Natural England Research Report NERR080

Natural England marine chalk characterisation project

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Authors: Charlotte Moffat, Heidi Richardson, Georgina Roberts

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Project manager

Charlotte Moffat
Marine Lead Adviser
Norfolk Coast and Marine Team
Natural England
Area 5A, Nobel House, 17 Smith Square
London SW1P 3JR
Charlotte.moffat@naturalengland.org.uk

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Executive Summary

Chalk is a sedimentary rock largely composed of the skeletons of calcareous nanoplankton, deposited between approximately 100 and 65 million years ago during the Late Cretaceous period. Chalk can be heterogenous, with local conditions and the proportion of clay present at time of deposition responsible for the diversity. The softness and friable nature of chalk results in the presence of unique species and communities not present on harder rocks. Chalk is a finite resource, and as such, any damage to the physical structure of chalk is permanent.

Marine chalk specifically is a scarce resource worldwide, with England holding a globally significant proportion of marine chalk habitats. This gives England an internationally significant responsibility to conserve its marine chalk habitats. Marine chalk is protected within various pieces of legislation in England, which has resulted in to the designation of a number of Marine Protected Areas (MPAs) with marine chalk as a feature.

Despite its importance, little is known about the diversity of marine chalk habitats, and whether all the chalk with the MPA network is comparable. In order to ensure the MPA network provides robust protection of chalk habitats, the diversity of the marine chalk habitats must be recognised and maintained. Natural England (NE) therefore completed a review of the chalk within the English inshore MPA network to understand the importance of each MPA designated for chalk in protecting the full range of diverse habitats and associated communities that marine chalk supports. A workshop was organised for NE staff with a breadth of relevant specialist knowledge. The aim of the workshop was to agree a set of criteria for characterising marine chalk, in order to be able to effectively describe the diversity of marine chalk habitats within and between sites. The differences between sites were considered, and the factors which influence these differences explored. Workshop participants agreed to a final list of seven criteria for characterising marine chalk habitats in England; depth and zonation, lithological composition, hydrodynamic regime, structural complexity extent and distribution, geographic context and community composition. This final list is in no particular order and should not be considered as a hierarchy.

The diversity of marine chalk in the English inshore MPA network can be clearly demonstrated using the chalk characterisation criteria. There is a wide range in diversity for almost all of the criteria; chalk from two different sites are not necessarily comparable, with each site adding something unique to the network. There can also be a significant range in chalk characteristics within a site. Being able to characterise the chalk in MPAs is important for understanding the diversity of chalk habitats which the MPA network is protecting. This characterisation demonstrates that the marine chalk habitats in each MPA are important for different reasons, and MPA management should seek to maintain this diversity. Anthropogenic impacts could lead to changes in marine chalk which cause a shift from one marine chalk habitat to another, while ostensibly maintaining the feature which the site is designated for. Without an understanding of how comparable sites are, or how scarce each characteristic of chalk is, then the wider significance of such changes may not be fully appreciated.

If the physical structure of chalk is altered, it will not recover, and potentially rare elements of the habitats may be completely lost from the marine chalk network. The scarcity of marine chalk habitats combined with the relatively high potential for permanent loss of habitats warrants precautionary management across the marine chalk network to prevent permanent losses. This report can be used alongside Natural England's statutory conservation advice by anyone wishing to undertake potentially damaging activates in sites designated for chalk in order to consider the full impacts and potential irreversibility of the activity, the level of precaution appropriate in the assessment and any targeted mitigation measures. The application of the characterisation criteria is currently limited by a paucity of data, in particular for some of the more recently designated sites and for particular criteria. Any conclusions drawn based on these datasets should be informed by an awareness of the resolution and confidence of the background data. Care needs to be taken to ensure that those areas that have not been surveyed, are not assumed to have no ecological value.

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1. Introduction

1.1 Chalk is a sedimentary rock that was deposited in the Late Cretaceous period. Marine chalk specifically is a scarce resource worldwide and across Europe, with c.57% of the European resource being located on the coast of Britain (JNCC 2011; Tittley 2009). Despite its scarcity, marine chalk habitats are diverse and ecologically significant, it is therefore critical that they are protected. To safeguard the marine chalk resource located in England a number of Marine Protected Areas (MPAs) have been designated with marine chalk as a feature. MPAs are clearly defined areas that are managed, through legal or other effective means, for the long term conservation of their features (JNCC 2015). The UK Government is committed to creating an ecologically coherent network of MPAs in order to meet its commitments made under the Convention on Biological Diversity and the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR convention) (JNCC 2018). The aim is that this network will work together to provide greater benefits for the environment than a single site could on its own (JNCC 2018). MPAs in the UK include those designated as Special Areas of Conservation (SACs), Special Protection Areas (SPAs), Marine Conservation Zones (MCZs), Ramsars and Sites of Special Scientific Interest (SSSI), further information on these designations and the legislation underpinning them is located is Section 3.

1.2 The MPA network being designated around England is almost complete and marine chalk habitats have been included within it. However, in order to ensure the MPA network provides robust protection for the different types of chalk habitats, the diversity of the chalk habitats must be recognised and maintained. It is therefore timely for Natural England (NE) to review the representation of chalk within the English inshore MPA network to understand the unique role that each MPA designated for chalk plays in protecting the full range of diverse habitats and associated communities that marine chalk supports.

1.3 To do this, this report will introduce marine chalk and provide further information on its geology, distribution and associated ecology as part of a literature review illustrating the importance of marine chalk habitats in the English inshore MPA network and across Europe. It will then go on to detail the legal protection given to marine chalk, list the various sites that have marine chalk as a designated feature and describe the results of the ‘Chalk characterisation workshop’ held for NE staff. This workshop was organised in order to increase our understanding of the variety of marine chalk currently protected in the English inshore MPA network. Site leads, with specific knowledge of marine MPAs that have chalk as a protected feature, as well as ecology and geology specialists, were invited to attend. In addition to increasing our understanding of the variety of marine chalk around England, the workshop also aimed to identify the key criteria most pertinent to characterising marine chalk habitats. The final list of criteria have been used in this report to describe in detail the habitats being protected by the individual sites in the MPA network. By characterising the marine chalk network using a consistent set of criteria, the aim is that the diversity and distribution of marine chalk will be better understood and thus maintained.

1.4 The objectives of this report are detailed below:

a) Finalise a list of criteria that can be used to describe the various types of marine chalk located around England.
b) Use the criteria to better understand the variety of marine chalk currently protected in designated sites, noting that the criteria are not hierarchical, but provide a structure to compare the differences between habitats rather than rank different habitat types.

c) Compliment Natural England's statutory conservation advice and site specific knowledge through providing context with respect to the marine chalk resource that England has compared to the worldwide distribution.

1.5 By understanding the diversity of chalk habitats and their rarity, NE will be better informed when advising on activities that are likely to damage chalk habitats particularly as this feature is rare and once lost is irreplaceable.

2. Literature review

Chalk geology

General composition

2.1 Chalk is a sedimentary rock made up of extremely pure and fine-grained limestone (Hiscock and others 1996) that is largely composed of the skeletons of calcareous nanoplankton, mainly comprising the remains of coccolithophores (UCL, 2018). Coarser components form a relatively small proportion of the chalk and generally consist of foraminifera, ostracods and finely broken shell derived from the destruction of the skeletons of larger organisms.

2.2 Traditionally, three main types of chalk (Upper, Middle and Lower) were recognised. The chalk is now divided into several different formations (Mortimore and others 2001) that differ in hardness and flint content (a siliceous rock deposited along bedding planes or vertical joints in chalk strata). As a generalisation, the Upper Chalk is the most pure and has the most flint bands, whereas the Lower Chalk has no flints, but contains a significant quantity of clay. The chalk also varies laterally, so that chalks forming Flamborough Head in the Northern Chalk Province are substantially harder than those of Kent and Sussex (Southern Chalk Province).

Age, origin and distribution

2.3 In Britain the Chalk Group was deposited between approximately 100 and 65 million years ago during the Late Cretaceous period. At this time world-wide sea-levels may have been up to 300m above present day sea-levels (Skelton and others. 2003), with approximately half the area that is currently land being under water, including much of north-western Europe. During the Cretaceous, atmospheric carbon dioxide levels were extremely high and average world temperatures are estimated to have been 15 degrees above the current means, making the Late Cretaceous a greenhouse world likely lacking any permanent ice at the poles.

2.4 During this time, the diversification of calcareous nanoplankton capable of photosynthesising in deeper water provided a major pathway for the removal and storage of carbon. Carbon was used by nanoplankton for their shells and they thus became carbonate reservoirs as their shells are the main component of chalk (Skelton and others 2003).

2.5 During the Tertiary Era, the seabed was uplifted, exposing the chalk to erosion. Tectonic activity driven by the closure of the Tethys Ocean and the opening of the Atlantic resulted in the folding and tilting of strata in northern Europe (King, 2006), although over much of southeast England, the chalk is almost horizontal or gently folded. The exception to this is chalk on the Isle of Wight and in Dorset, where chalk is vertically bedded (Fowler & Tittley 1993). Due to its method of formation, chalk is a finite and irreparable resource. As such, any damage to the physical structure of chalk bedrock or chalk reef is permanent.

Heterogeneous chalk

2.6 One of the main variables in the composition of chalk is the proportion of clay that may be present. As stated above, chalk ranges from very pure white chalks to chalk marls that have a very high clay content. The proportion of clay present in chalk can influence its hydrological and mechanical properties.

2.7 Despite its somewhat monotonous appearance, chalk is quite a heterogeneous material (Mortimore and others 2001), reflecting its deposition in a variety of different marine environments. Chalk may consist of:

a) Very soft or very hard limestones.
b) Chalk containing reworked chalk pebbles.
c) Chalk containing phosphatic nodules.
d) Flint-free chalk, or
e) Chalk with flints.

2.8 The effects of wave and current erosion on this range of chalk lithologies may result in a variety of different seafloor substrates, the diversity of which, may be further enhanced by the range of tectonic structures present at a particular site.

2.9 The lithology of the chalk was determined by the variety of conditions under which it was deposited. Chalk deposition was affected by:

a) water current speed at the time of deposition, which in turn had a strong influence on the kinds of structures that were generated, as well as on porosity;
b) sediment deposition rates whilst the chalk was being formed;
c) lithification of seafloors - the process of compaction and cementation of seafloor sediments into rocks.
d) erosion of seafloors providing sediment to be deposited elsewhere; and
e) sorting and re-deposition of partially lithified chalk. This is the consequence of the erosion of chalk seafloors, where the products of erosion (i.e. pebbles of chalk) may be transported and deposited at another location.

2.10 Additionally, during chalk formation particular conditions facilitated the precipitation of flint (silicon dioxide) and phosphate from seawater, which in some cases, replaced the surrounding sediment. The presence and abundance of flints and phosphate may be characteristic of some chalks (Figure 1). Climate change at the scale of astronomical cycles also influenced the depositional environment, leading to a regular sequence of chalks interbedded with more clay-rich chalky marls (Skelton and others 2003).

2.11 The lithological properties of chalk can influence the topography of the seafloor and through this, indirectly determine habitat through the provision of aspect, shelter and surfaces for colonisation at a variety of scales of roughness. Variations in the hardness of the chalk may determine the distribution of boring organisms.

2.12 Chalk, particularly in southern England, has been subject to tectonic activity and is now folded so that its bedding ranges from horizontal to vertical (Figure 2).

2.13 The orientation of the bedding of the chalk has a strong influence on the topography of the sea floor. The maps provided as part of the 'Site specific documents' in Appendix IV show the orientation of the bedding of the chalk for the different sites.

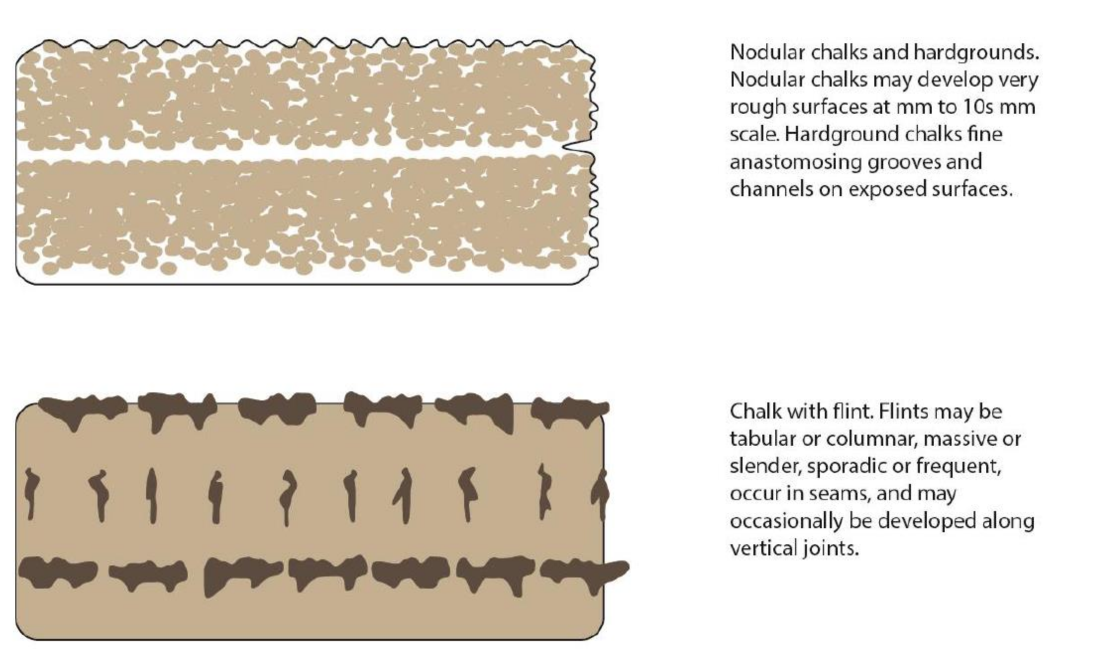

Figure 1. Illustration of nodular chalks and chalks with flints.

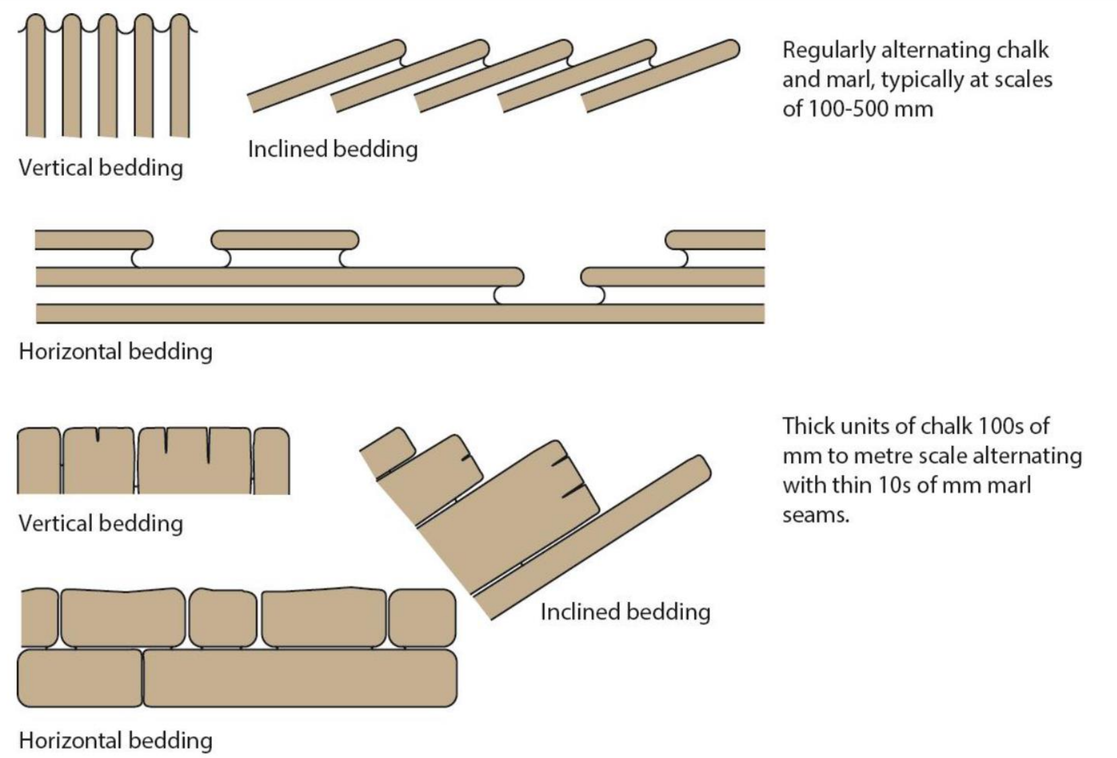

Figure 2. Illustrations of thin vertical, inclined and horizontally bedded chalk; thick vertical, inclined and horizontally bedded chalk.

Chalk distribution and scarcity

2.14 Littoral and sublittoral chalk are recognised as important habitats in need of protection through both national and international legislation, for example Natural Environment and Rural Communities (NERC) Act and the OSPAR convention. Internationally, chalk strata is present in England, Northern Ireland, Belgium, France, Denmark, Germany, Poland, Russia, the United States, Australia and the Middle East. However, in some of these locations, the chalk is not exposed on land or on the coast (Smith 1980). Within Europe, where chalk is exposed on the coast, this is generally in relatively small areas in comparison to the larger areas of inland chalk (Fowler & Tittley, 1993).

2.15 As chalk habitats are scarce, their conservation is critical. Only 0.6% of the British coastline is formed of chalk, however this is a majority (c.57%) of the total European coastal chalk resource (JNCC 2011; Tittley 2009). This gives England an internationally significant responsibility to ensure the conservation of its marine chalk habitats.

2.16 Littoral and sublittoral chalk in England is primarily found on the East and South East coast, in particular in Kent and Sussex (Tittley 2009). The relatively soft and friable nature of the chalk results in coastal formations which are distinct from the harder rocky coasts found elsewhere in England. Notably, chalk cliffs may abut extensive eroded chalk platforms, facilitating the formation of a range of microhabitats within caves and reefs (JNCC 2011).

2.17 In England the chalk crops out in a band from the south coast up to The Wash and through the East Riding as far as Flamborough Head (Figure 3). To the east of this band, the chalk largely underlies younger rocks except where it crops out around the Weald. The marine ecological designations that include chalk as a feature in England are shown in Figure 3. The map shows that there are extensive areas of chalk on the coast that are not covered by designations, however the chalk in the bulk of these areas is unlikely to be exposed. Most of the Yorkshire, Lincolnshire and Norfolk coasts are cloaked with Pleistocene glacial sediments and/or represent coasts where depositional processes have dominated since the end of the last glaciation. The situation is the same on the south coast, where the chalk between Brighton and Littlehampton is cloaked by Pleistocene sediments. This means that most of the coast where chalk is outcropping and visible is subject to one or more Nature Conservation or Geological designations.

2.18 Offshore, the chalk extends into the North Sea Basin and into North Germany, as well as extending into the English Channel and across to Northern France and the Paris Basin. Further south in Europe, chalks deposited in the deeper waters of the margins of the closing Tethys Ocean occur in Portugal, Corsica and Sardinia. A map of chalk distribution in Europe can be found here- http://www.europe-geology.eu/marine-geology/marine-geology-map/. [Accessed 23rd May 2019].

2.19 Within the English Channel and the North Sea area there are only two other major stretches of coastal chalk in addition to those located in the UK. They consist of approximately 150 km of chalk cliffs, caves and wave cut platforms on the coasts of Seine-Maritime and Pas de Calais in France (Tittley 2009). These areas fall into SPAs, Sites of Community Importance (SCI)1 and Marine National Parks, although it is not clear whether chalk substrate habitats form a component of these

[1] SCIs are sites which are in the process of being designated as SACs; they have been adopted by the European Commission but have not yet been formally designated by the government of the relevant country

designations. It is likely however that the chalks themselves would fall mainly into very extensive areas of horizontally bedded flint rich or nodular chalk and marl substrate and may thus lack the diversity of chalks of the English coast.

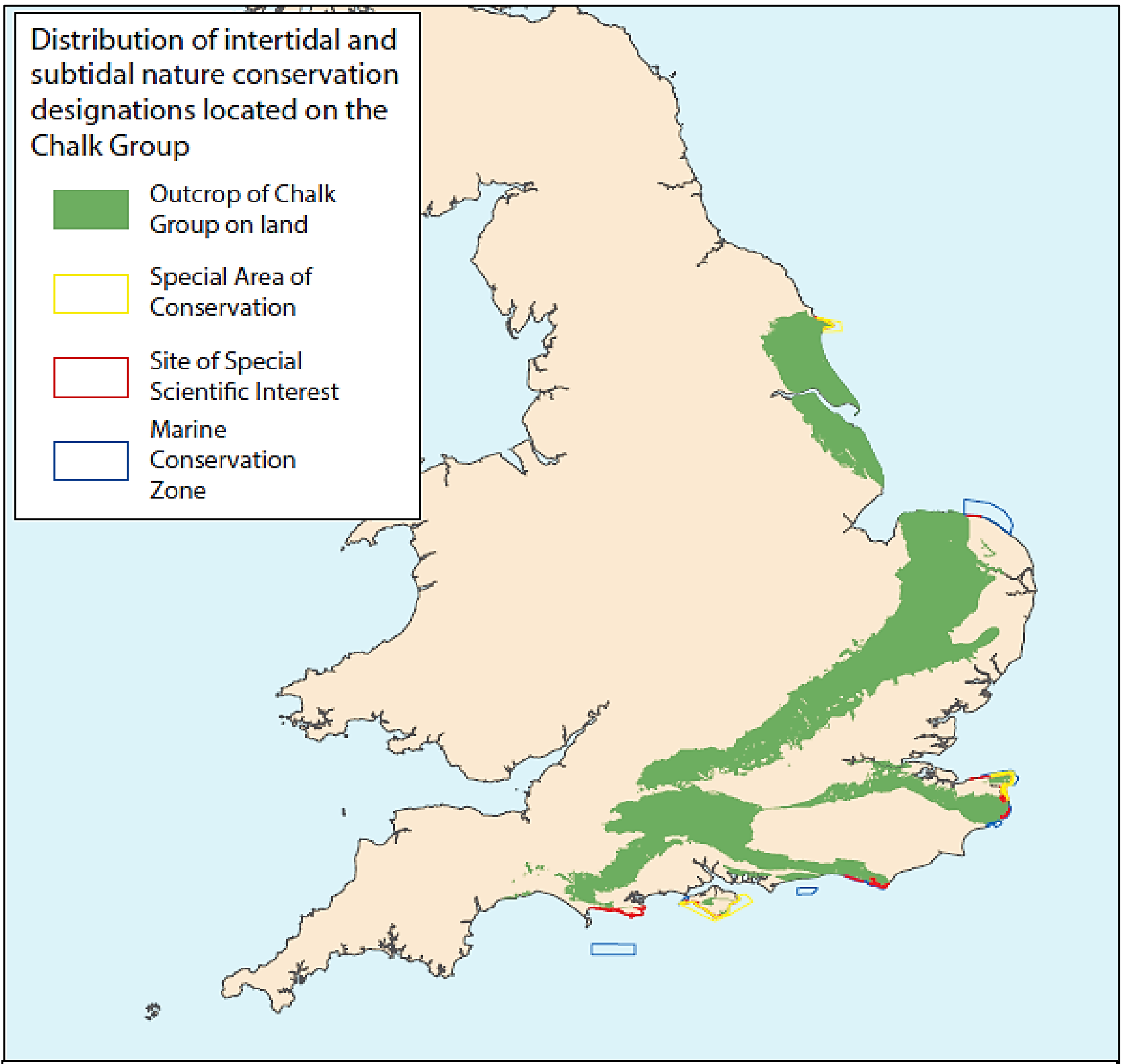

Figure 3. Distribution of Chalk in England and the distribution of coastal and marine designated sites on Chalk substrates as of summer 2018.

2.20 Littoral chalk exposures in Germany occur on the Island of Rügen, and as a small chalk outcrop with associated subtidal chalk reefs at Dune Island in Heligoland in the North Sea. Littoral chalk in Denmark occurs within the Baltic Sea at Sjaelland, Stevns Klint (Tittley 2009). The chalk present on the Baltic coast of Denmark and North Germany may not be comparable with chalk substrates in the English Channel and the North Sea because of the physical differences between the Baltic and the North Sea/English Channel, while the diversity of chalk lithologies is likely to be lower. This distribution of marine chalk across northwestern Europe can be seen in Figure 4, which displays in Google maps the approximate locations of the chalk sites listed above. It does not display the location of chalk sites in England.

2.21 The chalk of the Mediterranean is lithologically different from that of Northwestern Europe, and there are also physical differences between the Mediterranean and the North Sea/English Channel that would make designations between the two areas distinct.

Figure 4. Approximate location of marine chalk sites in Northwestern Europe.

Chalk ecology

2.22 The soft nature of chalk is of ecological significance, and the flora and fauna characteristic of chalk create distinct communities (Fowler & Tittley 1993). The softness of chalk enables the presence of rock-boring invertebrates, such as *Polydora sp*. and piddocks, which are not present on harder rocks, and are otherwise generally only seen in coastal clay and peat (Tittley and others 1998, UK Biodiversity Group 1999). Algal communities present in the intertidal and splash zone of chalk cliffs or sea caves are unique, and include Chrysophyceae and Haptophyceae, such as *Apistonema carterae* and *Chrysotila spp* (UK Biodiversity Group 1999). These English chalk algal communities are extremely scarce elsewhere in Europe. It has been recognised for some time that sites in Thanet, east Dorset, Flamborough Head and the Isle of Wight are of national and international marine nature conservation importance (Fowler & Tittley 1993).

2.23 Characteristic features of chalk coastlines include geomorphological formations such as cliffs, wave cut platforms, caves and reefs, which create a range of micro-habitats of biological importance (Figure 5). Subtidal chalk can comprise boulders, cobbles, and exposed chalk beds and outcrops. In areas of flat bedrock the subtidal chalk may be covered by a sand veneer or overlain by sand and boulders (Natural England 2017). Examples of subtidal chalk habitats and the associated flora and fauna can be seen in Figure 5. Examples of intertidal, littoral and supralittoral chalk habitats can be seen in Figure 6. It is important that conservation efforts in England protect the full range of these characteristic marine chalk habitats.

2.24 Where marine chalk is topographically distinct from the seabed, it forms reefs. Elevated chalk substrate provides a suitable habitat for a highly diverse range of fauna, making these chalk reefs a biodiversity hotspot. This is particularly the case where chalk reef is found in otherwise soft sediment areas and where chalk outcrops provide stable surfaces for seaweeds and sessile animals to attach to. Soft limestones and chalks have a pitted surface which can favour certain species.

2.25 Rare species observed in English sites which are well adapted to chalk-boring include the lichen *Eugomontia sacculata*, wrinkled rock borer *Hiatella arctica*, oval piddock *Zirfaea crispata* and *Polydora spp* (Howson 2001; Brazier and others, 1998; Tittley 1988). A number of species new to science have been discovered in English chalk sites, for example the purple *Hymedesmia* sponge discovered within Cromer Shoal MCZ (Spray & Watson 2012). Additionally, some species were first recorded in English chalk sites and haven't yet been recorded elsewhere, for example specialised algae and lichen communities such as those containing *Pseudendoclonium submarinum* and *Lyngbya spp*. which were first discovered in Thanet SAC (JNCC 2001).

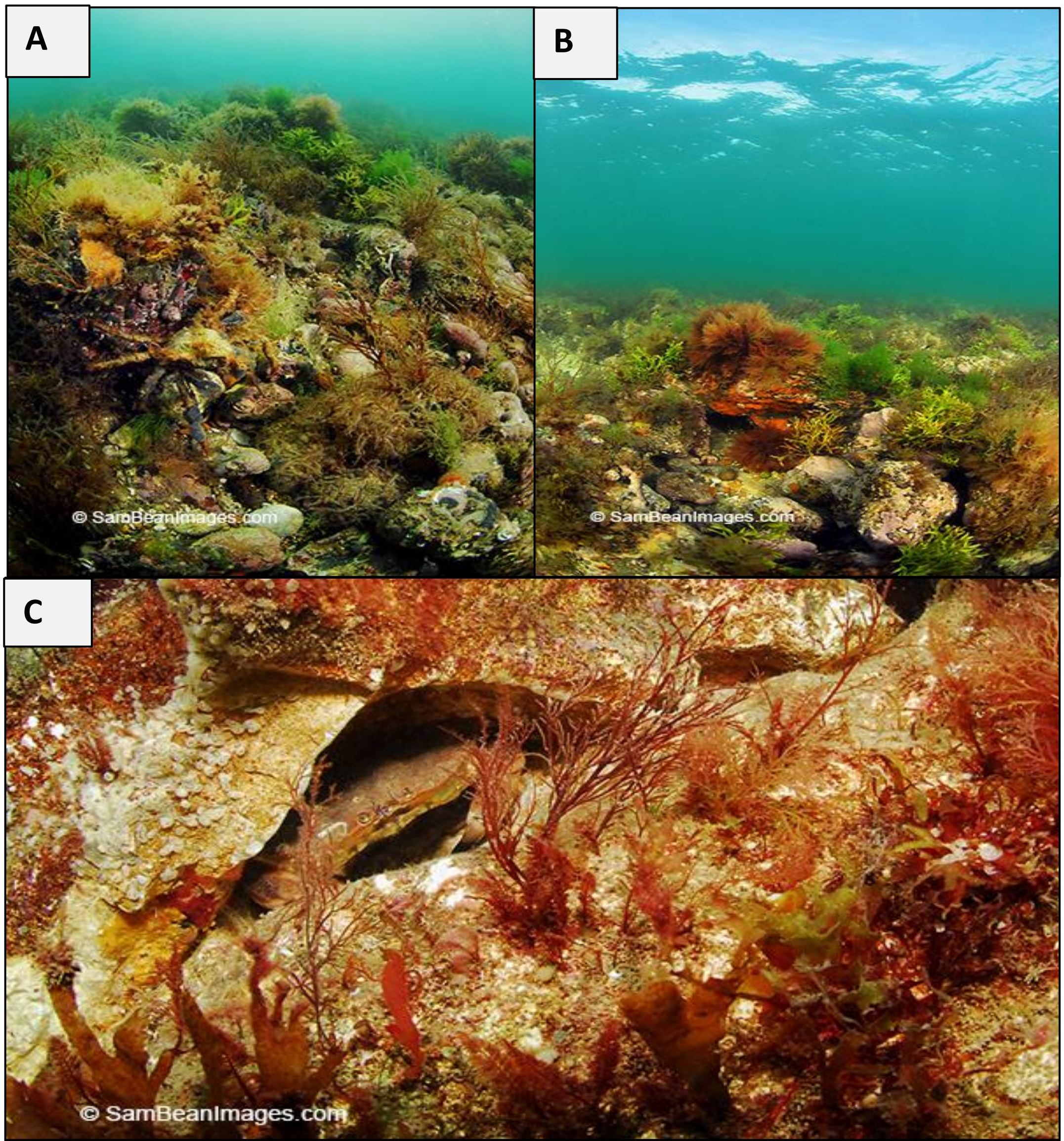

Figure 5. Examples of subtidal marine chalk habitats; A – sponge crab, *Pseudodromia latens*, on chalk reef, B – Sheringham chalk reef, C – edible crab, *Cancer pagurus*, in chalk. Photo credit: Sam Bean.

2.26 Chalk communities are also notable due to the absence of particular species and species groups. Chalk particles erode easily from cliffs and larger chalk boulders and become suspended in the water, often causing high levels of turbidity, therefore excluding species which require clear water. Additionally, species intolerant of the friable nature of chalk, such as large seaweeds and sessile filter-feeding animals may also be scarce, and may be replaced by more opportunistic species able to withstand the wave action. Epifauna is often limited on upward-facing surfaces, but can be richer on vertical faces (Fowler & Tittley 1993). One key exception to this generalisation is at Flamborough Head, where, because the chalk is much harder than in other locations in England, well developed kelp forests with an undergrowth of red algae are present at depths of 3- 4m.

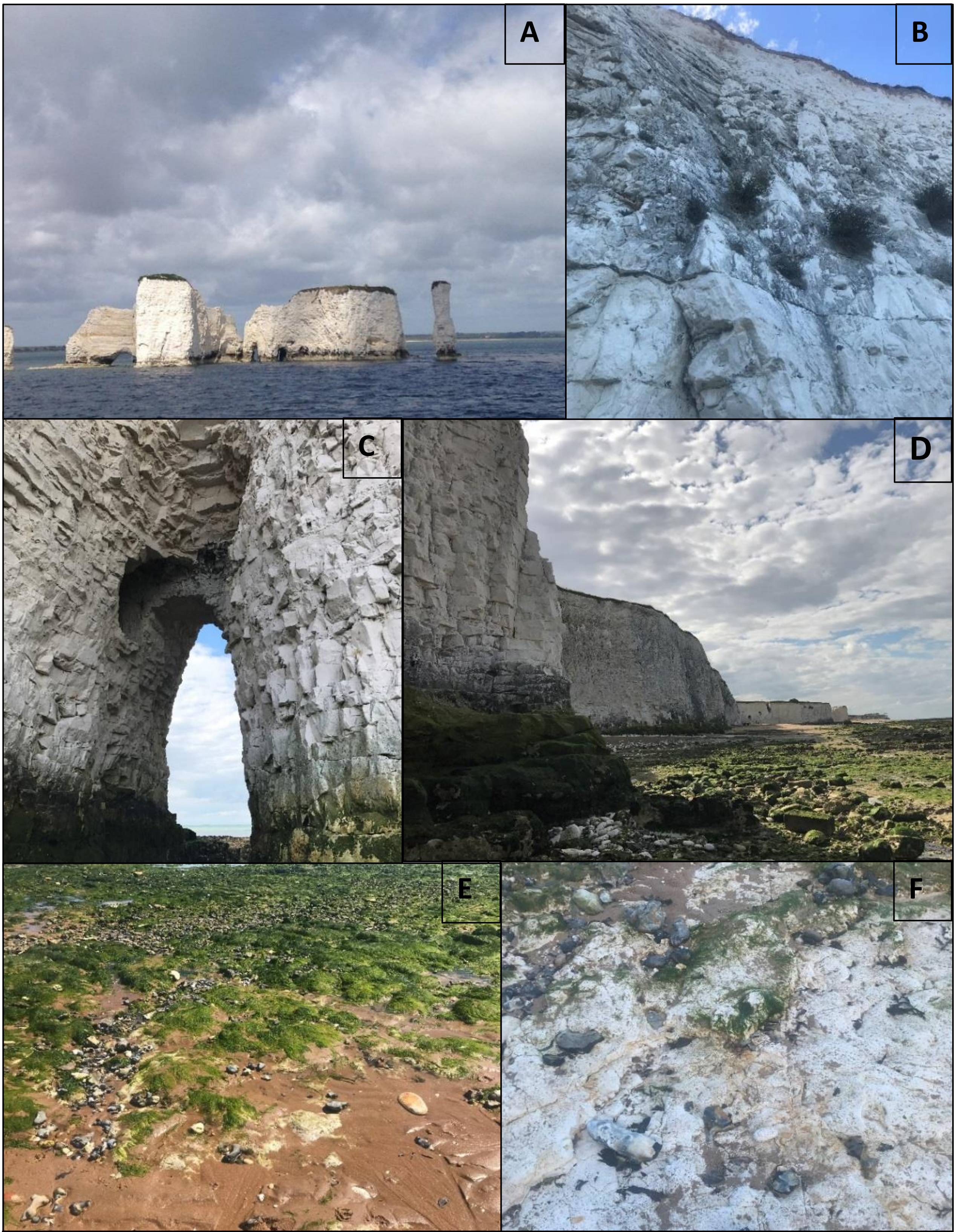

Figure 6. Examples of English intertidal, littoral and supralittoral marine chalk habitat features; A- sea stacks, B- vegetated sea cliffs of the Atlantic and Baltic Coasts , C- chalk arch, D- chalk cliffs and wave-cut platform, E- intertidal chalk reef, F- relatively flat chalk bedrock, interspersed with flint. Photo credit: Charlotte Moffat

3. Legal protection of marine chalk

3.1 Marine chalk habitats in England can be protected as Annex I reef, subtidal chalk or littoral chalk communities. This section will go through the different legislation that protects chalk in it its different forms.

3.2 Marine chalk habitats in England often constitute reefs, but do not always. There are several pieces of legislation that protect marine chalk habitats - five of which can be applied regardless of whether the chalk is in the form of a reef and one that only applies if the chalk is a reef. More detail is given on the legislative protection below, with a focus on the relevant provisions applying if an activity may impact the habitat, and ensuring the integrity of MPA networks.

3.3 The MPA network is made up of MCZs, SPAs, SACs, Ramsars and SSSIs. The aims of the network, as outlined in the Marine and Coastal Access Act 2009 (MCAA) are:

a) that the network contributes to the conservation or improvement of the marine environment in the UK marine area;

b) that the features which are protected by the sites comprised in the network represent the range of features present in the UK marine area; and

c) *that the designation of sites comprised in the network reflects the fact that the conservation of a feature may require the designation of more than one site* (MCAA)

3.4 In MPAs where chalk is a protected feature under any UK or European legislation, that feature will come with associated conservation advice and conservation objectives. The conservation advice aims to further the conservation objectives and provides information on the activities capable of affecting the features and the processes they depend on. The conservation objectives for a site state that subject to natural change, the protected features should be maintained, or restored where necessary, to favourable condition. It is these objectives that the condition of the site will be assessed against.

Legal protection given to marine chalk in England

Reefs listed under Annex I of the EC Habitats Directive (Council Directive EEC/92/43 on the Conservation of Natural Habitats and of Wild Fauna and Flora).

3.5 This Directive is transposed into UK law by the Conservation of Habitats & Species Regulations 2017. The directive requires designation of SACs to protect the species listed in Annex I and the habitats listed in Annex II. Reefs are listed on Annex II, and therefore where chalk is in the form of a reef it can be protected by the designation of SACs.

3.6 The Natura 2000 Interpretation manual of European Union Habitats advises that reefs are ‘hard compact substrata on solid and soft bottoms which arise from the sea floor in the sublittoral and littoral zone’. Hard substrata covered by a thin mobile veneer of sediment are classified as reefs if the associated biota are dependent on the hard substratum rather than the overlying sediment. Bedrock reef can be identified by the distinction from the seafloor. Irving (2009) presents ‘reefiness criteria’ which can be used to determine whether a habitat is stony reef and to classify the habitat as exhibiting high, medium or low ‘reefiness’. It is important to note that this reefiness criteria is only relevant for classifying stony chalk reef, it is not applicable to chalk bedrock reef. Member states have a duty to avoid the deterioration of natural habitats and the habitats of species, as well as disturbance of the species for which the areas have been designated. Article 6 (3) requires that any plan or project not directly necessary to the management of the SAC, but likely to have a significant effect on the site, either alone or in combination with other plans or projects must be subject to an appropriate assessment of its implications for the site in view of the site's conservation objectives. Appropriate assessments must consider direct or indirect effects on the feature's ecological requirements and the working components of a site's integrity i.e. its structure, function and supporting processes. The assessment should characterise the likely significance of effects including extent/ magnitude and duration, timing and frequency and recovery/reversibility. Competent Authorities should only agree to a plan or project after having ascertained it will not adversely affect the integrity of the site.

3.7 Under Article 6(4) of the Habitats Directive, or Section 64 of the Conservation of Habitats and Species Regulations 2017 a project that may impact the integrity of Annex I reef may be approved only if:

a) there are imperative reasons of overriding public interest relating to human health;
b) there are imperative reasons of overriding public interest relating to public safety;
c) there are beneficial consequences of primary importance to the environment; and
d) the appropriate authority secures any necessary compensatory measures to ensure that the overall coherence of the Natura 2000 network is protected.

3.8 Annex I reef can be either biogenic, such as that made by mussels, or geogenic, which includes all reef formed of rocks. Chalk therefore falls under the category of geogenic reef. Natural England characterise Annex I habitats by subfeature. Geogenic reef subfeatures include the following; intertidal rock, infralittoral rock, circalittoral rock, intertidal stony reef, and subtidal stony reef. It is these subfeatures that are used to describe the different types of chalk designated in SACs around England.

Subtidal chalk Habitat feature of conservation importance under the Marine and Coastal Access Act (MCAA) 2009

3.9 MCAA enables the designation of MCZs. MCZs protect a range of nationally important marine wildlife, habitats, geology and geomorphology. Nationally threatened, rare, or declining species and habitats are referred to as Features of Conservation Importance (FOCI). Littoral chalk communities and subtidal chalk are habitat FOCI. Chalk may also be protected in MCZs as broad-scale habitats. These include high energy intertidal rock, moderate energy intertidal rock, low energy intertidal rock, high energy infralittoral rock, moderate energy infralittoral rock, low energy infralittoral rock, high energy circalittoral rock, moderate energy circalittoral rock, and low energy circalittoral rock.

3.10 Section 125 of the Act applies to any public authority which may authorise activities that may significantly impact the protected features of an MCZ, and/or the ecological or geomorphological processes on which the conservation of any protected features is dependent. Under this section, public authorities must exercise their functions to further the conservation objectives of the MCZ, and where it is not possible to further these objectives, must carry out activities in the manner that least hinders the achievement of these objectives. To do this, public authorities complete an MCZ assessment.

3.11 An MCZ Assessment should consider the feature(s) for which the MCZ(s) has been designated, the current status of those features and the conservation objectives against each feature. In determining the significance of impacts from an activity, consideration will be given to the likelihood of an activity causing an effect, the magnitude of the effect should it occur, and the potential risk any such effect may cause on either the protected features of an MCZ or any ecological or geomorphological process on which the conservation of any protected feature of an MCZ is (wholly or in part) dependant.

3.12 Section 126 of the MCAA outlines that if a public authority believes there is, or may be, a significant risk a proposal will hinder the achievement of the conservation objectives of the MCZ, the authority may not grant authorisation for the activity unless:

a) there is no other alternative methods that would lower the risk;
b) the benefit to the public of proceeding outweighs the risk of damage to the environment that will be created; and
c) the person undertaking the project will put in place measures of equivalent environmental benefit to the damage that will occur within the MCZ.

Section 41 Habitats of Principle importance for conservation of biodiversity in England under the Natural Environment and Rural Communities (NERC) Act 2006

3.13 The Section 41 (S41) list is used to guide decision-makers such as public bodies, including local and regional authorities, in implementing their duty under Section 40 of the NERC Act 2006, 'the public authority must, in exercising its functions, have regard, so far as is consistent with the proper exercise of those functions, to the purpose of conserving biodiversity'. The S41 list includes habitats and species of principle importance for the conservation of biodiversity in England. The list must be kept under review by the Secretary of State, in consultation with Natural England, and currently intertidal chalk and subtidal chalk are included as habitats of principle importance. This means that decision-makers must have regard to intertidal and subtidal chalk habitats whenever they are present, even if they are not included within a protected site. More specifically:

a) Regional Planning Bodies and Local Planning Authorities will use it to identify the species and habitats that should be afforded priority when applying the requirements of Planning Policy Statement 9 (PPS9) to maintain, restore and enhance species and habitats;
b) Local Planning Authorities will use it to identify the species and habitats that require specific consideration in dealing with planning and development control, recognising that under PPS the aim of planning decisions should be to avoid harm to all biodiversity; and
c) All Public Bodies will use it to identify species or habitats that should be given priority when implementing the NERC Section 40 duty.

Wildlife and Countryside Act 1981

3.14 The Wildlife and Countryside Act 1981 provides for the notification and confirmation of SSSIs. These sites are identified for their flora, fauna, geological or physiographical features. Therefore in SSSIs chalk can be protected as a geological feature. Additionally many SSSIs underpin other national and international conservation designations.

3.15 Natural England is legally bound to act in the benefit of SSSIs as specified in the Wildlife and Countryside Act 1981 and subsequent amending legislation. Additionally, it has a duty to take reasonable steps, consistent with the proper exercise of its functions, to further the conservation and enhancement of the special interest of the SSSI.

3.16 Owners or occupiers of a SSSI must apply to Natural England to seek consent to undertake activities that may damage the special interest of the site. Natural England may then grant consent, with or without conditions or refuse consent if it is considered the proposal is not compatible with furthering the conservation and enhancement of the special interest of the site.

3.17 An assent under 28H of the Wildlife and Countryside Act 1981 is required in cases where public bodies request to carry out activities that have been identified as damaging to the features of a SSSI. If another public body is responsible for permitting an activity within or affecting a SSSI that public body must formally consult Natural England for advice under Section 28I. Where it is considered that activities may damage the interest features, Natural England has the legal right to advise against giving permissions, or advise that conditions are attached to the permission to avoid damage occurring.

Ramsar sites and SPA supporting habitats for internationally important populations for regularly occurring migratory species of SPA birds (Council Directive 209/14/EC)

3.18 There are additional types of protected areas that make up the protected area network in England, for example Ramsar sites and SPAs. Ramsar sites primarily protect wetland sites, the majority of which in England are of importance to waterbirds. SPAs are sites classified to protect rare and vulnerable bird species as well as regularly occurring migratory species in Europe. Some SPAs and Ramsar sites overlap with marine chalk MCZs and SACs, for example at Flamborough Head, and Thanet Coast.

3.19 The Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat 1971 aims to prevent the encroachment and loss of wetlands now and in the future. It requires contracting parties to designate suitable wetlands for inclusion in the list of wetlands of international importance. In the UK all designated Ramsars are underpinned by SSSIs and many overlap with Natural 2000 sites (SACs and SPAs), with the Convention's obligations being primarily met through the Wildlife and Countryside Act 1981 as amended (see above) and the equivalent devolved legislation. Additionally, as a matter of policy, Ramsar sites are given the same protection as Natura 2000 sites (see above).

3.20 The Birds Directive places emphasis on the protection of habitats for endangered and migratory bird species in Europe, and establishes a network of SPAs. For some SPAs, such as Thanet Coast and Sandwich Bay SPA, chalk shores are a supporting habitat for internationally important populations of regularly occurring migratory species- in this case Turnstone (*Arenaria interpres*) The Birds Directive is implemented in England primarily through the Wildlife and Countryside Act 1981 (as amended) (see above for details), the Conservation (Natural Habitats, & c.) Regulations 2010 (as amended) (see above) and the Offshore Marine Conservation (Natural Habitats & c.) Regulations 2007 as well as other legislation related to the uses of land and sea.

3.21 Although these are the key pieces of legislation, there are further pieces of legislation which complement those listed above, including provisions for other designation types. For example, Flamborough Head has a Local Nature Reserve (LNR) designation, as well as SAC, SSSI and SPA.

4. Sites designated for marine chalk in the English inshore marine protected area network

4.1 As outlined in Section 3 above, the different designation types all provide protection to marine chalk habitats. In this report, we focus on SACs and MCZs, as two designation types that explicitly protect marine chalk habitats. For context, the overlap of these sites with SSSIs, SPAs, MCZs, Ramsars, SCIs, and Areas of Outstanding Natural Beauty (AONB) is shown below in Table 1. Additionally Figure 7 shows the locations of the SACs and MCZs designated for marine chalk.

Table 1 MPAs by designation type and chalk feature type within 12nm in England in which chalk habitats are a protected feature. Information on designated sites is available on the Natural England Designated Sites System at https://designatedsites.naturalengland.org.uk/ [Accessed 23rd May 2019]. Note- this report was written in 2018, so Tranche 3 MCZs are not included here.

Site	Chalk feature	Component SSSIs	Overlapping Protected Areas	
Flamborough Head SAC	Annex I Reef	Flamborough Head SSSI	Danes Dyke LNR Flamborough Head and Bempton Cliffs SPA Flamborough Outer Headland LNR South Landing, Flamborough LNR	
Cromer shoal Chalk Beds MCZ	Subtidal chalk Habitat of Conservation Importance	None	None	
Thanet Coast MCZ and SAC	Subtidal chalk Habitat of Conservation Importance and Annex I Reef	Thanet Coast SSSI	Bishopstone Cliffs LNR Margate and Long Sands SCI Outer Thames Estuary SPA Thanet Coast and Sandwich Bay Ramsar Thanet Coast and Sandwich Bay SPA Thanet Coast SAC	All chalk features are Section 41 Habitats of principle importance for conservation of

Site	Chalk feature	Component SSSIs	Overlapping Protected Areas	
Dover to Deal MCZ	Subtidal chalk and Littoral chalk communities Habitats of Conservation Importance	Dover to Kingsdown Cliffs SSSI	South Foreland Heritage Coast Dover to Kingsdown Cliffs SAC Kent Downs AONB (abuts designation)	biodiversity in England
Dover to Folkestone MCZ	Subtidal chalk and Littoral chalk communities Habitats of Conservation Importance	Folkestone Warren SSSI	Kent Downs AONB (abuts MCZ) Folkestone Warren LNR	
Beachy Head West MCZ	Subtidal chalk and Littoral chalk communities Habitats of Conservation Importance	Brighton to Newhaven Cliffs SSSI Seaford to Beachy Head SSSI	Seaford Head LNR	
Kingmere MCZ	Subtidal chalk Habitat of Conservation Importance	N/A	N/A	
South Wight Maritime SAC	Annex I Reef	Bembridge Down SSSI Bonchurch Landslips SSSI Compton Chine to Steephill Cove SSSI Compton Down SSSI Headon Warren and West High Down SSSI Whitecliff Bay and Bembridge Ledges SSSI	Solent and Southampton Water Ramsar Solent and Southampton Water SPA The Needles MCZ Solent and Dorset Coast pSPA Isle of Wight AONB (abuts MCZ) Bembridge proposed MCZ	
The Needles MCZ	Subtidal chalk Habitat of Conservation Importance	Colwell Bay SSSI, overlaps the MCZ designation in some locations.	Headon Warren and West High Down SSSI abuts the MCZ with a small amount of overlap along the cliffs South Wight Maritime SAC Solent and Dorset Coast proposed SPA	

Site	Chalk feature	Component SSSIs	Overlapping Protected Areas	
South Dorset MCZ	Subtidal chalk Habitat of Conservation Importance	South Dorset SSSI	N/A	
Bideford to Foreland Point MCZ[2]	Littoral chalk communities Habitat of Conservation Importance			

[2] Bideford to Foreland Point MCZ has littoral chalk communities listed as a feature, however this site has not been considered in the scope of this report due to data limitations.

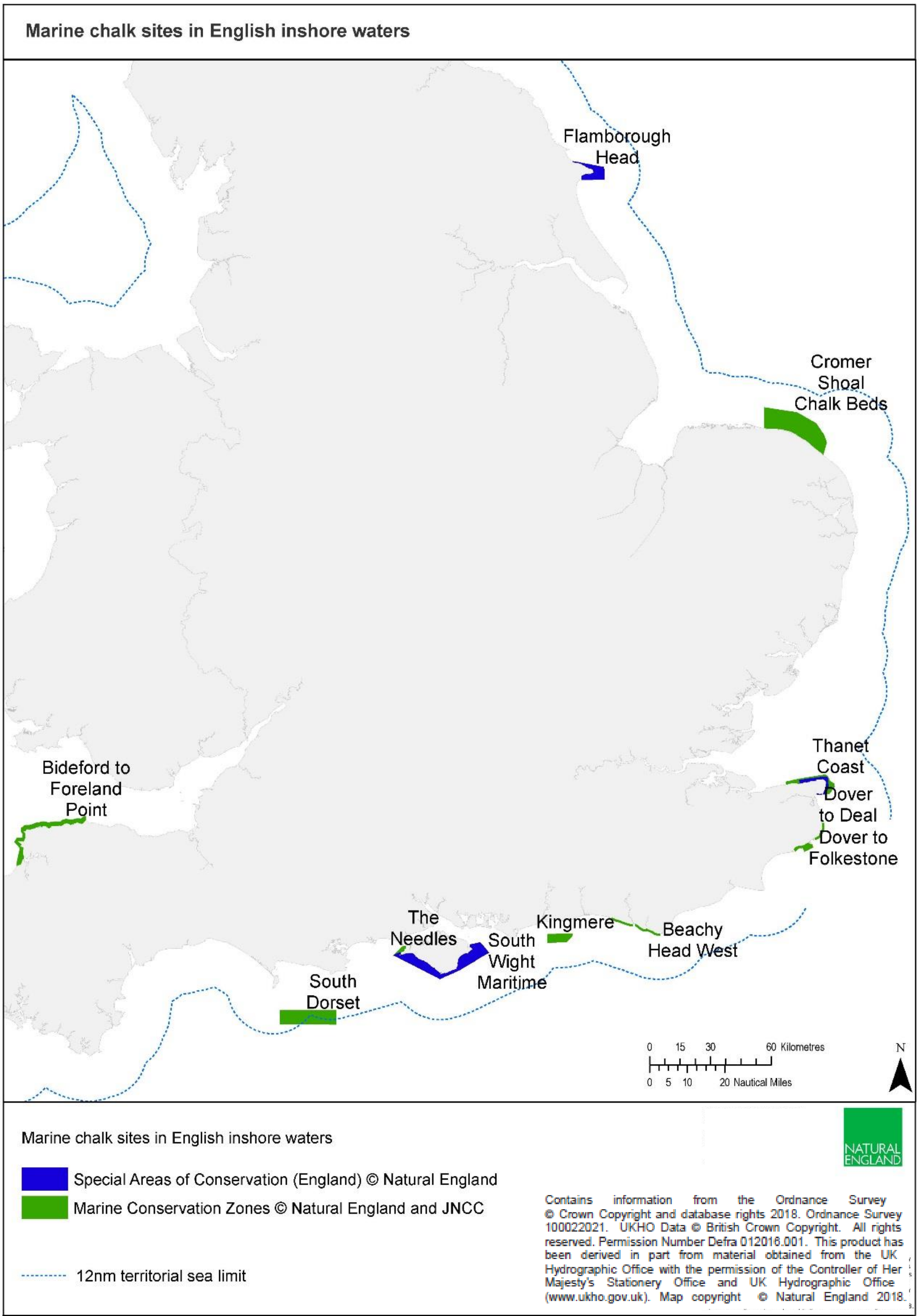

Figure 7. MPAs by designation type within 12nm in England in which chalk habitats are a protected feature as of summer 2018.

5. Chalk characterisation workshop

5.1 To further our understanding of the marine chalk habitats in England, a workshop was organised for NE staff, including those with detailed knowledge of individual sites and those with specialist knowledge of chalk habitats or relevant activities across the country. The aim of the workshop was to discuss and agree a set of criteria for characterising marine chalk. The differences between sites were considered, and the factors which influence these differences explored. The workshop aimed to strengthen the evidence for each site, and the understanding of the role each site plays in the marine chalk MPA network as a whole. The full list of attendees and the agenda is located in Appendix II.

5.2 A list of 16 possible criteria for characterising marine chalk was developed ahead of the workshop (see Appendix III). This list was not exhaustive and participants were invited to add additional criteria to the list. Several of the criteria were related to each other and so the importance of one could be captured under another, which meant that some criteria became surplus. The participants were divided into three groups and asked to discuss this initial list of criteria. Each group identified a list of approximately six priority criteria that they agreed were most important to characterising chalk habitats (see Appendix II), along with a justification. Participants also discussed whether data for each criteria is available.

5.3 After the groups had fed back the results of their discussions in plenary, a facilitated discussion on the three lists of prioritised criteria was undertaken so that an overall consensus on key chalk characterisation criteria could be reached. Through this process the initial list of 16 potential criteria were reduced to an agreed list of seven key chalk criteria, detailed in Section 6. During this discussion consideration was given to how best to align these criteria to NE's site based conservation advice.

5.4 Having established a final list of criteria site leads considered how their sites would fit into the list of different criteria. For example, for the criteria of 'zonation' site leads would consider the depth below chart datum of their sites, and what ecological zone this would relate to. Completing this process with the site leads present at the workshop gave a good indication of whether it would be possible to assess marine chalk using the final list of criteria, and also gave an indication of the variety of chalk in MPAs.

5.5 A full group session followed to discuss how characterising chalk using these criteria could contribute to specific areas of work completed.

6. Key Chalk criteria

6.1 A full table of all the criteria considered in the workshop, and the justification for including or excluding it from the final list, is located in Appendix III.

6.2 The final list of 7 criteria for characterising marine chalk agreed upon in the workshop is included below. This final list is in no particular order and should not be considered as a hierarchy. It includes the criteria participants believed to be most important for characterising the marine chalk network in England. The list includes a brief description of each criteria and a justification for using the criteria to characterise the marine chalk network.

Depth and zonation

6.3 **Description:** This criteria captures both the depth at which chalk occurs and the littoral zone it belongs to;

6.4 **Justification**: This criteria is important with respect to understanding how abiotic factors, such as light penetration, might affect the flora and fauna associated with the chalk. Chalk MPAs in England include intertidal and subtidal chalk. Some sites contain deep subtidal chalk, which is relatively rare and poorly understood.

Lithological composition

6.5 **Description**: Lithological composition looks at the different chalk formations in an MPA and captures the geological characteristics of chalk, such as hardness or softness and porosity;

6.6 **Justification:** Understanding the geology of the chalk across England will help understand the likely associated flora and fauna. For example, chalk hardness varies from soft enough to crush in your hand to very hard and resilient. This will affect the nature of the organisms which bore into or attach to it. The geology will also indicate the likely structural complexity of the chalk, for example some chalk has thin layers of very hard chalk with softer chalk below, which leads to the formation of ledges and microhabitats as the softer chalk erodes faster.

Hydrodynamic regime (including sedimentation rate, exposure and turbidity)

6.7 **Description**: This criteria captures water energy and exposure including current speed and direction, wave height and speed, suspended sediment, turbidity, exposure classification;

6.8 **Justification**: Understanding the hydrodynamics surrounding chalk in a particular location is important for understanding the chalk formations and associated communities likely to be found. Water energy can be received through waves and tidal flow. The exposure of communities to energy can vary with aspect and depending on the elevation and structural complexity of the chalk. Additionally water energy can impact sedimentation rate, scour and turbidity and sedimentation rate can impact ecological processes and potentially lead to smothering. Turbidity is caused by suspended particles, which can be organic or inorganic matter such as plankton or sediments. Increased turbidity can therefore have a range of possible impacts including restricting light availability for primary production, increasing food availability for filter feeders, and increasing scour. Chalk is easily eroded by water energy and movement, creating complex habitats.

Structural complexity

6.9 **Description**: The least structurally complex form of subtidal chalk is flat bedrock which does not outcrop above the seabed and may or may not be covered by a veneer of sand or other mobile sediments. Structural complexity increases as areas of chalk are elevated from the surrounding seabed, with crevices and fissures developing in the bedrock. This creates a greater surface area for epifauna to attach to, and creates crevices for mobile species to take shelter in. Bedrock may have eroded into stacks, arches, overhangs, tunnels, crevices and caves. The chalk may take the form of isolated boulders and cobbles, with outcrops separated by gullies with vertical faces;

6.10 **Justification**: There is a great variety of structural complexity in marine chalk across England. The structural complexity of the chalk will affect what flora and fauna is associated with it and as structural complexity can vary enormously between, and also within sites, it is important to understand which structures are located in which MPAs, as one MPA may contain the only example of a particular type of chalk structure.

Extent and distribution

6.11 **Description**: Extent can be measured as the total area of exposed chalk. The distribution describes where the chalk is within the site;

6.12 **Justification**: Understanding the total amount of marine chalk and its distribution is important for understanding the total amount of this resource in UK waters. The extent and distribution of chalk habitats will impact how they interact with other marine habitats.

Geographic context

6.13 **Description**: Some MPAs contain chalk in a notable geographic location. For example the chalk may be the most northerly / westerly chalk in the UK, or support biota which are at the limit of their geographic range;

6.14 **Justification**: This criteria is relevant as some chalk in MPAs may represent chalk at the extreme of a biogeographic zone. Knowing where these examples occur is fundamental to ensuring the importance of geographic location is taken into account when considering the chalk network. It is important for an ecologically coherent network to have representation of habitats within all the relevant regional seas.

Community composition

6.15 **Description**: This criteria can be captured through which biotopes (using the EUNIS classification system) are present combined with a list of commonly occurring and notable species;

6.16 **Justification**: The communities that chalk habitats support is fundamental to their ecology. Biotopes capture habitat and species information in a standardised format. Knowing how biotopes vary across the marine chalk sites is important in understanding the distribution and relative abundance of each biotope. Within a biotope species may be notable by their presence (e.g. rare species) or absence (e.g. species which are usually common in a habitat and so would be expected to be present). Listing notable species gives greater detail on the species within a community.

6.17 After the workshop, site leads were contacted and asked to provide details of the chalk habitats in their MPAs through completing a table of the agreed final criteria for each MPA. This information (located in Appendix IV) was used to further our understanding of marine chalk in MPAs and a summary of the results is located in Tables 3 – 15.

Table 2 Table showing the abbreviations used in the results for each protected site considered within this report

Note- this report was written in 2018, so Tranche 3 MCZs are not included here.

Key	Chalk MPA
FH	Flamborough Head SAC
Cro	Cromer Shoal Chalk Beds MCZ
Tha	Thanet Coast SAC/ MCZ
D-D	Dover to Deal MCZ
D-F	Dover to Folkestone MCZ
BHW	Beachy Head West MCZ
King	Kingmere MCZ
SWM	South Wight Maritime SAC
Need	The Needles MCZ
SD	South Dorset MCZ

Table 3 Information on the depths and zones recorded in each protected site considered in this report

Depth of site (m below CD)													Zones within which chalk is found			
≤50	**45**	**40**	**35**	**30**	**25**	**20**	**15**	**10**	**5**	**0**	**5 above CD**	**≥10 above CD**	**Circa littoral**	**Infra littoral**	**Littoral**	**Supra littoral**
	FH	FH	FH	FH	FH	FH	FH	FH	FH	FH	FH	FH	FH	FH	FH	FH
					Cro	Cro	Cro	Cro	Cro	Cro			Cro	Cro		
								Tha	Tha	Tha	Tha	Tha	Tha	Tha	Tha	
				D-D	D-D	D-D	D-D	D-D	D-D	D-D	D-D	D-D	D-D	D-D	D-D	
				D-F	D-F	D-F	D-F	D-F	D-F	D-F	D-F	D-F	D-F	D-F	D-F	
						BHW	BHW	BHW	BHW	BHW	BHW	BHW	BHW	BHW	BHW	
						King	King	King	King				King	King		
SWM	SWM	SWM	SWM	SWM	SWM	SWM	SWM	SWM	SWM	SWM	SWM		SWM	SWM	SWM	SWM
Need	Need	Need	Need	Need	Need	Need	Need	Need	Need	Need	Need	Need	Need	Need	Need	
SD	SD	SD	SD										SD			

Table 4 Information on the lithological composition of the marine chalk located in the protected sites considered in this report

Lithological composition							
Structural altitude			**Broad lithology type**		**Specific character**		
Horizontal	**Inclined**	**Vertical**	**Regularly alternating chalk and marl, typically at scales of 100- 500 mm**	**Thick units of chalk (100s of mm to metre) alternating with thin 10s of mm marl seams**	**With little or no flint**	**Flint rich**	**With nodular chalks and hardgrounds**
FH	FH		FH	FH		FH	
Cro				Cro		Cro	
Tha				Tha		Tha	
D-D				D-D		D-D	
D-F			D-F				D-D
BHW	BHW			BHW	BHW	BHW	
King	King			King		King	BHW
SWM	SWM	SWM	SWM	SWM	SWM	SWM	King
							SWM
SD	SD			SD		SD	SD

Table 5 Information on the hydrodynamic regime occurring in the protected sites considered in this report

Hydrodynamic regime																			
Maximum current speed (knots)					**Current direction**				**Turbidity**					**Exposure classification**			**Suspended sediment**	**Wave height**	**Wave speed**
≤2	**≤2.5**	**≤3**	**≤3.5**	**Insufficient data**	**NW-SE**	**E-W**	**W-E**	**Insufficient data**	**Low**	**Medium**	**High**	**Variable**	**Insufficient data**	**Low**	**Moderate**	**High**	Insufficient data		
				FH				FH			FH	FH			FH	FH			
Cro	Cro	Cro			Cro					Cro	Cro				Cro	Cro			
				Tha				Tha			Tha				Tha				
				D-D				D-D					D-D	D-D	D-D	D-D			
				D-F				D-F					D-F	D-F	D-F	D-F			
BHW	BHW						BHW							BHW	BHW	BHW			
King								King					King		King				
				SWM				SWM			SWM				SWM	SWM			
				Need				Need					Need		Need	Need			
			SD			SD				SD					SD				

Table 6a Information on the structural complexity of the marine chalk located in the protected sites considered in this report (Part 1 of 2)

Structural complexity												
Boulder/cobble on rock	**Boulder / cobble on sediment**	**Sediment on rock**	**Fissures >10mm (none – many)**	**Crevices <10mm (none – many**	**Gully**	**Cave**	**Tunnel**	**Stacks**	**Arches**	**Overhangs**	**Wave cut platform**	**Elevation (metres)**
FH	FH	FH	FH		FH	FH		FH	FH	FH	FH	FH (vertical faces)
Cro	Cro	Cro	Cro	Cro	Cro	Cro	Cro	Cro	Cro	Cro		Cro (3m wall)
					Tha	Tha	Tha	Tha	Tha		Tha	
D-D	D-D	D-D			D-D						D-D	D-D (up to 2m)
D-F		D-F		D-F	D-F					D-F	D-F	D-F (outcrops)
BHW		BHW			BHW					BHW	BHW	BHW (chalk ridges)
King	King	King		King	King							Kingmere (1-4m subtidal cliffs)
SWM	SWM	SWM		SWM	SWM	SWM		SWM		SWM	SWM	SWM (horizontal and vertical faces)
Need	Need	Need		Need	Need	Need		Need		Need	Need	Need (cliffs)
SD		SD										SD (smooth/ low elevation)

Table 6b Information on the structural complexity of the marine chalk located in the protected sites considered in this report (Part 2 of 2)

Structural complexity				
Boulder/cobble/pebble shape Rounded	**Boulder/cobble/pebble shape Angular**	**Unknown**	**Stability**	**Presence of silt**
		FH	Insufficient data	
Cro	Cro			
		Tha		
D-D	D-D			
		D-F		
		BHW		
		King		
		SWM		
		Need		
		SD		

Table 7 Information on the extent and distribution of marine chalk located in the protected sites considered in this report

Extent and distribution									
Extent (ha)									
≤ 5	**≤500**	**≤500**	**≤5000**	**≤10000**	**≥20000**	**Unknown**	**Distinct area only**	**Patches of chalk**	**Chalk throughout site**
			FH						FH
					Cro				Cro
			Tha						Tha
	D-D								D-D
	D-F								D-F
				BHW					BHW
King							King		
				SWM					SWM
						Need			Need
				SD				SD	

Note:

- Sites highlighted in orange have a greater extent of marine chalk present than listed, but extent data for some features has not yet been mapped; and
- Sites highlighted in grey may have significantly greater extents of marine chalk than listed, as additional rock features which could potentially be comprised of chalk are present in the site but were not included within the above extent calculations.

The following tables (Tables 8 – 15) relate to the biotopes recorded within in each protected sites. In the tables the only biotope codes are given, full descriptions of the biotopes are provided in Appendix V. Additionally it should be noted that the biotopes highlighted in green are those that specifically depend on the presence of chalk/ soft rock. Other biotopes included here are dependent on rock, but not necessarily chalk.

Table 8 Table showing the protected sites where high energy littoral rock biotopes have been recorded

Community composition													
Biotopes present (Chalk biotopes (from MarLIN))													
No biotopes recorded	**A1: Littoral rock and other hard substrates A1.1 High Energy littoral rock**												
	A1.11	**A1.111**	**A1.113**	**A1.1131**	**A1.1132**	**A1.1133**	**A1.12**	**A1.122**	**A1.1221**	**A1.123**	**A1.124**	**A1.125**	**A1.126**
	FH	FH		FH	FH		FH		FH	FH	FH	FH	FH
											Tha	Tha	Tha
							BHW						
			SWM	SWM				SWM		SWM			SWM
SD													

Table 9 Table showing the protected sites where moderate energy littoral rock biotopes have been recorded

Community composition												
Biotopes present (Chalk biotopes (from MarLIN))												
No biotopes recorded	**A1: Littoral rock and other hard substrates A1.2: Moderate energy littoral rock**											
	A1.21	**A1.212**	**A1.213**	**A1.214**	**A1.2141**	**A1.2142**	**A1.2143**	**A1.215**	**A1.22**	**A1.221**	**A1.222**	**A1.223**
	FH	FH	FH	FH	FH	FH		FH	FH	FH	FH	
								Tha				
							D-F					D-F
	BHW								BHW			
			SWM		SWM	SWM		SWM				
SD												

Table 10 Table showing the protected sites where low energy littoral rock and features of littoral rock biotopes have been recorded

Community composition										
Biotopes present (Chalk biotopes (from MarLIN))										
No biotopes recorded	**A1: Littoral rock and other hard substrates A1.3: Low energy littoral rock**					**A1.4 Features of littoral rock**				
	A1.31	**A1.3121**	**A1.313**	**A1.3131**	**A1.3151**	**A1.41**	**A1.411**	**A1.4111**	**A1.412**	**A1.413**
	FH	FH		FH	FH			FH	FH	FH
			Tha		Tha		Tha			
	BHW					BHW				
							SWM			
SD										

Table 11 Table showing the protected sites where features of littoral rock biotopes have been recorded (continued from Table 10)

Community composition												
Biotopes present (Chalk biotopes (from MarLIN))												
No biotopes recorded	**A1: Littoral rock and other hard substrates A1.4 Features of littoral rock**											
	A1.42	**A1.4121**	**A1.44**	**A1.44A**	**A1.441**	**A1.442**	**A1.443**	**A1.444**	**A1.445**	**A1.45**	**A1.451**	**A1.452**
			FH		FH					FH	FH	FH
		Tha								Tha		
	BHW				BHW					BHW		
		SWM	SWM	SWM	SWM	SWM	SWM		SWM			
SD												

Table 12 Table showing the protected sites where Atlantic and Mediterranean high energy and Atlantic and Mediterranean moderate energy infralittoral rock biotopes have been recorded

Community composition													
Biotopes present (Chalk biotopes (from MarLIN))													
No biotopes recorded	**A3: Infralittoral rock and other hard substrates A3.1 Atlantic and Mediterranean high energy infralittoral rock**				**A3.2: Atlantic and Mediterranean moderate energy infralittoral rock**								
	A3.115	**A3.116**	**A3.1161**	**A3.125**	**A3.21**	**A3.211**	**A3.212**	**A3.2113**	**A3.214**	**A3.2141**	**A3.2142**	**A3.215**	**A3.217**
				FH		FH	FH			FH	FH		FH
			Cro									Cro	
								Tha					
					BHW								
		SWM							SWM			SWM	SWM
	Need							Need				Need	
SD													

Table 13 Table showing the protected sites where Atlantic and Mediterranean low energy infralittoral rock biotopes and Atlantic and Mediterranean high energy circalittoral rock biotopes have been recorded

Community composition										
Biotopes present (Chalk biotopes (from MarLIN))										
No biotopes recorded	**A3: Infralittoral rock and other hard substrates A3.3: Atlantic and Mediterranean low energy infralittoral rock**					**A4: Circalittoral rock and other hard substrates A4.1: Atlantic and Mediterranean high energy circalittoral rock**				
	A3.31	**A3.312**	**A3.716**	**A3.7162**	**A3.72**	**A4.1121**	**A4.13**	A4.1341	A4.135	**A4.138**
		FH						FH	FH	
					Cro		Cro			
									Tha	
							D-D		D-D	D-D
							D-F		D-F	D-F
	BHW						BHW			
							King			
			SWM	SWM		SWM		SWM		
							Need			Need
SD										

Table 14 Table showing the protected sites where Atlantic and Mediterranean moderate energy circalittoral rock biotopes have been recorded

Community composition									
Biotopes present (Chalk biotopes (from MarLIN))									
No biotopes recorded	A4: Circalittoral rock and other hard substrates								
	A4.2: Atlantic and Mediterranean moderate energy circalittoral rock								
	A4.2141	A4.2143	A4.221	A4.23	A4.231	A4.232	A4.233	A4.241	A4.2511
	FH	FH			FH			FH	
						Cro			
					Tha				
				D-D	D-D		D-D		
				D-F	D-F	D-F	D-F		
				BHW					
				King					
	SWM		SWM	SWM	SWM				
				Need	Need		Need		Need
SD									

Table 15 Table showing the protected sites where subtidal coarse and subtidal mixed sediment biotopes have been recorded

Community composition									
Biotopes present (Chalk biotopes (from MarLIN))									
No biotopes recorded	**A5: Sublittoral sediment A5.1 Sublittoral coarse sediment**					**A5.4: Sublittoral mixed sediments**			
	A5.131	A5.137	**A5.141**	**A5.231**	**A5.243**	**A5.43**	**A5.44**	**A5.441**	**A5.444**
			FH				FH		FH
	Cro	Cro		Cro	Cro	Cro	Cro		
									Tha
		D-F						D-F	
			King						
				SWM					SWM
SD									

7. Application of marine chalk characterisation criteria and recommendations

7.1 The diversity of marine chalk in the English inshore MPA network can be clearly demonstrated using the chalk characterisation criteria. There is a wide range in diversity for almost all of the criteria; chalk from two different sites are not necessarily comparable, with each site adding something different and unique to the network. There can also be a significant range in chalk characteristics within a site.

7.2 Being able to characterise the chalk in MPAs is important for understanding the diversity of chalk habitats which the MPA network is protecting. It is important to note the chalk characterisation criteria are not a hierarchy. This characterisation demonstrates that the marine chalk habitats in each MPA are important for different reasons, and MPA management should seek to maintain this diversity. Anthropogenic impacts could lead to changes in marine chalk which cause a shift from one marine chalk habitat to another, while ostensibly maintaining the feature which the site is designated for. Without an understanding of how comparable sites are, or how scarce each characteristic of chalk is, then the wider significance of such changes may not be fully appreciated. A robust understanding of the breadth of marine chalk will help enable management to be implemented in a manner which proactively accounts for the variations in marine chalk to ensure the full range of diversity is maintained.

7.3 Site specific conservation advice for marine chalk is given within the Conservation Advice packages for the MPAs (available at https://designatedsites.naturalengland.org.uk/), and through the site specific knowledge of the Natural England Area Teams. This report does not supersede the Conservation Advice packages and/ or local Area Team expertise, but compliments that information. It provides important context with respect to the international importance of the English resource of marine chalk, and provides a set of criteria that can be used to explore the diversity of the marine chalk network and improve our understanding of site specific marine chalk. The marine chalk characterisation criteria will help with strategic conservation by improving our understanding of the contribution of each individual MPA within the chalk network, as well as in the European and worldwide context.

7.4 It should be noted that damage made to marine chalk is irreversible; if the physical structure of chalk is altered then it will not recover itself, so potentially rare elements of the habitats may be completely lost from the marine chalk network. This is a key distinction from many of the habitats in English inshore waters which are expected to recover through natural processes given sufficient time and appropriate protection. The scarcity of marine chalk habitats combined with the relatively high potential for permanent loss of habitats warrants precautionary management across the marine chalk network to prevent permanent losses. This approach to conservation across a network is particularly important for a habitats such as marine chalk, of which England contains the majority of the European, and worldwide resource, and so has a responsibility to ensure the diversity of the habitat it is effectively conserved. Bearing this in mind, this report can be used alongside Natural England's statutory conservation advice by anyone wishing to undertake potentially damaging activates in sites designated for chalk in order to consider the full impacts and potential irreversibility of the activity, the level of precaution appropriate in the assessment and any targeted mitigation measures.

7.5 It is noted that Natural processes can create new structural features as well as contributing to the loss of habitats and destroy features such as arches through erosion. However, until this happens, habitats should be protected to ensure they function for as long as possible and to allow the natural succession of geomorphological features.

7.6 The application of the characterisation criteria is currently limited by a paucity of data, in particular for some of the more recently designated sites and for particular criteria. Any conclusions drawn based on these datasets should be informed by an awareness of the resolution and confidence of the background data. For example, standardised data at an appropriate scale for the hydrodynamics criteria is scarce meaning some comparisons may be qualitative where quantitative comparisons would be preferable. For criteria such as lithology there are high quality datasets which have broad spatial coverage. These have the advantage of providing consistent information across sites, but mean that the resolution of the data may not allow for within site comparisons. For those criteria which rely on individual site surveys, such as biotopes and structural complexity, then although resolution is generally good, data coverage is lower meaning that confidence in presence (of biotope or structural feature) is higher than confidence in absence. This means that when interpreting the marine chalk network, care needs to be taken to ensure that those areas that have not been surveyed, are not assumed to have no ecological value.

7.7 This characterisation criteria could also be used to identify evidence gaps for future surveys. As the evidence base for English inshore chalk MPAs improves then this tool can be further developed so that comparisons are increasingly robust.

8. Conclusion

8.1 Marine chalk is an important habitat, protected through multiple legislative instruments. The majority of Europe's marine chalk habitats are in England, giving England a responsibility to ensure they are effectively managed. Discussion between staff representing the breadth of work relating to marine chalk identified the key criteria for characterising marine chalk habitats in inshore English waters. When chalk habitats, designated as a feature of MPAs, are characterised using these criteria it clearly illustrates the diversity of marine chalk habitats both within and between MPAs in the English inshore MPA network. This highlights the contribution of each MPA in the network to the protection of the overall chalk habitat resource. These criteria can be used to inform management advice, including casework advice, to ensure that conservation measures are effective in maintaining the diversity of marine chalk habitats present in England, and so the ecological coherence of the MPA network. In some instances the application of the criteria may be limited by the data available, this must be considered to ensure the decisions informed by the criteria are robust.

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Appendix 1 Generalised distribution of chalk lithologies in marine sites

Data sources (report title):

HOPSON P. M. 2005. A stratigraphical framework for the Upper Cretaceous Chalk of England and Scotland with statements on the Chalk of Northern Ireland and the UK Offshore Sector. British Geological Survey Research Report RR/05/01

Shape files for MCZs and SACs where chalk substrates are considered to be present.

Shape files for the bedrock geology of England (British Geological Survey 1:50,000 scale).

MAREMAP The Marine Environmental Mapping Programme. 2017. Distributions of seafloor bedrock, Quaternary and modern sediments, thickness of seafloor sediments. [online] URL: http://www.maremap.ac.uk/view/search/searchMaps.html [Accessed 23rd May 2019].

The maps available on MareMap are at a very large scale, and as a consequence there is substantial uncertainty as to the positions of boundaries, which given the difficulties of data collection in the marine environment are likely to inferred or represent probabilities of their distribution. This generates substantial uncertainties when addressing the more offshore sites (Kingmere and South Dorset).

Data Summary

Habitats developed on seafloors with a chalk substrate may be influenced by a range of factors that could include water depth, current speed and direction and traction of modern seafloor sediments amongst others. The lithological properties of the chalk can influence the nature of the topography developed on the seafloor and through this, indirectly determine habitat through the provision of aspect, shelter and surfaces for colonisation at a variety of scales of roughness. Variations in the hardness of the chalk may determine the distribution of boring organisms.

The purpose of this work was to develop a simple classification system that could be used for chalk in order to contribute to predictions on what types of habitat are likely to develop on different types of chalk.

This classification system has been presented in a series of maps produced for each protected site that can be seen in the site specific documents in Annex IV.

Method

For each of the sites, the site boundary and BGS bedrock data were exported into an Adobe Illustrator file and layers containing MareMap data added and rescaled to the best fit with the bedrock data.

The stratigraphical framework for the Chalk (Hopson 2005) was recast with any formations unique to the Transitional Province removed and the remainder reinterpreted as a small number of lithological types (Table A) to which different Chalk formations can be assigned. These are fairly broad-brush assignment based on what are considered here to be the dominant characteristics of a particular formation. For example, formations classed as rich in flint may not be completely devoid of nodular chalks or hardgrounds, but these are minor components compared with degree of development of flint.

This approach has produced four broad classes (Table A). These have been combined with a structural component reflecting whether the bedding is horizontal, dipping, or vertical to give twelve classes (Table B) the distribution of which have been mapped across each of the sites using the classification key in Figure A.

Table A: Assignment of lithostratigraphical formation to general groupings based on broad characteristics

Broad lithology type	Specific character	Map type	Formations
Regularly alternating chalk and marl, typically at scales of 100-500 mm		**A**	• West Melbury Marly Chalk • Zig Zag Chalk
Thick units of chalk 100s of mm to metre scale alternating with thin 10s of mm marl seams	With little or no flint	**B**	• Ferriby Chalk • New Pit Marl
	Flint rich	**C**	• Seaford Chalk • Newhaven Chalk • Culver Chalk • Portsdown Chalk • Welton Chalk • Burnham Chalk • Flamborough Chalk • Rowe Chalk Formation
	With nodular chalks and hardgrounds	**D**	• Holywell Nodular Chalk • Lewes Nodular Chalk

Table B: Broad characteristics combined with structural attitude

Type	Poise	Horizontal (H)	Inclined (I)	Vertical ((V)
A		AH	AI	AV
B		BH	BI	BV
C		CH	CI	CV
D		DH	DI	DV

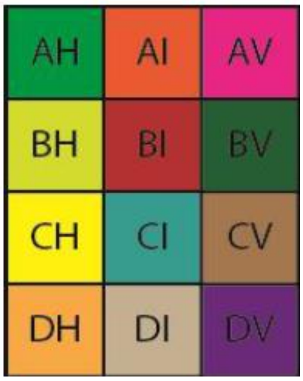


Figure A. Classification key for maps

Appendix 2 Workshop participants and agenda

Participants

- Charlotte Moffat (Chalk characterisation project Project Manager)
- Georgie Roberts (Marine Senior Advisor Southern North Sea)
- Heidi Richardson (Marine Lead Advisor Southern North Sea)
- Dylan Todd (National Specialist Marine monitoring and surveillance)
- Chris Pirie (Principal specialist Marine Ecology)
- Louise Burton (Marine Senior Advisor Southern North Sea)
- Fiona Tibbitt (Site Lead: Cromer Shoal MCZ)
- Nadine Atchison-Balmond (Site Lead: Thanet SAC)
- Alex Fawcett (Marine Senior Specialist: Major Casework)
- Dr David H Evans (Senior Environmental Specialist – Stratigraphy)
- Jessica Taylor (Dorset, Hampshire and Isle of Wight Area team, covering The Needles MCZ, South Dorset MCZ and South Wight Maritime SAC)
- Charlotte Johnson (Marine Senior Environmental Specialist)

Workshop agenda

10.30-10.40	Introduction Background, aims and objectives
10.40- 11.40	Introduction to the proposed criteria
	Breakout session- small group discussion on characterisation criteria
11.40-12.10	Break out groups to summarise discussion in feedback to group
12.10-12.40	Lunch – please bring your own
12.40- 13.40	Facilitated discussion on the outputs of the breakout session with the aim to reach an all group consensus on key chalk characterisation criteria
13.40- 13: 55	Tea break During the tea break site leads / those familiar with specific sites to consider where their site sits the scale for each different criterion (e.g. for the criterion chalk hardness is the chalk in their site relative hard, moderate or soft?).
13:55-14:25	Worked example break out groups to test the use of the agreed criteria - 1) Casework example - 2) Other applications- monitoring and marine visualisation
14:25-14.45	Break out groups to summarise discussion in feedback to group
14:45- 15:15	All group discussion on outputs and how individuals are likely to apply to their work
15:15-15:45	Wrap up and next steps

Appendix 3 Full list of chalk criteria with justification for inclusion or exclusion from the final list of key criteria

Table C. Original criteria discussed in initial group discussions with the final lists of criteria as decided by each group

Original Criteria	Group 1	Group 2	Group 3
Is the chalk a reef?			
Habitat composition/structural complexity	Yes		Yes
Elevation (m) above the surrounding seabed	Yes	Yes	
Area/extent (m^3)		Yes – with the addition of distribution	Yes – with the addition of distribution
Patchiness/percentage cover			
Biota		Yes	Yes - suggested this should be 'community composition' to align with Natural England's conservation advice terminology
Water depth (m)			Yes
Hardness			Yes
Roughness			
Turbidity			
Associated features/habitats			
Geographic context		Yes	Yes
Hydrodynamics			Yes
Water temperature			
Sedimentation rate			
Scour			
New criteria developed during discussions			
	Representivity/resilience	Physical factors – suggested to capture hydrodynamics, sedimentation rate and turbidity	
	Fragility	Lithological composition – suggested to capture geological characteristics of chalk	

Table D Full list of chalk criteria with justification for decisions on inclusion or exclusion based on discussions in the workshop.

Criteria and description	Included/excluded from the final list of chalk characterisation criteria	Justification
Depth and zonation Chalk MPAs in England include intertidal and subtidal chalk. Some sites contain deep subtidal chalk, which is relatively rare.	Included	This criteria was chosen to capture both the depth at which chalk occurs and the littoral zone it belongs to. This is important with respect to understanding how abiotic factors, such as light penetration and wave energy, might affect the flora and fauna associated with the chalk. This criteria was originally proposed as 'depth', but it was decided during discussion that 'zonation' is useful, and could be aligned to the zonation categories used in conservation advice packages.
Lithological composition Lithological composition looks at the different chalk formations in an MPA and captures the physical characteristics of chalk, such as hardness and softness.	Included	Understanding the geology of the chalk across England will help understand the likely associated flora and fauna. For example, chalk hardness varies from soft enough to crush in your hand to very hard and resilient. This will impact the nature of the organisms which bore into or attach to it. The geology will also indicate the likely structural complexity of the chalk, for example some chalk has thin layers of very hard chalk with softer chalk below, which leads to the formation of ledges and microhabitats as the softer chalk erodes faster. This criteria was not on the original list of possible criteria. It was decided that the inclusion of this criteria was the most effective means of capturing information which could otherwise have been captured in the following possible criteria: hardness, roughness
Hydrodynamic regime (including sedimentation rate, scour and turbidity) Water energy can be received through waves and tidal flow. The exposure of communities to energy can vary with aspect and depending on the elevation and structural complexity of the chalk. Additionally water	Included	Understanding the hydrodynamics surrounding chalk in a particular location is important for helping understand the likely impacts of sedimentation, scour and turbidity, which all have the potential to affect the flora and fauna. It was decided that the inclusion of this criteria was the most effective means of capturing information which could otherwise have been captured in the following possible criteria: Sedimentation rate, turbidity, scour

energy can impact sedimentation rate, scour and turbidity. Sedimentation rate can impact ecological processes and potentially lead to smothering. Scour may function as a disturbance mechanism, thereby influencing the community composition. Turbidity is caused by suspended particles and can be caused by inorganic matter such as sediments, or organic matter such a plankton. Increased turbidity can therefore have a range of possible impacts including restricting light availability for primary production, increasing food availability for filter feeders, and increasing scour.		
Structural complexity The least structurally complex form of subtidal chalk is flat bedrock which does not outcrop above the seabed and may or may not be covered by a veneer of sand or other mobile sediments. Structural complexity increases as areas of chalk are elevated from the surrounding seabed, with crevices and fissures developing in the bedrock. This creates a greater surface area for epifauna to attach to, and creates crevices for mobile species to take shelter in. Bedrock may have eroded into stacks, arches, overhangs, tunnels, crevices and caves. The chalk may take the form of isolated boulders and cobbles, with outcrops separated by gullies with vertical faces.	Included	There is a great variety of structural complexity in marine chalk across England. The structural complexity of the chalk will affect what flora and fauna is associated with it and as structural complexity can vary enormously between, and also within sites, it is important to understand which structures are located in which MPAs, as one MPA may contain the only example of a particular chalk structure. This criteria was originally proposed as ‘habitat composition / structural complexity’. It was decided that structural complexity was the most appropriate name. MNCR recording forms were used to standardise the feature options. It was decided that the inclusion of this criteria was the most effective means of capturing information which could otherwise have been captured in the following possible criteria: elevation, roughness, is it a reef?.

Extent and distribution Extent and distribution of chalk is likely to vary between and within MPAs.	Included	Understanding the total amount of marine chalk and its distribution is important for understanding the total amount of this resource in UK waters.
Geographic context Some MPAs contain chalk in a notable geographic location. For example the chalk may be the most northerly / westerly chalk in the UK, or support biota which are at the limit of their geographic range.	Included	This criteria is relevant as some chalk in MPAs may represent chalk at the extreme of a geographic location. Knowing where these examples occur is fundamental to ensuring the importance of geographic location is taken into account when considering the chalk network. It is important for an ecologically coherent network to have representation of habitats within all the relevant regional seas.
Community composition The community composition of chalk habitats can be described in a number of ways, including using modes of living (infauna, epifauna, mobile species) or feeding strategy (grazers, filter feeders etc.). For this report, we will be categorising community composition using standardised MarLIN biotopes.	Included	Knowing how biotopes vary across the MPA network is important in understanding the distribution and relative abundance of each biotope. It was decided that community composition was more appropriate than the alternative criteria option of ‘biotopes’ as this allows for additional information on the species within communities, as well as the higher level biotope information. It also makes this criteria consistent with conservation advice packages. It was decided that the inclusion of this criteria was the most effective means of capturing information which could otherwise have been captured in the following possible criteria: Water temperature
Water Temperature Water temperature can affect the presence and distribution of species. Processes and behaviours	Excluded	It was decided that this information could be more effectively captured by the inclusion of ‘community composition’, which will be dictated in part by the water temperature.

such as recruitment and spawning can be influenced by water temperature.		
Fragility This criteria was suggested in the workshop as a way of gauging the sensitivity of the marine chalk in different MPAs.	Excluded	This criteria was suggested in the workshop however it was decided that the fragility of the chalk could be inferred by using the other criteria. It was decided that this information could be more effectively captured by the inclusion of lithology and community composition.
Elevation Chalk bedrock may lie flat against the surrounding seabed, or outcrops may rise to up to 4m above the surrounding seabed. There may be a wide range of elevation within a site. This can influence the hydrodynamics in a site and the habitats available to associated fauna.	Excluded	It was decided that the variety in chalk caused by different elevations of chalk would be adequately captured under the structural complexity attribute.
Is the chalk a reef? Some of the MPAs contain subtidal chalk reef, and some support chalk which does not qualify as reef. It will not qualify as reef if it is bedrock which is not topographically distinct from the seafloor. Reef and flat bedrock are structurally different, and will result in different associated biota. Subtidal chalk is classified as reef when the chalk rises above the surrounding seabed, and may create greater structural complexity and surface area. Individual sites may include both flat bedrock and reef.	Excluded	Reef can become an emotive term with users reading reefiness as a hierarchy. It was decided that the reefiness of chalk was more effectively covered by the structural complexity attribute which allows for descriptions such as reef, bedrock, boulders, caves etc. to be used.
Patchiness/percentage cover Some sites may be entirely covered by chalk in one or various formats. Other sites are made up of chalk interspersed with other subtidal habitats. The chalk may be located in one specific section of the	Excluded	Patchiness/percentage cover were felt to be more effectively captured through the ‘Extent and distribution’ criterion.

site, or in multiple locations. Chalk composition and communities may be different in different sections of the site.		
Roughness The roughness of chalk substrate can occur at a range of different scales meaning it can influence organisms at different size ranges. Where chalk exhibits a fine scale roughness this may influence the organisms that can attach or graze on its surface. Where chalk exhibits a larger scale roughness this may provide shelter to small organisms. Roughness will be determined by the nature of the chalk and the prevailing environmental conditions.	Excluded	It was decided that the roughness of chalk was adequately covered by the structural complexity and lithology criteria.
Hardness Chalk hardness varies from soft enough to crush in your hand to very hard and resilient. This will impact the nature of the organisms which bore into rock or attach to it. Some chalk has thin layers of very hard chalk with softer chalk below, which leads to the formation of ledges and microhabitats as the softer chalk erodes faster.	Excluded	It was decided that the hardness of chalk was adequately covered by the lithology criterion.
Associated features/ habitats Sites designated for subtidal chalk and chalk reef often have other associated designated features, for example submerged or partially submerged sea caves, peat and clay exposures, subtidal sediments, biogenic reef, intertidal chalk, chalk cliffs and littoral caves. Biogenic reefs associated with chalk may be composed of mussel beds,	Excluded	This criteria was excluded as information on associated features and habitats should be already captured within the site descriptions for MPAs.

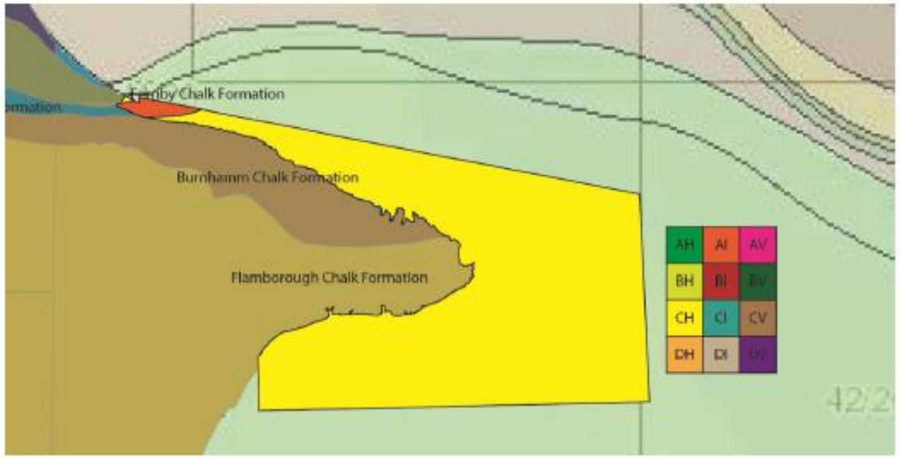
oyster beds or *Sabellaria* reefs forming a complex biogenic reef. In some cases the other features may be closely interspersed forming a mosaic of habitats. The surrounding habitats may influence species recruitment.		
Turbidity Turbidity is caused by suspended particles and can be caused by inorganic matter such as sediments, or organic matter such a plankton. Increased turbidity can therefore have a range of possible impacts including restricting light availability for primary production, increasing food availability for filter feeders, and increasing scour.	Excluded	It was decided that this information is more effectively captured by the ‘hydrodynamics’ criterion
Sedimentation rate Sedimentation rate can impact ecological processes and potentially lead to smothering.	Excluded	It was decided that this information is more effectively captured by the ‘hydrodynamics’ criterion
Scour Scour may function as a disturbance mechanism, thereby influencing the community composition.	Excluded	It was decided that this information is more effectively captured by the ‘hydrodynamics’ criterion

Appendix 4 Chalk characterisation project – site specific detail

Appendix 4.1 Flamborough Head SAC

<table>
<tr><th>Criteria name</th><th>Criteria classification</th><th>Site specifics</th></tr>
<tr><td rowspan="2">Zonation</td><td>Depth BCD (metres).</td><td>Up to 45m (Howson et al, 2002).</td></tr>
<tr><td>Zones (categories used in conservation advice e.g. Infralittoral, circalittoral).</td><td>Circalittoral, infralittoral, intertidal (English Nature, 2000). Supralittroral (Natural England, 2017).</td></tr>
<tr><td>Lithological composition</td><td>Structural attitude (Horizontal/ inclined/ vertical).

This map/ has been produced using the following data sources:
• Shapefiles for MCZs and SACs where chalk substrates are considered to be present.
• Shapefiles for the bedrock geology of England (British Geological Survey 1:50,000 scale).
• MareMap – providing distributions of seafloor bedrock, Quaternary and modern sediments, thickness of seafloor sediments (Hopson, 2005).
• For full method see Annex I.

<table><tr><th>Broad lithology</th><th>Specific character</th><th>Map type</th></tr><tr><td>Regularly alternating chalk and marl (typically</td><td></td><td>A</td></tr></table></td><td>

Primarily Chalk map type C:
- Thick units of chalk 100s of mm to meter scale alternating with thin 10s of mm marl seams.
- Chalk is flint rich and formations include Seaford Chalk, Newhaven Chalk, Culver Chalk, Portsdown Chalk, Welton Chalk, Burnham chalk, Flamborough Chalk, Rowe Chalk Formation.
- Structural attitude: Horizontally bedded.</td></tr>
</table>

<table>
<tr>
<td></td>
<td>
<table>
<tr><td>at scales of 100-500 mm)</td><td></td><td></td></tr>
<tr><td rowspan="3">Thick units of chalk (100s of mm to metre scale alternating with thin 10s of mm marl seams)</td><td>With little or flint</td><td>B</td></tr>
<tr><td>Flint rich</td><td>C</td></tr>
<tr><td>With nodular chalks and hardgrounds</td><td>D</td></tr>
</table>
<table>
<tr><td>Type</td><td>Horizontal (H)</td><td>Inclined (I)</td><td>Vertical (V)</td></tr>
<tr><td>A</td><td>AH</td><td>AI</td><td>AV</td></tr>
<tr><td>B</td><td>BH</td><td>BI</td><td>BV</td></tr>
<tr><td>C</td><td>CH</td><td>CI</td><td>CV</td></tr>
<tr><td>D</td><td>DH</td><td>DI</td><td>DV</td></tr>
</table>
</td>
<td>Also includes Chalk map type A:
- Regularly alternating chalk and marl (typically at scales of 100-500 mm).
- Includes formations such as West Melbury Marly Chalk and Zig Zag chalk.
- Structural attitude: Inclined bedding.</td>
</tr>
<tr>
<td>Hydrodynamics</td>
<td>Example possible descriptors:
• Current speed and direction,
• Turbidity,
• Suspended sediment,
• Wave height and speed and,
• Exposure classification.

Any other information site leads consider relevant / of interest.</td>
<td>Flamborough Head is located at the meeting of the colder water of the Northern North Sea and the warmer water of the Southern North Sea, resulting in a strong offshore frontal system called the Flamborough Front (English Nature, 2000). The mixing of waters results in increased plankton growth and secondary production (Institute of Estuarine and Coastal Studies 1992- cited by English Nature 2000).The northern and southern sides of the headland have a different hydrodynamic regime and temperature, which in turn influences the presence and distribution of species (English Nature, 2000).

Flamborough Head is situated in a current-swept area and increased water movement is important for the benthic communities on the reefs here. Flamborough head is exposed, with strong tides, generally resulting in very high turbidity, particularly in shallower water (Howson et al, 2002).

The reefs on the northern side are harder and slightly more exposed than those on the southern side of the headland (English Nature, 2000). Subtidal habitats on the southern side are more likely to be regularly covered with sediment, resulting in high levels of turbidity and varying levels of sedimentation (CEFAS 2000 cited in NE Conservation Advice).</td>
</tr>
</table>

Structural complexity	Example possible descriptors: • Boulder/cobble on rock, • Boulder / cobble on sediment, • Sediment on rock elevation (metres); • Stability (stable – mobile), • Silt (none – silted), • Fissures >10mm (none – many), • Crevices <10mm (none – many), • Boulder/cobble/pebble shape (rounded – angular), • Gully, • Cave, • Tunnel, • Stacks, • Arches, and • Overhangs.	Particularly on the North Coast, the sublittoral chalk wavecut platforms are dissected by deep gullies, with outcrops projecting above platform level. Circalittoral rock includes bedrock platform and gullies, broken bedrock, boulder and cobble, cobbles, which covered a large area of the south coast. Smithic Sand comprises an extensive area of mobile, rippled, coarse sand. The harder rock on the northern side has resulted in numerous sublittoral overhangs and vertical faces. The intertidal rocky shores on the south facing side of the headland are characterised by wave cut platforms (Howson et al, 2002). Erosion of chalk cliffs have resulted in the formation of sea caves, arches, and stacks. There are more than 200 sea caves on the head (English Nature, 2000).
Extent / distribution	Extent	Flamborough Head accounts for 14% of UK and 9% of European coastal chalk exposure. Bedrock and boulder reefs extend up to 6km offshore (Musk et al, 2010). The best available evidence estimates reef coverage of at least 1355 Ha of the total site (6311.96 Ha) (Channel Coastal Observatory (CCO), 2014), (Musk et al, 2010), (Fox, 2003), (Natural England, 2010), (Brazier et al, 1998), (European Marine Observation and Data Network (EMODnet), 2012). Most of this evidence considers bedrock extent, but it is thought boulder and cobble reef can be found throughout the site (NE Advice on Operations).
	Description of distribution; link to map where possible.	Link to map on Magic website
Geographic context	Descriptive (e.g. geographic limits of chalk in UK; geographic limits of species in UK).	Flamborough Head is the most northern chalk outcrop in the UK (NE Advice on Operations). The SAC marks the southern North Sea distribution limit of some marine species e.g. algaes *Ptilota plumosa* and *Callithamnion sepositum*, bottle-brush hydroid *Thuiaria thuja* reaches its southern limit of distribution in England here (Brazier et al, 1998). The nationally rare hydroid *Diphasia alata* and the bryozoan *Smittina affinis* have been recorded at Flamborough Head (Howson et al, 2002).

Community composition.	Biotopes present	In this site both intertidal biotopes (Musk et al, 2010) and subtidal biotopes (Howson et al, 2002) were identified. The Eunis biotope codes are listed below and a full description of the biotope codes is included in Annex V.
		
		A1: Littoral rock and other hard substrates
		• **A1.1: High energy littoral rock**
		  ○ A1.11, A1.111, A1.1131, A1.1132, A1.12, A1.1221, A1.123, A1.124, A1.125, A1.126
		• **A1.2: Moderate energy littoral rock**
		  ○ A1.21, A1.212, A1.213, A1.214, A1.2141, A1.2142, A1.215, A1.22, A1.221, A1.222
		• **A1.3: Low energy littoral rock**
		  ○ A1.31, A1.3131, A1.3151
		• **A1.4 Features of littoral rock**
		  ○ A1.4111, A1.412, A1.413,A1.44, A1.441, A1.45, A1.451, A1.452
		
		A3: Infralittoral rock and other hard substrates
		• **A3.1: Atlantic and Mediterranean high energy infralittoral rock**
		  ○ A3.125
		• **A3.2: Atlantic and Mediterranean moderate energy infralittoral rock**
		  ○ A3.211, A3.212, A3.2141, A3.2142, A3.217,
		• **A3.3: Atlantic and Mediterranean low energy infralittoral rock**
		  ○ A3.312
		
		A4: Circalittoral rock and other hard substrates
		• **A4.1: Atlantic and Mediterranean high energy circalittoral rock**
		  ○ A4.1341, A4.135,
		• **A4.2: Atlantic and Mediterranean moderate energy circalittoral rock**
		  ○ A4.2141, A4.2143, A4.231, A4.241
		
		A5: Sublittoral sediment
		• **A5.1 Sublittoral coarse sediment**
		  ○ A5.141
		• **A5.4 Subtidal mixed sediments**
		  ○ A5.44, A5.444

	Notable species (notable by their presence e.g. rare species; or notable by their absence e.g. species ordinarily characteristic of that biotope).	Kelp communities are key structural and functional components at Flamborough Head. The forests are found in the shallow subtidal waters to a maximum depth of 5-8m below the lowest tide. The turbidity of the water restricts the presence of kelp below this depth (Davies & Southern, 1995). See above- geographic context some of the kelp forest seaweeds, e.g. the red seaweeds *Lomentaria clavellosa, L. orcadensis, Haraldiophyllum bonnemaisonii, Odonthalia dentate* and *Ptilota gunneri* (Brazier et al, 1998) are not found any further south in the North Sea than Flamborough Head. Several rare species are found at Flamborough Head, including the chalk-boring wrinkled rock borer *Hiatella arctica*, oval piddock *Zirfaea crispate* and worms of the *Polydora* spp. (Howson et al, 2002), (Brazier et al, 1998). Due to the wide variety of habitats and physical conditions around Flamborough Head headland, there are a high number of intertidal rocky shore biotopes present (Brazier et al, 1998). More than 110 species of seaweed, and over 270 species of invertebrates have been recorded here (George et al, 1988).

Reference List: Flamborough Head SAC

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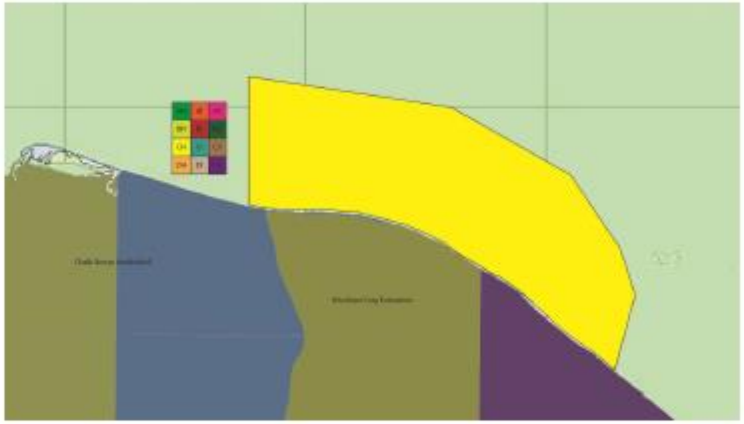
Appendix 4.2 Cromer Shoal MCZ

<table>
<tr><th>Criteria name</th><th>Criteria classification</th><th>Site specifics</th></tr>
<tr><td rowspan="2">Zonation</td><td>Depth BCD (metres).</td><td>0-25m (Green et al, 2015).</td></tr>
<tr><td>Zones (categories used in conservation advice e.g. Infralittoral, circalittoral).</td><td>Subtidal-infralittoral- circalittoral, (MCZ Designation Order).
Intertidal and littoral chalk is present within the area, but this falls outside the boundary of the MCZ.</td></tr>
<tr><td>Lithological composition</td><td>Structural attitude (Horizontal/ inclined/ vertical)

This map/ has been produced using the following data sources:
• Shapefiles for MCZs and SACs where chalk substrates are considered to be present.
• Shapefiles for the bedrock geology of England (British Geological Survey 1:50,000 scale).
• MareMap – providing distributions of seafloor bedrock, Quaternary and modern sediments, thickness of seafloor sediments (Hopson, 2005).
• For full method see Annex I.

<table>
<tr><th>Broad lithology</th><th>Specific character</th><th>Map type</th></tr>
<tr><td>Regularly alternating chalk and marl (typically at scales of 100-500 mm)</td><td></td><td>A</td></tr>
<tr><td rowspan="2">Thick units of</td><td>With little or flint</td><td>B</td></tr>
<tr><td>Flint rich</td><td>C</td></tr>
</table>
</td><td>
Entirely composed of Chalk map type C:
- Thick units of chalk 100s of mm to meter scale alternating with thin 10s of mm marl seams.
- Chalk is flint rich and formations include Seaford Chalk, Newhaven Chalk, Culver Chalk, Portsdown Chalk, Welton Chalk, Burnham chalk, Flamborough Chalk, Rowe Chalk Formation.
- Structural attitude: Horizontally bedded.</td></tr>
</table>

<table>
<tr>
<td></td>
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<table>
<tr><td>chalk (100s of mm
to metre scale
alternating with
thin 10s of mm
marl seams)</td><td>With nodular chalks and hardgrounds</td><td>D</td></tr>
</table>
<table>
<tr><td>Type</td><td>Horizontal (H)</td><td>Inclined (I)</td><td>Vertical (V)</td></tr>
<tr><td>A</td><td>AH</td><td>AI</td><td>AV</td></tr>
<tr><td>B</td><td>BH</td><td>BI</td><td>BV</td></tr>
<tr><td>C</td><td>CH</td><td>CI</td><td>CV</td></tr>
<tr><td>D</td><td>DH</td><td>DI</td><td>DV</td></tr>
</table>
</td>
<td></td>
</tr>
<tr>
<td>Hydrodynamics</td>
<td>Example possible descriptors:
Current speed and direction,
Turbidity,
Suspended sediment,
Wave height and speed, and
Exposure classification.
Any other information site leads consider relevant / of interest.</td>
<td>Tides are the dominant force in the region. Mean velocity at Spring tides is to 0.51 to 1.5 m/s, and at neap tides is 0.51-0.75 m/s. Waves also influence the site, with mean wave height of 1-1.5m, with mean annual wind speed of 7.1-9.0 m/s (ABP Marine Environmental Research Ltd, 2016).

Suspended sediment rates at Cromer are much lower than many other parts of the East Coast. Off the Cromer coast, summer suspended sediment ranges from 4—8 mg/l, compared to 8-32 mg/l along the rest of the coast, and up to 128mg/l within The Wash, and parts of the Lincolnshire and Suffolk coastline (HR Wallingford et al, 2002).

Within the MCZ, nearshore areas are subject to high energy waves and tides, and areas further offshore are much more sheltered. Mixed sediments within the site are subject to a range of exposures, and as a result, there are a range of sediment types within a highly dynamic environment (Net Gain, 2011). Chalk is regularly exposed and covered by sediment movement.

At Cromer the mean spring tide range is about 4.4m decreasing slightly moving south (Overstrand to Walcott Strategy study- Hydrodynamics Part 2. H.R Wallingford et al, 2002).</td>
</tr>
</table>

		Predominant tides run from north west to south east. Tidal currents are approx. between 1.2-1.5 knots at low and high tide respectively (H.R. Wallingford et al, 2002) with high levels of turbidity and suspended sediments. From May till Sept if periods of settled weather water will clear. Wave heights can be 1-2m in normal conditions and up to 2-3m in storms e.g. 2013 storm surge (North Norfolk District Council, 2016). Exposure is medium – high as there is little shelter from waves in strong north easterly winds, e.g. Sheringham. There is evidence of chalk in intertidal areas of West Runton, East Runton and Sheringham but this is not within MCZ boundary.
Structural complexity	Example possible descriptors: • Boulder/cobble on rock • Boulder / cobble on sediment, • Sediment on rock, • Elevation (metres), • Stability (stable – mobile), • Silt (none – silted), • Fissures >10mm (none – many), • Crevices <10mm (none – many), • Boulder/cobble/pebble shape (rounded – angular), • Gully, • Cave, • Tunnel, • Stacks, • Arches, and • Overhangs.	Chalk bedrock overlain with boulders and cobbles, as well as outcrops of chalk reef. Chalk outcrops are up to 3m high (Miller, 2014), and some outcrops have arches or ledges cut into them, and gullies in-between (Spray, 2010). Isolated boulders, stacks, arches, overhangs, tunnels and crevices are present (Spray, 2010), (Spray and Watson, 2012). Structural components include boulder/ cobble on rock; boulder/ cobble on sediment; sediment on rock; flint boulders and cobbles on rock; fissures, gullies from 50cm -1m depth and walls up to -3m high. There are tunnels and caves (20cm-50cm) for animals; overhangs and arches (up to 2m) and outcrops in the intertidal (up to 1m height) (NE Pers comm).
Extent / distribution	Extent	Infralittoral and circalittoral rock within the site are comprised of subtidal chalk, as well as other types of rock. It is not possible to accurately differentiate between chalk and the other types of rock using geophysical data. Therefore areas mapped as subtidal chalk, may also overlap with areas mapped as circalittoral and infralittoral rock (Natural England Conservation Advice).

		Natural England's feature extent data (Natural England, 2018) gives the following extent for features: • Subtidal chalk; 190.43 km^2
	Description of distribution; link to map where possible.	The site is broadly flat, but contains ridges, gullies and undulations. A large area of infralittoral rock extends almost across the whole site from east to west within the shallow inshore waters (up to 10m depth). Beyond this, in the deeper water, a band of circalittoral rock is present (Green et al, 2015). Link to map on Magic website
Geographic context	Descriptive (e.g. geographic limits of chalk in UK; geographic limits of species in UK).	None

Community composition	Biotopes present	In this site a variety of biotopes have been recorded (Spray and Watson, 2012). The Eunis biotope codes are listed below and a full description of the biotope codes is included in Annex V.
		
		A3: Infralittoral rock and other hard substrates
		• **A3.1: Atlantic and Mediterranean high energy infralittoral rock**
		  ○ A3.1161
		• **A3.2: Atlantic and Mediterranean moderate energy infralittoral rock**
		  ○ A3.215
		• **A3.3: Atlantic and Mediterranean low energy infralittoral rock**
		  ○ A3.312
		• **A3.7: Features of infralittoral rock**
		  ○ A3.72
		
		A4: Circalittoral rock and other hard substrates
		• **A4.1: Atlantic and Mediterranean high energy circalittoral rock**
		  ○ A4.13
		• **A4.2: Atlantic and Mediterranean moderate energy circalittoral rock**
		  ○ A4.2343
		
		A5: Sublittoral sediment
		• **A5.1 Sublittoral coarse sediment**
		  ○ A5.131, A5.137
		• **A5.2: Sublittoral sand**
		  ○ A5.231, A5.243, A5.43, A5.44

		• **A5.4 Subtidal mixed sediments** ◦ A5.44, A5.444
	Notable species (notable by their presence e.g. rare species; or notable by their absence e.g. species ordinarily characteristic of that biotope).	A new species of sponge, the purple *Hymedesmia* sponge was discovered on chalk walls within the site (Spray and Watson, 2012). There is a notable lack of kelp within the site, as it is too exposed, for the kelp to remain attached.

Reference List: Cromer Shoal MCZ

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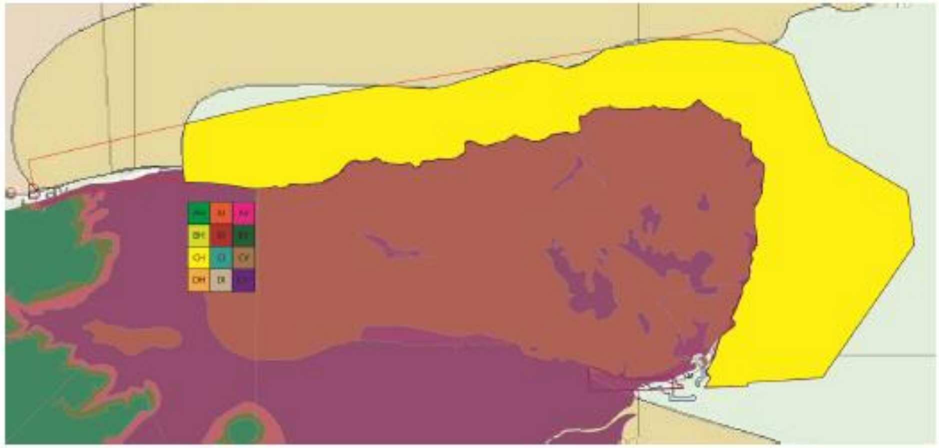
Appendix 4.3 Thanet Coast MCZ and SAC

<table>
<tr><th>Criteria name</th><th>Criteria classification</th><th>Site specifics</th></tr>
<tr><td rowspan="2">Zonation</td><td>Depth BCD (metres).</td><td>10 - -10m (UKHO, 2016).</td></tr>
<tr><td>Zones (categories used in conservation advice e.g. Infralittoral, circalittoral).</td><td>Circalittoral, infralittoral, sublittoral (Natural England, 2017).</td></tr>
<tr><td>Lithological composition</td><td>Structural attitude (Horizontal/ inclined/ vertical).

This map/ has been produced using the following data sources;

Shapefiles for MCZs and SACs where chalk substrates are considered to be present.
Shapefiles for the bedrock geology of England (British Geological Survey 1:50,000 scale).
MareMap – providing distributions of seafloor bedrock, Quaternary and modern sediments, thickness of seafloor sediments (Hopson, 2005).
For full method see Annex I.

<table>
<tr><th>Broad lithology</th><th>Specific character</th><th>Map type</th></tr>
<tr><td>Regularly alternating chalk and marl (typically at scales of 100-500 mm)</td><td></td><td>A</td></tr>
<tr><td rowspan="2">Thick units of</td><td>With little or flint</td><td>B</td></tr>
<tr><td>Flint rich</td><td>C</td></tr>
</table></td><td>

Entirely composed of Chalk map type C:

Thick units of chalk 100s of mm to meter scale alternating with thin 10s of mm marl seams.
Chalk is flint rich and formations include Seaford Chalk, Newhaven Chalk, Culver Chalk, Portsdown Chalk, Welton Chalk, Burnham chalk, Flamborough Chalk, Rowe Chalk Formation.
Structural attitude: Horizontally bedded.
</td></tr>
</table>

<table>
<tr>
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<table>
<tr><td>chalk (100s of mm
to metre scale
alternating with
thin 10s of mm
marl seams)</td><td>With nodular chalks and hardgrounds</td><td>D</td></tr>
</table>
<table>
<tr><th>Type</th><th>Horizontal (H)</th><th>Inclined (I)</th><th>Vertical (V)</th></tr>
<tr><td>A</td><td>AH</td><td>AI</td><td>AV</td></tr>
<tr><td>B</td><td>BH</td><td>BI</td><td>BV</td></tr>
<tr><td>C</td><td>CH</td><td>CI</td><td>CV</td></tr>
<tr><td>D</td><td>DH</td><td>DI</td><td>DV</td></tr>
</table>
</td>
<td></td>
</tr>
<tr>
<td>Hydrodynamics</td>
<td>Example possible descriptors:
Current speed and direction,
Turbidity,
Suspended sediment,
Wave height and speed, and
Exposure classification.
Any other information site leads consider relevant / of interest.</td>
<td>Moderate wave exposure around the headlands (Howson et al, 2005) and strong currents in site.
Very turbid water with low light penetration - due to porous nature of chalk (high concentration of particles in water column) plus close vicinity of site to the Thames estuary (English Nature 2000).</td>
</tr>
<tr>
<td>Structural complexity</td>
<td>Example possible descriptors:
Boulder/cobble on rock,
Boulder / cobble on sediment,
Sediment on rock,
Elevation (metres),
Stability (stable – mobile),
Silt (none – silted),
Fissures >10mm (none – many),
Crevices <10mm (none – many),</td>
<td>Gullies; caves; tunnels; stacks; arches and wave cut platforms (English Nature, 2000). Gullies (30cm deep and 1.5m wide) are at right angles to the shore. Reef up to 1m in height in places (Wood 1992).</td>
</tr>
</table>

	• Boulder/cobble/pebble shape (rounded – angular), • Gully, • Cave, • Tunnel, • Stacks, • Arches, and • Overhangs.	
Extent / distribution	Extent	Extent of subtidal chalk is 2421.196 Ha, moderate energy circalittoral rock is 1035.001 Ha, moderate energy infralittoral rock is 389.085 Ha (Natural England, 2018).
	Description of distribution; link to map where possible	Thanet has the second longest uninterrupted extent of chalk cliffs in England. The chalk extends into the intertidal and subtidal, forming large expanses extending offshore (JNCC, 2014). The wave-cut platform is more of less continuous. Link to map on MAGIC Thanet Coast MCZ partially overlaps with Thanet Coast SAC, and each designation protects different features.
Geographic context	Descriptive (e.g. geographic limits of chalk in UK; geographic limits of species in UK).	Thanet represents 12% of coastal chalk exposure in Europe and 20% of UK coastal chalk, and has the longest continuous stretch of coastal chalk in Britain (English Nature, 1995).

Community composition	Biotopes present	In this site both intertidal biotopes and subtidal biotopes (Tittley et al, 1998) were identified. The Eunis biotope codes are listed below and a full description of the biotope codes is included in Annex V.
		
		A1: Littoral rock and other hard substrates
		• **A1.1: High energy littoral rock**
		  ○ A1.124, A1.125, A1.126
		• **A1.2: Moderate energy littoral rock**
		  ○ A1.215
		• **A1.3: Low energy littoral rock**
		  ○ A1.313, A1.3151
		• **A1.4 Features of littoral rock**
		  ○ A1.411, A1.4121, A1.45

		A3: Infralittoral rock and other hard substrates
		• **A3.2: Atlantic and Mediterranean moderate energy infralittoral rock**
		  ○ A3.2113
		
		A4: Circalittoral rock and other hard substrates
		• **A4.1: Atlantic and Mediterranean high energy circalittoral rock**
		  ○ A4.135,
		• **A4.2: Atlantic and Mediterranean moderate energy circalittoral rock**
		  ○ A4.231
		
		A5: Sublittoral sediment
		• **A5.4 Subtidal mixed sediments**
		  ○ A5.444

	Notable species (notable by their presence e.g. rare species; or notable by their absence e.g. species ordinarily characteristic of that biotope)	Important location for scarce Chrysophyceae algae. Lack the mid to upper littoral biotope classifying species *Pelvetia canaliculata* and *Ascophyllum nodosom* which are common elsewhere (English Nature, 2000). Species diversity in the site is intrinsically low due to harsh environmental conditions and geologically unique environment. There is a low diversity of kelps, with apparently stunted growth. Rock boring fauna high are most common, with other animal life generally limited (Wood, 1992).

Reference List: Thanet Coast SAC and MCZ

ENGLISH NATURE. 2000. English Nature's advice for North East Kent European marine sites given under Regulation 33(2) of the Conservation (Natural Habitats &c.) Regulations 1994.

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NATURAL ENGLAND. 2017. Natural England Conservation Advice for Marine Protected Areas Thanet Coast MCZ – UKMCZ0017. Designated sites view [online], URL: https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UKMCZ0017&SiteName=thanet&SiteNameDisplay=Thanet+Coast+MCZ&countyCode=&responsiblePerson=&SeaArea=&IFCAArea= [Accessed 23rd May 2019].

NATURAL ENGLAND. 2018. Natural England Conservation Advice for Marine Protected Areas Thanet Coast MCZ – Supplementary advice. Designated sites view [online], URL: https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UKMCZ0017&SiteName=thanet%20coast&countyCode=&responsiblePerson=&SeaArea=&IFCAArea= [Accessed 23rd May 2019].

TITTLEY,I., SPURRIER,C.J.H., CHIMONIDES,P.J., GEORGE,J.D., MOORE,J.A., EVANS,N.J. and MUIR,A.I. 1998. Survey of chalk cave, cliff, intertidal and subtidal reef biotopes in the Thanet coast cSAC. English Nature Research Reports No. 325.

UK Hydrographic Office (UKHO). 2016. DepthAreas, DRVAL2

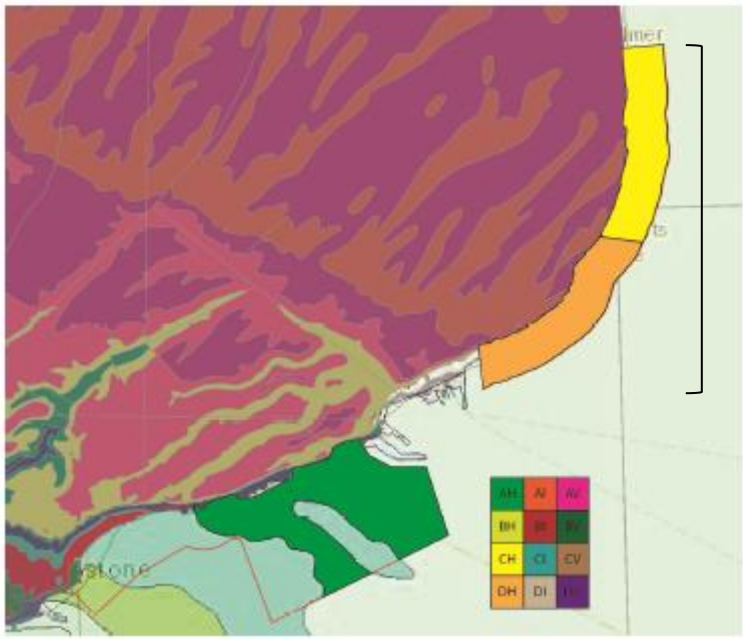
WOOD,C., 1992. Sublittoral chalk habitats in Southern England. Report to the Marine Conservation Society, South East Group Chalk Cliffs project 1985-1991

Appendix 4.4 Dover to Deal MCZ

<table>
<tr><th>Criteria name</th><th>Criteria classification</th><th>Site specifics</th></tr>
<tr><td rowspan="2">Zonation</td><td>Depth BCD (metres).</td><td>30m BCD (UKHO, 2016).</td></tr>
<tr><td>Zones (categories used in conservation advice e.g. Infralittoral, circalittoral)</td><td>Intertidal, littoral, infralittoral, subtidal (Designation Order)</td></tr>
<tr><td>Lithological composition</td><td>Structural attitude (Horizontal/ inclined/ vertical)

This map/ has been produced using the following data sources:

Shapefiles for MCZs and SACs where chalk substrates are considered to be present.
Shapefiles for the bedrock geology of England (British Geological Survey 1:50,000 scale).
MareMap – providing distributions of seafloor bedrock, Quaternary and modern sediments, thickness of seafloor sediments (Hopson, 2005).
For full method see Annex I.

<table>
<tr><th>Broad lithology</th><th>Specific character</th><th>Map type</th></tr>
<tr><td>Regularly alternating chalk and marl (typically at scales of 100-500 mm)</td><td></td><td>A</td></tr>
<tr><td rowspan="2">Thick units of</td><td>With little or flint</td><td>B</td></tr>
<tr><td>Flint rich</td><td>C</td></tr>
</table></td><td>

Primarily Chalk map type C:

Thick units of chalk 100s of mm to meter scale alternating with thin 10s of mm marl seams.
Chalk is flint rich and formations include Seaford Chalk, Newhaven Chalk, Culver Chalk, Portsdown Chalk, Welton Chalk, Burnham chalk, Flamborough Chalk, Rowe Chalk Formation.
Structural attitude: Horizontally bedded.

Also includes Chalk map type D:</td></tr>
</table>

<table>
<tr>
<td></td>
<td>
<table>
<tr><td>chalk (100s of mm
to metre scale
alternating with
thin 10s of mm
marl seams)</td><td>With nodular chalks and hardgrounds</td><td>D</td></tr>
</table>
<table>
<tr><td>Type</td><td>Horizontal (H)</td><td>Inclined (I)</td><td>Vertical (V)</td></tr>
<tr><td>A</td><td>AH</td><td>AI</td><td>AV</td></tr>
<tr><td>B</td><td>BH</td><td>BI</td><td>BV</td></tr>
<tr><td>C</td><td>CH</td><td>CI</td><td>CV</td></tr>
<tr><td>D</td><td>DH</td><td>DI</td><td>DV</td></tr>
</table>
</td>
<td>- Thick units of chalk 100s of mm to meter scale alternating with thin 10s of mm marl seams.
- Includes nodular chalks and hardgrounds. Formations include; Holywell Nodular Chalk and Lewes Nodular Chalk
- Structural attitude: Horizontally bedded.</td>
</tr>
<tr>
<td>Hydrodynamics</td>
<td>Example possible descriptors:
• Current speed and direction,
• Turbidity,
• Suspended sediment,
• Wave height and speed,
• Exposure classification.
Any other information site leads consider relevant / of interest.</td>
<td>Exposure ranges from low, moderate to high (Defra 2016).
Detailed information on hydrodynamics at this site is currently unavailable.</td>
</tr>
<tr>
<td>Structural complexity</td>
<td>Example possible descriptors:
• Boulder/cobble on rock,
• Boulder/ cobble on sediment,
• Sediment on rock,
• Elevation (metres),
• Stability (stable – mobile),
• Silt (none – silted),
• Fissures >10mm (none – many),
• Crevices <10mm (none – many),</td>
<td>Boulders, wavecut platform, gullies and rockpools (Natural England, 2014; Defra, 2016).

Beaches at this site are mainly composed of rounded chalk and a mixture of rounded and angular/unrounded flint. Boulders, chalk cobbles and flints erode from the cliffs (May, 2007).

The chalk platform extends across the intertidal, into the subtidal at varying distances from shore. Intertidally, the platform is scored with gullies and rockpools. The structural complexity of the subtidal chalk varies significantly within the site- ranging from flat exposures overlain</td>
</tr>
</table>

	• Boulder/cobble/pebble shape (rounded – angular), • Gully, • Cave, • Tunnel, • Stacks, • Arches, and • Overhangs.	with sediment to large outcropping chalk reef. Large boulders are also present. Subtidal gullies are up to 2m high (Balanced Seas, 2011).
Extent / distribution	Extent	Feature extents area (Natural England 2018); • High energy intertidal rock; 1.371 Ha. • Moderate energy infralittoral rock; 287.121 Ha. • Moderate energy intertidal rock; 87.526 Ha. • Subtidal chalk; 346.412 Ha.
	Description of distribution; link to map where possible	Feature map available here
Geographic context	Descriptive (e.g. geographic limits of chalk in UK; geographic limits of species in UK)	None

Community composition	Biotopes present	A variety of biotopes have been identified in this site (Seasearch and Kent Wildlife Trust, 2014; Seasearch and Kent Wildlife Trust, 2017) were identified. The Eunis biotope codes are listed below and a full description of the biotope codes is included in Annex V.
		A4: Circalittoral rock and other hard substrates
		• **A4.1: Atlantic and Mediterranean high energy circalittoral rock**
		  ○ A4.13, A4.135, A4.138
		• **A4.2: Atlantic and Mediterranean moderate energy circalittoral rock**
		  ○ A4.23, A4.231, A4.233

	Notable species (notable by their presence e.g. rare species; or notable by their absence e.g. species ordinarily characteristic of that biotope)	The chalk foreshore at St Margaret's Bay represents the richest algal community in SE England (Defra, 2016). Intertidal ross worm reef borders sand fringing the chalk foreshore reef at this site- this is a rare combination and has not been recorded anywhere else in the UK (Natural England, 2014). Intertidal chalk underboulder communities are important at this site and support rare sponges (Balanced Seas, 2011).

Reference List: Dover to Deal MCZ

BALANCED SEAS. 2011. Dover to Deal rMCZ no 11.1, Marine Conservation Zone: Selection Assessment Document. [online] URL: http://webarchive.nationalarchives.gov.uk/20120502155526/http://www.balancedseas.org/page/RSG%20Resources.html [Accessed 23rd May 2019].

DEFRA. 2015a. Dover to Deal Recommended Marine Conservation Zone January 2015 Consultation on Sites Proposed for Designation in the Second Tranche of Marine Conservation Zones. [online] URL: https://consult.defra.gov.uk/marine/tranche2mczs/supporting_documents/Dover%20to%20Deal%20rMCZ%20site%20summary.pdf/ [Accessed 23rd May 2019].

DEFRA. 2015b. Dover to Deal rMCZ Post-survey Site Report Contract Reference: MB0120 Report Number: 9 Version 7 March 2015.

DEFRA 2016C. Dover to Deal Marine Conservation Zone factsheet. [online] URL: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/492361/mcz-dover-deal-factsheet.pdf [Accessed 23rd May 2019].

HOPSON.P. 2005. A stratigraphical framework for the Upper Cretaceous Chalk of England and Scotland with statements on the Chalk of Northern Ireland and the UK Offshore Sector. British Geological Survey Research Report RR/05/01.

KENT WILDLIFE TRUST, SEASEARCH. 2014. Summary of Kent WT Seasearch Subtidal Surveys carried out in 2014 in Dover to Deal recommended Marine Conservation Zone. [online] URL: http://www.seasearch.org.uk/downloads/Dover%20to%20Deal%20rMCZ%20Kent%20WT%202014%20Seasearch%20Report.pdf [Accessed 23rd May 2019].

May,V.J. 2007. Kingsdown - Dover. Volume 28: Coastal Geomorphology of Great Britain Chapter 4: Soft-rock cliffs – GCR site reports Site: KINGSDOWN - DOVER (GCR ID: 1841) [online] URL: http://jncc.defra.gov.uk/pdf/gcrdb/GCRsiteaccount1841.pdf [Accessed 23rd May 2019].

NATURAL ENGLAND. 2014. Marine Conservation Zones Natural England's advice to Defra on recommended Marine Conservation Zones to be considered for consultation in 2015 Site-specific advice

SEASEARCH and KENT WILDLIFE TRUST. 2017. Gathering data on Marine Conservation Zone features in Kent. [online] URL: http://www.seasearch.org.uk/downloads/Kent-MCZs-2017.pdf [Accessed 23rd May 2019].

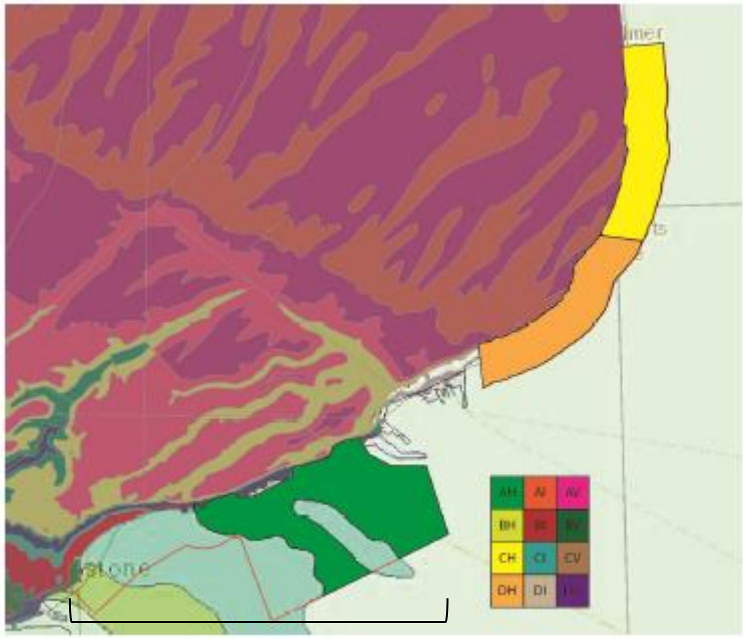
UK Hydrographic Office (UKHO). 2016. DepthAreas, DRVAL2

Appendix 4.5 Dover to Folkestone MCZ

<table>
<tr><th>Criteria name</th><th>Criteria classification</th><th>Site specifics</th></tr>
<tr><td rowspan="2">Zonation</td><td>Depth BCD (metres).</td><td>≤30m (UKHO, 2016).</td></tr>
<tr><td>Zones (categories used in conservation advice e.g. Infralittoral, circalittoral).</td><td>Intertidal, littoral, infralittoral, subtidal (Designation order).</td></tr>
<tr><td>Lithological composition</td><td>Structural attitude (Horizontal/ inclined/ vertical).

This map/ has been produced using the following data sources:

Shapefiles for MCZs and SACs where chalk substrates are considered to be present.
Shapefiles for the bedrock geology of England (British Geological Survey 1:50,000 scale).
MareMap – providing distributions of seafloor bedrock, Quaternary and modern sediments, thickness of seafloor sediments (Hopson, 2005).
For full method see Annex I.

<table>
<tr><td>Broad lithology</td><td>Specific character</td><td>Map type</td></tr>
<tr><td>Regularly alternating chalk and marl (typically at scales of 100-500 mm)</td><td></td><td>A</td></tr>
<tr><td rowspan="2">Thick units of</td><td>With little or flint</td><td>B</td></tr>
<tr><td>Flint rich</td><td>C</td></tr>
</table></td><td>

Primarily Chalk map type C:
- Thick units of chalk 100s of mm to meter scale alternating with thin 10s of mm marl seams.
- Chalk is flint rich and formations include Seaford Chalk, Newhaven Chalk, Culver Chalk, Portsdown Chalk, Welton Chalk, Burnham chalk, Flamborough Chalk, Rowe Chalk Formation.
- Structural attitude: Horizontally bedded.

Also includes Chalk map type D:</td></tr>
</table>

<table>
<tr>
<td></td>
<td>
<table>
<tr><td>chalk (100s of mm
to metre scale
alternating with
thin 10s of mm
marl seams)</td><td>With nodular chalks and hardgrounds</td><td>D</td></tr>
</table>

<table>
<tr><th>Type</th><th>Horizontal (H)</th><th>Inclined (I)</th><th>Vertical (V)</th></tr>
<tr><td>A</td><td>AH</td><td>AI</td><td>AV</td></tr>
<tr><td>B</td><td>BH</td><td>BI</td><td>BV</td></tr>
<tr><td>C</td><td>CH</td><td>CI</td><td>CV</td></tr>
<tr><td>D</td><td>DH</td><td>DI</td><td>DV</td></tr>
</table>
</td>
<td>
- Thick units of chalk 100s of mm to meter scale alternating with thin 10s of mm marl seams.
- Includes nodular chalks and hardgrounds. Formations include; Holywell Nodular Chalk and Lewes Nodular Chalk.
- Structural attitude: Horizontally bedded.
</td>
</tr>
<tr>
<td>Hydrodynamics</td>
<td>Example possible descriptors:
• Current speed and direction,
• Turbidity,
• Suspended sediment,
• Wave height and speed, and
• Exposure classification.
Any other information site leads consider relevant / of interest.</td>
<td>Low energy, moderate energy and high energy intertidal rock (Defra 2015, Defra 2016).
Detailed information on hydrodynamics at this site is currently unavailable.</td>
</tr>
<tr>
<td>Structural complexity</td>
<td>Example possible descriptors:
• Boulder/cobble on rock,
• Boulder/ cobble on sediment,
• Sediment on rock,
• Elevation (metres),
• Stability (stable – mobile),
• Silt (none – silted),
• Fissures >10mm (none – many),
• Crevices <10mm (none – many),</td>
<td>Intertidal wave-cut platforms, hard rocky outcrops, ledges, boulders and sediment on rock (Defra 2016).

Ledges and gullies, flint cobbles and pebbles, rockpools.
The chalk platform extends across the intertidal, into the subtidal at varying distances from shore. Intertidally, the platform is scored with gullies and rockpools. The structural complexity of the subtidal chalk varies significantly within the site- ranging from flat exposures overlain with sediment to large outcropping chalk reef. Large boulders are also present. Subtidal gullies are up to 2m high (Balanced Seas, 2011).
Crevices and overhangs of large boulders (Tittley et al, 1989).</td>
</tr>
</table>

	• Boulder/cobble/pebble shape (rounded – angular), • Gully, • Cave, • Tunnel, • Stacks, • Arches, and • Overhangs.	
Extent / distribution	Extent	Natural England's feature extent data includes; • Moderate energy infralittoral rock; 130.895 Ha. • Moderate energy intertidal rock; 57.322 Ha (Natural England, 2018)
	Description of distribution; link to map where possible.	Link to map on Magic Almost continuous reef from Kingsdown, Deal to Folkestone Warren (Defra 2016, Balanced Seas, 2011).
Geographic context	Descriptive (e.g. geographic limits of chalk in UK; geographic limits of species in UK).	Several species reach their eastern limit of distribution (Tittley et al, 1989).

Community composition	Biotopes present	A variety of biotopes have been identified in this site (Kent Wildlife Trust and Seasearch, 2014; Natural England, 2013) were identified. The Eunis biotope codes are listed below and a full description of the biotope codes is included in Annex V.
		
		A1: Littoral rock and other hard substrates
		• **A1.2: Moderate energy littoral rock**
		  ○ A1.2143, A1.223,
		
		A4: Circalittoral rock and other hard substrates
		• **A4.1: Atlantic and Mediterranean high energy circalittoral rock**
		  ○ A4.13, A4.135, A4.138
		• **A4.2: Atlantic and Mediterranean moderate energy circalittoral rock**
		  ○ A4.23, A4.231, A4.232, A4.233

		A5: Sublittoral sediment
		• **A5.1 Sublittoral coarse sediment**
		  ○ A5.137
		• **A5.4 Subtidal mixed sediments**
		  ○ A5.441
		
		Intertidal underboulder communities, and peat and clay exposures where the subtidal chalk grades into chalk marl clay are also present (Defra, 2016).

	Notable species (notable by their presence e.g. rare species; or notable by their absence e.g. species ordinarily characteristic of that biotope)	*Clathrina coriacea*, a sponge not previously recorded in Kent (Kent Wildlife Trust and Seasearch, 2014). Hard rock habitats are found in the vicinity of Shakespeare Cliff, supporting a range of species including kelp, red algae and worm tubes. This particular habitat is unusual for the region, which is mostly softer sediments. (Defra, 2015). Only known foreshore sighting of brown alga *Desmerestia ligulata* (Balanced Seas, 2011). Some animals found here that are usually rarely seen east of the Isle of Wight (Tittley, 1986, cited in Balanced Seas, 2011). A species of sponge Clathrina coriacea, never previously recorded in Kent has been identified within the MCZ (Kent Wildlife Trust and Seasearch, 2014).

Reference List: Dover to Folkestone MCZ

BALANCED SEAS. 2011. Dover to Folkestone rMCZ no 11.2, Marine Conservation Zone: Selection Assessment Document. [online] URL: http://webarchive.nationalarchives.gov.uk/20120502155526tf_/http://www.balancedseas.org/page/RSG%20Resources.html [Accessed 23rd May 2019].

DEFRA. 2016. Dover to Folkestone Marine Conservation Zone factsheet. [online] URL: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/492368/mcz-dover-folkestone-factsheet.pdf. [Accessed 23rd May 2019].

DEFRA 2016. The Dover to Folkestone Marine Conservation Zone Designation Order 2016. [online] URL: http://www.legislation.gov.uk/ukmo/2016/6/contents/created. [Accessed 2nd September 2019].

HOPSON.P. 2005. A stratigraphical framework for the Upper Cretaceous Chalk of England and Scotland with statements on the Chalk of Northern Ireland and the UK Offshore Sector. British Geological Survey Research Report RR/05/01.

KENT WILDLIFE TRUST AND SEASEARCH. 2014. Summary of Kent WT Seasearch Subtidal Surveys carried out in 2014 in Dover to Folkestone recommended Marine Conservation Zone. [online] URL: http://www.seasearch.org.uk/downloads/Dover%20to%20Folkestone%20rMCZ%20Kent%20WT%202014%20Seasearch%20Report.pdf. [Accessed 23rd May 2019].

NATURAL ENGLAND. 2013 Natural England Verification Survey of Intertidal Sediments within the Dover to Folkestone rMCZ. [online] URL: https://data.gov.uk/dataset/1ed8c99c-da1a-4573-ab02-80f94927677b/2013-natural-england-verification-survey-of-intertidal-sediments-within-the-dover-to-folkestone-rmcz [Accessed 7th September 2019.]

TITTLEY, I., GEORGE,J.D., EVANS,N.J. and CHIMONIDES,P.J. 1989. Macrobenthos of non-chalk rocky shores in southeastern England. A report for the Nature Conservancy Council. London: British Museum (Natural History)

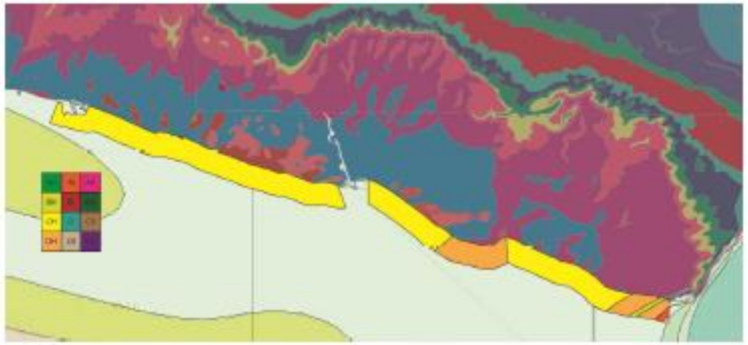
UK Hydrographic Office (UKHO). 2016. DepthAreas, DRVAL2

Appendix 4.6 Beachy Head West MCZ

<table>
<tr><th>Criteria name</th><th>Criteria classification</th><th>Site specifics</th></tr>
<tr><td rowspan="2">Zonation</td><td>Depth BCD (metres).</td><td>-20 to +10m (UKHO, 2016).</td></tr>
<tr><td>Zones (categories used in conservation advice e.g. Infralittoral, circalittoral).</td><td>Subtidal, Circalittoral, Infralittoral, Intertidal and Littoral (Natural England, 2013).</td></tr>
<tr><td>Lithological composition</td><td>Structural attitude (Horizontal/ inclined/ vertical).

This map/ has been produced using the following data sources:

Shapefiles for MCZs and SACs where chalk substrates are considered to be present.
Shapefiles for the bedrock geology of England (British Geological Survey 1:50,000 scale).
MareMap – providing distributions of seafloor bedrock, Quaternary and modern sediments, thickness of seafloor sediments (Hopson, 2005).
For full method see Annex I.

<table>
<tr><td>Broad lithology</td><td>Specific character</td><td>Map type</td></tr>
<tr><td>Regularly alternating chalk and marl (typically at scales of 100-500 mm)</td><td></td><td>A</td></tr>
<tr><td rowspan="2">Thick units of</td><td>With little or flint</td><td>B</td></tr>
<tr><td>Flint rich</td><td>C</td></tr>
</table>
</td><td>

Primarily Chalk map type C:
- Thick units of chalk 100s of mm to meter scale alternating with thin 10s of mm marl seams.
- Chalk is flint rich and formations include Seaford Chalk, Newhaven Chalk, Culver Chalk, Portsdown Chalk, Welton Chalk, Burnham chalk, Flamborough Chalk, Rowe Chalk Formation.
- Structural attitude: Horizontally bedded.

Also includes Chalk map type D:
- Thick units of chalk 100s of mm to meter scale alternating with thin 10s of mm marl seams.
- Includes nodular chalks and hardgrounds and formations such as Holywell Nodular Chalk and Lewes Nodular Chalk.
- Structural attitude: Inclined bedding.

Chalk map type B:
- Thick units of chalk 100s of mm to meter scale alternating with thin 10s of mm marl seams.</td></tr>
</table>

<table>
<tr>
<td></td>
<td>
<table>
<tr><td>chalk (100s of mm
to metre scale
alternating with
thin 10s of mm
marl seams)</td><td>With nodular chalks and hardgrounds</td><td>D</td></tr>
</table>

<table>
<tr><th>Type</th><th>Horizontal (H)</th><th>Inclined (I)</th><th>Vertical (V)</th></tr>
<tr><td>A</td><td>AH</td><td>AI</td><td>AV</td></tr>
<tr><td>B</td><td>BH</td><td>BI</td><td>BV</td></tr>
<tr><td>C</td><td>CH</td><td>CI</td><td>CV</td></tr>
<tr><td>D</td><td>DH</td><td>DI</td><td>DV</td></tr>
</table>
</td>
<td>- Chalk has little or no flint and formations include Ferriby Chalk and New Pit Marl.
- Structural attitude: Chalk of type B is found with both horizontal and inclined bedding.</td>
</tr>
<tr>
<td>Hydrodynamics</td>
<td>Example possible descriptors:
• Current speed and direction,
• Turbidity,
• Suspended sediment,
• Wave height and speed, and
• Exposure classification.
Any other information site leads consider relevant / of interest.</td>
<td>As the coastline here faces the prevailing currents and waves, wave energy is expected to be higher than that in other areas of the south coast with the largest effect being between Seaford and Beachy Head (Standing Conference on Problems Associated with the Coast Line [SCOPAC], 2015).

Wave direction is predominantly from southwest/west-southwest direction as indicated by the Seaford wave buoy (Channel Coastal Observatory, 2015); (Royal Haskoning, 2015). The eastward flood tide of each cycle provides a peak speed for the tidal stream (Wood, 1984) and as such the tidal current and thus the degree of tidal exposure increases eastwards towards Beachy Head (Wood, 1984), (Irving, 1999). At Beachy Head tidal currents can approach 1.25m/s (Irving, 1999).

There is limited information available on sedimentation rates and turbidity. However, sediment siltation increases at the eastern end of the fringing chalk reefs (Hiscock et al, 2006), (Wood, 1984) and Environment Agency water quality monitoring data from between 2009 and 2014 indicates a mean suspended sediment concentration of 5.15mg/l (Royal Haskoning, 2015).</td>
</tr>
<tr>
<td>Structural complexity</td>
<td>Example possible descriptors:
• Boulder/cobble on rock,</td>
<td>Aside from a gap between Newhaven and Seaford, littoral chalk wave cut platforms span the entire littoral zone (OSPAR Commission, 2009).</td>
</tr>
</table>

	• Boulder/ cobble on sediment, • Sediment on rock, • Elevation (metres), • Stability (stable – mobile), • Silt (none – silted), • Fissures >10mm (none – many), • Crevices <10mm (none – many), • Boulder/cobble/pebble shape (rounded – angular), • Gully, • Cave, • Tunnel, • Stacks, • Arches, and • Overhangs.	Subtidal chalk in the site includes areas covered by sediment (in the western zone). In the eastern zone where it is most exposed it forms irregular ridges and gullies running perpendicular to the shore from the low water mark. Additionally chalk platforms are present (Conservation Advice). Closer to the shore the gullies are larger and with vertical to undercutting sides, further from the shore the gullies become shallower, with wider ridges and are more regular. Occasionally chalk boulders are also present (Wood, 1984), (Wood, 1992).
Extent / distribution	Extent	The littoral chalk has an extent of approximately 103 Ha (Balanced Seas, 2011). The subtidal chalk has an extent of 5193 Ha. and is present throughout the site, although it is more exposed in the eastern zone (Natural England, 2016).
	Description of distribution; link to map where possible.	Aside from a gap between Newhaven and Seaford, littoral chalk spans almost the entire site (Balanced Seas, 2011). Map available on MAGIC here
Geographic context	Descriptive (e.g. geographic limits of chalk in UK; geographic limits of species in UK).	Beachy Head West MCZ is in the south-east of England and made up of two spatially separate sites. The site extends from Brighton to the Beachy Head Cliffs near Eastbourne and runs parallel to the East Sussex coastline, covering an area of approximately 24km^2 (Natural England, 2013). The intertidal wave cut chalk platforms and subtidal chalk ridges are among the best examples of marine chalk habitat in the south-east (SIFCA, 2018).
Community composition	Biotopes present	In this site both intertidal biotopes and subtidal biotopes (Brodie et al, 2007; Connor et al, 2004; Marine Ecological Surveys Limited, 2013; Balanced Seas, 2011; OSPAR Commission, 2009; Covey, 1998; James et al, 2010; Wood, 1984; Wood, 1992; British Geological Society (BGS) and ABPmer, 2003) were identified. The Eunis biotope codes are listed below and a full description of the biotope codes is included in Annex V.

		A1: Littoral rock and other hard substrates
		• **A1.1: High energy littoral rock**
		  ○ A1.12
		• **A1.2: Moderate energy littoral rock**
		  ○ A1.21, A1.22, A1.31, A1.41, A1.441, A1.45
		
		A3: Infralittoral rock and other hard substrates
		• **A3.2: Atlantic and Mediterranean moderate energy infralittoral rock**
		  ○ A3.21
		• **A3.3: Atlantic and Mediterranean low energy infralittoral rock**
		  ○ A3.31
		
		A4: Circalittoral rock and other hard substrates
		• **A4.1: Atlantic and Mediterranean high energy circalittoral rock**
		  ○ A4.13
		• **A4.2: Atlantic and Mediterranean moderate energy circalittoral rock**
		  ○ A4.23

	Notable species (notable by their presence e.g. rare species; or notable by their absence e.g. species ordinarily characteristic of that biotope)	None recorded.

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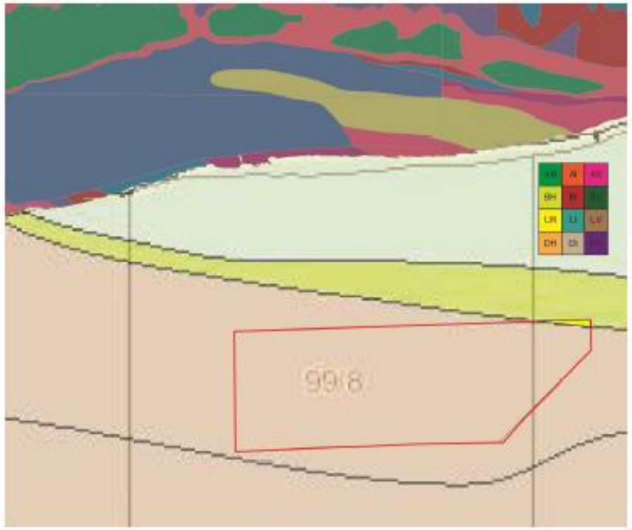
Appendix 4.7 Kingmere MCZ

<table>
<tr><th>Criteria name</th><th>Criteria classification</th><th>Site specifics</th></tr>
<tr><td rowspan="2">Zonation</td><td>Depth BCD (metres).</td><td>-5 to -20m deep (UKHO, 2016).</td></tr>
<tr><td>Zones (categories used in conservation advice e.g. Infralittoral, circalittoral).</td><td>Subtidal chalk (Natural England, 2015).</td></tr>
<tr><td>Lithological composition</td><td>Structural attitude (Horizontal/ inclined/ vertical).

This map/ has been produced using the following data sources:
Shapefiles for MCZs and SACs where chalk substrates are considered to be present.
Shapefiles for the bedrock geology of England (British Geological Survey 1:50,000 scale).
MareMap – providing distributions of seafloor bedrock, Quaternary and modern sediments, thickness of seafloor sediments (Hopson, 2005).
For full method see Annex I.
<table>
<tr><td>Broad lithology</td><td>Specific character</td><td>Map type</td></tr>
<tr><td>Regularly alternating chalk and marl (typically at scales of 100-500 mm)</td><td></td><td>A</td></tr>
<tr><td rowspan="2">Thick units of</td><td>With little or flint</td><td>B</td></tr>
<tr><td>Flint rich</td><td>C</td></tr>
</table></td><td>
This demonstrates the uncertainties an inaccuracies in the MareMap data. On the basis of the map, the bedrock consists entirely of Paleocene and Eocene sediments, yet the available survey data makes it clear the extreme north eastern corner of the site consists of a northerly facing submerged chalk cliff.

Primarily Chalk map type D:
- Thick units of chalk 100s of mm to meter scale alternating with thin 10s of mm marl seams.
- Includes nodular chalks and hardgrounds and formations such as Holywell Nodular Chalk and Lewes Nodular Chalk.
- Structural attitude: Inclined bedding.

Some chalk map type C:
- Thick units of chalk 100s of mm to scale alternating with thin 10s of mm marl seams.</td></tr>
</table>

<table>
<tr>
<td></td>
<td>
<table>
<tr><td>chalk (100s of mm
to metre scale
alternating with
thin 10s of mm
marl seams)</td><td>With nodular chalks and hardgrounds</td><td>D</td></tr>
</table>
<table>
<tr><td>Type</td><td>Horizontal (H)</td><td>Inclined (I)</td><td>Vertical (V)</td></tr>
<tr><td>A</td><td>AH</td><td>AI</td><td>AV</td></tr>
<tr><td>B</td><td>BH</td><td>BI</td><td>BV</td></tr>
<tr><td>C</td><td>CH</td><td>CI</td><td>CV</td></tr>
<tr><td>D</td><td>DH</td><td>DI</td><td>DV</td></tr>
</table>
</td>
<td>- Chalk is flint rich and formations include Seaford Chalk, Newhaven Chalk, Culver Chalk, Portsdown Chalk, Welton Chalk, Burnham Chalk, Flamborough Chalk, Rowe Chalk Formation.
- Structural attitude: Horizontally bedded.</td>
</tr>
<tr>
<td>Hydrodynamics</td>
<td>Example possible descriptors:
• Current speed and direction,
• Turbidity,
• Suspended sediment,
• Wave height and speed, and
• Exposure classification.
Any other information site leads consider relevant / of interest.</td>
<td>Within the vicinity of Kingmere MCZ the wave climate is characterised by the local sea waves generated within the Channel and from swell waves propagating from a fetch of up to 300km. Potential wave heights can reach 6m. Dominant wave direction is likely to be southerly to south-south-westerly (GoBe Consultants Ltd et al, 2014). Tidal currents in the central English Channel can be between a maximum of 0.75 and 1 metre per second on mean spring tides (Irving, 1999).
Sediment transport direction in the vicinity of Kingmere MCZ has been determined as being north-easterly and easterly which aligns with prevailing conditions (James and others 2010). An offshore to onshore transport pathway also potentially exists in the area (GoBe Consultants Ltd et al, 2014).</td>
</tr>
<tr>
<td>Structural complexity</td>
<td>Example possible descriptors:
• Boulder/cobble on rock,
• Boulder/ cobble on sediment,
• Sediment on rock,
• Elevation (metres),
• Stability (stable – mobile),
• Silt (none – silted),
• Fissures >10mm (none – many),
• Crevices <10mm (none – many),</td>
<td>Subtidal chalk outcropping reef systems.
The subtidal chalk cliffs often referred to as Worthing Lumps are the best examples of underwater chalk cliffs in Sussex and are located 8km southwest of Worthing sea front (Wildlife Trust, 2018).
The chalk cliffs have sheer faces standing 1-4m above the seabed (Williams and Clark, 2010). The cliff habitats provided by the chalk can be divided into three main types (Wood, 1984) including the flat cliff tops, dominated by mixed sediments of sand and gravel; sheer cliff faces that can form narrow gullies and crevices due to the high tidal flows and unstable nature of the cliff faces; and the base of the cliffs where there is exposed chalk with a covering of some pebbles and cobbles (Wood, 1984).</td>
</tr>
</table>

	• Boulder/cobble/pebble shape (rounded – angular), • Gully, • Cave, • Tunnel, • Stacks, • Arches, and • Overhangs.	Additionally, the soft chalk is bored by piddocks, which alters the structure of the rock (Irving, 1999).
Extent / distribution	Extent.	The subtidal chalk within Kingmere MCZ is found in the north east of the site with an approximate extent of 2 Ha (Natural England, 2015b).
	Description of distribution; link to map where possible.	The subtidal chalk is in the form of two distinctive chalk cliffs known as the Worthing Lumps (Wood, 1992). These are located approximately eight kilometres off the coast of Worthing. The two cliffs are 200 to 300 metres apart with the westerly cliff exceeding 350 meters and the easterly cliff exceeding 190 meters in length (Wood, 1992). Map available on Magic here
Geographic context	Descriptive (e.g. geographic limits of chalk in UK; geographic limits of species in UK).	Kingmere MCZ lies between 5 and 10 km offshore from the West Sussex coast between Worthing and Littlehampton (Natural England, 2015a).

Community composition	Biotopes present	A variety of biotopes have been identified in this site (Natural England, 2015b; Irving, 1999; Wood, 1984; Sussex Seasearch and Marine Conservation Society, 2012) were identified. The Eunis biotope codes are listed below and a full description of the biotope codes is included in Annex V.
		
		A4: Circalittoral rock and other hard substrates
		• **A4.1: Atlantic and Mediterranean high energy circalittoral rock**
		  ○ A4.13
		• **A4.2: Atlantic and Mediterranean moderate energy circalittoral rock**
		  ○ A4.23
		
		A5: Sublittoral sediment
		• **A5.1 Sublittoral coarse sediment**
		  ○ A5.141

	Notable species (notable by their presence e.g. rare species; or notable by their absence e.g. species ordinarily characteristic of that biotope).	Due to the reef and cliff formations of the Worthing lumps, a large variety of microhabitats are available. The upper horizontal chalk surfaces are dominated by Foliaceous red algae and a few individual kelp plants were also recorded near the top of the cliff face. Encrusting algae covered some areas of chalk and sponges were common. Tompot Blennies were located craters and channels ad Corkwing, Gladsinny and wrasses were common (Wood, 1992). A faunal turf dominated vertical faces, composed primarily of the hydroid *Tubularia indivisia*. Upper parts of the cliff were also bored by the White Piddock, *Barnea candida* and the Small Piddock *Barnea parva.* On the lower half of the cliff face, encrusting sponges were common, notably *Aplysilla* spp. (both *rosea* and *sulfurea*) and *Hemimycale columella.* Mobile marine life recorded at the lower cliff include crabs, lobsters and small fish (Wood, 1992). Within the infralittoral rock and thin mixed sediment feature at Kingmere MCZ, the circalittoral coarse sediment (A5.141 / SS.SCS.CCS) habitat types observed include biotopes that are known to have an intolerance to sediment smothering (GoBe Consultants Ltd et al, 2014). For example, the SS.SCS.CCS.PomB '*Pomatoceros triquester* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles' biotope identified to the north-east of Kingmere Rocks is known to have a high intolerance to sediment smothering (GoBe Consultants Ltd et al, 2014).

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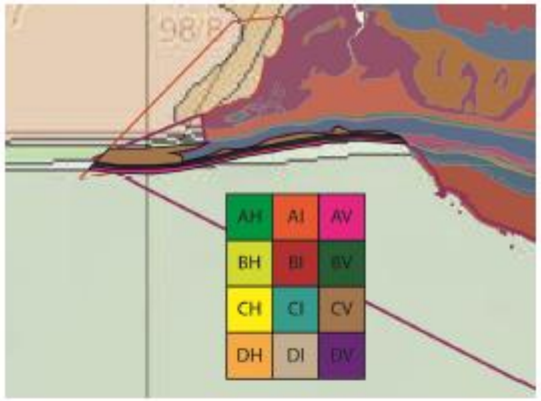
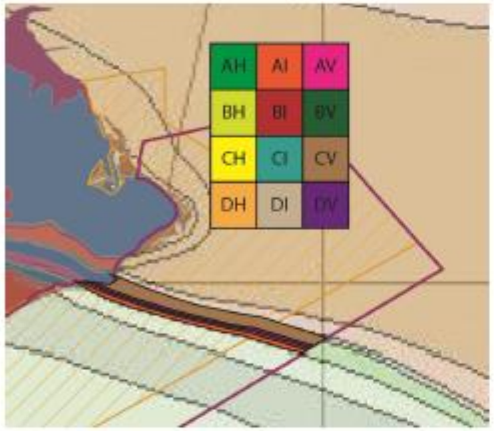
Appendix 4.8 South Wight Maritime SAC

<table>
<tr><th>Criteria name</th><th>Criteria classification</th><th>Site specifics</th></tr>
<tr><td rowspan="2">Zonation</td><td>Depth BCD (metres).</td><td>Greater than 40m (Bunker et al, 2005)</td></tr>
<tr><td>Zones (categories used in conservation advice e.g. Infralittoral, circalittoral).</td><td>Intertidal, Infralittoral, Circalittoral and subtidal (Natural, 2018).</td></tr>
<tr><td>Lithological composition</td><td>Structural attitude (Horizontal/ inclined/ vertical).

This map/ has been produced using the following data sources:

Shapefiles for MCZs and SACs where chalk substrates are considered to be present.
Shapefiles for the bedrock geology of England (British Geological Survey 1:50,000 scale).
MareMap – providing distributions of seafloor bedrock, Quaternary and modern sediments, thickness of seafloor sediments (Hopson, 2005).
For full method see Annex I.

<table>
<tr><th>Broad lithology</th><th>Specific character</th><th>Map type</th></tr>
<tr><td>Regularly alternating chalk and marl (typically at scales of 100-500 mm)</td><td></td><td>A</td></tr>
<tr><td rowspan="2">Thick units of chalk (100s of mm</td><td>With little or no flint</td><td>B</td></tr>
<tr><td>Flint rich</td><td>C</td></tr>
</table>
</td><td>Isle of Wight (west)


Isle of Wight (east)

</td></tr>
</table>

to metre scale alternating with thin 10s of mm marl seams)	With nodular chalks and hardgrounds	D

Type	Horizontal (H)	Inclined (I)	Vertical (V)
A	AH	AI	AV
B	BH	BI	BV
C	CH	CI	CV
D	DH	DI	DV

Isle of Wight (west) (marked by the purple line) from north west to south east

Chalk map type C:

- Thick units of chalk 100s of mm to meter scale alternating with thin 10s of mm marl seams.
- Chalk is flint rich and formations include Seaford Chalk, Newhaven Chalk, Culver Chalk, Portsdown Chalk, Welton Chalk, Burnham chalk, Flamborough Chalk, Rowe Chalk Formation.
- Structural attitude: Vertically bedded.

Chalk map type B

- Thick units of chalk (100s of mm to metre scale alternating with thin 10s of mm marl seams).
- Chalk has little or no flint. Formations include; Ferriby Chalk, New Pit Marl.
- Structural attitude: Vertically bedded.

Chalk map type D

- Thick units of chalk (100s of mm to metre scale alternating with thin 10s of mm marl seams).
- Includes nodular chalks and hardgrounds. Formations include; Holywell Nodular Chalk, Lewes Nodular Chalk.
- Structural attitude: Vertically bedded.

Chalk map type A

- Regularly alternating chalk and marl (typically at scales of 100 – 500 mm).
- Formations include; West Melbury Marly Chalk, Zig Zag Chalk.
- Structural attitude: Vertically bedded.

Isle of Wight (east) (marked by the purple line) from north east to south west

Chalk map type C:

- Thick units of chalk 100s of mm to meter scale alternating with thin 10s of mm marl seams.

		- Chalk is flint rich and formations include Seaford Chalk, Newhaven Chalk, Culver Chalk, Portsdown Chalk, Welton Chalk, Burnham chalk, Flamborough Chalk, Rowe Chalk Formation. - Structural attitude: Vertically bedded. Chalk map type D - Thick units of chalk (100s of mm to metre scale alternating with thin 10s of mm marl seams). - Includes nodular chalks and hardgrounds. Formations include; Holywell Nodular Chalk, Lewes Nodular Chalk. - Structural attitude: Vertically bedded. Chalk map type B - Thick units of chalk (100s of mm to metre scale alternating with thin 10s of mm marl seams). - Chalk has little or no flint. Formations include; Ferriby Chalk, New Pit Marl. - Structural attitude: Inclined bedded. Chalk map type A - Regularly alternating chalk and marl (typically at scales of 100 – 500 mm). - Formations include; West Melbury Marly Chalk, Zig Zag Chalk. - Structural attitude: Inclined bedded.
Hydrodynamics	Example possible descriptors: • Current speed and direction, • Turbidity, • Suspended sediment, • Wave height and speed, and • Exposure classification. Any other information site leads consider relevant / of interest.	Very exposed site. Exposure within the site ranges from extremely exposed to moderately sheltered. Wave and tide exposed headlands are present (English Nature, 2001). Friable nature of the cliffs and proximity to the Solent means that the waters of the South Wight Maritime SAC exhibit generally high turbidity (Bunker et al, 2005). The high exposure of the south coast of the Isle of Wight means the turbidity of the water is generally high. The natural turbidity of the water restricts kelp forest by limiting penetration of light through the water (Bunker et al, 2005). More detailed information on current speed, current direction, suspended sediment, wave height, and wave speed is unavailable.

Structural complexity	Example possible descriptors: • Boulder/cobble on rock, • Boulder/ cobble on sediment, • Sediment on rock, • Elevation (metres), • Stability (stable – mobile), • Silt (none – silted), • Fissures >10mm (none – many), • Crevices <10mm (none – many), • Boulder/cobble/pebble shape (rounded – angular), • Gully, • Cave, • Tunnel, • Stacks, • Arches, and • Overhangs.	There is a huge range of diversity of structural complexity within the site; Large chalk boulders and exposed rugged chalk bedrock (NE Advice on Operations), low lying limestone ledges with vertical and horizontal crevices (Howson, 2005) as well as intertidal rockpools and low elevation chalk bedrock (Mieszkowska et al, 2012). A number of different types of structural complexity have been identified through video survey (Bunker et al, 2005) including; • Large boulders with vertical and overhanging sides • Scattered boulders on mixed substrata and sand • Bedrock/ boulders outcropping from mixed substrata and sand • Cobbles and boulders • pebbles Intertidal reef surveys (Herbert, 2002) have identified; • rocky chalk shores with rock pools, • sea caves accessible by foot at extreme low tide • chalk boulders • exposed rugged chalk bedrock- in some areas, this bedrock has broken to form large boulders and overhangs • subtidal chalk caves • intertidal chalk caves • stacks • gullies • wave cut platform • cliffs
Extent / distribution	Extent	Accurate information for all marine chalk habitats is unavailable. NE's Conservation Advice Package, specifically Supplementary Advice on Conservation Objectives (SACOs) gives extent data for some of the features: • Circalittoral rock is 6065.68 Ha. • Infralittoral rock is 199.57 Ha. • Intertidal rock is 293.89 Ha. • Combined extent of intertidal rock, infralittoral rock and circalittoral rock within the site is 6559.14 Ha. • Subtidal stony reef extent is unavailable. • Vegetated sea cliffs extent is unavailable. Not all seacaves at site have been surveyed. 0.15 ha of intertidal sea caves have been surveyed so far (Irving, 2006), (Mieszkowska et al, 2012).

	Description of distribution; link to map where possible.	Areas across most of site most notably at Bembridge, Whitecliff, Culver Cliff, Alum Bay, Freshwater Bay. See MAGIC for distribution of various chalk features.
Geographic context	Descriptive (e.g. geographic limits of chalk in UK; geographic limits of species in UK)	Only known location of subtidal chalk caves in the UK (NE Conservation Advice Package). A number of species are at their eastern limit of distribution along the Eastern Channel at the Isle of Wight (English Nature, 2001).

Community composition	Biotopes present	A variety of biotopes have been identified in this site (Natural England, 2018; Sotheran and Foster Smith, 1995; Bunker et al, 2005; Herbert, 2002) were identified. The Eunis biotope codes are listed below and a full description of the biotope codes is included in Annex V.
		
		A1: Littoral rock and other hard substrates
		• **A1.1: High energy littoral rock**
		  ○ A1.113, A1.1131, A1.22, A1.123, A1.126
		• **A1.2: Moderate energy littoral rock**
		  ○ A1.213, A1.2141, A1.2142, A1.215
		• **A1.4 Features of littoral rock**
		  ○ A1.411, A1.4121, A1.44, A1.441, A1.441, A1.442, A1.443, A1.445
		
		A3: Infralittoral rock and other hard substrates
		• **A3.1: Atlantic and Mediterranean high energy infralittoral rock**
		  ○ A3.116
		• **A3.2: Atlantic and Mediterranean moderate energy infralittoral rock**
		  ○ A3.214, A3.215, A3.217
		• **A3.7: Features of infralittoral rock**
		  ○ A3.716, A3.7162
		
		A4: Circalittoral rock and other hard substrates
		• **A4.1: Atlantic and Mediterranean high energy circalittoral rock**
		  ○ A4.1121, A4.1341
		• **A4.2: Atlantic and Mediterranean moderate energy circalittoral rock**
		  ○ A4.2141, A4.221, A4.23, A4.231
		
		A5: Sublittoral sediment

<table>
<tr><td></td><td></td><td>A5.2 Sublittoral sand
A5.231
A5.4 Subtidal mixed sediments
A5.444</td></tr>
<tr><td></td><td>Notable species (notable by their presence e.g. rare species; or notable by their absence e.g. species ordinarily characteristic of that biotope)</td><td>Nationally scarce seaweed biotopes such as the shepherd’s purse seaweed Gracilaria bursa-pastoris and the Corallina officinalis seaweed community are present. Nationally scarce seaweed Padina pavonica which is now only recorded along South coast of Britain. Rare fish species such the trigger fish Balistes carolinensis, can be present in the summer months. These species are likely at the eastern limits of their distribution (English Nature, 2001).

Several rare and uncommon red algal species were recorded. Rare/ scare biotopes present include A1.441 Chrysophyceae and Haptophyceae on vertical upper littoral fringe soft rock (LR.FLR.CvOv.ChrHap); B3.1132 Verrucaria maura on very exposed to very sheltered upper littoral fringe rock (LR.FLR.Lic.Ver.Ver); and A1.126 Osmundea pinnatifida on moderately exposed mid eulittoral rock (LR.HLR.FR.Osm) (Bunker et al, 2005).</td></tr>
</table>

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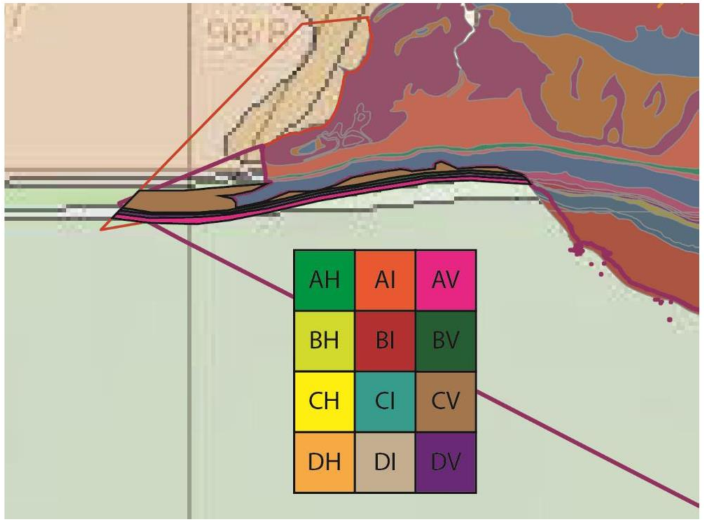
Appendix 4.9 The Needles MCZ

<table>
<tr><th>Criteria name</th><th>Criteria classification</th><th>Site specifics</th></tr>
<tr><td rowspan="2">Zonation</td><td>Depth BCD (metres).</td><td>-50 - +10 (UKHO, 2016).</td></tr>
<tr><td>Zones (categories used in Conservation Advice e.g. Infralittoral, circalittoral).</td><td>Infralittoral, circalittoral, subtidal and intertidal (DEFRA, 2016a).</td></tr>
<tr><td>Lithological composition</td><td>Structural attitude (Horizontal/ inclined/ vertical)

This map/ has been produced using the following data sources:
Shapefiles for MCZs and SACs where chalk substrates are considered to be present.
Shapefiles for the bedrock geology of England (British Geological Survey 1:50,000 scale).
MareMap – providing distributions of seafloor bedrock, Quaternary and modern sediments, thickness of seafloor sediments (Hopson, 2005).
For full method see Annex I.
<table>
<tr><th>Broad lithology</th><th>Specific character</th><th>Map type</th></tr>
<tr><td>Regularly alternating chalk and marl (typically at scales of 100-500 mm)</td><td></td><td>A</td></tr>
<tr><td rowspan="2">Thick units of</td><td>With little or flint</td><td>B</td></tr>
<tr><td>Flint rich</td><td>C</td></tr>
</table></td><td>

The Needles MCZ (marked by the orange line) from north west to south east

Chalk map type C:
- Thick units of chalk 100s of mm to meter scale alternating with thin 10s of mm marl seams.
- Chalk is flint rich and formations include Seaford Chalk, Newhaven Chalk, Culver Chalk, Portsdown Chalk, Welton Chalk, Burnham chalk, Flamborough Chalk, Rowe Chalk Formation.
- Structural attitude: Vertically bedded.

Chalk map type B</td></tr>
</table>

<table>
<tr>
<td></td>
<td>
<table>
<tr><td>chalk (100s of mm
to metre scale
alternating with
thin 10s of mm
marl seams)</td><td>With nodular chalks and hardgrounds</td><td>D</td></tr>
</table>
<table>
<tr><td>Type</td><td>Horizontal (H)</td><td>Inclined (I)</td><td>Vertical (V)</td></tr>
<tr><td>A</td><td>AH</td><td>AI</td><td>AV</td></tr>
<tr><td>B</td><td>BH</td><td>BI</td><td>BV</td></tr>
<tr><td>C</td><td>CH</td><td>CI</td><td>CV</td></tr>
<tr><td>D</td><td>DH</td><td>DI</td><td>DV</td></tr>
</table>
</td>
<td>
- Thick units of chalk (100s of mm to metre scale alternating with thin 10s of mm marl seams).
- Chalk has little or no flint. Formations include; Ferriby Chalk, New Pit Marl.
- Structural attitude: Vertically bedded.

Chalk map type D
- Thick units of chalk (100s of mm to metre scale alternating with thin 10s of mm marl seams).
- Includes nodular chalks and hardgrounds. Formations include; Holywell Nodular Chalk, Lewes Nodular Chalk.
- Structural attitude: Vertically bedded.

Chalk map type A
- Regularly alternating chalk and marl (typically at scales of 100 – 500 mm).
- Formations include; West Melbury Marly Chalk, Zig Zag Chalk.
- Structural attitude: Vertically bedded.
</td>
</tr>
<tr>
<td>Hydrodynamics</td>
<td>Example possible descriptors:
• Current speed and direction,
• Turbidity,
• Suspended sediment,
• Wave height and speed,
• Exposure classification.

Any other information site leads consider relevant / of interest.</td>
<td>Prevailing south western wind and swell. Strong tidal currents. The site is highly dynamic, including fast tidal flows and a narrowing channel (Arnold et al, 2016).

Moderate energy and high energy rock are present in the site (DEFRA, 2016b).

The area of subtidal chalk to the north of the Needles had virtually no silt on the surfaces, which reflects the strong tidal streams (Wood, 1992).</td>
</tr>
<tr>
<td>Structural complexity</td>
<td>Example possible descriptors:
• Boulder/cobble on rock,
• Boulder/ cobble on sediment,
• Sediment on rock,
• Elevation (metres),
• Stability (stable – mobile),
• Silt (none – silted),
• Fissures >10mm (none – many),
• Crevices <10mm (none – many),</td>
<td>There are a number of bays included in the MCZ. A description of the chalk types occurring in each bay is included below.

<u>Alum Bay</u>

The vertical chalk cliff on the southern side of Alum Bay does not extend significantly below the low water mark. From the cliff base, a horizontal chalk platform of approximately 50m width, extends out at or below the low water mark. At the outer edge of this platform there is a sublittoral chalk cliff about 3m in height. The lower half of the cliff has been undercut by wave action forming caves, overhangs and crevices. The upper part of the cliff remains vertical. This structural complexity provides a range</td>
</tr>
</table>

	• Boulder/cobble/pebble shape (rounded – angular), • Gully, • Cave, • Tunnel, • Stacks, • Arches, and • Overhangs.	of sloping, overhanging and cave-roof orientations, as well as open and shaded rock surfaces. A mixture of flint cobbles and chalk boulders from the chalk platform and cliffs make up the sea-bed below the chalk cliff. As you move further away from the chalk cliffs, these are replaced by a sand and pebble seabed, with boulders becoming more occasional with distance from the cliff base. At a depth of 7m, further offshore and running parallel to the main cliff, there is a second area of exposed chalk that forms a low reef not exceeding 1m in height. Grey clay and mobile ridges of gravel replace the chalk in some areas (Figure 1) (Wood, 1992). <u>The Needles</u> At the northern side of the needles the chalk is limited to about 50m from the stacks. Hereafter the seabed quickly drops to a gravel plain (Figure 2). The cliff (2-3m in height) found on the south side of Alum Bay continues to the north side of The Needles. In some areas, shallow gullies that run alongside a boulder slope and run parallel with the line of stacks, replace the cliffs. On the southern side of The Needles, an extensive shallow chalk reef system can be found. South-west of the lighthouse there is an underwater cliff about 3m high very close to the rock. Beyond this is an area of extensive chalk bedrock. A fairly regular ridge and gully pattern that runs parallel to the stacks can be seen in this chalk bedrock. Ridges are generally up to 1m in height, but there are ridges extending up to 2m. The sides of the gullies have little development of overhangs or caves being generally vertical (Figure 3). (Wood, 1992) <u>Scratchellls Nay</u> Here there is a shallow chalk and bedrock bottom that extends east to the south of The Needles. Sun Comer is the headland of the bay located at the easterly end. It also represents the most westerly extent of the southern coastal cliff, Main Bench. Underwater along the line of Main Bench there is a distinct reef running westsoutheast. There is a chalk reef 5m above the gravel and sea-bed on the southern side which has an irregular gully and reef formation that has large outcrops up to 2m above surrounding rocky areas. The reef in this location includes a variety of horizontal, vertical and sloping surfaces (Figure 4). (Wood, 1992).

<table>
<tr><td rowspan="2">Extent / distribution</td><td>Extent</td><td></td></tr>
<tr><td>Description of distribution; link to map where possible</td><td>Subtidal chalk is located throughout most of the site (Natural England, 2014).</td></tr>
<tr><td>Geographic context</td><td>Descriptive (e.g. geographic limits of chalk in UK; geographic limits of species in UK)</td><td>On the Isle of Wight and in Dorset, chalk is vertically bedded, which contrasts with the horizontally bedded chalk found elsewhere (Norfolk Biodiversity Partnership, 2006).</td></tr>
<tr><td rowspan="2">Community composition</td><td>Biotopes present</td><td>A variety of biotopes have been identified in this site (Hampshire and Isle of Wight Wildlife Trust, 2015). The Eunis biotope codes are listed below and a full description of the biotope codes is included in Annex V.
A3: Infralittoral rock and other hard substrates
• A3.1: Atlantic and Mediterranean high energy infralittoral rock
  ○ A3.115
• A3.2: Atlantic and Mediterranean moderate energy infralittoral rock
  ○ A3.2113, A3.215
A4: Circalittoral rock and other hard substrates
• A4.1: Atlantic and Mediterranean high energy circalittoral rock
  ○ A4.13, A4.138
• A4.2: Atlantic and Mediterranean moderate energy circalittoral rock
  ○ A4.23, A4.231, A4.233, A4.2511</td></tr>
<tr><td>Notable species (notable by their presence e.g. rare species; or notable by their absence e.g. species ordinarily characteristic of that biotope).</td><td>Laminaria hyperborean, Laminaria digitate, Foliaceous red algae, encrusting pink algae (which may stablise rocks and limit erosion), Piddocks (which extensively bore into rocks), squat lobsters, cave dwelling fish and leopard spotted goby Thorogobius ephippiatus are present.
Large squat lobster Galathea strigose can be found in caves. Small squat lobster Galathea squamifera among boulders.
In the offshore reef molluscs and worms are present. The exposed chalk had large numbers of the tiny horseshoe worm Phoronus hippocrepia. Animal ‘turf’ on northern side of The Needles included bryozoans such as Bugula turbinata, B. flabellata and Scrupocellaria species and hydroids such as Nemertesia antennina. To the south of the stacks, the Black Tar Sponge Dercitus bucklandi was noticeably common on the gully sides.
In Scratchells Bay, no kelp forests were present. Fish identified in the area included Pollack, Ballen Wrasse, Tompot Blenny and Leopard-Spotted Goby (Wood, 1992).</td></tr>
</table>

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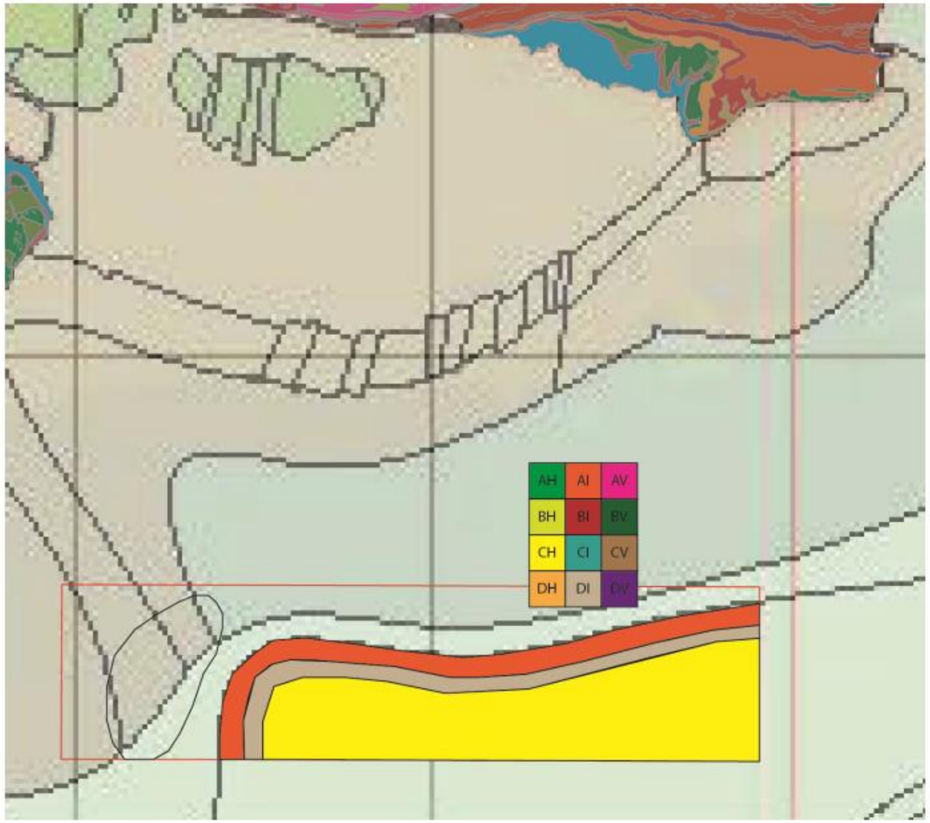
Appendix 4.10 South Dorset MCZ

<table>
<tr><th>Criteria name</th><th>Criteria classification</th><th>Site specifics</th></tr>
<tr><td rowspan="2">Zonation</td><td>Depth BCD (metres).</td><td>36 – 52m (UKHO, 2016).</td></tr>
<tr><td>Zones (categories used in conservation advice e.g. Infralittoral, circalittoral).</td><td>Circalittoral and subtidal (Natural England, 2016).</td></tr>
<tr><td>Lithological composition</td><td>Structural attitude (Horizontal/ inclined/ vertical).

This map/ has been produced using the following data sources:
Shapefiles for MCZs and SACs where chalk substrates are considered to be present.
Shapefiles for the bedrock geology of England (British Geological Survey 1:50,000 scale).
MareMap – providing distributions of seafloor bedrock, Quaternary and modern sediments, thickness of seafloor sediments. (Hopson, 2005).
For full method see Annex I.
<table>
<tr><td>Broad lithology</td><td>Specific character</td><td>Map type</td></tr>
<tr><td>Regularly alternating chalk and marl (typically at scales of 100-500 mm)</td><td></td><td>A</td></tr>
<tr><td rowspan="2">Thick units of</td><td>With little or flint</td><td>B</td></tr>
<tr><td>Flint rich</td><td>C</td></tr>
</table>
</td><td>

The level of confidence in this distribution is extremely low as a consequence of the scale of the bedrock map and the lack of data regarding the lithostratigraphy of the Chalk out in the Channel.</td></tr>
</table>

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<tr>
<td></td>
<td>
<table>
<tr><td>chalk (100s of mm
to metre scale
alternating with
thin 10s of mm
marl seams)</td><td>With nodular chalks and hardgrounds</td><td>D</td></tr>
</table>
<table>
<tr><th>Type</th><th>Horizontal (H)</th><th>Inclined (I)</th><th>Vertical (V)</th></tr>
<tr><td>A</td><td>AH</td><td>AI</td><td>AV</td></tr>
<tr><td>B</td><td>BH</td><td>BI</td><td>BV</td></tr>
<tr><td>C</td><td>CH</td><td>CI</td><td>CV</td></tr>
<tr><td>D</td><td>DH</td><td>DI</td><td>DV</td></tr>
</table>
</td>
<td>Chalk map type A
- Regularly alternating chalk and marl (typically at scales of 100 – 500 mm)
- Formations include; West Melbury Marly Chalk, Zig Zag Chalk
- Structural attitude: Inclined bedded.

Chalk map type D
- Thick units of chalk (100s of mm to metre scale alternating with thin 10s of mm marl seams).
- Includes nodular chalks and hardgrounds. Formations include; Holywell Nodular Chalk, Lewes Nodular Chalk.
- Structural attitude: Inclined bedded.

Chalk map type C:
- Thick units of chalk 100s of mm to meter scale alternating with thin 10s of mm marl seams.
- Chalk is flint rich and formations include Seaford Chalk, Newhaven Chalk, Culver Chalk, Portsdown Chalk, Welton Chalk, Burnham chalk, Flamborough Chalk, Rowe Chalk Formation.
- Structural attitude: Horizontally bedded.</td>
</tr>
<tr>
<td>Hydrodynamics</td>
<td>Example possible descriptors:
• Current speed and direction,
• Turbidity,
• Suspended sediment,
• Wave height and speed, and
• Exposure classification.

Any other information site leads consider relevant / of interest.</td>
<td>South Dorset MCZ is a relatively high energy environment, with tides generally flowing east west and running at up to 3.5 knots on a spring tide. The tides cause some movement of mobile substrate on the seabed on occasion (UK Hydrographic Office (UKHO). The site experiences strong spring tidal currents which are likely to mobilise sediments and lead to a degree of turbidity (UK Hydrographic Office (UKHO),</td>
</tr>
<tr>
<td>Structural complexity</td>
<td>Example possible descriptors:
• Boulder/cobble on rock,
• Boulder/ cobble on sediment,
• Sediment on rock,
• Elevation (metres),
• Stability (stable – mobile),
• Silt (none – silted),</td>
<td>Boulder/ cobble on rock; sediment on rock; smooth bedrock (Downie and Curtis, 2014).</td>
</tr>
</table>

	• Fissures >10mm (none – many), • Crevices <10mm (none – many), • Boulder/cobble/pebble shape (rounded – angular), • Gully, • Cave, • Tunnel, • Stacks, • Arches, and • Overhangs.	
Extent / distribution	Extent	96.56km^2 (9656 Ha.) (Downie and Curtis, 2014), (Downie and Whomersley, 2013).
	Description of distribution; link to map where possible	It is challenging to map the extent of the subtidal chalk due to veneers of coarse sediment and cobbles (Downie and Curtis 2014). There are currently only point records of subtidal chalk, however the circalittoral rock extent data can be used as a proxy. There are patches of circalittoral rock distributed throughout the site, creating a mosaic with the subtidal coarse sediment (Downie and Curtis, 2014), (Downie and Whomersley, 2013). Bedrock geology maps also show Upper Cretaceous chalk to be widespread within the site (BGS, 1983). Link to map on MAGIC
Geographic context	Descriptive (e.g. geographic limits of chalk in UK; geographic limits of species in UK).	South Dorset MCZ is one of the most westerly examples of subtidal chalk, with the majority occurring in the east and south east. South Dorset MCZ extends beyond 12nm (Natural England, 2017).
Community composition	Biotopes present	No biotope information available
	Notable species (notable by their presence e.g. rare species; or notable by their absence e.g. species ordinarily characteristic of that biotope).	No specific information available

Reference List: South Dorset MCZ

BRITISH GEOLOGICAL SURVEY (1983). Portland. 1:250000, Solid geology. British Geological Survey, Edinburgh, Scotland.

DOWNIE,A. and CURTIS,M., 2014. South Dorset MCZ Post-survey Site Report v2.: Department for Environment, Food and Rural Affairs (Defra), the Centre for Environment, Fisheries and Aquaculture Science (Cefas)

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MareMap – providing distributions of seafloor bedrock, Quaternary and modern sediments, thickness of seafloor sediments. [online], URL: http://www.maremap.ac.uk/view/search/searchMaps.html [Accessed 23rd May 2019].

NATURAL ENGLAND. 2017. Natural England Conservation Advice for Marine Protected Areas South Dorset MCZ – UKMCZ0022. Designated sites view [online], URL: https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UKMCZ0022&SiteName=SOUTH DORSET&countyCode=&responsiblePerson=&SeaArea=&IFCAArea= [Accessed 23rd May 2019].

UK Hydrographic Office (UKHO). 2016. DepthAreas, DRVAL2

Appendix 5 Full description of biotope codes

A1: Littoral rock and other hard substrates **A1.1: High energy littoral rock**	
A1.11	Mussel and/or barnacle communities
A1.111	*Mytilus edulis* and barnacles on very exposed eulittoral rock
A1.113	*Semibalanus balanoides* on exposed to moderately exposed or vertical sheltered eulittoral rock
A1.1131	*Semibalanus balanoides, Patella vulgata and Littorina* spp. on exposed to moderately exposed or vertical sheltered eulittoral rock
A1.1132	*Semibalanus balanoides, Fucus vesiculosus* and red seaweeds on exposed to moderately exposed eulittoral rock
A1.1133	*Semibalanus balanoides* and *Littorina* spp. on exposed to moderately exposed eulittoral boulders and cobbles
A1.12	Robust fucoid and/or red seaweed communities
A1.122	*Corallina officinalis* on exposed to moderately exposed lower eulittoral rock
A1.1221	*Corallina officinalis* and *Mastocarpus stellatus* on exposed to moderately exposed lower eulittoral rock
A1.123	*Himanthalia elongata* and red seaweeds on exposed lower eulittoral rock
A1.124	*Palmaria palmata* on very exposed to moderately exposed lower eulittoral rock
A1.125	*Mastocarpus stellatus* and *Chondrus crispus* on very exposed to moderately exposed lower eulittoral rock
A1.126	*Osmundea pinnatifida* on moderately exposed mid eulittoral rock
A1.2: Moderate energy littoral rock	
A1.21	Barnacles and fucoids on moderately exposed shores
A1.212	*Fucus spiralis* on full salinity exposed to moderately exposed upper eulittoral rock
A1.213	*Fucus vesiculosus* and barnacle mosaics on moderately exposed mid eulittoral rock
A1.214	*Fucus serratus* on moderately exposed lower eulittoral rock
A1.2141	*Fucus serratus* and red seaweeds on moderately exposed lower eulittoral rock
A1.2142	*Fucus serratus* and under-boulder fauna on exposed to moderately exposed lower eulittoral boulders
A1.2143	*Fucus serratus* and piddocks on lower eulittoral soft rock
A1.215	*Rhodothamniella floridula* on sand-scoured lower eulittoral rock
A1.22	Mussels and fucoids on moderately exposed shores
A1.221	*Mytilus edulis* and *Fucus vesiculosus* on moderately exposed mid eulittoral rock
A1.222	*Mytilus edulis, Fucus serratus* and red seaweeds on moderately exposed lower eulittoral rock
A1.223	*Mytilus edulis* and piddocks on eulittoral firm clay
A1.3: Low energy littoral rock	
A1.31	Fucoids on sheltered marine shores
A1.3121	*Fucus spiralis* on sheltered upper eulittoral rock
A1.313	*Fucus vesiculosus* on moderately exposed to sheltered mid eulittoral rock

A1.3131	*Fucus vesiculosus* on full salinity moderately exposed to sheltered mid eulittoral rock
A1.3151	*Fucus serratus* on full salinity sheltered lower eulittoral rock
A1.4: Features of littoral rock	
A1.41	Communities of littoral rockpools
A1.411	Coralline crust-dominated shallow eulittoral rockpools
A1.4111	Coralline crusts and *Corallina officinalis* in shallow eulittoral rockpools
A1.412	Fucoids and kelp in deep eulittoral rockpools
A1.413	Seaweeds in sediment-floored eulittoral rockpools
A1.42	Communities of rockpools in the supralittoral zone
A1.4121	*Sargassum muticum* in eulittoral rockpools
A1.44	Communities of littoral caves and overhangs
A1.44A	Barren and/or boulder-scoured littoral cave walls and floors
A1.441	Chrysophyceae and Haptophyceae on vertical upper littoral fringe soft rock
A1.442	Green algal films on upper and mid-shore cave walls and ceiling
A1.443	*Audouinella purpurea* and *Pilinia maritima* crusts on upper and mid-shore cave walls and ceilings
A1.444	*Audouinella purpurea* and *Cladophora rupestris* on upper to mid-shore cave walls
A1.445	*Verrucaria mucosa* and/or *Hildenbrandia rubra* on upper to mid shore cave walls
A1.45	Ephemeral green or red seaweeds (freshwater or sand-influenced) on non-mobile substrata
A1.451	*Enteromorpha* spp. on freshwater-influenced and/or unstable upper eulittoral rock
A1.452	*Porphyra purpurea* or *Enteromorpha* spp. on sand-scoured mid or lower eulittoral rock
A3: Infralittoral rock and other hard substrates A3.1 Atlantic and Mediterranean high energy infralittoral rock	
A3.115	*Laminaria hyperborea* with dense foliose red seaweeds on exposed infralittoral rock
A3.116	Foliose red seaweeds on exposed lower
A3.1161	Foliose red seaweeds with dense D*ictyota dichotoma* and/or *Dictyopteris membranacea* on exposed lower infralittoral rock
A3.125	Mixed kelps with scour-tolerant and opportunistic foliose red seaweeds on scoured or sand-covered infralittoral rock
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
A3.2113	*Laminaria digitata* and piddocks on sublittoral fringe soft roc
A3.214	*Laminaria hyperborea* and foliose red seaweeds on moderately exposed infralittoral rock
A3.2141	*Laminaria hyperborea* forest and foliose red seaweeds on moderately exposed upper infralittoral rock
A3.2142	*Laminaria hyperborea* park and foliose red seaweeds on moderately exposed lower 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	
A3.31	Silted kelp on low energy infralittoral rock with full salinity
A3.312	Mixed *Laminaria hyperborea* and *Laminaria saccharina* on sheltered infralittoral rock
A3.7: Features of infralittoral rock	

A3.716	*Balanus crenatus* and/or *Pomatoceros triqueter* with spirorbid worms and coralline crusts on severely scoured vertical infralittoral rock
A3.7162	Coralline crusts and crustaceans on mobile boulders or cobbles in surge gullies
A3.72	Infralittoral fouling seaweed communities
A4: Circalittoral rock and other hard substrates **A4.1: Atlantic and Mediterranean high energy circalittoral rock**	
A4.1121	*Tubularia indivisa* and cushion sponges on tide-swept turbid circalittoral bedrock
A4.13	Mixed faunal turf communities on circalittoral rock
A4.1341	*Polyclinum aurantium* and *Flustra foliacea* on sand-scoured tide-swept moderately wave-exposed circalittoral rock
A4.135	Sparse sponges, *Nemertesia* spp., and *Alcyonidium diaphanum* on circalittoral mixed substrata
A4.138	*Molgula manhattensis* with a hydroid and bryozoan turf on tide-swept moderately wave-exposed circalittoral rock
A4.2: Atlantic and Mediterranean moderate energy circalittoral rock	
A4.2141	*Flustra foliacea* on slightly scoured silty circalittoral rock
A4.2143	*Alcyonium digitatum* with *Securiflustra securifrons* on tide-swept moderately wave-exposed circalittoral rock
A4.221	*Sabellaria spinulosa* encrusted 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
A4.233	*Hiatella*-bored vertical sublittoral limestone rock
A4.241	*Mytilus edulis* beds with hydroids and ascidians on tide-swept exposed to moderately wave-exposed circalittoral rock
A4.2511	Cushion sponges, hydroids and ascidians on turbid tide-swept sheltered circalittoral rock
A5: Sublittoral sediment **A5.1 Sublittoral coarse sediment**	
A5.131	Sparse fauna on highly mobile sublittoral shingle (cobbles and pebbles)
A5.137	Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand
A5.141	*Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles
A5.2: Sublittoral sand	
A5.231	Infralittoral mobile clean sand with sparse fauna
A5.243	*Arenicola marina* in infralittoral fine sand or muddy sand]
A5.4: Sublittoral mixed sediments	
A5.43	Infralittoral mixed sediments
A5.44	Circalittoral mixed sediments
A5.441	*Cerianthus lloydii* and other burrowing anemones in circalittoral muddy mixed sediment
A5.444	*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment