Cefas Report (C6064)

Update of Annex 1 habitat mapping in the Lyme Bay and Torbay cSAC

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Executive Summary

Cefas were tasked by Natural England to review the potential Annex 1 reef assessment within the Lyme Bay and Torbay cSAC, previously interpreted by Vanstaen and Eggleton (2011), in light of new groundtruthing sample and acoustic data. Newly acquired high resolution multibeam bathymetry and backscatter data were available for the region of Torbay south of Berry Head and used to delineate potential Annex 1 reef. Also newly acquired groundtruth sample data was used to supplement the original assessment carried out by Vanstaen and Eggleton (2011) and update confidence for previously identified regions of potential reef.

The outcome from this assessment is a map presenting the extent of potential rocky/stony reef and the confidence that can be associated with each area of interest. As was found previously by Vanstaen and Eggleton (2011) it was possible to systematically identify rocky reef from multibeam echosounder data, whilst neither backscatter nor bathymetric data could confidently predict presence of stony reef. This assessment supports the findings of Vanstaen and Eggleton (2011), that the Lyme Bay region mainly comprises rocky reef habitats with locally associated stony reef habitat.

Where biological sample data were available, an attempt was made at attributing EUNIS habitat types to each of the areas identified as reef habitat. The EUNIS habitat types assigned to each area of interest are those that were dominant from currently available sample data and further survey effort has the potential, therefore, to reveal more habitats.

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1 Background and Introduction

In April 2011 Cefas were commissioned by Natural England (NE) to undertake an Annex 1 reef assessment of the Lyme Bay and Torbay candidate Special Area of Conservation (cSAC) that aimed to distinguish between exposed bedrock, stony reef and biogenic reef. A biotope map was created and published to demonstrate, where possible, the presence, extent and location of the different types of Annex 1 feature across the cSAC (Vanstaen and Eggleton, 2011). NE have now commissioned Cefas to update the maps created as part of the original report and improve confidence, where possible, as well as identify reef in areas where data was not previously available. It is again hoped that this information will be taken forward as a tool to better inform relevant authorities on potential management measures to preserve features at risk from anthropogenic pressures.

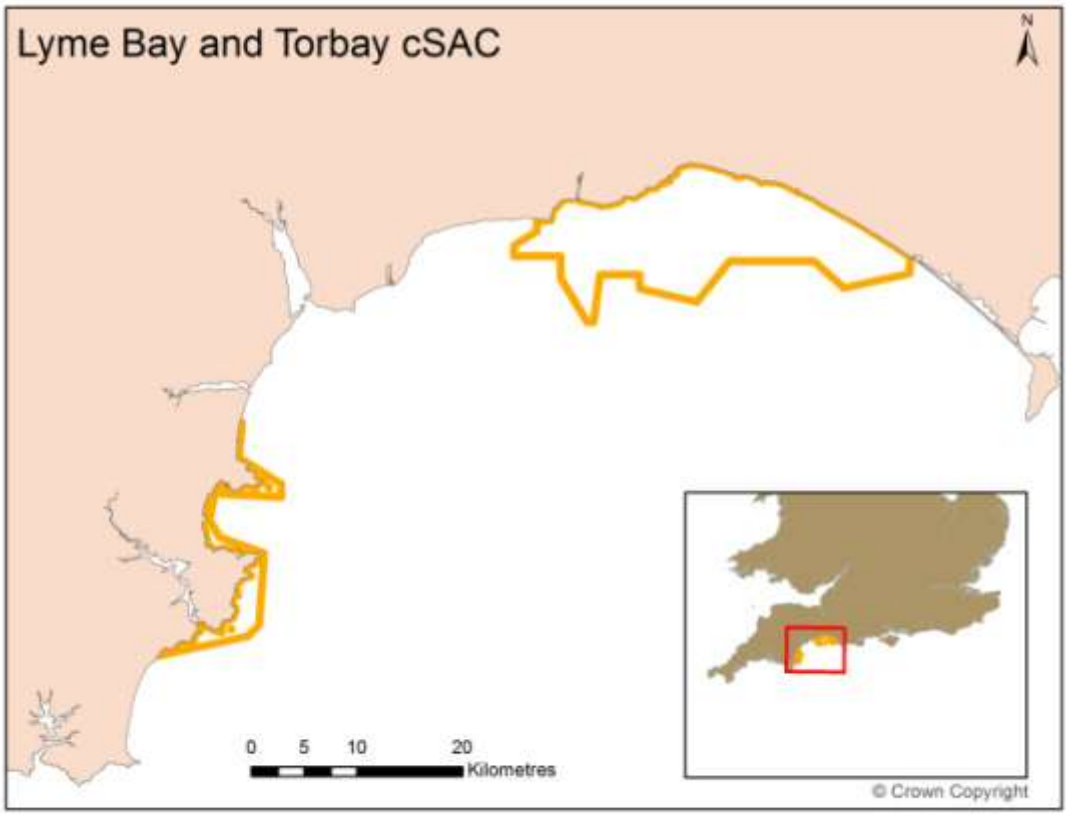

Figure 1 Location of the Lyme Bay and Torbay candidate SAC

2 Available data

It was agreed, between Cefas and NE, for the purposes of this update, that Cefas would only use readily available and processed data provided by NE. Data was assessed and interpreted for evidence of Annex 1 reef, where appropriate. Data sources used in this project are appraised below.

2.1 Acoustic seabed imagery

There was no new available acoustic data for the Lyme Bay region of the study area. Data was, however, collected in the previously un-surveyed southern region of Torbay, south of Berry Head.

In November 2012 Fugro Emu Ltd., under management by the Maritime and Coastguard Agency, collected Multibeam bathymetry and backscatter data between Bolt Head and Berry Head. The RV Discovery and EMU Surveyor used a Reson Seabat 7125 SV2 400KHz system to acquire this data, before processing within QPS QINSy v8 and Fledermaus software packages.

Data was provided to Cefas in an ASCII format that was converted in Fledermaus v8 for display and analysis in ESRI ArcGIS v10.1. Data was gridded at a 2 m resolution and found to be of a good quality (Figure 2 and Figure 3).

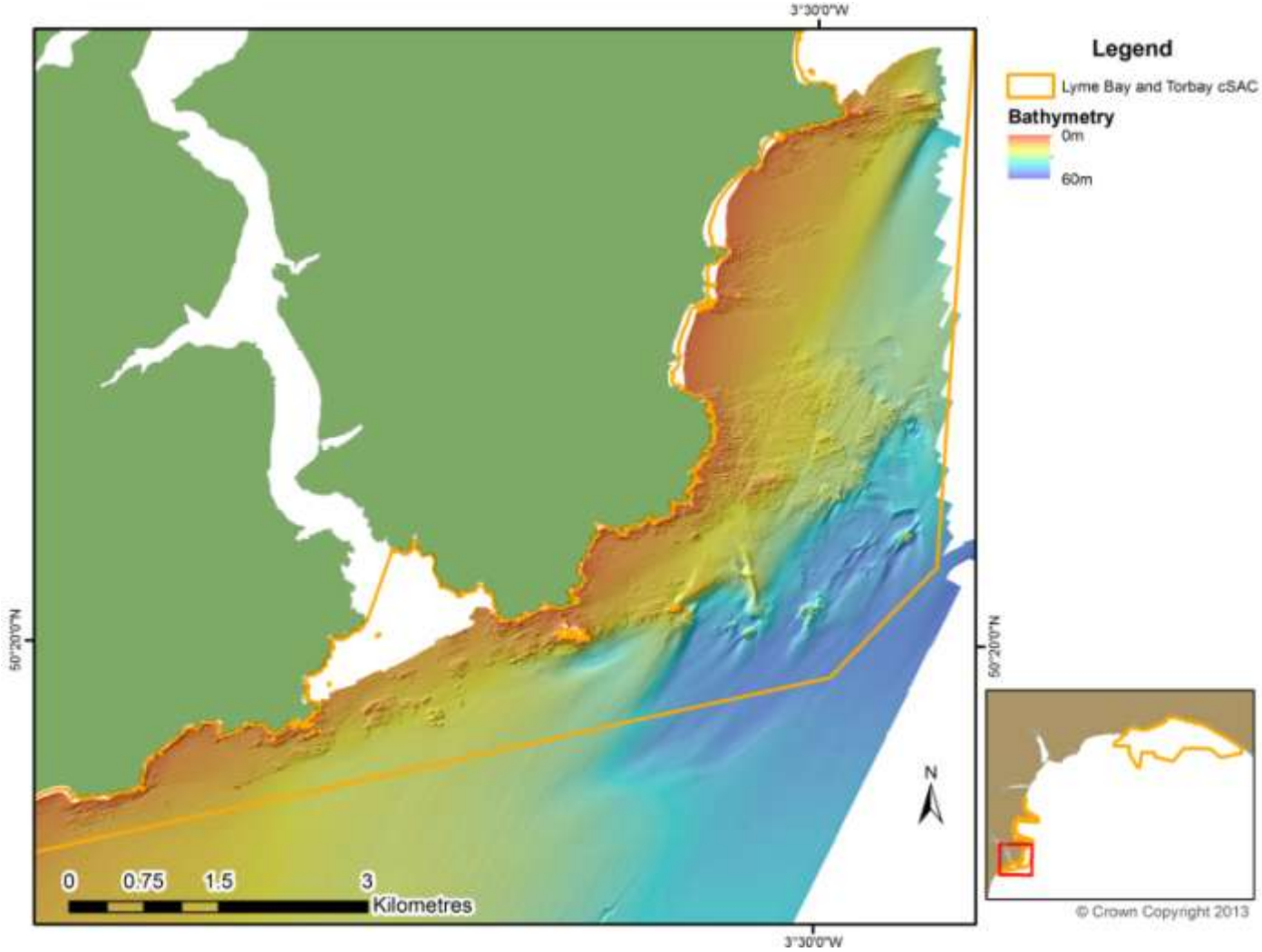

Figure 2 Newly acquired multibeam bathymetry coverage for the southern tip of the Torbay area, from Berry Head.

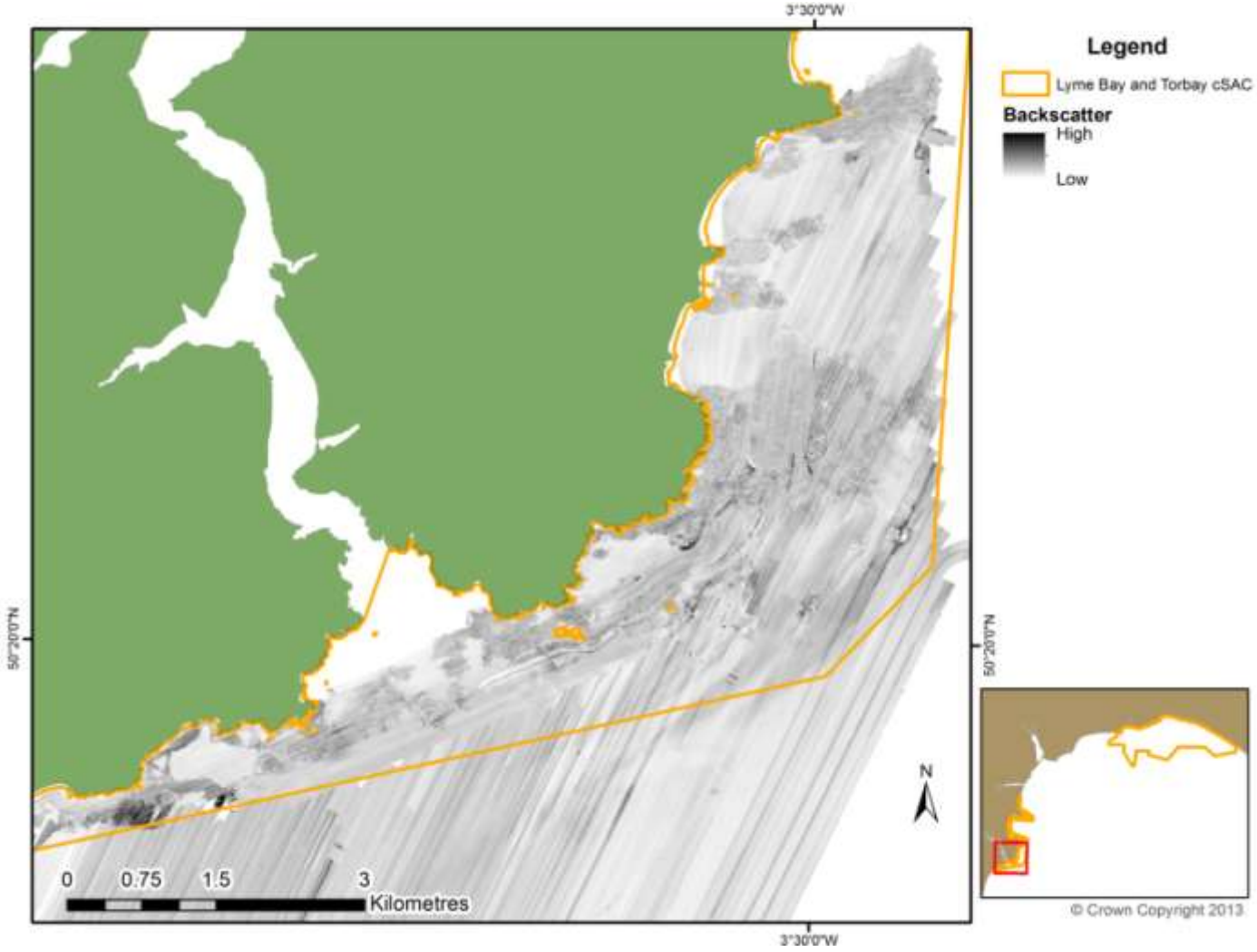

Figure 3 Newly acquired multibeam backscatter coverage for the southern tip of the Torbay area, from Berry Head.

2.2 Seabed sampling data

Natural England again provided all historic and recent sampling data to Cefas for review. Data previously used in Vanstaen and Eggleton (2011) can be found as Appendix A, and was utilised as part of the new reef identification exercise south of Berry Head. New data sources that were provided, along with data points mined from Marine Recorder, are shown in Figure 4. Those data points which were recorded but did not have an associated sediment description and/or EUNIS description were excluded from the analysis. This was deemed appropriate within the constraints of this project.

Datasets that were utilised in the reef designation and improved confidence exercise are listed in Table 1 along with an indication of whether physical and/or biological data was available.

Table 1 List of sample sources used for ground truthing of acoustic seabed signatures

Source	Description	Physical	Biological
Cefas	Video tows collected on behalf of Natural England and as part of this project (C6064) in 2013.	Yes	Yes
Southern Inshore Fisheries and Conservation Authority	Video tows of a specific low confidence reef at Lyme Bay in 2011.	Yes	Not Available
University of Plymouth	Condition assessment of the Lyme Bay and Torbay Annex 1 reef habitats, commissioned by Natural England (2013).	Yes	Yes
University of Plymouth	South Devon Reef Video Baseline Surveys for the Prawle Point to Plymouth Sound & Eddystone cSAC and Surrounding Areas (2011), commissioned by Natural England.	Yes	Some descriptions
Marine Recorder	Point source data extracted from Marine Recorder, August 2013.	Yes	For some samples

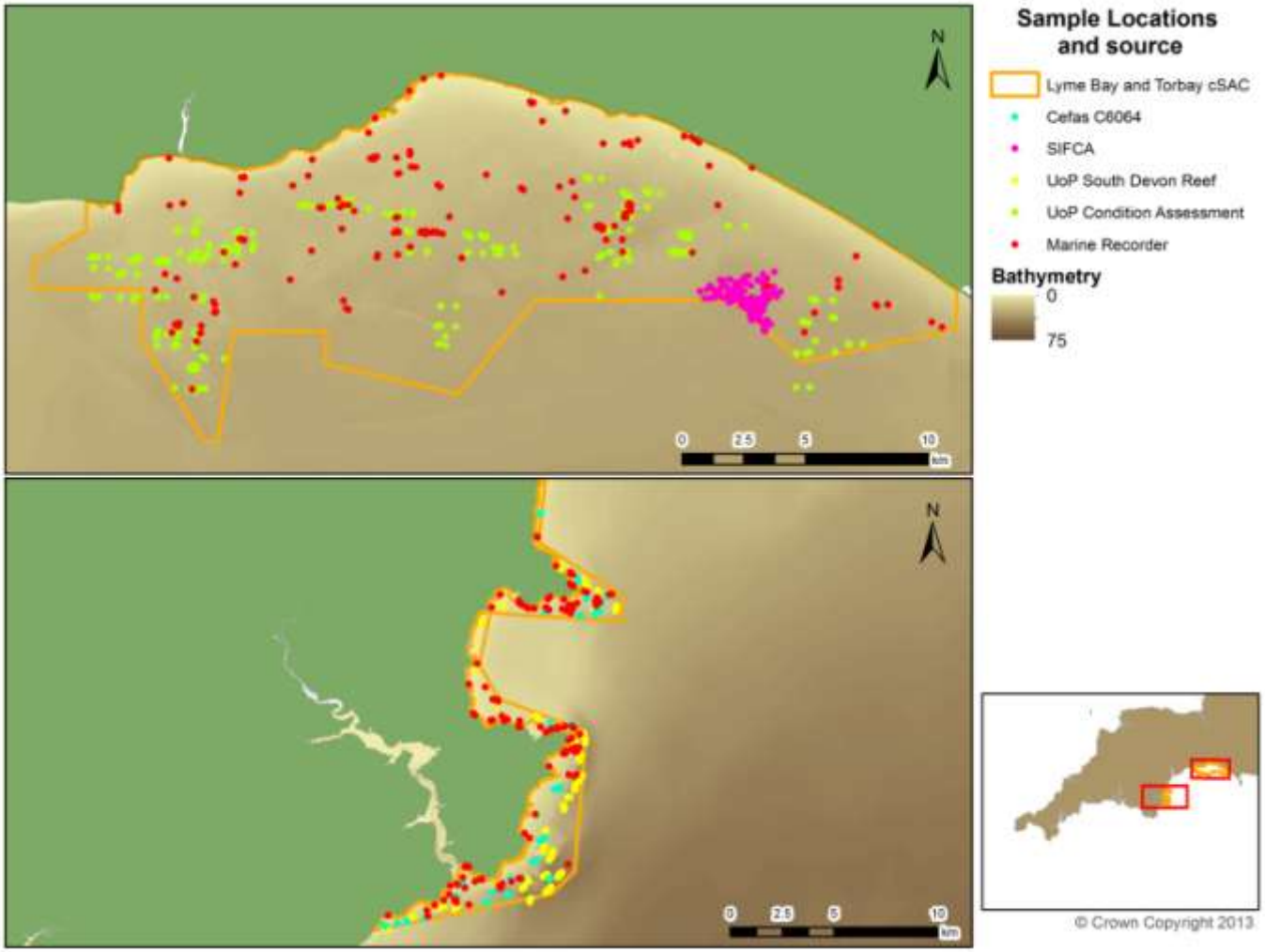

Figure 4 Distribution of samples within the Lyme Bay (above) and Torbay (below) cSAC. Marine recorder records include those extracted from previous reef delineation exercise by Vanstaen and Eggleton (2011). Bathymetry is from the Defra Digital Elevation Model (Astrium, 2011)

3 Results and Data Analysis

Acoustic seabed data interpretation

The multibeam bathymetry and backscatter data identified from the Maritime and Coastguard Agency (MCA) survey of the Torbay region south of Berry Head were subjected to expert interpretation to delineate potential areas of Annex I reef habitat, including exposed bedrock, stony reef or biogenic reef. As for Vanstaen and Eggleton's (2011) methodology, the definitions of reef habitats used in the "Interpretation manual of European Union habitats" were adopted. Exposed bedrock reefs were defined as those areas where bedrock was present at the surface. These reefs could be upstanding from the seabed or could be present as flat bedrock platforms. The stony reef definition used in this report was adopted from JNCC Stony Reef guidance document (Irving, 2009). Biogenic reefs were defined as those 'hard compact substrata from dead or living animals arising from the seabed'.

Sample stations from previous surveys were catalogued to identify where rocky substrate and/or rocky communities had been identified in a presence/absence exercise to help ground truth acoustic signatures. This exercise was also carried out over the area previously investigated by Vanstaen and Eggleton (2011) for new data sets. In this way confidence scores for previously low-moderate confidence areas could be revisited and adjusted accordingly.

Whereas for the majority of stations this was a subjective assessment, the data collected by Cefas (C6064) as part of this project, along with data collected by the University of Plymouth, allowed a quantitative assessment to be carried out building on the stony reef definition (Irving, 2009). In line with the guidance, transects were only considered to be stony reef habitat if more than 10% of the collected stills images showed cobble or boulder habitat.

As was found for the previous report (Vanstaen and Eggleton, 2011), the acoustic seabed data allowed for good identification of rocky reef exposures. However, no characteristic signature could again be associated with the occurrence of stony reef. It was, therefore, not possible to delineate stony reef habitats from the acoustic seabed data alone.

The new sample evidence was used to validate the observations from the acoustic data. As such this provided a measure of confidence in the resulting data interpretation as summarised in Table 2. This methodology is the same as that used in the original Vanstaen and Eggleton (2011) approach and was applied to the new reef designation in the southern region of Torbay. In those areas where additional samples have been collected, where previously there was no physical evidence, it has been possible to improve confidence in the designation of the bathymetric signature. Where confidence is still considered low, it is strongly recommended, as before, that further work is

continued to be undertaken by collecting additional samples to better characterise the nature of the seabed in those areas.

Table 2 Confidence scores used for reef assessment

Confidence score	Summary
1 (Low)	Unclear reef expression from acoustic seabed data. No reef evidence from samples or lack of samples.
2 (Moderate)	Clear reef expression from acoustic seabed data. No reef evidence from samples or lack of samples.
3 (High)	Clear reef expression from acoustic seabed data. Reef presence confirmed by one or more samples.

The updated reef assessments, along with the new confidence designations, can be found as Figure's 5-8.

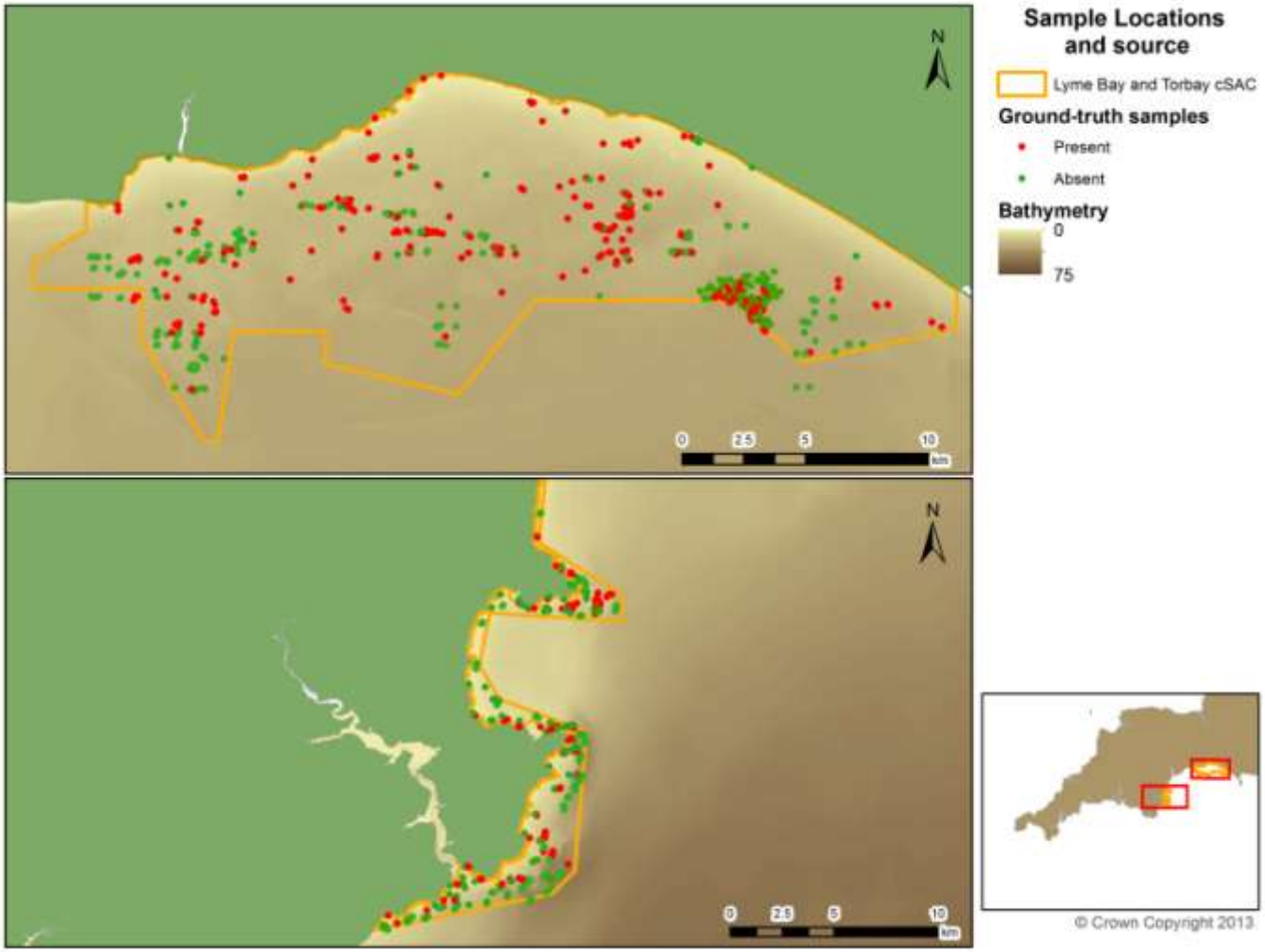

Figure 5 Reef classification for ground truth samples, within Lyme Bay (above) and Torbay (below) cSAC. Bathymetry is from the Defra Digital Elevation Model (Astrium, 2011)

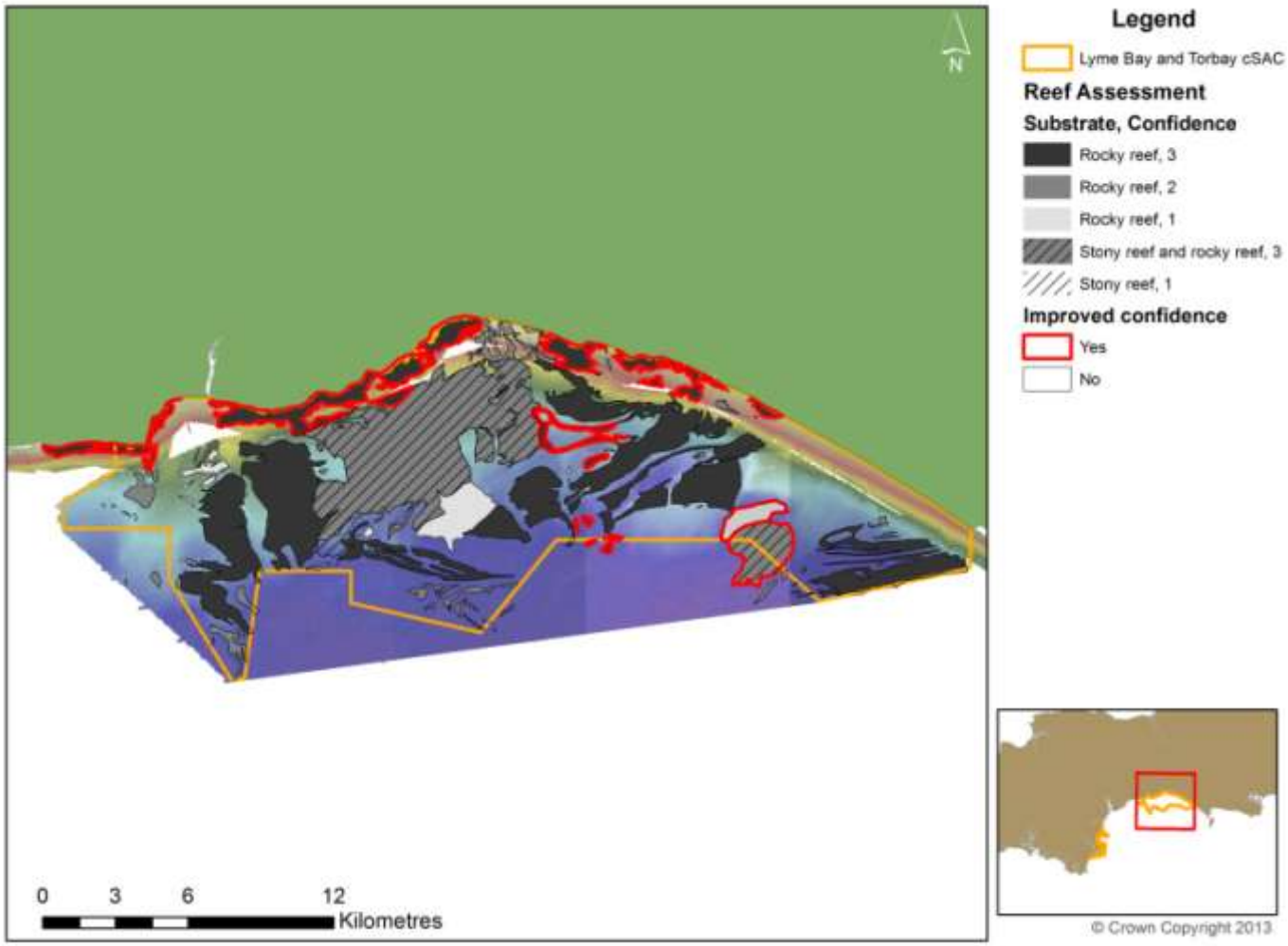

Figure 6 Updated confidence for distribution of Annex 1 habitats, within the Lyme Bay region of the Lyme Bay and Torbay cSAC, predicted in Vanstaen and Eggleton (2011).

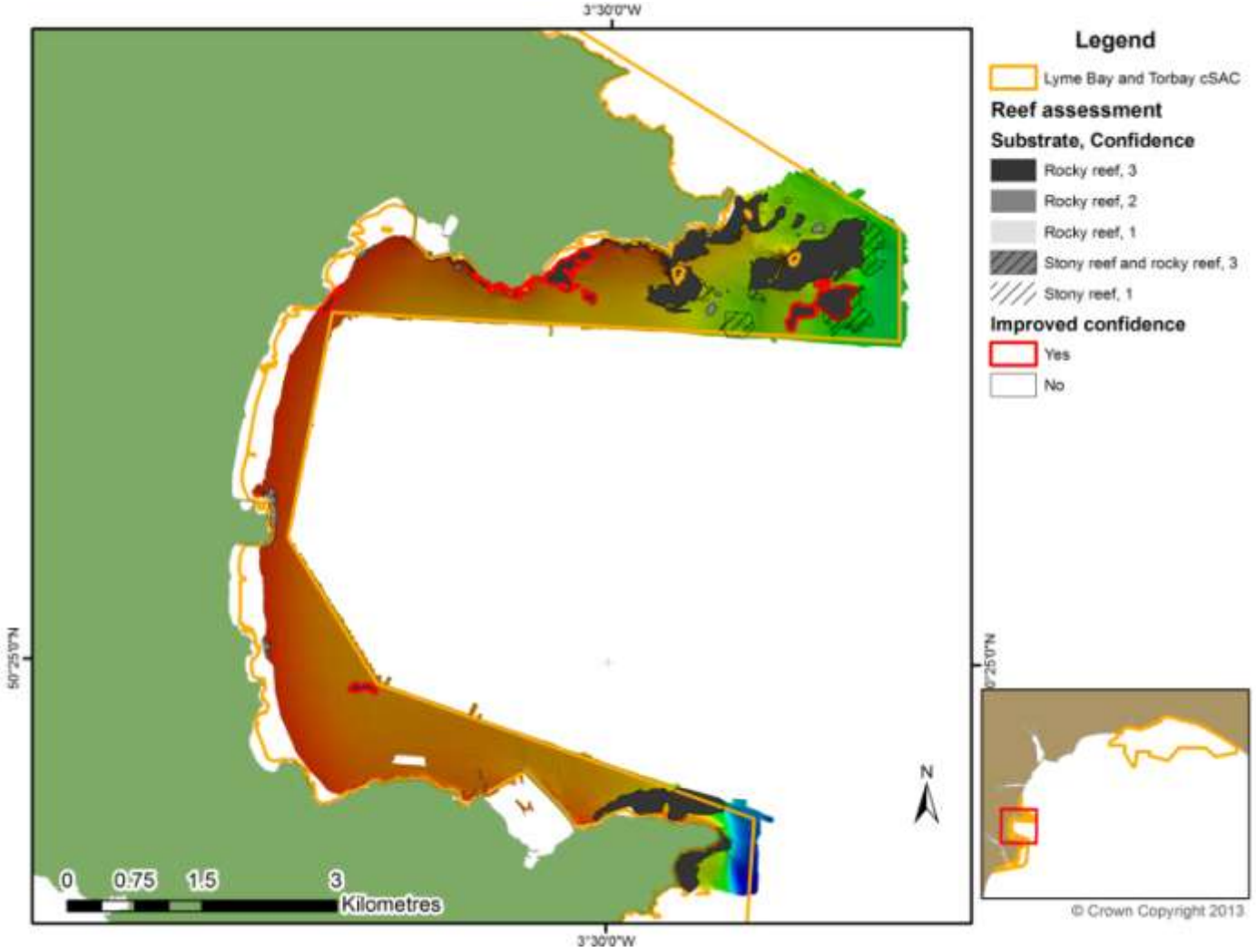

Figure 7 Updated confidence for distribution of Annex 1 habitats, within the Torbay region of the Lyme Bay and Torbay cSAC, predicted in Vanstaen and Eggleton (2011).

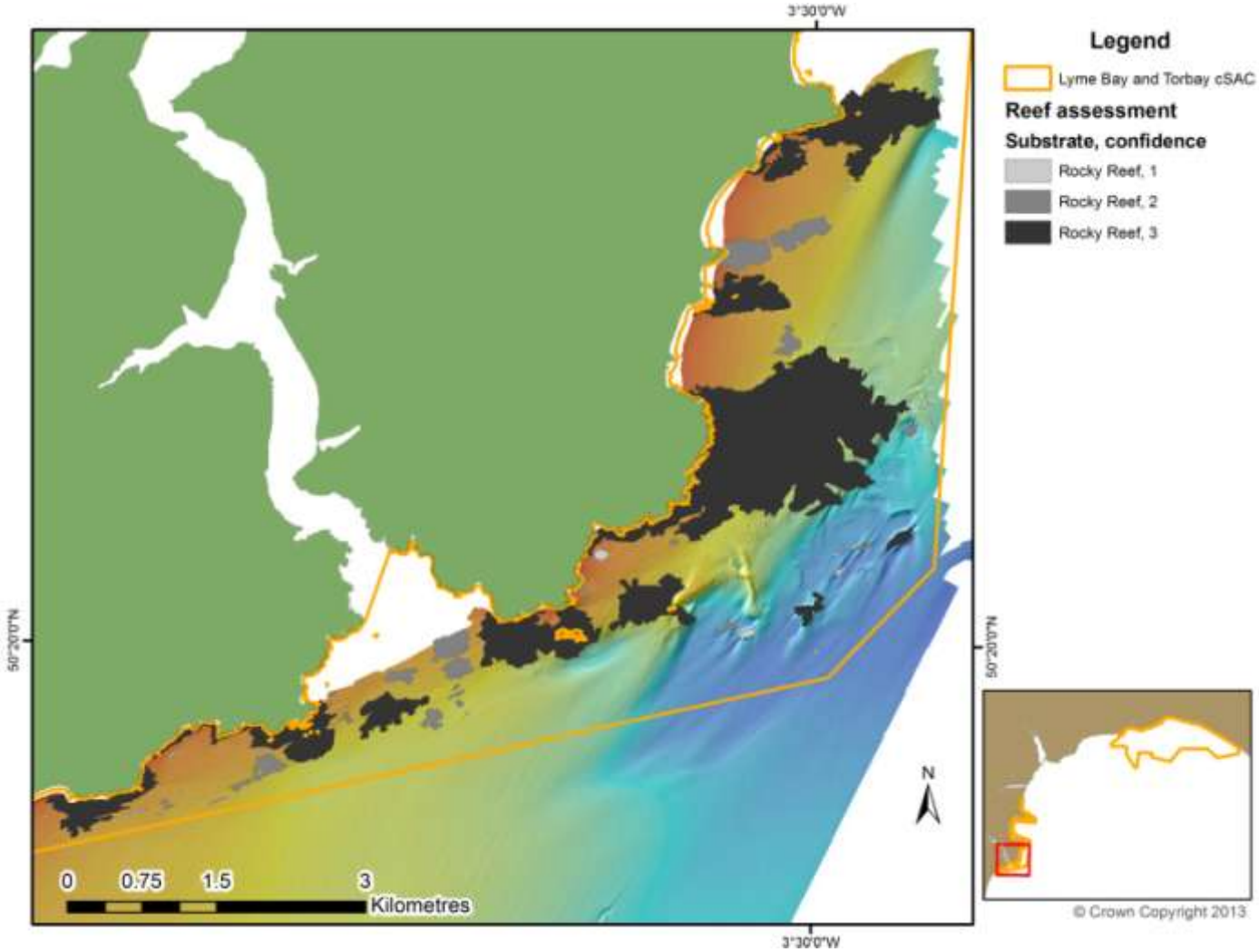

Figure 8 Distribution of rocky reef within the Torbay region of the Lyme Bay and Torbay cSAC, south of Berry Head, with associated confidence.

Mapping of the region south of Berry Head showed rocky habitats extending along long sections of the coast, with softer sediments appearing to be dispersed between and in the deeper regions further from the shore (Figure 8). There was a good correspondence between sample evidence and seabed interpretation from acoustic data (Figure 9).

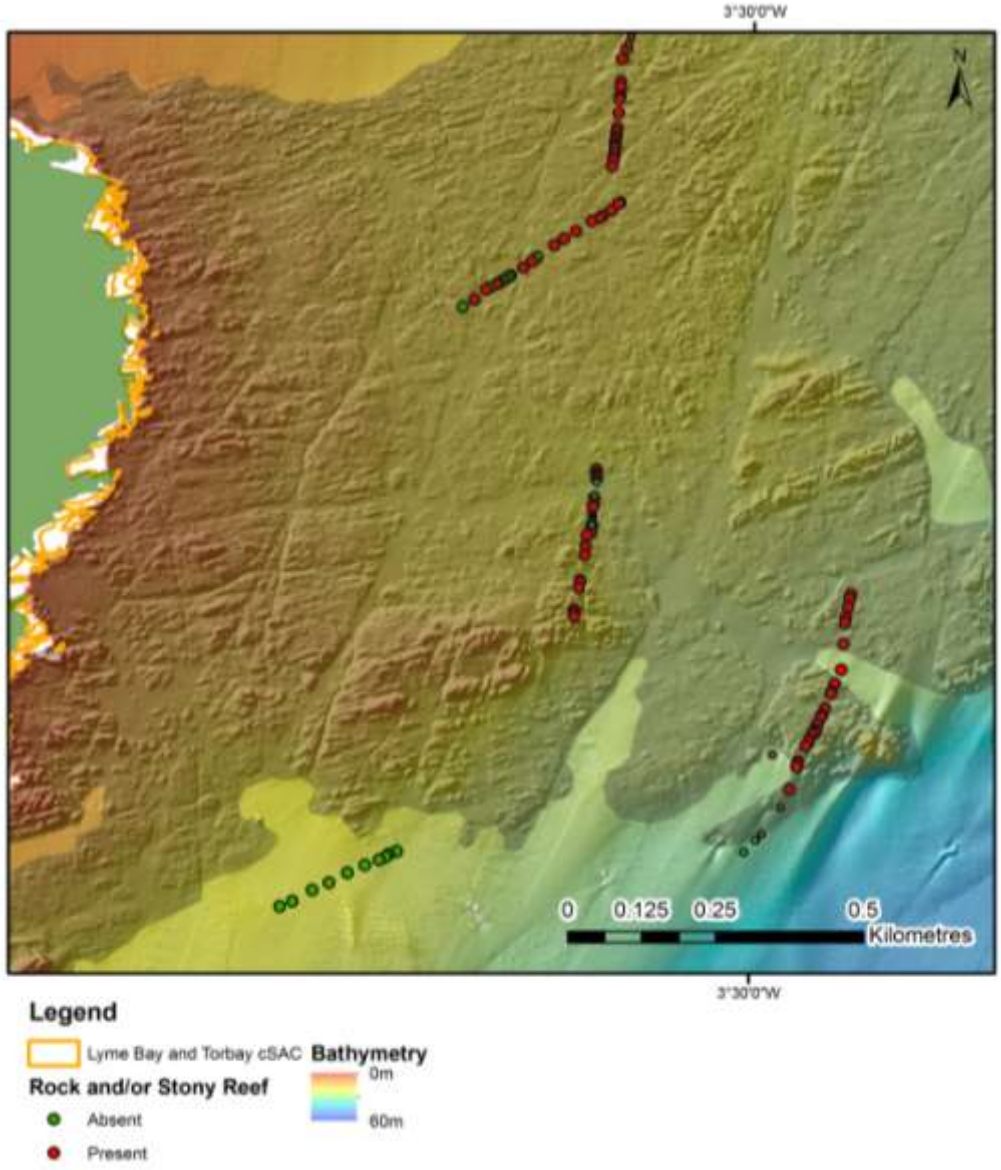

Figure 9 Sample evidence and agreement with an area of rocky reef identified from multibeam bathymetry. .

During August 2013 the Southern Inshore Fisheries and Conservation Authority (SIFCA) commissioned a survey to the Lyme Bay region of the cSAC which targeted a specific area of low confidence reef to the south east of the site. Using local knowledge they targeted this site as an area of high commercial fishing interest and, therefore, a region of high importance for improved reef confidence (Evans, in press, 2013). Using a random grid sample approach they used camera tows to

ground truth the area. Data points demonstrating presence or absence of reef overlaying backscatter and rugosity layers are presented in Figure 10. It was possible in our study here to utilise this data and improve confidence in reef designation for a large portion of the survey area. A portion of the reef designation was amended to reflect evidence of 'no reef' where, previously, rocky reef had been thought to extend. The high confidence region has also been reclassified to reflect the evidence of stony reef (Figure 6). It was, however, not been possible to completely rule out the presence of rocky reef as the data were provided to Cefas as presence or absence of reef with no quantified data (Evans, in press, 2013). Though there is some evidence to demonstrate an absence of reef, in the northern portion of this surveyed area, the non-targeted nature of the survey design leaves patches of reflectivity on the backscatter (Figure 11) that are, as yet, undefined. As was found previously by Vanstaen and Eggleton (2011) there was little/no conformity between groundtruthing samples and acoustic signatures. If, as the data appear to suggest, there are regions of stony reef, then they may well not be significantly raised from the seabed and, therefore, not easily recognisable using bathymetric techniques such as multibeam analysis. Patches of higher reflectivity seen to the north in Figure 11 may still be representative of stony reef. Figure 11 presents improved confidence to the south of the site whilst demonstrating the need for further evidence to the north to be confident of a 'no reef' assessment. Future work may wish to utilise, where available, acoustic data to ground truth potential habitat changes identified from remote techniques such as multibeam bathymetry and backscatter.

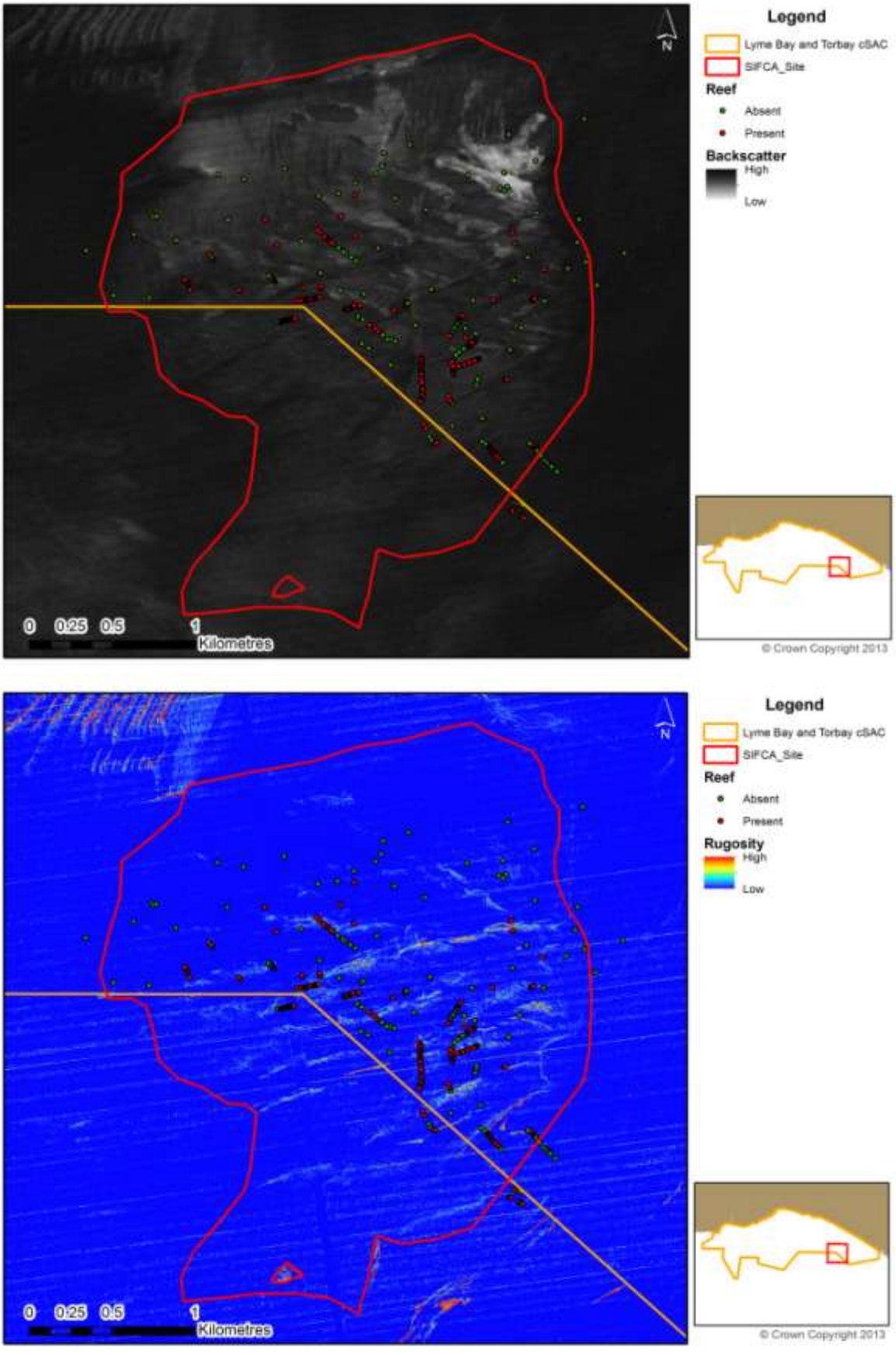

Figure 10 Patch of previously designated low confidence reef explored by Southern IFCA using video tows, showing backscatter (above) and rugosity (below) within the Lyme Bay region of the cSAC.

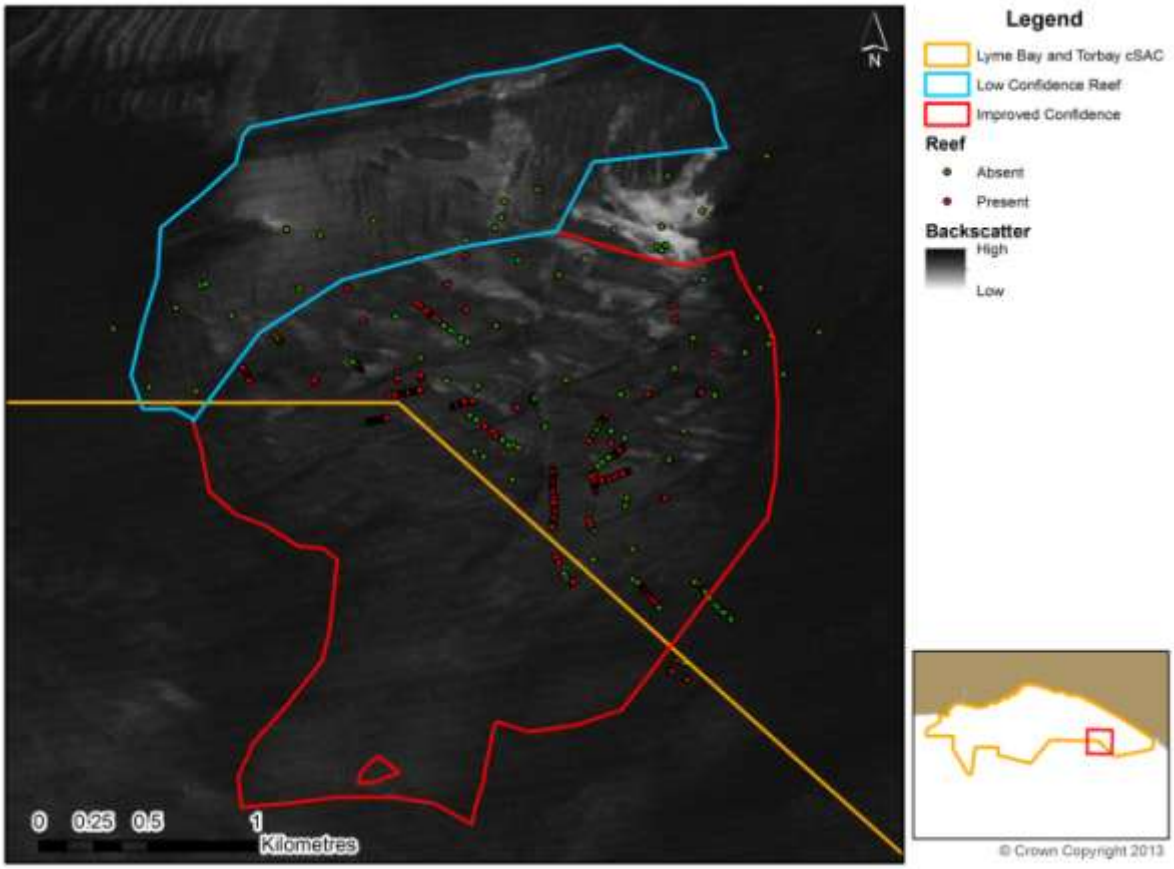

Figure 11 Reclassified patch of stony and rocky reef based on Southern IFCA video tows within the Lyme Bay region.

Of the original designations it was possible to improve confidence in reef presence for 15 polygons. An updated ESRI shapefile will be made available to Natural England, by Cefas, to demonstrate areas previously identified as reef, along with the new potential reef regions identified south of Berry Head. The file will contain four columns related to the physical characterisation of the seabed and a fifth to identify which polygons have increased in confidence since the Vanstaen and Eggleton (2011) assessment. These attributes are listed below:

- Substrate: Defines the nature of the seabed: rocky reef or stony reef.
- Source: Lists the datasets used in defining the substrate type.
- Subst_Conf: Scores the confidence in the substrate assessment, 3 = High; 2 = Moderate; 1 = Low.
- Comments: Includes any additional information in support of the confidence assessment or relevant to the substrate classification.

- Reclassed: In a ‘Yes’, ‘No’ or ‘NA’ format to demonstrate whether confidence has increased since the 2011 assessment. Those samples classed ‘NA’ demonstrate the newly delineated polygons south of Berry Head.

4 EUNIS Classification

Following the reclassification of the acoustic data for potential Annex I reef habitats, further assessment was undertaken of the benthic habitats associated with the reclassified areas using recent information extracted from Marine Recorder and data supplied by the University of Plymouth. For the newly mapped Torbay region south of Berry Head, both new (e.g. C6064) and old (used by Vanstaen and Eggleton, 2011) sample data were explored. Where species and/or existing biotope data were available for the sampling stations within the potential reef habitats, an attempt was made to assign a European Nature Information System (EUNIS) Level 4 or 5 habitat type. Where no species or biotope data were available, a predictive EUNIS modelling approach was adopted using the data layers available from UKSeaMap2010. Biotope records from Marine Recorder and the recent 2013 survey conducted by Cefas in Torbay were found to have the best source for confidently assigning biotopes to levels 4 or 5. The EUNIS habitats assigned to each polygon give an indication of the potential habitats and species found in the area and are not exhaustive. The majority of data extracted from Marine Recorder was gathered by divers and hence contains far more detailed information than for data gathered remotely by drop down video. The EUNIS biotope assignments may therefore be highly variable from site to site and within sites, especially where vertical rock is present.

The Lyme Bay and Torbay cSAC regions are generally situated in the infralittoral zone according to UKSeaMap, and subject to high/moderate energy. However, the majority of sample data suggested the reef habitats were more closely aligned with circalittoral habitat descriptions and species lists (Figure 12Figure 14, Table 3). Although some of the outer reefs may be situated in a transitional zone, it is more likely that the habitats have not yet been described within the infralittoral section of the EUNIS classification system. In addition, sample data was not extensive in many areas and may have been restricted to small areas within the reef polygons. Further survey effort has, therefore, the potential to reveal more habitats.

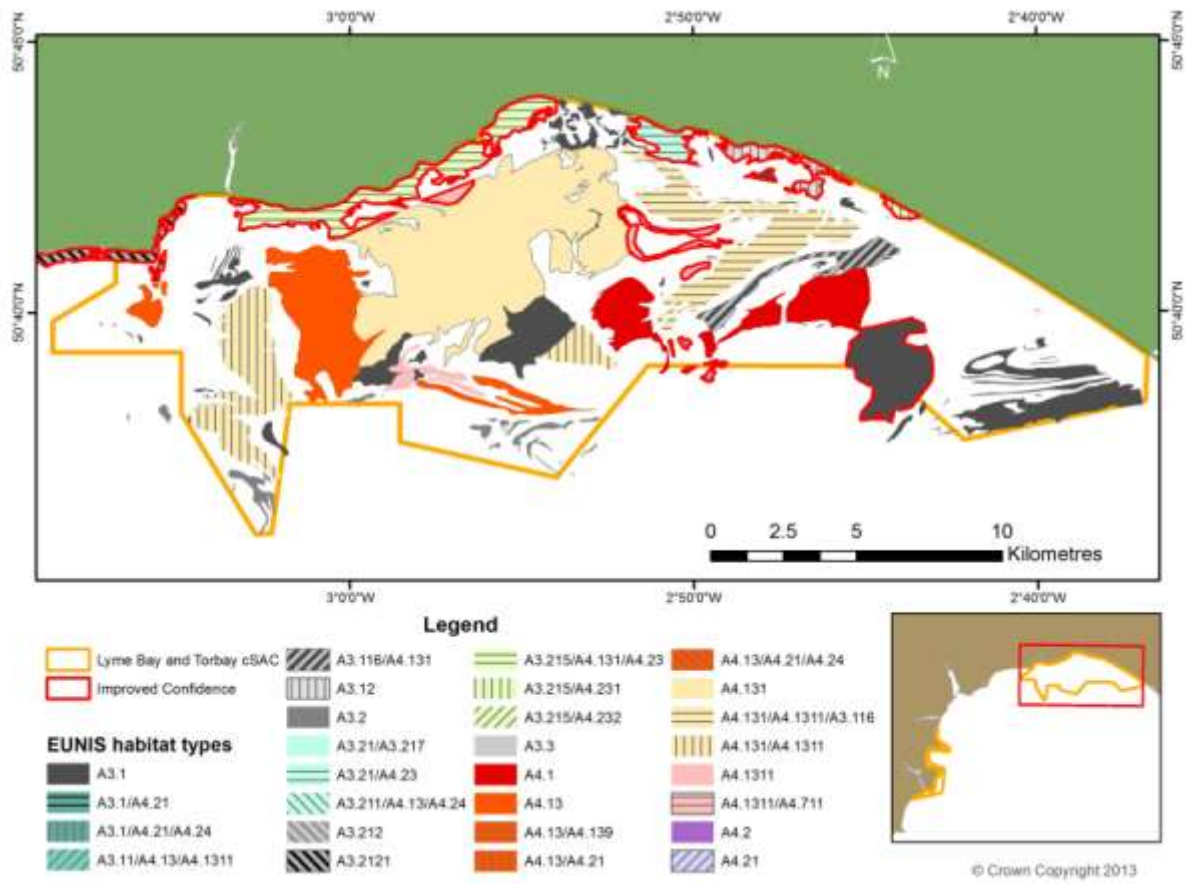

Figure 12 Distribution of EUNIS habitat types within the Lyme Bay region of the cSAC. Reclassified areas only have been updated with EUNIS codes since Vanstaen & Eggleton (2011).

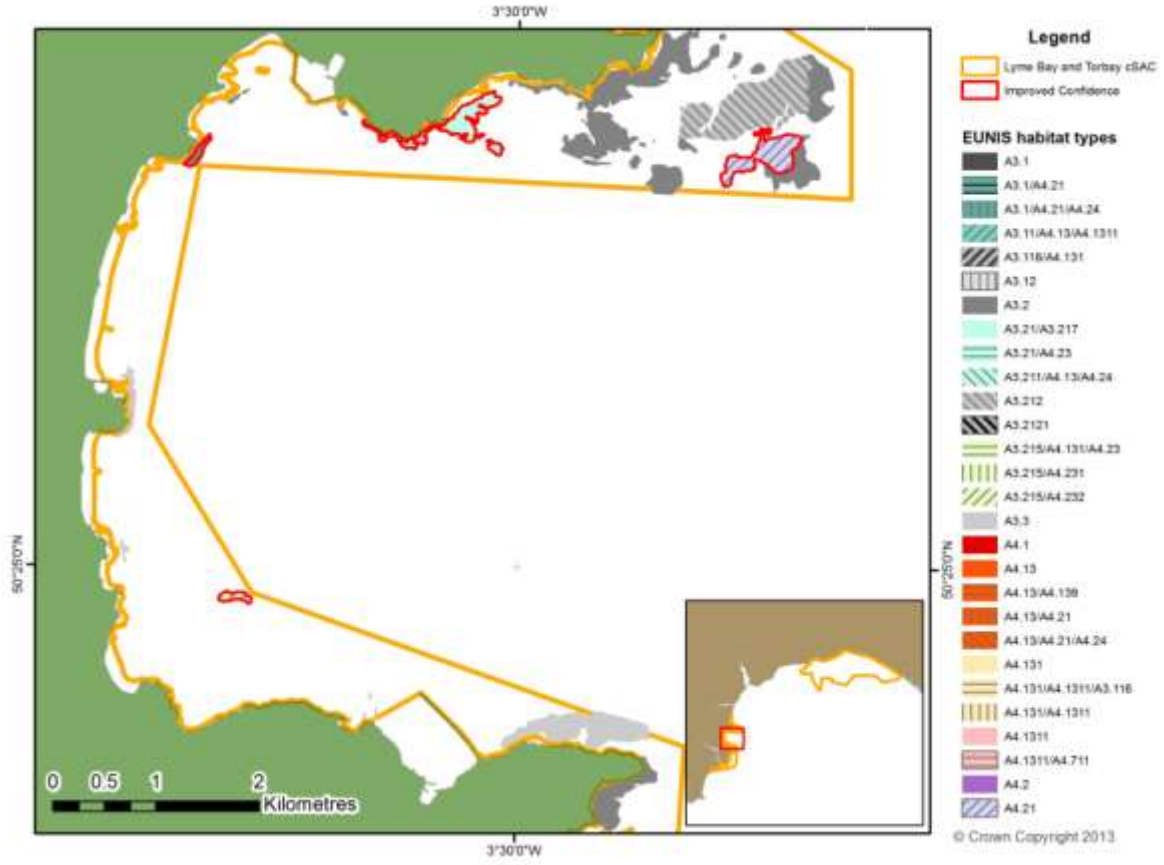

Figure 13 Distribution of EUNIS habitat types in the Torbay region of the cSAC, north of Berry Head. Reclassified areas only have been updated with EUNIS codes since Vanstaen & Eggleton (2011).

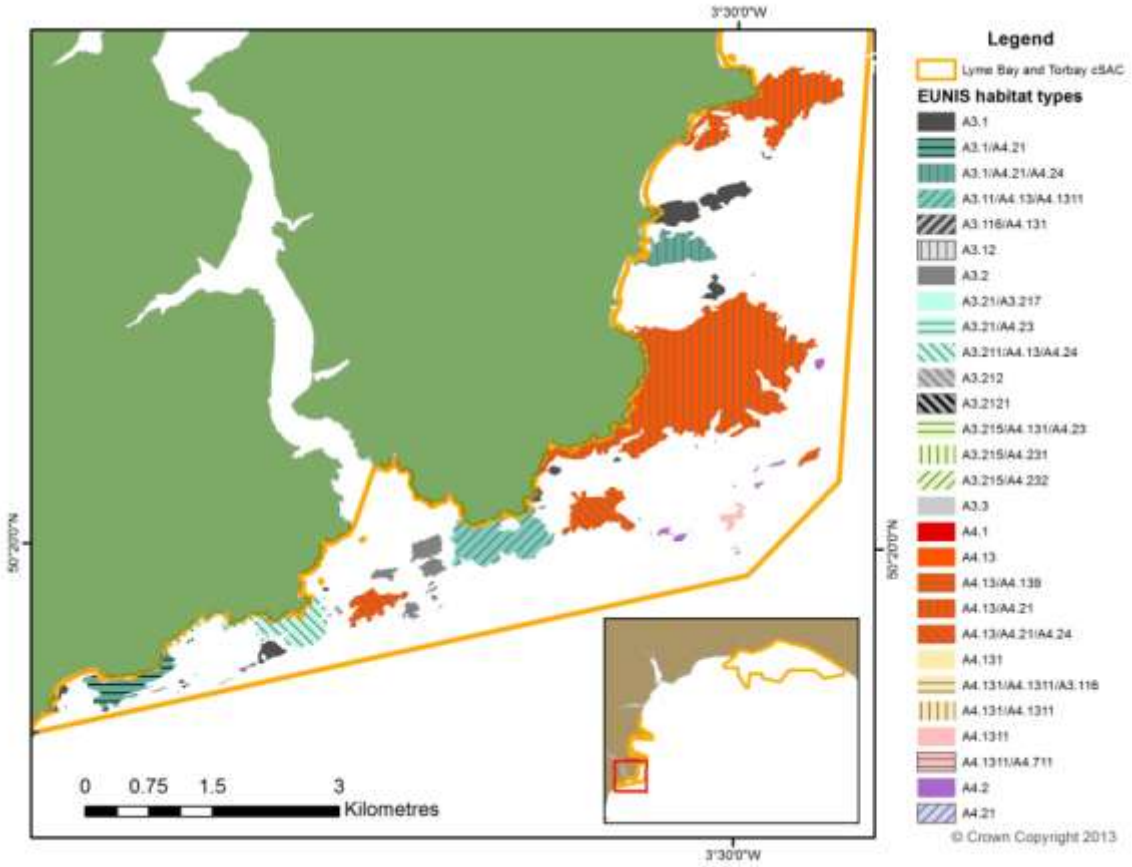

Figure 14 Distribution of EUNIS habitat types in the Torbay region of the cSAC, south of Berry Head.

Table 3: EUNIS code and associate biotope name

5 EUNIS code	6 EUNIS name
A3.1	Atlantic and Mediterranean high energy infralittoral rock
A3.11	Kelp with cushion fauna and/or foliose red seaweeds
A3.116	Foliose red seaweeds on exposed lower infralittoral rock
A3.12	Sediment-affected or disturbed kelp and seaweed communities
A3.2	Atlantic and Mediterranean moderate energy infralittoral rock
A3.21	Kelp and red seaweeds (moderate energy infralittoral rock)
A3.211	*Laminaria digitata* on moderately exposed sublittoral fringe rock
A3.212	[Laminaria hyperborea] on tide-swept, infralittoral rock
A3.2121	*Laminaria hyperborea* forest, foliose red seaweeds and a diverse fauna on tide-swept upper infralittoral rock
A3.215	Dense foliose red seaweeds on silty moderately exposed infralittoral rock
A3.217	*Hiatella arctica* and seaweeds on vertical limestone / chalk
A3.3	Atlantic and Mediterranean low energy infralittoral rock
A4.1	Atlantic and Mediterranean high energy circalittoral rock
A4.13	Mixed faunal turf communities on circalittoral rock
A4.131	Bryozoan turf and erect sponges on tide-swept circalittoral rock
A4.1311	[Eunicella verrucosa] and [Pentapora foliacea] on wave-exposed circalittoral rock

5 EUNIS code	6 EUNIS name
A4.139	Sponges and anemones on vertical circalittoral bedrock
A4.2	Atlantic and Mediterranean moderate energy circalittoral rock
A4.21	Echinoderms and crustose communities on circalittoral rock
A4.23	Communities on soft circalittoral rock
A4.231	Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay
A4.232	*Polydora* sp. tubes on moderately exposed sublittoral soft rock
A4.24	Mussel beds on circalittoral rock
A4.711	Sponges, cup corals and anthozoans on shaded or overhanging circalittoral rock

7 Conclusions

Cefas was contracted by Natural England to review the potential Annex 1 reef assessment within the Lyme Bay and Torbay cSAC, previously interpreted by Vanstaen and Eggleton (2011), in light of new data. As part of this updated report new acoustic data were used to classify areas of rocky reef where previously data were not available. New groundtruthing data were utilised to map the newly identified patches of reef and also improve confidence on the original assessment of Vanstaen and Eggleton (2011).

The output from this assessment is available as a map presenting the extent of potential rocky/stony reef and the confidence that can be associated with each particular polygon (Figures 6-8). As was found previously by Vanstaen and Eggleton (2011) it was possible to systematically identify rocky reef from multibeam echosounder data, whilst neither backscatter nor bathymetric data could confidently predict presence of stony reef. This assessment supports the findings of Vanstaen and Eggleton (2011), that the Lyme Bay region mainly comprises rocky reef habitats with locally associated stony reef habitat.

Additional biological samples increased the number and combination of EUNIS habitat types mapped within both Lyme Bay and Torbay cSAC. Samples were generally widely separated or restricted to discrete areas within reef polygon. The EUNIS habitat types assigned to each polygon are those that were dominant from currently available sample data and further survey effort has the potential, therefore, to reveal more habitats. Further survey effort is needed in some areas, and detailed analysis using all the raw data is recommended for a comprehensive assessment of the habitats found in the region. Many of the polygons were tagged with circalittoral biotopes, although the

regions were largely situated in the infralittoral according to UKSeaMap. Emphasis should therefore be placed on the species, and or habitats, identified rather than the biological zone that the EUNIS code refers to.

8 References

European Commission (2007) Interpretation Manual of European Union Habitats. European Commission, DG Environment, Nature and Biodiversity. 142p

Evans (2013) Lyme Bay underwater video survey report. In press

Irving, R, (2009) The identification of the main characteristics of stony reef habitats under the Habitats Directive, JNCC Report 432, ISSN 0963 8091. 44pp

Vanstaen, K. and Eggleton, J. (2011) Mapping Annex 1 reef habitat present in specific areas within the Lyme Bay Torbay cSAC. Cefas; C5291B. 34pp

Appendix A: Original Data Sources

Source	Description	Physical	Biological
Devon Biodiversity Record Centre (DBRC)	Extract from Marine Recorder database for period **2004 - 2007**. Diver survey observations.	✔	✔
Marin Mätteknik	Samples collected during the **2010** Lyme Bay multibeam echosounder survey.	✔	
University of Plymouth	Video transect within the Lyme Bay region collected as part of Defra funded contract MB0101 in **2010**. Although biological data was collected, this was not available at the time this work was undertaken.	✔	
University of Plymouth	Video transects between Teignmouth and Dartmouth undertaken on behalf of Natural England in **2010**. Although biological data was collected, this was not available at the time this work was undertaken.	✔	
Devon Wildlife Trust	Video monitoring of reef sites in Lyme Bay region in **2003 and 2004**	✔	✔
Devon Wildlife Trust	Video transects within the Lyme Bay and Torbay cSAC area collected during **2006**	✔	✔
English Nature, Environment Agency, Devon Biodiversity Records Centre and Dorset Environmental Records Centre	Inventory of *Zostera* communities along the Devon and Dorset coast in **2004**.		✔
HC cores	Location and description of cores taken within Torbay area in **1975**	✔	

Taken from Vanstaen and Eggleton (2011).

Appendix B: EUNIS Habitat Types

A3.1: Atlantic and Mediterranean high energy infralittoral rock

Rocky habitats in the infralittoral zone subject to exposed to extremely exposed wave action or strong tidal streams. Typically the rock supports a community of kelp [Laminaria hyperborea] with foliose seaweeds and animals, the latter tending to become more prominent in areas of strongest water movement. The depth to which the kelp extends varies according to water clarity, exceptionally (e.g. St Kilda) reaching 45 m. The sublittoral fringe is characterised by dabberlocks [Alaria esculenta].

A3.2: Atlantic and Mediterranean moderate energy infralittoral rock

Predominantly moderately wave-exposed bedrock and boulders, subject to moderately strong to weak tidal streams. On the bedrock and stable boulders there is typically a narrow band of kelp [Laminaria digitata] in the sublittoral fringe which lies above a [Laminaria hyperborea] forest and park. Associated with the kelp are communities of seaweeds, predominantly reds and including a greater variety of more delicate filamentous types than found on more exposed coasts (cf. A3.11).

A3.3: Atlantic and Mediterranean low energy infralittoral rock

Infralittoral rock in wave and tide-sheltered conditions, supporting silty communities with [Laminaria hyperborea] and/or [Laminaria saccharina] (A3.31). Associated seaweeds are typically silt-tolerant and include a high proportion of delicate filamentous types. In turbid-water estuarine areas, the kelp and seaweeds (A3.32) may be replaced by animal-dominated communities (A3.36) whilst stable hard substrata in lagoons support distinctive communities (A3.34).

A4.1: Atlantic and Mediterranean high energy circalittoral rock

Occurs on extremely wave-exposed to exposed circalittoral bedrock and boulders subject to tidal streams ranging from strong to very strong. Typically found in tidal straits and narrows. The high energy levels found within this habitat complex are reflected in the fauna recorded. Sponges such as [Pachymatisma johnstonia], [Halichondria panicea], [Esperiopsis fucorum] and [Myxilla incrustans] may all be recorded. Characteristic of this habitat complex is the dense 'carpet' of the hydroid [Tubularia indivisa]. The barnacle [Balanus crenatus] is recorded in high abundance on the rocky substrata. On rocky outcrops, [Alcyonium digitatum] is often present.

A3.11: **Kelp with cushion fauna and/or foliose red seaweeds**

Rocky habitats in the infralittoral zone subject to exposed to extremely exposed wave action or strong tidal streams. Typically the rock supports a community of kelp Laminaria hyperborea with foliose seaweeds and animals, the latter tending to become more prominent in areas of strongest water movement (A3.113, A3.115 and A3.1152). The depth to which the kelp extends varies according to water clarity, exceptionally (e.g. St Kilda) reaching 45 m. In some areas, there may be a band of dense foliose seaweeds (reds or browns) below the main kelp zone (A3.116). The sublitttoral fringe is characterised by dabberlocks Alaria esculenta (A3.111). In very strong wave action the sublittoral fringe A. esculenta zone extends to 5 to 10 m depth, whilst at Rockall A. esculenta replaces L. hyperborea as the dominant kelp in the infralittoral zone (A3.112). Situation: Very exposed rocky coasts, from low water to depths up to 45m. Temporal variation: Winter storms may remove patches of kelp, and fast-growing annuals may form a temporary forest (A3.122).

A3.116: Foliose red seaweeds on exposed lower infralittoral rock

A dense turf of foliose red seaweeds on exposed or moderately exposed lower infralittoral rock, generally, at or below the lower limit of the kelp. Most of the red seaweeds are common to the kelp zone above, while the faunal component of the biotope is made up of species that are found either in the kelp zone or the animal-dominated upper circalittoral below. Foliose species commonly present include [Dilsea carnosa], [Hypoglossum hypoglossoides, Schottera nicaeensis], [Cryptopleura ramosa] and [Delesseria sanguinea]. The red seaweed species composition varies considerably; at some sites a single species may dominate (particularly [Plocamium cartilagineum]). Small filamentous red seaweeds can be found here as well. These include species such as [Heterosiphonia plumosa, Brongniartella byssoides]. As well as a varied red seaweed component, this biotope may also contain occasional kelp plants and patches of the brown foliose seaweed [Dictyota dichotoma]. Coralline crusts covers the bedrock beneath the seaweeds. The fauna generally comprises low-encrusting forms such as the tubeworms [Pomatoceros] spp., anthozoans including [Alcyonium digitatum], [Urticina felina] and [Caryophyllia smithii]) and occasional sponge crusts such as [Cliona celata, Esperiopsis fucorum], [Scypha ciliata] and [Dysidea fragilis]. More mobile fauna include the gastropod [Calliostoma zizyphinum], the echinoderms [Echinus esculentus] as well as the starfish [Asterias rubens] and [Marthasterias glacialis] and lastly, the crab [Cancer pagurus]. Bryozoan crusts such as [Electra pilosa] can be found fronds on the foliose red seaweeds while scattered hydroids such as [Nemertesia antennina] form colonies on shells, cobbles and available rock. At some sites erect bryozoans [Crisia] spp. and [Bugula] spp. are present. Ascidians such as [Clavelina lepadiformis] and [Clavelina lepadiformis] may also be common. In the north the foliose red seaweed [Callophyllis laciniata] may occur.

Situation: This biotope is generally found at or below the lower limit of the kelp, below either kelp forest or park (LhypR.Ft and LhypR.Pk).

Temporal variation: Many of the red seaweeds, which occur in this biotope, have annual fronds, which tend to die back in the autumn and regenerate again in the spring. This produces a seasonal change in the density of the seaweed cover, which is substantially reduced over winter months and reaches its most dense between April to September.

A3.12: Sediment-affected or disturbed kelp and seaweed communities

Infralittoral rock habitats, subject to disturbance through mobility of the substratum (boulders or cobbles) or abrasion/covering by nearby coarse sediments or suspended particulate matter (sand). The associated communities can be quite variable in character, depending on the particular conditions, which prevail. The typical *Laminaria hyperborea* and red seaweed communities of stable open coast rocky habitats (A3.21) are replaced by those, which include more ephemeral species or those tolerant of sand and gravel abrasion. As such *Laminaria saccharina*, *Saccorhiza polyschides* or *Halidrys siliquosa* may be prominant components of the community.

A3.21: Kelp and red seaweeds (moderate energy infralittoral rock)

Infralittoral rock subject to moderate wave exposure, or moderately strong tidal streams on more sheltered coasts. On bedrock and stable boulders there is typically a narrow band of kelp *Laminaria digitata* in the sublittoral fringe which lies above a *Laminaria hyperborea* forest and park. Associated with the kelp are communities of seaweeds, predominantly reds and including a greater variety of more delicate filamentous types than found on more exposed coasts (A3.11). The faunal component of the understorey is also less prominant than in A3.11.

A3.211: *Laminaria digitata* on moderately exposed sublittoral fringe rock

Exposed to moderately exposed sublittoral fringe rock characterised by the kelp *Laminaria digitata* with coralline crusts covering the rock beneath the kelp canopy. Foliose red seaweeds such as *Palmaria palmata, Membranoptera alata, Chondrus crispus* and *Mastocarpus stellatus* are often present along with the calcareous *Corallina officinalis*. The brown seaweed *Fucus serratus* and the green seaweeds *Cladophora rupestris* and *Ulva lactuca* can be present as well. The sponge *Halichondria panicea* can be found among the kelp holdfasts or underneath overhangs. Also present on the rock are the tube-building polychaete *Pomatoceros triqueter*, the gastropods *Patella vulgata* and *Gibbula cineraria*. The bryozoan *Electra pilosa* can form colonies on especially *C. crispus, M. stellatus* and *F. serratus* while the hydroid *Dynanema pumila* are more common on the kelp. Three

variants of this biotope are described: *L. digitata* forest on rocky shores (unit A3.2111). *L. digitata* on boulder shores (unit A3.2112) and soft rock supporting *L. digitata*, such as the chalk found in south-east England (unit A3.2113). For *L. digitata* in sheltered, tide-swept conditions see unit A3.221.

A3.212: **[Laminaria hyperborea] on tide-swept, infralittoral rock**

Wave exposed to moderately wave exposed, tide-swept bedrock and boulders with [Laminaria hyperborea], characterised by a rich under-storey and stipe flora of foliose seaweeds including the brown seaweed [Dictyota dichotoma]. The kelp stipes support epiphytes such as [Cryptopleura ramosa] and [Phycodrys rubens]. At some sites, instead of being covered by red seaweeds, the kelp stipes are heavily encrusted by the ascidian [Botryllus schlosseri]. Epilithic seaweeds [Delesseria sanguinea], [Plocamium cartilagineum] [Heterosiphonia plumosa, Hypoglossum hypoglossoides], [Callophyllis laciniata], [Kallymenia reniformis], [Brongniartella byssoides] and crustose seaweeds commonly occur beneath the kelp. The kelp fronds are often covered with growth of the hydroid [Obelia geniculata] or the bryozoan [Membranipora membranacea]. On the rock surface, a rich fauna comprising the bryozoan [Electra pilosa], the sponge [Pachymatisma johnstonia], anthozoans such as [Alcyonium digitatum], [Sagartia elegans] and [Urticina felina], colonial ascidians such as [Clavelina lepadiformis], the calcareous tubeworm [Pomatoceros triqueter] and the barnacle [Balanus crenatus] occur. More mobile species include the gastropod [Calliostoma zizyphinum], the crab [Cancer pagurus] and the echinoderms [Asterias rubens] and [Echinus esculentus]. Two variants have been described: Tide-swept kelp forest (LhypT.Ft) and tide-swept kelp park (LhypT.Pk).

Situation: This biotope occurs below [Alaria esculenta] (Ala) at exposed sites or [L. digitata] (Ldig.Ldig) at moderately exposed locations. With increasing depth the kelp density diminishes to become tide-swept kelp park (LhypT.Pk).

A3.2121: *Laminaria hyperborea* forest, foliose red seaweeds and a diverse fauna on tide-swept upper infralittoral rock

Exposed to moderately exposed, tide-swept bedrock and boulders, with dense *Laminaria hyperborea* forest, characterised by a rich under-storey and stipe flora of foliose seaweeds. The kelp stipes support epiphytes such as *Callophyllis laciniata, Corallina officinalis, Cryptopleura ramosa, Membranoptera alata*, and *Phycodrys rubens*. At some sites, instead of being covered by red seaweeds, the kelp stipes are heavily encrusted by the ascidians *Botryllus schlosseri* and in the south-west *Distomus variolosus*. Epilithic seaweeds (*Dilsea carnosa*, *Hypoglossum hypoglossoides*, *Delesseria sanguinea, Plocamium cartilagineum*, *Brongniartella byssoides*, and *Dictyota dichotoma*) and crustose seaweeds commonly occur beneath the kelp. The kelp fronds are often covered with

growth of the hydroid *Obelia geniculata* or the bryozoan *Membranipora membranacea*. Although these species are also found in most kelp forests, in this biotope they are particularly dense. On the rock surface, a rich fauna comprising of the sponges *Pachymatisma johnstonia*, *Halichondria panicea*, *Esperiopsis fucorum* and *Dysidea fragilis*, anthozoans such as *Urticina felina*, *Alcyonium digitatum* and *Caryophilia smithii*, the barnacle *Balanus crenatus*, colonial ascidians such as *Clavelina lepadiformis*, and the gastropods *Calliostoma zizyphinum* and *Gibbula cineraria*, occur. Also found on the rock is the echinoderm *Asterias rubens* and the crab *Cancer pagurus*. Situation: This biotope occurs below *Alaria esculenta* (unit A3.111) at exposed sites or *L. digitata* (unit A3.2111) at moderately exposed locations. With increasing depth the kelp density diminishes to become tide-swept kelp park (unit A3.2122).

A3.215: Dense foliose red seaweeds on silty moderately exposed infralittoral rock

Upward-facing surfaces of shallow, infralittoral bedrock and boulders in areas of turbid water dominated by dense red seaweeds, with the notable absence of kelp. The stable rock, which can be cobbles or boulders but is more typically bedrock, is usually silted. Individual species of foliose red seaweeds such as *Plocamium cartilagineum* or *Calliblepharis ciliata* often dominate. Other red seaweeds likely to be present include *Phyllophora crispa*, *Rhodymenia holmesii*, *Halurus flosculosus*, *Cryptopleura ramosa*, *Hypoglossum hypoglossoides*, *Heterosiphonia plumosa* and coralline crusts. The brown seaweed *Dictyota dichotoma* is sometimes present, although never abundant. This biotope does not generally occur below kelp park but rather occurs on shallow, silted rock on which kelp would normally grow in less turbid conditions. The fauna can be variable but is generally typified by the presence of silt-tolerant animals such as encrusting sponges, particularly *Dysidea fragilis* and *Halichondria panicea*, the hydroid *Tubularia indivisa*, bryozoan crusts and scattered *Sabellaria spinulosa* and *Balanus crenatus*. In the summer months the seaweeds can become heavily encrusted with the bryozoan *Electra pilosa* and the ascidian *Molgula manhattensis* which can also form dense mats on the rock. The polychaete *Lanice conchilega* can be present, where sandy and muddy patches occur. Where this biotope occurs on chalk bedrock, such as off the Sussex coast, the piddock *Pholas dactylus* is often found bored into the rock. This biotope is recorded from the English Channel, off Kent, Sussex and the Isle of Wight. Please notice that individual sites of this biotope can vary significantly in the species composition. Situation: This biotope generally occurs on discrete bedrock outcrops surrounded by areas of mixed sediment or mobile sand. Off Sussex, it occurs on the horizontal chalk bedrock forming the tops of cliffs (2-3m in height). Temporal variation: The seaweeds die back in late autumn and summer leaving, silted, coralline-encrusted rock with a sparse

fauna of sponges, *S. spinulosa* and occasional hydroids and bryozoans. The bryozoan *Amathia lendigera* can also become abundant amongst the seaweeds during the summer months.

A3.217: *Hiatella arctica* and seaweeds on vertical limestone / chalk

This biotope is found in the infralittoral zone on moderately exposed vertical limestone/chalk surfaces in weak tidal streams, and has been recorded most frequently between 0-10m. This biotope is characterised by abundant *Hiatella arctica* and a rich sponge community including *Cliona celata*, *Dysidea fragilis* and *Pachymatisma johnstonia*. Other species that may be frequent in this biotope are the crab *Necora puber*, the sea squirt *Clavelina lepadiformis*, and the top shell *Calliostoma zizyphinum*, although these species are found in other vertical rock biotopes, however in lesser abundance. Situation: Shallow rocky coasts with vertical limestone faces.

A4.13: Mixed faunal turf communities on circalittoral rock

This habitat type occurs on wave-exposed circalittoral bedrock and boulders, subject to tidal streams ranging from strong to moderately strong. This complex is characterised by its diverse range of hydroids ([Halecium halecinum], [Nemertesia antennina] and [Nemertesia ramosa]), bryozoans ([Alcyonidium diaphanum], [Flustra foliacea], [Bugula flabellata] and [Bugula plumosa]) and sponges ([Scypha ciliata], [Pachymatisma johnstonia], [Cliona celeta], [Raspailia ramosa], [Esperiopsis fucorum], [Hemimycale columella] and [Dysidea fragilis]) forming an often dense, mixed faunal turf. Other species found within this complex are [Alcyonium digitatum], [Urticina felina], [Sagartia elegans], [Actinothoe sphyrodeta], [Caryophyllia smithii], [Pomatoceros triqueter], [Balanus crenatus], [Cancer pagurus], [Necora puber], [Asterias rubens], [Echinus esculentus] and [Clavelina lepadiformis].

A4.131: Bryozoan turf and erect sponges on tide-swept circalittoral rock

This biotope is typically found on wave-exposed circalittoral bedrock or boulders subject to tidal streams ranging from moderately strong to strong. It often has a thin layer of silt covering the seabed, and is characterised by a bryozoan/hydroid turf with erect sponges. Typical bryozoans to be found include crisiids, [Alcyonidium diaphanum], [Flustra foliacea], [Pentapora foliacea], [Bugula plumosa] and [Bugula flabellata], while typical hydroids include [Nemertesia antennina], [Nemertesia ramosa] and [Halecium halecinum]. The soft coral [Alcyonium digitatum] is frequently recorded on the tops of boulders and rocky outcrops. Characteristic erect sponges include [Raspailia ramosa], [Stelligera stuposa] and [Stelligera rigida]; other sponges present include [Cliona celata], [Dysidea fragilis], [Pachymatisma johnstonia], [Polymastia boletiformis], [Hemimycale columella],

[Esperiopsis fucorum], [Polymastia mamillaris] and [Tethya aurantium]. Other species present include [Caryophylia smithii], [Actinothoe sphyrodeta], [Corynactis viridis], [Urticina felina], [Balanus crenatus], [Asterias rubens], [Marthasterias glacialis], [Henricia oculata], [Echinus esculentus], [Clavelina lepadiformis], [Calliostoma zizyphinum] and [Necora puber]. Three variants of this biotope have been described, but all are characterised by a bryozoan turf with erect sponges. ByErSp.Eun is found primarily on circalittoral bedrock and is dominated by the seafan [Eunicella verrucosa]. ByErSp.DysAct is found under slightly stronger tide-swept conditions, and is characterised particularly by the sponge [D. fragilis] and the anemone [A. sphyrodeta]. Finally ByErSp.Sag is characterised by the anemone [Sagartia elegans].

A4.1311: [Eunicella verrucosa] and [Pentapora foliacea] on wave-exposed circalittoral rock

This variant typically occurs on wave-exposed, steep, circalittoral bedrock, boulder slopes and outcrops, subject to varying tidal streams. This silty variant contains a diverse faunal community, dominated by the seafan [Eunicella verrucosa], the bryozoan [Pentapora foliacea] and the cup coral [Caryophyllia smithii]. There are frequently numerous [Alcyonium digitatum], and these may become locally abundant under more tide-swept conditions. [Alcyonium glomeratum] may also be present. A diverse sponge community is usually present, including numerous erect sponges; species present include [Cliona celata], [Raspailia ramosa], [Raspailia hispida], [Axinella dissimilis], [Stelligera stuposa], [Dysidea fragilis] and [Polymastia boletiformis]. [Homaxinella subdola] may be present in the south west. A hydroid/bryozoan turf may develop in the understorey of this rich sponge assemblage, with species such as [Nemertesia antennina], [Nemertesia ramosa], crisiids, [Alcyonidium diaphanum] and [Bugula plumosa]. The sea cucumber [Holothuria forskali] may be locally abundant, feeding on the silty deposits on the rock surface. Other echinoderms encountered include the starfish [Marthasterias glacialis] and the urchin [Echinus esculentus]. Other fauna includes aggregations of colonial ascidians [Clavelina lepadiformis] and [Stolonica socialis]. Anemones such as [Actinothoe sphyrodeta] and [Parazoanthus axinellae] may be seen dotted across the rock surface. This biotope is present in south west England and Wales.

Situation: This biotope is commonly found on rocky outcrops, surrounded by coarse sediment. This may be in the form of shelly gravel or muddy gravel, supporting [Urticina felina], [Cerianthus lloydi] and [Neopentadactyla mixta]. Above ByErSp.Eun, dense kelp forest containing [Saccorhiza polyschides] is usually found.

A4.139: Sponges and anemones on vertical circalittoral bedrock

This biotope is found on exposed to moderately wave exposed , vertical and overhanging, circalittoral bedrock, subject to strong through to weak tidal streams. This biotope is characterised by a mixed faunal turf of hydroids (*Nemertesis antennina*, *Tubularia indivisa* and *Halecium halecium*) and bryozoans (*Alcyonidium diaphanum* and crisiid turf). There is frequently a diverse range of sponges recorded, including *Cliona celata*, *Pachymatisma johnstonia*, *Dysidea fragilis* and *Hemimycale columella*. There may be dense aggregation of dead man's fingers *Alcyonium digitatum* along with clumps of the cup coral *Caryophyllia smithii*, and the anthozoans *Corynactis viridis*, *Actinothoe sphyrodeta*, *Sagartia elegans* and *Metridium senile*. Other species present include the echinoderms *Echinus esculentus*, *Asterias rubens*, *Marthasterias glacialis*, *Henricia oculata*, *Holothuria forskali* and *Antedon bifida*, clumps of the lightbulb tunicate *Clavelina lepadiformis* and the top shell *Calliostoma zizyphinum*. Three regional variations of this biotope have been recorded. The first variant is characterised by a *Bugula* turf along with the pink sea fan *Eunicella verrucosa*, and has been recorded from around southwest England and Wales. The second variant, characterised by a dense 'carpet' of *Corynactis viridis* and *Metridium senile* has been recorded predominantly from the west coast of Ireland. The final variant is characterised by a very diverse, dense faunal turf of hydroids, bryozoans and ascidians and has been recorded from the coasts around Northern Ireland.

A4.2: Atlantic and Mediterranean moderate energy circalittoral rock

Mainly occurs on exposed to moderately wave-exposed circalittoral bedrock and boulders, subject to moderately strong and weak tidal streams. This habitat type contains a broad range of biological subtypes, from echinoderms and crustose communities (A4.21) to Sabellaria reefs (A4.22) and circalittoral mussel beds (A4.24).

A4.21: Echinoderms and crustose communities on circalittoral rock

This habitat type occurs on wave-exposed, moderately strong to weakly tide-swept, circalittoral bedrock and boulders. Echinoderms, faunal (*Parasmittina trispinosa*) and algal crusts (red encrusting algae) dominate this biotope, giving a sparse appearance. Typical echinoderms present are the starfish *Asterias rubens*, the brittlestar *Ophiothrix fragilis* and the sea urchin *Echinus esculentus*. There may be isolated clumps of the hydroids *Nemertesia antennina* and *Abietinaria abietina*, *Alcyonium digitatum*, the anemone *Urticina felina* and the cup coral *Caryophyllia smithii*. Other species present may include the polychaete *Pomatoceros triqueter* and the top shell *Calliostoma zizphinum.*

A4.23: Communities on soft circalittoral rock

This habitat type occurs on moderately wave-exposed, circalittoral soft bedrock subject to moderately strong tidal streams. As this complex is found in highly turbid water conditions, the circalittoral zone may begin at the low water mark, due to poor light penetration. This complex is dominated by the piddock *Pholas dactylus*. Other species typical of this complex include the polychaete *Polydora* and *Bispira volutacornis*, the sponges *Cliona celata* and *Suberites ficus*, the bryozoan *Flustra foliacea*, *Alcyonium digitatum*, the starfish *Asterias rubens*, the mussel *Mytilus edulis* and the crab *Necora puber* and *Cancer pagurus*. Foliose red algae may also be present. Please note: in areas subject to very high turbidity, biotopes within this habitat type may occur in the infralittoral and even the littoral zone.

A4.231: Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay

This biotope occurs on circalittoral soft rock, such as soft chalk or clay, most often in moderately exposed tide-swept conditions. As soft chalk and firm clay are often too soft for sessile filter-feeding animals to attach and thrive in large numbers, an extremely impoverished epifauna results on upward-facing surfaces, although vertical faces may be somewhat richer. The rock is sufficiently soft to be bored by bivalves. Species vary with location, but *Pholas dactylus* is the most widespread borer and may be abundant. Other species present may include the sponges *Dysidea fragilis* and *Suberites carnosus* and the polychaete *Bispira volutacornis*. Foliose red algae may be present on the harder, more stable areas of rock. Mobile fauna often include the crabs *Necora puber* and *Cancer pagurus*. Situation: Subtidal chalk reefs or clay outcrops, mostly known from south-east England.

A4.232: *Polydora* sp. tubes on moderately exposed sublittoral soft rock

Large patches of chalk and soft limestone are occasionally covered entirely by *Polydora* sp. tubes to the exclusion of almost all other species. This tends to occur in highly turbid conditions and spans the infralittoral and circalittoral in limestone areas such as the Great and Little Ormes (North Wales) and Gower (South Wales). It is even present on the lower shore in the Severn estuary. The boring form of the sponge *Cliona celata* often riddles the surface layer of the stone. Other sponges present include *Halichondria panicea*, *Haliclona oculata* and *Hymeniacidon perleve*. *Polydora* sp. also frequently occurs in small patches as part of other biotopes (e.g. unit A4.134). Other species present include *Alcyonium digitatum*, *Sarcodictyon roseum*, the hydroids *Halecium halecinum*, *Abietinaria abietina* and *Tubularia indivisa*, the ascidians *Clavelina lepadiformis*, *Botryllus schlosseri* and *Morchellium argus*, the anemones *Urticina felina*, *Metridium senile* and *Sagartia elegans* and the bryozoans *Flustra foliacea* and a crisiid turf. The starfish *Asterias rubens*, the crabs *Inachus phalangium* and *Carcinus maenas*, the polychaete *Pomatoceros triqueter*, the barnacle *Balanus*

crenatus and the brittlestar *Ophiothrix fragilis* may also be seen. Please note: this biotope may extend into the infralittoral and littoral zone in areas where water turbidity is sufficiently high.

A4.24: Mussel beds on circalittoral rock

This habitat type occurs on moderately wave-exposed upper circalittoral bedrock subject to strong or moderately strong tidal streams. This complex is characterised by dense aggregations of the mussels *Mytilus edulis* or *Musculus discors* carpeting the underlying substrata. Sponges that may be recorded in this complex are *Scypha ciliata*, *Tethya aurantium*, *Pachymatisma johnstonia*, *Dysidea fragilis* and *Cliona celata*. A sparse hydroid/bryozoan turf composed primarily of *Nemertesia antennina*, *Alcyonidium diaphanum* and *Flustra foliacea* is often recorded. Anemones present are *Urticina felina* and *Sagartia elegans*. Other species recorded are the crabs *Cancer pagurus*, *Carcinus maenas* and *Necora puber*, the starfish *Crossaster papposus* and *Asterias rubens*, and *Alcyonium digitatum* and in this upper circalittoral complex, algae species such as *Dictyota dichotoma*, *Cryptopleura ramosa* and *Plocamium cartilagineum*.

A4.711: Sponges, cup corals and anthozoans on shaded or overhanging circalittoral rock

This biotope occurs on shaded and overhanging rock, such as on cave walls and ceilings although there are very few records of caves in conditions not subject to wave surge (i.e. deeper circalittoral habitats) and almost all are different in species composition. There are also a few examples of similar communities on very deep (70-100 m+) upward-facing rock (in Loch Hourn) and more may be found through the use of ROVs. These often species-rich habitats are almost invariably adjacent to well-mixed turbulent water. Characteristic species include the sponges *Stryphnus ponderosus*, *Dercitus bucklandi*, *Chelonaplysilla noevus*, *Pseudosuberites* sp. and *Spongosorites* sp., the anemones *Parazoanthus* spp., the cup corals *Leptopsammia pruvoti*, *Hoplangia durotrix*, *Caryophyllia inornatus* and the soft coral *Parerythropodium coralloides*. *Thymosia guernei* is sometimes present. This biotope is likely to need further splitting with further data and analysis. Situation: Subtidal rocky coasts.

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