Nomination

Coral Gardens

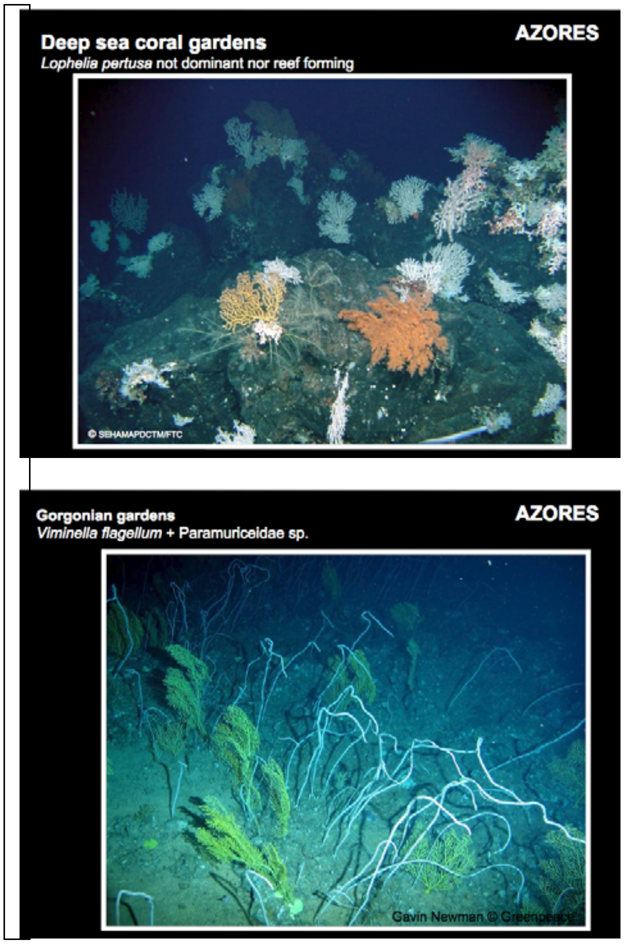


Fig. 1: Example of a coral gardens around the Azores. Upper photo: – on hard substrate, taken at the Menez Gwen hydrothermal vent field during the campaign SEHAMA, and the lower photo: hard substrate with a thin soft sediment veneer on Condor de Terra seamount, during the "Defending Our Oceans" campaign by Greenpeace International, with the collaboration of the DOP/UAç Azores.. Pictures courtesy of IMAP/DOP

Definition for habitat mapping

Coral gardens

Habitat occurs within each of the following deep seabed EUNIS types:

A6.1 Deep-sea rock and artificial hard substrata

A6.2 Deep-sea mixed substrata

A6.3 Deep-sea sand

A6.4 Deep-sea muddy sand

A6.5 Deep-sea mud

A6.7 Raised features of the deep sea bed

A6.8. Deep sea trenches and canyons, channels, slope failures and slumps on the continental slope

A6.9 Vents, seeps, hypoxic and anoxic habitats of the deep sea

Where the coral garden communities found in the above EUNIS deep water habitats occur also in shallower water, such as in fjords or on the flanks of islands and seamounts (A6.7), they are also included in this definition

National Marine Habitat Classification for UK & Ireland code: Not defined

The main characteristic of a coral garden is a relatively dense aggregation of colonies or individuals of one or more coral species. Coral gardens can occur on a wide range of soft and hard seabed substrata. For example, soft-bottom coral gardens may be dominated by solitary scleractinians, sea pens or certain types of bamboo corals, whereas hard-bottom coral gardens are often found to be dominated by gorgonians, stylasterids, and/or black corals (ICES 2007).

The biological diversity of coral garden communities is typically high and often contains several species of coral belonging to different taxonomic groups, such as leather corals (Alcyonacea), gorgonians (Gorgonacea), sea pens (Pennatulacea), black corals (Antipatharia), hard corals (Scleractinia) and, in some places, stony hydroids (lace or hydrocorals: Stylasteridae). However, reef-forming hard corals (e.g. *Lophelia, Madrepora* and *Solenosmilia*), if present, occur only as small or scattered colonies and not as a dominating habitat component. The habitat can also include relatively large numbers of sponge species, although they are not a dominant component of the community. Other commonly associated fauna include basket stars (*Gorgonocephalus*), brittle stars, crinoids, molluscs, crustaceans and deep-water fish (Krieger and Wing 2002). Krieger and Wing (2002) conclude that the gorgonian coral *Primnoa* is both habitat and prey for fish and invertebrates and that its removal or damage may affect the populations of associated species.

Densities of coral species in the habitat vary depending on taxa and abiotic conditions, e.g. depth, current exposure, substrate). The few scientific investigations available indicate that smaller species (e.g. the gorgonians *Acanthogorgia* and *Primnoa*, and stylasterids) can occur in higher densities, e.g. 50 – 200 colonies per·100m^2, compared to larger species, such as *Paragorgia,* which may not reach densities of 1 or 2 per 100 m^2. Depending on biogeographic area and depth, coral gardens containing several coral species may in some places reach densities between 100 and 700 colonies per·100m^2. These densities merely indicate the biodiversity richness potential of coral gardens. In areas where the habitat has been disturbed, by for example, fishing activities, densities may be significantly reduced. Currently, it is not possible to determine threshold values for the presence of a coral garden as knowledge of the *in situ* growth forms and densities of coral gardens (or abundance of coral by-catch in fishing gear) is very limited, due to technical or operational restrictions. Visual survey techniques will hopefully add to our knowledge in the coming years.

Non-reef-forming cold-water corals occur in most regions of the North Atlantic, most commonly in water with temperatures between 3 and 8ºC (Madsen, 1944; Mortensen *et al*., 2006) in the north, but also in much warmer water in the south, e.g. around the Azores. Their bathymetric distribution varies between regions according to different hydrographic conditions, but also locally as an effect of topographic features and substrate composition. They can be found as shallow as 30 m depth (in Norwegian fjords) and down to several thousand meters on open ocean seamounts. The habitat is often subject to strong or moderate currents, which prevents silt deposition on the hard substrata that most coral species need for attachment. The hard substrata may be composed of bedrock or gravel/boulder, the latter often derived from glacial moraine deposition, whilst soft sandy/clayey sediments can also support cold-water corals (mostly seapens and some gorgonians within the Isididae).

Notes on practical identification and mapping of the habitat: Given the diversity of possible appearances of the habitat across the North East Atlantic, a more precise description of the habitat as it occurs in relation to different substrates, depths and regions will need to be developed. For individual locations, expert judgement is required to distinguish this habitat from surrounding habitats, including an assessment of the appropriate densities of octocoral species to constitute this habitat. As a first step to further clarification a site-by-site description of coral gardens is required that will lead to further refinement of this habitat definition and its inclusion in national and European habitat classifications. The habitat definition above does not encompass shelf and coastal water habitats with seapen and octocoral communities (for example *Alcyonium* spp. *Caryopyllia* spp.), including the OSPAR habitat 'seapens and burrowing megafauna' or deeper-water habitats where colonial scleractinian corals (*Lophelia pertusa* reefs) or sponges (Deep-sea sponge aggregations) dominate.

The main feature of a coral garden is a relatively dense aggregation of colonies or individuals of one or more coral species, supporting a rich associated fauna of benthic and epi-benthic species. Scleractinian corals such as *Lophelia*, *Madrepora*, and *Solensosmilia*, may also be present but not as a dominating habitat component. Habitats where colonial scleractinians dominate are defined as coral reef. Coral gardens can occur on a wide range of soft and hard seabed substrata. For example, soft bottom coral gardens may be dominated by solitary scleractinians, sea pens, or some representatives of bamboo corals, whereas hard bottom coral gardens are most often found to be dominated by gorgonians, stylasterids, and/or black corals (ICES 2007).

The biological diversity of coral garden communities is typically high and often contains several species of coral belonging to different taxonomic groups, such as such as "leather corals" (Alcyoniidae), "bamboo corals" (Isididae), "anemones" (Actinaria), "precious corals" (*Corallium*), non-reef building colonies of Scleractinia, and stony corals (*Lophelia, Madreporia, Solensosmilia*). However, these potentially reef-forming species occur only as small colonies. In some areas the coral gardens can also include stony hydroids /"lace corals" (Stylasteridae). The habitat can also include relatively large, although not dominant, numbers of sponge species. Other commonly associated fauna include basket stars (*Gorgonocephalus*), brittle stars, crinoids, molluscs, crustaceans and deep-water fish (e.g. Krieger and Wing 2002). They concluded that, "*Primnoa* is both habitat and prey for fish and invertebrates" and that "removal or damage of *Primnoa* may affect the populations of associated species, especially at depths >300 m, where species were using *Primnoa* almost exclusively".

ICES (2007) attempted a first characterisation of 'coral gardens' based on the density of stands and faunistic associations in order to aid objective and comparable characterisations: They note that the quantification of the *in situ* density (or abundance of coral by-catch in fishing gear) is often not possible due to technical or operational restrictions. Qualitative or semi-quantitative approaches will in many cases be more appropriate which is the reason why the definition of 'coral gardens' (see first paragraph) does not include mention of the densities of colonies. To enable comparisons between studies from different sites it would be useful to provide, as a minimum, relative densities.

Quantitative density estimates are given by Mortensen and Buhl-Mortensen (2004) for the Northeast Channel, off Nova Scotia with peak values of *Paragorgia arborea* between roughly 10 and 50 colonies per 100m^2. For *Primnoa resedaeformis* maximum values were higher, between 50 and 140 per 100m^2. The average densities were much lower (0.6 colonies per·100m^2 for *Paragorgia* and 4.8 colonies per·100m^2 for *Primnoa*). In the Gully, a submarine canyon off Nova Scotia, Mortensen and Buhl-Mortensen (2005a) found lower densities of these two species compared to the Northeast Channel, but in stands comprising several gorgonian species they found peak values between 100 and 600 colonies per 100m^2. In Alaska, where the term 'coral garden' was first used to describe dense stands of non-reefal corals, the densities are comparable to the studies by Mortensen and Buhl-Mortensen (2004; 2005a), with a maximum for gorgonians of 232 colonies per 100m^2 (652 colonies per 100m^2 including stylasterids).

Based on this limited information it is evident that the densities of developed coral gardens vary with taxonomic composition of the habitat forming corals. Smaller species (e.g. the gorgonians *Acanthogorgia* and *Primnoa* and stylasterids occur in higher densities [50 – 200 colonies per·100m^2]), compared to larger species such as *Paragorgia*. Coral gardens with several species may have densities between 100 and 700 colonies per·100m^2). These values could be used as a background for distinguishing between sparse and dense coral gardens (ICES 2007).

Probably the tallest coral gardens are found within the sea fans, or gorgonian corals. Sea fans are anchored to the bottom on cobbles and boulders in glacial deposits and often have both mobile and sessile associated species, including fishes. The sea fans grow like a tree with a central flexible trunk that branches up into the water column, oriented towards prevailing currents. Colonies that are several centuries old can be as tall as 5 metres thus, and in a descriptive way, being comparable with "trees" in the cold-water environment (Andrews *et al*. 2002). Common genera with a cosmopolitan distribution are *Paramuricea*, *Paragorgia* and *Primnoa.* An analysis of the associated fauna of *Paragorgia arborea* yielded 97 species whilst 47 species were identified associated with *Primnoa resedaeformis* (Buhl-Mortensen and Mortensen 2004). They conclude that the diversity of cold-water gorgonians is comparable with that found for shallow water gorgonians, but in general lower than for cold-water coral reefs. However, as cold-water gorgonians are known to host several symbiontic species, negative impacts on cold-water gorgonians will also affect their associated species. to a larger degree than for the scleractinian species, due to the larger degree of host-specific occurrence. These observations underline the importance of these corals as major habitat-formers and providers.

Current status

- Neither coral gardens as defined above nor any of the soft coral species which characterise coral gardens are subject to a national or international protection regime in the OSPAR area.

Geographical extent

- o OSPAR Regions: I, II, IV, V
- o Biogeographic zones: 9 , 11, 13, 15, 16, 22, 23 – full distribution not known
- o Region & Biogeographic zones specified for decline and/or threat: anywhere within demersal fishing depth

The occurrence and distribution of coral gardens in the North East Atlantic is insufficiently known at present. The current scientific information on the occurrence of non-reefal corals is patchy and is not based on systematic surveys, nor do characterisations of the density of occurrences exist for most of the sampling locations. However recently, ICES (2007) compiled a first inventory of where corals are known to occur in the North Atlantic (see Figure 2). The description of the observed habitat preferences and the regional distribution of soft corals potentially occurring in coral gardens in the North East Atlantic is taken from this review.

Non-reefal coldwater corals occur in most regions of the North Atlantic, most commonly in water with temperatures between 3 and 8ºC (Madsen, 1944; Mortensen *et al*., 2006)) in the north, but also in much warmer water in the south, e.g. around the Azores. The bathymetric distribution of such cold-water corals varies between regions with different hydrographic settings, but also locally as an effect of topographic features and substrate composition. On the Norwegian continental shelf corals occur mainly between 200 and 500 m depth restricted by seasonal hydrographic variations above, and cold Arctic Intermediate Water below. In the Norwegian fjords, gorgonians such as *Paramuricea placomus* occur in waters as shallow as 30m due to stratification of the water column and good supply of Atlantic water. On the northern Mid Atlantic Ridge cold-water corals are found from 800 to 2100m, with the highest number of coral taxa observed shallower than 1400m depth (Mortensen *et al*., in press).

Such habitats are often subject to strong or moderate currents that prevent silt deposition on the hard substrates that most coral species need as an attachment. The hard substrate may be constituted of exposed bedrock or gravel/boulder, often from morainic deposition, but also soft sandy/clayey sediments can be used as substrate for cold-water corals (most seapens and some gorgonians within the Isididae. Areas with a high diversity of substrates support a higher diversity of corals. This is, for example, reflected in the depth distribution of coral taxa on the Mid Atlantic Ridge (Mortensen *et al*., in press) where taxa like scleractinians, predominantly occur in the shallower depths where the percentage of hard bottom in a variety of substrata is high, whereas the soft sediment flanks of the sampled seamounts were occupied by seapens (the distribution intervals reflect the discontinuous sampling effort).

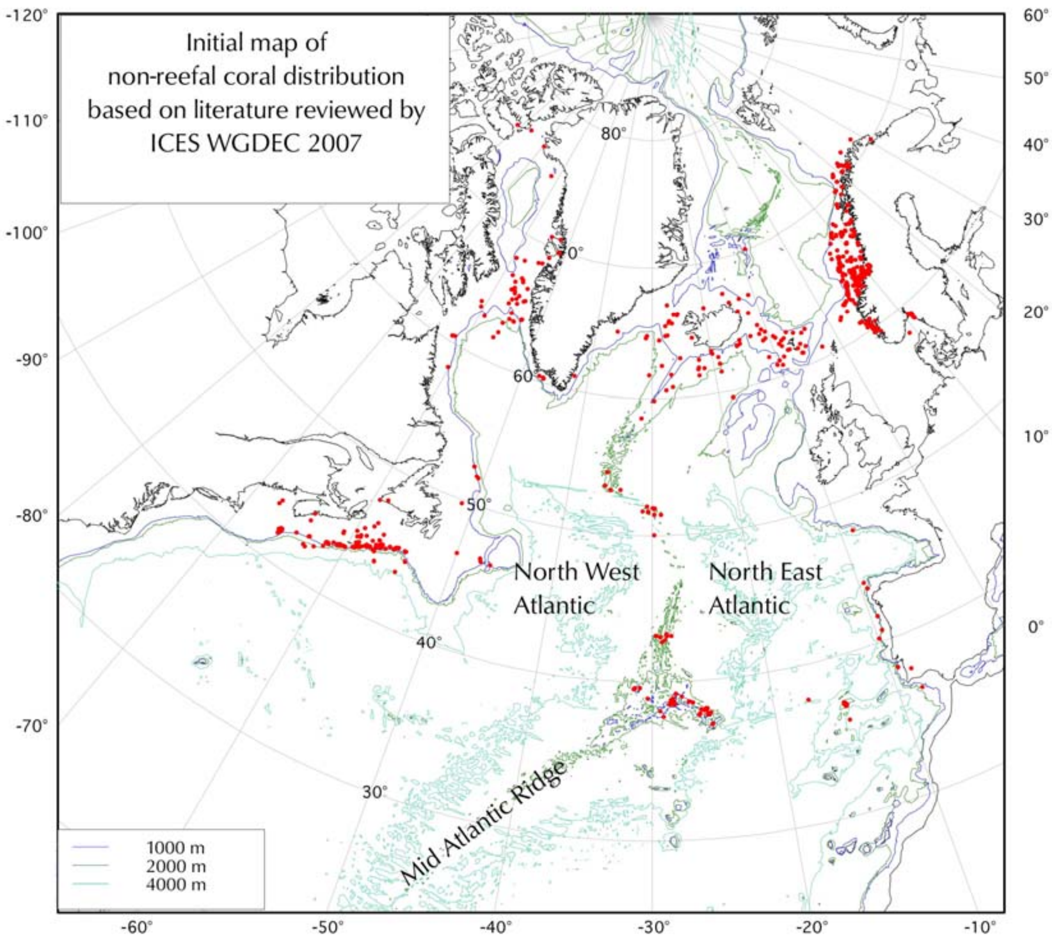


Figure 2: Initial map of the currently known occurrence of soft corals in the North Atlantic Ocean. Data compiled by ICES WGDEC 2007).

The distribution of cold-water corals (including non-reefal species) in the North Atlantic have been reviewed earlier by (Madsen 1944; Zibrowius, 1980; Cairns and Chapman, 2001; Watling and Auster, 2005; Mortensen *et al*., 2006). Grasshoff (in several publications 1972-1986, see ICES 2007) especially focused on the distribution of Gorgonaria, Anthipatharia and Pennatularia in the Northeast Atlantic.

Norway

In their compilation of benthic macro-organisms in Norway, Brattegard and Holthe (1997) lists 38 cold-water coral species from the Norwegian coast. The majority of these (31 species) are octocorals. Of these, sea pens comprise most species rich (12 species). Species known to form habitats are represented among seven gorgonian species: *Paragorgia arborea*, *Primnoa resedaeformis* and *Paramuricea placomus* are known to occur in relatively high densities. These habitats have been referred to as 'coral forest' among fishers. Because of the abundant occurrence of *Lophelia* reefs off Norway, most recent research on cold-water corals has been directed to studies on the distribution, ecology and fisheries impact on reefs. The large gorgonians mentioned here are all typical components of the associated fauna on *Lophelia* reefs off Norway. The distribution of 'coral forests' or coral gardens, outside reefs is poorly known, but it is known that Trondheimsfjord has areas with such habitats (Strømgren, 1970). Indeed, there are coral gardens also offshore, indicated by local fishers off the coast of Finnmark and observed on the continental shelf break off mid-Norway during research cruises directed by the Institute of Marine Research (Pål Buhl-Mortensen pers. comm.).

Sweden and southern Norway

In several locations in the Skagerrak, mostly in the channels connecting the Oslofjord proper with the open Skagerrak, and in one area (Bratten) in the open Skagerrak, Lundälv (2004), Lundälv & Johnsson (2005) and Sköld et al (2007) found rich communities of gorgonian corals (*Primnoa resedaeformis, Paramuricea placomus and Muriceides kuekenthali*) and basket stars (*Gorgonocephalus caputmedusae*). On soft bottom, dense stands of *Funiculina quadrangularis* and other seapens, were observed. New records of the gorgonian *Anthothela grandiflora* in the Skagerrak and Swedish waters were established.

Faroe Islands and nearby Banks

Much of the information about the distribution of cold-water corals in the Faroe region comes from the research programme BIOFAR (Bruntse and Tendal, 2001; Tendal et al, 2005). Figure 3 shows the distribution of the gorgonians *Paragorgia arborea* and *Primnoa resedaeformis* around the Faroes. Also the majority of the stylasterid samples are from the outer shelf and upper slope fauna zones of the Faroe plateau and outer banks, an area characterised by diverse hard substrate, good water movement, low fine sediment load and temperatures above 6 °C. This area also holds the greatest diversity of those coral groups that are slow-growing, long-lived and reliant on long-term environmental stability. Faroese fishermen reported colonies of *Paragorgia arborea* of 2.5 m height (estimated to be at least 1500 years old). *Primnoa resaediformes* is more widespread around the Faroes and was first recorded in 1906. Most records, including the present ones, come from 200-500 m depth, in North Atlantic water. Specimens of 1 m size were recorded, corresponding to an estimated age of about 500 years.

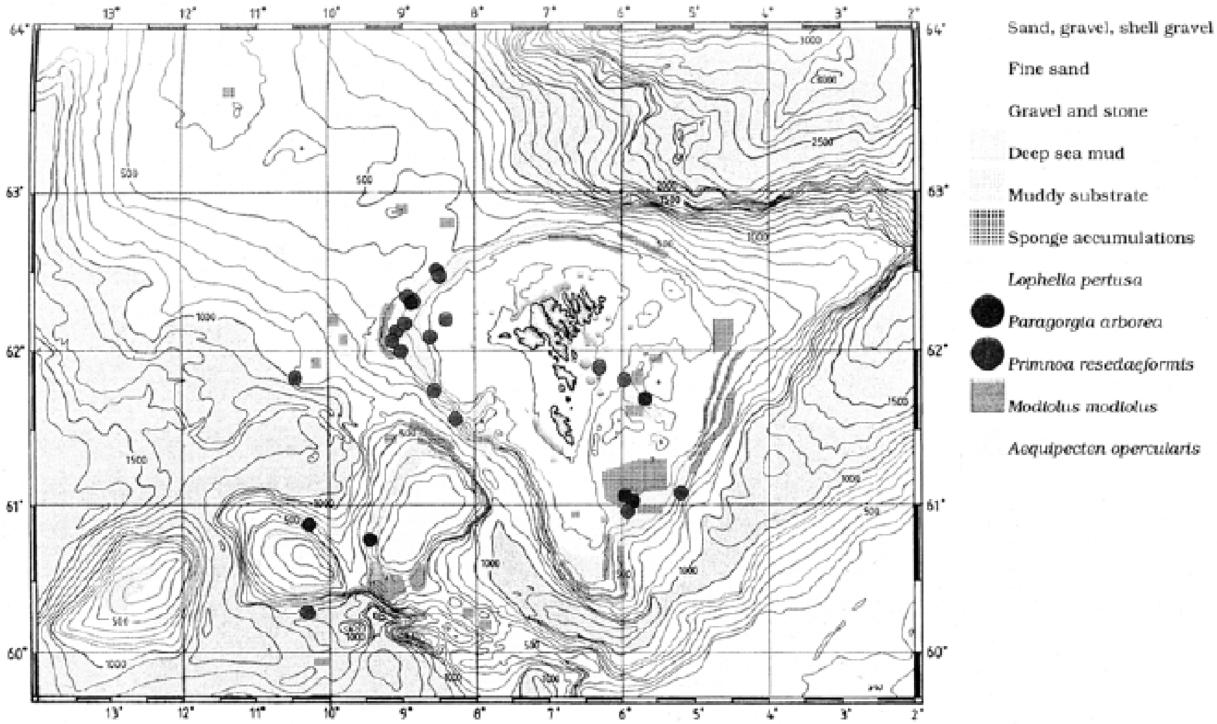
Iceland

Around Iceland, Ragnarsson and Steingrimsson (2003) mapped the present occurrence of octocorals in relation to fishing pressure with otter trawl gear (Figure 4). However, ICES WGDEC was unable to obtain information on the taxonomic composition of the coral community.

United Kingdom and nearby Banks
Hatton Bank

Durán Muñoz et al. (2007) recorded soft corals as part of the bycatch occurring in the Spanish bottom trawl and bottom longline cooperative surveys on the Hatton Bank and adjacent waters and in the Spanish bottom trawl commercial fishery on the Hatton slope (1000-1500m). The frequency and volume of soft-corals (Gorgonians and Antipatharians) in the catches was low on the regularly-used fishing grounds. Most of the Gorgonian records were obtained at shallow depths (<1000m), but Antipatharians were found over a wide depth range.

Figure 3: Locations of corals around the Faroe Islands (from Bruntse and Tendal, 2001)



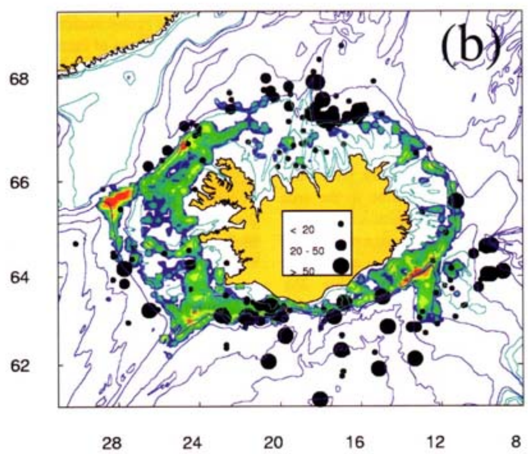


Figure 4: Total number of octocorals per sample collected in the BIOICE project superimposed over otter trawling effort(Steingrimsson and López-Conzález, unpublished data in: Ragnarsson and Steingrimsson, 2003). The colour scale of fishing effort ranges from blue (low effort) to red (high effort). The size of the dots represents abundance.

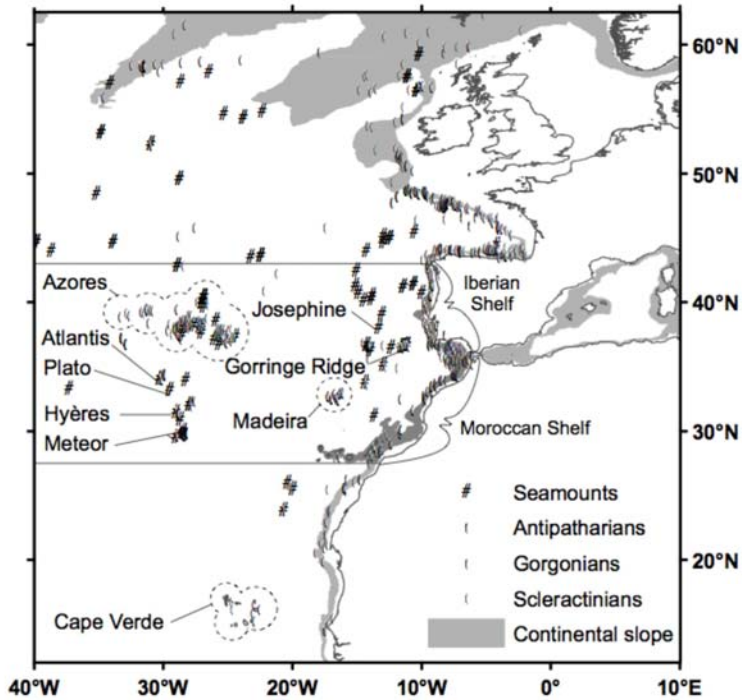


Figure 5: Records of deep-water corals in the north-east Atlantic south of 60°N from historic samples taken prior to 1985 (from Hall-Spencer *et al*. 2007)

North-east Atlantic south of 61^{o}N

Hall-Spencer et al. (2007) reviewed the literature and compiled a database of deep-water (> 200m) anthipatharians, scleractinians and gorgonians of the north-east Atlantic south of 60°N, including 2547 records from benthic sampling expeditions between 1868 and 1985 (Figure 5). The majority of records came from steeply-sloping seabed types around seamounts, oceanic islands and the continental slope and confirmed the importance of the Mid-Atlantic Ridge as a biogeographic boundary between corals characterising the American boreal continental slope to the west and the European continental slope communities to the east (see e.g. Cairns and Chapman 2001, Watling and Auster 2005, Schröder-Ritzrau et al. 2005). North Atlantic antipatharians appear to be restricted to open ocean areas, with Antipathes erinaceus, Distichopathes sp., Phanopathes sp. and Stauropathes punctata only recorded on Josephine seamount, the Azores and Cape Verde Islands (Molodtsova 2006).

Spain
From several locations in Spanish waters, at least 13 octocoral species are described and several coral associations can be recognised (see e.g. Aguirrezabalaga et al. 1984, Sánchez & Olaso 2004, and pers. com. Sánchez to P. Marcos 2006). These associations can include species of scleractinians (e.g. Madrepora oculata with Lophelia pertusa) mixed with gorgonians (e.g. Paramuricea spp) and stony hydroids. The composition of these associations is probably depth related. (e.g. on Galicia Bank, Spain). In Northern Spain (Galician coasts), gorgonian and black corals occur with Dendrophyllia cornigera (Sánchez pers.com.). Dendrophyllia ramea with gorgonians (Paramuricea clavata) occurs below 20 m in the Gulf of Cádiz, south-west Spain (Templado et al. 1993).

Mid-Atlantic Ridge
The non-hydrothermal hard bottom areas of oceanic ridges are often colonised by erect megafauna such as gorgonians, sponges, hydroids, and black corals (Grigg, 1997). Mortensen et al. (in press) observed corals on all sites surveyed with ROVs at depths between 800 and 2400 m on the northern Mid-Atlantic Ridge. The species richness of corals was high with a total of 40 taxa. Octocorals (Alcyonacea, Gorgonacea, Pennatulacea) were taxonomically richer than hexacorals (Antipatharia and Scleractinia) with 27 versus 14 taxa. Gorgonacea was the most diverse order comprising 14 taxa, whereas Antipatharia and Alcyonacea were represented with the lowest number of taxa (two and three taxa, respectively).

Oceanic islands
Overall, deep-sea corals are common around the Azores, particularly in the steep volcanic biotopes of the insular slopes and offshore seamounts (e.g. Braga-Henriques et al. 2006). The most commonly-sampled gorgonians include large Callogorgia verticillata, Dentomuricea spp., Acanthogorgia hirsuta and A. armata, Viminella flagellum. The substrate availability may influence the patchy occurrence of the species: Viminella flagellum is the dominant species on boulder beds (Figure 6), whereas Paramuriceidae were relatively more abundant in bottoms with a sediment veneer (Figure 7). The Antipatharian fauna is apparently dominated by the Antipathella wollastoni in the littoral of the islands and shallow seamounts below ca. 20m. The black coral Leiopathes glaberrima can reach up to 2m high and it probably forms dense forests between 200 and 800m.

Figure 6 *Viminella flagellum* dominated coral gardens on Condor da Terra seamount, Azores (Braga-Henriques *et al*. 2006, Copyright Gevin Newman, Greenpeace).

Figure 7. Paramuriceidae spp. dominated coral gardens on Condor da Terra seamount, Azores (Braga-Henriques *et al*. 2006, Copyright Gevin Newman, Greenpeace)

Several coral associations can be recognised. These associations can include species of the same group (e.g. Madrepora oculata with Lophelia pertusa) mixed with gorgonians (e.g. Paramuricea spp), stony hydroids, etc. The composition of those associations is probably depth related. The associated non-coral fauna was abundant and highly diverse.

Isolated North East Atlantic seamounts

Josephine Seamount

The summit region of Josephine Seamount, a seamount rising from more than 4000m to less than 200m depth is characterised by dense gorgonian beds on gravelly substrate (Gage & Tyler 1991, Figure 8). The species rich fauna of Josephine Seamount is typical for the eastern Atlantic, more closely related to the islands than to the continental shelf. This particularly well investigated summit region offers a wide variety of substrates which are readily populated by sometimes high densities of mostly sessile filter feeding species. Sixteen species of horny and black corals, thirteen species of stony corals, but no pennatulids and neither shelf nor deep sea benthic species were found. Dense beds of the gorgonian Callogorgia verticillata, coincide with large sponges on the summit of Josephine, quite different from other seamounts (Grasshoff 1985).

Figure 8 Gorgonian bed on the summit of Josephine Seamount (ca. 200m, Photograph by A.L. Rice, copyright: DEEPSEAS Group, NOC)

Application of the Texel-Faial criteria

Global/regional importance

Many of the habitat forming taxa of coral gardens, like e.g. *Paramuricea, Paragorgia or Primnoa* , but also most of the anthipatharians and stylasterid corals have a cosmopolitan distribution. Therefore the OSPAR area does not have specific global or regional importance for their occurrence. However, due to the high fishing pressure in deep waters in the OSPAR area, the probability of decline and the degree of threat may be higher than in other oceans.

Decline

Probability of significant decline.

There are no known scientific records or time series about decline in this habitat or bycatch of corals in the OSPAR area. Unlike scleractinian reefs, these corals do not leave clear evidence of trawling damage so it is not possible to determine their historical distribution and abundance based on post-fishing surveys (Hall-Spencer et al. 2007). Pooling data on the distributions of sensitive benthic species with data on the distribution of deep-water trawling to highlight areas where pristine habitats are likely to still be found are only beginning.

However, fishermen's experience indicates a significant decline in areas where bottom trawling occurs, with observations off Iceland and the Faroes (Bruntse and Tendal 2001 quote fishermen) and in the Skagerrak (off Sweden/Norway, Lundälf pers. com), as well as probably on all the "good" fishing places for redfish which lives within the habitat. This is also known from Canada, where fishermen reported significant changes to the seafloor over the duration of their fishing careers, including a decrease in the size and number of corals they caught (Gass & Willison 2005). Mortensen *et al.*

(2005) observed broken live corals, tilted corals, scattered skeletons and lost fishing gear entangled in corals off Nova Soctia.

In other regions, the volume of gorgonian bycatch in bottom fisheries was estimated (e.g. off Alaska 200 000 kg of mostly gorgonian and antipatharian corals between 1990 and 2002) giving a further indication for the likely significant decline of this habitat caused by bottom fisheries. Long-line gear is also noted to tip and dislodge corals (Krieger 2001). Bycatch data from a long-line survey in the Gulf of Alaska and Aleutian Islands showed *Primnoa* and other coral taxa were caught on 619 of 541,350 hooks •shed at 150-900 m depths (Krieger 2001).

Sensitivity

Very sensitive – for several reasons:

1. **Longevity**: Analysis of the life span of octocorals indicates that some of the large colony-forming species, such as *Primnoa resedaeformis*, can live for centuries (Risk *et al.* 2002, Andrews 2002). However, gorgonian corals are difficult to age. Growth rate estimations indicate that off Nova Scotia a *Primnoa resaediformes* of 80 cm is an estimated 46 years old (Mortensen & Buhl-Mortensen 2005b). Acc. to Bruntse & Tendal (2001), Faroese fishermen reported of *Paragorgia arborea* colonies of 2.5 m hight, which is assumed to correspond to an individual age of at least 1500 years. *Primnoa resaediformes* specimens of 1 m size were recorded, corresponding to the maximum size for the species allover the North Atlantic. Specimens of that size are at least 500 years old (all acc. to literature quoted by Bruntse & Tendal 2001).

2. **Unknown reproductive patterns**: Knowledge on recruitment patterns is very limited. Bruntse & Tendal (2001) reviewed the literature finding that *Primnoa resaediformis* was reported to be viviparous (Strömgren 1979, Risk *et al*. 1989). Acc. to their review, the reproduction frequency of both *Primnoa resedaeiformis* and *Paragorgia arborea* is unknown . A single series of observations in the Gulf of Alaska suggest that recruitment of *Primnoa* sp. is patchy and aperiodic (Krieger 2001).

3. **Uncertain recovery**: Knowledge on recovery patterns is sparse: Krieger (2001) observed no recruitment of new colonies in an area where *Primnoa* was removed by trawling after seven years. However, six new colonies were observed at a second site one year after trawling. Four of these colonies were attached to the bases of colonies removed by trawling. Recruits of *Primnoa* were also observed on two 7 cm diameter cables (>15 colonies each). On the other hand, in the Gulf of Maine and in submarine canyons limited observations have revealed abundant new recruits of both *Primnoa resedaeformis and Paramuricea* spp. (Watling, Auster, and France, unpublished observations, in Watling & Auster 2005). Whether these young colonies were produced by larval recruitment or branch dropping (as in shallow-water gorgonians) "is impossible to say at this time" (Watling & Auster 2005). However, studies from deep water, high latitudinal, hard bottom communiities are lacking (Mortensen et al. 2005).

4. **Large size perpendicular to the seafloor**: The most prominent gorgonian coral species can grow to a size of several meters up into the water column, their delicate branches being highly susceptible to physical damage (Bruntse & Tendal 2001). Probert *et al*. (1997) examined benthic invertebrate by-catch from a deep-water trawl fishery off New Zealand, and found that Gorgonacea was one of the best represented groups in the catch. They concluded that large sessile epibenthic species were among taxa especially vulnerable to impacts from commercial trawling, and that large gorgonians such as *Paragorgia arborea* would be unlikely to recover “within a foreseeable future”.

Threat

Currently threatened.

There are indications from a Canadian (DFO) fisheries observer programme that all the most frequently-used fishing gears (gill nets, trawls, long lines) cause damage to the corals. Coral gardens on soft bottoms within fishing depths are subject to the highest threat, however, advances in fisheries technology such as "rock hopper" gear on bottom trawls have eliminated some of the areas that would have been refuges from trawling (Watling & Norse 1998).

Evidence from Canada suggests that there, long-lining is the most significant threat to gorgonian corals to date, as otter trawling may be restricted in boulder areas which provide the substrate for the gorgonian corals. Video transects e.g. off Nova Scotia, Canada, revealed long-lines entangled in damaged corals. This was confirmed by fishermen.

Secondary damage may occur from the long free end of a snagged long-line (Mortensen et al. 2005).

Around Iceland, Ragnarsson & Steingrimsson (2003) mapped the present occurrence of octocorals in relation to fishing pressure from otter trawl gear (see Fig. 3). Trawling and occurrence of corals mostly did not coincide, which either indicates that no trawling occurs in boulder areas, or that decades of trawling may have diminished the previously wider distribution of these corals. An indication for the latter hypothesis comes from evidence given by German fishermen who targeted redfish around Iceland in the 1970s. They reported having caught as a bycatch huge fragments of "bubble gum trees" (*Paragorgia*), for example in an area called "Rosengarten" to the south east of Iceland. Fishing in this area continued for many years with decreasing catches of both fish and coral bycatch (pers. com. to S. Christiansen, WWF, in 2004).

Apart from directly smashing or tilting the gorgonians, fishing also weakens the structure of individual colonies by damaging the tissue resulting in a higher rate of epibiont and parasite colonisation, increasing the mortality and lowering the fertility.

Among other species, redfish live associated with corals in the boulder fields which they use for rest and shelter. Decreasing availability of such three-dimensional current-reducing structure may have an effect on the competitiveness/success of redfish.

Relevant additional considerations

Sufficiency of data

Although there are some records of the occurrence of coral garden habitat-forming species in the North East Atlantic, the habitat as such has not been described so far. It will be necessary to revisit the existing data for likely locations and extent of coral gardens. Considering octocorals in general, data are absolutely insufficient, in particular as concerns the more southerly/warmer species. However, the species *Paragorgia arborea and Primnoa resaediformes* are in some areas well described (e.g. Faroes, Iceland, partially Norway). The overall distribution is yet not entirely known.

Changes in relation to natural variability

No knowledge

ICES WG DEC Evaluation

Despite an obvious lack of information about the current distribution and thus potential threat to the habitat in the OSPAR area, the two reviewers of the nomination both consider it appropriate to include "coral gardens" on the OSPAR list of threatened and/or declining species and habitats. Evidence from other parts of the world, and initial reports of coral bycatch from around Iceland indicate the vulnerability of the habitat to demersal fishing operations. A more in depth habitat definition and indications of coral garden occurrences in the OSPAR area were requested in order to enable targeted protection measures.

Threat and link to human activities

Relevant human activity: fishing (all demersal fishing operations) and other physically impacting activities (locally e.g. oil installations, pipeline construction)

Category of effect of human activity: physical damage or destruction of individuals and their habitat, potentially also indirect effect of reduced viability due to increased sediment suspension

Management considerations

Current management

No current management apart from the likely protection from trawling in areas designated for the protection of scleractinian corals. However, demersal long-lining in these areas is still allowed.

Required further management

1. Information collection from scientific and fisheries sources, and mapping of presently known records
2. Designation of protected areas
3. Fisheries management to prohibit use of damaging gear (trawls, bottom long-lines, bottom-set gill nets) in known areas of coral occurrence
4. New research and habitat mapping, including predictive mapping of the likely occurrence of coral gardens.

Further information

Nominated by:

Submitted by WWF to OSPAR's Working Group on Marine Protected Areas, Species and Habitats in 2006 and OSPAR's Biodiversity Committee in 2007. This case report was compiled from the nomination as revised by MASH 2006, incorporating comments received from ICES WGDEC in 2007, and also drawing upon ICES ACE (2007), based on a report of the working group on Deep Water Ecology, WGDEC (2007) .

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