Supplementary Advice on Conservation Objectives for The Barra Fan and Hebrides Terrace Seamount Nature Conservation Marine Protected Area

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Contents

Introduction

What the conservation advice package includes

The information provided in this document sets out JNCC's supplementary advice on the conservation objectives set for this site. This forms part of JNCC's formal conservation advice package for the site and must be read in conjunction with all parts of the package as listed below:

- Background Document explaining where to find the advice package, JNCC's role in the provision of conservation advice, how the advice has been prepared, when to refer to it and how to apply it;
- Conservation Objectives setting out the broad ecological aims for the site;
- Statements on:
    - the site's protected feature condition;
    - conservation benefits that the site can provide; and
    - conservation measures needed to further the conservation objectives stated for the site. This includes information on those human activities that, if taking place within or near the site, can impact it and hinder the achievement of the conservation objectives stated for the site; and
- Supplementary Advice on Conservation Objectives (SACO) providing more detailed and site-specific information on the conservation objectives (this document).

The most up-to-date conservation advice for this site can be downloaded from the conservation advice tab in the Site Information Centre (SIC) on JNCC's website.

The advice presented here describes the ecological characteristics or 'attributes' of the site's protected features: Burrowed mud, Offshore deep-sea muds, Offshore subtidal sands and gravels, Seamount communities and orange roughy specified in the site's conservation objective. These attributes are: extent and distribution, structure and function and supporting processes.

Supplementary advice on the conservation objectives for the geological / geomorphological features (including iceberg ploughmark field, prograding wedges, continental slope turbidite canyons, slide deposits, scour moat, continental slope, Hebrides Terrace Seamount) and the large-scale features: Continental slope and Seamount are not currently provided in this document. Further information regarding these features can be found on the Site Information Centre.

Figure 1 below illustrates the concept of how a feature's attributes are interlinked: with impacts on one potentially having knock-on effects on another e.g. the impairment of any of the supporting processes on which a feature relies can result in changes to its extent and distribution and structure and function.

Collectively, the attributes set out in the following tables describe the desired ecological condition (favourable) for the site's features. Each feature within the site must be in favourable condition as set out in the site's conservation objective. All attributes listed in the following tables must be taken into consideration when assessing impacts from an activity.

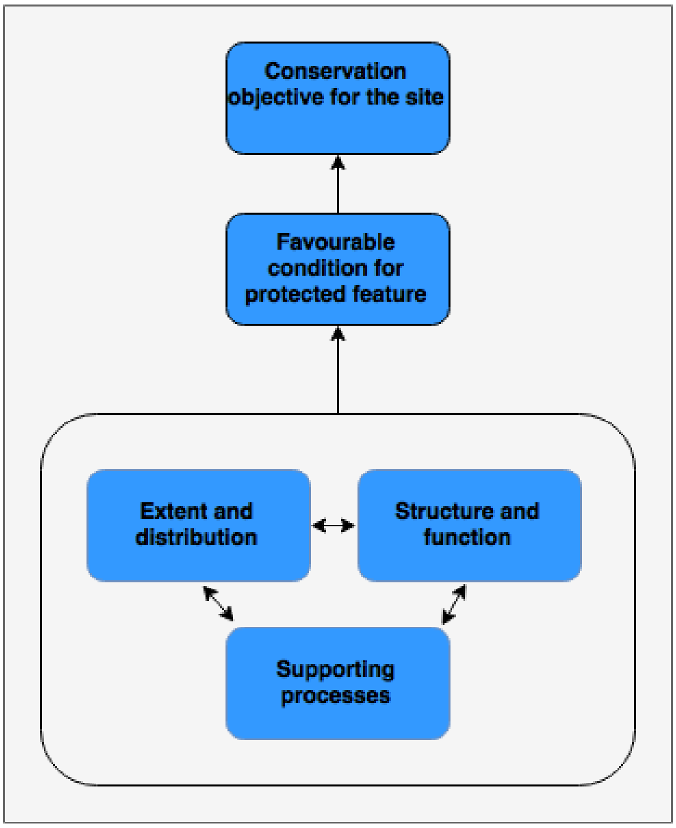

Figure 1. Conceptual diagram showing how a feature's attributes are interlinked and collectively describe favourable condition and contribute to the conservation objectives stated for the site.

In Table 1 below, the attributes for the sedimentary seabed habitats Burrowed mud, Offshore deep sea muds and Offshore subtidal sands and gravels are listed. Attributes for Seamount communities and orange roughy are listed in Table 2 and Table 3, respectively. Descriptions of the feature attributes are provided in the explanatory notes of each table.

Please note our current understanding of whether the available evidence indicates that each attribute needs to be recovered or conserved is not provided. However, links to available evidence for the site are provided in the tables below and should you require further site-specific information on the attributes listed for the site's features, please contact JNCC at OffshoreMPAs@jncc.gov.uk.

Table 1: Supplementary advice on the conservation objectives for the protected sedimentary habitats (Burrowed mud, Offshore deep-sea muds and Offshore subtidal sands and gravels) in The Barra Fan and Hebrides Terrace Seamount NCMPA

Attribute: Extent and distribution

Objective:
An objective has not been set for this attribute. Links to available evidence are provided below. Please contact JNCC at OffshoreMPAs@jncc.gov.uk for further site-specific information on this attribute.

Explanatory notes

Extent refers to the total area in the site occupied by Subtidal sedimentary habitats and must include consideration of their distribution i.e. how spread out they are within a site. A reduction in extent has the potential to alter the biological and physical functioning of Subtidal sedimentary habitat types (Elliott *et al.,* 1998; Tillin and Tyler-Walters, 2014). The distribution of a habitat influences the component communities present, and can contribute to the health and resilience of the feature (JNCC, 2004). The extent of the Subtidal sedimentary habitats within the site must be conserved to their full known distribution.

Subtidal sedimentary habitats are defined by:

- ***Sediment composition*** (grain size and type) (e.g. Cooper *et al.,* 2011; Coates *et al.,* 2015; 2016; Coblentz *et al.,* 2015). Some species can inhabit all types of sediment, whereas others are restricted to specific types; and
- ***Biological assemblages*** - See JNCC's Marine Habitats Correlation Table for more detail about the range of biological communities (biotopes) that characterise Subtidal sedimentary habitats in the UK marine environment. In offshore environments, note that Subtidal sedimentary habitats are not typically dominated by algal communities.

A significant change in sediment composition and/or biological assemblages within an MPA could indicate a change in the distribution and extent of Subtidal sedimentary habitats within a site (see UK Marine Monitoring Strategy for more information on significant change). Reduction in extent has the potential to affect the functional roles of the biological communities associated with Subtidal sedimentary habitats (Elliott *et al.,* 1998; Tillin and Tyler-Walters, 2014) e.g. a change from coarser to finer sediment would alter habitat characteristics, possibly favouring deposit feeders over suspension feeders (Tillin and Tyler-Walters, 2014). Maintaining extent is therefore critical to maintaining or improving conservation status of Subtidal sedimentary habitats.

A general description of the different types of Subtidal sedimentary habitats found in the UK offshore marine environment of relevance to this MPA is provided below:

- *Burrowed mud* – Consists of areas of fine mud, sandy mud and muddy sand in water depths ranging from 10 m to >500 m. The habitat is found in a range of environments, including sheltered muddy basins of sea lochs and voes, in full or variable salinities, and in deep water. This habitat is home to a range of burrowing crustaceans, including Norway lobster (*Nephrops norvegicus*), mud shrimps (*Calocaris macandreae* and *Callianassa subterranean*), amphipods (*Maera loveni*) and crabs (*Goneplax rhomboids*). The burrowing action of these species creates burrows and mounds, a prominent feature of this habitat. In some areas, burrowed mud may support conspicuous populations of seapens, typically *Virgularia mirabilis* and *Pennatula phosphorea* (noting that sea-pens are not a key and influential component of the habitat). In deeper waters off the continental shelf, *Kophobelemnon stelliferum* and *Umbellula encrinus* may also be recorded. Burrowed mud can also support populations of fireworks anemones (*Pachycerianthus multiplicatus*), tall seapens (*Funiculina quadrangularis*) and mud volcano worms (*Maxmuelleria lankesteri*) (Tyler-Walters *et al.,* 2016).
- *Offshore deep-sea muds* - Comprises of mud and cohesive sandy mud. This habitat is predominantly found in stable deeper/offshore areas where the reduced influence of wave action and/or tidal streams allow fine sediments to settle. These habitats are often dominated by polychaetes and echinoderms, such as *Amphiura* spp., sea-pens, such as the slender sea-pen (*Virgularia mirabilis*), and burrowing megafauna, such as the Norway lobster (*Nephrops norvegicus*) (Connor *et al.,* 2004), although polychaetes, sea spiders, molluscs, crustaceans and fish are also found. Bathymetry, current velocity, bottom water-mass distribution and particle size of the mud (clay, silty or sandy) have a significant influence on the distribution and composition of the seabed communities present. Subtidal mud is defined by a ratio of mud to sand being greater than 4:1, with particle sizes of less than 0.063 mm for mud and 0.063 mm to 2 mm for sand (McBreen and Askew, 2011). On the continental shelf, the Priority Marine Feature (PMF) Offshore deep-sea muds directly equates to the EUNIS habitat A5.3 Subtidal mud, but the PMF also covers deep-water examples that occur on or beyond the continental slope (Tyler-Walters *et al.,* 2016).
- *Offshore subtidal sands and gravels* - Offshore subtidal sands and gravels are more stable than their shallower equivalents, with diverse infaunal communities dominated by polychaetes, hatchet shells and small bivalves. Offshore fine to muddy sands support a variety of tube-building polychaetes, burrowing brittlestars and bivalves, while medium sands support the pea urchin (*Echinocyamus pusillus*) and fine sands host amphipods. Mobile predators present in this habitat include flatfish, starfish, crabs and hermit crabs. On the continental shelf, Offshore subtidal sands and gravels are equivalent to the EUNIS habitats A5.1: Subtidal coarse sediments, A5.2: Subtidal sand, and A5.4: Subtidal mixed sediments, but the Priority Marine Feature also covers deep-water examples of the habitat which occur on or beyond the continental slope in Scotland (Tyler-Walters *et al.,* 2016).

Extent and distribution of the protected sedimentary habitats within the site

The designated features for this site are Burrowed mud (seapen and burrowing megafauna communities), Offshore deep-sea muds and Offshore subtidal sands and gravels. The extent and distribution of these features within the site is shown in the site map. For further site-specific information please see the Site Information Centre.

For information on activities capable of affecting the protected features of the site, please see FeAST.

Attribute: Structure and function

Objective:

An objective has not been set for this attribute. Links to available evidence are provided below. Please contact JNCC at OffshoreMPAs@jncc.gov.uk for further site-specific information on this attribute.

Explanatory notes

Structure refers to the physical structure of a Subtidal sedimentary habitat and its biological structure. Physical structure refers to finer scale topography and sediment composition. Biological structure refers to the key and influential species and characteristic communities present.

Physical structure: Finer scale topography

The topography of Subtidal sedimentary habitats may be characterised by features, such as mega-ripples, banks and mounds, which are either formed and maintained by ongoing hydrodynamic processes (active bedforms) or the result of long since passed geological processes (relict bedforms). As these bedforms support different sedimentary habitats and associated communities compared to the surrounding seabed it is important that they are conserved (Elliott *et al.,* 1998; Barros *et al.,* 2004; Limpenny *et al.,* 2011). Recovery of active bedforms is likely so long as the prevailing hydrodynamic regime remains largely unimpeded. However, the reverse is true with regards to relict bedforms.

Physical structure: Sediment composition

On the continental shelf, sediment composition is highly dependent on the prevailing hydrodynamic regime. Coarser sediments tend to dominate in high energy environments that are subject to strong prevailing currents. Conversely, finer sedimentary habitats are typically associated with lower energy environments. However, storm conditions can mobilise all sediment types, including the coarser fractions, most notably in shallower waters (Green *et al.,* 1995).

In deeper waters, bottom currents may impact sediment composition through erosional and depositional processes (Sayago-Gil *et al.,* 2010). The continental shelf edge and upper continental slope (>200 m) have been shown to be impacted by currents, influencing sediment composition by depositing finer particles in deeper waters (Hughes, 2014). Indeed, mud content can increase exponentially with depth as hydrodynamic influence is reduced (Bett, 2012).

As sediment composition may be a key driver influencing biological community composition it is important that natural sediment composition is conserved (Cooper *et al.,* 2011; Coates *et al.,* 2015; 2016; Coblentz *et al.,* 2015).

Biological structure: Key and influential species
Key and influential species are those that have a core role in determining the structure and function of Subtidal sedimentary habitats. For example, bioturbating species (animals that forage and burrow tunnels, holes and pits in the seabed) help recycle nutrients and oxygen between the seawater and the seabed supporting the organisms that live within and on the sediment. Grazers, surface borers, predators or other species with a significant functional role linked to the Subtidal sedimentary habitats can also be classed as a key or influential species. Changes to the spatial distribution of communities across a Subtidal sedimentary habitat could indicate changes to the overall feature and as a result how it functions (JNCC, 2004). It is important to conserve the key and influential species of a site to avoid diminishing biodiversity and the ecosystem functioning provided by the protected Subtidal sedimentary habitats, and to support their conservation status (JNCC, 2004; Hughes *et al.,* 2005).

Due to the prevailing influence of the hydrodynamic regime, higher energy, coarser sedimentary habitats show greater recovery potential following impact than lower energy, finer sedimentary habitats (Dernie *et al.,* 2003). Recovery of the feature is thought to be largely dependent on the scale of the disturbance and action of remaining key and influential species, such as burrowers. However, recovery of the communities associated with Subtidal sedimentary habitats also depends on the life-history traits of the species themselves (e.g. their growth rate, longevity) and their interactions with other species, including predators and prey. Furthermore, the environmental connectivity between populations or species patches, the suitability of the habitat (e.g. substrate type), depth, water and sediment quality will also influence the recovery potential of Subtidal sedimentary habitats (Mazik *et al.,* 2015).

Biological structure: Characteristic communities

The variety of biological communities present make up the habitat and reflect the habitat's overall character and conservation interest. Characteristic communities include, but are not limited to, representative communities, such as those covering large areas, and notable communities, such as those that are nationally or locally rare or scarce, listed as OSPAR threatened and/or declining, or known to be particularly sensitive to anthropogenic activities.

Biological communities within Subtidal sedimentary habitats vary greatly depending on location, sediment type and depth, as well as other physical, chemical and biological processes. Burrowing bivalves and infaunal polychaetes thrive in coarse sedimentary habitats where the sediment is well-oxygenated with animals, such as hermit crabs, flatfish and starfish, living on the seabed. In deeper and more sheltered areas, the effects of wave action and prevailing currents may be diminished, resulting in finer sedimentary habitats where burrowing species may have a key role to play in maintaining the biological diversity of the habitat.

Changes to the spatial distribution of biological communities across a Subtidal sedimentary habitat could indicate changes to the overall feature (JNCC, 2004). It is therefore important to conserve the natural spatial distribution, composition, diversity and abundance of the main characterising biological communities of the Subtidal sedimentary habitats within a site to avoid diminishing biodiversity and ecosystem functioning within the habitat and to support its health (JNCC, 2004; Hughes *et al.,* 2005).

Similar to the biological structure of key and influential species, the recovery of characterising species' function is dependent on the influence of prevailing environmental conditions, life-history traits and interactions between species, with environmental connectivity between populations or species patches, the suitability of the habitat (e.g. substrate type), depth, water and sediment quality further influencing the recovery potential of Subtidal sedimentary habitats (Mazik *et al.,* 2015).

Function

Functions are ecological processes that include sediment processing, secondary production, habitat modification, supply of recruits, bioengineering and biodeposition. These functions rely on the supporting natural processes and the growth and reproduction of those biological communities which characterise the habitat and provide a variety of functional roles within it (Norling *et al.,* 2007), i.e. the key and influential species and characteristic communities present. These functions can occur at a number of temporal and spatial scales and help to maintain the provision of ecosystem services locally and to the wider marine environment (ETC, 2011).

Ecosystem services that may be provided by Subtidal sedimentary habitats include:

- Nutrition: Different sediment types offer habitat for breeding and feeding for various commercial species, which in turn are prey for larger marine species, including birds and mammals (FRS, 2017);
- Bird and whale watching: Foraging seals, cetaceans and seabirds may also be found in greater numbers near some Subtidal sedimentary habitats due to the common occurrence of prey for the birds and mammals (e.g. Daunt *et al.,* 2008; Scott *et al,* 2010; Camphuysen *et al.,* 2011; McConnell *et al.,* 1999, Jones *et al.,* 2013); and
- Climate regulation: Providing a long-term sink for carbon within sedimentary habitats.

Similar to the biological structure of key and influential species and characterising species, function is dependent on the influence of prevailing environmental conditions, life-history traits and interactions between species: environmental connectivity between populations or species patches, the suitability of the habitat (e.g. substrate type), depth, water and sediment quality further influencing the recovery potential of Subtidal sedimentary habitats (Mazik *et al.,* 2015). It is critical to ensure that the extent and distribution of Subtidal sedimentary habitats within a site, along with the composition of any key and influential species and characteristic biological communities, are conserved to ensure the functions they provide are maintained.

Structure and function of the feature within the site

For further site-specific information on the structure and function of the feature within the site, please see the Site Information Centre.

For information on activities capable of affecting the protected features of the site, please see FeAST.

Attribute: Supporting processes

Objective:

An objective has not been set for this attribute. Links to available evidence are provided below. Please contact JNCC at OffshoreMPAs@jncc.gov.uk for further site-specific information on this attribute.

Explanatory notes

Subtidal sedimentary habitats and the communities they support rely on a range of natural processes to support function (ecological processes) and help any recovery from adverse impacts. For the site to fully deliver the conservation benefits set out in the statement on conservation benefits (hyperlink is provided in the box at the top of this document), the following natural supporting processes must remain largely unimpeded - Hydrodynamic regime and Water and sediment quality.

Hydrodynamic regime

Hydrodynamic regime refers to the speed and direction of currents, seabed shear stress and wave exposure. These mechanisms circulate food resources and propagules, as well as influence water properties by distributing dissolved oxygen, and facilitate gas exchange from the surface to the seabed (Chamberlain *et al.,* 2001; Biles *et al.,* 2003; Hiscock *et al.,* 2004; Dutertre *et al.,* 2012). Hydrodynamic regime also effects the movement, size and sorting of sediment particles. Shape and surface complexity within Subtidal sedimentary habitat types can be influenced by hydrographic processes, supporting the formation of topographic bedforms (see finer scale topography). Typically, the influence of hydrodynamic regime on Subtidal sedimentary habitats is less pronounced in deeper waters, although contour-following currents (e.g. on the continental slope) and occasional episodes of dynamic flows can occur (Gage, 2001).

Water and sediment quality

Contaminants may affect the ecology of Subtidal sedimentary habitats through a range of effects on different species within the habitat, depending on the nature of the contaminant (JNCC, 2004; UKTAG, 2008; EA, 2014). It is therefore important to avoid changing the natural water quality and sediment quality in a site and, as a minimum, ensure compliance with existing Environmental Quality Standards (EQSs).

The targets listed below for water and sedimentary contaminants in the marine environment and are based on existing targets within OSPAR or the Water Framework Directive (WFD) that require concentrations and effects to be kept within levels agreed in the existing legislation and international commitments as set out in The UK Marine Strategy Part 1: The UK Initial Assessment (2012). Aqueous contaminants must comply with water column annual average (AA) EQSs according to the amended EQS Directive (2013/39/EU) or levels equating to (High/Good) Status (according to Annex V of the WFD (2000/60/EC), avoiding deterioration from existing levels).

Surface sediment contaminants (<1 cm from the surface) must fall below the OSPAR Environment Assessment Criteria (EAC) or Effects Range Low (ERL) threshold. For example, mean cadmium levels must be maintained below the ERL of 1.2 mg per kg. For further information, see Chapter 5 of the Quality Status Report (OSPAR, 2010a) and associated QSR Assessments.

The following sources of information are available regarding historic or existing contaminant levels in the marine environment:

- Marine Environmental and Assessment National Database (MERMAN);
- The UK Benthos database available to download from the Oil and Gas UK website;
- Cefas' Green Book;
- Strategic Environmental Assessment Contaminant Technical reports available from the British Geological Survey website; and
- Charting Progress 1: The State of the UK Seas (2005) and Charting Progress 2: The State of the UK Seas (2014).

Water quality

The water quality properties that influence the communities living in or on Subtidal sedimentary habitats include salinity, pH, temperature, suspended particulate concentration, nutrient concentrations and dissolved oxygen. They can act alone or in combination to affect habitats and their communities in different ways, depending on species-specific tolerances. In fully offshore habitats, these parameters tend to be relatively more stable, particularly so for deeper waters, although there may be some natural seasonal variation. In deeper waters, dissolved oxygen levels are generally lower due to stratification of the water column and the isolation of bottom water masses (Greenwood *et al.,* 2010). Salinity also increases with depth, peaking about 50 m down, after which the salinity decreases with increasing depth to a minimum around 1000 m in North Atlantic waters (Talley, 2002).

Water quality can influence habitats and the communities they support by affecting the abundance, distribution and composition of communities at relatively local scales (Elliott *et al.,* 1998; Little, 2000; Gray and Elliott, 2009). For example, a prolonged increase in suspended particulates can also have several implications, such as affecting fish health, clogging filtering organs of suspension feeding animals and affecting seabed sedimentation rates (Elliott *et al.,* 1998). Low dissolved oxygen can also have sub-lethal and lethal impacts on fish, infauna and epifauna (Best *et al.,* 2007). Conditions in the deep-sea are typically more stable than in shallower habitats, therefore deep-sea organisms are expected to have a lower resilience to changes in abiotic conditions (Tillin *et al.,* 2010). Concentrations of contaminants in the water column must not exceed the EQS.

Sediment quality

Various contaminants are known to affect the species that live in or on the surface of Subtidal sedimentary habitats. These include heavy metals like mercury, arsenic, zinc, nickel, chromium and cadmium, polyaromatic hydrocarbons, polychlorinated biphenyls, organotins (such as TBT) and pesticides (such as hexachlorobenzene). These metals and compounds can impact species sensitive to contaminants, degrading the community structure (e.g. heavy metals) and bioaccumulate within organisms thus entering the marine food chain (e.g. polychlorinated biphenyls) (OSPAR, 2009; 2010a; 2012). The biogeochemistry of mud habitats in particular is such that the effects of contaminants are greater (Sciberras *et al.,* 2016) leading in some cases to anoxic or intolerant conditions for several key and characterising species and resulting in a change to species composition. It is therefore important to ensure sediment quality is maintained by avoiding the introduction of contaminants and as a minimum ensure compliance with existing EQS as set out above, particularly in mud habitats.

Supporting processes for the feature within the site

For further site-specific information on the natural processes which support the feature within the site, please see the Site Information Centre.

For information on activities capable of affecting the protected features of the site, please see FeAST.

Table 2: Supplementary advice on the conservation objectives for Seamount communities in The Barra Fan and Hebrides Terrace Seamount NCMPA

Attribute: Extent and distribution

Objective:
An objective has not been set for this attribute. Links to available evidence are provided below. Please contact JNCC at OffshoreMPAs@jncc.gov.uk for further site-specific information on this attribute.

Explanatory notes

Extent refers to the total area in the site occupied by the biogenic habitat and must include consideration of its distribution, i.e. how it is spread out within the site. A reduction in extent has the potential to alter the biological and physical functioning of biogenic habitats. The distribution of a habitat influences the component communities present, and can contribute to the health and resilience of the feature (JNCC, 2004). It is important therefore to conserve the full known extent and distribution of the biogenic habitat within a site. The extent of coral habitats can vary naturally due to environmental conditions, and future increases in temperature and sea-water acidity could lead to a decline in coral extent (Jackson *et al.,* 2014). Thus, activities should not be permitted that are likely to reduce the distribution of the biogenic habitats.

Seamounts are submarine mountains that have peaks over 1000 m from the surrounding seafloor (OSPAR, 2010b). Seamount communities are the biogenic habitats that occur on seamounts. Seamount communities can be communities of non-reef forming corals (Hall-Spencer *et al.,* 2007), but may be also characterised by individual sponges, bivalves or bryozoans that combine to create a complex structural habitat on a seamount (Clark *et al.,* 2010). The communities can also be dominated by a single species of hard coral, forming dense cold-water coral reefs. If the densities of sponges or non-reef forming corals are high enough to meet the technical definitions for coral gardens (Henry and Roberts, 2014a) or deep-sea sponge aggregations (Henry and Roberts, 2014b), then the habitat is classified as that habitat rather than a seamount community.

Growth rates of many corals are slow, but where they do persist, colonies can live for several thousands of years (Sun *et al.*, 2010; Carreiro-Silva *et al.*, 2013). Some reef-forming cold-water corals however have been recorded growing on average 1.4 cm per year (Sabatier *et al.,* 2012) and other deep-water corals can have growth rates exceeding 2 cm per year (Andrews *et al.,* 2002; Sherwood and Edinger, 2009). Coral habitats completely damaged by physical pressures such as those associated with benthic trawling do not show signs of recovery a decade after such pressure has been removed (Hall-Spencer *et al.*, 2002; Althaus *et al.,* 2009; Williams *et al.,* 2010; Howell *et al.,* 2013; Buhl-Mortensen *et al.* 2013; Buhl-Mortensen, 2017). However, recovery has been observed in areas were some living coral remains after impact (Buhl-

Mortensen *et al.,* 2013; Buhl-Mortensen*,* 2017). If coral colonies are killed, any recovery of extent and distribution will be influenced by the method of reproduction, dispersal potential, the relative location of a potential source population of reproductive adults and the presence of suitable supporting habitat (Dahl *et al.,* 2012, Fox *et al.,* 2016). Evidence indicates that for some types of cold-water corals, successful recruitment events may occur once a decade (Stone *et al.,* 2015), which could limit recovery. Restoration could be encouraged by transplanting fast-growing corals from other locations.

Seamount communities form over hundreds or thousands of years (OSPAR, 2010b). The sporadic reproduction of corals and slow growth rates of some species means that population recovery of the corals could take hundreds or thousands of years (Andrews *et al.,* 2002; Sherwood and Edinger, 2009; Carreiro-Silva *et al.*, 2013). In addition, if direct physical pressures are removed from a coral habitat, recovery of extent and distribution is uncertain due to predicted future decreases in ocean pH, which dissolves coral skeletons (Jackson *et al.,* 2014). Therefore, it is important to conserve the extent and distribution of the feature as this cannot be easily be restored.

Extent and distribution of the Seamount communities within the site

The extent and distribution of the Seamount communities within the site is shown in the site map. For further site-specific information please see the Site Information Centre.

For information on activities capable of affecting the protected features of the site, please see FeAST.

Attribute: Structure and function

Objective:

An objective has not been set for this attribute. Links to available evidence are provided below. Please contact JNCC at OffshoreMPAs@jncc.gov.uk for further site-specific information on this attribute.

<u>Explanatory notes</u>

Structure with respect to coral habitats encompasses:

- Coral composition - namely the species, morphology and size of the coral colonies that characterise the community;
- Density of the coral colonies characterising the feature;

- Physical structure of the reef – including the topography of the reef and the available macrohabitats;
- Key and influential species; and
- Characteristic communities present.

Coral composition

Coral colonies are made up of genetically identical polyps. Sessile and mobile benthic organisms may be associated with coral colonies, living on or within the coral tissue and around the colonies (Buhl-Mortensen and Mortensen, 2005; Bo *et al*., 2009; Guilloux *et al*., 2010; Ballion *et al.,* 2012; Mueller *et al.*, 2013; Ballion *et al.,* 2014; De Clippele *et al.*, 2015). The abundance, diversity and composition of associated organisms can vary between coral species, even within the same order (Ballion *et al.,* 2014; Carvalho *et al.,* 2014). A significant positive relationship has been found between both abundance and richness of associated organisms and coral colony size, number of branches and percentage of exposed skeleton (Buhl-Mortensen and Mortensen, 2005; Bo *et al*., 2009; Buhl-Mortensen *et al.,* 2010; Ballion *et al.,* 2012; Carvalho *et al.,* 2014). These characteristics of the coral colony contribute towards its structural complexity, therefore structural complexity of an individual coral colony is likely to be influenced by age and species. Biodiversity may be increased by enhanced structural complexity because of an increase in the heterogeneity of habitats available for other benthic organisms e.g. providing elevated perches for other filter feeders (De Clippele *et al*., 2015) or refugia from predators (Buhl-Mortensen and Mortensen, 2005; Buhl-Mortensen *et al.,* 2010). The size and morphology of corals may also influence their susceptibility to damage from physical pressures such as abrasion, with larger individuals and species with less flexible skeletons more likely to be impacted, and the ability of corals to repair tissue after damage (Mortensen *et al.,* 2005; Henry and Hart, 2005; Stone *et al.,* 2015).

Species composition, and size and age structure of the coral community or communities forming the biogenic habitat, will influence the associated biological community and therefore it is important that these aspects of the habitat should be conserved.

Density of coral colonies

The density of coral colonies can influence characteristic communities that are present. A positive relationship between coral colony density and benthic invertebrate diversity has been observed in gorgonian coral gardens in the Mediterranean and Antarctica (Pascual, 2015). A similar pattern has also been observed in biogenic habitats created by sponges in the north-west Atlantic (Beazley *et al.,* 2015). However, De Clippele *et al.* (2015) found that Gorgonian colonies were associated with fewer taxa when more coral colonies were growing nearby. Change in the density of corals may therefore have an impact on the characteristic biological communities and the biodiversity that a site can support, and natural density should be conserved.

Physical structure of the reef

Physical structure refers to finer scale topography and habitat composition. Physical structure can have a strong influence on the hydrodynamic regime at varying spatial scales in the marine environment as well as the presence and distribution of biological communities (Elliot *et al.,* 1998). Reef size and structure can create sheltered areas and increases sedimentation of particulate organic matter. This can result in higher abundances of associated organisms than surrounding habitats (Morigi *et al*., 2012). Fish species associated with coral reefs have been shown to prefer different altitudes within a reef, and different slope aspects (Söffker *et al.*, 2011; Quattrini *et al.,* 2012). Variations in slope and surface roughness of a reef can increase diversity in benthic communities across the reef (Henry *et al.,* 2009) and so should be maintained.

Different habitats can occur across a cold-water coral reef (Buhl-Mortensen *et al.,* 2010; Lancaster *et al.,* 2014):

- **Living coral tissue** – dense areas of living cold water coral reef colonies. Within areas of live reef there are additional microhabitats, such as the tissue of living corals, surfaces of exposed coral skeletons, spaces within coral skeletons and the gaps between coral branches.
- **Dead coral framework communities –** dead coral reef framework can support communities of species that create biogenic habitats, such as sponges and non-reef forming corals, along with communities of other organisms such as hydroids, bryozoans and ascidians
- **Coral rubble communities –** coral rubble creates a potentially mobile environment and therefore supports unique communities of meiofauna that are adapted to this
- **Coral sediment communities –** infaunal and epifaunal communities associated with the coral sediment.

As conditions vary between these habitats, populations and diversity of associated benthic communities also differ between them (Mortensen and Fosså, 2006; Roberts *et al.,* 2008; Henry *et al.,* 2009; Purser *et al.,* 2013; Buhl-Mortensen, 2017). As a result, the presence and extent of these macrohabitats generate biodiversity across cold-water coral reefs and therefore all need to be conserved.

Key and influential species

Key and influential species are those that have a core role to play in determining the structure and function of a biogenic habitat. For example, species that increase vertical complexity and provide a substrate for epibionts to colonise and use as an elevated perch (Braga-Henriques *et al.*, 2010). The main key and influential species within coral habitat features will be the coral community itself, however there may be other species such as sponges or bryozoans that also provide additional physical structure and habitat complexity. The tube dwelling polychaete *Eunice norvegica* lives in close association with cold-water corals particularly *Lophelia pertusa,* stealing food particles from the coral host (Mueller *et al.,* 2013). The presence of the worm has been observed to almost quadruple calcification rates of corals (Mueller *et al.,* 2013) suggesting that its presence can influence reef development.

Changes to the spatial distribution of communities across coral habitats could indicate changes to a feature and as a result how it may function (JNCC, 2004). It is therefore important to conserve the key and influential species of biogenic habitats within a site to avoid diminishing biodiversity and ecosystem functioning and to support their conservation status (JNCC, 2004; Hughes *et al.*, 2005).

Characteristic communities

The variety of biological communities present make up the habitat and reflect the habitat's overall character and conservation interest. Characteristic communities include, but are not limited to, representative communities, for example, those covering large areas, and notable communities, for example, those that are nationally or locally rare or scarce such as those listed as OSPAR threatened or declining, or known to be particularly sensitive to anthropogenic activities. Seamount communities are listed on the OSPAR threatened and/or declining habitats list, and this includes the characteristic communities associated with them (OSPAR, 2010b). Cold-water coral reefs have also been recognised as Vulnerable Marine Ecosystems (VMEs) by the International Convention for the Exploration of the Sea (ICES).

Biological communities found within and on coral habitats can vary depending on the corals creating the habitat, location, and depth, as well as fine-scale physical, chemical and biological processes. A range of species have been found to have commensal or parasitic associations with deep-water coral species, some of which are obligate relationships (Buhl-Mortensen and Mortensen, 2004) such as strong associations of the brittlestar *Ophiomusium lymani* with bamboo corals (Henry and Roberts, 2014a). Biological communities associated with coral habitats typically include filter feeders, such as ascidians, bryozoans, zoantherians, brittlestars and shrimp (Buhl-Mortensen and Mortensen, 2005; Bo *et al*., 2009; Buhl-Mortensen *et al.,* 2010; De Clippele *et al.,* 2015; Carreiro-Silva *et al.,* 2017) which use the vertical structure created by corals as elevated perches to improve feeding (De Clippele *et al.,* 2015). As coral habitats develop in areas with relatively high currents, communities found in sediments within coral habitats are adapted to physical disturbance (Raes and Vanreusel, 2006). The characteristic communities associated with living coral colonies usually includes copepods that have evolved to be endoparasites in coral tissue (Buhl-Mortensen and Mortensen, 2005; Baillon *et al.,* 2012; De Cippele *et al.,* 2015). Coral rubble becomes covered with a biofilm, which supports communities of organisms that feed on this (Raes and Vanreusel, 2006).

It is important to conserve the natural spatial distribution, composition, diversity and abundance of the main characterising biological communities of the coral habitat within the site to avoid diminishing biodiversity and ecosystem functioning within the habitat and to support its health (Hughes *et al.*, 2005).

Function

Functions are ecological processes that include sediment processing, secondary production, habitat modification, supply of recruits, bioengineering and biodeposition. These functions rely on the supporting natural processes and the growth and reproduction of corals, and associated biological communities (Armstrong *et al.,* 2014).

These functions can occur at a number of temporal and spatial scales and help to maintain the provision of ecosystem services locally and to the wider marine environment (ETC, 2011). Ecosystem services typically provided by these habitats include:

- Nutrition: Coral habitats are potentially an important link in the flow of carbon between the pelagic and benthic environment (Cathalot *et al.,* 2015). Cold-water coral species secrete mucus which becomes a source of dissolved and particulate organic matter for the ecosystem. Sponge species can feed on this and it is incorporated into sponge detritus (Rix *et al.,* 2016), which is then consumed by higher trophic levels. This may serve to increase the availability of prey species to predators through enhancement of biological diversity, potentially providing refugia from predators (Stone *et al.,* 2015), locations to lay eggs (Henry *et al.*, 2016) or nurseries (Ballion *et al.,* 2012) for fish species. There is some evidence that the abundance of certain commercial fish species is higher within coral habitats compared to non-coral habitats (D'Onghia *et al.,* 2012; Pham *et al.,* 2015).
- Climate regulation: Dead coral skeletons are a long-term store of carbon (Armstrong *et al.,* 2014), although the coral calcification process emits carbon dioxide. Ocean acidification is expected to corrode the skeletons of dead deep-water scleractinian corals although cold-water coral reefs shallower than ~150 m, are not expected to be subject to corrosion as they will remain above the aragonite saturation horizon (Jackson *et al.,* 2014).

- Provision of recruits: The larvae of corals have a planktonic phase giving the potential for long distance dispersal. A coral habitat can create a supply of recruits to establish new or help maintain existing coral habitats elsewhere (Wright *et al.,* 2015; Fox *et al.,* 2016).
- Provision of biochemical and biotechnological products: Chemicals extracted from corals have been shown to have applications in the pharmaceutical industry (Sawadogo *et al.,* 2015; Ruiz-Torres *et al.*, 2017).

It is critical to ensure that the extent and distribution of coral habitats within a site, along with the composition of any key, influential and characteristic biological communities are conserved to ensure the functions they provide are maintained.

Structure and function of the feature within the site
For further site-specific information on the structure and function of the feature within the site, please see the Site Information Centre.

For information on activities capable of affecting the protected features of the site, please see FeAST.

Attribute: Supporting processes

Objective:
An objective has not been set for this attribute. Links to available evidence are provided below. Please contact JNCC at OffshoreMPAs@jncc.gov.uk for further site-specific information on this attribute.

Explanatory notes
Biogenic habitats and the communities they support rely on a range of natural processes to support function (ecological processes) and help any recovery from adverse impacts. For the site to fully deliver the conservation benefits set out in the statement on conservation benefits, the natural supporting processes of hydrodynamic regime, physical topography, supporting habitat and water and sediment quality must remain largely unimpeded.

Hydrodynamic regime

Hydrodynamic regime refers to the speed and direction of currents, seabed shear stress and internal and surface wave exposure. These mechanisms circulate food resource and propagules, influence water properties by distributing dissolved oxygen, and facilitate gas exchange from the surface to the seabed (Hiscock *et al.,* 2004; Mienis *et al.*, 2007; Hosegood and van Haren, 2004; Wagner *et al.,* 2011).

Cold-water corals feed on zooplankton and other organic matter, therefore cold-water coral habitats require hydrographic conditions that result in a supply of sufficient organic matter to the seabed. Coral habitats occur where hydrodynamic conditions re-suspend particulate organic matter (POM) from the seabed into the water column, or where downwelling brings a fresh supply of POM from the sea surface (Mienis *et al.*, 2007; Davies *et al.,* 2009). The presence of various coral species is influenced by current velocities (Jones *et al.,* 2009; Tracey *et al*., 2011). Moreover, the shape and orientation of coral reefs and carbonate mounds can be driven by the prevailing currents (Davies *et al.,* 2009; Buhl-Mortensen *et al.*, 2010; Järnegren and Kutti, 2016). Although corals require water movement to supply them with POM, feeding rates can reduce at high velocities (Purser *et al.,* 2010) suggesting that coral habitats may require a certain range of current velocities to develop. The hydrodynamic regime transports coral larvae as well as food. Changes to the hydrodynamic regime can alter the source and number of new recruits to coral habitats (Fox *et al.,* 2016). Morphology of sponges can be influenced by local hydrodynamics (De Clippele *et al*., 2017). Hydrodynamic regime also effects the movement, size structure and sorting of sediment particles, and can therefore influence the supporting habitat.

If is therefore important to conserve the prevailing hydrodynamic regime, in order to maintain the supply of food and larval recruits, and the supporting habitat of the coral habitats.

Physical topography

The hydrodynamic conditions required by corals are generated by the interaction of water currents and topographic features that strengthen internal tides (Davies *et al.*, 2009), generate internal waves (Mienis *et al.*, 2007) or increase mixing and primary productivity in shallower water (Roberts *et al.,* 2009). Coral habitats therefore tend to develop on continental slopes, along ridges and on topographic structures such as seamounts and carbonate mounds (Hall-Spencer *et al.*, 2007, Davies *et al.,* 2009, Tracey *et al.,* 2011; Tong *et al.,* 2012; Tong *et al.,* 2013). Hydrodynamic regime, specifically the direction of prevailing currents, influence the growth and morphology of carbonate mounds themselves, which can influence the type and distribution of biogenic communities occurring on the mounds (Wheeler *et al.* 2007). At a more local scale, coral colonies prefer elevated areas of seabed (Tong *et al.,* 2012; Tong *et al.,* 2013) to give them access to faster flowing water. This suggests that the surface topology of the seabed could influence density and distribution of non-reef forming corals within coral habitat features.

There are three types of reef forms; inherited reef forms have a morphology that reflects the underlying seabed; developed reef forms have a large scale morphology that has developed independent of the underlying seabed; and wall reef forms that occur on vertical slopes (Järnegren and Kutti, 2016). For inherited and wall reefs, the physical structure of the reef and therefore the associated biodiversity is dependent on the underlying topography.

Supporting habitat

Most species of coral require hard substratum to attach to (e.g. Stone *et al.,* 2015), however some bamboo corals and sea-pens grow on sandy and muddy seabeds (Buhl-Mortensen *et al.,* 2010; Henry and Roberts, 2014a). For reef forming corals, initial colonisation only requires a very small area of available hard substratum, such as a single pebble. After initial colonisation, the coral itself can provide hard substrata for subsequent colonies to develop (Buhl-Mortensen *et al.,* 2010). Species composition and density of colonies characterising other coral habitats will be influenced by the availability and type of underlying substratum.

Water and sediment quality

Contaminants may affect the quality of coral habitats through a range of effects on different species within the habitat, depending on the nature of the contaminant (JNCC, 2004; UKTAG, 2008; EA, 2014). It is important therefore to avoid changing the natural water quality and sediment quality properties of a site and as a minimum ensure compliance with existing Environmental Quality Standards (EQS) as set out below.

Environmental Quality Standard (EQS)

The targets listed below for water and sediment contaminants in the marine environment are based on existing targets within or the Water Framework Directive (WFD) and require concentrations and effects to be kept within levels agreed in the existing legislation and international commitments as set out in The UK Marine Strategy Part 1: The UK Initial Assessment 2012.

Aqueous contaminants must comply with water column annual average (AA) Environmental Quality Standards (EQSs) according to the amended Environmental Quality Standards Directive (EQSD) (2013/39/EU) or levels equating to (High/Good) Status (according to Annex V of the Water Framework Directive (WFD) (2000/60/EC), avoiding deterioration from existing levels.

Surface sediment contaminants (<1 cm from the surface) must fall below the OSPAR Environment Assessment Criteria (EAC) or Effects Range Low (ERL) threshold. For example, mean cadmium levels must be maintained below the ERL of 1.2 mg per kg. For further information, see Chapter 5 of the Quality Status Report (OSPAR, 2010a) and associated QSR Assessments.

There are little data on the impact of aqueous and sediment contaminants on cold-water coral species, therefore no tolerance thresholds have been established for cold-water coral habitats. The general standards described above apply to these habitat features until more habitat specific information is available.

The following sources of information are available regarding historic or existing contaminant levels in the marine environment:

- Marine Environmental and Assessment National Database (MERMAN);
- The UK Benthos database available to download from the Oil and Gas UK website;
- Cefas Green Book;
- Strategic Environmental Assessment Contaminant Technical reports available to download from the British Geological Survey website; and
- Charting Progress 1: The State of the UK Seas (2005) and Charting Progress 2: The State of the UK Seas (2014).

Water quality
The water quality properties that influence these habitats include salinity, pH, temperature, suspended particulate concentration, nutrient concentrations and dissolved oxygen. They can act alone or in combination to affect habitats and their communities in different ways, depending on species-specific tolerances. In fully offshore habitats these parameters tend to be relatively more stable, particularly so for deeper waters, although there may be some natural seasonal variation. Water quality properties can influence the abundance, distribution and composition of coral habitat features and associated communities at relatively local scales (Elliott *et al.*, 1998; Gray and Elliott, 2009).

Spawning in sea-pens has been shown to occur at specific water temperatures (Baillon *et al.,* 2013) and cold-water corals in laboratory experiments began to die at temperatures above 8.7°C (Leifman, 2016). This suggests that coral habitat features can only develop and survive within a specific range of water temperatures, and this is likely to be species specific.

Increased concentrations of sediment in the water column can have a negative impact on corals by reducing feeding activity, preventing access to oxygen and damaging corals by becoming embedded in their surface (Allers *et al.*, 2013; Leifman, 2016). *Lophelia pertusa* can tolerate short term increases in sedimentation, however burial of living coral tissue for more than a day resulted in death (Allers *et al.*, 2013). Responses to increases in suspended particles are likely to vary between coral species, nature of suspended sediment and presence of other species in the community (Girard *et al*., 2016; Leifman, 2016). As coral colonies feed on suspended particles, coral habitat features do require a supply of particulate organic matter to the seabed. Changes to water quality that reduces the supply of particulate organic matter and nutrients to corals may be detrimental.

Scleractinian cold-water corals create their skeleton from aragonite, which is a mineral of calcium carbonate. Atmospheric carbon dioxide emissions are lowering the amount of aragonite in seawater in a process called ocean acidification (Jackson *et al*., 2014). This threatens deep-water scleractinian coral reefs and communities as seawater is becoming corrosive to their skeletons.

It is important therefore to avoid changing the natural water quality of a site as a minimum to ensure compliance with existing EQS as set out above until thresholds specific to coral habitats have been identified.

Sediment quality

Various contaminants are known to have different effects on the species that live in or on coral habitats. These include heavy metals like mercury, arsenic, zinc, nickel, chromium and cadmium, poly-aromatic hydrocarbons (PAHs), poly-chlorinated biphenyls (PCBs), organotins (TBT) and pesticides such as hexachlorobenzene. These can impact species sensitive to particular contaminants (e.g. heavy metals), and bioaccumulate within organisms thus entering the marine food chain (e.g. polychlorinated biphenyls) (OSPAR, 2009; 2010a; 2012). There is little research into the impact of sediment contaminants on corals, particularly from deep cold-water systems. If contamination occurs, this can lead to intolerant conditions and result in a change to typical species composition. It is therefore important to ensure sediment quality is maintained by avoiding activities that may cause resuspension of existing or the introduction of new contaminants. As a minimum, it is important to ensure compliance with existing EQS as set out above until thresholds specific to coral habitats have been developed.

Supporting processes for the feature within the site

For further site-specific information on the natural processes which support the feature within the site, please see the Site Information Centre.

For information on activities capable of affecting the protected features of the site, please see FeAST.

Table 3: Supplementary advice on the conservation objectives for orange roughy in The Barra Fan Hebrides and Terrace Seamount NCMPA

Attribute: Presence and distribution
Objective: An objective has not been set for this attribute. Links to available evidence are provided below. Please contact JNCC at OffshoreMPAs@jncc.gov.uk for further site-specific information on this attribute.
Explanatory notes The presence describes orange roughy occurrence, with the spatial distribution providing a more detailed overview of the location(s) and pattern of occurrence within a site, both in the water column and the seabed. Orange roughy may use a site for feeding, courtship or spawning purposes as well as nursery grounds. It is important to consider the key life stages and behaviours of a species within a site as this may influence its distribution which can fluctuate over time and be patchy in nature. The life history characteristics of orange roughy across the North-east Atlantic is not very well understood; much of the available evidence-base comes from areas where orange roughy is or has been targeted as a commercial fishery, such as Australia and New Zealand. Orange roughy have a worldwide but patchy distribution in temperate regions (Branch, 2001). In Scottish waters, adult orange roughy have been recorded on the Hebrides Terrace, Anton Dohrn and Rosemary Bank seamounts and on the continental slope south of the Wyville-Thomson Ridge (ICES, 2013). Orange roughy are a deep-water species, found at depths ranging from ~450 m to 1,500 m (Branch, 2001). Juveniles are normally found in greatest abundance in the shallower depths (850-900 m), extending into deeper water (to about 1,500 m) as they mature (Shephard and Rogan, 2006; Dunn *et al*., 2009). Depth selection may be related to preference for particular prey as well as prey abundance. Some evidence from Australian temperate waters indicates orange roughy diet varies from year to year and with geographical area (Bulman and Koslow, 1992). As well as depth, topography also plays an important role in the distribution of orange roughy. Orange roughy are usually found dispersed at low densities (0-10 individuals per hectare) over rough bottoms and at depths of 700-1400 meters. They can form dense feeding and spawning aggregations, which can reach typically 2,500 individuals or more per hectare (Lorance *et al.,* 2002), around topographic features like pinnacles canyons, ridges, rocks and seamounts. It is unclear whether these aggregations are driven by environmental factors such as water temperature or phases of the moon and why they are particularly associated with topographic features (AFMA, 2006). The timing of spawning varies

geographically; off the Faroe Islands, the main spawning season is between late January and early March (Thomsen, 1998); off Iceland, spawners first appear in November and spawning continues until March (Magnússon and Magnússon 1995). Outside of spawning seasons, orange roughy are typically more widely distributed along the continental slope in relation to UK waters around Scotland, with lower densities around seamounts (Clark *et al.,* 2010). Some evidence from an American study suggests that small juveniles may inhabit open, soft-bottomed areas, where predation risk may be lessened (Ross and Quattrini, 2007).

Orange roughy have slow grow rates and are long living, with records of individuals estimated at 150 years old (Allain and Lorance, 2000; ICES, 2014). Little is known of the basic biology of orange roughy in the North-East Atlantic although they are late to mature, only spawning when they reach over 35 years of age and have one of the lowest fecundity rates of all commercially exploited fishes (Minto and Nolan, 2006). It also is likely that they do not spawn every year (Annala *et al*., 2003).

The species' long life-span, slow growth rate, late maturity, low fecundity and episodic recruitment characteristics contribute to its vulnerability, making the species particularly susceptible to population declines if mature adults are removed (Dransfeld *et al.,* 2013). Recovery of orange roughy populations is likely therefore to be slow given the lack of recruits arriving from other distant populations. As such, it is important to conserve orange roughy across its likely distribution within a site. Conserving orange roughy in the context of site management involves ensuring continued access of individuals to resources within a site on which they rely as well as avoidance of disturbance, particularly during periods of aggregation. Resources can include, but may not be limited to, available prey as well as supporting habitat for spawning and feeding aggregations. Advice on the conservation of supporting processes including supporting habitats is provided below.

Presence and distribution within the site

The presence and distribution of orange roughy within the site is shown in the site map. For further site-specific information please see the Site Information Centre.

For information on activities capable of affecting the protected features of the site, please see FeAST.

Attribute: Supporting processes

Objective:

An objective has not been set for this attribute. Links to available evidence are provided below. Please contact JNCC at OffshoreMPAs@jncc.gov.uk for further site-specific information on this attribute.

Explanatory notes

For a site to fully deliver the conservation benefits set out in the statement on conservation benefits, continued access to the following natural supporting processes within a site must remain largely unimpeded:

Hydrodynamic regime;
Structure and function of supporting habitats; and
Water quality.

Hydrodynamic regime

Hydrodynamic regime refers to the speed and direction of currents, seabed shear stress and wave exposure. These mechanisms circulate food resources and propagules, as well as influence water properties by distributing dissolved oxygen. (Chamberlain *et al.,* 2001; Biles *et al.,* 2003; Hiscock *et al.,* 2004). In a study of orange roughy off the continental slope in the Bay of Biscay, it has been speculated that as an active predator of a sparse food resource, orange roughy have developed adaptations to exploit areas with specific hydrological conditions which offer high prey encounter rates and shelter during metabolic relaxation phases between foraging trips (Lorance *et al*., 2002). It is possible that the natural hydrodynamic regime plays an important role, particularly in supporting orange roughy aggregations. It is important to conserve the natural hydrodynamic regime within a site such that it should remain largely unimpeded by human activities.

Structure and function of supporting habitats

As mentioned previously, the areas of seabed that supports orange roughy is important for the conservation of the species and its distribution within a site. The physical structure of the seabed in terms of its elevation and roughness seem to play an important, if not fully understood, role in influencing the presence and distribution of more mature orange roughy. In particular, the presence of topographic features are key to the development of orange roughy aggregations, supporting their feeding and spawning.

As mentioned previously, orange roughy congregate around topographic features (such as seamounts, canyons and continental slopes) at depths greater than 450 m, but mostly between 900-1500 m (Bailey *et al*., 2009; Dransfeld *et al*., 2013). Seamounts generate a productive hydrodynamic regime, creating important hotspots for feeding, breeding and spawning of many deep-sea and open ocean species, including orange roughy (UNEP, 2006). The largest individuals are more frequently found on and around seamounts (Shephard and Rogan, 2006; Dunn *et al.,* 2009) and spawning aggregations can also form here. Outside the spawning season, they are more widely distributed along the continental slope with lower densities around seamounts (Clark *et al.,* 2010). Juveniles are normally found in greatest abundance around seamounts and continental slopes (850-900 m), extending into deeper water (up to about 1,500 m) as they mature. Some evidence from an American study suggests that small juveniles may inhabit open, soft-bottomed areas, where predation risk may be lowered (Ross and Quattrini, 2007). It is not clear if the sedimentary composition of the seabed plays any function in supporting juvenile orange roughy.

The rocky substrate of seamounts can provide a refuge function, sheltering orange roughy from predators. The associated habitats created by organisms such as sponges and corals are also important for harbouring prey. Prey size and prey abundance are important factors for predators such as orange roughy to survive, reproduce and recruit. They feed near the seabed as well as in midwater, and prey selection depends on the life stage of the fish. Orange roughy feed mostly on crustaceans, fish and squid. Juveniles feed mostly on *Boreomysis* species (small crustaceans) while adults have a more diverse diet, including fish, squid and crustaceans from the genus *Gnathophausia* (Gordon and Duncan, 1987). The structure that these habitats provide attracts benthic invertebrates, such as *Boreomysis* species and *Gnathophausia* genus, as well as other crustaceans, fish and squid. As such, structures created by sponges and corals can provide orange roughy with an important food resource (Beckman, 2012).

Evidence indicates that throughout its life, orange roughy may require seabed habitat of varying depths, roughness and composition and notably the presence and physical structure of topographic features. It is important therefore to conserve the presence and physical structure of the range of supporting habitat types within a site and ensure continued access for orange roughy.

Water quality
Environmental Quality Standard (EQS)

The targets listed below for water contaminants in the marine environment are based on existing targets within OSPAR or the Water Framework Directive (WFD) and require concentrations and effects to be kept within levels agreed in the existing legislation and international commitments. These targets are set out in The UK Marine Strategy Part 1: The UK Initial Assessment, 2012.

Aqueous contaminants must comply with water column annual average (AA) Environmental Quality Standards (EQSs) according to the amended Environmental Quality Standards Directive (EQSD) (2013/39/EU), or levels equating to (High/Good) Status (according to Annex V of the Water Framework Directive (WFD) (2000/60/EC), avoiding deterioration from existing levels.

The following sources provide information regarding historic or existing contaminant levels in the marine environment:

- Marine Environmental and Assessment National Database (MERMAN); and
- Charting Progress 1: The State of the UK Seas (2005) and Charting Progress 2: The State of the UK Seas (2014).

The water quality properties that might influence orange roughy include salinity, pH, temperature, suspended particulate concentration, nutrient concentrations and dissolved oxygen. Little is known about sensitivity of orange roughy to many of these environmental parameters, but their range is likely to be influenced by temperature as they are generally found in water between 3 to 8ºC (Lack *et al*., 2003). Studies suggest that different life stages may even prefer different temperature ranges (Shepherd *et al.*, 2007 and Dunn *et al.*, 2009).

It is therefore important to avoid reducing natural water quality within a site so that orange roughy can continue to use the site.

Supporting processes for the feature within the site
For further site-specific information on the natural processes which support the feature within the site, please see the Site Information Centre.

For information on activities capable of affecting the protected features of the site, please see FeAST.

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