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Fal and Helford SAC Maerl Drop-down Video and Dive Survey 2013

Fal and Helford Special Area of Conservation (SAC)

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Foreword

The **Improvement Programme for England's Natura 2000 sites (IPENS)**, supported by European Union LIFE+ funding, is a new strategic approach to managing England's Natura 2000 sites. It is enabling Natural England, the Environment Agency, and other key partners to plan what, how, where and when they will target their efforts on Natura 2000 sites and areas surrounding them.

As part of the IPENS programme, we are identifying gaps in our knowledge and, where possible, addressing these through a range of evidence projects. The project findings are being used to help develop our Theme Plans and Site Improvement Plans. This report is one of the evidence project studies we commissioned.

A survey was commissioned for the Fal and Helford Special Area of Conservation (SAC) in order to gather data on the distribution, extent and range of communities to provide evidence for assessing changes within the site and to be able to monitor future changes. The survey comprised of a drop-down camera survey and a scientific diving survey. Anthropogenic impacts on the site's features and invasive species were also discussed.

The report indicates no change in extent or distribution of existing live maerl beds. Although there were some differences in the species composition compared to previous surveys, the community present was largely the same. The study has also provided a more accurate picture of the distribution of habitats present within the maerl beds.

The key audience for this work is the staff within Natural England and should be used to inform current site condition and future monitoring and management requirements.

Natural England Project officer: Gavin Black, **gavin.black@naturalengland.org.uk**

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Fal and Helford SAC Maerl Drop-down Video and Dive Survey 2013

For further information please contact Dr Magnus Axelsson
Seastar Survey Ltd., Ocean Quay, Belvidere Road, Southampton, SO14 5QY
Email: maxelsson@seastarsurvey.co.uk

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SUMMARY

Fal and Helford SAC Maerl Drop-down Video and Dive Survey 2013

Background

Seastar Survey Ltd. was contracted by Natural England (NE) to undertake a survey of the Fal and Helford Special Area of Conservation (SAC) in the summer of 2013. The survey was intended to gather data to inform condition monitoring of the maerl bed sub-feature of the Fal and Helford SAC. Three attributes were to be assessed during the survey:

- Extent of maerl bed communities
- Distribution of maerl bed communities
- Species composition of maerl bed communities

In order to achieve these objectives, a two phase survey was planned, comprising of a drop-down camera survey and a scientific diving survey. The drop-down video survey was designed to investigate the extent and distribution of the maerl bed communities within the SAC. The main aim of the scientific diving survey was to assess the species composition of the maerl beds within the SAC, supporting the data gathered during the drop-down video survey.

Main findings

- The drop-down camera survey was conducted from 5th to 14th September 2013. A total of 100 camera drops were undertaken, with 28 hours, 08 minutes and 20 seconds of video footage recorded, and 1984 still photographic images taken.
- The scientific diving survey took place between 19th and 26th September 2013. 15 dive stations were investigated, and a total of 418 quadrats were analysed over a six day period.
- Video and still photograph data were analysed to examine the habitats within the Fal and Helford SAC, and to assess the extent and boundaries of the maerl bed sub-features.
- The majority of the sediments within Falmouth Bay were comprised of coarse or mixed sediments, much of which had a significant dead maerl component (**SS.SMx** and **SS.SCS** biotope complexes). The coarse sediments often had patches of red algae and kelp (**SS.SMp.KSwSS.LsacR** biotopes). Areas of seagrass (**SS.SMp.SSgr**), kelp forest and fragile sponge and anthozoan communities on circalittoral rock (**CR.HCR.XFa.ByErSp.Eun**) were also identified.
- The known live maerl beds at St. Mawes Bank and Castle Point were shown to roughly match the currently known extent and boundaries of the sub-feature. Video and still photographs showed the beds to be comprised of both **SS.SMp.Mrl.Lcor** and **SS.SMp.Mrl.Pcal** biotopes.
- Static fishing gear meant that the planned survey lines to assess the extent of the live maerl bed in Helford River could not be completed. The data gathered suggested that the live bed matches the **SS.SMp.Mrl.Lcor** biotope, and that the boundaries may match the current known extent of the sub-feature, although this could not be confirmed due to the presence of the fishing gear.
- It was initially intended to use historic data to complete comparisons between the 2013 data and historic data. In particular, raw data from the survey completed by Howson *et al.* (2004) was meant to be used to assess any potential change in maerl cover, health and extent as well as assess any changes in the algal community found on the maerl beds. Whilst it was possible to assess changes in extent, unfortunately

it was not possible to assess the remaining parameters (maerl cover, health and red algal communities) as the available historic data were inconsistent, unclear (e.g. confusing site numbering with different site names in the report and in the spreadsheets) and incomplete. Such statistical tests and comparisons with historic data were therefore not completed as part of the current contract.

- Multivariate analysis of the data from the scientific diving survey showed that there were distinct differences in the communities present on areas dominated by *Phymatolithon calcareum* compared to those dominated by *Lithothamnion corallioides*. In addition, the community present on the *L. corallioides* beds showed some differences based on geographical location, with dive sites within St. Mawes Bank having different communities to those from Castle Point and Helford River.
- The maerl habitat species composition showed some small differences to previous surveys, mainly due to the presence / absence of red algae species. These differences may be due to previous surveys being conducted at a different time of year compared to the current survey, or varying levels of taxonomic expertise with regards to red algae, rather than representing significant differences in maerl community composition over time.
- The drop-down camera survey and scientific diving survey data suggested that the maerl bed sub-features within the Fal and Helford SAC have not changed significantly from the known data at the time of the survey.

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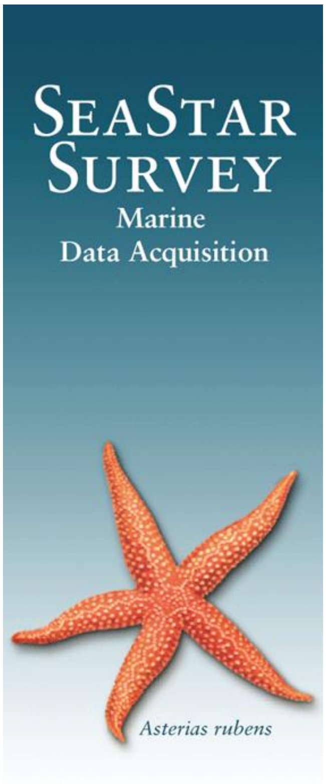
PROJECT PERSONNEL

This report and the surveys detailed within were undertaken by Seastar Survey Ltd. on behalf of Natural England. All of the Seastar Survey Ltd. personnel involved in the project are listed below.



Project Tendering	Steven Dewey
Drop-down Video Team	
Field work team leader	Chris Allen
Vessel skipper	Simon Hoole
Survey team members	Nick Grey Alex Shakspeare Andrew Jackson
Dive Survey Team	
HSE dive contractor	Steven Dewey
Project manager	Magnus Axelsson
Survey team members	Magnus Axelsson Juliet Wilson Frederick Tones
Data Analysis	
Still photography analysis	Chris Allen Magnus Axelsson Juliet Wilson
Video analysis	Chris Allen Juliet Wilson
GIS processing	Chris Allen Magnus Axelsson
Report Writing	
Lead authors	Chris Allen & Magnus Axelsson
Additional authors	Juliet Wilson

1 INTRODUCTION

The Fal and Helford was designated SAC status in 2004, primarily due to the presence of extensive maerl beds of *Phymatolithon calcareum* and *Lithothamnion corallioides*. Extensive beds of live maerl occur in the lower Fal on St. Mawes Bank and in the Helford River, whilst there are widespread areas of maerl gravel that extend throughout the Carrick Roads and Falmouth Bay. These represent the largest maerl beds in south-west Britain, and harbour a rich variety of both epifaunal and infaunal species. The extent and variety of these subtidal habitats supports a wide diversity of habitats and species.

Previous surveys have been undertaken to examine the maerl communities within the SAC, identifying the composition and abundance of species within the maerl communities (e.g. Howson *et al.,* 2004; Bunker, 2013). A recent report has used previously acquired data to map habitats and sub-features within the SAC (Natural England, 2013). This report represents the most comprehensive collation to date of spatial data on the features and sub-features of the Fal and Helford SAC, including maerl bed communities. The habitat polygons were created from spatial data extracted from a number of surveys conducted over the last 40 years, with the intention of creating a dataset to be used for informing future conservation and management of the SAC (Natural England, 2013).

Seastar Survey Ltd. was contracted by Natural England (NE) to undertake a survey of the Fal and Helford Special Area of Conservation (SAC) in the summer of 2013. The data gathered from the survey would be used to inform condition monitoring of the maerl bed sub-feature of the Fal and Helford SAC. Three attributes were to be assessed during the survey:

- Extent of maerl bed communities
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In order to achieve these objectives, a two phase survey was planned, comprising of a drop-down camera survey and a scientific diving survey. The drop-down video survey was designed to investigate the extent and distribution of the maerl bed communities within the SAC. The main aim of the scientific diving survey was to assess the species composition of the maerl beds within the SAC, supporting the data gathered during the drop-down video survey.

The drop-down video survey was designed around the habitat polygons from the 2013 Natural England report, which were used to select survey stations to order to achieve the objectives of the current survey (Figure 1.1). Diving survey sites were to be selected to be evenly spread over the live maerl beds, with sites in both the St. Mawes Bank (including Castle Point) and the Helford River maerl beds. The selection of sites at St Mawes Bank was largely based on the sites assessed by Howson *et al.* (2004), but the locations were also chosen based on the results of the drop down video survey that had just been completed in the same area. All survey sites were in water depths of less than 30 m and had safe access. In addition, stations were chosen so that they could easily be resurveyed in the future.

The data collected will be used to monitor the condition of the Fal and Helford SAC. The subtidal monitoring initiated by this survey aims to further develop a baseline for a long-term monitoring programme under the Habitats Directive and enable any 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.

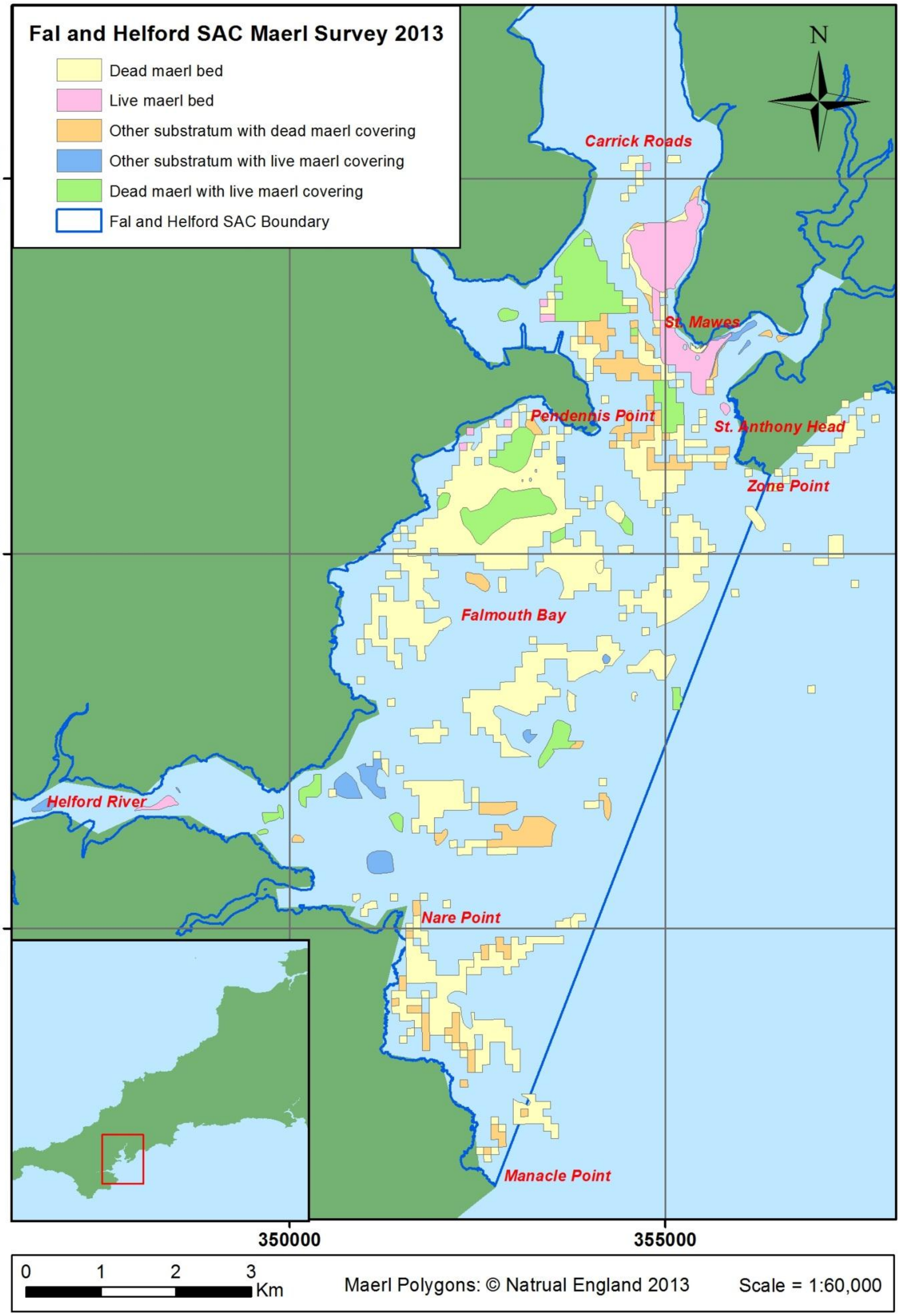

Figure 1.1. Fal and Helford SAC, with maerl habitat polygons (data from Natural England, 2013).

1.1 Survey area

Falmouth Bay is located on the south coast of Cornwall in the south-west coast of the UK. The mouth of the Fal Estuary lies between Pendennis Point and St. Anthony Head, where it extends 18 km inland to the tidal limit at Tresillian (Royal Haskoning, 2009). Within the Fal estuary there is a sheltered area called Carrick Roads, which has been dredged to create a deeper channel in the middle. The entire area encompassing Falmouth Bay, including the Fal and Helford Rivers and Carrick Roads, has been selected as a Special Area of Conservation (SAC) under the EU Habitats Directive for the presence of several Annex I habitats.

1.2 Fal and Helford SAC

The Fal and Helford was designated a Special Area of Conservation (SAC) under the 1994 Habitat Regulations, forming an area of approximately 64 km^2 (JNCC, 2013a). The site has been designated for the following Annex I habitats:

- 1110 Sandbanks which are slightly covered by sea water all the time
- 1130 Estuaries
- 1140 Mudflats and sandflats not covered by seawater at low tide
- 1160 Large shallow inlets and bays
- 1170 Reefs
- 1330 Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)

The following Annex II qualifying species is also present which was a primary reason for selection of the site:

- 1441 Shore dock *Rumex rupestris*

The Fal and Helford SAC is in the centre of the distribution of the rare shore dock *Rumex rupestris* in south-west England. Three sections of open coastline within the SAC were found to support 12 colonies and at least 34 plants when surveyed in 1999 (JNCC, 2013a). There are also further extensive areas of suitable habitat in the area (JNCC, 2013a).

Maerl beds are of high conservation importance as they support a highly diverse community of species and grow very slowly, and therefore take a long time to recover if damaged (Hall-Spencer *et al.*, 2008). Growth rates for maerl that have been recorded from Ireland, England, France, Norway, Scotland and Spain, are within the order of tenths of millimetres to one millimetre per year (Bosence & Wilson, 2003). Studies by Blake & Maggs (2003) concluded that the three most abundant species of maerl in Europe (*Phymatolithon calcareum, Lithothamnion corallioides* and *L. glaciale*) grow between 0.5 – 1.5 mm per tip per year under a wide range of field and artificial conditions. The maerl beds are also significant for commercial fisheries, since they act as nursery areas for the juvenile stages of commercial species such as cod (*Gadus morhua*), edible crabs (*Cancer pagurus*) and scallops (*Aequipecten opercularis*) due to their complex three-dimensional structure (Kamenos *et al.*, 2004). They can also support high densities of broodstock bivalves (Hall-Spencer *et al.*, 2008).

There has been a proposal to define an area of ~0.75 km^2 within the SAC to the east of Carrick Roads a Marine Conservation Zone (MCZ) reference area, protecting the nationally important maerl bed at St. Mawes Bank and also *Zostera marina* beds. No extraction, deposition or any activity that would damage the maerl habitat would be permitted within the area, including anchoring (The Wildlife Trusts, 2013). Defra is currently planning a review of MCZ reference areas.

1.3 Background environment

1.3.1 Geology and sedimentary environment

Falmouth Bay consists of thick, alternating sandstone and mudstone sequences from the Middle and Upper Devonian age (Royal Haskoning, 2009). At Falmouth, younger Upper Devonian mudstones and siltstones are present below, which are visible along the western side of Carrick Roads. Within the estuary itself, Carnmellis granite is mainly present, with surrounding metamorphic rocks to the west of the estuary (Royal Haskoning, 2009).

The Devonian metasediments and granites contain very important polymetallic mineralisation (Pirrie *et al.*, 2003). There has been mining of metalliferous deposits (mainly tin, copper, lead and iron) since the Bronze Age, with a peak in the 19^{th} century in the Carnon Valley (Pirrie *et al.*, 2003). There has previously been a large input of china clay wastes from St. Austell that has caused major silting in the upper estuary and its saltmarshes. Towards the mouth of the estuary marine sands begin to dominate (Langston *et al.*, 2003).

The Helford catchment consists of sedimentary, Devonian carboniferous rocks. To the north of the river there is a large mass of granite, which was quarried during the 19^{th} century (Langston *et al.*, 2003).

1.3.2 Physical conditions

The Fal and Helford estuaries create a ria system (drowned river valley), which formed as a result of eustatic sea level rise at the end of the last ice age (Langston *et al.*, 2003). Therefore a range of exposures to wave action is present within the SAC. Sites in the Fal and Helford Rivers are very sheltered and Carrick Roads is moderately sheltered, whereas sites in Falmouth Bay along the open coast are fully exposed to wave action (Howson *et al.*, 2004).

The SAC area is generally shallow with depths predominantly less than 20 m (Howson *et al.*, 2004). Carrick Roads is a deep meandering channel with a maximum depth of 34 m at the seaward end, and there are wide, shallow platforms on both sides of the main channel (Royal Haskoning, 2009). The channel becomes narrower and shallower further inland. There are six main tributaries and 28 minor creeks and rivers at the northern part of the Fal estuary, all of which discharge into Carrick Roads (Royal Haskoning, 2009). The Helford is quite shallow, with a depth of only 8-10 m at the mouth (English Nature, 2006).

The estuary has a mean spring tidal range of 4.6 m and a mean neap tidal range of 2.2 m, creating peak spring tidal currents of 0.8 ms^{-1} and peak neap tidal currents of 0.2 ms^{-1} (Royal Haskoning, 2009). The peak tidal currents on both flood and ebb tides occur at Pendennis Point, since the flow is constricted between headlands. There is a series of eddies during the flood and ebb tides in Falmouth Harbour entrance as the flow in and out of the inner harbour interacts with the flow in and out of Carrick Roads (Royal Haskoning, 2009). These strong currents combined with the low freshwater input means that the Fal estuary is well mixed during much of the year, but stratification occurs in the summer months. The marine part of the Helford is highly stratified in both temperature and salinity (Langstone *et al.*, 2003).

The prevailing wind direction is from the south-west, with 47% of the observed wind data being between 225° and 285° (Royal Haskoning, 2009). However, Falmouth Bay is relatively protected from south-westerly winds (English Nature, 2006). Wave conditions around Falmouth are a combination of offshore swell and locally generated wind-waves (Falmouth Harbour Commissioners, 2013). Therefore the most common wave direction (63%) is between 255° and 285° coinciding with the prevailing winds, and most of the largest waves are also in this direction (Royal Haskoning, 2009).

The mean surface water temperature ranges from a maximum of 17°C average in August to a minimum of 9.7°C average in March (Global Sea Temperature, 2013). Salinity within most of the Fal estuary is fully marine, because of the very low riverine input and strong tidal influence (Howson *et al.*, 2004).

1.3.3 Ecology

The Fal and Helford supports a wide range of communities that are representative of marine inlets and shallow bays (JNCC, 2013a). The rias have a low freshwater input, so the area consists of a variety of fully marine habitats, from extremely sheltered in the inlets to the wave-exposed open coast (JNCC, 2013a). There are patches of rocky reef with gullies, outcrops and crevices, boulders and cobbles, faunal turf and beds of maerl, eelgrass and brittlestars (Seasearch, 2003). Several warm-water species are present and there is a wide range of algal species (JNCC, 2013a). The rich diversity of species present include dead man's fingers *Alcyonium digitatum*, the boring sponge *Cliona celata*, hydroids and spiny starfish *Marthasterias glacialis* (Seasearch, 2003). Large colonies of the bryozoan *Pentapora foliacea* can be found as well as occasional patches of pink sea fans *Eunicella verrucosa* (Seasearch, 2003). There are also kelp forests with other mixed seaweeds, such as the dense kelp forest at Castle beach, which supports a wide range of fish species including ballan, corkwing, goldsinny and cuckoo wrasse, pollack, pipefish, tompot blenny, sandeels and plaice (Seasearch, 2003). Thornback rays have been recorded several times in the area (Seasearch, 2010).

The site supports such a wide diversity of habitats and species due to a number of factors:

- variety of wave exposures from open to sheltered coast, providing different environments required by a range of habitats and species;
- different rate of tidal flow within the embayment, contributing to the variety of marine environments;
- south western location, with seawater temperatures allowing species to occur that are usually more southern in their distribution;
- varying topography, with vertical faces, overhangs, gullies and rockpools all increasing habitat and community diversity.

Sublittoral sandbanks are present throughout most of the ria system and Falmouth Bay, and are one of the richest examples of sandbanks in the UK (JNCC, 2013a). This is due to the sheltered nature of the site, the low tidal range and wide variety of substrates. There are eelgrass (*Zostera* sp.) beds at the mouth of the Fal and Helford and in some of the channels of the rias, with diverse invertebrate communities (JNCC, 2013a). Many snakelocks anemones *Anemonia viridis* can be found on the stems of the eelgrass, with *Megalomma vesiculosum*, *Sabella pavonina*, cuttlefish, greater and snake pipefish and pollack also present (Seasearch, 2006). Maerl beds of *Lithothamnion corallioides* and *Phymatolithon calcareum* are present in the lower Fal and St. Mawes Bank, and extensive maerl gravel beds extend throughout Carrick Roads and Falmouth Bay (Howson *et al.*, 2004). These are the largest maerl beds in England and support a wide variety of epifaunal and infaunal species (JNCC, 2013). The maerl bed is at a depth of 6.5 – 8 m and also has sand, mixed sediment, kelp and mixed seaweeds (Seasearch, 2006). Many species were recorded on the maerl beds during Seasearch dives, including *Cerianthus lloydii*, *Pagurus bernhardus*, *Obelia geniculata*, *Sabella pavonina* and *Sagartiogeton undatus* (Seasearch, 2006). Some rare species have also been recorded, such as Couch's goby *Gobius couchi* (JNCC, 2013a).

In the inner sheltered parts of Carrick Roads are finer sediments with *Ostrea edulis* (native oyster) and the fan shell *Atrina fragilis*. In the more wave-exposed and tide-swept areas there are subtidal reefs with kelp forest and rich epibenthic communities (Howson *et al.*, 2004).

The Helford estuary encompasses one of the largest eelgrass (*Zostera* sp.) beds in Cornwall at depths of 2-5m, with silty sand on the seabed at the edges of the estuary (Seasearch, 2003). These eelgrass beds provide shelter, feeding and breeding grounds for a wide variety of species including peacock worms *Sabella pavonina*, tube worms *Myxicola infundibulum*, daisy anemones *Cereus pedunculatus* and snakelocks anemones *Anemonia viridis*, as well as fish such as gobies, bib and wrasse (Seasearch, 2003). The invasive non-native species Japanese wireweed *Sargassum muticum,* harpoon weed *Asparagopsis armata* and slipper limpet *Crepdula fornicata* are also present (Seasearch, 2003; Seasearch, 2010). The Helford River was also designated as a Voluntary Marine Conservation Area in 1987 (Helford Voluntary Marine Conservation Area, 2013).

Most of the Fal and Helford rias and their upper parts are fringed by sheltered intertidal mudflats and sandflats (JNCC, 2013a). Many important species, including amphipods, polychaetes, bivalve molluscs and the holothurian *Leptopentacta elongata*, are found living in the sediments. The sediments are stable and diverse because the area is so sheltered, consisting of muds, muddy sand and clean sand (JNCC, 2013a). There are particularly rich and nationally important sediment communities, including dwarf eelgrass *Zostera noltei* beds and diverse invertebrate communities (JNCC, 2013a). The salt meadows within the SAC show typical saltmarsh zonation, and contain vegetation only found within ria environments in south-west England and west Wales (JNCC, 2013a).

1.3.4 Invasive species

Invasive non-native species have been recorded all along the Fal from the upper river at Ruan Lanihorne to the Black Rock buoy in the middle of Falmouth Bay (Seasearch, 2012). Seasearch dives have recorded 12 different invasive species within the SAC, including the barnacle *Elminius modestus*, the seasquirt *Asterocarpa humilis*, the bryozoan *Bugula neritina*, slipper limpet *Crepidula fornicata* and Japanese wireweed *Sargassum muticum* (Seasearch, 2012).

1.3.5 Anthropogenic impacts

Maerl is an extremely slow growing algae (tenths of millimetres to one millimetre a year) (Blake & Maggs, 2003), and therefore the impacts of damage to the maerl is long lasting due to the long recovery times. Substratum loss, smothering, increase in suspended sediment, abrasion and physical disturbance can all have a negative impact by preventing light reaching the maerl and ceasing photosynthesis (Hall-Spencer *et al.*, 2008). The recovery potential of maerl after a single mortality event has been classified as 'poor' by OPSAR, which means that partial recovery is likely to take 10 years and full recovery may take up to 25 years (Hall-Spencer *et al.*, 2008).

Dredging has been shown to cause significant damage to maerl beds. A survey in 2007 by Seastar Survey Ltd. found that dredging in Falmouth Harbour would remove the present maerl bed community (Axelsson *et al.*, 2008). Repeat sites were surveyed where dredging had previously been carried out. This showed that over time the infaunal community can recover so that the differences between the dredged and non-dredged sites are minor. However the large epifauna and algae take a longer time to recover, as well as the epifauna and epiflora associated with these taxa. The study also showed that sites near to the docks and marinas may never recover back to a species rich maerl community (Axelsson *et al.*, 2008). Sediment dredging may have caused the loss of some maerl beds in Ireland and Wales, since dead maerl beds are present in areas where dredging has previously been carried out (Hall-Spencer *et al.*, 2008).

Significant decline in maerl quality were observed in the Fal Estuary due to maerl extraction, since this removes the productive surface layer and causes a large increase in the suspended sediment load which later settles out and smothers the maerl (Hall-Spencer *et al.*, 2008). Smothering by fine sediment has an adverse effect on maerl since it is a photosynthesising algae that relies on sunlight to survive. A study on the effects of maerl extraction in the Fal found suggested that high levels of extraction cause a reduction in the abundance of individuals in the infaunal community but an increase in the diversity of species compared to the reference area where no extraction had taken place (White, 2004). However, commercial extraction was banned in 2005 when extraction licences in Cornwall were removed (Hall-Spencer *et al.*, 2008). In 2003 a no-take zone, covering an area of 500m by 100m, was designated in Falmouth Bay where maerl extraction was prohibited (White, 2004). Maerl extraction had previously taken place in this area since 1988.

The surface of maerl beds can also be damaged by heavy demersal fishing gear, pollution by finfish and shellfish aquaculture in inshore waters and suction dredging for bivalves (Hall-Spencer *et al.*, 2008). Other major impacts include sewage pollution, coastal construction and agricultural discharge which increase the sediment load or cause excessive growth of macroalgae on the maerl beds (De Grave *et al.*, 2000). Permanent boat moorings could have a localised adverse effect due to abrasion as the mooring chains are dragged in circles over the maerl (Hall-Spencer *et al.*, 2008). Other pollutants including oil and heavy metals may contaminate the water, for example in 2009 13,600 litres of waste oil were dumped in Falmouth docks (Falmouth Packet, 2009). Finally the spread of non-native invasive species such as *Crepidula fornicata* may also have an impact on maerl beds in the Fal and Helford SAC, since on the Milford Haven maerl bed *C. fornicata* has increased so rapidly recently that the habitat has changed in some areas from maerl and shell to a bed of *C. fornicata* (Bunker, 2011).

Falmouth estuary is affected by eutrophication, caused by elevated nitrogen and phosphorous levels from agriculture and sewage discharges. Toxic dinoflagellate blooms, such as *Alexandrium minutum*, have occurred since 1995. Despite the upper Fal being designated as a Sensitive Area (Eutrophic) under the Urban Waste Water Treatment Directive, harmful algal blooms have continued to occur (Langston *et al.*, 2003). This is a threat to both the maerl beds and *Zostera* beds due to decreased light levels from blanketing algae and algal blooms (Langston *et al.*, 2003).

Although the last active mine at Wheal Jane was closed in 1991, industrial impacts may still occur from Falmouth docks and several marinas, which are potential sources of disturbance through dredging, oil and release of antifouling and sewage. Residual drainage from old mines, spoil heaps and groundwater may also continue to affect the sediments (Langston *et al.*, 2003).

It has been suggested that species sensitive to disturbance could be used to monitor maerl beds (Hall-Spencer et al., 2008). For example, a group of small red algae, *Cruoria cruoriaeformis, Halymenia latifolia* and *Gelidiella calcicola*, are virtually confined to maerl and are a nationally scarce species (Hall-Spencer *et al.*, 2008). Two of these species are also listed as BAP priority species. Therefore monitoring the presence of these species at regular intervals could be very useful in monitoring disturbance. It has been suggested that the depth of live and dead maerl has an indication of the condition of the maerl bed. For example, in Brittany a reduction in the depth of the maerl had significant impacts on the biodiversity of the maerl beds (Hall-Spencer *et al.*, 2008).

The ratio of live to dead maerl or the abundance of live maerl has also been used as a proxy for the biota of maerl beds. In Milford Haven a very good correlation was found between the recorded impacts of construction work on the amount of live maerl and the effects on the biota (invertebrate and algae diversity and abundance) (Camplin, 2007).

1.3.6 Maerl bed communities

The maerl beds in the Fal and Helford SAC are of high conservation importance since they are the largest beds in England and the most south-westerly in the UK (Howson *et al.*, 2004). Two species of maerl are present - *Phymatolithon calcareum* and *Lithothamnion corallioides*. There are also extensive areas of dead maerl and living maerl overlaying dead maerl (Howson *et al.*, 2004). Maerl beds have been found to have an extremely high biodiversity compared to surrounding habitats, with some species being unique to maerl or rarely found elsewhere (Hall-Spencer *et al.*, 2008). Dead maerl also supports rich associated fauna, though not as diverse as those in live maerl beds (Hall-Spencer *et al.*, 2008).

Maerl is a group of calcified red algae which live unattached on sediments, especially coarse clean gravel or sand or on muddy mixed sediment (Hall-Spencer *et al.*, 2008). It can grow both on the open coast and in tide-swept channels of marine inlets. In favourable conditions it can form extensive beds with 30 % cover or more (Hall-Spencer *et al.*, 2008). Maerl has been found at depths from the lower shore down to 30 m. The depth is determined by water turbidity, since maerl requires light to photosynthesise (Hall-Spencer *et al.*, 2008). Therefore maerl usually occurs in areas with clear water and strong currents (Axelsson *et al.*, 2008). In the UK it occurs off the south and west coasts and north to Shetland, as well as in south and south-west Ireland, but it is rare in England except for the beds at Falmouth (Hall-Spencer *et al.*, 2008).

Maerl beds have a high biodiversity primarily due to the complex three-dimensional nature of the habitat. A wide range of species live within the interstitial spaces of the maerl bed, and some, such as the tanaid *Leptognathia paramanca*, have specific associations with maerl beds (Bamber, pers. comm.). This complex structure is also important because it provides feeding areas for juvenile fish, such as Atlantic cod *Gadus morhua*, and acts as nursery areas for commercially important species including *Pecten maximus*, *Venus verrucosa* and *Ensis* spp. (Kamenos *et al.*, 2004). In addition to the fauna living in the interstitial spaces there is also a variety of epifauna that grows on the heterogeneous hard surface of the maerl (Howson *et al.*, 2004). Rich algal communities are present at the maerl beds, which show distinct seasonal variation (JNCC, 2001).

Within the Fal and Helford maerl beds two maerl biotopes have been identified (Howson *et al.*, 2004). These are **SS.SMp.Mrl.Lcor** (*Lithothamnion corallioides* maerl beds on infralittoral muddy sand and gravel) and **SS.SMp,Mrl.Pcal.R** (*Phymatolithon calcareum* maerl beds with red seaweeds in shallow infralittoral clean gravel or coarse sand). Dead maerl gravel (**SS.SMp.Mrl**) was also found (Howson *et al.*, 2004). It appears that the distribution of the maerl species and communities across the beds is patchy, which contributes to the richness of the maerl biotopes (Howson *et al.*, 2004).

In the diving survey conducted by Howson *et al.* (2004) two living maerl beds were found on St. Mawes Bank in depths down to 5 m, separated by maerl gravel. There was a northern, main bed to the northwest of the St. Mawes headland and a smaller bed to the west of Castle Point along the narrow shelf. There appeared to be a large bed of *Lithothamnion corallioides* (**Lcor**) with a smaller area of *Phymatolithon calcareum* (**Pcal.R**) in the centre of it and another smaller bed of *L. corallioides* to the south of the main bed. However both maerl species were present in most areas. There was a higher percentage of dead maerl on the deeper western edge of the bed. The total area of maerl was approximately 5 km^2, with **Pcal.R** covering ~2.33 km^2 and **Lcor** comprising ~2.67 km^2 (Howson *et al.*, 2004). Foliose algae covered the maerl in many places, ranging from a few percent to 60% cover, especially on the northern bed. The dominant algal species were *Dictyota dichotoma* and *Calliblepharis ciliata* (Howson *et al.*, 2004). Fauna were more abundant in the southern areas, with an abundance of the sabellid worm *Megalomma vesiculosum* as well as the presence of *Gibbula* spp., *Chaetopterus variopedatus* and *Ascidiella aspersa* (Howson *et al.*, 2004). The communities present at the **Pcal.R** biotope appeared to differ from those at the **Lcor** biotope, since the polychaetes *Megalomma vesiculosum* and *Chaetopterus variopedatus* which characterised the **Lcor** sites in the south were very rare in the *P. calcareum* areas, but *Anemonia viridis* was abundant. Also species such as *Brongniartella byssoides*, *Nitophyllum punctum* and *Cryptopleura ramosa* were the dominant algae rather than *Calliblepharis ciliata* and *D. dichotoma* (Howson *et al.*, 2004). However it was suggested that this difference could possibly be due to seasonal variation, since part of the survey was undertaken in the spring and part was undertaken in the autumn.

On the opposite bank of the Fal, to the north of the harbour entrance, small amounts of live maerl (**Lcor**) were found mixed with dead maerl gravel (**SMp.Mrl**) (Howson *et al.*, 2004). Another small area of living *Lithothamnion corallioides* was found at 11 m depth to the south of Pendennis Point (Howson *et al.*, 2004).

Another maerl bed was found in the Helford estuary running approximately east to west in direction at a depth of around 4 m below chart datum (Gall, 2012). It is a wedge-shaped bed, widest at the mouth of the estuary, covering an area of approximately 2.2 hectares. The maximum width is around 100 m and it extends for a length of 430 m (Gall, 2012). The dominant maerl species is *Lithothamnion corallioides*, with an average of about 80% live maerl. Typical species found are algae including *Dictyota dichotoma* and *Gracilaria multipartita*, the polychaetes *Megalomma vesiculosum* and *Myxicola infundibulum*, the burrowing anemones *Cerianthus lloydii* and *Cereus pedunculatus* and the molluscs *Gibbula* spp.. It also supports the Biodiversity Action Plan (BAP) species *Cruoria cruoriaeformis* (a red algae), *Ostrea edulis* (native oyster) and *Edwardsia timida* (a burrowing anemone) (Gall, 2012).

2 METHODOLOGY

The survey of the maerl beds in Fal and Helford SAC was split into two phases. The methodologies for the drop-down camera survey and the scientific diving survey are detailed below in turn.

2.1 Drop-down camera survey

Drop-down camera deployments were planned to be run as transects of approximately 15 minutes length. At a vessel speed of 0.5 knots, this equated to roughly 300 m line lengths. Camera transects were positioned to cross the boundaries of maerl habitats as identified from historic data. Some camera lines were planned as double lengths (i.e. 30 minutes / 600m) to maximise efficiency in achieving the survey objectives.

A total of 99 camera lines were proposed (representing an equivalent 118 x 15 minute deployments). The locations of the proposed camera deployments are shown in Figure 2.1. Two camera stations were held in reserve to allow for some *in-situ* assessment of data and site selection. Camera lines were positioned in an attempt to ground truth the majority of the maerl habitat polygons provided by Natural England, with the boundaries of polygons principally targeted. All survey stations were agreed with Natural England prior to the commencement of fieldwork.

The drop-down camera survey was undertaken between 5th and 14th September 2013. All survey operations were conducted from Seastar Survey's own vessel, SV *Otarie*. The survey equipment was mobilised at Falmouth Yacht Haven on Thursday 5th September. Survey operations took place over a period of eight days, starting on 6th September and concluding on 13th September. All survey equipment was demobilised at Falmouth Yacht Haven on Saturday 14th September.

A total of 100 camera drops were undertaken. All proposed survey stations were completed with the exception of FH056, FH057 and FH095 in the Helford River. These three proposed lines were not attempted due to large areas of static fishing gear and moored vessels present on the transects. Line FH084 was cut short due to wreckage on the seafloor and the potential danger of snagging and damaging the camera frame. Several lines were cut short due to rapidly shallowing seabed topography. To compensate for the missed survey stations some of the lines over the live maerl bed off St. Mawes were extended to cover the full width of the maerl bed. Figure 2.2 shows the locations of the completed camera transects. Full survey logs can be found in Appendices A and B.

Figure 2.1. Proposed drop-down camera survey lines, Fal and Helford maerl survey 2013.

Figure 2.2. Achieved drop-down camera survey lines, Fal and Helford maerl survey 2013.

2.1.1 Drop-down camera methodology

The camera system used was a Kongsberg OE 14-208 digital video and stills camera, mounted obliquely on a drop-down camera frame. A Kongsberg OE 11-242 flash gun and four LED sub-sea lights were also mounted on the frame. The camera, flash and lights were linked to the surface using a 100m soft umbilical. All the controls for the camera system were kept in the vessels wheel house.

The camera sent a continuous video feed to the surface, where the deployment was monitored and the camera was controlled by the camera operator using the Kongsberg OE 14-208 Graphic User Interface (GUI) software on a laptop connected to the camera control box via a USB connection. The analogue video from the camera was recorded throughout each deployment onto mini digital video (miniDV) tapes using two miniDV recorders. Each time a photograph was taken a representation of each still photograph was also seen in real time on the miniDV recorder monitor, allowing for *in-situ* examination of image quality. Photographs were taken at approximately one minute intervals, or at the discretion of the camera operator. Still photographs were taken to capture representative images of the dominant seabed habitats and sediment types along each video transect, and to capture images of interesting features with a particular focus to identify any key fauna, seabed features or sediment types.

Before each deployment a ‘clapperboard’ displaying the site name, sample number and date was videoed and photographed as a quality assurance record. The camera was deployed over the port side of the vessel by a line via a capstan and davit. Once the camera system was in the water and approximately 1m above the seabed the on-board surveyor began to log navigation data. The skipper positioned the vessel into the tide and began to make way along the transect line. The optimal speed for the camera transects was 0.5 knots. During the deployment the height of the camera system above the seabed was controlled by a winch operator on deck, but within clear sight of a live feed of the seabed from the camera.

Throughout the camera deployment navigation data was recorded. All camera deployment logs were synchronised to the navigation data from the GPS system. The camera operator recorded the time in UTC from the GPS at the start and end of each deployment and the time each photograph was taken. The position of each photograph was then extracted from the navigation data.

While recording the video lines the camera frame was suspended just off the seabed to reduce the impact on the seabed environment. The camera was landed on the seabed to take photographs; this is particularly advantageous in areas of high current speeds where high levels of suspended sediment in the water column and greater speeds over the ground can otherwise result in blurred photographs.

The digital photographs from the camera were uploaded from the camera to a survey laptop computer via a USB lead (using Canon Zoom Browser EX software). During the upload process each photograph was named with the sample number, line number and photograph number. Following the survey the miniDV tapes from the video camera were uploaded to a computer, edited, titled and burnt to DVD at Seastar Survey’s office in Southampton.

Survey navigation was achieved by the use of a Differential GPS. Position data were logged using the Hypack 2012 survey management software. All navigation data for the survey were collected and logged in WGS84 Latitude and Longitude (decimal degrees) to a minimum of 6 decimal places. Navigation data were converted to UTM North Zone 30 (6°W - 0°) within the Hypack software. All raw and processed positions were logged throughout survey operations.

Raw depth data were provided by SV *Otarie's* echosounder and were logged manually during camera deployments. The position of the camera system was calculated as a lay-back from the vessels GPS system. Both the vessel and the camera position were recorded in the Hypack survey management software. The lay-back was calculated within the survey management software, which bases its calculation on the vessel's known position, vessel heading, height of the davit and the length of rope out.

At the end of each survey day, of all survey navigation data and still photographs were backed-up onto an external hard drive, which was removed from the vessel along with one copy of each MiniDV tape.

2.2 Scientific diving survey

2.2.1 Dive site selection

The rationale for the site selection was based on a total of five scuba-diving survey days with three dives per day (resulting in 15 potential dive stations in total) were allocated for the Fal and Helford SAC maerl diving survey.

The potential scuba-diving survey locations included St. Mawes Bank (South of St. Mawes Castle), west of Castle Point (west of St Mawes Castle), Helford River (previously surveyed by Bunker, 2012; see Bunker, 2013) and other maerl gravel locations within the SAC. Repeat monitoring of data from St. Mawes Bank and west of Castle Point was required under the contract to allow comparisons with data from Howson *et al*. (2004). A total of 12 locations (Table 2.1) were surveyed by Howson *et al*. (2004), leaving three potential survey locations for other sections of the estuary. As Helford River was poorly understood in terms of the maerl communities present it was decided to focus the remaining three dives on the Helford River maerl bed.

The rationale for selecting 12 stations at St. Mawes bank was also based on the preliminary drop-down camera results. Images obtained during the drop-down camera survey were briefly reviewed to provide additional information on the maerl habitats of interest. According to these results there appeared to be a change in health and quality of the maerl across St. Mawes Bank (compared to images from 2004; see Howson *et al.*, 2004) with three broad levels of maerl health. The healthiest maerl (live, healthy maerl) was found at the centre of the bank (stations Dive 04, Dive 05 and Dive 06) with poor quality and low health maerl (maerl gravel with some live thalli) seen along the fringe of the bank (stations Dive 01, Dive 02, Dive 07 and Dive 08). Between these two extremes were maerl of an intermediary quality and health, typically with a considerable red algae influence (stations Dive 03, Dive 09 and Dive 10). The positioning of the 2004 stations by coincidence resulted in three stations within the healthiest maerl, four along the fringe (spread from north to south), and three in the intermediary quality maerl. With a minimum of three stations within each broad group of maerl it was considered sensible and sufficiently statistically vigorous to survey these locations to allow three replicates from each group. It would furthermore allow the repeat survey of the 12 stations from 2004, including repeat survey effort at the remaining two locations at Castle Point. Figure 2.3 shows the locations of the planned dive stations.

Table 2.1. Proposed dive locations, Fal & Helford SAC maerl survey 2013 (all positions are WGS84).

Station	Location	Easting (m)	Northing (m)	Approx. Depth (m)	Maerl Condition / Habitat (based on 2013 drop-down camera survey)
Dive 01	St Mawes	355336	5559601	4.5	Fringe of bed - gravel
Dive 02	St Mawes	354982	5559370	6.0	Some live and gravel, edge of bed with algae, tube worms
Dive 03	St Mawes	355248	5559311	5.0	Some live and gravel, edge of bed with algae, tube worms
Dive 04	St Mawes	354831	5559027	3.5	Live, healthy, mid-bed
Dive 05	St Mawes	354984	5559043	3.5	Live, healthy, mid-bed
Dive 06	St Mawes	355210	5559001	3.0	Live, healthy, mid-bed
Dive 07	St Mawes	354592	5558938	8.0	Live, some gravel, edge of bed, red algae
Dive 08	St Mawes	354694	5558720	7.5	Some live and gravel, edge of bed with algae, tube worms
Dive 09	St Mawes	354890	5558729	7.0	Live and gravel, algal mats, worm tubes
Dive 10	St Mawes	354952	5558519	7.0	Live and gravel, algal mats, worm tubes
Dive 11	Castle Point	354979	5558039	7.0	Live, healthy, some brown algae
Dive 12	Castle Point	355079	5557788	4.0	Live, healthy, some brown algae, some gravel
Dive 13	Helford River	348019	5551597	10.0	Live, healthy, some algae
Dive 14	Helford River	348080	5551605	8.5	Live, healthy, some red algae, some gravel
Dive 15	Helford River	348097	5551591	8.5	Live, healthy, some red algae, some gravel

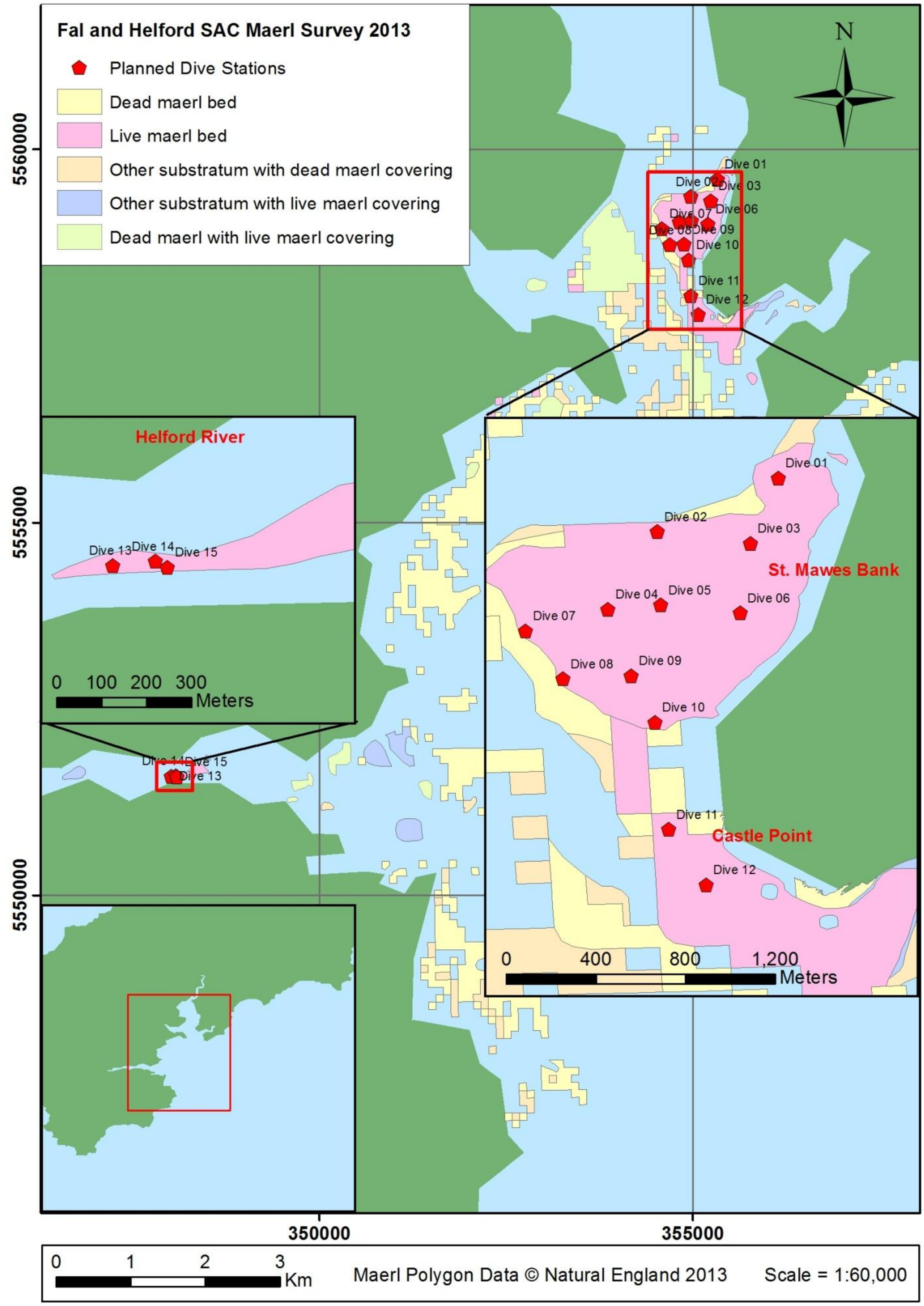

Figure 2.3. Planned scientific diving stations, Fal and Helford SAC diving survey 2013.

2.2.2 Diving operations

The scientific diving survey was conducted between 19th and 26th September, which allowed for a total of six diving days. The breakdown of survey activity was as follows:

- Thursday 19th September – travel to Falmouth, mobilise vessel
- Friday 20th September to Wednesday 25th September – scientific diving operations
- Thursday 26th September – demobilise vessel

The original plan was to complete all the diving operations in five days and therefore finish on 24th September. However, dense fog on 22nd and 23rd September prevented safe diving operations, resulting in the need for one additional survey day.

Diving was planned to coincide with slack water whenever possible but with three dives each day, some dives were completed in the most sheltered locations along the bank during other states of the tide. Diving operations were all conducted from the Seastar Survey's vessel *SV Otarie*.

2.2.3 Scuba-diving team

All diving work was undertaken in accordance with the HSE "Science and Archaeological Diving Projects" Approved Code of Practice (ACOP). Standard scuba equipment was used with either air and nitrox depending on preference and diver qualification.

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 (CMAS 3* equivalent)
5. Four Natural England scientific divers (CMAS 3* equivalent)

For each dive site two buddy pairs were diving at any one time, with one standby diver and the dive supervisor remaining on the vessel. Table 2.2 details the scientific diving team used during the survey. All divers were qualified to CMAS 3*, or equivalent, as a minimum.

Table 2.2. Scientific dive team, Fal and Helford SAC maerl survey 2013.

Name of diver	Organisation	Diving qualifications
Juliet Wilson (JW)	Seastar Survey	PADI Divemaster
Frederick Tones (FT)	Seastar Survey	HSE Part I
Kathryn Dawson (KD)	Natural England	PADI Divemaster
Holly Latham (HL)	Natural England	HSE Part IV, PADI Open Water SCUBA Instructor & Speciality Instructor
Ross Bullimore (RB)	Natural England	HSE Part IV, PADI Divemaster
Roger Covey (RC)	Natural England	HSE Part IV

2.2.4 Permissions

Natural England obtained permission from seabed (fundus) owners or leaseholders for survey work on the seabed. Permissions to complete diving operations had been sought from the Falmouth Port and St. Mawes Harbour by Natural England. Permission was also gained each day from the Falmouth Harbour Commissioners to drop divers in the estuary. Additional consent had been gained from Natural England to allow scientific diving operations to be completed within the SAC.

2.2.5 Scuba-diving survey methodology

The methodology for the maerl bed survey largely followed Seastar Survey's Standard Survey Methodology (SSM) – scuba-diving quadrat survey methodology – as detailed in Axelsson *et al*. (2013). The methodology involved laying a ground line and carrying out quadrat based survey work at random locations along the ground line. A summary of the methodology is given below, with a full survey methodology statement provided in Appendix C with the associated recording forms in Appendix D.

2.2.5.1 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.

The quadrat analysis was based on using 0.25 m^2 quadrats (50 cm x 50 cm) and a 10 m ground line. An area 1 m either side of the line was to be analysed, creating 80 x 0.25 m^2 cells. From these 80 cells, 30 cells 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.

2.2.5.2 Summary of the maerl bed survey methodology

The dive surveys were completed with the following equipment:

- Ground rope (marked at 1 m intervals) 10 m in length
- 2x still photography camera (with strobes)
- Dive slates (with clips), pencils and recording paper (log sheets)
- 2x quadrats of 0.25m^2
- Laminated sheet with quadrat numbers
- Sample collection bags

The ground line marked at one metre intervals was laid from the vessel, and was marked by a buoy at each end of the line. As described above, sites were pre-selected within the St. Mawes Bank (including Castle Point) and the Helford River maerl beds based on locations of previous dive surveys and the results of the drop down video survey. The abundance of both flora and fauna were assessed in each 0.25 m^2 quadrat. Depending on the species, abundance was measured as either numbers of individuals or percentage cover.

The 30 quadrats were divided between the two diving pairs, so that each pair aimed to complete 15 quadrats along the transect line (up to 1 m either side). The randomly generated and pre-selected quadrat positions were listed on the recording forms on the diving slates. Each buddy pair started at opposite ends of the ground line, with each pair tackling the 15 quadrats closest to their end of the line. Still photographs of each quadrat were taken and the identification and abundance data were recorded onto the pre-prepared recording forms. *In-situ* recording was made as far as possible, but samples of red algae were collected for later identification and verification.

2.2.6 Scuba diving effort

The plan was for each diver to complete three dives per day, 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 60 person dives in the planned five days. However, the presence of dense fog on two days resulted in a delay to the start of diving operations. Therefore the survey period was extended by one day in order to complete the 15 planned sites.

A total of 60 person dives were completed in September 2013 over six days (Table 2.3). All of the 15 sites on the St. Mawes Bank and Helford River maerl beds were completed successfully. However, due to time constraints on the length of dives not all of the planned 30 quadrats for each site were completed.

Table 2.3. Summary of diving effort, Fal and Helford SAC maerl survey 2013 (see Table 2.2 for diver names in full).

Date	Maerl bed targeted	Dive Number	Number of person-dives	Divers
20/09/13	St. Mawes	1	4	HL, RB, KD, FT
20/09/13	Castle Point	2	4	HL, RB, KD, JW
20/09/13	St. Mawes	3	4	HL, RB, KD, JW
21/09/13	St. Mawes	4	4	KD, RB, JW, RC
21/09/13	Castle Point	5	4	KD, RB, JW, RC
21/09/13	St. Mawes	6	4	KD, RB, JW, RC
22/09/13	Helford River	7	4	HL, KD, JW, RC
22/09/13	Helford River	8	4	HL, KD, JW, RC
23/09/23	St. Mawes	9	4	HL, RB, KD, JW
23/09/13	St. Mawes	10	4	HL, RB, KD, JW
24/09/13	St. Mawes	11	4	HL, RB, KD, JW
24/09/13	St. Mawes	12	4	HL, RB, KD, JW
24/09/13	St. Mawes	13	4	HL, RB, JW, RC
25/09/13	Helford River	14	4	HL, RB, KD, JW
25/09/13	St. Mawes	15	4	HL, RB, KD, JW
Total	**60**			

To improve the quality of the data and make the most of the expertise at hand, during the first three days it was decided to keep one diver on the shore to examine the algae samples collected from previous dives and verify the identification. The divers took it in turns to remain on-shore to allow everyone the chance to get familiar with the material but also some time to rest between dives.

2.2.7 Achieved survey

A total of fifteen dive locations were surveyed in September 2013 (Figure 2.4). Strong currents and tides meant that by the time divers had entered the water and set up ground lines, some dive stations had drifted away from their planned co-ordinates. Navigation error resulted in Dive 07 being positioned close to site Dive 04 rather than at the edge of the maerl bed. The sites were spread over the St. Mawes Bank (including Castle Point) and Helford River maerl beds, with sites at the centre and fringes of the bed (Figure 2.3). A total of twelve sites were completed on St. Mawes Bank (including two at Castle Point) and three sites on the Helford River maerl bed. Tables 2.4 and 2.5 give a brief description and details of the dive sites and the data collected at each site.

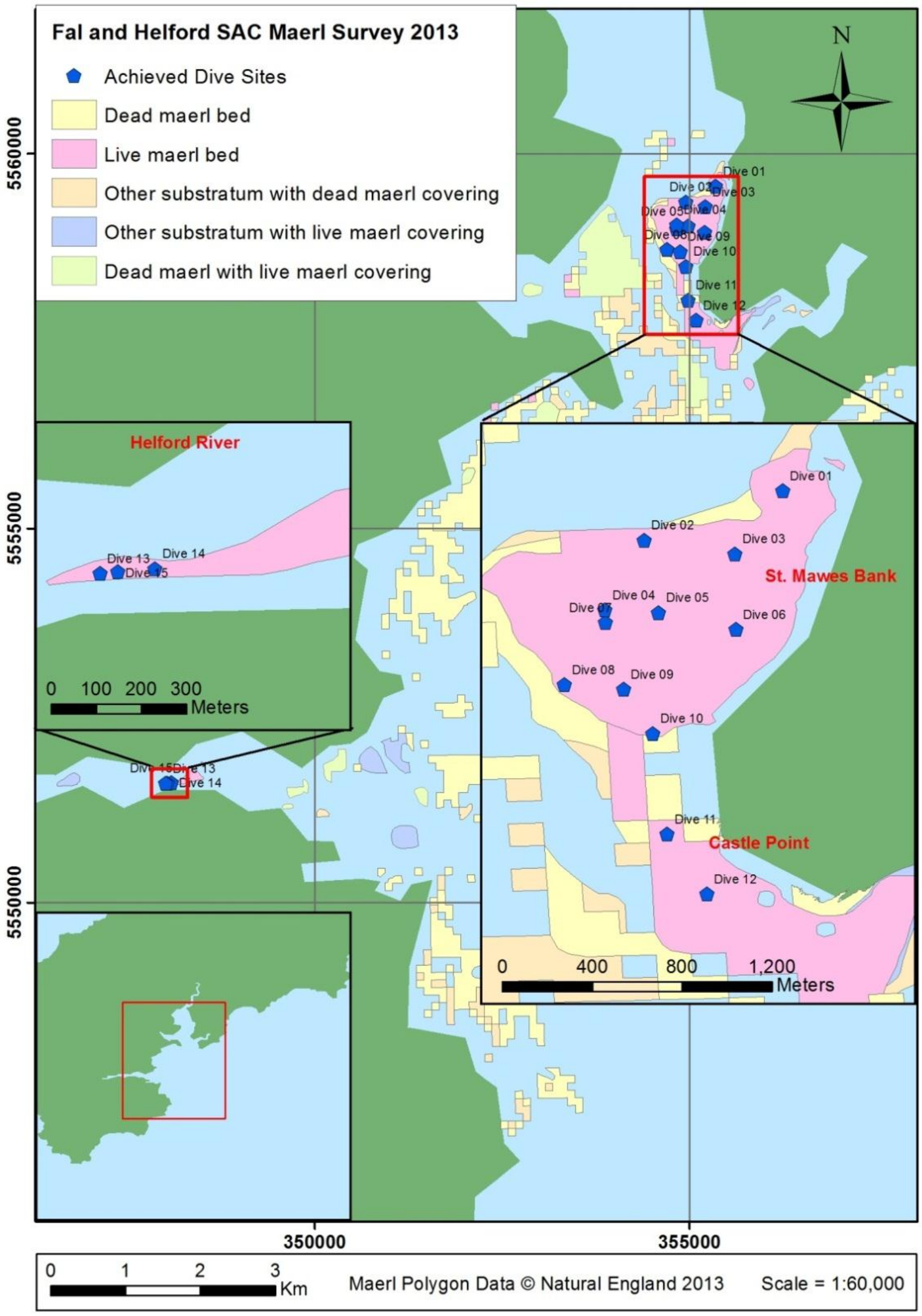

Figure 2.4. Achieved dive survey stations, Fal and Helford scientific diving survey 2013.

Table 2.4. Summary of dive locations surveyed, Fal and Helford SAC maerl survey 2013 (depth is the echo sounder depth at the GPS position; positions are in WGS84 Latitude & Longitude decimal minutes).

Dive Number	**Site location**	**Site Name**	**Station Number**	**Date**	**Time**	**Latitude N** (dd mm.mmm)	**Longitude W** (dd mm.mmm)	**Line bearing (°)**	**Depth (m)**
1	St Mawes	Dive 07	370-01	20/09/2013	09:39	50° 09.922’	05° 01.957’	317	4.5
2	Castle Point	Dive 11	370-02	20/09/2013	12:42	50° 09.414’	05° 01.809’	270	3.5
3	St Mawes	Dive 06	370-03	20/09/2013	15:48	50° 09.906’	05° 01.644’	80	5.0
4	St Mawes	Dive 02	370-04	21/09/2012	09:23	50° 10.120’	05° 01.865’	340	6.6
5	Castle Point	Dive 12	370-05	21/09/2012	12:28	50° 09.270’	05° 01.714’	60	3.8
6	St Mawes	Dive 03	370-06	21/09/2012	15:48	50° 10.088’	05° 01.646’	87	2.9
7	Helford River	Dive 14	370-07	22/09/2013	09:47	50° 05.834’	05° 07.445’	110	7.9
8	Helford River	Dive 15	370-08	22/09/2013	13:01	50°.05.830’	05° 07.489’	265	6.2
9	St Mawes	Dive 01	370-09	23/09/2013	10:41	50° 10.239’	05° 01.532’	45	5.9
10	St Mawes	Dive 05	370-10	23/09/2013	13:47	50° 09.946’	05° 01.830’	205	2.5
11	St Mawes	Dive 08	370-11	24/09/2013	08:47	50° 09.773’	05° 02.056’	20	7.3
12	St Mawes	Dive 10	370-12	24/09/2013	11:47	50° 09.656’	05° 01.843’	200	5.6
13	St Mawes	Dive 09	370-13	24/09/2013	14:56	50° 09.762’	05° 01.914’	35	3.4
14	Helford River	Dive 13	370-14	25/09/2013	09:23	50° 05.828’	05° 07.511’	248	10.7
15	St Mawes	Dive 04	370-15	25/09/2013	12:34	50° 09.953’	05° 01.959’	181	5.0

*Table 2.5. Summary of data collected scientific diving survey 2013 (*Max. depth by divers).*

Site Name	Max Depth (m)*	Still photographs (total)	Useable photographs	Number of quadrats completed
Dive 07	4.5	83	70	23
Dive 11	4.0	144	143	22
Dive 06	6.4	194	192	30
Dive 02	7.3	262	250	25
Dive 12	4.4	234	231	30
Dive 03	6.0	220	208	22
Dive 14	9.1	204	201	28
Dive 15	6.6	252	229	30
Dive 01	6.4	234	228	29
Dive 05	3.2	206	205	30
Dive 08	8.2	211	199	28
Dive 10	6.6	206	204	30
Dive 09	4.2	191	205	30
Dive 13	12.5	212	206	30
Dive 04	5.6	218	209	30
Total		**3071**	**2980**	**418**

2.3 Data analysis

It was initially intended to use historic data to complete comparisons between the 2013 data and historic data. In particular, raw data from the survey completed by Howson *et al.* (2004) was meant to be used to assess any potential change in maerl cover, health and extent as well as assess any changes in the algal community found on the maerl beds. Whilst it was possible to assess changes in extent, unfortunately it was not possible to assess the remaining parameters (maerl cover, health and red algal communities) as the available historic data were inconsistent, unclear (e.g. confusing site numbering with different site names in the report and in the spreadsheets) and incomplete. Such statistical tests and comparisons with historic data were therefore not completed as part of the current contract.

2.3.1 Drop-down camera survey video and still analysis

The analysis of the photographs and video records was carried out 'blind' without any prior knowledge of the sites, using a personal computer and software that allowed slow-motion, freeze frame and standard play analysis (e.g. VLC media player). An initial assessment of a station was carried out by first briefly examining photographs and video from that station to acquire a broad understanding of the substratum, flora and fauna. The video footage was viewed at 2x normal speed in order to divide the footage into segments representing different substrata. The start and end time and position of each segment were recorded. Brief changes in substrate type (i.e. less than one minute of video footage) were considered to be incidental patches and were not logged as discrete segments, but were recorded as part of the habitat description. More detailed analysis of the video footage was then undertaken. All still images were assessed with reference to the corresponding video clip, thus allowing each still image to be assessed with knowledge of the wider habitat in which it fell. The habitats and biotopes assigned to the video analysis were then cross-checked with the assessment of the still images, resulting in an on-going quality control process.

Detailed video analysis consisted of a description of the seabed and the identification of flora and fauna to the lowest certain practical taxonomic level. The positions of any boundaries of different biotopes/habitats were determined using time codes and related back to the navigation data. General descriptions of the fauna were made and any other features of interest such as trawl marks were also recorded. The abundance data were recorded using the SACFOR scale. A list of the encountered fauna was produced for each site using species reference numbers as cited in the Marine Conservation Society Species Directory (Howson and Picton, 1997), with species nomenclature used as per the World Register of Marine Species (WoRMS Editorial Board, 2014). The video sections were subsequently assigned a biotope according to the habitat and fauna present as per The Marine Habitat Classification for Britain and Ireland (Connor *et al*., 2004).

The still images were analysed to supplement and validate the video analysis, and to provide a more detailed analysis than could be extracted from the video footage. The still photography analysis was carried out using a personal computer. The methodology was similar to the video analysis methodology described above, and included a general seabed description. Substrata were described according to the Folk Trigon and Wentworth scale (see Leeder, 1982), with boulders and cobbles being described within ‘gravel’, and ‘rock’ referring to bedrock. The fauna was identified to the lowest practical taxonomic level, and abundance data were recorded using the SACFOR scale. A list of the encountered fauna was produced for each photograph using species reference numbers as cited in the Marine Conservation Society Species Directory (Howson and Picton, 1997). Species nomenclature was as per WoRMS (WoRMS Editorial Board, 2014). Each still image was assigned a biotope according to the habitat and fauna present as per The Marine Habitat Classification for Britain and Ireland (Connor *et al*., 2004).

Special attention was paid to the amount of maerl observed in every still. The amount of dead and live maerl visible in each image was estimated and recorded as a percentage, and also converted to SACFOR abundance. The live maerl was then examined in further detail to ascertain the species identity, and then percentage cover and SACFOR abundance estimated for each species present in each image.

Examples of seabed still photograph images taken during the survey can be seen in Figure 2.5. These images display a small selection of the different habitats observed during the survey.

The species lists from the video and photograph analyses were combined to give a single complete species list from the drop-down camera survey. The final biotopes assigned to each station were a combination of those decided from the video analysis, but moderated by the photo analysis i.e. where the still images provided information on fauna not identifiable during the video analysis, lower biotope levels were could be applied to stations. Appendix E shows the results of the video and stills analysis.

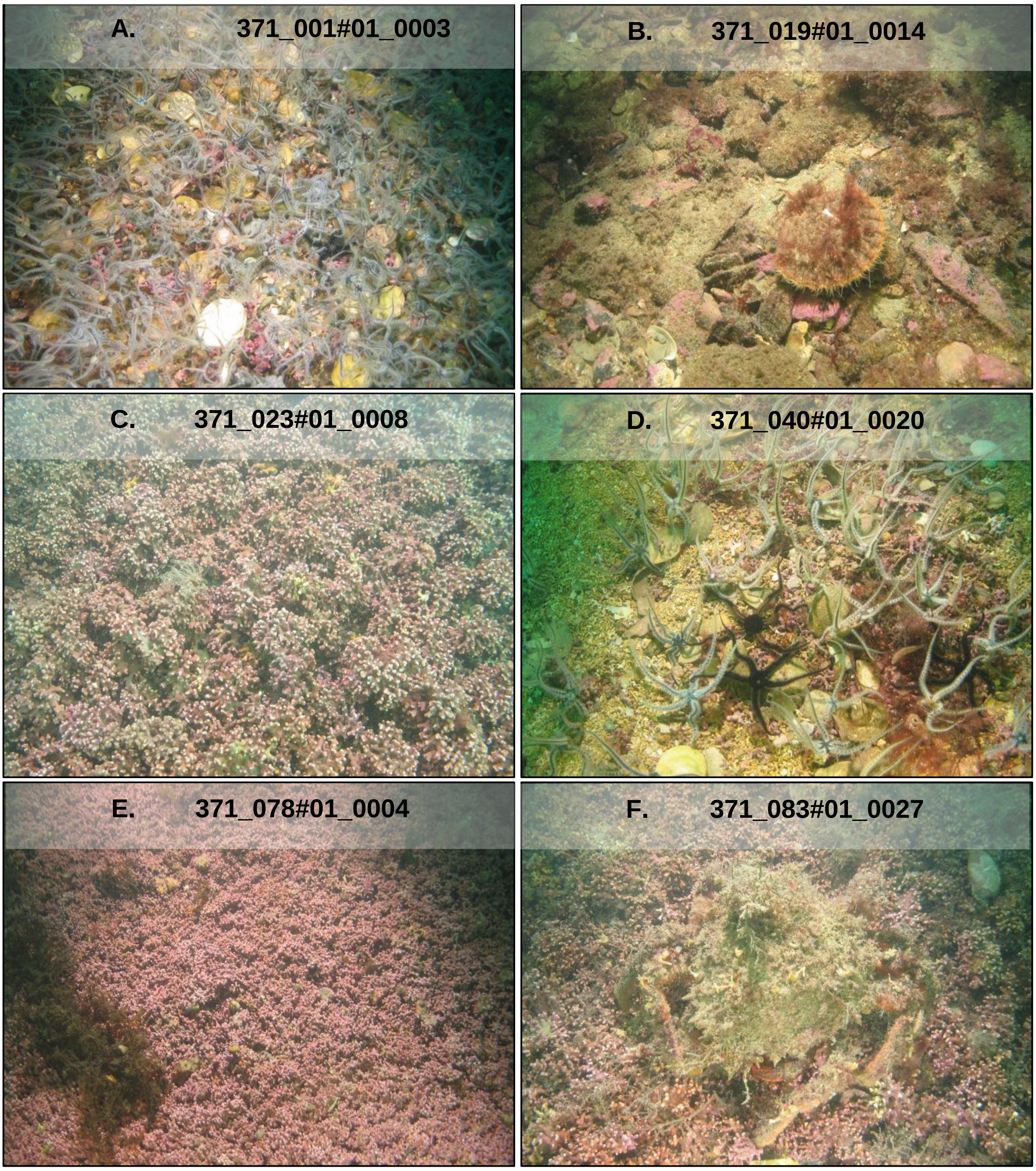

Figure 2.5. Example still photograph images collected during Fal and Helford SAC maerl drop-down video survey, 2013. A. Brittlestar bed on live and dead maerl; B. Algae on mixed sediment; C. Phymatolithon calcareum*; D. Brittlestars on coarse sediment; E.* Lithothamnion corallioides*; F.* Maja squinado *on* P. calcareum.

2.3.2 Dive survey

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 and the SACFOR scale (Connor *et al*., 2004). All dive logs can be found in Appendix F.

Site descriptions were completed for each survey location with information including positions, depths and the number of quadrats analysed recorded. The mean percentage cover for the maerl species present was calculated together with a list of the most widespread faunal and floral taxa were noted as well as still photographs to illustrate the habitat.

In order to examine any differences between the faunal and floral communities present at each dive site, various multivariate analyses were carried out using the PRIMER (Plymouth Routines in Multivariate Ecological Research) v.6 software package (Clarke and Warwick, 2001). Due to the abundance data being recorded in different formats, the data were rationalised so every taxon was expressed as a frequency of the number of quadrats within which they were present at each dive site. This was calculated by counting the number of quadrats at a given dive site from which each taxon was identified, and expressing this as a percentage of the total number of quadrats sampled at the dive site. This data manipulation procedure was felt to be the most appropriate method to give a broad picture of the community structure across each dive site, and to establish which species were the most common and characteristic of each area. Actual abundance data (counts or percentage cover) could then be examined in more detail for selected species if required.

The resulting data matrix was then imported into PRIMER for multivariate analysis. A resemblance matrix was created using the Bray-Curtis similarity coefficient. Cluster analysis was undertaken, with dive sites group-averaged and the resultant dendrogram plotted to illustrate the results. Additional SIMPER analysis was completed to illustrate the characterising species in each group.

2.3.3 Algae pressing

During the diving survey, some of the red algal species were difficult to identify *in situ.* Therefore samples of red algae were collected at some of the sites to allow subsequent verification of their identity. These algal samples were retained and pressed to keep as a record. Appendix G shows scanned examples of pressed red algae samples.

3 RESULTS

3.1 Drop-down camera survey

A total of 28 hours, 08 minutes and 20 seconds of video footage were recorded, and 1984 still photographic images were taken. Table 3.1 summaries the biotopes observed during the analysis of video and still image data. Biotopes were designated after assessment of the composition of biological communities captured within the video footage and still data.

Table 3.1. Summary table of biotopes observed in Fal and Helford SAC, drop-down camera survey 2013. 'Number of observations' equals the count of stations from which each habitat was identified.

Biotope	Biotope Code	Number of Observations
Mixed faunal turf communities	CR.HCR.XFa	1
Eunicella verrucosa and *Pentapora foliacea* on wave-exposed circalittoral rock	CR.HCR.XFa.ByErSp.Eun	5
Echinoderm and crustose communities	CR.MCR.EcCr	2
Brittlestar bed on faunal and algal encrusted, exposed to moderately wave-exposed circalittoral rock	CR.MCR.EcCr.FaAlCr.Bri	4
Foliose red seaweeds on exposed lower infralittoral rock	IR.HIR.KFaR.FoR	13
Foliose red seaweeds on exposed infralittoral rock / *Laminaria saccharina* and robust red algae on infralittoral gravel and pebbles	IR.HIR.KFaR.FoR / SS.SMp.KSwSS.LsacR.G	2
Sand or gravel-affected or disturbed kelp and seaweed communities	IR.HIR.KSed	2
Halidrys siliquosa and mixed kelps on tide-swept infralittoral rock with coarse sediment	IR.HIR.KSed.(XHal)	1
Mixed kelps with scour-tolerant and opportunistic foliose red seaweeds on scoured or sand-covered infralittoral rock ***/*** Echinoderm and crustose communities	IR.HIR.KSed.XKScrR/ CR.MCR.EcCr	1
Mixed kelp with foliose red seaweeds, sponges and ascidians on sheltered, tide-swept infralittoral rock	IR.MIR.KT.XKT	6
Mixed kelp with foliose red seaweeds, sponges and ascidians on sheltered, tide-swept infralittoral rock / *Laminaria saccharina* and robust red algae on infralittoral gravel and pebbles	IR.MIR.KT.XKT / SS.SMp.KSwSS.LsacR.Gv	1
Mixed kelp and red seaweeds on infralittoral boulders, cobbles and gravel in tidal rapids	IR.MIR.KT.XKTX	27
Mixed kelp and red seaweeds on infralittoral boulders, cobbles and gravel in tidal rapids / Infralittoral coarse sediment	IR.MIR.KT.XKTX / SS.SCS.ICS	4
Circalittoral coarse sediment	SS.SCS.CCS	12
Infralittoral coarse sediment	SS.SCS.ICS	22
Infralittoral coarse sediment / Brittlestar bed on faunal and algal encrusted, exposed to moderately wave-exposed circalittoral rock	SS.SCS.ICS / CR.MCR.EcCr.FaAlCr.Bri	2
Infralittoral coarse sediment / *Laminaria saccharina* and robust red algae on infralittoral gravel and pebbles	SS.SCS.ICS / SS.SMp.KSwSS.LsacR.Gv	1
Infralittoral coarse sediment / Red seaweeds and kelp on tide-swept mobile infralittoral cobbles and pebbles	SS.SCS.ICS / SMp.KSwSS.LsacR.CbPb	2
Infralittoral coarse sediment / *Laminaria saccharina* and filamentous red algae on infralittoral sand	SS.SCS.ICS / SS.SMp.KSwSS.LsacR.Sa	1
Infralittoral coarse sediment / *Lithothamnion corallioides* maerl beds on infralittoral muddy gravel	SS.SCS.ICS / SS.SMp.Mrl.Lcor	2
Red seaweeds and kelp on tide-swept mobile infralittoral cobbles and pebbles	SS.SMp.KSwSS.LsacR.CbPb	8

Biotope	Biotope Code	Number of Observations
Laminaria saccharina and robust red algae on infralittoral gravel and pebbles	SS.SMp.KSwSS.LsacR.Gv	45
Laminaria saccharina and filamentous red algae on infralittoral sand	SS.SMp.KSwSS.LsacR.Sa	11
Laminaria saccharina and filamentous red algae on infralittoral sand and patches of seagrass	SS.SMp.KSwSS.LsacR.Sa / SS.SMp.SSgr	3
Poor quality *Lithothamnion corallioides* maerl beds on infralittoral muddy gravel	SS.SMp.Mrl.(Lcor)	15
Poor quality *Lithothamnion corallioides* maerl beds on infralittoral muddy gravel / *Laminaria saccharina* and robust red algae on infralittoral gravel and pebbles	SS.SMp.Mrl.(Lcor)/ SS.SMp.KSwSS.LsacR.Gv	1
Lithothamnion corallioides maerl beds on infralittoral muddy gravel	SS.SMp.Mrl.Lcor	17
Lithothamnion corallioides maerl beds on infralittoral muddy gravel covered with a dense covering of *Dictyota dichotoma*	SS.SMp.Mrl.Lcor / IR.HIR.KFaR.FoR.Dic	1
Lithothamnion corallioides maerl beds on infralittoral muddy gravel / *Laminaria saccharina* and robust red algae on infralittoral gravel and pebbles	SS.SMp.Mrl.Lcor / SS.SMp.KSwSS.LsacR.Gv	8
Lithothamnion corallioides maerl beds on infralittoral muddy gravel / Infralittoral fine sand	SS.SMp.Mrl.Lcor / SS.SSa.IFiSa	1
Phymatolithon calcareum maerl beds in infralittoral clean gravel or coarse sand	SS.SMp.Mrl.Pcal	13
Phymatolithon calcareum maerl beds in infralittoral clean gravel or coarse sand with a dense covering of *Dictyota dichotoma*	SS.SMp.Mrl.Pcal / IR.HIR.KFaR.FoR.Dic	1
Sublittoral seagrass beds	SS.SMp.SSgr	5
Circalittoral sandy mud	SS.SMu.CSaMu	5
Infralittoral sand mud	SS.SMu.ISaMu	1
Circalittoral mixed sediments	SS.SMx.CMx	10
Cerianthus lloydii and other burrowing anemones in circalittoral muddy mixed sediment	SS.SMx.CMx.ClloMx	2
Ophiothrix fragilis and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment	SS.SMx.CMx.OphMx	25
Ophiothrix fragilis and/or *Ophiocomina nigra* brittlestar beds on circalittoral mixed sediment, patches of coarse sediment	SS.SMx.CMx.OphMx/ SS.SCS.CCS	4
Ophiothrix fragilis and/or *Ophiocomina nigra* brittlestar beds on infralittoral mixed sediment, patches of coarse sediment	SS.SMx.CMx.OphMx / SS.SCS.ICS	1
Infralittoral mixed sediment / *Laminaria saccharina* and robust red algae on infralittoral gravel and pebbles	SS.SMx.IMx / SS.SMp.KSwSS.LsacR.Gv	3
Circalittoral sandy mud	SS.SSa.CMuSa	3
Infralittoral fine sand	SS.SSa.IFiSa	2
Infralittoral fine sand and segrass patches	SS.SSa.IFiSa / SS.SMp.SSgr	1
Infralittoral muddy sand	SS.SSa.IMuSa	9
Infralittoral muddy sand with seagrass patches	SS.SSa.IMuSa / SS.SMp.SSgr	1

The distributions of the biotopes identified are illustrated in Figures 3.2 – 3.8. All the figures have biotopes coloured according to the legend below (Figure 3.1). Figure 3.2 illustrates the whole of the Fal and Helford SAC, whilst Figures 3.3 – 3.8 show zoomed in details of various areas of the SAC.

Seastar Survey Ltd.
Fal & Helford SAC Maerl Survey 2013
Drop-down Camera Biotopes

- CR.HCR.XFa
- CR.HCR.XFa.ByErSp.Eun
- CR.MCR.EcCr
- CR.MCR.EcCr.FaAlCr.Bri
- IR.HIR.KFaR.FoR
- IR.HIR.KFaR.FoR/ SS.SMp.KSwSS.LsacR.Gv
- IR.HIR.KSed
- IR.HIR.KSed.(XKHal)
- IR.HIR.KSed.XKScrR/ CR.MCR.EcCr
- IR.MIR.KT.XKT
- IR.MIR.KT.XKT/ SS.SMp.KSwSS.LsacR.Gv
- IR.MIR.KT.XKTX
- IR.MIR.KT.XKTX/ SS.SCS.ICS
- SS.SCS.CCS
- SS.SCS.ICS
- SS.SCS.ICS/ CR.MCR.EcCr.FaAlCr.Bri
- SS.SCS.ICS/ IR.MIR.KT.XKTX
- SS.SCS.ICS/ SS.SMp.KSwSS.Lsac.Gv
- SS.SCS.ICS/ SS.SMp.KSwSS.LsacR.CbPb
- SS.SCS.ICS/ SS.SMp.KSwSS.LsacR.Sa
- SS.SCS.ICS/ SS.SMp.Mrl.Lcor
- SS.SMp.KSwSS.LsacR.CbPb
- SS.SMp.KSwSS.LsacR.Gv
- SS.SMp.KSwSS.LsacR.Sa
- SS.SMp.KSwSS.LsacR.Sa/ SS.SMp.SSgr
- SS.SMp.Mrl.(Lcor)
- SS.SMp.Mrl.(Lcor)/ SS.SMp.KSwSS.LsacR.Gv
- SS.SMp.Mrl.Lcor
- SS.SMp.Mrl.Lcor/ IR.HIR.KFaR.FoR.Dic
- SS.SMp.Mrl.Lcor/ SS.SMp.KSwSS.LsacR.Gv
- SS.SMp.Mrl.Lcor/ SS.SSa.IFiSa
- SS.SMp.Mrl.Pcal
- SS.SMp.Mrl.Pcal/ IR.HIR.KFaR.FoR.Dic
- SS.SMp.SSgr
- SS.SMu.CSaMu
- SS.SMu.ISaMu
- SS.SMx.CMx
- SS.SMx.CMx.ClloMx
- SS.SMx.CMx.OphMx
- SS.SMx.CMx.OphMx/ SS.SCS.CCS
- SS.SMx.CMx.OphMx/ SS.SCS.ICS
- SS.SMx.IMx
- SS.SMx.IMx/ SS.SCS.ICS
- SS.SMx.IMx/ SS.SMp.KSwSS.LsacR.Gv
- SS.SSa.CMuSa
- SS.SSa.IFiSa
- SS.SSa.IFiSa/ SS.SMp.SSgr
- SS.SSa.IMuSa
- SS.SSa.IMuSa/ SS.SMp.SSgr

Figure 3.1. Biotope colour legend for biotope distribution maps (Figures 3.2 – 3.8).

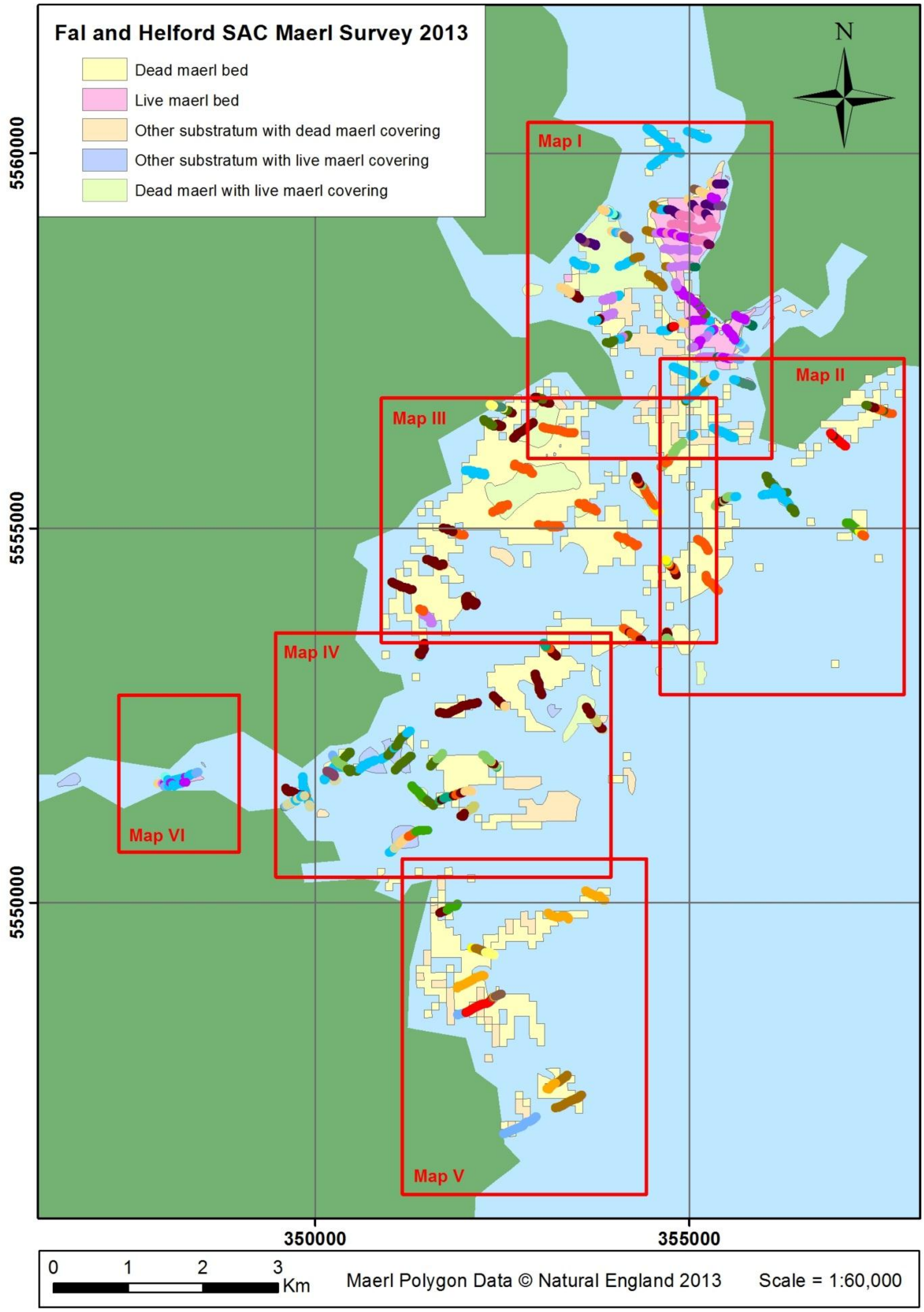

Figure 3.2. Distribution of biotopes within the Fal and Helford SAC according to drop-down survey data, 2013. See Figures 3.3 – 3.8 for details of Map I – Map VI.

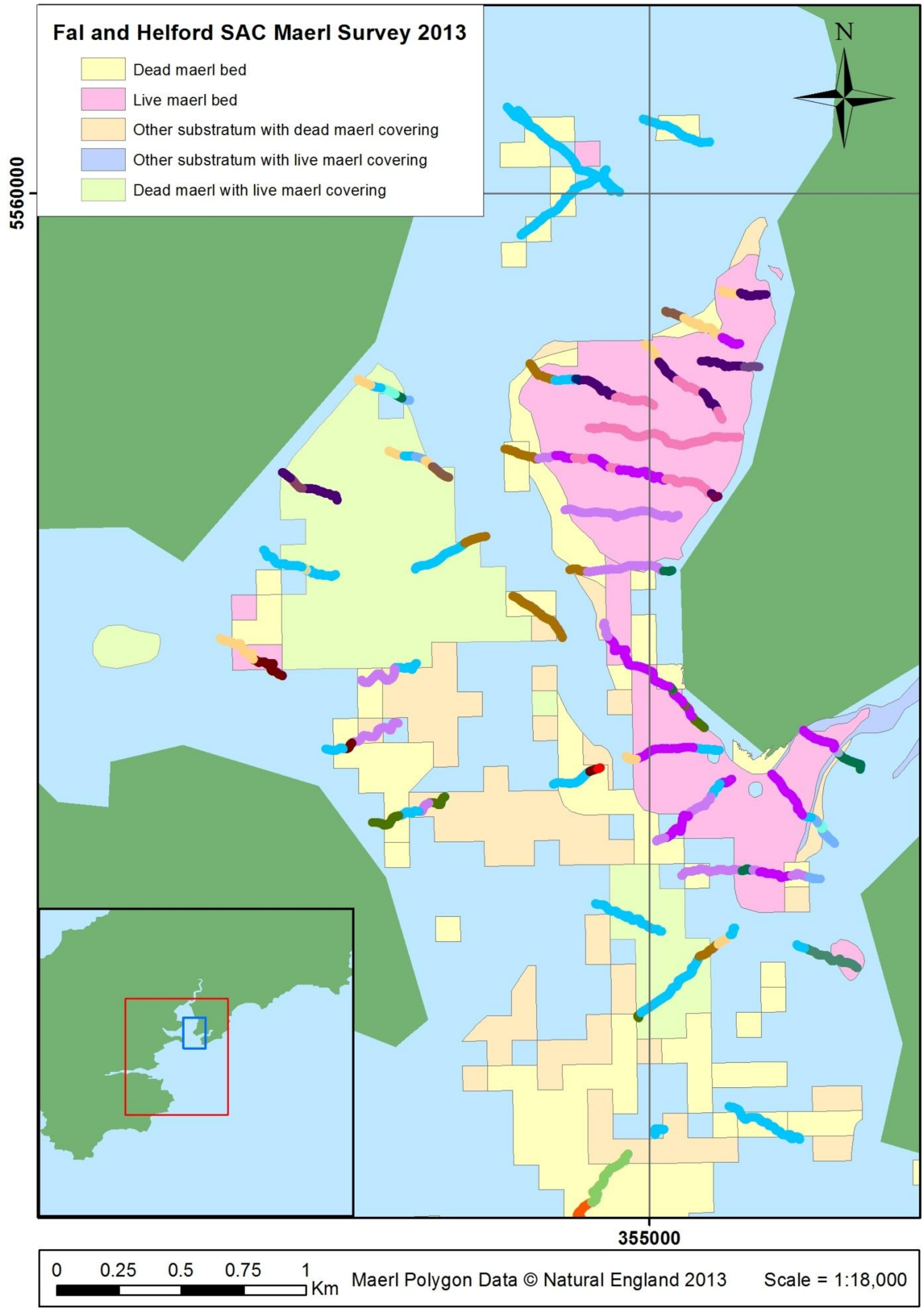

Figure 3.3. Map I - further detail of biotope distribution within Fal and Helford SAC, St. Mawes Bank and Castle Point.

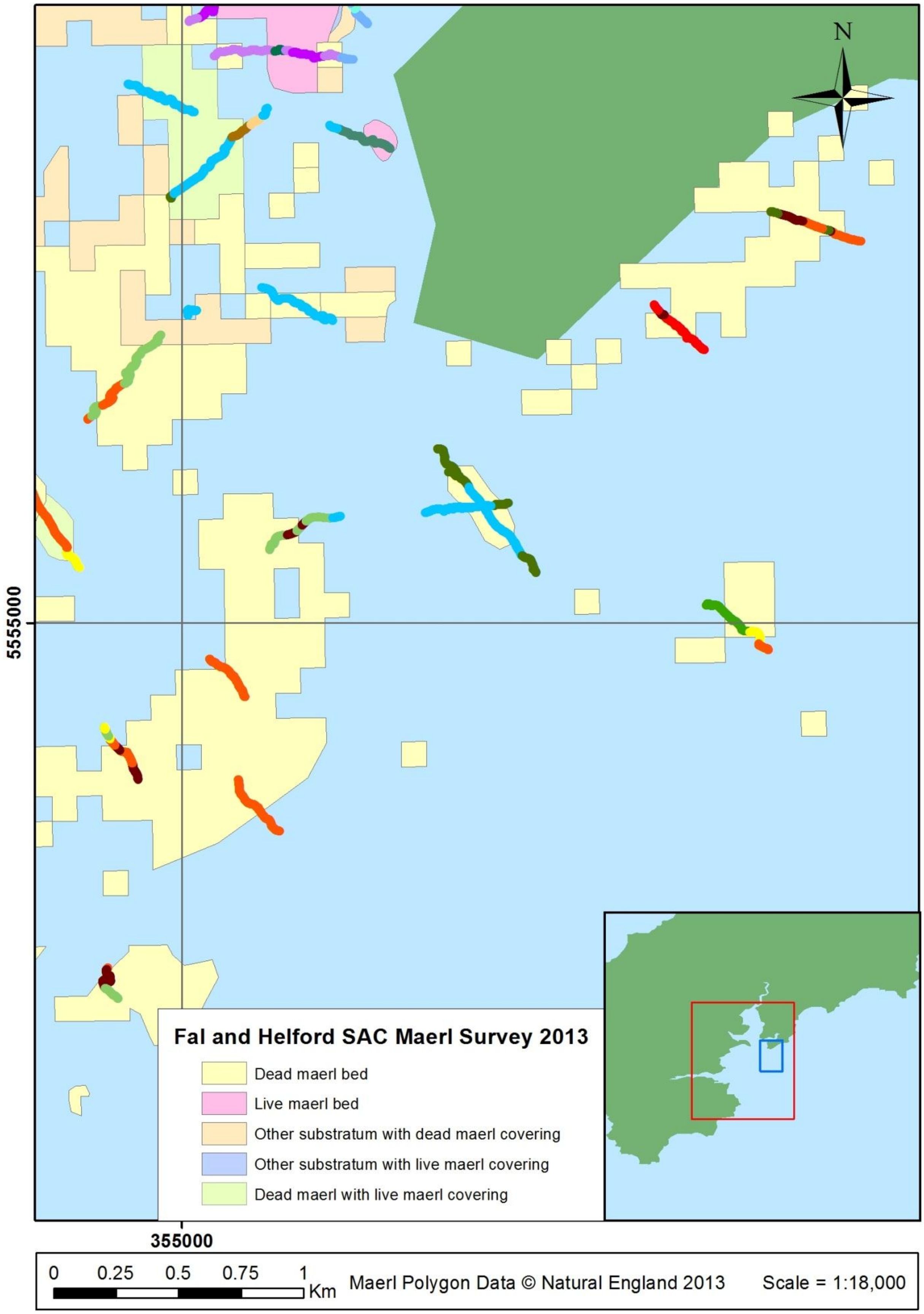

Figure 3.4. Map II - further detail of biotope distribution within Fal and Helford SAC, Zone Point.

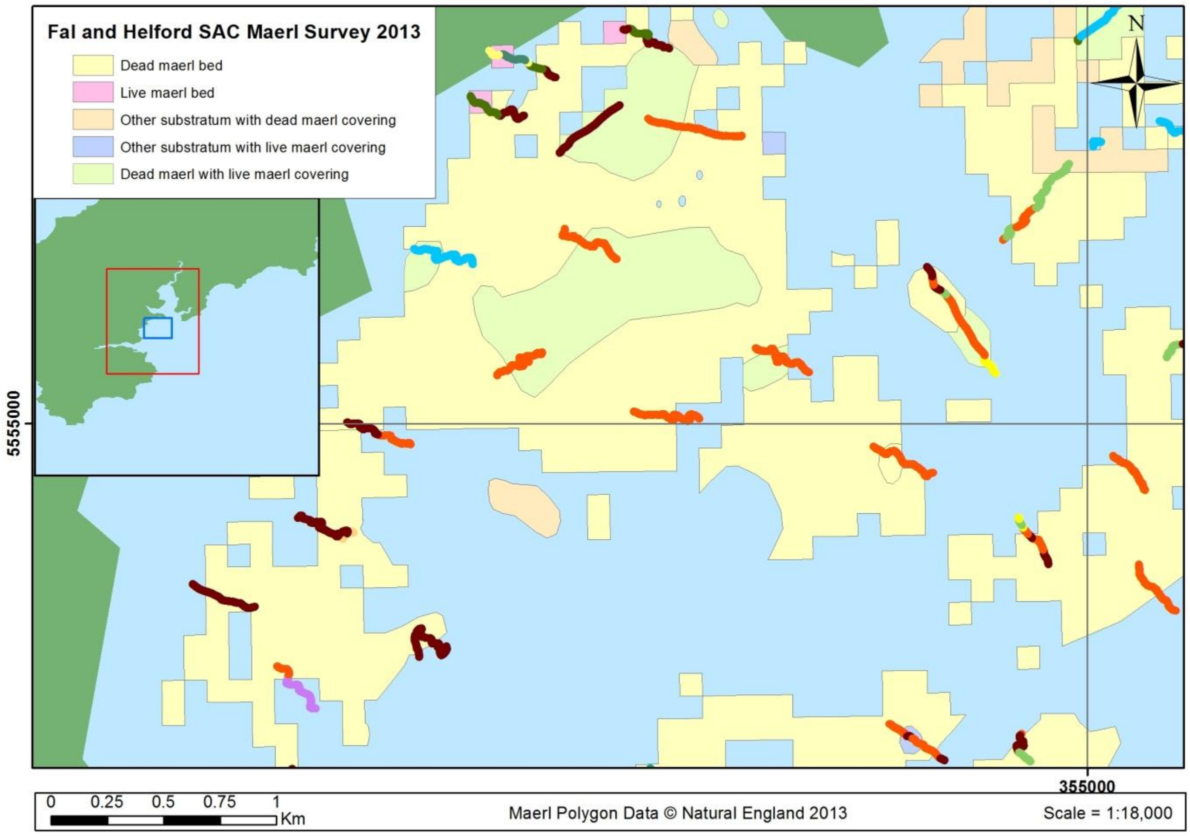

Figure 3.5. Map III - further detail of biotope distribution within Fal and Helford SAC, Falmouth Bay.

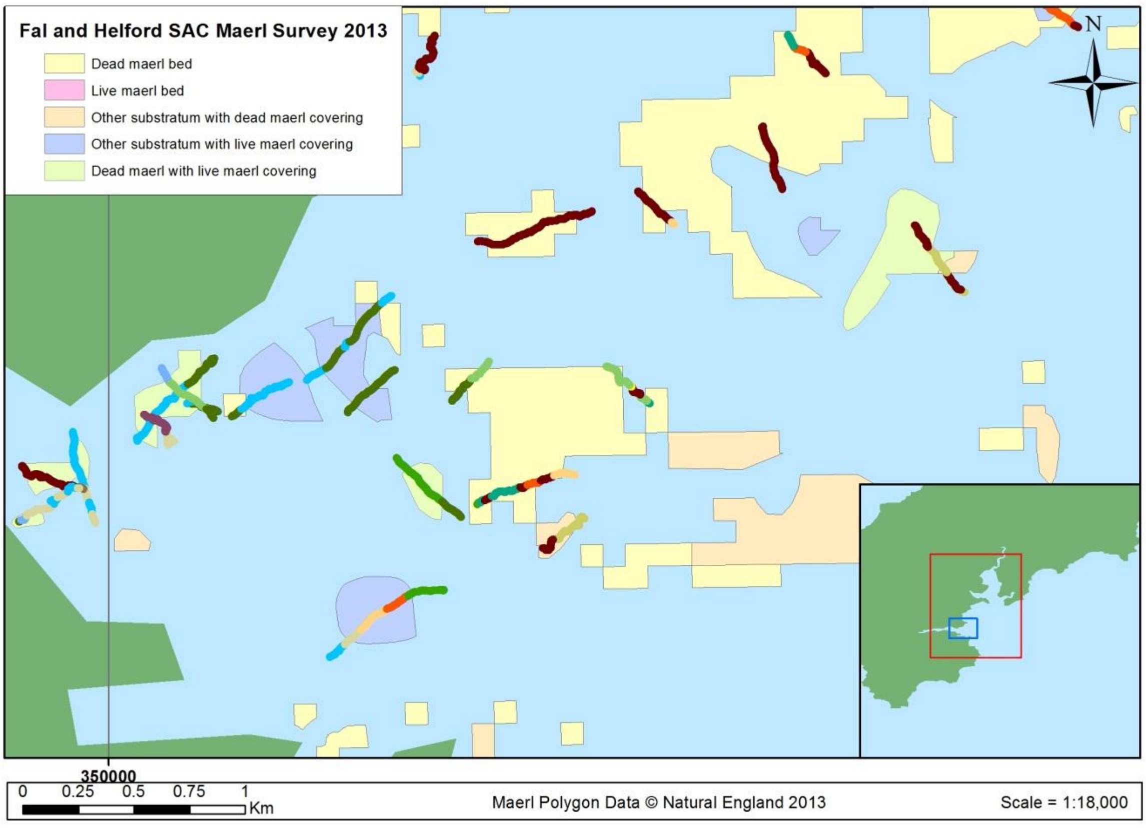

Figure 3.6. Map IV - further detail of biotope distribution within Fal and Helford SAC, mouth of Helford River.

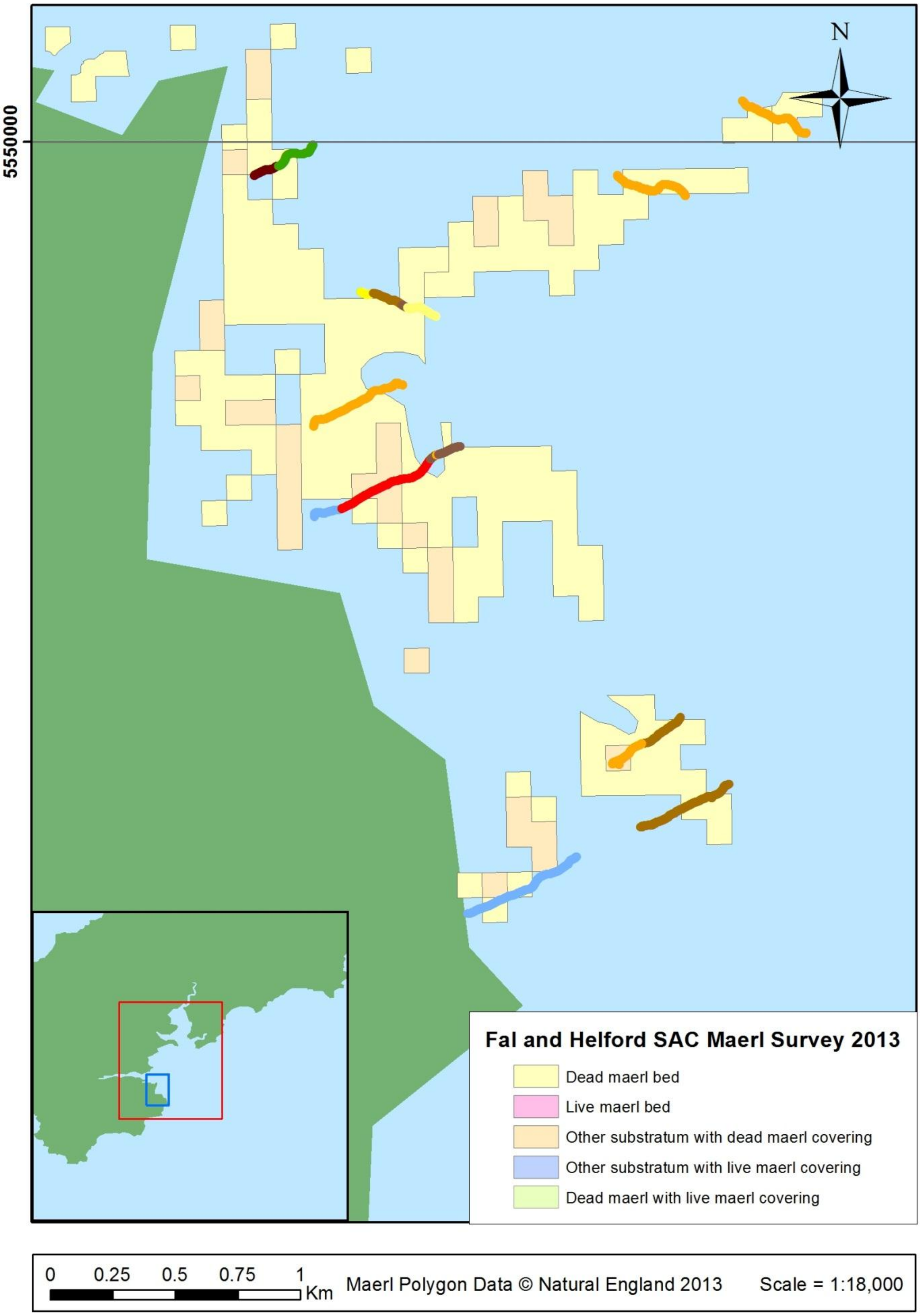

Figure 3.7. Map V - further detail of biotope distribution within Fal and Helford SAC, Nare Point.

Figure 3.8. Map VI - further detail of biotope distribution within Fal and Helford SAC, Helford River.

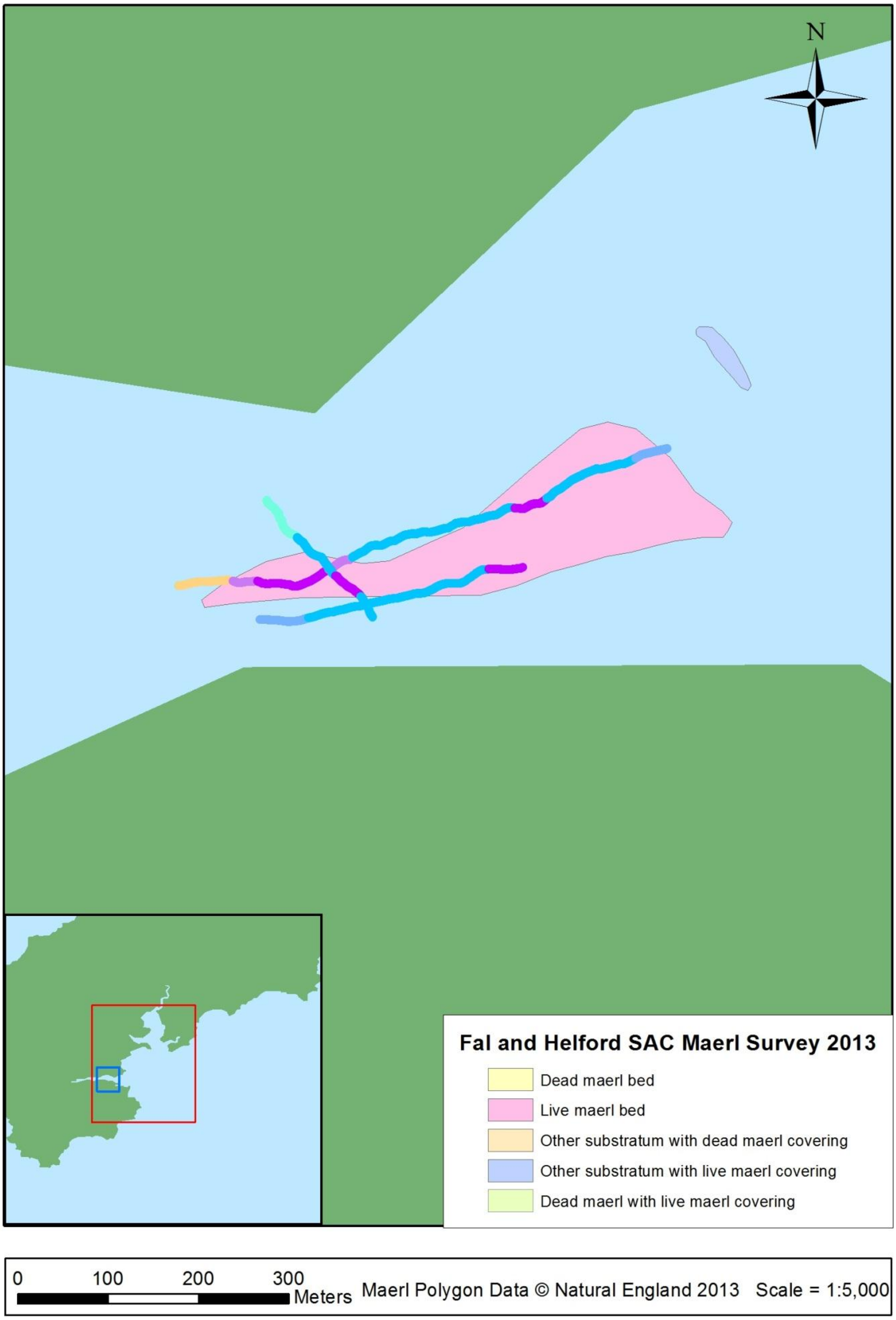

Figure 3.8. Map VI - further detail of biotope distribution within Fal and Helford SAC, Helford River.

3.1.1 Summary of broadscale habitats identified

The drop-down camera survey confirmed the presence of large maerl beds around St. Mawes Bank and Castle Point, and in Helford River. See section 3.1.2 for more detail on the extent and distribution of the maerl beds surveyed.

Aside from the maerl beds, the most frequently observed habitats within the Fal and Helford SAC were coarse and mixed sediments (**SS.SCS** and **SS.SMx** habitat complexes; Figure 3.9a). Large numbers of brittlestars *Ophiothrix fragilis* and *Ophiocomina nigra* were frequently observed over these coarse and mixed sediments (**SS.SMx.CMx.OphMx;** Figure 3.9b). A large degree of the gravel component of the coarse and mixed sediments across the whole of the SAC was dead maerl gravel. The distribution of maerl gravel is examined in more detail in section 3.1.2. Species commonly identified form these coarse sediment areas included *Marthasterias gracilis*, hermit crabs, *Cancer pagurus*, and brittlestars. Mixed sediments often included tubes of the polychaete *Megalomma vesiculosum*, and various burrowing anemones such as *Cerianthus lloydii.* The coarse sediments sometimes had a large degree of foliose red algae present (**IR.HIR.KFaR.FoR** biotope; Figure 3.9c), or sparse clumps of kelp and red algae (**SS.SMp.KSwSS.LsacR** biotope complex; Figure 3.9d).

In addition to the coarse sediment areas and maerl beds, other broadscale habitats observed included kelp forests, seagrass beds and faunal communities on bedrock and boulders. The kelp forest areas were mainly comprised of *Laminaria hyperborea*, with some *Saccharina latissima*, various red algae, and patches of brown algae such as *Chorda filum*, *Dictyota dichotoma* and *Halidrys siliquosa*. Fauna present included snakelock anemones (*Anemonia viridis*), colonial ascidians, sponges and various echinoderms. These kelp communities typically fitted within the 'Tide-swept kelp and seaweed communities (sheltered infralittoral rock)' biotope complex (**IR.MIR.KT**), although variations in the species of macrophytes and fauna led to some areas being assigned biotopes under the Sand or gravel-affected or disturbed kelp and seaweed communities' biotope complex (**IR.HIR.KSed**). Several areas of seagrass (**SS.SMp.SSgr)** were observed close to the coastline around Castle Point (FH013, FH014, FH017, FH018, FH019, FH020 & FH021), and in Falmouth Bay (FH045 & FH055). The seagrass beds appeared to be composed of *Zostera marina* (Figure 3.9e)*,* and were surrounded by sandy sediments, occasionally with live maerl within the seagrass bed. Areas of silt covered rock were observed off Nare Point, with a variety of epifauna including pink seafans *Eunicella verrucosa*, *Caryophyllia smithii, Pentapora foliacea*, various sponges and *Holothuria forskali* (**CR.HCR.XFa.ByErSp.Eun** biotope; Figure 3.9f).

Several invasive species were seen during the survey, including slipper limpets *Crepidula fornicata*, Japanese wireweed *Sargassum muticum,* and the leathery sea squirt *Styela clava.* Other species of note observed during the survey included large numbers of thornback rays *Raja clavata* observed around the maerl beds and coarse sediment off St. Mawes Bank, and numerous observations of the greater pipefish *Syngnathus acus* throughout the survey area.

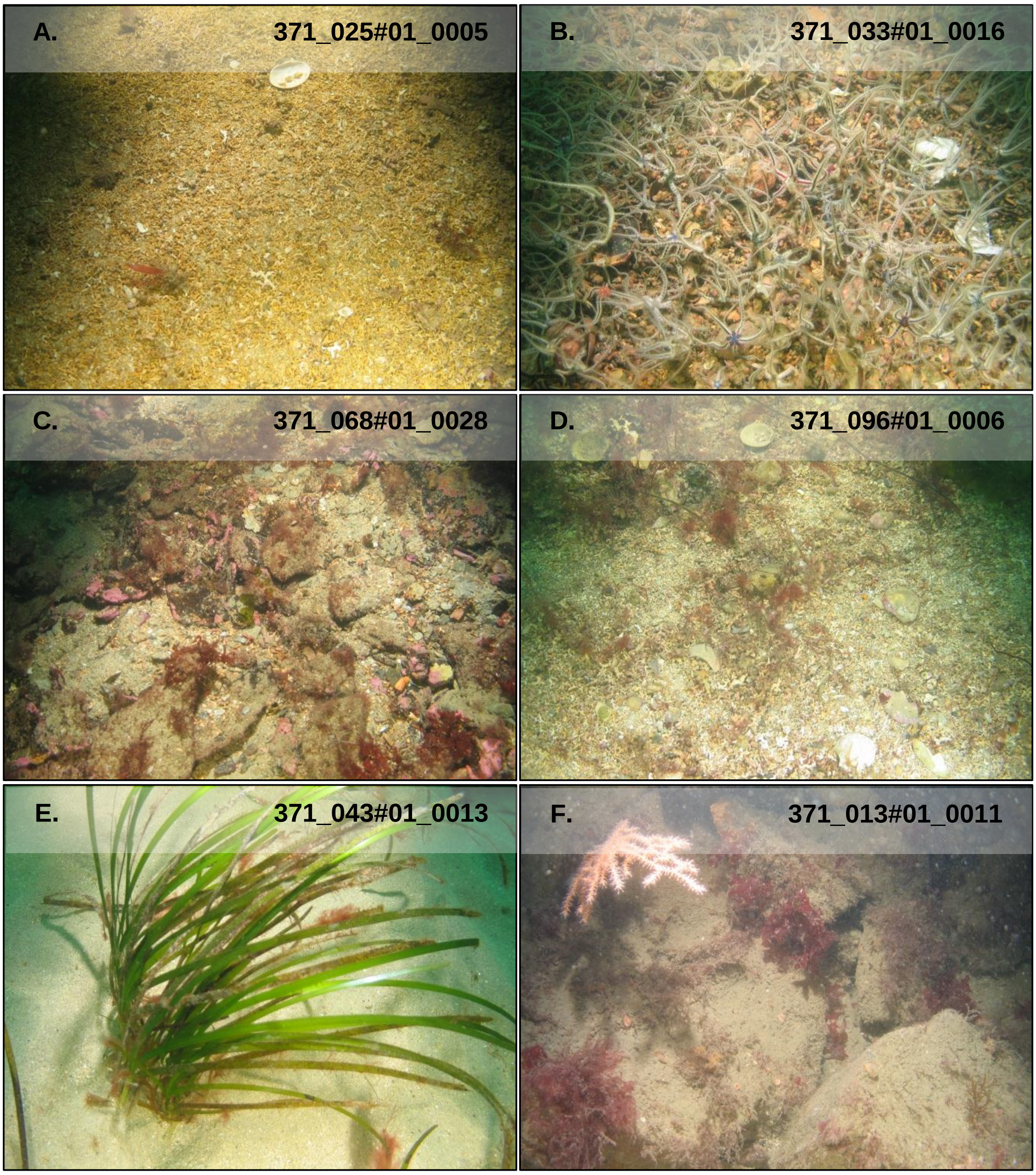

Figure 3.9. Example images of common habitats observed during the drop-down camera survey of Fal and Helford SAC, 2013. A. ***SS.SCS.CCS*** *(with maerl gravel); B.* ***SS.SMx.CMx.OphMx****; C.* ***IR.HIR.KFaR.FoR****; D.* ***SS.SMp.KSwSS.LsacR.Gv****; E.* ***SS.SMp.SSgr****; F.* ***CR.HCR.XFa.ByErSp.Eun****.*

3.1.2 Distribution and extent of maerl beds

The abundance of live and dead maerl observed from the still images is displayed in Figure 3.12. Figures 3.13 – 3.19 show more detailed views, examining the percentage cover of live and dead maerl. The identification of maerl species was extremely difficult from the video footage. Still images allowed a better view of maerl, but again diagnosis of maerl species was not certain. Identification of maerl species was based principally on the size, shape and thickness of the maerl rhodoliths, supported by cross-comparisons with diver observations to confirm species identification. The edges of live maerl beds were typically composed of maerl gravel, with a gradual increase in the amount of live maerl present towards the centre of the maerl beds. It was therefore generally hard to define a precise boundary to the start / end of a maerl bed from the video footage, which may have resulted in a slight mismatch between the previously defined polygon boundaries and the current survey data.

In general, the maps show that was a relatively good match between the live maerl polygons and the data collected during the drop-down camera survey. Figure 3.13 – 3.14 show that the boundaries of the St. Mawes Bank and Castle Point maerl bed were in approximate agreement with the 'Live maerl bed' polygon boundaries. The areas of maerl bed tended to become sparser at their outer fringes, especially to the north. The other boundaries matched well with the presence of maerl gravel, but to a lesser extent with the degree of live maerl present. The live maerl bed found in St. Mawes Bank was composed of both *Lithothamnion corallioides* and *Phymatolithon calcareum.* It was often difficult to distinguish between the two maerl species unless they occurred at very high densities. *Phymatolithon calcareum* was mainly observed in the middle of the St. Mawes Bank maerl bed (Figure 3.10a), whilst *L. corallioides* was more common to the north, south and on the edges of the bed. Analysis of the drop-down video data suggested that the majority of the *P. calcareum* bed was between stations FH007, FH008 and FH009 (Figure 3.11). Further survey work would be needed to accurately define the boundaries of this different maerl habitat within St. Mawes Bank.

Figure 3.14 shows the maerl bed within the Helford River. The presence of static fishing gear prevented all the planned survey lines from being run over this area. The maerl bed there was typically less dense than in St. Mawes Bank. The data acquired showed some agreement with the boundaries of the polygon, but it appeared that the maerl bed may be very patchy. The maerl bed in Helford River was comprised of *L. corallioides* (Figure 3.10b). Further details of the faunal and floral composition of the maerl beds at St. Mawes Bank, Castle Point and Helford River can be found in the results of the scientific diving survey (section 3.2).

The video lines run over the rest of the Fal and Helford SAC (Figures 3.15 – 3.19) showed relatively good agreement with the polygons in terms of the presence of maerl gravel. However, the amount of live maerl present did not necessarily match with the polygon categories. Falmouth Bay was characterised by mainly coarse and mixed sediment, much of which was composed of maerl gravel, with a very small component of live maerl. Although there were a few small areas where live maerl was recorded as frequent or common, these tended to be very discrete and relatively scattered, and did not represent cohesive beds like those observed around St. Mawes Bank, Castle Point and in the Helford River. Very small amounts of live maerl (1 - 5 % cover) were usually seen among maerl gravel. These small pieces of maerl may represent fragments broken off healthy beds and moved by the current, which have yet to lose the pink colouration characteristic of live maerl.

Although the maerl habitat polygons had five different categories, examining the cover of live and dead maerl suggested that several of these categories were not distinguishable from one another. The 'Live maerl bed' habitat appeared to be well supported, but the polygons for 'Dead maerl bed' and 'Other substratum with dead maerl covering' did not appear to be different in terms of the amount of live and dead maerl present. Likewise, the 'Other substratum with live maerl covering' and 'Dead maerl with live maerl covering' did not appear to be differentiated from the other maerl habitat categories, excluding the 'Live maerl bed' habitat. No guidelines within how these habitat categories were defined could be found within Natural England (2013) beyond 'Live maerl bed' being assigned to areas with live maerl cover >20%.

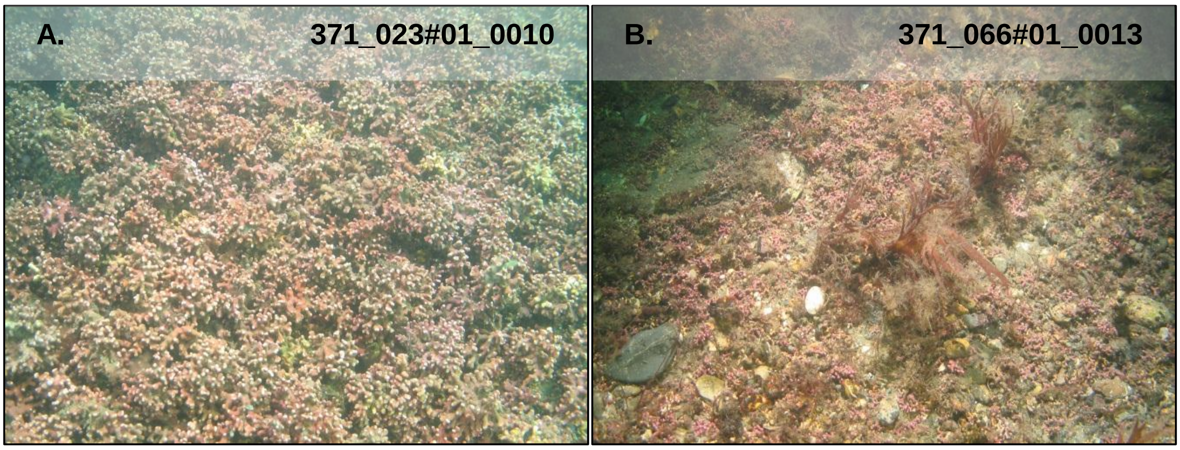

Figure 3.10. Example images of Phymatolithon calcareum *from St. Mawes Bank (A), and* Lithothamnion corallioides *from Helford River (B).*

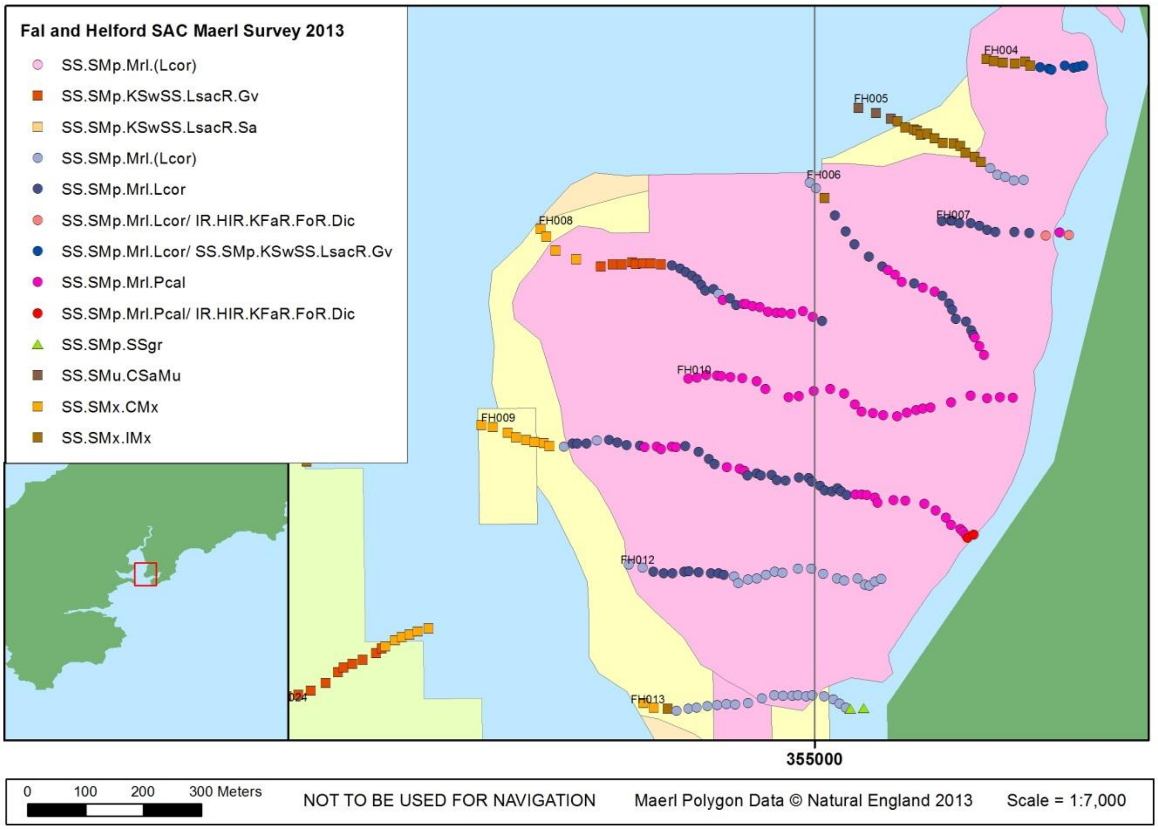

Figure 3.11. Map illustrating spread of biotopes across St. Mawes Bank following still photograph analysis.

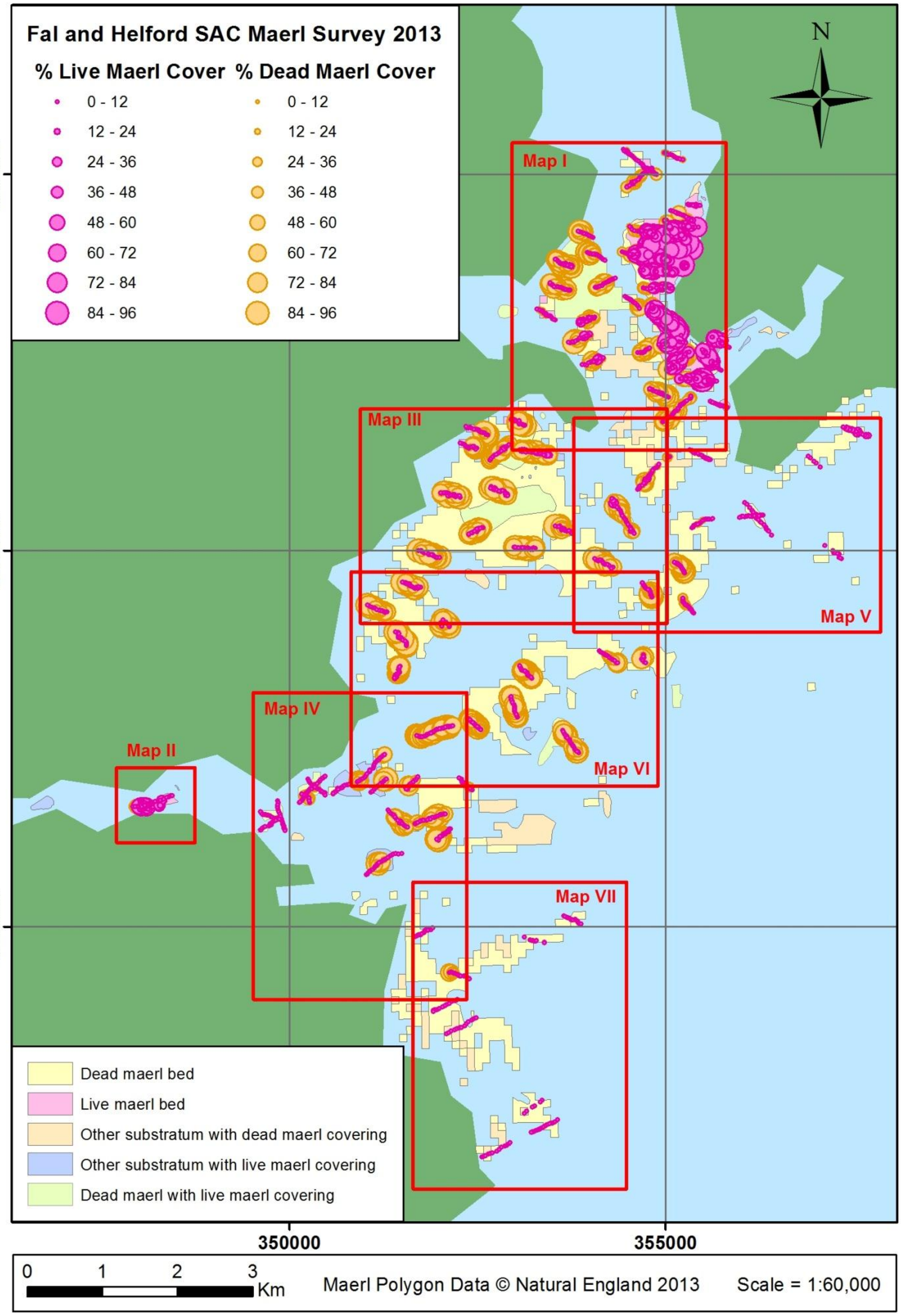

Figure 3.12. SACFOR abundance of live and dead maerl within the Fal and Helford SAC, drop-down camera survey 2013. See Figures 3.12 – 3.18 for further detail of Maps I – VI.

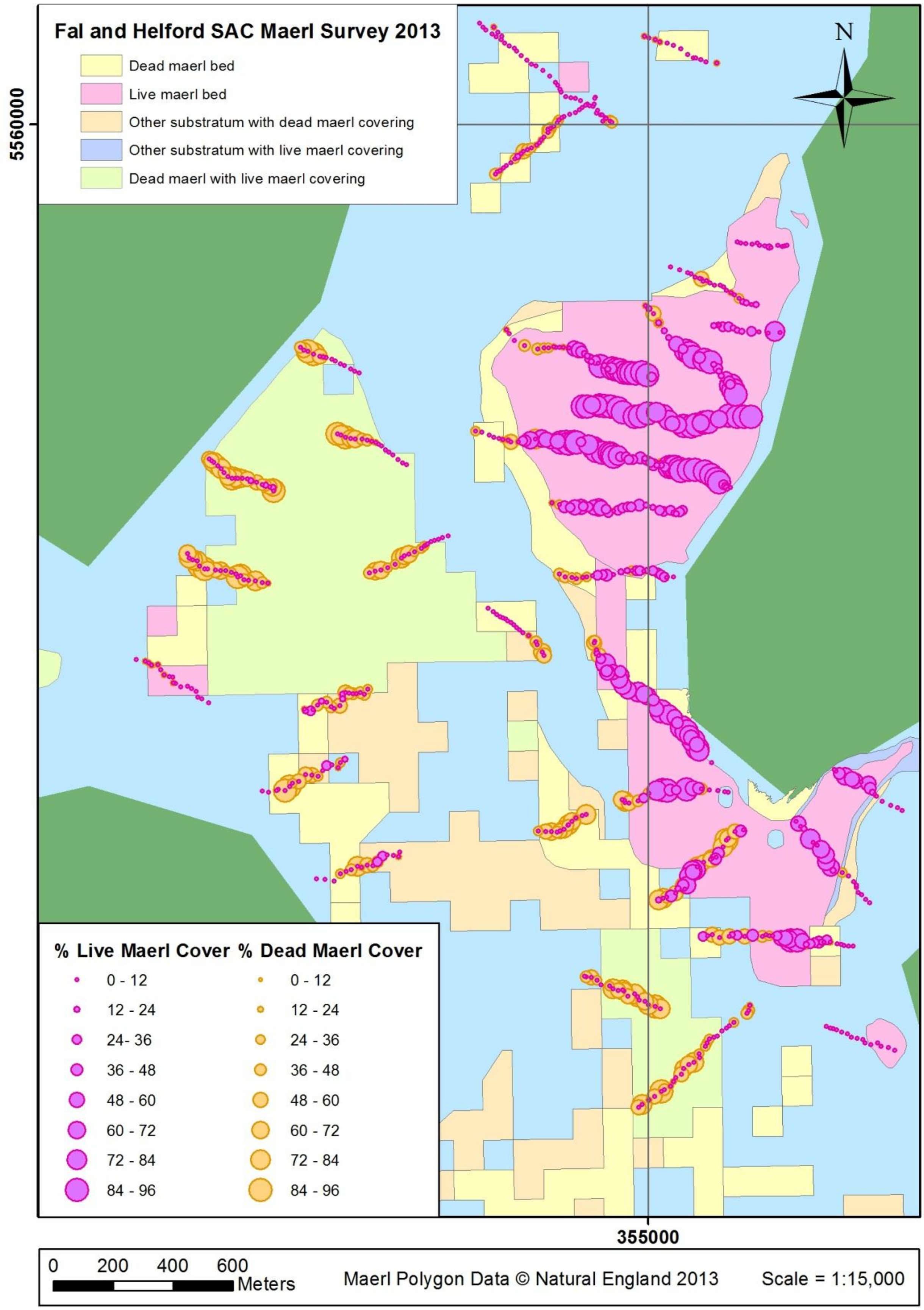

Figure 3.13. Map I – further detail of percentage live and dead maerl cover estimated from still images, St. Mawes Bank.

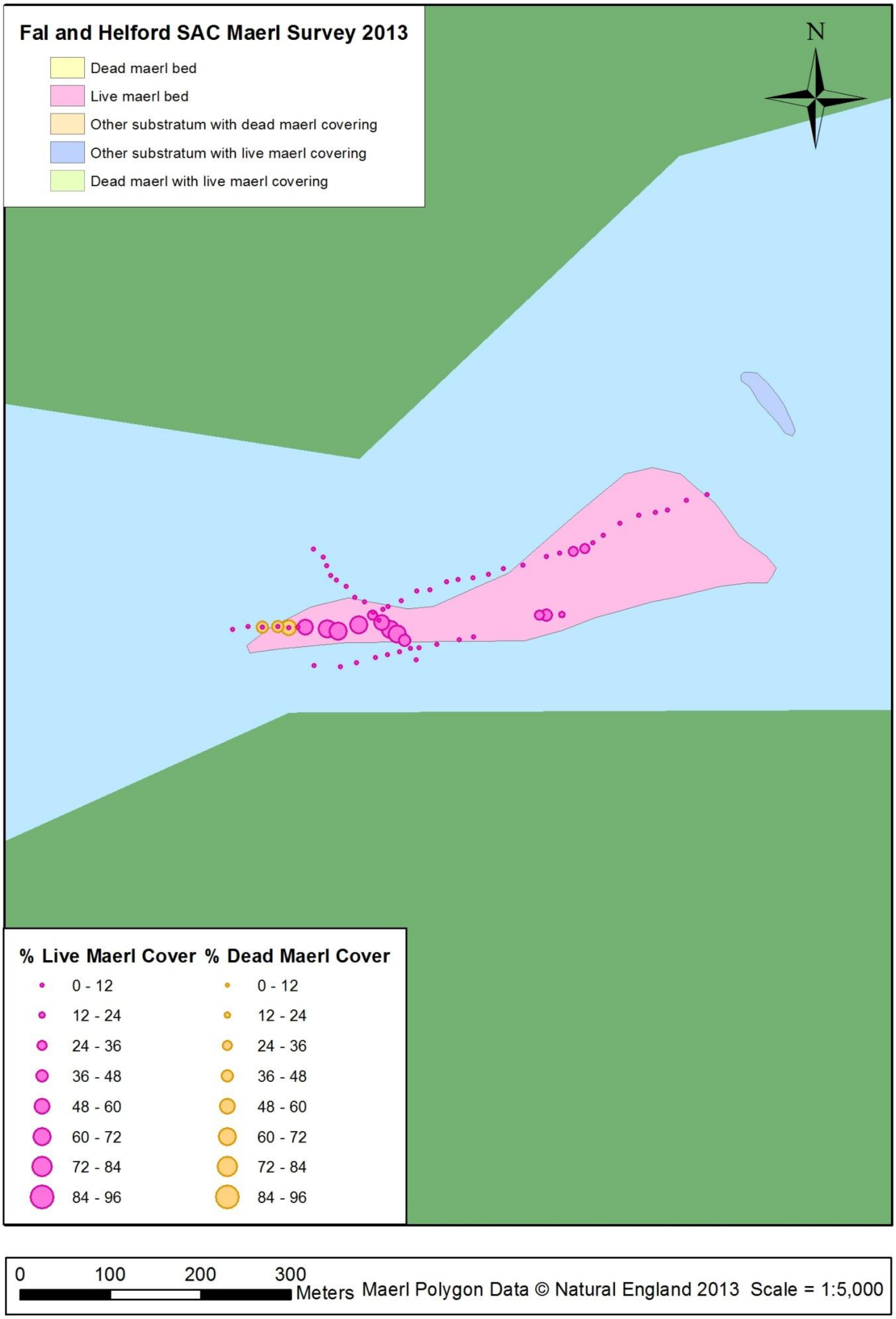

Figure 3.14. Map II – further detail of percentage live and dead maerl cover estimated from still images, Helford River.

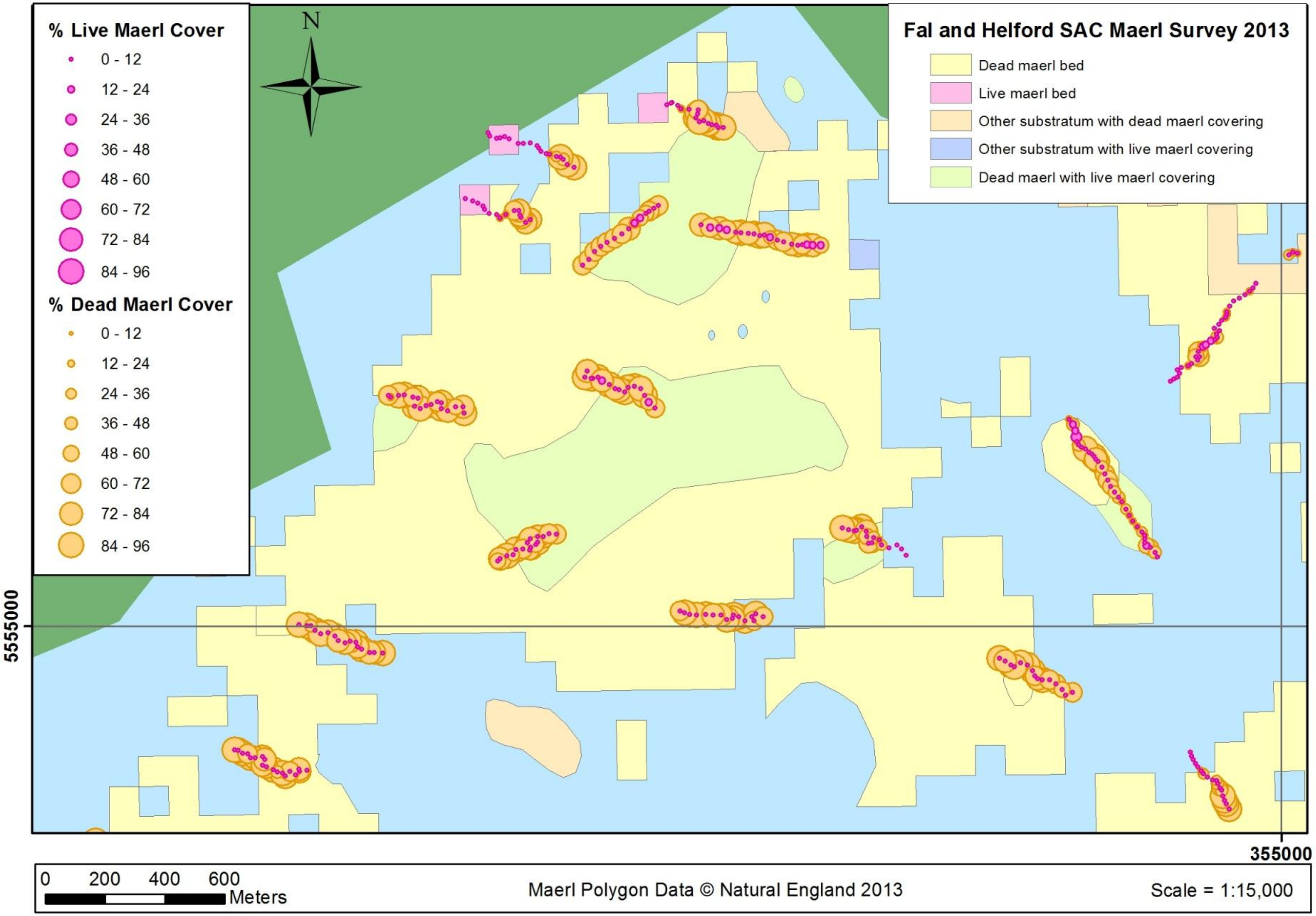

Figure 3.15. Map III – further detail of percentage live and dead maerl cover estimated from still images, north Falmouth Bay.

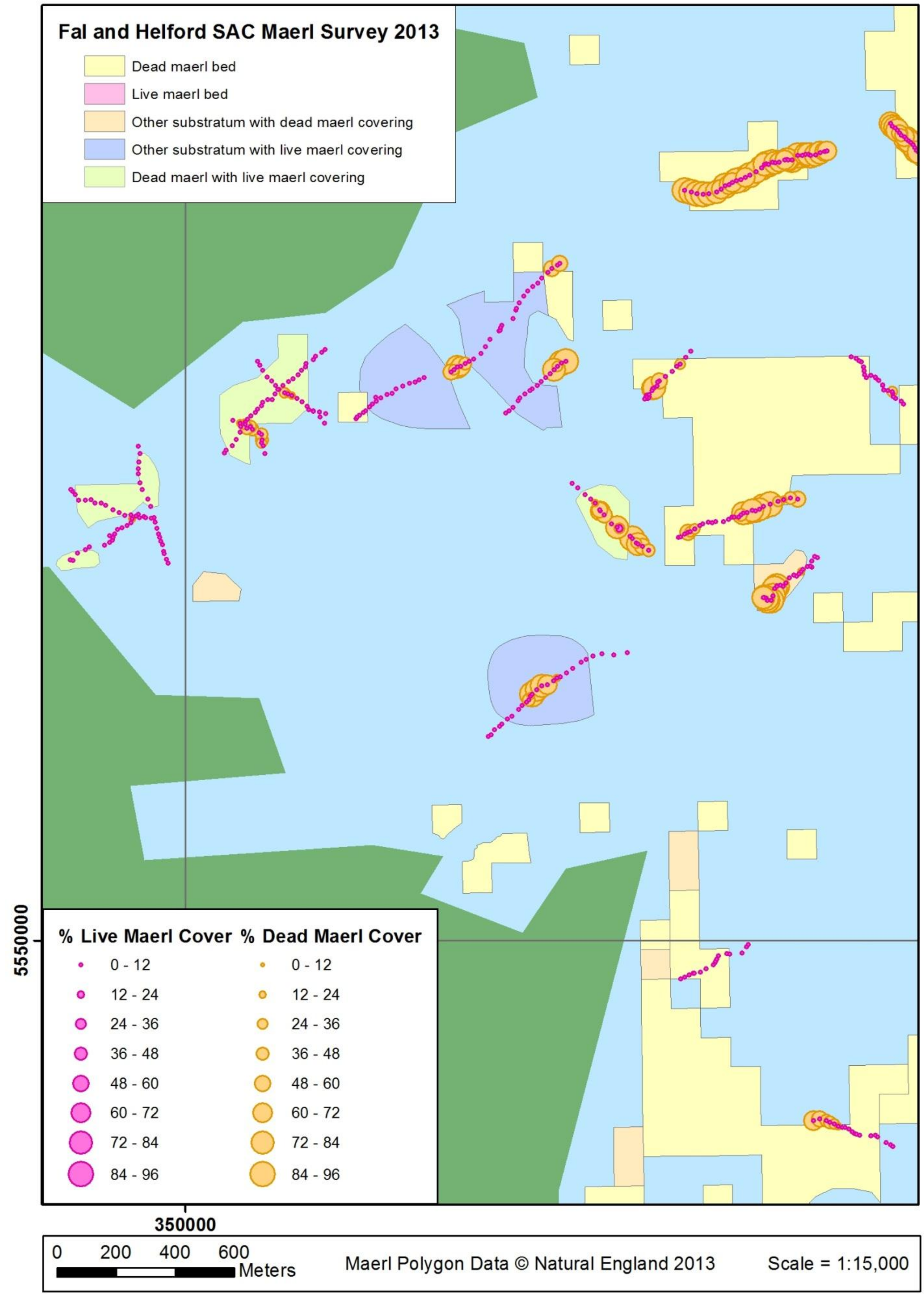

Figure 3.16. Map IV – further detail of percentage live and dead maerl cover estimated from still images, mouth of Helford River.

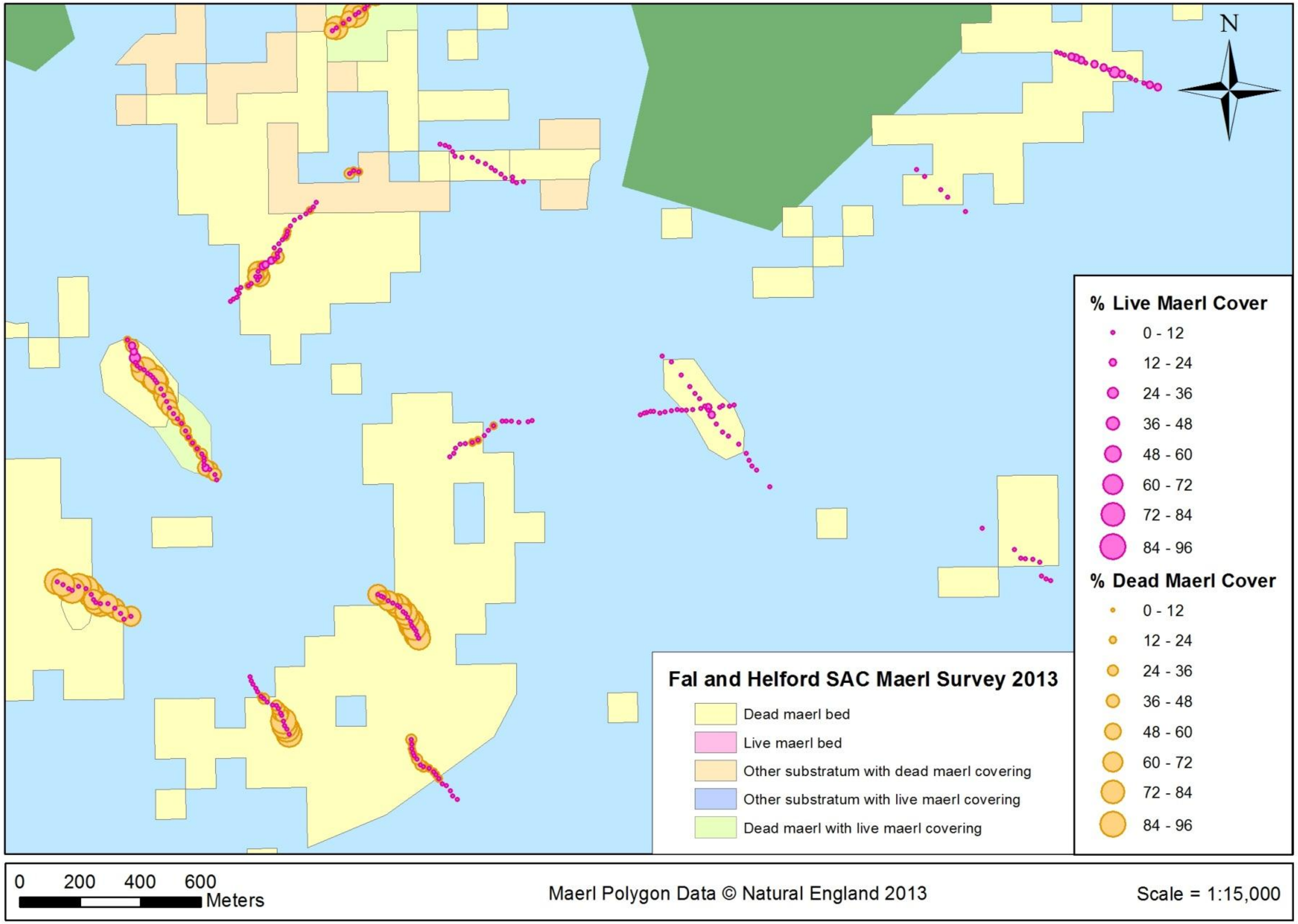

Figure 3.17. Map V – further detail of percentage live and dead maerl cover estimated from still images, Zone Point.

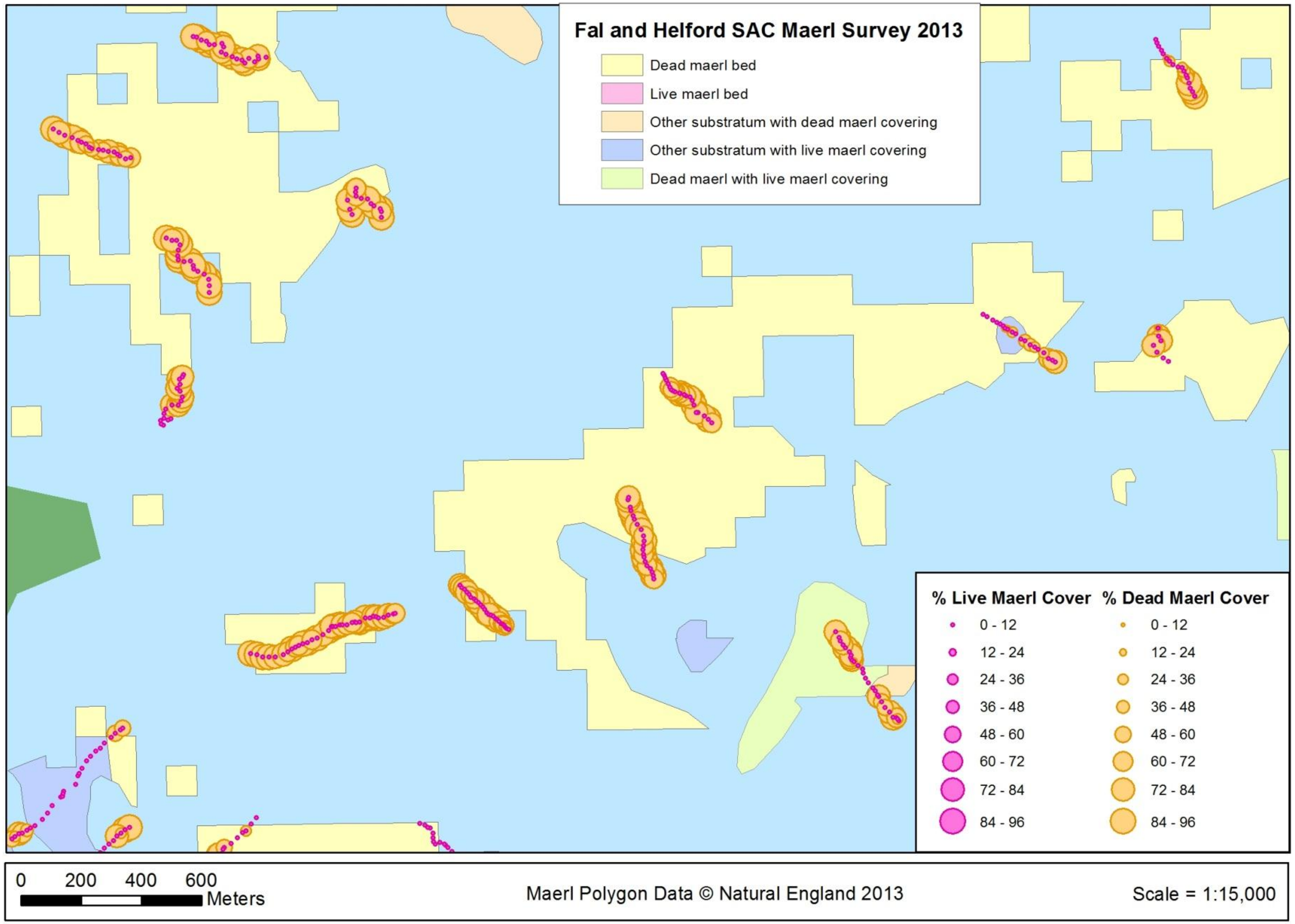

Figure 3.18. Map VI – further detail of percentage live and dead maerl cover estimated from still images, centre of Falmouth Bay.

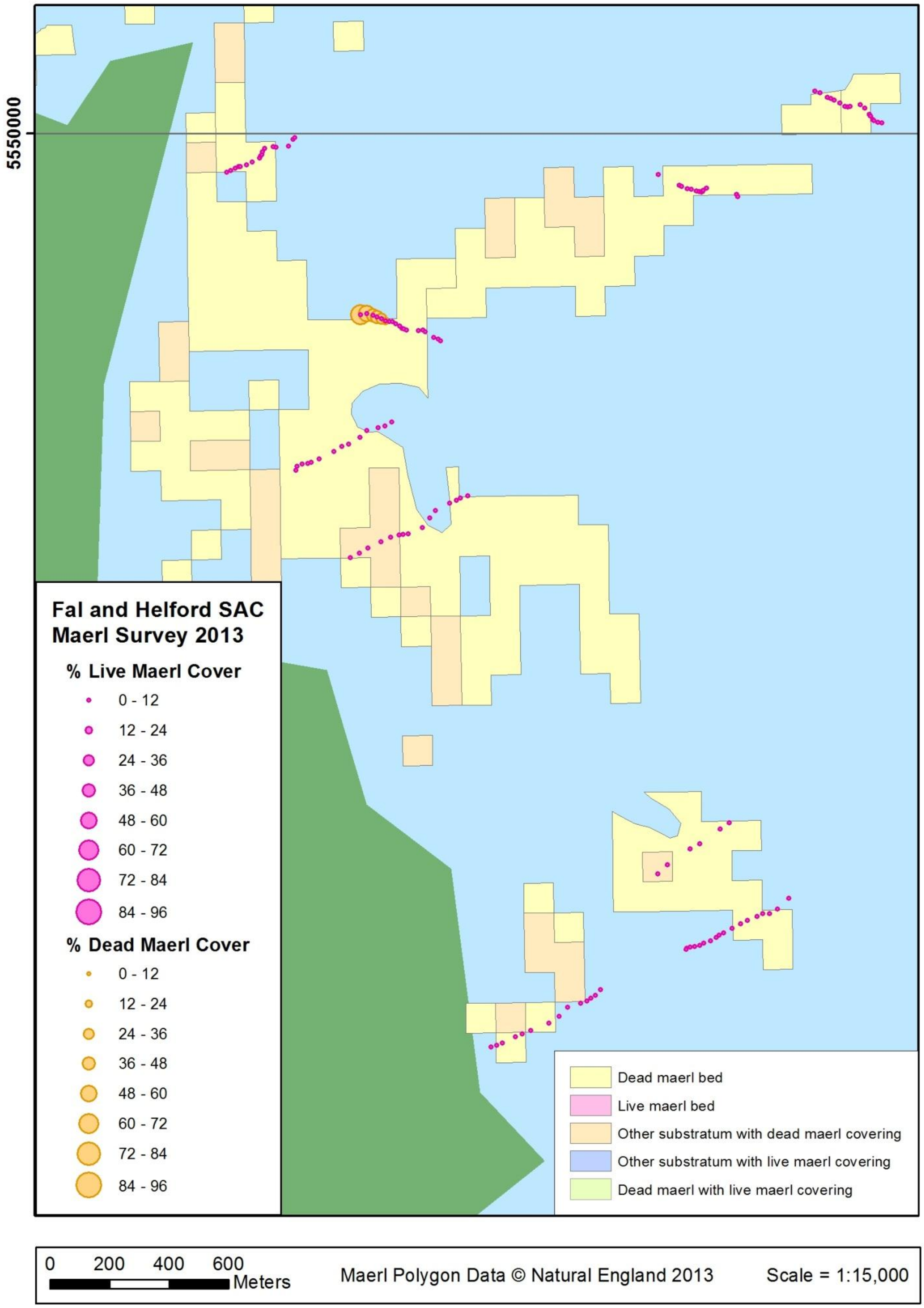

Figure 3.19. Map VII – further detail of percentage live and dead maerl cover estimated from still images, Nare Point to Manacale Point.

3.2 Scientific diving survey

The locations of the dive stations are shown in Figure 2.4. A description of each dive site is included below, with a table summarising the type and amount of maerl present, and the top three algal and faunal species present at each dive station. The top three species were selected to illustrate the dominate fauna and algae present at each dive site, with full results present in Appendix F.

3.2.1 Station Descriptions

3.2.1.1 St. Mawes Bank – Dive01

Scuba-diving station Dive01 was the northern-most dive location in the 2013 survey. The substratum was characterised by mud and muddy sand with some maerl gravel (Table 3.2 and Figure 3.20). Both species of maerl (*Phymatolithon calcareum* and *Lithothamnion corallioides*) were recorded, but at low densities of 2% and 4% mean percentage cover respectively.

In addition to the maerl cover there was also a considerable algal influence. Some algae were unattached, but a large portion was attached, making recording and identification of all the individuals challenging. The most widespread algal taxa were *Dictyota dichotoma, Rhodophyllis/ Acrosorium* (these two genera were aggregated due to difficulties in identification) and *Gracilaria gracilis*. Other algal taxa included *Calliblepharis* sp., *Ulva lactuca, Pterothamnion plumula, Polyides rotunda, Griffithsia corallinoides, Polysiphonia sp.* and *Cryptopleura ramosa*.

Among the fauna *Megalomma vesiculosum* was endemic and the most abundant species recorded. Polychaetes (Sabellidae spp.) and molluscs (Trochidae spp.) were also widespread across the site. Other fauna recorded included *Sagartiogeton undatus, Cereus pedunculatus, Myxicola infundibulum, Lanice conchilega, Liocarcinus* sp. and *Serpula vermicularis*.

Table 3.2. Summary of data collected at station Dive01 on St. Mawes Bank in 2013 (depth: maximum depth recorded by divers; cover (%): the mean percentage cover of all analysed quadrats; substratum: any other sediment type present other than maerl gravel; frequency (n): number of quadrats with a species record; frequency (%): percentage of quadrats with a species record).

Dive01 (St Mawes Bank)	Latitude Longitude	50° 10.239' N 05° 01.532' W	Depth max (m) Quadrats analysed Area (m^2) analysed	6.4 29 7.25

Species		**Cover (%)**	**Frequency (n)**	**Frequency (%)**
Maerl	*Lithothamnion corallioides* live (%)	3.19	23	79.3
	Lithothamnion corallioides dead (%)	0.86	18	62.1
	Phymatolithon calcareum live (%)	0.90	9	31.0
	Phymatolithon calcareum dead (%)	1.59	14	48.3
Substratum	Gravelly mud / gravelly muddy sand			
Algae	*Dictyota dichotoma*	-	28	96.6
	Rhodophyllis/ Acrosorium	-	24	82.8
	Gracilaria gracilis	-	22	75.9
Fauna	*Megalomma vesiculosum*	-	29	100.0
	Sabellidae sp.	-	26	89.7
	Trochidae sp.	-	21	72.4

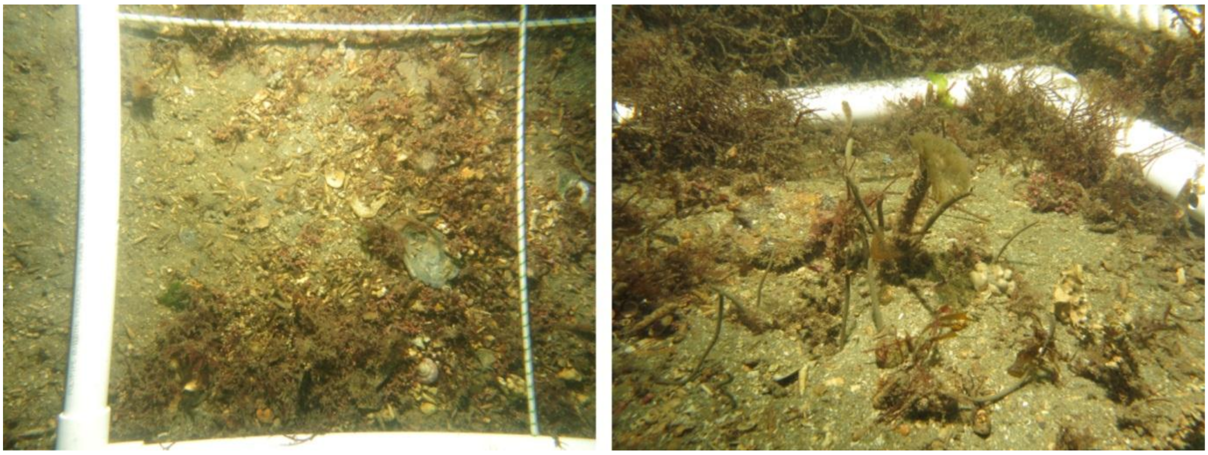

Figure 3.20. Example still photographs from station Dive01 on St. Mawes Bank in 2013, illustrating general seabed habitat.

3.2.1.2 St. Mawes Bank – Dive02

Station Dive02 was located centrally along the northern boundary of the St. Mawes Bank maerl bed. The substratum was characterised by maerl gravel but mud and shell material was also recorded. Both species of maerl (*Phymatolithon calcareum* and *Lithothamnion corallioides*) were recorded at densities of 4-5% and 58% respectively (Table 3.3 and Figure 3.21). In addition to the maerl cover there was also a considerable epiphytic algal influence. As at Dive01, some of the algae were unattached but a large portion was attached making recording and identification of all the individuals challenging.

The most widespread algal taxa were *Calliblepharis* sp., *Rhodymenia* sp. and *Ceramium* sp. but other relatively widespread algal taxa included *Heterosiphonia japonica*, *Spyridia filamentosa*, *Pterothamnion plumula, Stilophora tenella, Dasya* sp.*, Griffithsia corallinoides, Griffithsia devoniensis* and *Cryptopleura ramosa*.

In addition to the fauna in Table 3.3 Gobiidae sp., *Myxicola infundibulum, Lanice conchilega, Dysidea fragilis, Crepidula fornicata*, Terebellidae sp., *Liocarcinus* sp. and *Nemertesia antennina* were also recorded.

Table 3.3. Summary of data collected at station Dive02 on St. Mawes Bank in 2013 (depth: maximum depth recorded by divers; cover (%): the mean percentage cover of all analysed quadrats; substratum: any other sediment type present other than maerl gravel; frequency (n): number of quadrats with a species record; frequency (%): percentage of quadrats with a species record).

Dive02 (St Mawes Bank)	Latitude / Longitude	50° 10.120' N / 05° 01.865' W	Depth max (m) / Quadrats analysed / Area (m^2) analysed	6.6 / 25 / 6.25	
Species			**Cover (%)**	**Frequency (n)**	**Frequency (%)**
Maerl	*Lithothamnion corallioides* live (%)		30.1	25	100.0
	Lithothamnion corallioides dead (%)		28.1	25	100.0
	Phymatolithon calcareum live (%)		2.7	16	64.0
	Phymatolithon calcareum dead (%)		1.6	5	20.0
Substratum	Mud and shell material				
Algae	*Calliblepharis* sp.		-	20	80.0
	Rhodymenia sp.		-	20	80.0
	Ceramium sp.		-	17	68.0
Fauna	Trochidae sp.		-	16	64.0
	Megalomma vesiculosum		-	15	60.0
	Paguridae sp.		-	12	48.0

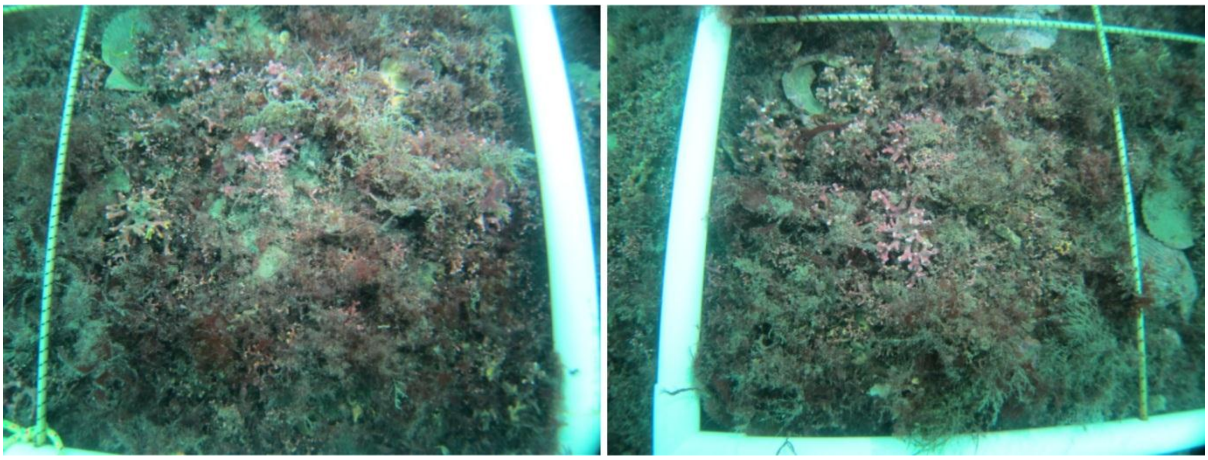

Figure 3.21. Example still photographs from station Dive02 on St. Mawes Bank in 2013, illustrating general seabed habitat.

3.2.1.3 St. Mawes Bank – Dive03

Dive station Dive03 was located southeast of Dive02 and adjacent the northern boundary of the St. Mawes Bank maerl bed. In addition to the maerl gravel the sediment was characterised by mud and shell material. As at Dive01 and Dive02 both species of maerl (*Phymatolithon calcareum* and *Lithothamnion corallioides*) were recorded at Dive03. The former was recorded at mean percentage cover of 9-10% and the latter at 55% (Table 3.4 and Figure 3.22) making *L. corallioides* the dominant and characteristic maerl species at this location in terms of density. However, *P. calcareum* was widespread across the survey line but at low densities.

Similarly to Dive02 the habitat had a considerable epiphytic algal component challenging the identification skills of the divers. The most widespread floral taxa were *Calliblepharis* sp., *Dictyota dichotoma* and *Rhodophyllis / Acrosorium* (team was unable to distinguish between the two taxa). Other relatively widespread algal taxa included *Ulva lactuca, Gracilaria multipartita, Ceramium* sp., *Pterothamnion plumula, Heterosiphonia plumosa, Rhodymenia sp.* and *Stilophora tenella*.

Of the fauna *Megalomma vesiculosum* was the most widespread but other faunal species recorded were *Crepidula fornicata,* Terebellidae sp., Paguridae sp., *Liocarcinus* sp., and *Myxicola infundibulum.*

Table 3.4. Summary of data collected at station Dive03 on St. Mawes Bank in 2013 (depth: maximum depth recorded by divers; cover (%): the mean percentage cover of all analysed quadrats; substratum: any other sediment type present other than maerl gravel; frequency (n): number of quadrats with a species record; frequency (%): percentage of quadrats with a species record).

Dive03 (St Mawes Bank)	Latitude / Longitude	50° 10.088' N / 05° 01.646' W	Depth max (m) / Quadrats analysed / Area (m^2) analysed	2.9 / 22 / 5.5
Species		**Cover (%)**	**Frequency (n)**	**Frequency (%)**
Maerl	*Lithothamnion corallioides* live (%)	47.7	22	100.0
	Lithothamnion corallioides dead (%)	8.5	18	81.8
	Phymatolithon calcareum live (%)	8.9	21	95.5
	Phymatolithon calcareum dead (%)	0.9	8	36.4
Substratum	Mud and some shell material			
Algae	*Calliblepharis* sp.	-	20	90.9
	Dictyota dichotoma	-	17	77.3
	Rhodophyllis / Acrosorium	-	17	77.3
Fauna	*Megalomma vesiculosum*	-	21	95.5
	Trochidae sp.	-	19	86.4
	Sabellidae sp.	-	16	72.7

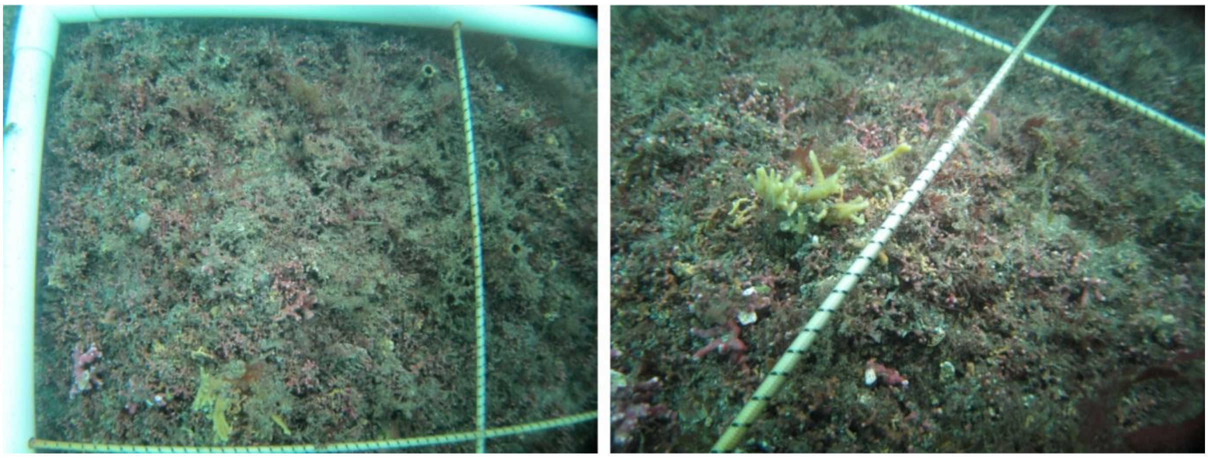

Figure 3.22. Example still photographs from station Dive03 on St. Mawes Bank in 2013, illustrating general seabed habitat.

3.2.1.4 St. Mawes Bank – Dive04

Station Dive04 was located centrally on the St. Mawes Bank maerl bed. The maerl at this station formed a thick layer of globules all across the survey line. Both species of maerl (*Phymatolithon calcareum* and *Lithothamnion corallioides*) were recorded, but *P. calcareum* was more abundant and was found at higher densities. *Lithothamnion corallioides* was widespread but only found at low densities (Table 3.5).

In relative terms there was less algal cover (Figure 3.23) on the maerl bed compared stations Dive01, Dive02 and Dive03, with the maerl globules being large and clearly visible in most of the quadrats along the survey line. In addition to the most widespread algal species as given in Table 3.5, other recorded algal species included *Calliblepharis* sp., *Rhodophyllis divaricata* / *Acrosorium ciliatum, Rhodymenia* sp., *Pterothamnion plumula* and *Spyridia filamentosa*.

Pisidia longicornis and *Galathea* sp. were particularly widespread and abundant among the fauna. Other fauna seen were hydroids, Terebellidae sp., Gobiidae sp., Sabellidae sp. and Trochidae sp.

Table 3.5. Summary of data collected at station Dive04 on St. Mawes Bank in 2013 (depth: maximum depth recorded by divers; cover (%): the mean percentage cover of all analysed quadrats; substratum: any other sediment type present other than maerl gravel; frequency (n): number of quadrats with a species record; frequency (%): percentage of quadrats with a species record).

Dive04 (St Mawes Bank)	Latitude Longitude	50° 09.953' N 05° 01.959' W	Depth max (m) Quadrats analysed Area (m^2) analysed		5.0 30 7.5
Species			**Cover (%)**	**Frequency (n)**	**Frequency (%)**
Maerl	*Lithothamnion corallioides* live (%)		17.0	29	96.7
	Lithothamnion corallioides dead (%)		8.2	23	76.7
	Phymatolithon calcareum live (%)		65.1	30	100.0
	Phymatolithon calcareum dead (%)		3.1	26	86.7
Substratum	Muddy sand / sand and shell material				
Red algae	*Ceramium* sp.		-	26	86.7
	Heterosiphonia japonica		-	20	67.7
	Hypoglossum hypoglossoides		-	15	30.0
Fauna	*Pisidia longicornis*		-	28	93.3
	Galathea sp.		-	27	90.0
	Terebellidae sp.		-	23	76.7

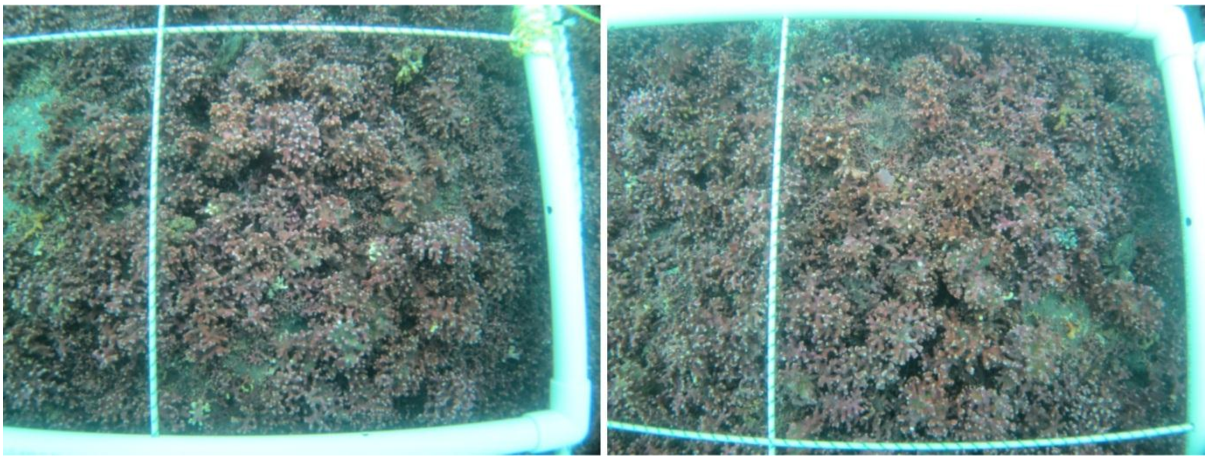

Figure 3.23. Example still photographs from station Dive04 on St. Mawes Bank in 2013, illustrating general seabed habitat.

3.2.1.5 St. Mawes Bank – Dive05

Station Dive05 was located centrally on the maerl bed, near and immediately east of station Dive04. As at Dive04 the maerl at this station formed a thick layer of globules all across the survey line (Figure 3.24). Both species of maerl (*Phymatolithon calcareum* and *Lithothamnion corallioides*) were recorded (Table 3.6) but *P. calcareum* was more abundant and was found at higher densities (~90% mean cover) along the line. *Lithothamnion corallioides* was widespread but it was only found at low densities (~7% mean cover).

The epiphytic algal cover was less dense compared to the northerly locations. The maerl globules were characteristic of the station. However, some algal taxa including *Spyridia filamentosa* were widespread (96.7% occurrence across the analysed quadrats). *Cryptopleura ramosa,* together with *Heterosiphonia japonica, Calliblepharis sp.* and *Spyridia filamentosa* were also recorded at Dive05.

There was a relatively rich faunal component at Dive05 and it was numerically dominated by primarily *Pisidia longicornis*. *Galathea* sp. was also widespread and numerically abundant with other species such as Gobiidae sp., Terebellidae sp. and *Liocarcinus* sp. also present.

Table 3.6. Summary of data collected at station Dive05 on St. Mawes Bank in 2013 (depth: maximum depth recorded by divers; cover (%): the mean percentage cover of all analysed quadrats; substratum: any other sediment type present other than maerl gravel; frequency (n): number of quadrats with a species record; frequency (%): percentage of quadrats with a species record).

Dive05 (St Mawes Bank)	Latitude Longitude	50° 09.946' N 05° 01.830' W	Depth max (m) Quadrats analysed Area (m²) analysed	2.5 30 7.5	
Species			**Cover (%)**	**Frequency (n)**	**Frequency (%)**
Maerl	*Lithothamnion corallioides* live (%)		6.4	24	80.0
	Lithothamnion corallioides dead (%)		1.4	18	60.0
	Phymatolithon calcareum live (%)		84.9	30	100.0
	Phymatolithon calcareum dead (%)		5.3	30	100.0
Substratum	Mud / muddy sand and shell material				
Red algae	*Spyridia filamentosa*		-	29	96.7
	Cryptopleura ramosa		-	24	80.0
	Rhodophyllis / Acrosorium		-	15	50.0
Fauna	Gobiidae sp.		-	23	76.7
	Pisidia longicornis		-	22	73.3
	Galathea sp.		-	20	66.7

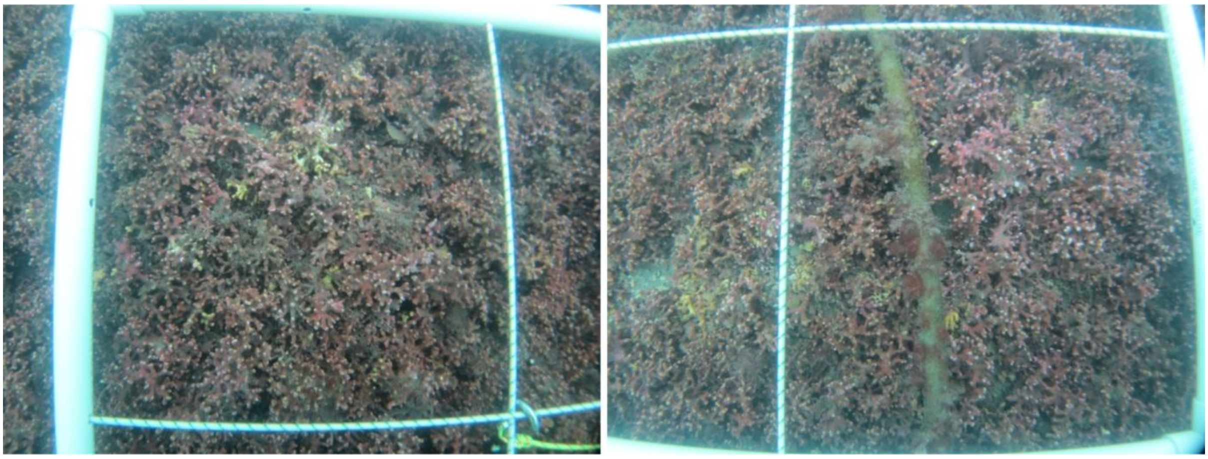

Figure 3.24. Example still photographs from station Dive05 on St. Mawes Bank in 2013, illustrating general seabed habitat.

3.2.1.6 St. Mawes Bank – Dive06

Dive06 was located centrally on the St. Mawes Bank maerl bed (Figure 3.24) but nearer the coast in relation to the other dive sites. This station was characterised by *Phymatolithon calcareum* with ~95% mean cover and was present within 29 of the 30 quadrats analysed (Figure 3.25 and Table 3.7). The maerl formed globules and the bed appeared thick (>20 cm). There were no *Lithothamnion corallioides* recorded.

The algal cover was limited, perhaps the lowest abundance seen of all the stations surveyed in 2013. The most widespread genus was *Calliblepharis* sp. but other unknown red algae species were also seen.

The fauna was characterised by *Pisidia longicornis* and *Galathea* sp., but Terebellidae sp. and Trochidae sp. were also relatively widespread. *Serpula vermicularis,* gobies, scallops (possibly *Mimachlamys varia*), *Carcinus maenas* and *Dysidea fragilis* were recorded, although these taxa were not present all along the whole line.

Table 3.7. Summary of data collected at station Dive06 on St. Mawes Bank in 2013 (depth: maximum depth recorded by divers; cover (%): the mean percentage cover of all analysed quadrats; substratum: any other sediment type present other than maerl gravel; frequency (n): number of quadrats with a species record; frequency (%): percentage of quadrats with a species record).

Dive06 (St Mawes Bank)	Latitude Longitude	50° 09.906' N 05° 01.644' W	Depth max (m) Quadrats analysed Area (m^2) analysed		5.0 30 7.5
Species			**Cover (%)**	**Frequency (n)**	**Frequency (%)**
Maerl	*Lithothamnion corallioides* live (%)		0.0	0	0.0
	Lithothamnion corallioides dead (%)		0.0	0	0.0
	Phymatolithon calcareum live (%)		91.7	29	96.7
	Phymatolithon calcareum dead (%)		4.5	21	70.0
Substratum	Mud with occasional cobble				
Red algae	Red algae sp.		-	14	46.7
	Calliblepharis sp.		-	3	10.0
Fauna	Terebellidae sp.		-	30	100.0
	Pisidia longicornis		-	15	50.0
	Galathea sp.		-	15	50.0

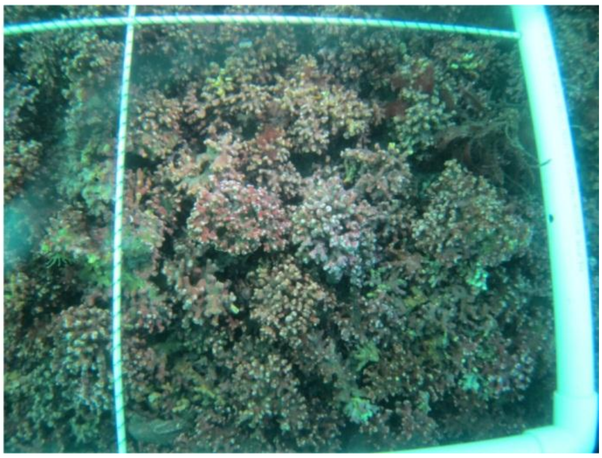

Figure 3.25. Example still photographs from station Dive06 on St. Mawes Bank in 2013, illustrating general seabed habitat.

3.2.1.7 St. Mawes Bank – Dive07

Dive site Dive07 was situated close to station Dive04 within the Mawes Bank maerl bed. This survey line was characterised and dominated by *Phymatolithon calcareum* with no records of *Lithothamnion corallioides*. *Phymatolithon calcareum* formed large globules and the bed appeared thick (>20 cm) all across the survey line (Figure 3.26). Maerl was recorded in all of the analysed quadrats with a mean density of ~99 % (live and dead) with most of it being live (~96%).

The epiphytic algal cover was limited with low densities along the line. The most widespread species was *Rhodymenia* sp. but it was only recorded in 7 of the 23 analysed quadrats (30%). *Ulva lactuca* was observed and recorded at only 13% of the 23 quadrats. Other red algal species were seen but not identified.

Gastropods within the Trochidae family were the most widespread fauna at Dive07. *Pisidia longicornis* and *Galathea* sp. were also relatively widespread. Compared to dive stations Dive04, Dive05 and Dive06, Dive07 appeared less species rich in terms of the fauna present despite the maerl appearing healthy.

Table 3.8. Summary of data collected at station Dive07 on St. Mawes Bank in 2013 (depth: maximum depth recorded by divers; cover (%): the mean percentage cover of all analysed quadrats; substratum: any other sediment type present other than maerl gravel; frequency (n): number of quadrats with a species record; frequency (%): percentage of quadrats with a species record).

Dive07 (St Mawes Bank)	Latitude / Longitude	50° 09.922' N / 05° 01.957' W	Depth max (m) / Quadrats analysed / Area (m^2) analysed		4.5 / 23 / 5.75
Species			**Cover (%)**	**Frequency (n)**	**Frequency (%)**
Maerl	*Lithothamnion corallioides* live (%)		0.0	0	0.0
	Lithothamnion corallioides dead (%)		0.0	0	0.0
	Phymatolithon calcareum live (%)		95.9	23	100.0
	Phymatolithon calcareum dead (%)		2.9	19	82.6
Substratum	Mud with occasional cobble				
Red algae	*Rhodymenia* sp.		-	7	30.4
	Red algae sp.		-	6	26.1
	Ulva lactuca			3	13.0
Fauna	Trochidae sp.		-	22	95.7
	Galathea sp./*Pisidia longicornis*		-	14	60.9
	Hydrozoa sp.		-	13	56.5

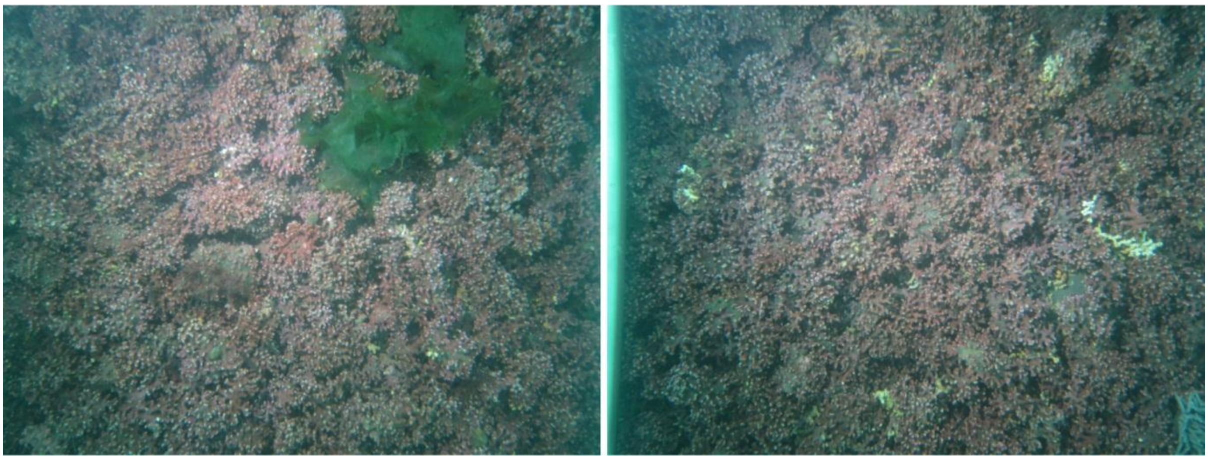

Figure 3.26. Example still photographs from station Dive07 on St. Mawes Bank in 2013, illustrating general seabed habitat.

3.2.1.8 St. Mawes Bank – Dive08

Lithothamnion corallioides was the dominant maerl species at Dive08. *Phymatolithon calcareum* was observed but only dead thalli were recorded (as ‘present’) in two quadrats. Mean percentage cover of live and dead *L. corallioides* were recorded at 44.2% and 32.1% respectively (Figure 3.27). Dive site Dive08 was situated along the western fringe of the St. Mawes Bank maerl bed.

The algal component at Dive08 was considerable. Many different algal species were recorded but with the most widespread and endemic given in Table 3.9. Other frequently recorded taxa were *Spyridia filamentosa, Pterothamnion plumula, Rhodymenia sp., Chondria* sp. and *Heterosiphonia plumosa* but *Hypoglossum hypoglossoides* was among other algal species recorded.

Megalomma vesiculosum was endemic across dive site Dive08. Tubes of *Chaetopterus variopedatus* were also frequently recorded but it is possible that some of these tubes were in fact *M. vesiculosum* as these tubes are very similar in appearance. Other fauna included Paguridae sp., Gobiidae sp., hydroids and *Myxicola infundibulum*.

Table 3.9. Summary of data collected at station Dive08 on St. Mawes Bank in 2013 (depth: maximum depth recorded by divers; cover (%): the mean percentage cover of all analysed quadrats; substratum: any other sediment type present other than maerl gravel; frequency (n): number of quadrats with a species record; frequency (%): percentage of quadrats with a species record).

Dive08 (St Mawes Bank)	Latitude Longitude	50° 09.773’ N 05° 02.056’ W	Depth max (m) Quadrats analysed Area (m^2) analysed		7.3 28 7.0
Species			**Cover (%)**	**Frequency (n)**	**Frequency (%)**
Maerl	*Lithothamnion corallioides* live (%)		44.2	28	100.0
	Lithothamnion corallioides dead (%)		32.1	28	100.0
	Phymatolithon calcareum live (%)		0.0	0	0.0
	Phymatolithon calcareum dead (%)		0.0	2	7.1
Substratum	Muddy sand with shell material				
Red algae	*Ceramium* sp.		-	23	82.1
	Heterosiphonia japonica		-	20	71.4
	Calliblepharis sp.			20	71.4
Fauna	*Megalomma vesiculosum*		-	27	96.4
	Chaetopterus variopedatus		-	25	89.3
	Trochidae sp.		-	24	85.7

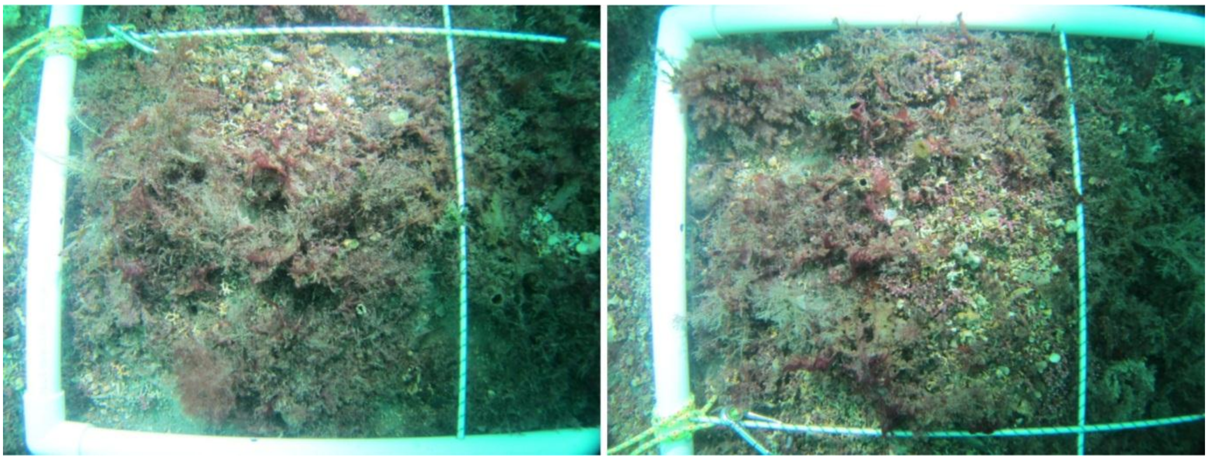

Figure 3.27. Example still photographs from station Dive08 on St. Mawes Bank in 2013, illustrating general seabed habitat.

3.2.1.9 St. Mawes Bank – Dive09

Station Dive09 was located centrally in the southern section of St. Mawes Bank maerl bed. Both maerl species were recorded at Dive09 but *Lithothamnion corallioides* was more widespread and dense (Table 3.10), recorded in all of the 30 quadrats with a mean cover of 71% live and 8% dead maerl. *Phymatolithon calcareum* was also recorded in 46.7% of the quadrats, but the mean cover was low at ~0.6%. The visible sediment fraction was described as sandy mud with the occasional shell and varied in percentage cover across the transect line but typically contributed with a 5-10% at each quadrat location.

The algal component was considerable at Dive09 (Figure 3.28), challenging the identifications skills but also the time management skills in terms of the time available for analysis for each quadrat. The most widespread algal species are given in Table 3.10 with *Rhodophyllis* / *Acrosorium* (divers were unable to separate these two species during the *in-situ* assessments) and *Calliblepharis* sp. being the most widespread. Other taxa included *Rhodymenia* sp., *Pterothamnion plumula, Heterosiphonia japonica, Callithamnion* sp., *Dictyota dichotoma, Heterosiphonia plumosa* and *Plocamium cartilagineum*.

The faunal component was primarily characterised by gastropods (Trochidae sp.) followed by Sabellidae sp. and Gobiidae sp., but other faunal species included Paguridae sp., Terebellidae sp., *Megalomma vesiculosum*, *Macropodia* sp., *Liocarcinus* sp., *Galathea* sp. and *Chaetopterus variopedatus*. Of note is that there may some misidentification of the tubes observed as *Megalomma* and *Chaetopterus* tubes are visually similar.

Table 3.10. Summary of data collected at station Dive09 on St. Mawes Bank in 2013 (depth: maximum depth recorded by divers; cover (%): the mean percentage cover of all analysed quadrats; substratum: any other sediment type present other than maerl gravel; frequency (n): number of quadrats with a species record; frequency (%): percentage of quadrats with a species record).

Dive09 (St Mawes Bank)	Latitude Longitude	50° 09.762' N 05° 01.914' W	Depth max (m) Quadrats analysed Area (m^2) analysed	3.4 30 7.5	
Species		**Cover (%)**	**Frequency (n)**	**Frequency (%)**	
Maerl	*Lithothamnion corallioides* live (%)	71.3	30	100.0	
	Lithothamnion corallioides dead (%)	8.2	29	96.7	
	Phymatolithon calcareum live (%)	0.6	14	46.7	
	Phymatolithon calcareum dead (%)	0.0	0	0.0	
Substratum	Sandy mud with occasional shell				
Red algae	Rhodophyllis / Acrosorium	-	25	83.3	
	Calliblepharis sp.	-	23	76.7	
	Stilophora / Spyridia		14	46.7	
Fauna	Trochidae sp.	-	26	86.7	
	Sabellidae sp.	-	20	66.7	
	Gobiidae sp.	-	19	63.3	

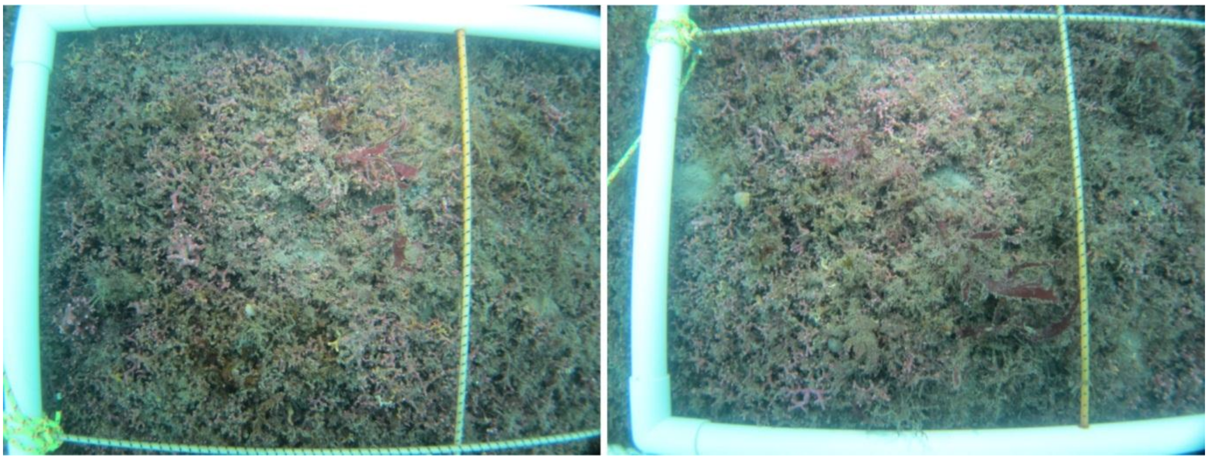

Figure 3.28. Example still photographs from station Dive09 on St. Mawes Bank in 2013, illustrating general seabed habitat.

3.2.1.10 St. Mawes Bank – Dive10

Scuba-diving station Dive10 was located along the southern fringe of St. Mawes Bank. Only *Lithothamnion coralloides* was recorded but it was widespread across the line and recorded at 100% of the quadrats assessed. The mean cover of live maerl was 78.5%, but there was also 13.5% component of dead maerl thalli. The sediment between the maerl was described as mud or muddy sand with some shell material and the occasional cobble.

As at Dive09, there was a considerable algal component at Dive10 (Figure 3.29), making the identification and time management tasks challenging, but despite all these challenges all the 30 quadrats were completed at this station (Table 3.11). *Rhodophyllis / Acrosorium* (divers were unable to separate these two species during the *in-situ* assessments) and *Spyridia filamentosa* were the most widespread and characterising algae at Dive10. Other algal species included *Plocamium cartilagineum, Rhodymenia* sp., *Dictyota dichotoma, Drachiella* sp., *Heterosiphonia japonica, Pterothamnion plumula, Heterosiphonia plumosa* and *Hypoglossum hypoglossoides*.

The faunal component was dominated by polychaetes, predominantly terebellids and sabellids with *Megalomma vesiculosum* being the most commonly recorded. Gastropods (Trochidae sp.) and crustaceans (Paguridae sp.) were also widespread with *Liocarcinus* sp. being one of the most commonly recorded taxon.

Table 3.11. Summary of data collected at station Dive10 on St. Mawes Bank in 2013 (depth: maximum depth recorded by divers; cover (%): the mean percentage cover of all analysed quadrats; substratum: any other sediment type present other than maerl gravel; frequency (n): number of quadrats with a species record; frequency (%): percentage of quadrats with a species record).

Dive10 (St Mawes Bank)	Latitude Longitude	50° 09.656' N 05° 01.843' W	Depth max (m) Quadrats analysed Area (m^2) analysed	5.6 30 7.5
Species		**Cover (%)**	**Frequency (n)**	**Frequency (%)**
Maerl	*Lithothamnion corallioides* live (%)	78.5	30	100.0
	Lithothamnion corallioides dead (%)	13.5	28	93.3
	Phymatolithon calcareum live (%)	0.0	0	0.0
	Phymatolithon calcareum dead (%)	0.0	0	0.0
Substratum	Mud / muddy sand with shell material			
Red algae	Rhodophyllis / Acrosorium	-	28	93.3
	Spyridia filamentosa	-	28	93.3
	Plocamium cartilagineum		20	66.7
Fauna	Sabellidae sp.	-	22	73.3
	Gobiidae sp.	-	20	66.7
	Terebellidae sp..	-	15	50.0

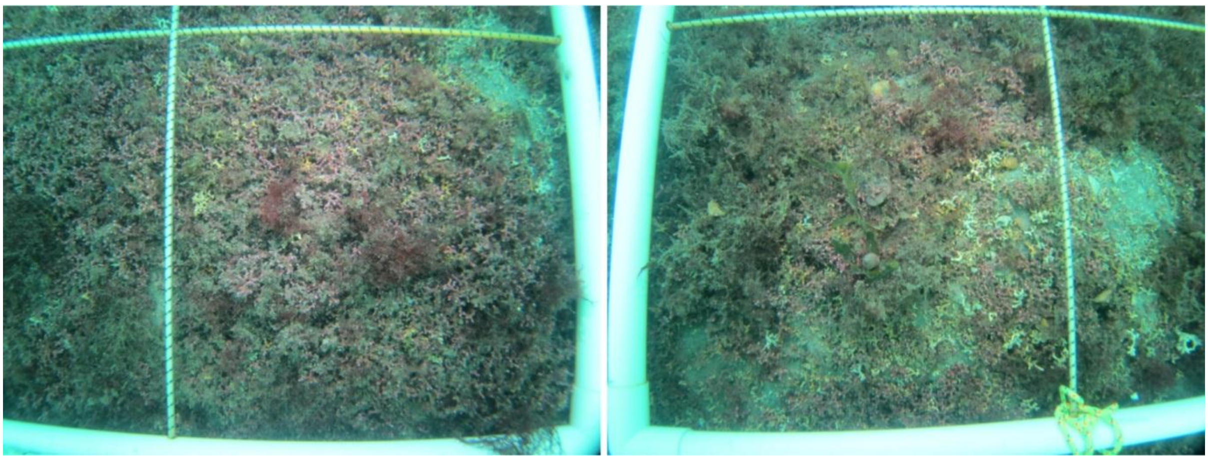

Figure 3.29. Example still photographs from station Dive10 on St. Mawes Bank in 2013, illustrating general seabed habitat.

3.2.1.11 Castle Point – Dive11

Scuba-diving station Dive11 was one of two locations situated on the Castle Point maerl bed. Dive11 was situated near the northern-most point of the Castle Point bed, in a narrow section of the maerl bed stretching between St. Mawes bank and Castle Point. The maerl at Dive11 was characterised by *Lithothamnion corallioides* with 97% mean cover (93.4% live maerl). *Phymatolithon calcareum* was also present albeit at low densities and only in one quadrat (Table 3.12). There was some sediment seen between the maerl and it was typically described as mud. Shell material was also recorded along the line.

Epiphytic algae were present (Figure 3.30) but these species were generally low-lying and the percentage cover was lower compared to those seen at Dive09 and Dive10. *Dictyota dichotoma* was endemic across Dive11. *Hypoglossum hypoglossoides* and *Plocamium cartilagineum* were also recorded in at least half of the analysed quadrats. *Heterosiphonia japonica, Heterosiphonia plumosa, Ulva lactuca, Rhodymenia* sp., *Pterothamnion plumula, Calliblepharis* sp., *Cryptopleura ramosa* and *Apoglossum ruscifolium* were also recorded at Dive11.

Top shells (Trochidae) and hermit crabs (Paguridae) were the most widespread faunal groups at Dive11. Other fauna included gobies, *Cerianthus lloydii, Pisidia longicornis, Aplysia punctata,* Anomiidae sp., *Edwardsiidae* sp. and *Anemonia viridis.*

Table 3.12. Summary of data collected at station Dive11 at Castle Point in 2013 (depth: maximum depth recorded by divers; cover (%): the mean percentage cover of all analysed quadrats; substratum: any other sediment type present other than maerl gravel; frequency (n): number of quadrats with a species record; frequency (%): percentage of quadrats with a species record).

Dive11 (Castle Point)	Latitude 50° 09.414’ N Longitude 05° 01.809’ W	Depth max (m) Quadrats analysed Area (m^2) analysed		3.5 22 5.5
Species		**Cover (%)**	**Frequency (n)**	**Frequency (%)**
Maerl	*Lithothamnion corallioides* live (%)	93.4	22	100.0
	Lithothamnion corallioides dead (%)	3.8	19	86.4
	Phymatolithon calcareum live (%)	0.0	1	4.5
	Phymatolithon calcareum dead (%)	0.2	1	4.5
Substratum	Mud with shell material			
Red algae	*Dictyota dichotoma*	-	20	90.9
	Hypoglossum hypoglossoides	-	13	59.1
	Plocamium cartilagineum		11	50.0
Fauna	Trochidae sp.	-	21	95.5
	Paguridae sp.	-	21	95.5
	Gobiidae sp.	-	3	13.6

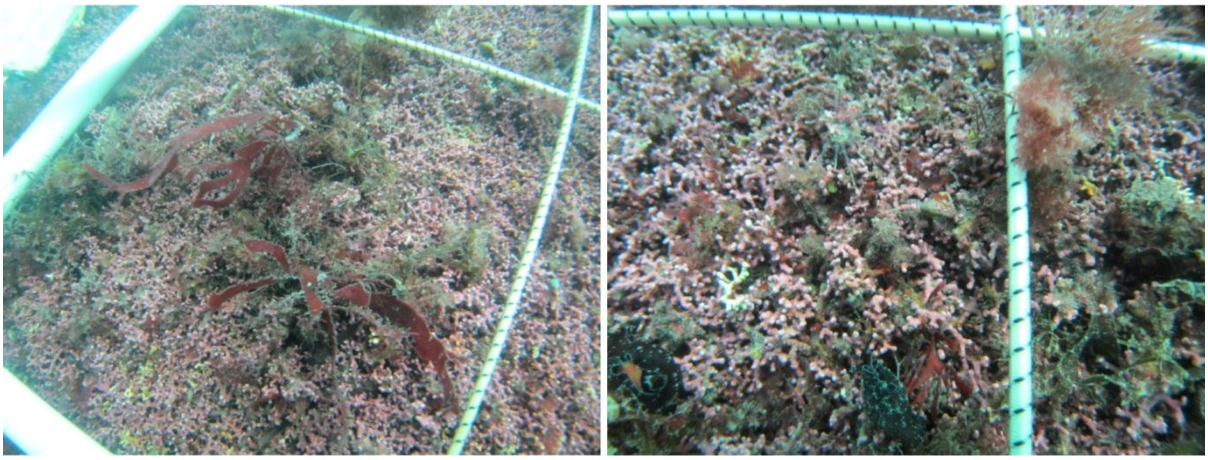

Figure 3.30. Example still photographs from station Dive11 at Castle Point Bank in 2013, illustrating general seabed habitat.

3.2.1.12 Castle Point – Dive12

The second of the stations (Dive12) on the Castle Point maerl bed was the most southerly of all the dive survey locations on the St. Mawes Bank/ Castle Point maerl bed. This station was characterised by *Lithothamnion coralloides* with 97% mean cover recorded in the analysed quadrats. *Phymatolithon calcareum* was not recorded at Dive12. The maerl was divided approximately 50/50 between live and dead thalli (Table 3.13). In addition to maerl, shell and sand material were also recorded.

There was a considerable algal component at Dive12 (Figure 3.31) with *Dictyota dichotoma* endemic across the site. Other epiphytic algae included *Rhodymenia* sp., *Saccharina latissima, Heterosiphonia japonica, Hypoglossum hypoglossoides, Saccorhiza polyschides, Ceramium* sp., *Spyridia filamentosa, Stilophora tenella* and *Sphaerococcus coronopifolius.*

Top shells (Trochidae) and hermit crabs (Paguridae) were relatively widespread across location Dive12. *Megalomma vesiculosum* and *Chaetopterus variopedatus* were also recorded, together with *Anemonia viridis* and *Cerianthus lloydii*.

Table 3.13. Summary of data collected at station Dive12 at Castle Point in 2013 (depth: maximum depth recorded by divers; cover (%): the mean percentage cover of all analysed quadrats; substratum: any other sediment type present other than maerl gravel; frequency (n): number of quadrats with a species record; frequency (%): percentage of quadrats with a species record).

Dive12 (Castle Point)	Latitude 50° 09.270' N Longitude 05° 01.714' W	Depth max (m) Quadrats analysed Area (m^2) analysed	3.8 30 7.5	
Species		**Cover (%)**	**Frequency (n)**	**Frequency (%)**
Maerl	*Lithothamnion corallioides* live (%)	50.5	30	100.0
	Lithothamnion corallioides dead (%)	46.8	30	100.0
	Phymatolithon calcareum live (%)	0.0	0	0.0
	Phymatolithon calcareum dead (%)	0.0	0	0.0
Substratum	Sand with shell material			
Red algae	*Dictyota dichotoma*	-	29	96.7
	Rhodymenia sp.	-	15	50.0
	Rhodophyllis / Acrosorium		10	33.3
Fauna	Trochidae sp.	-	22	73.3
	Chaetopterus variopedatus	-	22	73.3
	Paguridae sp.	-	10	33.3

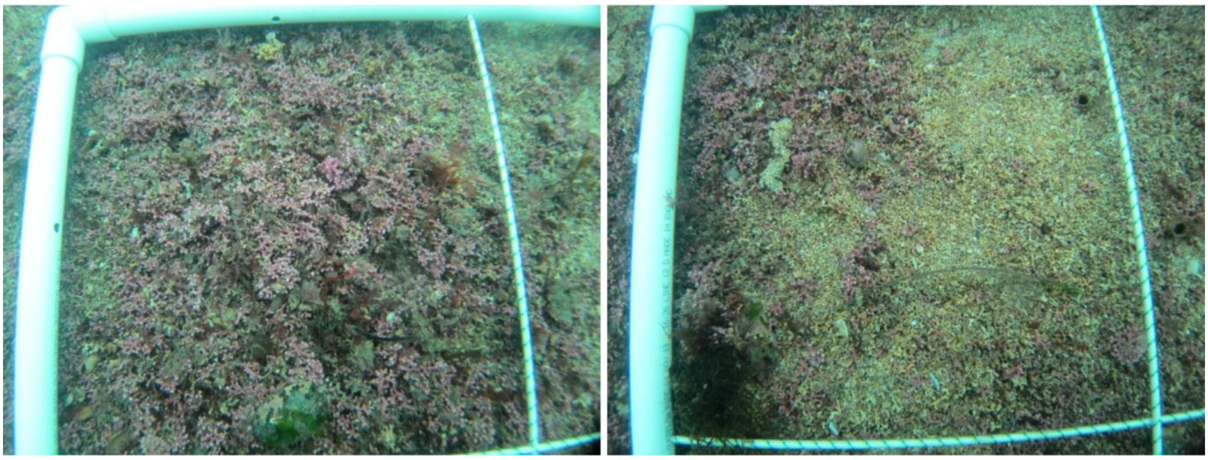

Figure 3.31. Example still photographs from station Dive12 at Castle Point in 2013, illustrating general seabed habitat.

3.2.1.13 Helford River – Dive13

The maximum recorded depth at Dive13 was 11 m and this was the most westerly located station at Helford River. The maerl was characterised by *Lithothamnion corallioides* with no other maerl species observed. *Lithothamnion corallioides* was widespread and recorded in all of the 30 quadrats analysed. A mean cover of 40% dead maerl was recorded, with an additional mean cover of 40% live maerl (Table 3.14 and Figure 3.32). The remaining part of the seabed was described as mud with shell material and cobbles.

The epiphytic component was variable across the line, but not as considerable as seen in some sections of St. Mawes bank. Several species were recorded with *Gracilaria* *multipartita* and *Rhodymenia* sp. the most widespread. Other taxa included *Stenogramma interruptum, Calliblepharis* sp., *Dictyota dichotoma, Champia parvula, Ceramium* sp., *Spyridia filamentosa, Callophyllis laciniata* and *Cryptopleura ramosa.*

Megalomma vesiculosum was endemic across dive station Dive13. Top shells (Trochidae) and gobies (Gobiidae) were also relatively widespread.

Table 3.14. Summary of data collected at station Dive13 at Helford River in 2013 (depth: maximum depth recorded by divers; cover (%): the mean percentage cover of all analysed quadrats; substratum: any other sediment type present other than maerl gravel; frequency (n): number of quadrats with a species record; frequency (%): percentage of quadrats with a species record.

Dive13 (Helford River)	Latitude / Longitude	50° 05.828’ N / 05° 07.511’ W	Depth max (m) / Quadrats analysed / Area (m^2) analysed		10.7 / 30 / 7.5
Species			**Cover (%)**	**Frequency (n)**	**Frequency (%)**
Maerl	*Lithothamnion corallioides* live (%)		40.2	30	100.0
	Lithothamnion corallioides dead (%)		41.4	30	100.0
	Phymatolithon calcareum live (%)		0.0	0	0.0
	Phymatolithon calcareum dead (%)		0.0	0	0.0
Substratum	Mud and sandy mud, cobbles & shell				
Red algae	*Gracilaria multipartita*		-	17	56.7
	Rhodymenia sp.		-	15	50.0
	Stenogramma interruptum			13	43.3
Fauna	*Megalomma vesiculosum*		-	27	90.0
	Trochidae sp.		-	22	73.3
	Paguridae sp.		-	13	43.3

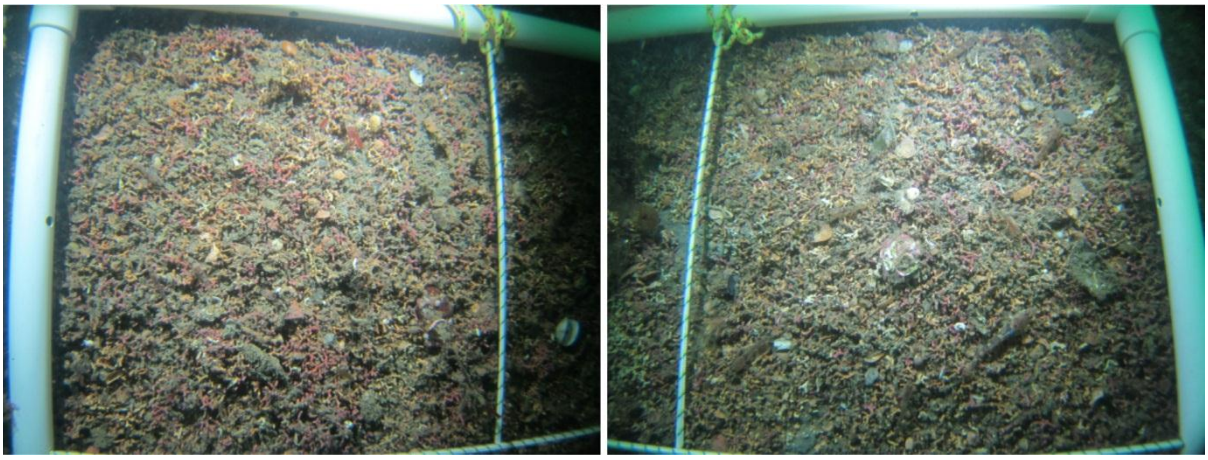

Figure 3.32. Example still photographs from station Dive13 at Helford River in 2013, illustrating general seabed habitat.

3.2.1.14 Helford River – Dive14

Dive14 was situated in between the two other Helford River dive stations. *Lithothamnion corallioides* was the only maerl species present at Dive14. Most of the maerl recorded was

live (~79% mean cover) with the dead maerl fraction amounting to approximately 8% mean cover. Mud, shell material and pebbles were also recorded within the bed.
The amount of large algal taxa was relatively small (Figure 3.33), but there was a considerable amount of smaller species present. The small size and the large abundance made identification difficult. The most widespread taxon being *Pterothamnion plumula* with other species such as *Heterosiphonia japonica*, *Ceramium* sp., *Stenogramma interruptum, Chondrus crispus, Cryptopleura ramosa, Dictyota dichotoma, Hypoglossum hypoglossoides, Lomentaria clavellosa, Spyridia filamentosa, Rhodymenia* sp., *Stilophora tenella, Plocamium cartilagineum, Saccharina latissima, Heterosiphonia plumosa, Polysiphonia* sp. and *Griffithsia corallinoides* also seen (Table 3.15).

Top shells were endemic with records in all of the quadrats analysed in Dive14. Sabellids, gobies and hermit grabs were also recorded together with *Lanice conchilega, Myxicola infundibulum* and *Crepidula fornicata*.

Table 3.15. Summary of data collected at station Dive14 at Helford River in 2013 (depth: maximum depth recorded by divers; cover (%): the mean percentage cover of all analysed quadrats; substratum: any other sediment type present other than maerl gravel; frequency (n): number of quadrats with a species record; frequency (%): percentage of quadrats with a species record).

Dive14 (Helford River)	Latitude Longitude	50° 05.834' N 05° 07.445' W	Depth max (m) Quadrats analysed Area (m^2) analysed		7.9 28 7.0
Species			**Cover (%)**	**Frequency (n)**	**Frequency (%)**
Maerl	*Lithothamnion corallioides* live (%)		78.7	28	100.0
	Lithothamnion corallioides dead (%)		8.0	25	89.3
	Phymatolithon calcareum live (%)		0.0	0	0.0
	Phymatolithon calcareum dead (%)		0.0	0	0.0
Substratum	Mud, pebbles, cobbles & shell material				
Red algae	*Pterothamnion plumula*		-	17	60.7
	Gracilaria multipartita		-	13	46.4
	Calliblepharis sp.			12	42.9
Fauna	Trochidae sp.		-	28	100.0
	Megalomma vesiculosum		-	19	67.9
	Gobiidae sp.		-	19	67.9

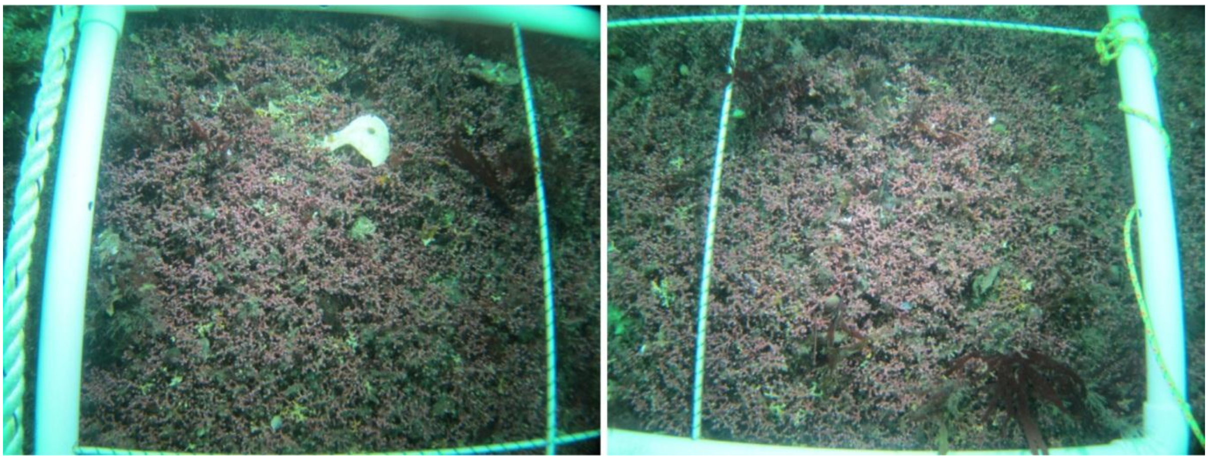

Figure 3.33. Example still photographs from station Dive14 at Helford River in 2013, illustrating general seabed habitat.

3.2.1.15 Helford River – Dive15

The third and final dive station (Dive15) in Helford River was located to the southwest of Dive14. Both *Lithothamnion corallioides* and *Phymatolithon calcareum* were recorded at Dive15. Whist *L. corallioides* was widespread and at a high density (80% mean cover), *P. calcareum* was only recorded in one quadrat, all of which was dead. The *L. corallioides* were found to be both live (65% mean cover) and dead (16% mean cover) with the other type of substrata being described as mud, cobble and shell material (Figure 3.34).

As seen at Dive13 and Dive14, *Gracilaria multipartita* was the most widespread algal taxon (Table 3.16). As at Dive14, the amount of large algal species was relatively low (Figure 3.33), but there was a considerable amount of smaller algal species present, making the *in-situ* identification challenging. Other algae recorded during the survey were *Calliblepharis* sp., *Cryptopleura ramosa, Chondrus crispus, Stenogramma interruptum, Heterosiphonia japonica, Hypoglossum hypoglossoides* and *Apoglossum ruscifolium.*

Top shells were again endemic across the survey line with the other most widespread faunal species given in Table 3.16. *Megalomma vesiculosum,* Gobiidae sp., Anomiidae sp., *Nassarius* sp., *Lanice conchilega,* Sabellidae sp., *Crepidula fornicata* and *Pisidia longicornis* were also recorded.

Table 3.16. Summary of data collected at station Dive15 at Helford River in 2013 (depth: maximum depth recorded by divers; cover (%): the mean percentage cover of all analysed quadrats; substratum: any other sediment type present other than maerl gravel; frequency (n): number of quadrats with a species record; frequency (%): percentage of quadrats with a species record).

Dive15 (Helford River)	Latitude Longitude	50° 05.830' N 05° 07.489' W	Depth max (m) Quadrats analysed Area (m^2) analysed		6.2 30 7.5
Species			**Cover (%)**	**Frequency (n)**	**Frequency (%)**
Maerl	*Lithothamnion corallioides* live (%)		64.9	30	100.0
	Lithothamnion corallioides dead (%)		16.5	29	96.7
	Phymatolithon calcareum live (%)		0.0	0	0.0
	Phymatolithon calcareum dead (%)		1.2	1	3.3
Substratum	Mud, cobbles & shell material				
Red algae	*Gracilaria multipartita*		-	17	56.7
	Rhodymenia sp.		-	16	53.3
	Pterothamnion plumula		-	13	43.3
Fauna	Trochidae sp.		-	30	100.0
	Terebellidae sp.		-	25	83.3
	Paguridae sp.		-	23	76.7

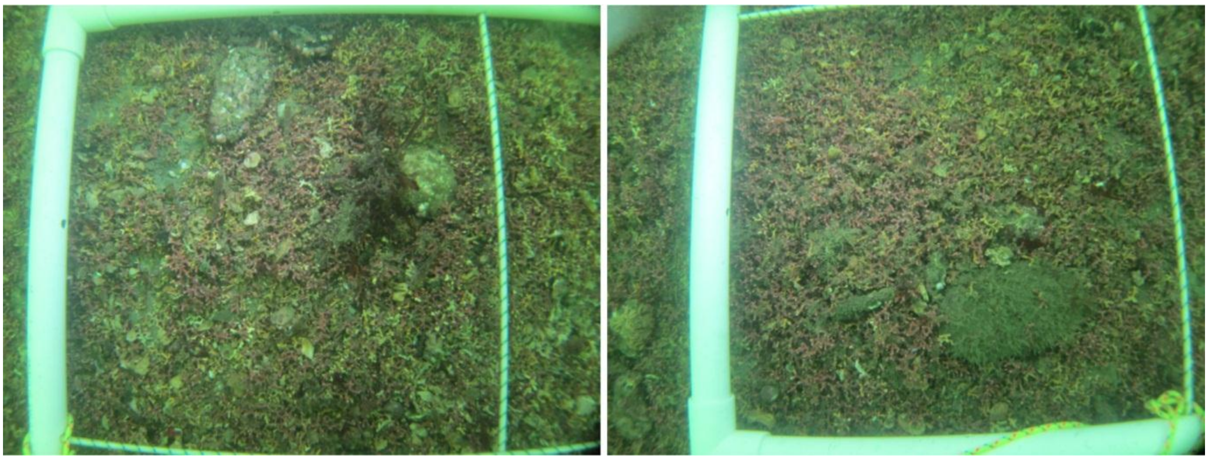

Figure 3.34. Example still photographs from station Dive15 at Helford River in 2013, illustrating general seabed habitat.

3.2.2 The maerl bed community composition in 2013

During the dive survey in 2013 a total of 10 dive survey locations were completed at St. Mawes Bank, two at Castle Point and three on the maerl bed at Helford River. The dive survey transects were distributed across St. Mawes Bank from north to south. The two stations at Castle Point were situated in the northern section of the bank, whilst the three stations at Helford River were all situated at the eastern edge of the bank where the maerl appeared (based on the drop-down camera survey) the most abundant and widespread.

The geographical distribution of stations together with the difference in community structure outlined in the section above suggested similarities and differences between the various areas in the study. In order to examine the community structure at each dive site, multivariate analyses were completed on the maerl communities (based on the abundance of the two maerl species, fauna and flora) using the Bray-Curtis similarity coefficient followed by cluster analysis. To account for the different methods of measuring abundance (i.e. counts, percentage cover and presence/ absence), the abundances of the various taxa were expressed as a percentage of the number of quadrats in which they were present at each dive station. It was felt that average values of faunal abundances could be very distorted by the patchiness across a site, whereas this method more accurately reflected the distribution of the constituent organisms of the community at a given site.

The community cluster analysis resulted in two main clusters (Figure 3.35). One cluster (cluster D) consisted of all the stations characterised by *Phymatolithon calcareum* on St. Mawes Bank (Table 3.17). The second main cluster included all the remaining stations characterised primarily by *Lithothamnion corallioides* (Table 3.17). The clusters within the latter group were the *L. corallioides* dominated stations in Castle Point (group A), Helford River (group B) and St. Mawes Bank (group C). Figure 3.36 shows a geographical spread of stations, colour coded according to their cluster group.

The percentage cover of live and dead maerl in each of the cluster groups is given in Table 3.17 and Figure 3.37. The percentage cover of live maerl was highest at stations in cluster D (the central area across St. Mawes Bank), with the lowest cover found in cluster C. Cluster A (Castle Point) had the highest amount of dead maerl, but also the highest percentage cover of live *Lithothamnion corallioides* (68.7%).

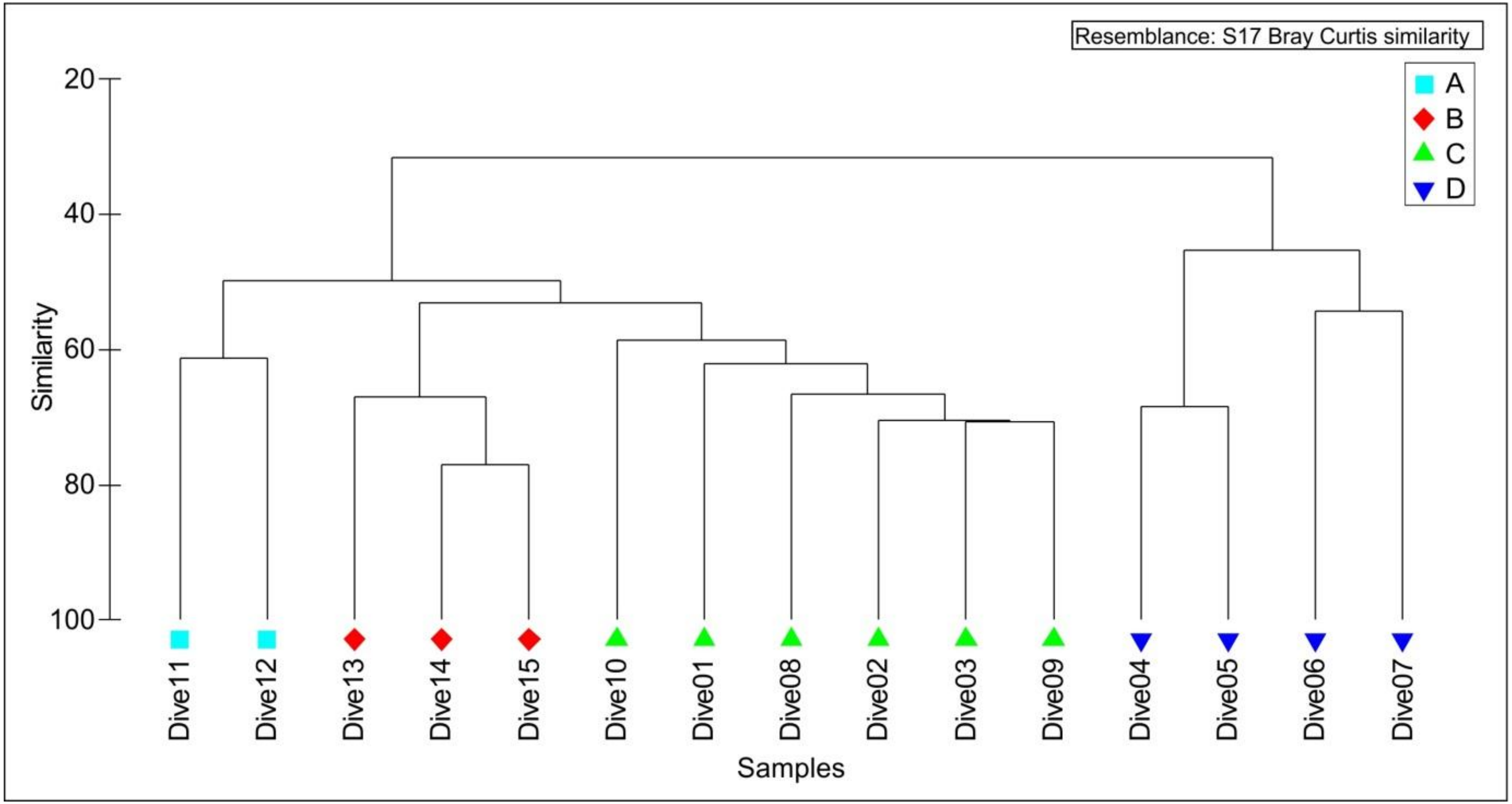

Figure 3.35. Cluster analysis of the 2013 maerl community data.

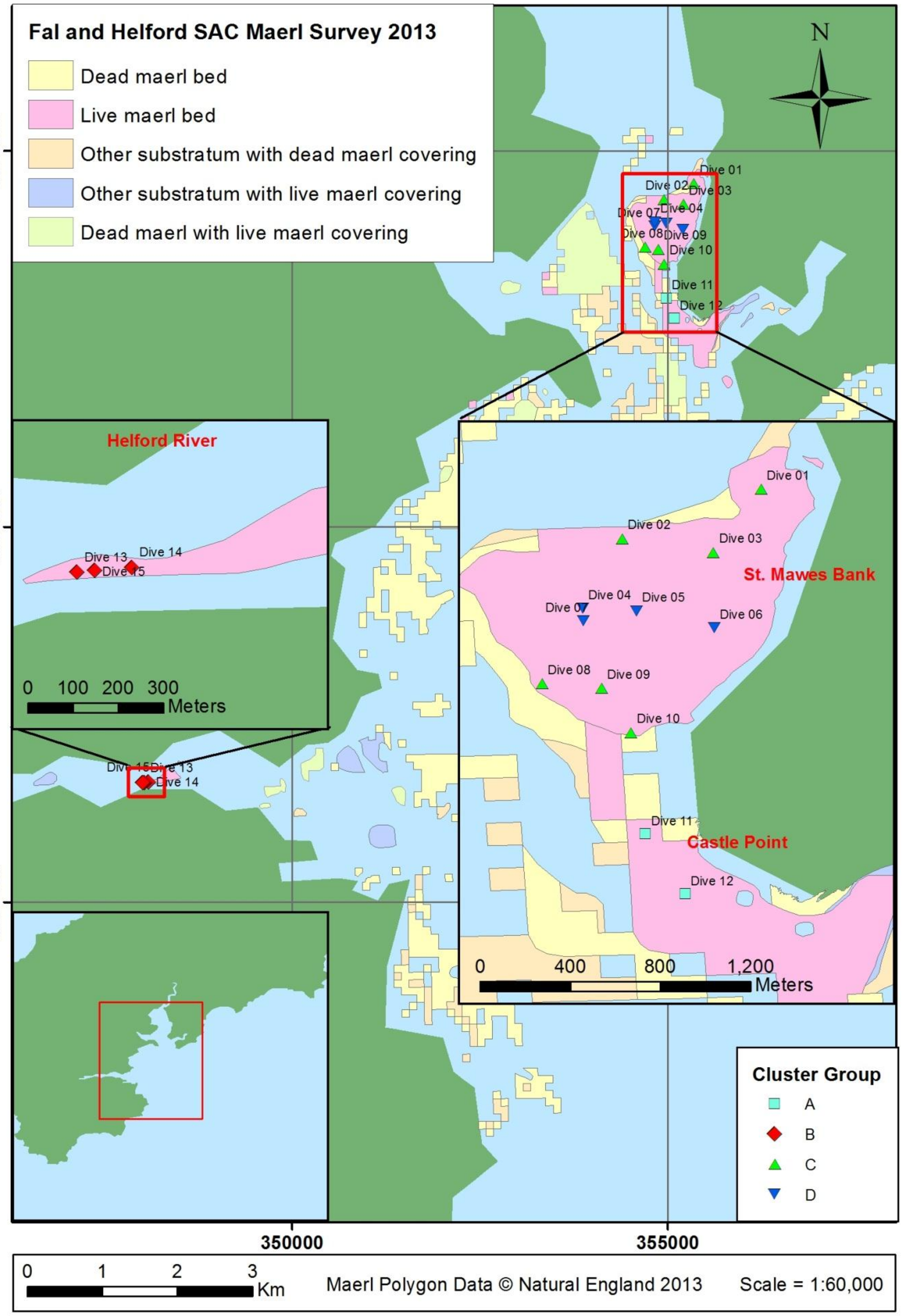

Figure 3.36. Geographical distribution of dive sites, colour coded according to community cluster analysis.

*Table 3.17. Percentage cover of live and dead maerl and the two maerl species (*Lithothamnion corallioides *and* Phymatolithon calcareum*) for the four clusters of the 2013 maerl community data (values: mean percentage maerl cover ± Standard Error; n: the number of quadrats analysed).*

Clusters	**A** (n=52)	**B** (n=88)	**C** (n=164)	**D** (n=113)
Live maerl (%)	68.7 (± 3.5)	60.9 (± 2.6)	36.8 (± 4.0)	89.9 (± 1.4)
Dead maerl (%)	28.7 (± 3.4)	22.7 (± 2.1)	10.8 (± 2.1)	6.6 (± 0.7)
Lithothamnion corallioides live (%)	68.7 (± 3.5)	60.9 (± 2.6)	46.5 (± 3.3)	6.2 (± 0.8)
Phymatolithon calcareum live (%)	0.0 (-)	0.0 (-)	1.9 (± 0.4)	83.7 (± 1.87)

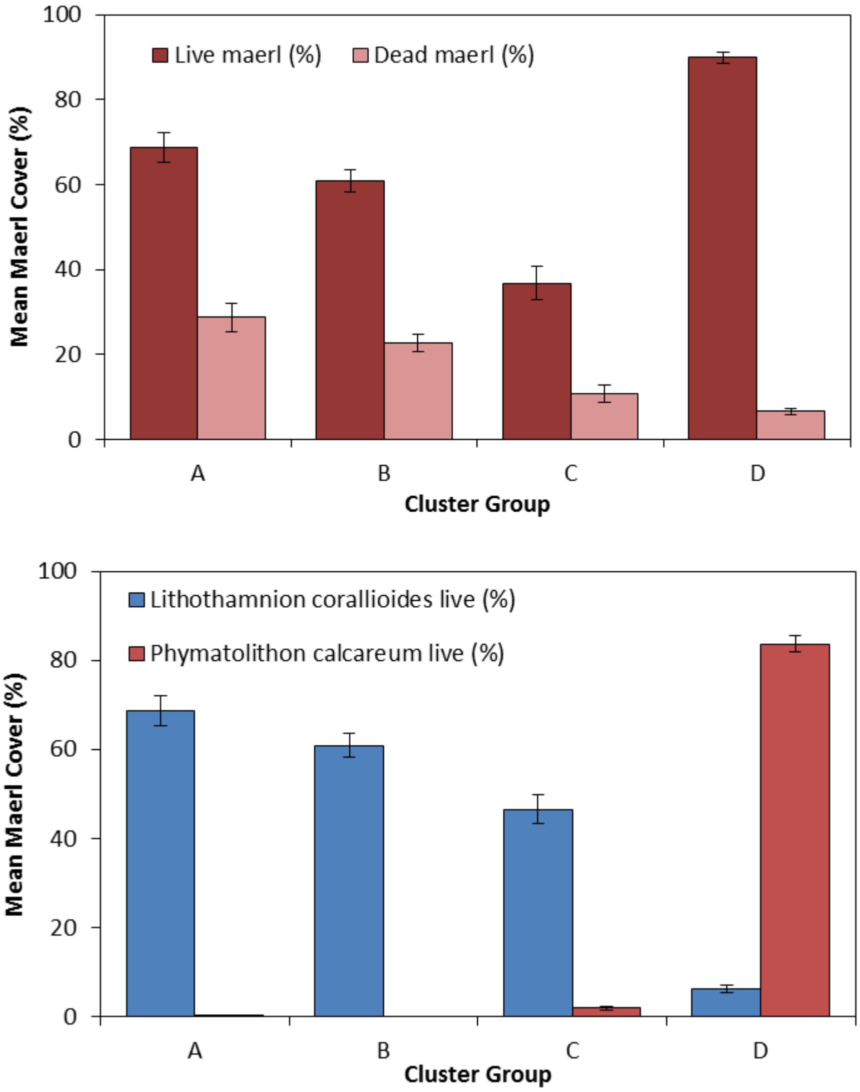

Figure 3.37. Percentage cover of live and dead maerl and the two maerl species (Lithothamnion corallioides and Phymatolithon calcareum) for the four clusters of the 2013 maerl community data (bars: mean percentage maerl cover ± SE).

To assess these groupings further, additional cluster analysis tests were completed (results provided in Appendix H). Of particular note was the test based on the fauna and flora (excluding the maerl species), which resulted in near identical clusters to those seen in Figure 3.35 above. The main difference was the level of similarity between clusters (which was higher when all the taxa (i.e. including maerl) were used). These results suggested that the community structure observed within the cluster analysis was principally based on differences in the floral and faunal species, with less importance given to the particular species of maerl present. However, the two main clusters were either characterised by *P. calcareum* (group D) or *L. corallioides* (groups A – C), suggesting that each species of maerl had particular associated flora and fauna. The further subdivisions of the *L. corallioides* group suggested that geographical and environmental differences (e.g. sediment type present, current speed, depth) between the dive locations may be very important in influencing the community structure.

A SIMPER analysis was undertaken to examine which taxa were characteristic for each of the groups identified from the cluster analysis. Table 3.18 lists the taxa that contributed at least 70% similarity for each group. Full SIMPER analysis results can be found in Appendix H. These results supported the differences in maerl taxa, with group D characterised by *P. calcareum* whilst the other groups (A – C) were characterised by *L. corallioides*.

Whilst *P. calcareum* was important in terms of the taxa present within group D, other notable fauna contributing to the similarity of stations within group D were *Galathea* sp. and *Pisidia longicornis*. These Decapoda taxa were apparent in some of the still photographs taken from these stations despite the small size and cryptic lifestyle of these taxa. Although these taxa were also recorded at Dive11 (group A), Dive14 (group B) and Dive15 (group B), they did not contribute to the clustering of the stations within groups A and B.

Groups A – C were characterised by *L. corallioides*, with the other taxa present within the communities largely similar, as the cluster analysis (~50% similarity) suggested. Subtle differences between the three groups were therefore expected rather than large community-scale differences. The SIMPER analysis results suggested that apart from differences in the relative abundance of *L. corallioides* between groups, particular faunal and floral species were predominantly recorded in one of these groups and not the others, therefore contributing to the subtle differences in community structure.

One example of this was *Dictyota dichotoma.* Although present at all of the stations within groups A – C, the contribution to the community was highest (16.8%) in group A, with contributions to groups B and C of 0.98% and 2.59% respectively (N.B. not recorded at all in cluster D). Group A also had a relatively high contribution by live *L. coralloides* thalli but a low contribution by *Megalomma vesiculosum* in relation to the other two groups. Similarly, *Gracilaria multipartita* and gobies were present at several stations, but contributed most to the similarity of the stations within group B.

Table 3.18. Results of the SIMPER analysis based on the clusters of the 2013 dive survey data, showing % contribution of each taxa to the similarity of samples within each group defined from the cluster analysis.

Group/ Cluster	% Contribution of characterising species	
	Taxa / Species	**Contribution (%)**
A	*Lithothamnion corallioides* live	18.52
	Dictyota dichotoma	16.84
	Lithothamnion corallioides dead	15.99
	Trochidae	13.58
	Rhodophyllis / Acrosorium	6.17
B	*Lithothamnion corallioides* live	12.63
	Lithothamnion corallioides dead	11.59
	Trochidae	10.35
	Megalomma vesiculosum	8.47
	Gobiidae	7.90
	Gracilaria multipartita	6.31
	Terebellidae	6.05
	Paguridae	5.43
	Lanice conchilega	3.65
C	*Lithothamnion corallioides* live	11.62
	Lithothamnion corallioides dead	10.07
	Rhodophyllis / Acrosorium	8.71
	Trochidae	7.68
	Megalomma vesiculosum	6.59
	Sabellidae	5.50
	Spyridia filamentosa	5.36
	Calliblepharis sp.	5.19
	Paguridae	5.05
	Rhodymenia sp.	4.64
D	*Phymatolithon calcareum* live	19.73
	Phymatolithon calcareum dead	15.33
	Pisidia longicornis	8.96
	Galathea sp.	8.30
	Filamentous red algae	6.36
	Trochidae	5.86
	Gobiidae	5.28
	Galathea sp./ *Pisidia longicornis*	4.06

3.3 Comparisons between dive and drop-down video data

The benthic communities identified from the diver based observations were compared to those identified from the drop-down video data taken from approximately concurrent positions to the dive stations. Every still image taken within a 50m radius of each dive location was examined, ignoring any images that represented a different biotope to that observed at the dive site. The records of the fauna and flora seen in the still images were amalgamated, and abundance expressed as a frequency of occurrence within the still images for each dive site. This data was then imported into PRIMER, Bray-Curtis similarity matrix constructed, and group average cluster analysis undertaken (Figure 3.38). No still images were taken within 50m of Dive07, so this station was omitted from this process

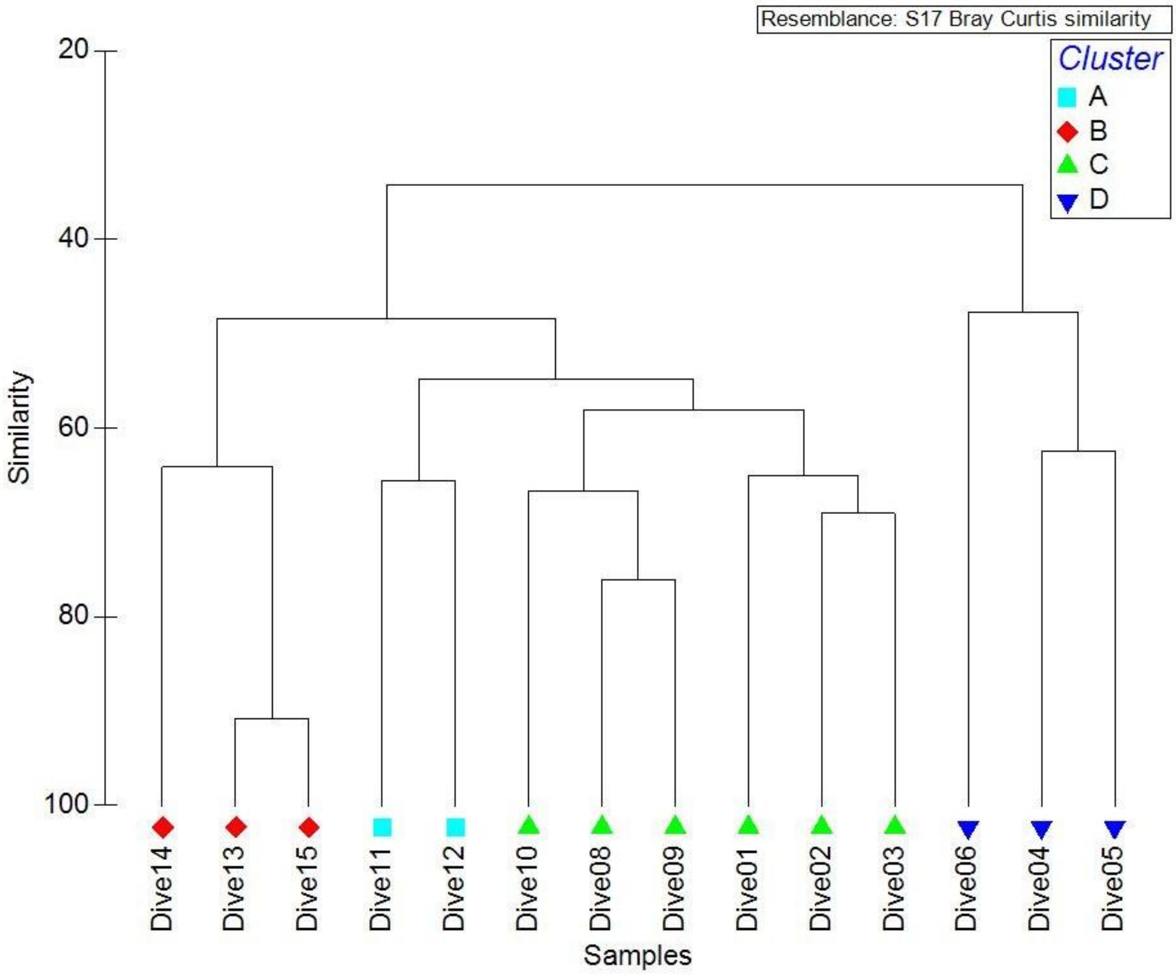

Figure 3.38. Cluster analysis of the concurrent still images from 2013 dive stations.

The dendrogram plot showed a similar structure to that based on the dive data, with the three *Phymatolithon calcareum* dominated sites separated from the *Lithothamnion corallioides* sites. The *L. corallioides* sites clustered within the same groups as seen in Figure 3.35, with groups based on geographical location. The main differences between the cluster analyses based on dive data versus still image data were that the similarities between dive locations within each group were typically higher from the dive data. Also, group C was more similar to group A than group B within the still data dendrogram.

SIMPER analysis of the still image cluster groups identified that the groups included similar characteristics species to those identified from SIMPER analysis of the diving data. Chracteristic species from group A included *Dictyota dichotoma*, group B had terebellid and tube dwelling polychaetes, various red algae characterised group C, whilst group D included *Phymatoliton calcareum*, *Galathea* and Brachyura crustaceans. The comparison between the still data and diver observation data was limited by the difficulties in accurately identifying red algae from the still images, with most species identified according to morphology rather than by taxonomic classification.

3.4 Comparisons of maerl bed populations 2002 and 2013

The 2013 dive stations were positioned to coincide with the 2002 survey (Howson *et al.,* 2004) stations to allow for direct comparison between the data sets as far as possible. Derived values of mean percentage maerl cover for the 2002 stations grouped together according to cluster analysis were available. In order to produce comparable data from the current 2013 survey, stations would have to be grouped according to the 2002 analysis. However, the 2013 cluster analysis resulted in different station groupings compared to the 2002 data (Table 3.19). For example, the two 2013 dive stations from Castle Point clustered out as distinctly from those on St. Mawes Bank, whereas the 2002 survey grouped them with Dive10 as the 'Southern bed'. The 2013 survey found that Dive05 was dominated by *Phymatolithon calcareum*, which was not recognised from the previous survey. This could represent a shift in the dominant type of maerl species present at this site, but without the raw data it is hard to confirm. These differences mean that any combining 2013 stations into the groupings suggested from the 2002 survey to get comparable mean percentage cover values would be extremely misleading.

Table 3.19. Comparison of dive station cluster analysis groupings from 2002 survey and 2013 survey. Please note dive station names have been converted to their 2013 equivalent for ease of comparison.

2002 Survey (Howson *et al.,* 2004) [A]		**Current Survey**	
Cluster Group	**Stations (2013 equiv)**	**Cluster Group**	**2013 Dive Stations**
Northern	Dive01, Dive03	A	Dive11, Dive12
P. cal	Dive04, Dive06, Dive07 [B]	B [D]	Dive13, Dive14, Dive15
Central [C]	Dive02, Dive05, Dive09	C	Dive01, Dive02, Dive03, Dive08, Dive09, Dive10
Southern Bed	Dive10, Dive11, Dive12	D	Dive04, Dive05, Dive06, Dive07

[A] *2002 site 12 (equivalent of 2013 Dive08) unknown cluster group from 2002*
[B] *Dive04 and Dive07 both equivalent to 2002 site 9*
[C] *No 2013 dive at equivalent position of 2002 site 11*
[D] *No dives undertaken in Helford River in 2002 (2013 Dive13, Dive14, Dive15)*

3.4.1 Comparisons of biotope species composition

One of the objectives of the study was to assess the favourable condition of the 'Maerl bed communities' against the relevant attributes and compared with previous survey data using the Common Standards Monitoring Guidance, which for the scuba-diving aspect of the project included a species composition assessment (presence / absence of composite species) of the maerl bed communities for the two biotopes **SS.SMp.Mrl.Lcor** and **SS.SMp.Mrl.Pcal**. The 2013 St. Mawes Bank data have therefore been compared to the 2002 data collected across St. Mawes Bank. Note, however, that the 2013 data in Table 3.23 have been summarised from the St. Mawes Bank stations only. The 2013 results suggested differences in species communities on St. Mawes Bank and at Castle Point, so the Castle Point data was removed from this comparison.

In terms of *Phymatolithon calcareum* community the **SS.SMp.Mrl.Pcal** biotope was chosen over **SS.SMp.Mrl.Pcal.R**. The rationale behind this decision was the apparent lack of red algae on the *P. calcareum* community. Algae were widespread and abundant on the *Lithothamnion corallioides* beds (**SS.SMp.Mrl.Lcor**) but not on the *P. calcareum* beds, which may come as a surprise but the large globules on clear beds were one of the characteristic features of the *P. calcareum* beds in 2013. It was therefore felt that **SS.SMp.Mrl.Pcal.R** could not be selected as the primary biotope for this habitat.

3.4.1.1 *Lithothamnion corallioides* maerl beds on muddy gravel (**SS.SMp.Mrl.Lcor**)

Lithothamnion corallioides was the most important contributor to the community structure both in 2002 and 2013 (21% and 31% respectively), but whilst *Phymatolithon calcareum* was contributing with 10% to the community in 2002, it was only 2% in 2013 (Table 3.20).

Megalomma vesiculosum and Trochidae sp. (e.g. *Gibbula cineraria*) were widespread both in 2002 and 2013 but whilst several species of red algae were important in terms of the community structure in 2013, these species appeared to be less important in 2002. Species such as *Heterosiphonia japonica, Ceramium* sp. and *Rhodophyllis / Acrosorium* were widespread in 2013 but not recorded in this community in 2002.

Calliblepharis sp. and *Dictyota dichotoma* were both recorded in 2002 and 2013. Other taxa were also recorded in both years, but were less widespread and less important compared to the other fauna and flora. However, all of these taxa add to the suggestion that there are similarities between the two surveys. The differences in methodology in terms of which stations are included in the analyses, together with the lack of raw data from 2002, restricted the amount of comparative analysis that can be completed but there were apparent similarities between the two communities in 2002 and 2013.

Table 3.20. SIMPER analysis of the 2013 species recorded in the ***SS.SMp.Mrl.Lcor*** *communities compared to the 2002 data (Howson* et al., *2004) from similar habitats.*

2013 survey data		**2002 survey data (Howson *et al.*, 2004)**	
Species	**% contr.**	**Species**	**% contr.**
Lithothamnion corallioides live	11.6	*Lithothamnion corallioides*	31
Lithothamnion corallioides dead	10.1	*Phymatolithon calcareum*	10
Rhodophyllis divaricata / Acrosorium ciliatum	8.7	*Cryptopleura ramosa*	9
Trochidae sp.	7.7	*Megalomma vesiculosum*	6
Megalomma vesiculosum	6.6	*Gibbula cineraria*	5
Sabellidae sp.	5.5	*Pomatoceros* sp.	5
Spyridia filamentosa	5.4		
Calliblepharis sp.	5.2		
Paguridae sp.	5.1		
Rhodymenia sp.	4.6		
Heterosiphonia japonica	3.5		
Chaetopterus variopedatus	2.7		
Dictyota dichotoma	2.6		
Pterothamnion plumula	2.2		
Other taxa		**Other taxa**	
Gobiidae sp.	2.2	*Cerianthus lloydii*	-
Phymatolithon calcareum live	2.1	*Anemonia viridis*	-
Terebellidae sp.	2.1	*Calliblepharis ciliata*	-
Ceramium sp.	1.8	*Aiptasia mutabilis*	-
		Dictyota dichotoma	-
		Chaetopterus variopedatus	-

3.4.1.2 *Phymatolithon calcareum* maerl beds on gravel and sand (**SS.SMp.Mrl.Pcal**)

As expected *Phymatolithon calcareum* was the most important species in terms of contribution to the overall community structure in both 2002 and 2013 (30% and 35% respectively). In addition to *P. calcareum,* species within the Terebellidae, Gobiidae, Galatheidae and Trochidae as well as *Liocarcinus* sp. were recorded consistently both in 2002 and 2013. However, there were some differences, particularly in terms of the contribution of some red algal taxa (see Table 3.21) which appeared to be higher in 2002 compared to 2013. Some species, such as *Pisidia longicornis*, were widespread in 2013 but were not important community species in 2002.

Many of the red algae contributing highly to the community structure in 2002 were also recorded in 2013 (see Appendix F). However, some of these species (e.g. *Nitophyllum punctum, Plumularia setacea* and *Antithamnionella ternifolia*) were not recorded in 2013. The most likely reason for these species not being recorded in 2013 is that the survey was completed in the autumn whilst the 2002 survey was completed in May. According to Howson *et al.* (2004) these plants show a seasonal cycle disappearing before the arrival of autumn. Another potential explanation for these taxa not being recorded was the challenges in red algae identification. The expertise within the 2013 dive team was considerable and most of the species would have been anticipated to be found, but with some species the identification skills needed are specialised. In future years there may therefore be a need to use phycologists at the beginning of a survey to inform the dive team further (see section 4.4.2) before and during the dive survey. Any future surveys should be completed in the autumn rather than the spring in order to make the data comparable to the current survey. As discussed above, the differences in methodology in terms of which stations are included in the analyses, together with the lack of raw data from 2002, restricted the amount of comparative analysis that can be completed. However, there were some apparent similarities between the two communities in 2002 and 2013.

Table 3.21. SIMPER analysis of the 2013 species recorded in the ***SS.SMp.Mrl.Pcal*** *communities compared to the* ***SS.SMp.Mrl.Pcal.R*** *2002 data (Howson* et al., *2004) from similar habitats.*

2013 survey data		**2002 survey data (Howson *et al.*, 2004)**	
Species	**% contr.**	**Species**	**% contr.**
Phymatolithon calcareum live	19.7	*Phymatolithon calcareum*	30
Phymatolithon calcareum dead	15.3	Ectocarpaceae indet	25
Pisidia longicornis	8.9	*Brongniartella byssoides*	10
Galathea sp.	8.3	*Anemonia viridis*	8
Filamentous red algae	6.4	*Nitophyllum punctum*	7
Trochidae sp.	5.9	*Plumularia setacea*	5
Gobiidae sp.	5.3	*Cryptopleura ramosa*	5
Galathea sp./*Pisidia longicornis*	4.1	*Antithamnionella ternifolia*	2
Terebellidae sp.	3.3		
Other taxa		**Other taxa**	
Calliblepharis sp.	2.3	Terebellidae indet.	-
Lithothamnion corallioides live	2.1	*Pagurus bernhardus*	-
Liocarcinus sp.	2.0	*Galathea intermedia*	-
Lithothamnion corallioides dead	1.5	*Liocarcinus arcuatus*	-
Amphilectus fucorum	1.4	*Tectura testudinalis*	-
Calliblepharis sp.	2.3	*Gibbula magus*	-
Red foliose algae	1.3	*Gibbula cineraria*	-
		Pomatoschistus sp.	-

4 DISCUSSION

4.1 Previous studies

Previous drop-down video data within the Fal and Helford SAC was collected in 2002 by Howson *et al*. (2004). The data was restricted to four discrete areas – St. Mawes Bank and Castle Point, Pendennis Point, the mouth of Helford River, and to the north-east of Nare Point. Due to the date of the survey, Howson *et al*. (2004) used MNCR v97.06 (Connor *et* al., 1997a; 1997b) biotope codes. After translating these to MNCR v04.05 (Connor *et* al., 2004) equivalent biotopes, a generally good agreement can be seen between the 2002 data and the drop-down camera data collected in the current survey.

The largest discrepancies are due to the assignment of biotopes to mixed / coarse sediment with an element of maerl gravel. In the current survey dead maerl gravel was treated as 'gravel' when deciding biotopes. The majority of the dead maerl observed by the drop-down video survey had been broken down into small fragments, and did not retain much 3D complexity, so it was not deemed suitable to report these areas as **SS.SMp.Mrl** as some had been in Howson *et al*. (2004). Based on the descriptions of these maerl gravel habitats within Howson *et* al. (2004), it seems probable that the same habitats are being referred to under different biotope headings, rather than these discrepancies indicating a decline in condition of previous dead maerl beds into maerl gravel. The presence of various algae across coarse and mixed sediments resulted in more **SS.SMp.KSwSS.LsacR** biotopes being assigned to the current data set than the 2002 data. Some of these were characterised as **SS.SMp.Mrl** or **SS.SMp.Mrl.Lcor** in 2002 data set. Examining the distribution of live and dead maerl from the current survey as opposed to the designated biotopes showed a closer relationship to some of the biotopes designated by Howson *et al*. (2004).

Some discrepancies also existed between the designations of kelp forest biotopes. The community compositions of these biotopes were quite hard to distinguish from video, with red algae understorey obscured from view, and kelp species difficult to distinguish. Many of the areas visited by Howson *et al.* (2004) that were assigned kelp biotopes were not re-visited during the current survey, with only those areas that coincided with the maerl habitat polygons targeted in the current survey.

The St. Mawes and Castle Point maerl bed was assigned mainly the biotopes **SS.SMp.Mrl.Lcor** and **SS.SMp.Mrl.Pcal**. These correspond with the biotopes assigned by Howson *et* al. (2004), although they assigned the sub-biotope **SS.SMp.Mrl.Pcal.R** to the areas of *Phymatolithon calcareum.* As discussed in the diving results, the lack of large amounts of red algae in 2013 meant that the **Pcal.R** biotope was deemed inappropriate. There were some patches of seagrass and kelp within the maerl bed identified from the current survey which were not identified in the 2002 survey. The description from Howson *et al.* (2004) of scattered *Lithothamnion corallioides* being present within the *P. calcareum* dominated areas (and vice versa) were also observed in the current survey. Conspicuous fauna reported from 2002 on the maerl beds included *Anemonia viridis* and sabellid worms. These were also commonly seen in 2013, in addition to *Cancer pagurus*, galatheid squat lobsters and gobies.

As mentioned in the results section, there were some differences between the communities observed during the scientific diving on the maerl beds from the current survey compared to previous surveys. However, most of these differences were due to the presence / absence of various red algae species, which may be due to sampling occurring at different times of year.

The maerl habitat polygons (Natural England, 2013) largely matched the patterns observed during the current survey. The boundaries of the areas of live maerl bed appeared to be relatively accurate. The areas designated as dead maerl gravel, other substratum with live or dead maerl, and live maerl on dead maerl do not appear to be as accurately defined. These categories were hard to separate out and distinguish from one another using the video data, suggesting that these discrete categories may not be the most appropriate way to represent these areas with the SAC.

4.2 Favourable condition assessment

Table 4.2 details the favourable condition assessment criteria for maerl bed communities. The aims of the survey were to assess the condition of the maerl bed communities within the Fal and Helford SAC under the three attributes on the table – extent, distribution and species composition. The assessment made on each attribute following the current survey are also summarised in the table, along with any comments and recommendations, which are discussed in more detail below.

4.2.1 Extent of maerl bed communities

The drop-down camera survey was able to confirm the boundaries of the existing live maerl habitat polygons at St. Mawes Bank and Castle Point, suggesting no change in extent of these particular maerl beds. The presence of static fishing gear prevented the exact extent of the live maerl bed in Helford River from being confirmed. The vast areas of dead maerl gravel within the Fal and Helford SAC would be impossible to accurately assess on a survey of this scale. Dead maerl gravel was prevalent throughout the majority of the survey area, and to adequately map the extent of this sub-feature a much larger scale survey would be necessary. It is unlikely that maerl gravel could be distinguished from coarse sediment using acoustic methods, so it may be difficult to find an appropriate technique to get a completely accurate picture of the extent and distribution of dead maerl with the Fal and Helford SAC.

In attempting to assess the ‘extent’ attribute, there were two main questions that need to be clarified: what constituents a maerl bed, and what level of change would be deemed to be significant? In order to ascertain the extent of a maerl bed, a proper working definition of what constituents a ‘maerl bed’ needs to be defined. Factors requiring consideration include percentage cover of maerl (e.g. the condition assessment could include a definition for a minimum percentage cover), the use of live or dead maerl (or both), and the spatial complexity of the maerl (e.g. the thickness of the bed and the size of nodules). The fringes of the St. Mawes maerl beds had increasing levels of dead maerl gravel and then increasing live maerl towards the centre of the beds. During the current survey, the ‘edge’ of the maerl bed was a subjective judgement based on the amount of live maerl (at least ~5-10% live maerl along with at least ~15% dead maerl) seen from the drop-down video footage. A different definition of what constituents a maerl bed could potentially move these boundaries considerably, resulting in a very different condition assessment. Most of the dead maerl with the SAC was broken down into gravel, which is unlikely to be as important in terms of enriching biodiversity as any 3D rhodoliths interlocked together as a bed. The Fal and Helford SAC covers a large area, with large time and cost implications to accurately assess the extent of the dead maerl gravel across the whole region. The factors noted above therefore have to be defined to allow the condition assessment to be completed. Once a definition of a maerl bed is established, then a definition of what constitutes ‘change in extent’ also need to be determined. Of most importance is the level of change required in order to be consider a change in extent significant (bearing in mind limitations of positional accuracy). There is currently no advice on what constituents an acceptable shift in feature extent due to natural change versus that lost due to other impacts.

4.2.2 Distribution of maerl bed communities

The attribute 'distribution of maerl bed communities' is intended to examine the relative distribution of biotopes within maerl bed features. The analysis of the drop-down video lines showed changes in habitats type not only between the boundary of the live maerl beds and the surrounding sediment, but also some differences between the maerl habitats within the St. Mawes Bank bed. Most notably, the boundaries to the area of *Phymatolithon calcareum* within St. Mawes Bank were more clearly defined, although this needs to be confirmed by further survey work. Although Howson *et al.* (2004) identified the presence of this different maerl habitat, no attempt was made to pinpoint the distribution of the habitat within St. Mawes Bank. The attribute 'distribution of maerl bed communities' could therefore not be assessed in the current study.

Assigning biotopes to habitats where maerl dominated was relatively easy as long as the identity of the maerl species was obvious. However, those areas with small maerl components were more difficult to assign to an appropriate biotope. This was particular apparent around the fringes of the live maerl beds. The current survey has provided a more accurate picture of the distribution of habitats present within the maerl beds.

The rationale behind the assignation of the different maerl bed habitats to the polygons within the Natural England (2013) report is unclear. A scheme whereby categories are based on an easily recordable metric is required in order to monitor the 'health' of an area, changes in habitat towards the edges of maerl beds, and to assess patchiness within the maerl beds. The most useful metric in terms of ease of monitoring would be based on the total percentage cover of all maerl (live and dead), and the percentage cover of live maerl. Table 4.1 outlines a suggested category system for maerl bed habitats that could be used to assess maerl habitats more accurately.

Table 4.1. Suggested category scheme for designating maerl habitats. Habitats are assigned a numeric 'Total Maerl Category' according to the percentage cover of all maerl present (live and dead), and alpha 'Live Maerl Category' according to the percentage cover of live maerl, and a 'Maerl Species Code' according to the dominant maerl species present.

% Cover	Total Maerl Category	Live Maerl Category	Maerl Species Code
>75%	1	A	Pcal - *Phymatolithon calcareum* Lcor - *Lithothamnion corallioides* Lgla - *Lithothamnion glaciale* Lfas - *Lithophyllum fasciculatum*
51 - 75%	2	B	
26 - 50%	3	C	
11 - 25%	4	D	
6 - 10%	5	E	
1 - 5%	6	F	
< 1%	7	G	

Based on this category system, an area of maerl bed composed of *Lithothamnion corallioides* with 75% maerl cover, of which 40% was live, would be assigned a category of 1C_Lcor. This is only a suggested category system to produce a working definition for maerl bed habitats to aid monitoring for these habitats. Figure 4.1 demonstrates the type of maerl habitat distribution map that could be produced using this scheme, based on still image data collected from St. Mawes Bank during the current survey. This type of scheme with definitions for the attribute 'distribution of maerl bed communities' would allow future studies to assess the condition of this feature.

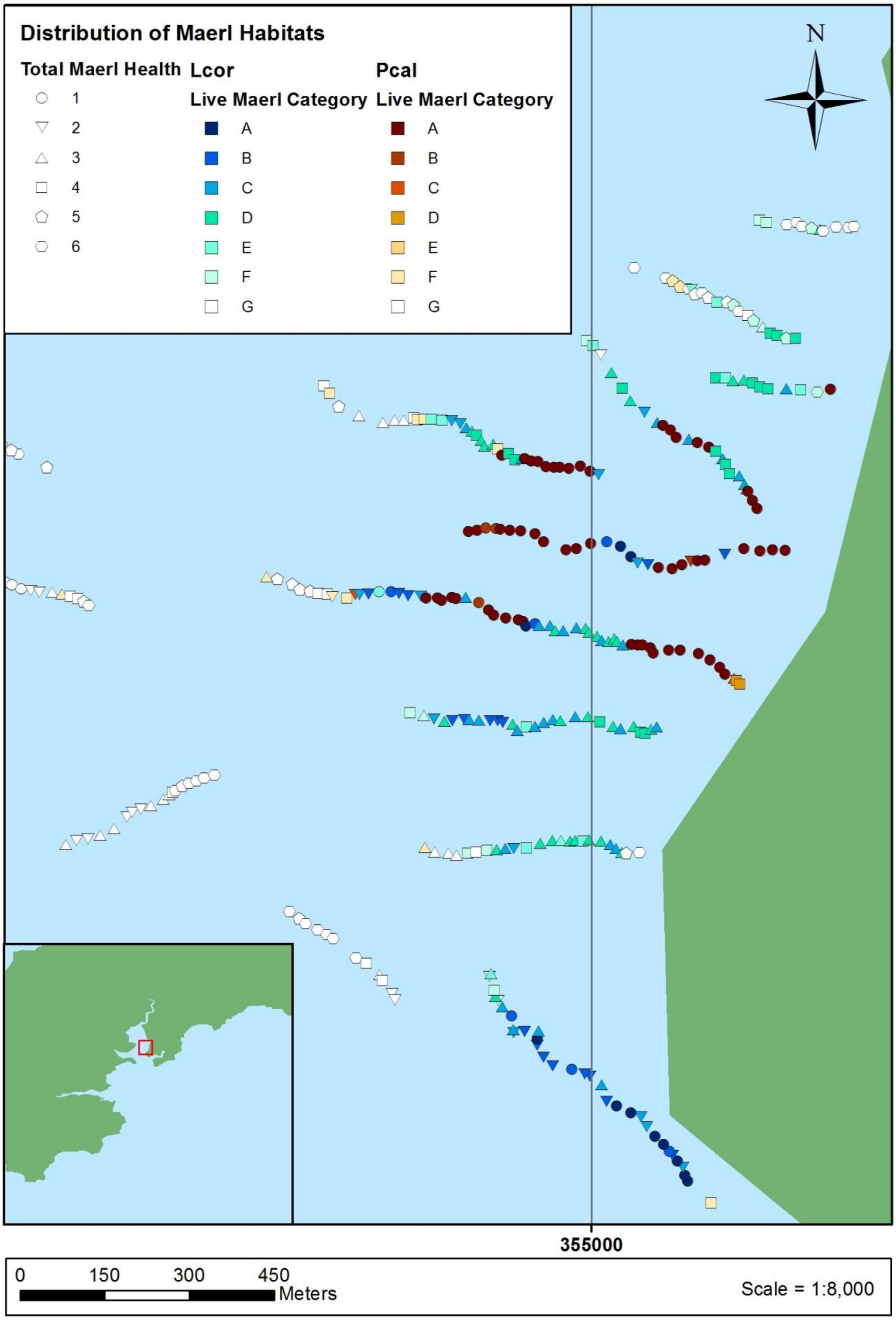

Figure 4.1. Maerl habitat distribution map, still image data from 2013 survey. Symbol shape defines 'Total maerl Health', colour defines 'Live maerl category', with different colour palettes for different maerl species. See Table 4.1 for definitions of maerl categories.

4.2.3 Species composition of maerl bed communities

The scientific diving survey was able to investigate the species composition of the maerl communities at St. Mawes Bank, Castle Point and Helford River. Although there were some changes in the presence / absence of some red algae species compared to previous studies, the community compositions were broadly similar. Differences between the current survey results and previous survey data may stem from sampling at different times of year, and differences in the level of taxonomic experience when identifying red algae rather than representing any significant shift in community structure over time.

The multivariate analysis of the data demonstrated that there were distinct differences in the communities present on areas dominated by the two different maerl species. Differences between *Phymatolithon calcareum* and *Lithothamnion corallioides* communities on St. Mawes Bank were also reported by Howson *et* al. (2004). In addition, the community present on the *L. corallioides* beds showed some geographical differences, with dive sites within St. Mawes Bank having different communities to those from Castle Point and Helford River. The lack of raw data from previous surveys makes it hard to accurately assess whether the current data showed significant changes from the known communities at these sites. These different community compositions have important implications with regards to ensuring data from comparative geographical points within the maerl beds are used when conducting monitoring assessments over time.

One element of maerl bed species composition not assessed during the current survey was the infaunal component. Maerl beds are diverse habitats partly due to small fauna inhabiting gaps between interlocking maerl rhodoliths. It is not possible to accurately assess these taxa by diving or drop-down video, overlooking a significant component of maerl bed communities. Although beyond the scope of the current survey, core samples could be obtained by divers at each site in order to allow assessment of the infauna. Studies have shown that infaunal invertebrate species can be good indicators of the quality of benthic habitats (e.g. Hiscock *et al*., 2004, 2005; Dean, 2008). Coring would also allow assessment of maerl depth, which has been shown by previous studies to be a good indicator of maerl bed health (e.g. Hall-Spencer *et al.*, 2008).

Table 4.2. Favourable condition assessment criteria for maerl bed communities sub feature. Adapted from Regulation 33(2), English Nature (2000).

Feature	Sub-Feature	Attribute	Measure	Target	Assessment after 2013 survey	Recommendations
Subtidal sand banks	Maerl bed communities	Extent	Area (ha) of maerl (live and dead) measured once during reporting cycle	No decrease in extent of maerl as a whole, or of either dead or live maerl, from an established baseline, subject to natural change	Extent of live maerl beds on St. Mawes Bank similar to those defined by maerl habitat polygons – **no change in extent** Presence of fishing gear prevented confirmation of Helford River maerl bed extent Dead maerl gravel prevalent across the majority of the survey area – extent of these areas was not possible to confirm with a survey of this size	Helford River maerl bed extent needs confirming with additional surveying In order to accurately assess this attribute two questions need to be addressed: - What constituents a maerl bed? - What level of extent change is significant?
		Distribution of maerl bed communities	Distribution of maerl bed communities. Measured once per reporting cycle.	Distribution of maerl bed communities should not deviate significantly from an established baseline, subject to natural change	Distribution of live maerl habitats match previous data. Distribution of dead maerl habitats approximately similar A better picture of *P. calcareum* area within St. Mawes Bank was obtained Distribution of different habitats within St. Mawes maerl bed obtained Unable to assess whether distribution of habitats has changed since it is unclear how current habitat polygons have been defined	Use data from video lines to guide future surveying to establish boundaries of *P. calcareum* habitat more definitively Definition of maerl habitat categories required to accurately designate biotopes/ habitats – see suggested scheme
		Species composition of maerl bed communities	Presence and abundance of composite species of species from maerl areas. Measured during summer, once per reporting cycle	Presence and abundance of composite species should not deviate significantly from an established baseline, subject to natural change	Species composition of *P. calcareum* and *L. corallioides* areas on St. Mawes Bank not significantly different from previous survey data – **no change in attribute** Current data suggest differences in species composition between Helford River and St. Mawes bank *L. corallioides* maerl bed habitats, and to a lesser extent between Castle Point and St. Mawes Bank	Collection of core samples to assess infaunal community composition Care must be taken to ensure future comparisons are made between samples from equivalent geographical areas within the SAC

4.3 Survey limitations

Aside from the weather altering the planned diving survey, several other limitations were encountered during the drop-down camera and dive survey. The principal limitation during the drop-down camera survey was the presence of static fishing gear that prevented survey lines being completed over the maerl bed in Helford River. Strong currents and tidal flow also made it hard to keep an adequate the camera speed over ground. More limitations were encountered during the scientific diving survey, and these are explained in more detail below. These limitations should be taken into consideration before planning any future surveys of the Fal and Helford SAC.

4.3.1 Currents and tides

There were strong currents at some sites which meant that sites had to be selected carefully depending on the tidal state at the time. The slightly more exposed sites were surveyed when the tidal currents were not too strong, and slack water was targeted whenever possible.

Of particular note was the difficulty in completing three dives at Helford River in any one survey day. Completion of safe dive operations in Helford River at the two slack water periods was achievable but adding a third dive in between proved problematic. In the event of a repeat survey it is therefore recommended to visit Helford River on two occasions rather than one.

4.3.2 Time constraints

Despite the relatively shallow depths where the maerl beds are found, the large number of tasks required for the assessment resulted in fewer than the planned 30 quadrats along each transect being completed at some sites. This was mainly a problem at sites with abundant red algae present, since careful observation of these species was necessary for their *in-situ* identification.

4.3.3 Photographic skills

The assessments of the maerl beds required some *in-situ* identification skills. However, it was also important to obtain some permanent records of the quadrats in the form of video or still photographic data. To acquire such data required experience in underwater photography and video operations, familiarity with the equipment and the use of lights and strobes, in addition to good buoyancy control whilst underwater.

4.3.4 Red algae identification

The identification of red algae was the most challenging task during this survey. The small size, similarity between different species (e.g. *Heterosiphonia plumosa* and *Heterosiphonia japonica*), and large number of plants present at some sites resulted in this task being particularly difficult. However, the collection of samples greatly aided the process and allowed verification of *in-situ* identification to a large degree.

The basis for the survey methodology was ‘simplicity and repeatability’ whilst still allowing statistically robust data to be collected. There might be a need to assess the suitability of species to be used as indicators further, especially as other species might be easier to identify *in-situ*. Spending time on shore verifying red algae identification improved the ability to recognise and distinguish between different species significantly. Time and cost allocation for this aspect of future work should be considered.

4.3.5 Characterising species

Some 60 different species algae had been identified in the studies completed by Howson *et al.* (2004) and Bunker (2013). Creating a list of taxa to be surveyed, bearing in mind the overall strategy of 'simplicity and repeatability', proved to be a very challenging task. The selection of flora to be included was therefore an amalgamation of the taxa identified during these two surveys. It resulted in many more species of both flora and fauna being recorded in the current study than just those listed on the pre-prepared recording forms. These additional species therefore had to be added to the forms during the dives. Furthermore, some of the species recorded during previous surveys (Howson *et al.*, 2004; Bunker, 2013) and therefore added to the pre-prepared recording forms, were not observed in the field.

4.3.6 Specific red algae

Divers observed several very small filamentous red algal species that were difficult to identify *in-situ*, which were recorded as 'red algal fluff'. One of these species, *Compsothamnion thuyoides,* was recorded in one quadrat from a sample taken and identified later on shore. However, it is possible that this species was much more widespread on the maerl bed, but due to the difficulty of *in-situ* identification it was only recorded once, with other records potentially recorded as 'red algal fluff'.

4.3.7 Comparisons with previous data

The sample locations were selected based on previous studies with the aim of allowing comparisons with previously collected data (e.g. Howson *et al*., 2004) as well as collecting baseline data to allow comparisons with future surveys. Whilst the latter was achieved successfully, the former was not, primarily as a result of limited access to the raw historic data but also as the available historic data were inconsistent, unclear (e.g. confusing site numbering with different site names in the report and in the spreadsheets) and incomplete.

4.4 Conclusions and recommendations

4.4.1 Conclusions

The survey was successful in gathering sufficient data to assess the extent, distribution and species composition of maerl bed communities within the Fal and Helford SAC. There was no evidence from the current survey data to suggest that condition of the live maerl beds have deteriorated compared to the known data at the time of sampling. The extent and distribution of the live maerl beds does not appear to have altered. Although there were some differences in the species composition compared to previous surveys, the community present was largely the same. The differences in species presence / absence may be due to different survey sampling times, or varying levels of taxonomic experience of the dive team involved during the survey.

Multivariate analysis of the scientific dive data showed that there were distinct differences in the communities present on areas dominated by *Phymatolithon calcareum* compared to those dominated by *Lithothamnion corallioides*. In addition, the community present on the *L. corallioides* beds showed some differences based on geographical location, with dive sites within St. Mawes Bank having different communities to those from Castle Point and Helford

River. These differences should be considered when assessing future condition monitoring of the species composition attribute of the maerl beds.

4.4.2 Recommendations

4.4.2.1 Working definitions

As discussed in section 4.2, in order to accurately assess whether the attributes measured as part of the condition assessment have declined significantly, some working definitions on what represents a significant change in attribute need to be made. For the maerl extent attribute, guidance needs to be made about how much change in extent is considered to be significant. For the maerl distribution attribute, an index that relates to maerl health needs to designed to allow for more accurate assessment of changes in distribution. MNCR biotopes are subjective, and can cover a relatively broad sweep of habitat ‘health’. Some index that takes into account maerl ‘health’ is necessary to enable finer scale assessment of maerl habitat distributions. Assessment of maerl bed communities needs to be supported by infaunal samples, since this important component of the habitat has not been assessed by the diving or drop-down camera surveys. Hand cores taken by divers would be most suitable, which would also allow for the measurement of maerl bed depth, which should be considered as a potential indicator for maerl bed health.

4.4.2.2 Indicator species

In order to monitor change at a site, a list of indicator species should be drawn up. These species should represent taxa that have been shown to respond in a meaningful way to environmental change, be it natural or anthropogenic. Many of the species recording during the diving survey were those that were 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*.

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. 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.

4.4.2.3 Dive survey operations

In order to improve future surveys, it is recommended that a red algae workshop should be integrated into the scientific diving plan. One of the major challenges with this survey was the red algae identification, not only the difficulties in identifying all the species *in-situ* with the time constraints (e.g. slack water periods and safe working times), but also as the number of algae in each quadrat was high. For future surveys it is therefore recommended to allow funds for at least two days of laboratory work as well as a familiarisation dive. All the scuba divers partaking in survey operations should be involved in these aspects of the survey. This recommendation is site specific as the red algae species diversity on the maerl beds in the Fal and Helford SAC is particularly high and the challenge to complete this task is considerable. A summary of a potential survey plan is given in Table 4.3.

Table 4.3. Summary of recommended scientific dive survey plan.

Schedule	Task	Comments
Day 1	Mobilise kit and complete familiarisation dive(s)	• Check kit • Get used to local conditions and the vessel • Collect red algae samples
Day 2	Red algae identification workshop – laboratory work	• Equipment: microscopes (minimum of 1 per two divers), identification keys, trays, , petri dishes and dissection kits, • Experienced red algal identifier to help and teach red algae identification
Day 3	First survey day	• Complete three survey sites • Collect red algae samples from each site
Day 4	Red algae identification workshop - laboratory work	• A second day of red algae identification • Experienced red algal identifier to help and teach red algae identification
Day 5 onwards	Second and following survey days	• Complete three survey sites per day • Consider additional laboratory days as necessary

Our recommendation is to spend the first day mobilising the kit and completing one or two familiarisation dives to get used to the conditions and check the kit but primarily to collect red algal samples. On day two the divers should attend a red algal identification workshop at a local laboratory (or at the accommodation if appropriate) to get familiar with the red algal species. The laboratory (or accommodation) needs sufficient space to allow several microscopes (a minimum of one microscope for two divers), trays, dissection kits and identification keys. An experienced red algae identifier should then go through the main species likely to be present and use the samples collected during the familiarisation dive(s) to allow all the divers to improve their red algal identifications skills. Ideally an entire day should be allocated for this task as the quality of the data would improve and the speed of the future tasks would increase.

The third day should be the first scuba-diving survey day with the successful completion of three maerl stations. The collection of a conservable amount of samples from each station is of vital importance. On day four the divers should return to the laboratory and complete another red algae identification workshop to further improve the identification skills and use the samples collected on day three to improve the quality of the data collected and recorded. Following a second successful day in the laboratory the survey work can begin in earnest and the team should be able to complete the survey to a very high standard.

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