	Grid Cell	Depth	Rough stipe with epiphytes. Round in X-section.	Smooth stipe with no epiphytes (though possibly encrusting bryozoans). Golden patch at base of blade.	Massive lobose base with small projections. Flat stipe with wavy edges, partic. at base.	Single undivided ribbon-like blade with crinkly edge. Short thin stipe.	Narrow, slightly crinkly blade with midrib. Club-like repro. bodies on short stipe.	Smooth stipe, oval in shape, flexible (just below blade), Smooth and shiny brown	
Q16									
Q17									
Q18									
Q19									
Q20									
Q21									
Q22									
Q23									
Q24									
Q25									
Q26									
Q27									
Q28									
Q29									
Q30									

Kelp Forest Red Algae Communities (A3)					Date:			Divers:			
Site:					Station No:			Latitude: Longitude:			
Depth (ES):			Kallymenia reniformis	Delesseria sanguinea	Membranoptera alata	Phycodrys rubens	Heterosiphonia plumosa	Pterosiphonia parasitica	Sphaerococcus coronopifolius	Dilsea carnosa	Halurus equisetifolius
Quadrat No	Grid Cell	Depth									
Q1											
Q2											
Q3											
Q4											
Q5											
Q6											
Q7											
Q8											
Q9											
Q10											
Q11											
Q12											
Q13											
Q14											
Q15											

Kelp Forest Red Algae Communities (A3)					Date:			Divers:			
Site:					Station No:			Latitude: Longitude:			
Depth (ES):			Kallymenia reniformis	Delesseria sanguinea	Membranoptera alata	Phycodrys rubens	Heterosiphonia plumosa	Pterosiphonia parasitica	Sphaerococcus coronopifolius	Dilsea carnosa	Halurus equisetifolius
Quadrat No	Grid Cell	Depth									
Q16											
Q17											
Q18											
Q19											
Q20											
Q21											
Q22											
Q23											
Q24											
Q25											
Q26											
Q27											
Q28											
Q29											
Q30											

Vertical Rock (B1)	Date:	Divers:
Site Name:	Station No:	Latitude: Longitude:
Depth (ES):	Notes:	
Depth at top of transect (m):		
Depth at bottom of transect (m):		

Species / Quadrat	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
Grid															
Depth															
Axinella dissimilis (count)															
Tethya citrina (count)															
Cliona celata (%)															
Hemimycale columella (%)															
Dysidea fragilis (%)															
Haliclona viscosa (%)															
Alcyonium digitatum (%)															
Alcyonium glomeratum (%)															
Corynactis viridis (%)															
Actinothoe sphyrodeta (%)															
Sagartia elegans (%)															
Leptopsammia pruvoti (%)															
Caryophyllia smithii (%)															
Hoplangia durotrix (%)															
Parazoanthus axinellae (%)															
Parazoanthus anguicomus (%)															
Echinus esculentus (%)															
Marthasterias glacialis (%)															
Holothuria forskali (%)															
Antedon bifida (%)															
Clavelina lepadiformis (%)															
Stolonica socialis (%)															

Vertical Rock (B1)	Date:	Divers:
Site Name:	Station No:	Latitude: Longitude:
Depth (ES):	Notes:	
Depth at top of transect (m):		
Depth at bottom of transect (m):		

Species / Quadrat	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30
Grid															
Depth															
Axinella dissimilis (count)															
Tethya citrina (count)															
Cliona celata (%)															
Hemimycale columella (%)															
Dysidea fragilis (%)															
Haliclona viscosa (%)															
Alcyonium digitatum (%)															
Alcyonium glomeratum (%)															
Corynactis viridis (%)															
Actinothoe sphyrodeta (%)															
Sagartia elegans (%)															
Leptopsammia pruvoti (%)															
Caryophyllia smithii (%)															
Hoplangia durotrix (%)															
Parazoanthus axinellae (%)															
Parazoanthus anguicomus (%)															
Echinus esculentus (%)															
Marthasterias glacialis (%)															
Holothuria forskali (%)															
Antedon bifida (%)															
Clavelina lepadiformis (%)															
Stolonica socialis (%)															

Site Description (all)	Date:	Site Name:
Depth SOL:		Station Number:
Depth EOL:		Depth (ES):
Divers:		Latitude: Longitude:

APPENDIX 3 CHARACTERISTIC SPECIES FOR KELP FOREST AND VERTICAL ROCK COMMUNITIES

The characteristic species for kelp forest communities:

- *Laminaria hyperborea*
- *Laminaria ochroleuca*
- *Saccharina latissima* (formerly *Laminaria saccharina*)
- *Saccorhiza polyschides*
- *Laminaria digitata*
- *Alaria esculenta*

Laminaria hyperborea is found on most coasts around Britain and Ireland. It has a broad, large, flat blade, divided into 5-20 straps (digitate). The stipe is rough and usually covered with epiphytes such as red algae. The blade is golden brown to very dark brown in colour and it has a large and conical holdfast (MarLIN).

Laminaria ochroleuca is a yellow-brown digitate kelp, similar in appearance to *L. hyperborea*. It is generally found on the south west coast of England, including the Isles of Scilly. Its characterising features are a bright yellow patch at the junction of the stipe and the blade, and a rigid round stipe that is free of any epiphytes (MarLIN).

Laminaria hyperborea (MarLIN)

Laminaria ochroleuca (MarLIN)

Red algae species to be surveyed in the understorey of kelp forests:

Kallymenia reniformis – thin but strong and flat blade up to 30 cm long and 18 cm broad. Large lobes, usually broader than long. Small discoid holdfast with short and rounded stipe (up to 1.5 cm). Blades are translucent and mucilaginous when young, dark-purple to brownish-red. Some have characteristic white marks. Irregular, kidney-shaped blades may grow from the margins. Sometimes found on the kelp stipes (Encyclopaedia of Marine Life, seaweeds book pg 118). Image from http://www.habitas.org.uk/marinelife/index.html

Identity confusions: Growth form variable depending on habitat (e.g. exposure to wave action, age). *Dilsea carnosa* has longer stipe, more gradual tapering at base of the frond, much thicker blade and not the mucilaginous feel of younger *K. reniformis*. Starry liver weed, *Schizymenia dubyi*, has thicker blade, is much more browny-red, and feels rough (a bit like sand paper) whereas *K. reniformis* is more smooth and slippery. An undescribed *Kallymenia* species found in the southwest has a longer stipe and more triangular blade shape.

Delesseria sanguinea – a crimson seaweed up to 30 cm in length. Oval or lanceolate leaf-like blades with pointed apices. Membranous lamina with a wavy margin (but not serrated) and a thickened midrib with pairs of lateral veins. A short cylindrical stipe arises from the irregularly shaped, thickened holdfast (about 0.5 cm diameter). Spirally arranged blades (1.5-4 cm wide) from the stipe, usually branched from or near to the base of the stipe. The leaves may be pointed in young algae (MarLIN, seaweeds book pg 92). Occasionally epiphytic on the stipes of *Laminaria hyperborea*. Image from http://www.habitas.org.uk/marinelife/index.html

Identity confusions: battered plants may look like *Phycodrys rubens*, but *P. rubens* has lobed or toothed margins. *Apoglossum ruscifolium* and *Hypoglossum hypoglossoides* may look similar but are much smaller and lack macroscopic veins.

Membranoptera alata – Thin and membranous, deep crimson to brownish red fronds, up to 20 cm long. Flat, narrow frond and short stipe. Well marked midrib, many fine lateral veins (largely microscopic) and pincer-like apices. Many branches from the central axis, which are irregular and dichotomous (forked) in one plane. (algae base, MarLIN, seaweeds book pg 94). Particularly found on kelp stipes. Image from http://www.algaebase.org/search/species/detail/?species_id=Q649d4dc86bb1ce27&-session=abv4:D944F7431aeea29E1CJr949FB48A

Identity confusions: Can become heavily encrusted with bryozoan and blades become eroded in older individuals. May be confused with *Apoglossum ruscifolium*, but this species has symmetrical apices whereas *M. alata* has asymmetrical, pincer-like tips.

Phycodrys rubens – a single stipe with groups of oak-leaf shaped blades, light crimson to dull browny-red in colour and up to 30 cm long. Blades have a prominent flexible midrib and paired lateral veins. Fronds are branching and membranous. (MarLIN, Encyclopedia of Marine Life, seaweed book pg 95). Particularly found on kelp stipes. Image from http://www.habitas.org.uk/marinelife/index.html

Identity confusions: Similar to *Delesseria sanguinea*, but distinguished by the serrated margin and the large lobes like the primary lamina on the blades of *P. rubens*. Also *P. rubens* has a flexible midrib whereas *D. sanguinea* has a tough semi-rigid midrib.

Heterosiphonia plumosa – a red to deep crimson seaweed with a flattened, fern-like appearance. Hairy thallus growing from a discoid holdfast. Each tuft has its own main axis. Fronds are flat or slightly cylindrical (up to 20 cm length, 0.5 cm diameter), tapering towards the apex. Alternate and irregular primary and secondary branching. Each branch has many pointed branchlets, giving a tufted and feather-like appearance (MarLIN, seaweed book pg 73). Image from http://www.habitas.org.uk/marinelife/species.asp?item=ZM10390

Identity confusions: when densely clothed in branches and reproducing, plants have a different bushier appearance.

Pterosiphonia parasitica – Bright red seaweed of erect tufts 2-7 cm high. Thallus flattened and irregularly triangular in outline, primary and secondary branching of laterals (pg 146 in seaweeds book - photo).

Identity confusions: possible confusion with *Polysiphonia fucoides*, but coloration is darker (brownish-red to black) and grows as dense tufts.

Sphaerococcus coronopifolius – scarlet, opaque fronds and dark brownish-red main axis. Flattened, two-edged, erect and very branched thallus of up to 30 cm. Discoid holdfast and stipe is 4 mm wide. Branching is irregularly alternate, generally on one plane, and branches are fringed with small branchlets (Encyclopedia of Marine Life, seaweed book pg 46). Image from http://www.habitas.org.uk/marinelife/index.html

Identity confusions: similar to *Plocamium cartilagineum*, but *S. coronopifolius* has an irregular rather than regular alternating branching pattern and does not have comb-like teeth on branchlets. *Sphaerococcus coronopifolius* is also thicker and more opaque than *P. cartilagineum*.

Halurus equisetifolius – dark red cartilaginous filaments up to 22 cm long. Erect plant with up to 7 main axes, irregularly branched, resembling a miniature horsetail. Branched to 4 orders and with whorls of short, incurved branchlets. Plants are soft and spongy when young (algae base, seaweed book pg 33 - photo). Image from http://www.algaebase.org/search/species/detail/?species_id=148andsk=0andfrom=results and http://www.marevita.org/index.php?option=classificationandpath=/Algues%20et%20plantes%20marines/Rhodophyta/Florideophycidae/Ceramiales/Ceramiaceae/Halurus/Halurus%20equisetifolius

Identity confusions: Similar to *Sphondylothamnion multifidum*, but it is a more delicate plant with very fine whorled branches whereas *H. equisetifolius* is more robust. May also resemble

Cladostephus spongiosus, but *H. equisetifolius* is a dark red colour and *C. spongiosus* is dark-brown to olive green.

Dilsea carnosa – tough and leathery, dark reddish-brown blades. Disc shaped holdfast with several large, flat blades gradually expanding from a short cylindrical stipe. Rounded oblong or spoon shaped blades (up to 50 cm long and 5-20 cm wide), with no midrib or veins. The blades can be split when older (MarLIN, seaweeds book pg 97).

Identity confusions: similar to *Schizymenia dubyi*, but the fronds of *D. carnosa* are opaque and fleshy whereas the fronds of *S. dubyi* are thicker, slightly translucent and have a texture like sandpaper. *Dilsea carnosa* also has a longer stipe, a more gradual taper at the base of the frond and a thicker blade. Young plants could also be confused with *Meredithia microphylla*, but this species is a characteristic lilac-purple colour and tends to favour vertical faces, which is not the usual habitat for *D. carnosa*.

(from Irving and Northen, 2012).

The 22 characteristic species for vertical rock communities:

Axinella dissimilis	*Caryophyllia smithii*
Tethya citrina	*Hoplangia durotrix*
Cliona celata	*Parazoanthus axinellae*
Hemimycale columella	*Parazoanthus anguicomus*
Dysidea fragilis	*Echinus esculentus*
Alcyonium digitatum	*Marthasterias glacialis*
Alcyonium glomeratum	*Holothuria forskali*
Corynactis viridis	*Antedon bifida*
Actinothoe sphyrodeta	*Clavelina lepadiformis*
Sagartia elegans	*Stolonica socialis*
Leptopsammia pruvoti	

APPENDIX 4 DIVE LOGS

Kelp Forest Communities (A2)	Date: 12 May 2013	Site Name: Frenchman's Rock
Divers:	Pair 1: Fiona Tibbitt & Holly Latham; Pair 2: Kathryn Dawson & Jennifer Ashworth (Q01-Q15)	Station Number: 349-02
	Pair 3: Magnus Axelsson & Holger Anlauf (Q16-Q30)	Pair 1: lay line, film along the line and do site description; Pairs 2 and 3: survey work
Depth (ES):	12 m	Latitude: 49° 56.634" N Longitude: 006° 15.691" W
Notes:		

Quadrat	Grid	Depth (m)	L. hyperborea	L. ochroleuca	Saccorhiza polyschides	Saccharina latissima	Alaria esculenta	L. digitata	Kelp juv.	Kallymenia reniformis	Delesseria sanguinea	Membranoptera alata	Phycodrys rubens	Heterosiphonia plumosa	Pterosiphonia parasitica	Sphaerococcus coronopifolius	Dilsea carnosa	Halurus equisetifolius
Q1	1A	8.7	0	0														
Q2	1B	9.5	0	0														
Q3	1C	9.8	0	0											P			
Q4	3A	7.5	0	0														
Q5	3B	8.5	1	0						P	P							
Q6	3C	8.4	1	3					1									
Q7	3D	8.4	0	0					2									
Q8	4A	7.7	10	1						P			P					
Q9	4C	8.5	4	1					3									
Q10	6B	7.9	0	0														
Q11	8A																	
Q12	8B																	
Q13	8C																	
Q14	8D																	
Q15	9B																	
Q16	9C	9.6	0	6							P							
Q17	10B	8.2	10								P							
Q18	10D	9.1	7										P					
Q19	11A	9	13										P					
Q20	11D	8.5	8										P					
Q21	12A		11							P			P					
Q22	13B	7.6	4							P			P					
Q23	13D	7.8	13						1	P			P					
Q24	14A	6.9	14							P			P					
Q25	14B	6.8	6							P			P					
Q26	14C	7.3	17	3	3					P			P					
Q27	15B	7.1	8										P					
Q28	15D	7.2	3						3				P					
Q29	18B	7.4	6						3	P			P					
Q30	20D	8.5	4	2						P	P		P					

Vertical Rock (B1)	Date: 13 May.2013 & 14 May 2013	Divers (13/05/13): Pair 1: Magnus Axelsson & Holger Anlauf (piton, line & video); Pair 2: Holly Latham & Katherine Dawson (Q10-Q15); Pair 3: John Bleach & Fiona Tibbitt (Q28-30); Divers (14/05/13): Pair 1: Magnus Axelsson & Holger Anlauf (Q21-Q27); Pair 2: John Bleach & Fiona Tibbitt (Q1-7); Pair 3: Holly Latham & Jennifer Ashworth (Q8, Q9, Q16-Q20)

Site Name: JS Wall	Station No: 349-03 & 349-05	Latitude: 49° 55.481" Longitude: 06° 16.429"
Depth (ES): 17 Depth at top of transect (m): 17 Depth at bottom of transect (m): 23	Notes: Data was obtained over two days 13.5. & 14.5.2013 (depths are affected by the tides)	

Species / Quadrat	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30
Line Distance	0.25	0.25	0.5	0.5	0.5	0.75	1.25	1.25	1.75	2	2	2.25	2.25	2.75	2.75	3	3	3.25	3.25	3.25	3.5	3.75	4.25	4.25	4.25	4.5	4.5	4.75	5	5
Grid	C	D	B	C	D	C	A	C	D	B	D	B	D	B	D	B	D	B	C	D	A	B	A	C	D	A	B	C	B	C
Depth								18.4	19	19.5	19.6			20	20.7	20.2	20	20.4	20.3	20.2	20.5	20.8	21.7	21.7	21.7	21.8	21.8			
Axinella dissimilis (count)																														
Tethya citrina (count)																														
Cliona celata (%)																														
Hemimycale columella (%)									5	10	5	5	2	5	1	5	20	15	10	10	5	5						1	2	
Dysidea fragilis (%)																														
Haliclona viscosa (%)										1	2		1	1	5						5		2	2	5	2	2	5	1	5
Alcyonium digitatum (%)				2	5	1																								
Alcyonium glomeratum (%)											5			5												1	5		5	2
Corynactis viridis (%)	20	15	20	20	20	20	20	5	30	40	25	30	20	35	30	40	20	25	15	15	25	20	40	20	20	20	20	15	25	30
Actinothoe sphyrodeta (%)																														
Sagartia elegans (%)																														
Leptopsammia pruvoti (%)					1																									
Caryophyllia smithii (%)	1							10			2	3	1	2	1		3	1	2		2	1		2			2	1	1	1
Hoplangia durotrix (%)																														
Parazoanthus axinellae (%)																														
Parazoanthus anguicomus																														
Echinus esculentus (%)				10																										
Marthasterias glacialis (%)							5			10						10							5							
Holothuria forskali (%)											5		25																	
Antedon bifida (%)																														
Clavelina lepadiformis (%)								10			1						5			3										
Stolonica socialis (%)							5																							

Kelp Forest Communities (A2)		Date: 13 May 2013 & 15 May 2013	Site Name: Porth Hellick
Divers:	Divers (13/05/13): Pair 1: Magnus Axelsson & Holger Anluaf (site selection, line & video); Pair 2: Holly Latham & Katherine Dawson (Q1-05); Pair 3: John Bleach & Fiona Tibbit (Q16-Q21)		Station Number: 349-04 & 394-07
	Divers (15/05/13): Magnus Axelsson & Holger Anluaf (Q12-Q15, Q22-24); Pair 2: John Bleach & Katherine Dawson (Q06-11); Pair 3: Holly Latham & Jen Ashworth (Q25-Q30)		Notes: Quadrats 29+30 were mislabeled as 19&20 in the videos. Videos in order are Q30, Q29 -> Q25
Depth (ES):	10		Latitude: 49° 54.864 Longitude: 06° 16.816"
Notes:	Magnus & Holger selected the site, laid the line and filmed along it.		

Quadrat	Grid	Depth (m)	L. hyperborea	L. ochroleuca	Saccorhiza polyschides	Saccharina latissima	Alaria esculenta	L. digitata	Kelp juv.	Kallymenia reniformis	Delesseria sanguinea	Membranoptera alata	Phycodrys rubens	Heterosiphonia plumosa	Pterosiphonia parasitica	Sphaerococcus coronopifolius	Dilsea carnosa	Halurus equisetifolius
Q1	1C	10.9	1	8										P				
Q2	2B	11.1	4	8						P*c	P							
Q3	2D	10.7	0	2						P					P*c			
Q4	3B	11	8	3						P	P				P			
Q5	3D	10.2	8	5						P								
Q6	4A	10.5	8							P				P	?			
Q7	4B	10.5	10	4									P	P	?			
Q8	5A	10.6	4	9						P			P	P	?			
Q9	5C	10.8	2	2						P			P	P	?			
Q10	5D	10.8		10						P				P				
Q11	6B	10.9	5	7						P			P	P	?			
Q12	7B	10.8	4	4					2	P	P	Sample A						
Q13	9D	10.5	6	2					2	P		Sample B	P					
Q14	10A	10.3	2	4					1		P							
Q15	10B	10.3	4	3					1				P		Sample C			
Q16	10C	9.1	16							P	P		P					
Q17	11A	8.4	27										P		P			
Q18	11C	10.2	12								P		P		P			P
Q19	12B	9.6	7							P		P	P				P	
Q20	13A	9.7	10								P			P				
Q21	14B	10.4	6							P				P				
Q22	15A	9.4	4	4						P	P		P					
Q23	15C	9.4	7	10						P	P							
Q24	15D	9.4	7	4						P	P		P (Sample D)		P (Sample A1)			
Q25	16A	9.5	1	1					3		P		Sample B1		P			
Q26	16C	9.6	11	10	1				4									
Q27	17A	8.9	8	1					4	P	P		P					
Q28	18C	9.5	2	5					2		P			P				
Q29	19D	9.3	1	5					2	P	P			P				
Q30	20D	8.7	7	2					4	P	P		P	P				

Vertical Rock (B1)	Date: 15.5.2013 & 16.5.2013	Divers (150513): Pair 1: Magnus Axelsson & Holger Anlauf (piton, line & video); Pair 2: John Bleach & Katherine Dawson (Q01-Q06); Pair 3: Holly Latham & Jennifer Ashworth (Q24-Q30)	Divers: Group 1: Magnus Axelsson & John Bleach (Q19-Q23); Group 2: Fiona Tibbit & Holly Latham (Q8-Q13) Kathryn Dawson & Jennifer Ashworth (Q14-Q18) *

Site Name: Newfoundland Point	Station No: 349-06 & 349-08	Latitude: 49° 54.745" Longitude: 06° 16.840"
Depth (ES): 15	Notes:	
Depth at top of transect (m): 17.2		
Depth at bottom of transect (m): 22.2		

* incorrect positioning of quadrats on the transect line

Species / Quadrat	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30
Line distance	0.25	0.5	0.5	0.75	1	1.25	1.5	1.5	1.5	1.75	1.75	2	2.25	2.25	2.5	2.5	2.5	2.75	2.75	3	3.5	3.5	3.75	3.75	4	4	4.5	4.75	4.75	5
Grid	C	B	D	A	A	A	A	B	D	A	B	B	A	D	A	B	C	A	C	C	B	C	C	D	A	C	C	A	B	B
Depth	17.1	17.3	17.4	18	18.9	19.4	19.7	19.9	20	20.2	20.3	20.4	20.3	20.3	20.5	20.5	20.5	20.8	20.8	21	21.4	21.5	21.7	20.6	20.7	21	21.5	21.7	22	22
Axinella dissimilis (count)																														
Tethya citrina (count)																														
Cliona celata (%)					2																									
Hemimycale columella (%)								5	10			1	5	5			1	1	5	5				10	10		5	2	10	5
Dysidea fragilis (%)									3		2	3																		
Haliclona viscosa (%)					1														2				5	5			5	5		
Alcyonium digitatum (%)									1																					2
Alcyonium glomeratum (%)																														10
Corynactis viridis (%)	20	40	30	50	50	30	40	60	50	70	40	50	50	30	40	30	50	75	75	70	50	80	60	25	20	30	25	20	30	30
Actinothoe sphyrodeta (%)																														
Sagartia elegans (%)																														
Leptopsammia pruvoti (%)																														
Caryophyllia smithii (%)	1					2						2			1	1					2									
Hoplangia durotrix (%)																														
Parazoanthus axinellae (%)																														
Parazoanthus anguicomus (%)																														
Echinus esculentus (%)																														
Marthasterias glacialis (%)			1					5		5	2					5	5					5						5	10	5
Holothuria forskali (%)																														
Antedon bifida (%)																														
Clavelina lepadiformis (%)																								5						
Stolonica socialis (%)																														

Kelp Forest Communities (A2)		Date: 16 May 2013	Site Name: Lizard Rock (St Agnes)
Divers:	Magnus Axelsson & Holger Anlauf (Q13-Q18) Katherine Dawson and John Bleach (Q01-Q12)		Station Number: 349-09
	Holly Latham & Fiona Tibbit (Q19-Q30)		Magnus and Holger laid the line and then completed some quadrat work; no footage from Q19 to Q24 as camera ran out of battery.
Depth (ES):	13 m		Latitude: 49° 53.315" N Longitude: 006° 20.118" W
Notes:	SOL: 11.4 m; EOL: 8.0 m		

Quadrat	Grid	Depth (m)	L. hyperborea	L. ochroleuca	Saccorhiza polyschides	Saccharina latissima	Alaria esculenta	L. digitata	Kelp juv.	Kallymenia reniformis	Delesseria sanguinea	Membranoptera alata	Phycodrys rubens	Heterosiphonia plumosa	Pterosiphonia parasitica	Sphaerococcus coronopifolius	Dilsea carnosa	Halurus equisetifolius
Q1	1A			3		1				P								
Q2	2A		1	10						P					P			
Q3	2C		2	7								P			P			
Q4	3A		2	9						P				P		P		
Q5	5B		3	7							P					P		
Q6	5D	9.1	3	11									P	P				
Q7	6A		7	2						P								
Q8	6C	8.7	3	12						P					P			
Q9	7A		1	8						P								
Q10	7B	9.5	1	7						P					P			
Q11	7D		8	13					1	P		P						
Q12	8A			6						P					P			
Q13	9B	9.9	3	4						P			P					
Q14	10C	9.0	6	1						P			P					
Q15	10D	9.0	7	1					1	P			P			P		
Q16	12C	9.3	3	2	1					P			P					
Q17	13C	9.1	2	4						P								
Q18	13D	8.7	1	5	1				1	P			P	P				
Q19	14A	7.3	3	10					2		P			P	P	P		
Q20	14C	7.6	3						1				P		P			
Q21	15C	7.6	3	2					3	P					P			
Q22	17A	7.1	8	2					10			P	P		P			
Q23	17D	7.1	4						3		P		P					
Q24	18B	7.3	4	2					1	P				P	P	P		
Q25	18D	7.3	7	3					3		P	P	P		P	P		
Q26	19A	7.2	3	4	3				8	P		P	P			P		
Q27	19D	7.3	5	4	1				3	P				P				
Q28	20A	7.6	4	7	1				3	P		P	P		P			
Q29	20C	7.7	8	6					4	P	P	P	P	P	P	P		
Q30	20D	7.5	1	2					4	P					P	P		

Vertical Rock (B1)	Date: 17.5..2013	Divers: Pair 1: Magnus Axelsson & Holger Anlauf (piton, line & video), Pair 2: Holly Latham & Fiona Tibbit (Q25-Q30); Pair 3: John Bleach & Katherine Dawson (Q19-Q24)	Divers: Pair 1: Magnus Axelsson & Holger Anlauf (Q18-Q13); Pair 2: Fiona Tibbit & Holly Latham (Q1-Q6) Kathryn Dawson & Jennifer Ashworth (Q7-Q12)

Site Name: Menawethan	Station No: 349-10#1 and 349-11#2	Latitude: 49° 56.634" Longitude: 006° 14.746"
Depth (ES): 16 m	Notes: Magnus:"N. ramosa, N. antenina" present	
Depth at top of transect (m): 18.0		
Depth at bottom of transect (m): 23.0		

Species / Quadrat	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30
Line distance	0.25	0.25	0.5	0.5	0.75	1	1.5	1.75	2	2	2.25	2.5	2.5	2.75	3	3.25	3.25	3.25	3.25	3.5	3.5	3.75	4.25	4.25	4.5	4.75	4.75	4.75	5	5
Grid	A	C	B	C	C	A	B	D	B	D	D	C	C	D	A	A	D	C	D	A	B	C	B	D	B	A	B	D	A	D
Depth	18.3	18.3	18.3	18.3	18.3	18.3	17.8	18.1	18.3	18.3	18.6	19						20	21	21	21	21.5	21.5	21.5	24.2	24.2			24.2	
Axinella dissimilis (count)																														
Tethya citrina (count)																														
Cliona celata (%)			10																											
Hemimycale columella (%)								5	5	10													5						5	
Dysidea fragilis (%)																														
Haliclona viscosa (%)							5						5																	5
Alcyonium digitatum (%)								5																						
Alcyonium glomeratum (%)																														
Corynactis viridis (%)	50	50	50	30	40	50	30	30	30	30	30	40	50	50	60	60	50	70	60	50	50	70	50	60	75	60	70	70	75	75
Actinothoe sphyrodeta (%)																														
Sagartia elegans (%)																														
Leptopsammia pruvoti (%)																														
Caryophyllia smithii (%)																														
Hoplangia durotrix (%)																														
Parazoanthus axinellae (%)																														
Parazoanthus anguicomus (%)																														
Echinus esculentus (%)																														
Marthasterias glacialis (%)			5									5								5		10				5				
Holothuria forskali (%)																														
Antedon bifida (%)																2														
Clavelina lepadiformis (%)																														
Stolonica socialis (%)																						5								

Kelp Forest Communities (A2)		Date: 21 July 2013	Site Name: Carn Morval
Divers:	Dive 12: Pair 1: Holger Anlauf & Tom Hardy; Pair 2: Holly Latham & Ian Saunders (Q07-Q12); Pair 3: Ross Bollymore & Kevan Cook (Q19-Q24)		Station Number: 349-12 &13
	Dive 13: Pair 1: Juliet Wilson & Tom Hardy (Q01-Q06); Pair 2: Ross Bullimore & Kevan Cook (Q25-Q30); Pair 3: Holly Latham & Ian Saunders (Q13-Q18)		Dive 12: Pair 1: lay line, film along the line and do site description; Pairs 2 and 3: survey work. Samples (quadrats) taken: Dive 12: HL A-J (10 samples); RB A, C, D, H (4 samples); Dive 13:JW A-E (5 samples); HL A-C (3 samples); RB I-J (2 samples)
Depth (ES):	7m & 8m		Latitude: 49° 55.594" N Longitude: 006° 18.882" W
Notes:			

Quadrat	Grid	Depth (m)	L. hyperborea	L. ochroleuca	Saccorhiza polyschides	Saccharina latissima	Alaria esculenta	L. digitata	Kelp juv.	Kallymenia reniformis	Delesseria sanguinea	Membranoptera alata	Phycodrys rubens	Heterosiphonia plumosa	Pterosiphonia parasitica	Sphaerococcus coronopifolius	Dilsea carnosa	Halurus equisetifolius
Q1	1A	7.5		11	5					a	P		P a	P a				
Q2	2A	7.5		4	4					b	P		P	P b		b		
Q3	2C	7.6		3	2	1					P		P	P c		P	P c	
Q4	3B	7.6	1	7	3								P	P		d		
Q5	3C	7.7	3	6						e	P		P	P e		P		
Q6	4B	8.0		7	5						P		P	P		P		
Q7	4C	6.1		5						P a	P		P	P b		P		
Q8	5B	6.3		5	2					P	P			P	c	P		d
Q9	5C	6.3		6	1						P			P	e	P		P
Q10	5D	6.3	1	3	1			1			P	P	P	P	f			
Q11	6D	6.0		7	1	1				P	P			P		P		
Q12	7B	6.8		5							P		P	P	P		P	
Q13	9B	9.0		5	3					P a	P					P	P	
Q14	10A	9.5		5	2				2	P	P			P			P	
Q15	12A	9.9		8	4					P						P	P	
Q16	12D	9.7	5	2		1			1		P			P			P	
Q17	13A	10.0	2	7						P c				P	b			
Q18	13C	10.2	2	5		1					P			P			P	
Q19	14A	6.2	1	2	1					P				P		P		
Q20	15B	6.1		1	3					P				P				
Q21	16A	6.0	2	10	4					c	P							
Q22	16B	6.0	1							h	P					P		
Q23	17C	6.1		3	3						P							
Q24	18A	6.3		10		1				a	P					P		
Q25	19B	8.3	2	7						P				P			P	
Q26	19C	8.4	1	5	4					i	P			P				
Q27	19D	8.1	4	4		1				j	P			P				
Q28	20B	8.9	2	2	1									P		P		
Q29	20C	9.0		6	1						P			P		P		
Q30	20D	8.9	1	1							P			P		P		

Vertical Rock (B1)	Date: 22.07.2013 & 23.07.2013	Divers (220713): Pair 1: Holger Anlauf & Tom Hardy (piton, line & video); Pair 2: Holly Latham & Ian Saunders (Q25-Q30); Pair 3: Ross B & Kevan Cook (Q13-Q18)	Divers (230713): Pair 1: Tom Hardy & Kevan Cook (Q10-12, Q19-Q24); Group 2: Holger Anlauf & Juliet Wilson (Q01-Q09)

Site Name: Men-a-vaur	Station No: 349-14 & 349-16	Latitude: 49° 58.606" Longitude: 06° 20.137"
Depth (ES): 30 m	Notes: Line start at 14.7 m and ends at ledge at 18.5, then moves out to endge of ledge with another 0.5 m below the ledge (could not get lower as there was a large boulder with red algae making it impossible to survey)	
Depth at top of transect (m): 14.7		
Depth at bottom of transect (m): 18.5 m & 19.5 m		

Species / Quadrat	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30
Line distance	0.25	0.25	0.25	0.50	0.50	0.50	0.75	0.75	0.75	1.00	1.25	1.50	1.75	1.75	2.00	2.50	2.50	2.50	2.75	3.00	3.00	3.00	3.00	3.25	4.00	4.00	4.25	4.25	4.25	4.25
Grid	B	C	D	A	B	C	A	B	C	A	D	A	B	D	D	A	C	D	B	D	A	C	D	A	B	C	C	A	B	D
Depth	15.8	15.8	15.8	15.9	15.9	15.9	16.2	16.2	16.2	16.6			16.5	16.5	16.7	17.2	17.2	17.2	16.6					19.5	17.9	17.9	18.2	18.1	18.2	18.5
Axinella dissimilis (count)																														
Tethya citrina (count)																														
Cliona celata (%)																														
Hemimycale columella (%)								5?	10?				5			5									4	3			1	2
Dysidea fragilis (%)		10?				5?	5																				5		2	1
Haliclona viscosa (%)		20	50																											
Alcyonium digitatum (%)																			5											
Alcyonium glomeratum (%)			10																											
Corynactis viridis (%)		10	30			40	40	20	40	45	25	75	50	50	40	50	50	50	50	75	75	50	50	50	40	20	10	20	20	30
Actinothoe sphyrodeta (%)	10	10	2	10	10			2	2			5				1														
Sagartia elegans (%)										25										1										
Leptopsammia pruvoti (%)																														
Caryophyllia smithii (%)																											1			
Hoplangia durotrix (%)																														
Parazoanthus axinellae (%)																														
Parazoanthus anguicomus (%)																														
Echinus esculentus (%)																														
Marthasterias glacialis (%)																														
Holothuria forskali (%)																														
Antedon bifida (%)																														
Clavelina lepadiformis (%)																														
Stolonica socialis (%)																														

Kelp Forest Communities (A2)	Date: 22 July 2013	Site Name: Cromwell's Castle (Tresco Channel)
Divers:	Divers (22/07/13): Pair 1: Holger Anluaf & Juliet Wilson (site selection, line & video; Q13-Q18); Pair 2: Holly Latham & Ian Saunders (Q01-012); Pair 3: Ross B. & Kevan Cook (Q19-Q30)	Station Number: 349-15
		Notes:
Depth (ES):	11 m	Latitude: 49° 57.761" Longitude: 06° 21.057"
Notes:	Holger & Juliet selected the site, laid the line & filmed it + did 6 quadrats	

Quadrat	Grid	Depth (m)	L. hyperborea	L. ochroleuca	Saccorhiza polyschides	Saccharina latissima	Alaria esculenta	L. digitata	Kelp juv.	Kallymenia reniformis	Delesseria sanguinea	Membranoptera alata	Phycodrys rubens	Heterosiphonia plumosa	Pterosiphonia parasitica	Sphaerococcus coronopifolius	Dilsea carnosa	Halurus equisetifolius
Q1	1A	8.6	1	5						P	P			P	P a			
Q2	2B	8.5	1	8						b	P				b			
Q3	4D	9.2		9						P	P			P	c			
Q4	6B	10.0	1	8						P	P			P	d			
Q5	6C	9.9	3	5						P	P			P	e			
Q6	7B	10.3	1	3						P	P			P			P	
Q7	7C	10.2	3	6							P		P	P	f		P	
Q8	7D	9.9		8					4		P	P		P				
Q9	8D	10.0	1	10						P	P			P	h			
Q10	9C	9.8	2	7	2						P	P		P	i			
Q11	9D	10.0		11						P	P			P	i			
Q12	10B	11.0	1	6	1						P			P	i			
Q13	11B	8.0		6	1					a	P			P				
Q14	12A	8.2		9						P b	P							
Q15	12C	8.4	2	4	5					P c	P			P				
Q16	13A	8.6		4						P	P							
Q17	13B	8.8	2	9		1				P	P							
Q18	13C	8.7	3	7							P			P d				
Q19	14B	10.1	1	3						P	P			P				
Q20	15A	10.0	1	12							P			P		P	P	
Q21	15B	9.9		4						P				P				
Q22	15C	9.8	2	4						P	P			P				
Q23	16A	9.7		5	1					P	P			P		P	P	
Q24	16B	9.5	1	9	1						P			P		P		
Q25	16C	9.5	1	6	2						P				P e	P		
Q26	16D	9.2	1	5										P			P	
Q27	17B	9.3	1	11	1						P						P	
Q28	17D	9.2		3							P			P				
Q29	18A	9.0	1	10	3						P			P			P	
Q30	19A	8.5		9							P			P				

Kelp Forest Communities (A2)		Date: 23 July 2013	Site Name: Porth Morran (White Island)
Divers:	Divers (23/07/13): Pair 1: Holger Anluaf & Juliet Wilson (site selection, line & video; Q13-Q18); Pair 2: Holly Latham & Tom Hardy (Q01-012); Pair 3: Ross B. & Kevan Cook (Q19-Q30)		Station Number: 349-17
			Notes:
Depth (ES):	7.4 m		Latitude: 49° 57.761" Longitude: 06° 21.057"
Notes:	Holger & Juliet selected the site, laid the line & filmed it + did 6 quadrats		

Quadrat	Grid	Depth (m)	L. hyperborea	L. ochroleuca	Saccorhiza polyschides	Saccharina latissima	Alaria esculenta	L. digitata	Kelp juv.	Kallymenia reniformis	Delesseria sanguinea	Membranoptera alata	Phycodrys rubens	Heterosiphonia plumosa	Pterosiphonia parasitica	Sphaerococcus coronopifolius	Dilsea carnosa	Halurus equisetifolius
Q1	1A	7.3	3	7	2					P	P			P				
Q2	1B	7.5	4	6						P	P			P	P a	P		
Q3	1D	7.7	4	5								P		P				
Q4	2B	7.6	3	4							P			P				
Q5	3D	7.6		4	1					P				P	P b	P	P	
Q6	4A	7.8	3	5										P	P c			
Q7	5A	7.8	2	4						P				P	P e		P	
Q8	5A	8.1	5	4						P	P			P	P f			
Q9	6C	8.1	1	5						P		P			P g			
Q10	6D	8.6	2	4										P		P		
Q11	7B	8.4	4	3							P			P				
Q12	7C	8.9		6										P		P		
Q13	7D	7.5	2	5	1									P a				
Q14	8A	7.7	1	2						P b								
Q15	8C	7.9	4	12						P			P	P		P c		
Q16	10A	8.2		4						P				P				
Q17	12A	8.6	1	2												P d		
Q18	12D	8.7	3	14						P	P			P				
Q19	13B	9.2		9										P		P		
Q20	13D	8.6		4	1				2	P				P	g	P		
Q21	14D	8.5		1						P	P	f		P	f	P	P	
Q22	15B	8.8	1	5										P		P		
Q23	15C	8.2	3	3			1			P	P			P	P i	P		
Q24	15D	8.6	1	2						P b	P			P		P		
Q25	16A	8.3		10										P	P j	P		
Q26	17C	8.4	3	10										P		P		
Q27	18A	8.7		2						P a				P		P	P	
Q28	20A	8.7	1	5						P				P		P	P	
Q29	20B	8.6		3						P				P		P		
Q30	20C	8.7		1			1									P		

Vertical Rock (B1)	Date: 24.07.2013 & 25.07.2013	Divers (240713): Pair 1: Holger Anlauf & Magnus Axelsson (piton, line & video); Pair 2: Ross B. & Kevan Cook (Q19-Q24); Pair 3: Holly Latham & Ian Saunders (Q25-Q30)		Divers (250713): Pair 1: Magnus Axelsson & Kevan Cook (Q17-18, Q25-Q29); Group 2: Holly Latham & Ian Saunders (Q09-Q16)) Tom & Juliet Wilson (Q01-Q08)
Site Name: John Thomas Ledge		Station No: 349-18 & 349-20 & 349-23	Latitude: 49° 58.628" Longitude: 06° 16.404"	Divers (26072013): Pair 1: Magnus Axelsson & Kevan Cook (Q17-18, Q25-Q29) - extra survey as camera not working on 25072013. *
Depth (ES): 16 m		Notes: Line starts at 19.7 m and ends at ledge at 22.5 (where there is a ledge), then moves out to endge of ledge with another 2.0 m below the ledge. On 25/07/13 quadrats Q25-Q29 were re-analysed as these were previously completed on the ledge rather than the wall		* Camera worked fine - photos taken.
Depth at top of transect (m): 19.4 m				
Depth at bottom of transect (m): 22.5 m & 25.5 m				

Repeated - do not use

Quadrats repeated - do not use

Species / Quadrat	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30
Line distance	0.50	0.50	0.50	0.75	0.75	1.50	1.50	1.75	2.00	2.00	2.25	2.25	2.50	2.75	3.00	3.00	3.25	3.25	3.50	3.50	3.75	3.75	4.00	4.00	4.25	4.25	4.50	4.50	4.50	5.00
Grid	A	B	C	A	D	B	C	B	A	C	C	D	D	D	A	D	B	D	B	D	A	C	C	D	B	C	A	B	D	C
Depth									19.0	18.8	19.2	19.3	19.6	19.6	20.0	20.0	22.4	22.4									22.8	22.8	22.8	
Axinella dissimilis (count)																														
Tethya citrina (count)																														
Cliona celata (%)																														
Hemimycale columella (%)																								10						
Dysidea fragilis (%)																														
Haliclona viscosa (%)					5																									
Alcyonium digitatum (%)															1	1										5		1		
Alcyonium glomeratum (%)																														
Corynactis viridis (%)	85	75	40	80	20	60	35	30	70	50	30	40	40	50	40	30	75	75	50	65	60	50	60	70	60	60	60	60	60	60
Actinothoe sphyrodeta (%)					1																									
Sagartia elegans (%)																														
Leptopsammia pruvoti (%)																							5							
Caryophyllia smithii (%)											1		1			1														
Hoplangia durotrix (%)																														
Parazoanthus axinellae (%)																														
Parazoanthus anguicomus (%)																														
Echinus esculentus (%)																														
Marthasterias glacialis (%)				5							10											10								
Holothuria forskali (%)		10	20																											
Antedon bifida (%)																														
Clavelina lepadiformis (%)															3	10														
Stolonica socialis (%)																														

Vertical Rock (B1)	Date: 24.07.2013 & 26.07.2013	Divers (240713): Pair 1: Holger Anlauf & Tom Hardy (piton, line & video); Pair 2: Ross B & Kevan Cook (Q01-Q06); Pair 3: Holly Latham & Ian Saunders (Q07-Q12)	Divers (230713): Pair 1: Tom Hardy & Holly Latham (Q13-Q18), Pair 2: Ross B. & Ian Saunders (Q19-Q24); Pair 3: Holger Anlauf & Juliet Wilson (Q25-Q30)

Site Name: East Withan	Station No: 349-19 & 349-22	Latitude: 49° 58.606" Longitude: 06° 20.137"
Depth (ES): 13 m	Notes: Line start at 16.5 m and ends at ledge at 21.0, making it a 4.5 m long vertical wall. Current too strong further out (E) and there are no long walls further in.	
Depth at top of transect (m): 16.5		
Depth at bottom of transect (m): 21.0		

Species / Quadrat	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30
Line distance	0.25	0.25	0.75	1.00	1.00	1.25	1.50	1.50	1.75	2.00	2.00	2.25	2.25	2.50	2.75	2.75	2.75	3.00	3.00	3.25	3.25	3.50	3.50	3.75	3.75	4.00	4.00	4.25	4.50	4.50
Grid	A	C	A	C	D	C	A	B	B	C	D	A	D	C	A	C	D	A	B	A	B	A	B	C	D	C	D	C	A	B
Depth							18.7	18.5		19.1	19.0	19.2	23.1	23.3	23.6	23.7	23.7	24.0	23.3	23.6	23.6	23.7	23.7	23.9	22.8	23.0	23.0	23.6	24.0	24.0
Axinella dissimilis (count)																														
Tethya citrina (count)																														
Cliona celata (%)																														
Hemimycale columella (%)				10			5																							
Dysidea fragilis (%)																														
Haliclona viscosa (%)																										20			5	5
Alcyonium digitatum (%)									1																					
Alcyonium glomeratum (%)																														
Corynactis viridis (%)	20	15	10	20	25	40	50	60	50	70	80	90	70	80	90	80	80	80	75	75	80	30	80	60	80	70	60	70	40	70
Actinothoe sphyrodeta (%)			5																											
Sagartia elegans (%)																														
Leptopsammia pruvoti (%)																														
Caryophyllia smithii (%)		5					1	1	3													15								
Hoplangia durotrix (%)																														
Parazoanthus axinellae (%)																														
Parazoanthus anguicomus (%)																														
Echinus esculentus (%)																														
Marthasterias glacialis (%)																									5					
Holothuria forskali (%)																														
Antedon bifida (%)																														
Clavelina lepadiformis (%)																														
Stolonica socialis (%)																														

Kelp Forest Communities (A2)		Date: 25 July 2013	Site Name: Frenchman's Rock (Little Arthur)
Divers:	Divers (25/07/13): Pair 1: Magnus Axelsson & Kevan Cook (site selection, line & video; Q13-Q18); Pair 2: Holly Latham & Ross B. (Q19-30); Pair 3: Juliet Wilson & Tom Hardy (Q01-Q12)		Station Number: 349-21
			Notes:
Depth (ES):	12.1 m		Latitude: 49° 56.713" Longitude: 06° 15.695"
Notes:			

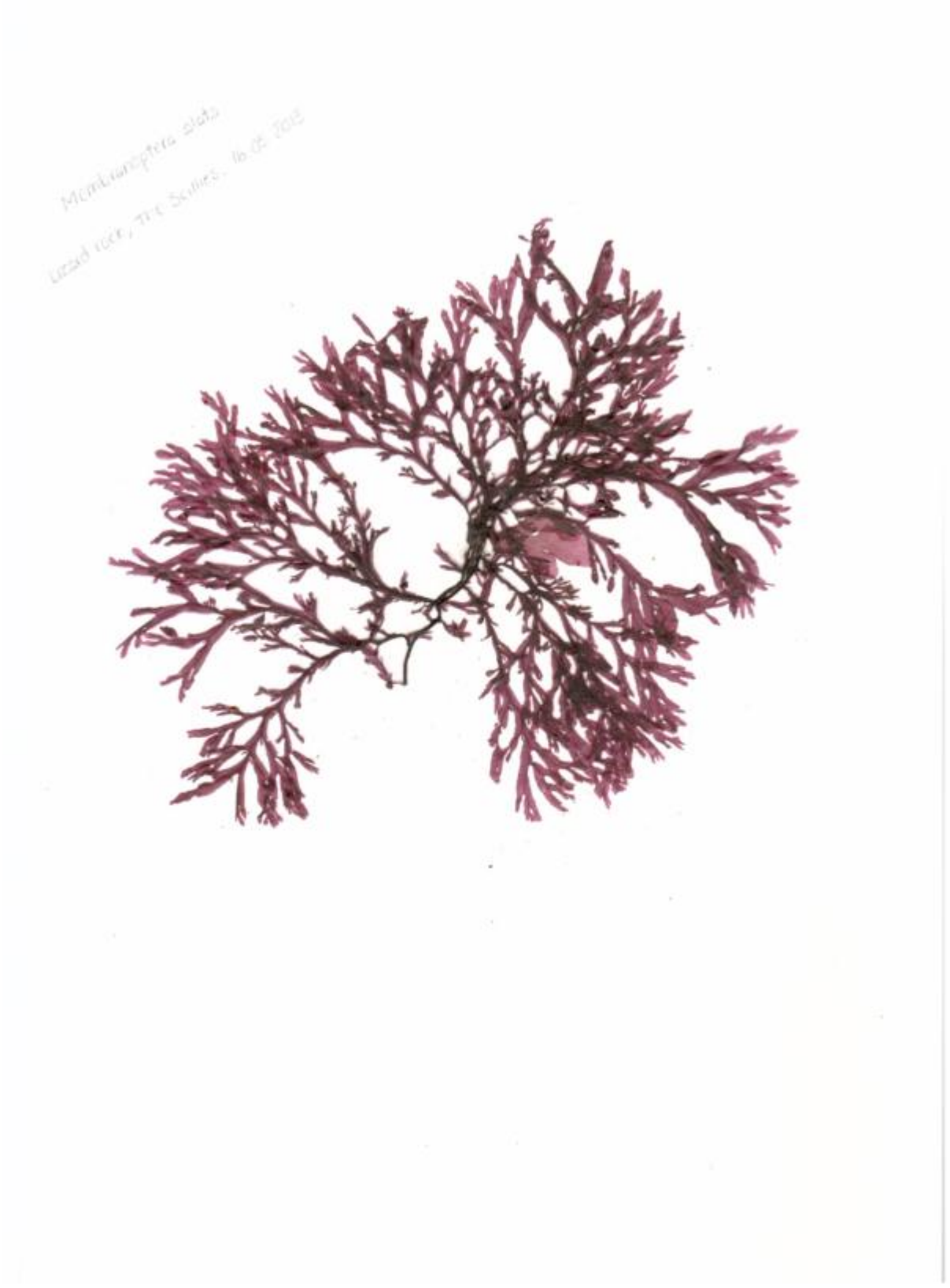
Quadrat	Grid	Depth (m)	L. hyperborea	L. ochroleuca	Saccorhiza polyschides	Saccharina latissima	Alaria esculenta	L. digitata	Kelp juv.	Kallymenia reniformis	Delesseria sanguinea	Membranoptera alata	Phycodrys rubens	Heterosiphonia plumosa	Pterosiphonia parasitica	Sphaerococcus coronopifolius	Dilsea carnosa	Halurus equisetifolius
Q1	1A	6.5	12										P					
Q2	1B	6.8	7	2								P a	P	P				
Q3	1C	7.1	4	3							P c							
Q4	3A	6.4	6										P					
Q5	3B	6.4	7										P d					
Q6	3C	6.9	16	4						P		P e	P					
Q7	3D	7.0	5										P					
Q8	4A	7.2	8	1								P	P					
Q9	4C	7.5	13	2						P f	P		P					
Q10	6B	7.4	9							P i	P							
Q11	8A	5.3	10										P					
Q12	8B	6.0	12							P g	P	P g	P					
Q13	8C	4.5	2	7					1	P			P					
Q14	8D	4.5	6	5	2					P	P		P					
Q15	9B	4.3	2	5	1				2	P	P		P			P		
Q16	9C	4.5	3	3					1	P			P					
Q17	10B	4.7	2	4							P		P					
Q18	10D	4.8	5	3					2	P	P		P					
Q19	11A	6.1	17										P		P d			
Q20	11D	5.8	26							P	P	P	P					
Q21	12A	3.8	16								P	P	P					
Q22	13B	5.3	8							P		P	P		P c			
Q23	13D	5.8	19								P	P	P					
Q24	14A	5.0	35								P		P					
Q25	14B	4.5	14								P	P	P	P				
Q26	14C	4.9	11							P		P	P		P b			
Q27	15B	4.8	14									P	P					
Q28	15D	4.4	15												P a			
Q29	18B	5.2	4															
Q30	20D	4.0	28								P	P						

APPENDIX 5 PRESSED ALGAE

Delesseria sanguinea

Heterosiphonia plumosa

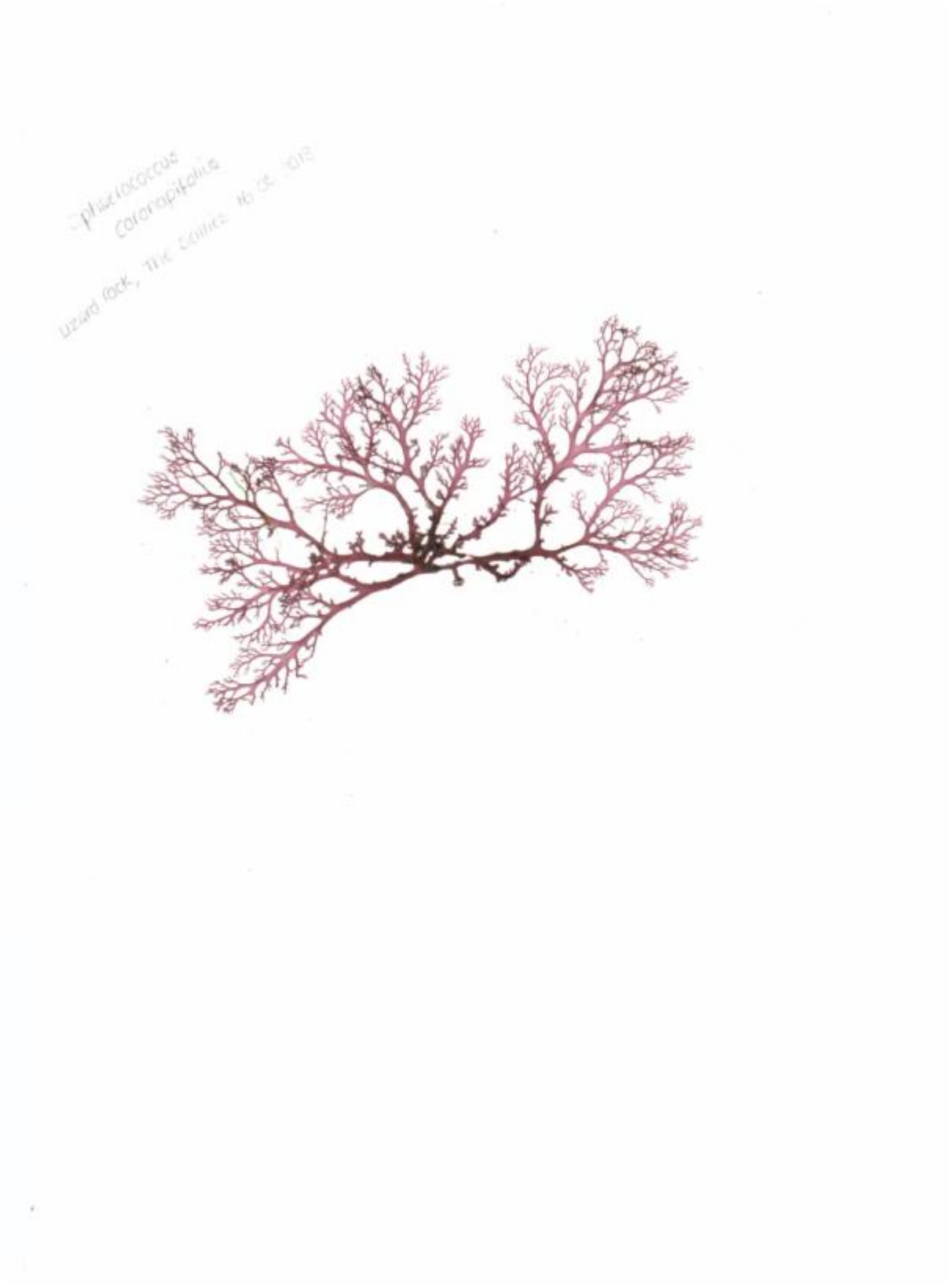
Kallymenia reniformis



Membranoptera alata

Phycodrys rubens

Pterosiphonia parasitica



Sphaerococcus coronopifolius