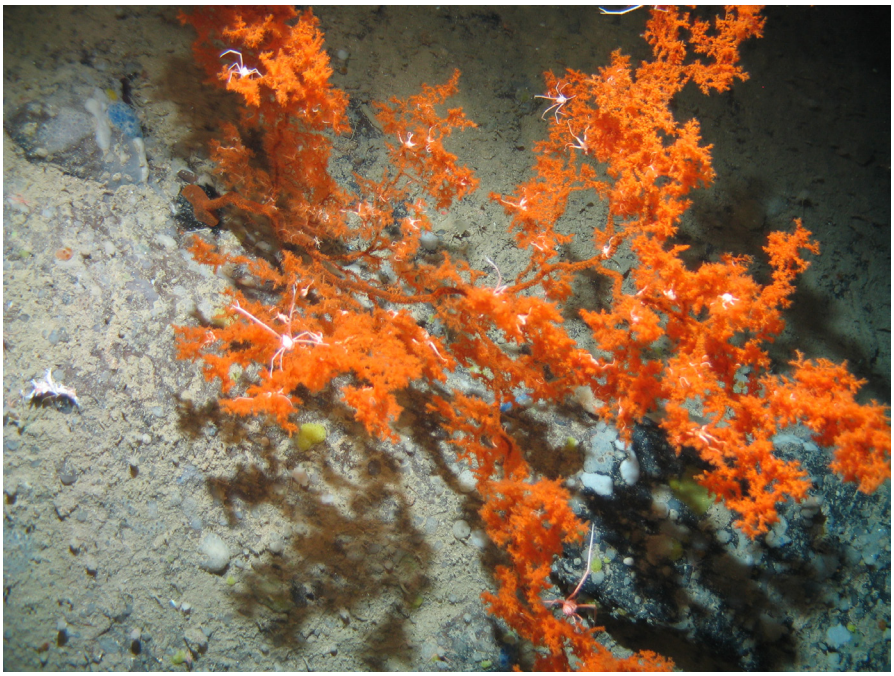
OSPAR COMMISSION

Background Document for Seamounts



Biodiversity Series

2010

OSPAR Convention

The Convention for the Protection of the Marine Environment of the North-East Atlantic (the “OSPAR Convention”) was opened for signature at the Ministerial Meeting of the former Oslo and Paris Commissions in Paris on 22 September 1992. The Convention entered into force on 25 March 1998. It has been ratified by Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, Netherlands, Norway, Portugal, Sweden, Switzerland and the United Kingdom and approved by the European Community and Spain.

Convention OSPAR

La Convention pour la protection du milieu marin de l'Atlantique du Nord-Est, dite Convention OSPAR, a été ouverte à la signature à la réunion ministérielle des anciennes Commissions d'Oslo et de Paris, à Paris le 22 septembre 1992. La Convention est entrée en vigueur le 25 mars 1998. La Convention a été ratifiée par l'Allemagne, la Belgique, le Danemark, la Finlande, la France, l’Irlande, l’Islande, le Luxembourg, la Norvège, les Pays-Bas, le Portugal, le Royaume-Uni de Grande Bretagne et d’Irlande du Nord, la Suède et la Suisse et approuvée par la Communauté européenne et l’Espagne.

Acknowledgement

This report has been prepared by Ricardo Serrão Santos, Fernando Tempera and Telmo Morato (Department of Oceanography and Fisheries of the University of the Azores) for Portugal as lead country [ricardo@uac.pt].

Cover photograph provided by Bhavani Narayanaswamy showing an orange bushy antipatharian coral (*Leiopathes* sp.) growing on silty bedrock face can be seen in the middle of the photograph. Many small decapod crustaceans (possibly galatheids) and tiny ophiuroids are also seen amongst the branches. This photograph was taken as part of the UK Department of Trade and Industry’s offshore energy Strategic Environmental Assessment programme. © Crown Copyright, all rights reserved.

Contents

Background Document for Seamounts

Executive Summary

This Background Document for Seamounts has been developed by OSPAR following the inclusion of this habitat on the OSPAR List of threatened and/or declining species and habitats (OSPAR agreement 2008-6). The document provides a compilation of the reviews and assessments that have been prepared concerning this habitat since the agreement to include it in the OSPAR List in 2003. The original evaluation used to justify the inclusion of seamounts in the OSPAR List is followed by an assessment of the most recent information on its status (distribution, extent, condition) and key threats prepared during 2009-2010. Chapter 7 provides recommendations for the actions and measures that could be taken to improve the conservation status of the habitat. In agreeing to the publication of this document, Contracting Parties have indicated the need to further review these proposals. Publication of this background document does not, therefore, imply any formal endorsement of these proposals by the OSPAR Commission. On the basis of the further review of these proposals, OSPAR will continue its work to ensure the protection of seamounts, where necessary in cooperation with other competent organisations. This background document may be updated to reflect further developments or further information on the status of the habitat which becomes available.

Récapitulatif

Le présent document de fond sur les monts sous-marins a été élaboré par OSPAR à la suite de l'inclusion de cet habitat dans la liste OSPAR des espèces et habitats menacés et/ou en déclin (Accord OSPAR 2008-6). Ce document comporte une compilation des revues et des évaluations concernant cet habitat qui ont été préparées depuis qu'il a été convenu de l'inclure dans la Liste OSPAR en 2003. L'évaluation d'origine permettant de justifier l'inclusion des monts sous-marins dans la Liste OSPAR est suivie d'une évaluation des informations les plus récentes sur son statut (distribution, étendue et condition) et des menaces clés, préparée en 2009-2010. Le chapitre 7 fournit des propositions d'actions et de mesures qui pourraient être prises afin d'améliorer l'état de conservation de l'habitat. En se mettant d'accord sur la publication de ce document, les Parties contractantes ont indiqué la nécessité de réviser de nouveau ces propositions. La publication de ce document ne signifie pas, par conséquent que la Commission OSPAR entérine ces propositions de manière formelle. A partir de la nouvelle révision de ces propositions, OSPAR poursuivra ses travaux afin de s'assurer de la protection des monts sous-marins le cas échéant avec la coopération d'autres organisations compétentes. Ce document de fond pourra être actualisé pour tenir compte de nouvelles avancées ou de nouvelles informations qui deviendront disponibles sur l'état de l'habitat.

1. Background information

Nomination

Seamounts

EUNIS Code: A6.72

Definition for habitat mapping

OSPAR has defined seamounts as undersea mountains whose summits rise more than 1000 metres above the surrounding sea floor (Menard, 1964 in Rogers, 1994). Seamounts can be a variety of shapes, but are generally conical with a circular, elliptical or more elongated base. Seamounts are usually of volcanic origin, and are often associated with seafloor 'hotspots' (thinner areas of the earth's crust where magma can escape) (see Wessel, 2007). Seamounts, often with a slope inclination of up to 60°, provide a striking contrast to the surrounding 'flat' abyssal plain. Their relief has profound effects on the surrounding oceanic circulation, with the formation of trapped waves, jets, eddies and closed circulations known as Taylor columns (Taylor, 1917 in Rogers, 1994). Seamounts occur frequently within the OSPAR Maritime Area. Analysis of narrow beam bathymetric data by the US Naval Oceanographic office from 1967-1989 identified more than 810 seamounts within the North Atlantic. The majority occur along the Mid-Atlantic ridge between Iceland and the Hayes fracture zone (Gubbay, 2002). The enhanced currents that occur around seamounts provide ideal conditions for suspension feeders. Gorgonian, scleratinian and antipatharian corals may be particularly abundant, and other suspension feeders such as sponges, hydroids and ascidians are also present. Concentrations of commercially important fish species, such as orange roughy, aggregate around seamounts and live in close association with the benthic communities (Gubbay, 2002).

As our understanding of the geologic processes that form seamounts and their distribution has improved, the strict 1000-m-relief limitation has been relaxed in practice, as the geological literature now routinely apply the term "seamount" to much smaller structures (down to a few tens of metres). Studies of seamount populations reveal that their size-frequency distributions are continuous with no obvious break. Thus, seamounts do not have a clear lower-size limit, making a size-based criteria for defining them arbitrary. Consequently, the term "seamount" has been applied more generally to topographic "hill" elevations regardless of size and relief.

Recently, a more functional definition was proposed (Pitcher *et al*., 2007) which defines as a seamount any topographically distinct seafloor feature that is at least 100 metres high but which does not break the sea surface. However, it excludes large banks and shoals (e.g. Georges Bank, Porcupine Bank) as well as topographic features on continental shelves since these have been dealt with elsewhere in the literature and, in any case, differ from true seamounts in terms of size (in the case of large banks and shoals) and proximity to other shallow topography (in the case of topographic features on the continental shelf). Individual seamounts can be classified on the basis of summit depth (Pitcher *et al*., 2007): shallow seamounts as those that penetrate the euphotic zone, intermediate seamounts as those that are shallower than the daytime depth of the deep scattering layer (but which do not reach the euphotic zone), and deep seamounts as those with summits below the deep scattering layer. Finally, seamounts can be classified as being large or small (Pitcher *et al*., 2007), depending on whether the heights exceed 1500 metres (regardless of depth). This height separation is useful in isolating large seamounts, whose global distribution is well resolved by satellite altimetry, from small seamounts whose distribution must be inferred from local, acoustic mapping and therefore remain poorly sampled.

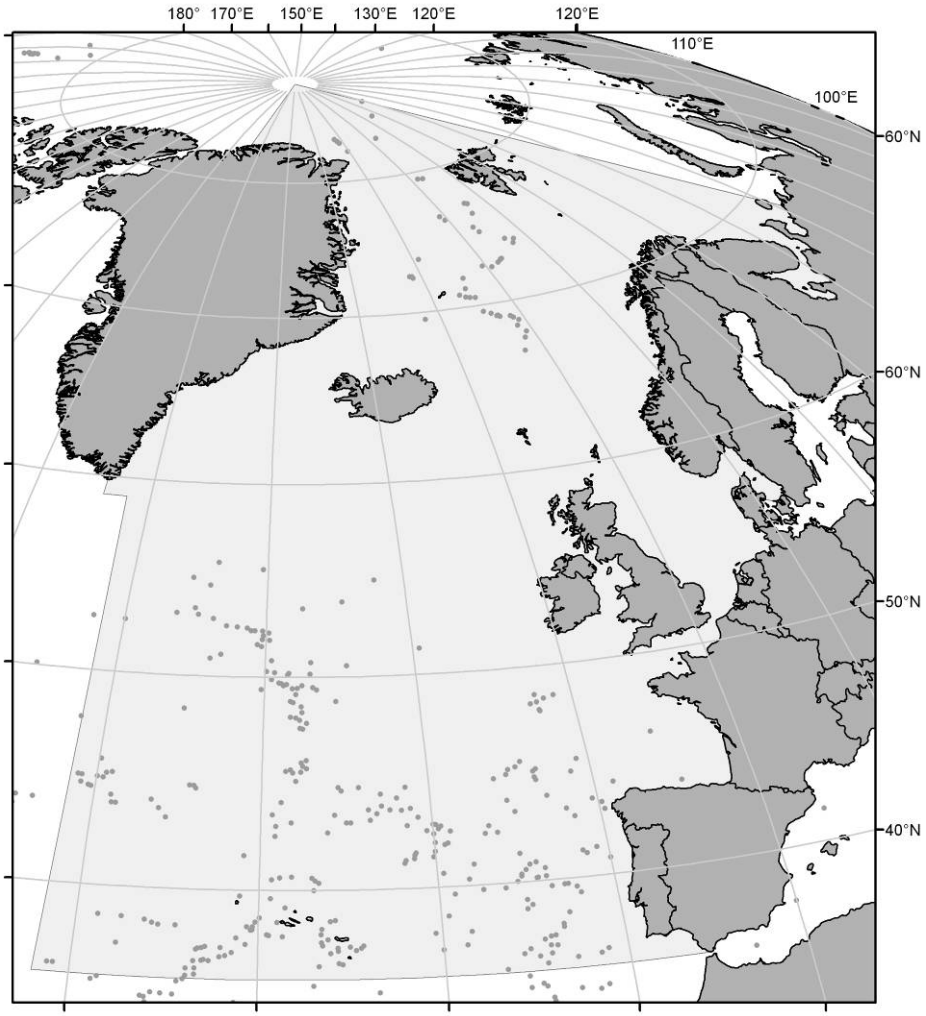


Figure 1: Potential location of large seamounts in OSPAR inferred by the Sea Around Us Project analysis (from Kitchingman *et al*., 2007)

The number of seamounts in the OSPAR area still needs to be validated. However, from the Kitchingman *et al*., (2007) dataset there may be at least 325 large seamounts. The majority occur along the Mid-Atlantic ridge, off Portugal, Spain and the UK.

2. Original Evaluation against the Texel-Faial selection criteria

OSPAR Regions and Dinter biogeographic zones where the habitat occurs

OSPAR Regions; I, IV, V

Biogeographic zones: Warm-temperate waters, Cold-temperate waters, Cold-Arctic waters, Seamounts and plateus, Atlantic (Deep sea), Arctic subregion (Deep sea),

Seamounts have been identified in the territorial seas and/or the EEZs (or equivalents) of Portugal (Azores), Spain, the United Kingdom (UK), Ireland, Norway, Iceland, and Denmark (Greenland/Faroes), and in the international waters of the Arctic Ocean and Wider Atlantic. In the Norwegian Sea and Greenland Sea, several underwater heights that may be classified as seamounts have recently been identified on multibeam bathymetry data from the Norwegian Petroleum Directorate.

OSPAR Regions where the habitat is under threat and/or in decline

All where they occur.

General

Seamounts are hotspots of marine life (Pitcher *et al*., 2007). Due to their more or less isolated location, seamounts create alterated current systems which most often lead to accelerated current speeds (White *et al*., 2007) leading to exposed hard substrates and improved food conditions for epibenthic suspension feeders (Genin & Dower 2007; Cartes *et al*., 2007a, b) such as cold water corals or deep water sponges (Samadi *et al*., 2007; Sánchez *et al*., 2008, 2009). Forty-eight species of scleractinian corals, 27 species of octocorals, 8 species of anthipatarian and 7 species of stylasterids were described from North-East Atlantic seamounts, Rogers *et al*., 2007). Many form colonies or even reefs, as in the case of *Lophelia pertusa*, which provide extra complexity and structure to seamounts. Though the diversity and localised distribution of species living in these communities are recognised, their biology and life history remain poorly studied, except that some of these species may be extremely long-lived, e.g., >100 years.

The species richness and diversity of fish fauna on seamounts is not well documented. Although the number of investigated seamounts is small, it is increasingly evident that the associated fish assemblages display specific adaptations to these habitats and represents a relatively large and unique portion of fish biodiversity (Morato & Clark 2007). One group of fish species living on (or visiting) seamounts that has raised much attention because of their high abundance and commercial value, are the orange roughy (*Hoplostethus atlanticus*) and alfosinos (*Beryx splendens* and *B. decadactylus*) (Morato & Clark 2007). These fish aggregate on seamounts and have been intensively exploited since the late 1970s. Fish species living on seamounts, but particularly those forming large aggregations, have higher intrinsic vulnerability than other groups of fish due to their longer lifespan, later sexual maturity, slower growth and lower natural mortality (Morato *et al*., 2006). The biodiversity values and biomass levels on the Le Danois Bank is considerably high in relation to the same depths of the near continental shelf area of the Cantabrian Sea (Sánchez *et al*., 2008). Additionally, recent studies have demonstrated that some marine predators are associated with shallow water seamounts in the OSPAR region (Morato *et al*., 2008). Seamounts act as feeding stations for some tuna species such as skipjack and bigeye, common dolphin and Cory's shearwater. The geographical distribution of catch per unit effort of albacore in the Bay of Biscay showed high catches in the Le Danois Bank area in summer time (Rodríguez-Cabello et al. 2009). These seamounts should be considered hotspots of marine life and a special effort should be made in order to ensure a sustainable management of these habitats.

A number of seamount populations have already been depleted and some species will become extinct if fishing on seamounts continues at current or even reduced levels. Deep-sea trawling causes extensive damage to benthic habitats. There is growing evidence of extensive collateral damage of cold-water coral reefs, sponge aggregations, etc, by fishing trawls (Clark and Koslow, 2007). Deep-sea corals and deep-sea sponges are long-lived (~1000y), colonial reef-building organisms. Recovery from damage may take thousands of years, if they recover at all. Resilience may be low in highly structured deep-sea ecosystems based on reef building long-lived species, at least in comparison to shallow habitats.

The majority of the seamounts in the OSPAR Maritime Area lie along the Mid-Atlantic Ridge (MAR) between Iceland and the Hayes fracture zone. There are also groups of seamounts some distance from the MAR to the south-west of the Rockall Bank, west of Portugal on the Madeira-Tore Rise, and the Milne seamounts to the east of the MAR. Seamounts have also been identified in the territorial seas and/or the EEZs, Spain, the United Kingdom (UK), Ireland, Norway, Iceland, and Denmark (Greenland/Faroes), and in the international waters of the Arctic Ocean and Wider Atlantic.

Original Evaluation against the Texel-Faial Criteria for which the habitat was included on the OSPAR List

Seamounts were nominated in a joint submission by three Contracting Parties citing decline, sensitivity, and ecological significance with information also provided on threat. The nomination was for Region V.

Decline: Consideration of decline is most relevant to the biological communities associated with seamounts rather than the physical structure of the feature itself. There are documented cases of extensive damage to seamount communities in some parts of the world (see WWF/IUCN/WCPA, 2001; Clark and Koslow, 2007; Clark *et al*., 2007) but limited information specific to seamounts in the OSPAR Maritime Area.

Sensitivity: Consideration of sensitivity is most relevant to the biological communities associated with seamounts rather than the physical structure of the feature itself. Fish species living on seamounts, but particularly those forming large aggregations, have higher intrinsic vulnerability than other groups of fishes due to their longer lifespan, later sexual maturity, slower growth and lower natural mortality (Morato *et al*., 2006). The orange roughy *Hoplostethus atlanticus* is probably the best known as it is slow growing and, with an estimated life span of more than 100 years, one of the longest lived fish species (Allain & Lorance, 2000). Orange roughy tend to form discrete and dense aggregations around seamounts from which high catch rates can be obtained, fisheries can rapidly deplete the stocks.

Seamount diverse benthic assemblages contain species of limited geographic distribution (endemics) and species with ancient lineages or previously believed to have become extinct (‘living fossils’) (Samadi *et al*., 2007). Evidence shows that deep-sea corals have the potential to live for thousands of years and are typically slow growing, yet where food supply and water conditions are optimal some can grow quickly (Rogers et al., 2007). For example, the scleractinian *L. pertusa* has rapidly colonised oil rigs and exhibited growth rates of up to 33 mm/year. Recent carbon dating work on isidid corals by revealed ages of 75–126 years confirming the longevity of certain deep-water corals.

Ecological significance: Seamounts are a distinct and different environment from much of the deep sea. They act as ‘islands’ for epibenthic and pelagic faunas, have potentially high rate of endemic species, are used as ‘stepping stones’ for the transoceanic dispersion of shell species and as reproduction/feeding grounds for migratory species (Stocks and Hart, 2007). Their steep slopes, which are often current-swept, and the predominance of hard exposed rock surfaces provide a marked contrast to the characteristically flat and sediment-covered abyssal plain. Their profile and elevation from the surrounding seafloor also affects the circulation of water in the area, for example by deflecting currents as well as leading to the formation of trapped waves, jets and eddies (Rogers, 1994).

Studies of the pelagic communities above seamounts reveal both qualitative and quantitative differences when compared to the surrounding water. The biomass of planktonic organisms over seamounts is often higher than surrounding areas, which, in turn, become an important component of the diet of fish and top predators such as sharks, rays, tuna and swordfish. Zooplankton and suprabenthic species are one of the key prey taxa in seamounts, even in large-bodied species such as sharks. Preciado *et al*.,(2009) described different feeding strategies among deep-water sharks dwelling at Le Danois Bank, with high levels of resource partitioning: euphausiids represent the main prey taxa in the top of the bank, as an indicative of higher zooplankton productivity over this submarine mount, and bathypelagic shrimps in the surrounding basin, in both cases together with fish preys. The ecological importance of seamounts for top predators is emphasised by the fact that some far-ranging pelagic species concentrate in such places. An example in the OSPAR Area is the Formigas Bank (Morato *et al*., 2008) in the south eastern part of the Azores which appears to act as a

feeding ground and possibly a fish spawning and nursery area for many species as suggested by the groups of small cetaceans such as bottlenose dolphin, common dolphin, spotted dolphin and pilot whales as well as captures of loggerhead turtles recorded in the area.

The benthic fauna are dominated by suspension feeders some of which are typically restricted to the seamount environment. They are characterised by high levels of endemism, which suggests limited reproductive dispersal. At present, two new crustacean species were described on Le Danois Bank but the analysis is in progress and 47 species are putatively new (Kavanagh & Sorbe, 2006; Guerra-García *et al*., 2008). Sampling of the benthic seamount fauna in the SW Pacific, for example, suggests that some of these species are notably localised. Somewhere between 29-34% of the species collected during 23 cruises to the region are believed to be new to science and potentially endemic to these seamounts (Richer de Forges *et al.,* 2000). Less is known about the level of endemism on seamounts in the North East Atlantic.

The concentration of commercially valuable fish species around seamounts is well documented. Fishes such as the orange roughy and some deep-water oreos appear to be adapted to life in this environment, their substantial aggregations supported in the otherwise food-poor deep sea by the enhanced flow of prey organisms past the seamounts (Morato and Clark, 2007). It is noteworthy the presence on Le Danois Bank of large adults and spawners of some fish species (e.g. blue whiting, anglerfish, forkbeard and bluemouth), which are very scarce at the same depths of the Cantabrian Sea shelf (Sánchez *et al*., 2008). Probably the lower degree of fishing activity in the Bank and the habitat complexity, due to scarce sedimentary coverage, plays an important role in structuring the communities of the Bank by increasing the presence of large fish species.

Apart from these general characteristics of seamounts that make them ecological significant there are also unique situations which make some even more significant. One example is the João de Castro bank which is the only known example of a shallow water hydrothermal vent seamount in the NE Atlantic (Cardigos *et al.*, 2005). Its uniqueness and rare fauna assemblages mean it might have an important role as a 'stepping stone' for species colonising the Azorean islands.

Threat: Seamounts are the focus of many commercial fisheries and most of them have some impact either on the target species, associated by-catch species, or the benthic communities and habitat. Longlines, gillnets, traps, and pots can all have some effect on seafloor habitats, but bottom trawling is the best known for causing considerable impacts. Many of the seamount targeted fish species have life-history strategies that make them particularly sensitive to exploitation (Morato and Clark 2007). There is no published information on whether crashes have also occurred on NE Atlantic seamounts but there are certainly anecdotal reports of sites being fished out and vessels moving to new areas to sustain their fishing activity as seamounts beyond the EEZ of the Azores become depleted.

Seamount habitats are also very sensitive to the physical impact of trawling and to the removal of benthic and pelagic key species by commercial fisheries (Clark and Koslow, 2007). Being isolated and confined to small areas, seamount habitats and faunas will be able to recover only over long time periods by the sporadic re-colonisation from nearby seamounts and shelf areas. Where this is not possible, as in the case of endemic species, disturbance might lead to extinction. Indirect effects of fishing, such as sediment re-suspension and mixing, and discharge of processing waste are also important factors that need further examination.

While commercial fishing is the overriding threat to seamount fauna at the present time there is also the possibility that some areas may be targeted by deep sea mining companies that are already looking at the possibility of extracting ferromanganese crusts and polymetallic sulphides from seamounts, and where the potential physical damage could also be considerable (Sarma *et al*., 1998).

Relevant additional considerations

Sufficiency of data: Historic and recent hydrographic surveys and satellite altimetry are the main sources of information on the location of seamounts (Wessel, 2007; Kitchingman *et al*., 2007). They give an overview of the main areas of distribution as well as more information on the bathymetry of locations that have been studied in some detail. Less is known about the biological resources of seamounts in the OSPAR Area as only a few have been studied in detail. The majority of these are seamounts around the Azores, as well as El Cachucho in North Spain, although there is also some basic information on others such as the Gorringe Ridge and Galicia Bank off the coast of Portugal, the Anton Dohrn Seamount in the Rockall Trough and the Josephine and Gettysburg seamounts south of the Tagus Abyssal Plain. Landings records from the commercial fisheries that operate on seamounts are another source of information about seamount fauna, however, as this is pooled it is rarely possibly to distinguish information for individual seamounts. This also makes it difficult to show the level of fishing effort on particular seamounts.

Changes in relation to natural variability: Little is known about natural fluctuations in the populations of seamount fauna however this is likely to be less significant when compared to the changes caused by fishing some of the long-lived species to the point of commercial extinction in a few years. The extensive damage to benthos to the point where areas have been reduced to bare rock, rubble and sand is also unlikely without some catastrophic event such as landslips.

Expert judgement: There is a limited amount of detailed information about the level of threat and damage to individual seamounts in the OSPAR Maritime Area, but lessons learnt from other parts of the world show that seamounts and their associated fauna are seriously threatened. Documented examples include the crash in populations of the rock lobster, *Jasus tristani* on the Vema seamount due to a combination of overfishing and unpredictable larval recruitment; fishing of the pelagic armourhead *Pseudopentaceros wheeleri* over the southern Emperor seamounts and seamounts in the northern Hawaiian Ridge to commercial extinction within 10 years of their discovery; and the orange roughy *Hoplostethus atlanticus* fishery on seamounts off the coasts of New Zealand and Australia where new discoveries of stocks are typically fished down to 15-30% of their initial biomass within 5-10 years (Koslow *et al*., 2001). Given this pressure and the fact that seamounts in the OSPAR Maritime Area are targeted by commercial fisheries, expert judgement suggests that seamounts should be on the OSPAR list of threatened and/or declining species and habitats.

ICES evaluation: The ICES evaluation of the nomination of this habitat in 2003 acknowledges the threat to seamount habitats in some parts of the world but pointed to limited information on threat and decline to seamounts in the OSPAR Maritime Area with the original nominations (ICES, 2002). ICES concluded that there is insufficient evidence for the nomination, but noted that inclusion of this habitat should be considered on the grounds of “precaution” until further data are available. Further ICES Advice on this issue was given in 2005 (ICES 2005a). This background document makes the case for such inclusion with particular reference to expert judgement as described above.

3. Current status of the habitat

Distribution in the OSPAR maritime area

Seamounts are widespread features in the whole OSPAR area. There are presently 104 seamounts in the official OSPAR database, as compiled in 22/09/2008, with records from the High Seas and within territorial waters of Norway, Sweden, Faroe Islands, UK, Ireland, France, Spain and Portugal (Fig. 2). This estimate is much higher than the previous estimates mainly due to new mapping by the Norwegian Petroleum Directorate that has provided maps that can be used to identify seamounts. Seamounts are, however, still underestimated since many more are known in the Mid Atlantic Ridge or

in the French EEZ, for example. From the 104 seamounts in the OSPAR dataset 74 are located within national EEZ with only 30 located in the High Seas.

The majority of seamounts lie along the Mid-Atlantic Ridge (MAR) between Iceland and the Hayes Fracture Zone. In the OSPAR area there are also clusters of seamounts some distance from the MAR such as those along the south west of the Rockall Bank and west of Portugal on the Madeira-Tore Rise. The greatest concentrations of seamounts in the NE Atlantic (see Fig 1) are found between the Charlie-Gibbs Fracture Zone and on the latitude of the Azores (Gubbay, 2003).

Extent of the habitat (current/trends/future prospects)

Current extent: Seamounts occur in the whole OSPAR area with the majority lying along the Mid-Atlantic Ridge (MAR) between Iceland and the Hayes Fracture Zone. Clusters of seamounts are also found along the south-west of the Rockall Bank and west of Portugal on the Madeira-Tore Rise.

Trends in extent: Little is known about natural fluctuations in physical structure of the seamount features itself. The numbers of known seamounts tend to increase as we gain more knowledge on the bathymetry of the oceans and the topography of its floor.

Future prospects: Over the next 10 years the numbers of known seamounts will dramatically increase due to the continuous acquisition of new bathymetry data and the continuous increase in mapping techniques.

Condition (current/trends/future prospects)

Condition of most OSPAR seamounts is not known.

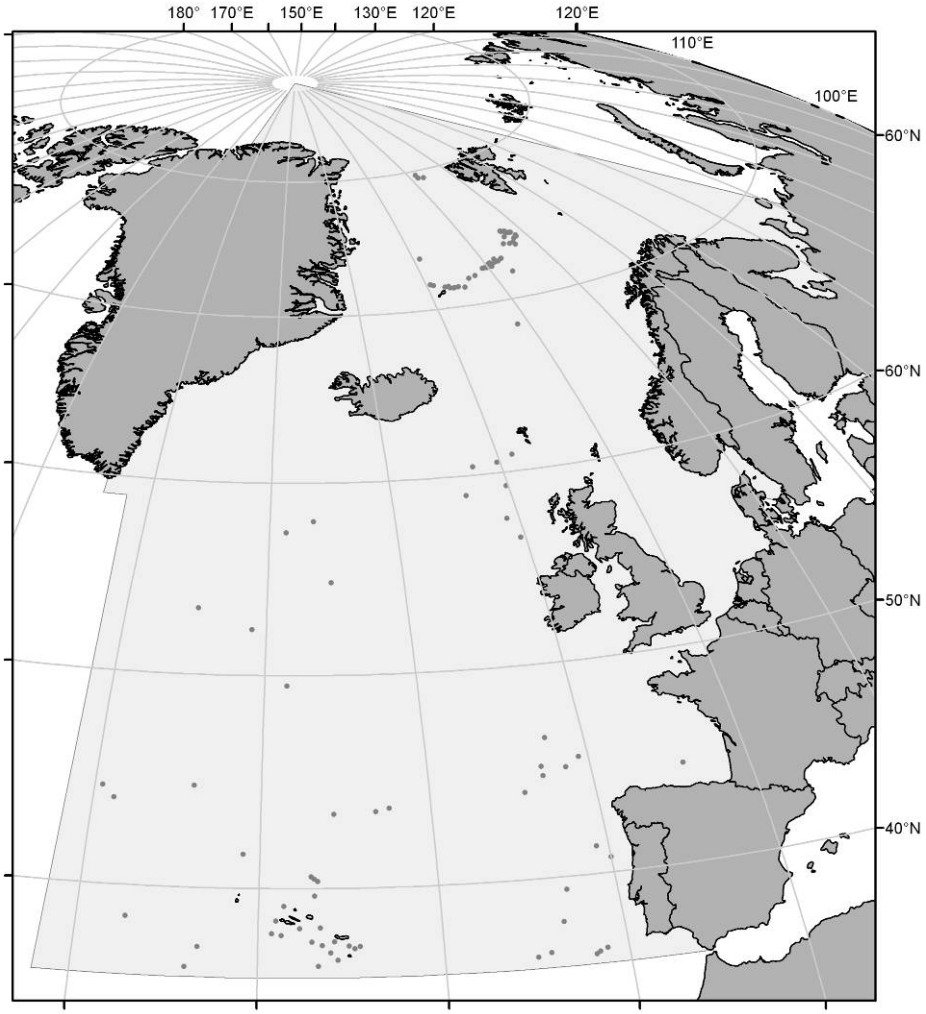


Figure 2: Location of the 104 seamounts included in the OSPAR dataset as compiled by 22/09/2008 (http://www.searchnbn.net/hosted/ospar/ospar.html).

Limitations in knowledge

Seamounts represent important ecosystems that have not, to date, received scientific attention consistent with their biological and ecological value. A comprehensive understanding of ocean biodiversity and biogeography, will require directed study of seamount ecosystems. Furthermore, seamounts are becoming increasingly affected by human activities. Important policy and management decisions regarding seamounts will be made over the coming years and scientific knowledge will be essential for guiding management and conservation efforts.

There is limited information on the numbers and location of seamounts in the OSPAR area. Also, there is a limited knowledge on what species inhabit seamounts in the OSPAR area. Human activities taking place on OSPAR seamounts are also largely unknown and unregulated. All these aspects strongly limit the assessment of seamount habitats.

4. Evaluation of threats and impacts

Consideration on the evaluation of threats and impacts is most relevant to the biological communities associated with seamounts rather than the physical structure of the feature itself. The damage to biological resources on seamounts has been clearly linked to fishing and therefore to human activity.

This is the most pressing threat to the environment of seamounts at the present time both within and outside the OSPAR Maritime Area.

Human impacts on seamounts have arisen almost solely from commercial fishing, and in particular the physical impact of towed gears (Clark and Koslow, 2007). Threats arise mainly from the physical impact of fishing gears on benthic habitats and communities, and from the removal of pelagic species through overfishing and by-catch. Possible impacts of the exploitation of seamounts on the wider ocean ecosystems are not yet fully understood. The overall structural integrity of individual seamounts is not thought to be significantly affected by the impact of bottom gear. That said, threats from erosion and topographic change of the seascape are to date little documented, and may require additional investigation.

Threats are listed in order of priority.

Threats from fishing:

- over-exploitation of easily targeted seamount associated fisheries;
- destruction and smothering of benthic fauna, in particular corals and sponges;
- unsustainable by-catch of non-target species, including sea turtles, sharks and cetaceans, in long-lines and other fishing gears;
- suspected indirect effects on community structure and ecosystem health through the removal of biomass and key species; and
- scarring of the slopes and summits of seamounts, notably by bottom trawlers and other bottom-set gears.

Threats from activities other than fishing: (It should be noted that most or all of the threats listed below need to be regulated at larger geographical scale, going beyond individual seamounts.)

- *global climate change and associated changes in ocean currents* – thought to be a growing problem with potentially severe impacts on the functioning of deep sea ecosystems. However, there is though to be enough knowledge about the possible or potential effects of global climate change to call for a precautionary approach to marine management;
- the commercial extraction of minerals, oil and petroleum – thought to pose a significant future threat to seamounts, although this will depend on technological advances and international regulation for the deep sea. In general, extraction activities are related to direct physical impacts and indirect effects due to increased sediment movement;
- bio-prospecting – thought to be of growing concern in the marine environment in general, with regulation needed to limit activities to sustainable level. More knowledge is needed to assess threats and impacts;
- water pollution – of general concern in the marine environment. There is limited knowledge of impacts but some studies indicate a risk to deep sea species, and would seem to support a precautionary approach (Borghiand and Porte, 2002);
- CO_2 sequestration - thought to pose a future threat to seamounts, though the extent of problems will depend on technological advances and international regulation for the deep sea. More information is needed to assess impacts and risks;
- shipping and accidents at sea – thought to be potential threat with respect to direct physical impact, and air and noise pollution; and

- research and leisure activities – if unregulated and irresponsibly managed these activities may cause considerable damage.

In conclusion, seamount habitats are very sensitive to the physical impact of fishing and to the removal of benthic and pelagic key species by commercial fisheries. Being isolated and confined to small areas, seamount habitats and faunas will be able to recover only over long time periods by the sporadic re-colonisation from nearby seamounts and shelf areas. Where this is not possible, as in the case of endemic species, disturbance might lead to extinction. While commercial fishing is the overriding threat to seamount fauna at the present time there is also the possibility that some areas may be targeted by deep-sea mining companies that are already looking at the possibility of extracting ferromanganese crusts and polymetallic sulphides from seamounts, and where the potential physical damage could also be considerable (Sarma *et al*., 1998).

5. Existing Management Measures

Management of human activities affecting biodiversity on and around seamounts raises six major issues (Probert *et al*., 2007):

- Deep-sea bottom fishing (presently to 2000 m) has been identified as the major threat to seamount communities and habitats.
- Addressing fisheries impacts is critical to conservation of seamount biodiversity. This requires dealing with destructive gear types, access rights, enforcement, and surveillance.
- Management objectives need to (a) incorporate natural variability on both short and very long timescales; (b) work within, and potentially across, the major jurisdictional divisions of ocean space; (c) be highly precautionary (given the state of knowledge and nature and extent of human impacts on seamounts); (d) target recovery and restoration as well as prevention of degradation; (e) be within a wider management framework; this may be regional as well as global.
- No single management model is applicable to all seamounts. Measures are likely to range from activity-based restrictions to marine protected areas (MPAs), and regulation of activities beyond the immediate vicinity of seamounts.
- Sustainable, economically viable fisheries may not be possible for some species on seamounts, so fisheries management will have to adjust. Likely knock-on effects on fishing activity elsewhere will also need to be considered.
- In the short term, there is little likelihood of cataloguing every seamount and detailing their key characteristics. Action can most usefully be directed at regions and clusters of seamounts within fishing depth, and seamounts that have been studied in detail. Grouping seamounts according to their general characteristics can help to prioritize conservation action.

MPAs in waters under national jurisdiction: Legal and administrative competencies are generally simpler in waters under national jurisdiction than in international waters. Even so, only four MPAs have been declared for the protection of seamounts in OSPAR waters under national jurisdiction to date – the Formigas Islets & Dollabarat bank Nature Reserve (Azores/Portugal), D. João de Castro Seamount (Azores/Portugal), Sedlo Seamount (Azores/Portugal) (see Santos *et al*. 1995 for background information, and Santos et al. 2010a,b) and El Cachucho (Spain). In addition, a number of potential MPAs have been identified. Various tools are being used to manage seamount MPAs, including spatial zoning, size considerations, mapping, enforcement and policing etc. These are summarised in the WWF Offshore Toolbox (Schmidt and Christiansen, 2004) and in Probert *et al*. (2007). A management plan was developed for Sedlo based on the scientific results of OASIS, and

extended discussions with stakeholders (Santos *et al.* 2009). In Spanish waters the Fisheries Administration prohibited (from the year 2006) the use of gears equipped with rockhoppers to avoid the access of trawlers to the hard bottoms having biogenic habitats (such as Galicia Bank and Le Danois Bank seamounts). Also, in 2008 the Le Danois Bank was declared an MPA where the use of all bottom gears (including gillnet and longline) are strictly forbidden.

MPAs in international waters: The legal and administrative situation for MPA designation in international waters is more complex than in national/EU waters. To date, there are no High Seas MPAs, with the exception of the recently adopted trans-boundary Mediterranean MPA, designated within the context of the Barcelona Convention. There are, however, new proposals being planned for the network of OSPAR MPA in Areas Beyond National Jurisdiction in Region V.

The most advanced proposal is the Mid-Atlantic Ridge / Charlie-Gibbs Fracture Zone (http://www.ngo.grida.no/wwfneap/Publication/briefings/MAR%20flyer.pdf). The proposed area covers the northern part of the Mid-Atlantic Ridge (MAR) between 55° N and 49° N and fully incorporates representative sections of the MAR north and south of the Charlie-Gibbs Fracture Zone, adjacent abyssal plain and the meandering subpolar front. The boundaries include also a variety of seamount communities of different types and depths, including Faraday and Hecate Seamount, as well as a section of the Reykjanes Ridge where bottom trawling and fishing with static gear, including bottom set gillnets and longlines, has been prohibited since 2004. In 2008 NEAFC adopted a Recommendation prohibiting until 2015 the use of bottom contact fishing gear in an area approximately corresponding to that covered by the MAR/Charlie Gibbs Fracture Zone proposal.

To date, the main management measures that have been taken for the protection of seamounts in the OSPAR Maritime Area have been by Portugal (Azores) and Spain. In international waters. NEAFC has the competence to regulate fisheries through various mechanisms, including gear restrictions and closed areas, in the waters beyond national jurisdiction in the NE Atlantic. NEAFC agreed in 2004 to close four seamounts to fishing with demersal trawl and static gear for 3 years, two on the Mid-Atlantic Ridge, and two in the ocean basins to the east and west, as well as a section of the Reykjanes Ridge (NEAFC, 2005). Since then further temporary closures have been introduced on the Rockall and Hatton Banks, in three large areas on the Mid-Atlantic Ridge (Reykjanes ridge, Middle MAR (roughly corresponding to the proposed MAR/CGFZ MPA described above and the southern MAR) and for two distinct seamounts (Altair and Anti-Altair). All have the purpose of protecting vulnerable marine ecosystems.

6. Conclusion on overall status

Seamounts are widespread features in the whole OSPAR area. There are presently 104 seamounts in the official OSPAR database, as compiled in 22/09/2008, but many more will be mapped in the future. From the 104 seamounts, 74 are located within national EEZ with only 30 located in the High Seas. The majority lay along the Mid-Atlantic Ridge (MAR) between Iceland and the Azores. However, over the next 10 years the numbers of known seamounts will dramatically increase due to the continuous acquisition of new bathymetry data and the continuous increase in mapping techniques. Little is known about natural fluctuations in physical structure of the seamount features itself. Also, there is a limited knowledge on what species inhabit seamounts in the OSPAR area. Human activities taking place on OSPAR seamounts are also largely unknown and unregulated. All these aspects strongly limit the assessment of seamount habitats.

The evaluation of threats and impacts is most relevant to the biological communities associated with seamounts rather than the physical structure of the feature itself. Threats arise mainly from the physical impact of fishing gears on benthic habitats and communities, and from the removal of pelagic species through overfishing and by-catch. There is also the possibility that some areas may be

targeted by deep-sea mining companies that are already looking at the possibility of extracting ferromanganese crusts and polymetallic sulphides from seamounts, and where the potential physical damage could also be considerable.

Legal and administrative competencies are generally simpler in waters under national jurisdiction than in international waters. Even so, only four MPAs have been declared for the protection of seamounts in OSPAR waters under national jurisdiction to date – the Formigas Islets & Dollabarat Bank Nature Reserve (Azores), D. João de Castro Seamount (Azores), Sedlo Seamount (Azores), and El Cachucho (Spain). To date, there are no OSPAR High Seas MPAs. Few management measures have been taken specifically for the protection of seamounts in the OSPAR Maritime Area. None have been taken outside MPAs (existing or proposed). Portugal (Azores) and Spain are the only OSPAR Contracting Parties thought to have in place management measures for seamounts. No measures have been taken to date to protect seamounts in international waters.

7. Action to be taken by OSPAR

Action/measures that OSPAR could take, subject to OSPAR agreement

As set out in Article 4 of Annex V of the Convention, OSPAR has agreed that no programme or measure concerning a question relating to the management of fisheries shall be adopted under this Annex. However where the Commission considers that action is desirable in relation to such a question, it shall draw that question to the attention of the authority or international body competent for that question. Where action within the competence of the Commission is desirable to complement or support action by those authorities or bodies, the Commission shall endeavour to cooperate with them.

The principal management measures that would help with the conservation of seamount fauna at the present time are those which will address the damaging effects of fisheries. These could include controls on the directed fishery and by-catch, and closed areas. These measures fall outside the remit of OSPAR although OSPAR can communicate an opinion on its concern about these habitats and their biological communities to the relevant bodies. OSPAR could also introduce any relevant supporting measures that fall within its own remit if such measures exist. Marine Protected Areas on seamounts are one possibility and would complement the provisions in the EU Habitats & Species Directive to establish Special Areas of Conservation on “reefs” within the 200 nm zones of Member States of the European Union.

The effectiveness of current arrangements is highly variable, and frequently dependent on the capacity and resources of national or regional authorities and organisations. A supra-national approach to seamount management would appear to be preferable, not least given the number of seamounts occurring in international waters. Pivotal to any seamount management is the political commitment and availability of sufficient implementing and enforcement resources.

The following section summarises recommendations for general supportive measures, for the designation of MPAs, and for activity-based management measures.

Recommendations for supportive measures:

- research programmes should be continued and extended, notably to provide sufficient knowledge on distribution, and reference data to provide the basis for monitoring and management;
- the inclusion of seamounts as a representative ecosystem for deeper marine waters in existing or planned international monitoring and assessment programmes, such as the Global

Ocean Observing System (GOOS), the Global Marine Assessment (GMA), and relevant programmes under Regional Seas Conventions and Action Plans;

- precautionary regulations and management measures should be adopted in the absence of sufficient knowledge, this should include interim prohibitions where appropriate;
- the co-ordination of management approaches at the international level should be improved;
- the mandate of regional fisheries bodies and regional seas bodies should be reviewed, so that these bodies can develop a co-ordinated approach to the management of seamounts.
- the exchange of good practice should be encouraged;
- guidelines for responsible and sustainable management of seamounts and associated biota should be developed;
- the use of other policy instruments for the protection of seamounts should be explored and extended, notably Environmental Impact Assessment (EIA), Strategic Environmental Assessment (SEA), and ocean and coastal planning; and
- stakeholders should be consulted and informed of the state and management of seamounts.

Recommendation for the designation of seamount MPAs:

- more resources should be dedicated to supporting research on seamounts, including mapping and modelling;
- the three-dimensional protection of seamounts through MPA zoning is thought to be an effective tool for the management of nature values as well as sustainable fisheries, and should be encouraged;
- provisions for seamount protection should be integrated into national and regional MPA networks, including under the EU Habitats Directive, ensuring adequate representation of seamount habitat and species;
- time effectiveness is an important factor in the protection of seamounts, and the use of emergency measures may be necessary to protect previously untrawled seamounts; and
- MPAs and relevant legislation should be developed for the protection of seamounts outside national jurisdiction, consistent with UNCLOS and other international agreements.

Recommendations for fisheries management measures for seamounts:

- more resources need to be dedicated to the collection of fisheries data, including on by-catch;
- measures should be taken to address the impacts of bottom and pelagic gears;
- bottom trawling should be prohibited on seamounts, including in a buffer zone around the mount;
- other gear restrictions and effort reduction should be used to decrease by-catch of seamount associated fauna;
- the conservation of deep water sharks should be raised with the European Commission and NEAFC;
- deep water fisheries should be managed in accordance with the precautionary approach;
- no-take areas should be implemented as a long-term measure in some or all MPAs;

- new legal instruments to regulate impacts on seamounts and the wider marine environment at the international level should be developed, including emergency measures available to the European Commission;
- the fishing industry and fishing fleets should be encouraged to comply with the Code of Conduct for Responsible Fisheries of the Food and Agriculture Organization (FAO) of the United Nations;
- illegal, unreported and unregulated fishing (IUU) should be addressed as a matter of urgency, notably by putting into place enforcement and surveillance provisions; and
- the feasibility of Vessel Monitoring Systems should be assessed and legal requirements for their use extended, notably to include all relevant fisheries and to require signal transmission intervals which are frequent enough for the purpose of policing MPAs.

Recommendations for the management of activities other than fishing around seamounts:

- more research should be undertaken to improve our understanding of the influence of non-fishing activities on seamounts;
- codes of conducts should be established for research and leisure activities around seamounts;
- new legal instruments to regulate bioprospecting and CO_2 sequestrating in the deep sea should be developed; and
- the exploitation of the sea bed should be regulated at sustainable levels.

Other policy instruments that could be used to protect seamounts are:

- Environmental Impact Assessment;
- Ocean and coastal planning; and
- Strategic Environmental Assessment.

Competent authorities

Table 1 provides a useful list of relevant authorities and international instruments that may, if further developed, be used in the protection of seamounts in international waters.

It should be noted that only those marked with * are directly applicable to the member countries, i.e. they are legally binding without further ratification and transposition into national law.

Role of OSPAR

The role of OSPAR in promoting the protection of seamounts in the OSPAR Maritime Area could include:

- maintaining the political momentum for and commitment to the designation of MPAs, including in international waters;
- developing and adopting guidelines for the protection and management of seamounts;
- taking a lead role in bringing the different competent authorities together in developing a seamount management strategy for the North-East Atlantic;
- where management activities are outside the remit of OSPAR, requesting and advising the relevant authorities of desired conservation actions;

- developing and adopting a code of conduct with responsible sectors for the management of seamount ecosystems; and raising awareness of the conservation status and needs of seamount ecosystems.

Table 1: Relevant Authorities for the Protection of Seamounts in the OSPAR Maritime Area

Activities	***Legal basis***	***Relevant authority***
designation of MPAs (territorial waters)	national legislation* or national legislation in conjunction with the EU Habitats and Birds Directives*	national ministries/agencies; European Community
designation of MPAs (EEZs or equivalent)	national legislation* or national legislation in conjunction with the EU Habitats and Birds Directives*	national ministries/agencies; European Community
designation of MPAs (High Seas)	CBD	CBD COP
	OSPAR	OSPAR MOP
	UNCLOS	International Sea Bed Authority
fishing (territorial waters)	national legislation*, or national legislation within the CFP, or EU level CFP legislation*	national ministries/agencies; European Community, or the Commission in case of emergency measures
fishing (EEZs or equivalent)	national legislation*, or for EU Member States the CFP*	national ministries/agencies; European Community, or the Commission in case of emergency measures
fishing (High Seas)	NEAFC Convention	NEAFC
	national legislation*, or for EU Member States the CFP*	national ministries/agencies; European Community; or the Commission in case of emergency measures
	UNCLOS, the UN Fish Stocks Agreement and other associated agreements	United Nations General Assembly UNFA – Informal consultations of the Parties to the FSA
fishing (general)	UN FAO Code of Conduct for Responsible Fisheries, and FAO Compliance Agreement	FAO
	IPOA-IUU	FAO
	IPOA-Sharks	FAO
tuna and billfish fisheries	ICCAT	ICCAT
by-catch of migratory species	CMS & ASCOBANS	CMS COP

Activities	*Legal basis*	*Relevant authority*
mineral, petroleum, gas and oil extraction	UNCLOS	national ministries/agencies for the legal continental shelf, International Sea Bed Authority for the Area
bioprospecting	UNCLOS	national ministries/agencies for the legal continental shelf, International Sea Bed Authority for the Area
	CBD	CBD COP
pollution	OSPAR	OSPAR Secretariat & MOP
climate change	UNFCCC	UNFCCC COP
shipping	UNCLOS & IMO instruments	IMO, MEPC, MSC and Assembly

Brief summary of the proposed monitoring system

While a number of recent research initiatives have provided better insights into seamount ecology and distribution in the OSPAR Maritime Area, there appear to be few (regular) seamount monitoring programmes. Only two seamounts in the Azores (Formigas and Castro bank) and one in Spain (El Cachucho) are thought to benefit from ongoing and continuous research. Results from these initiatives are informing discussions on seamount protection, and could be considered as a first step towards monitoring. However, this work is not undertaken as part of a wider monitoring strategy for seamounts. There is an obvious need for more reference data and adequate seamount monitoring, particularly at a wider geographical scale.

Some work exists on seamount biogeography and ecology in the OSPAR area. To date, however, these data remain fragmented and, in many cases, are inaccessible to the scientific community. It is thus suggested that a compilation of the available information should be made helping to create an analysis and synthesis effort on existing data (databases SeamountsOnline, Seamounts catalogue, and OBIS). This is not to say that future field studies should not be undertaken until such a synthesis is complete, but rather that full advantage must be taken of existing data to assist in the planning and refining of future field efforts.

Given that only a very small fraction of seamounts have been explored in any detail, new field research is obviously critical to improve our understanding of seamount ecosystems. Therefore, promoting field efforts and developing new projects have been identified as high priorities for achieving a reasonable knowledge of the species inhabiting seamounts in the OSPAR area.

Field studies should, however, follow a standardized sampling allowing reliable inter-seamount comparisons of occurring species, density and/or biomass. It should also be possible to draw up a prioritized list of seamounts or taxonomic groups that warrant particular attention. This could be based either on 1) lack of existing seamount data from a particular area or a category of seamount, or 2) the recognition that a particular seamount (or seamounts) is at imminent risk from fishing or other destructive activities.

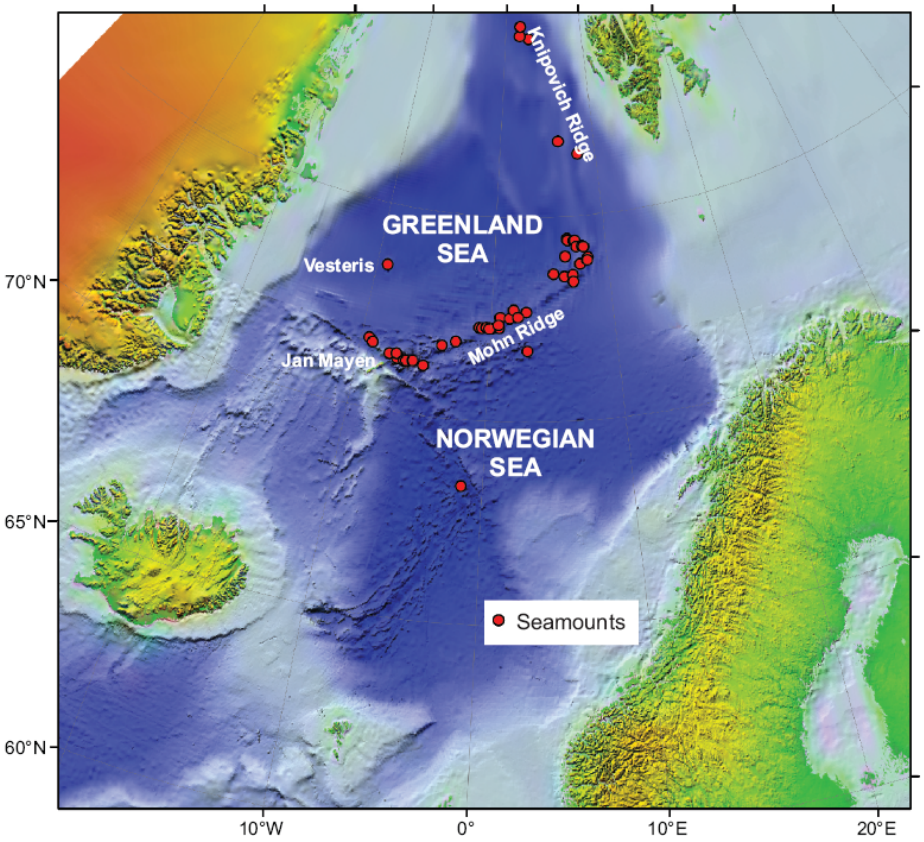
Annex 1: Overview of data and information provided by Contracting Parties

Contracting Party	Feature occurs in CP's Maritime Area	Contribution made to the assessment (e.g. data/information provided)	National reports References or weblinks
Belgium	No	No	--
Denmark	Yes	No	--
European Commission			
France	No	No	--
Germany	No	No	--
Iceland	Yes	No	--
Ireland	Yes	No	--
Netherlands	No	No	--
Norway	Yes	Yes	Jan Helge Fosså pers. comm.
Portugal	Yes	Yes	Morato, T. et al. (2008). Abundance and distribution of seamounts in the Azores. Marine Ecology Progress Series 357:17-21. Gui Menezes pers. comm.
Spain	Yes	Yes	Francisco Sánchez Delgado pers. comm. See Annex 3 References. www.ecomarg.net
Sweden	No	No	--
UK	Yes	No	--

Original nomination: Seamounts were nominated for inclusion in the OSPAR List in 2001 by Iceland, Portugal and UK

Norway: In the Norwegian Sea and Greenland Sea one find seamounts along the extension of the Mid Atlantic Ridge north of Jan Mayen. There is limited information about these seamounts, but new mapping by the Norwegian Petroleum Directorate has provided us with maps that can be used to identify seamounts. We have identified seamounts higher then 1000 m above the surrounding seabed (strict definition) (see figure). The summits of the seamounts are between 550 and 2100 m of depth with an average of 1420 m.

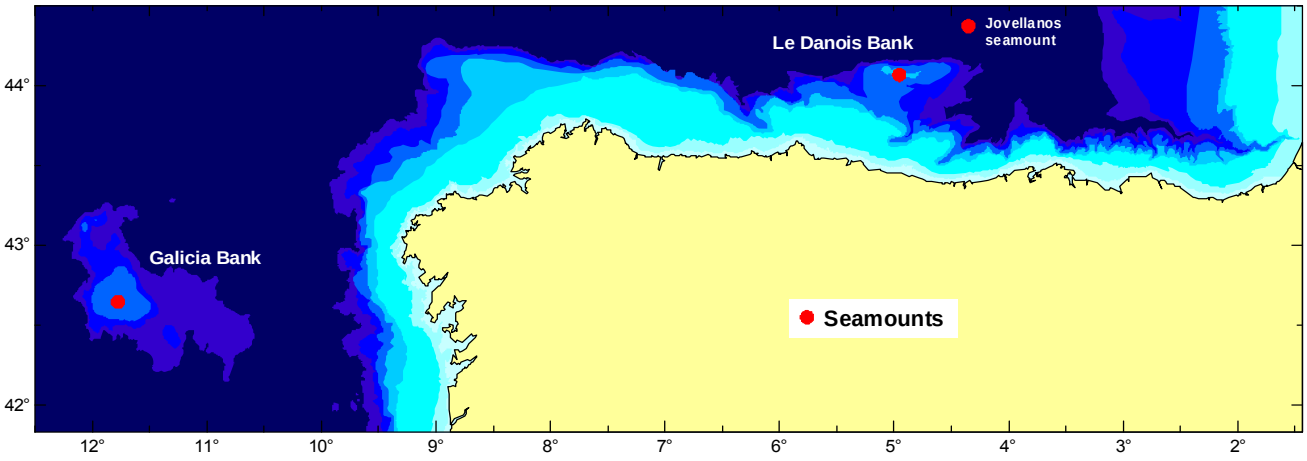
There is very little information about the biota on these seamounts. However, recently the University of Bergen made ROV surveys on two of the seamounts on the Mohn- and Knipovich Ridges, and extensive sampling of the macrofauna of one of them from 2700 m and up to the summit at about 550 m depth. The temperature range is about - 0.9 to 0 °C. The preliminary impression is that the fauna is very rich with dense aggregations of large sized sponges and octocorals.



From: Jan Helge Fosså, Institute of Marine Research, Bergen, Norway

One very shallow seamount (133-260 m), Vesteris, in the Greenland EEZ has been studied. This seamount is not very accessible due to the cover of ice for about 10 months of the year. The seamounts are deep and cold and as far as we know they have no commercial fish stocks, which mean that they at the time being most likely are not impacted or threatened by fisheries.

Spain:



Seamounts on Spanish waters (to add to OSPAR database)

Seamount name	Central location	Minimum depth (m)
Galicia Bank	42º 40.00' N – 011º 45.00' W	625
Le Danois Bank	44º 04.40' N – 004º 58.00' W	430
Jovellanos seamount	44º 47' N - 4º 25' W	> 3500 m

Annex 2: Detailed description of the proposed monitoring and assessment strategy

Rationale

Seamounts represent important ecosystems for study that have not, to date, received scientific attention consistent with their biological and ecological value. A comprehensive understanding of ocean biodiversity and biogeography, will require directed study of seamounts to learn of their unique features. Furthermore, seamounts are becoming increasingly affected by human activities. Important policy and management decisions regarding seamounts will be made in the next years and scientific knowledge will be essential for guiding management and conservation efforts. There is limited information on the numbers and location of seamounts in the OSPAR area. Also, there is a limited knowledge on what species inhabit seamounts in the OSPAR area. Human activities taking place on OSPAR seamounts are also largely unknown and unregulated. Monitoring programmes are most relevant to the biological communities associated with seamounts rather than the physical structure of the feature itself.

Use of existing monitoring programmes

At present there are no monitoring programmes established for OSPAR seamounts. New data has been made available through fishing monitoring programs or sequential scientific research surveys. A monitoring project on the effects of the MPA establishment in Le Danois Bank area is currently in progress.

Synergies with monitoring of other species or habitats

Most seamounts are quite remote, difficult to access and with deep summits. Seamount monitoring could be combined with assessment of other deep-sea habitats or species such as *Lophelia pertusa* reefs, Coral Gardens, Deep-sea sponge aggregations, Oceanic ridges with hydrothermal vents/fields and, among other fish species, *Hoplostethus atlanticus*.

Assessment criteria

To be defined.

Techniques/approaches

A long-term programme should be established to assess population trends of selected species in OSPAR seamounts as a whole or in reference sites subject to different ecological and exploitation regimes. For the latter, focus could be on seamounts where exploitation is more intense. Comparison with non-exploited sites shall also be ensured. Selected species should be those more vulnerable and those that are likely to be heavily damaged by fishing activities. A tentative list of species could be provided shortly and should include fish and invertebrate species. The methodologies involved in assessing the status of the communities and species should be standardized and involve *in situ* observations using advanced and no invasive technology such as ROV's, submersibles, photo-sledges, landers, and so on.

Assessment of the distribution of seamounts in the OSPAR area and habitat classification following the most appropriate scheme

The aim of this task is to infer potential seamount locations and to generate estimates of the actual number of seamounts in the OSPAR area. It should also describe seamount population according to location, and other physical characteristics. It should compile all the available information from existing databases like SeamountsOnline, Seamounts catalogue, and OBIS.

A preliminary indirect method is suggested to identify topographic structures with high probability of being seamounts in the OSPAR area. This method (Kitchingman *et al*., 2007) involves the use of the best available bathymetry datasets and performing three successive steps: 1) identifying all detectable peaks in the bathymetry dataset; 2) isolating peaks with heights greater than 200 m and displaying an approximately circular or elliptical shape; and 3) isolating large seamount-like features. This methodology will produce a list of potential seamount-like features in the OSPAR area that need to be validated by *in situ* research. Moreover, it can be assumed that there are more seamounts that cannot be detected by low-resolutions bathymetry datasets and automated locating methods. Thus, detailed bathymetric are required to identify in detail all the seamount habitats within OSPAR maritime area.

Seamount population characteristics should also be assessed since several physical factors will influence populations inhabiting seamounts. Although by no means exhaustive, the following factors were identified as being important to consider and assess: 1) physical and geological setting of the seamount (age, substrate type, etc.), 2) geography: latitude, distance from nearest continental margin and seamount, 3) seamount size, depth, shape, and physiography, 4) productivity of the overlying water column and its associated hydrographic characteristics.

Assessment and monitoring the number of species inhabiting individual seamounts in the OSPAR area

A detailed catalogue of species occurring on seamounts should be the second priority when assessing this habitat in the OSPAR area. This will 1) produce an exhaustive list of species living on OSPAR's seamounts; 2) assist the identification of new species; 3) identify the fraction of endemic species living on OSPAR's seamounts. This task will involve 1) the synthesis of seamount studies that have been conducted in the OSPAR area and 2) promote field efforts to improve our knowledge on the species inhabiting seamounts in the OSPAR area.

Some work exists on seamount biogeography and ecology in the OSPAR area. To date, however, these data remain fragmented and, in many cases, are inaccessible to the scientific community. It is thus suggested that a compilation of the available information should be made helping to create an analysis and synthesis effort on existing data (databases SeamountsOnline, Seamounts catalogue, and OBIS). This is not to say that future field studies should not be undertaken until such a synthesis is complete, but rather that full advantage must be taken of existing data to assist in the planning and refining of future field efforts.

Given that only a very small fraction of seamounts have been explored in any detail, new field research is obviously critical to improving our understanding of seamount ecosystems. Therefore, promoting field efforts and developing new projects have been identified as high priorities for achieving a reasonable knowledge on the species inhabiting seamounts in the OSPAR region.

Field studies should, however, follow a standardized sampling allowing reliable inter-seamount comparisons of occurring species, density and/or biomass. It should also be possible to draw up a prioritized list of seamounts or taxonomic groups that warrant particular attention. This could be based either on 1) lack of existing seamount data from a particular area or a category of seamount, or 2) the recognition that a particular seamount (or seamounts) is at imminent risk from fishing or other destructive activities.

Assessment and monitoring of threats and sensitivity posed to the individual seamounts

Describing the catch of fish from OSPAR seamounts presents two major challenges. The first is where are seamounts located? The second proves to be rather more controversial; which are the commercial species associated with seamounts? Information on seamounts fisheries is very sparse, and it is difficult to make a distinction between deep-water fishing activities in general and those occurring on seamounts. Moreover, fish species living on seamounts are also known to occur on other habitats,

such as continental slope, and landings statistics are not spatially allocated, making it difficult to make an estimate of the total fisheries occurring on seamounts worldwide.

The aim of this task may be divided in two levels: 1) to quantify total catches from OSPAR seamounts and 2) to quantify catches from individual seamounts in OSPAR area, 3) Assessment of biotope sensitivity based on key species response to perturbation using MARLIN approach for example. The first goal could be achieved by automated mapping techniques such as the ones developed by the Sea Around Us Project at the University of British Columbia (Watson *et al*., 2004). This methodology involves the use of the best available catch data for the region and the development of algorithm that would allocate catch to spatial grids. This procedure may be developed to enhance predictions of a taxon's distribution based on its association with different habitats including seamounts. The process assumes that relative abundance of a taxon in a spatial grid is partly determined by the area of habitat(s) with which it is associated as well as how far that association or enhancement effect will extend from the habitat. This algorithm could then be run to time-series datasets to analyse the development of fishing catches from OSPAR seamounts.

The second goal could only be achieved with information from fishing vessels, i.e., where individual fishing vessels were operating within the OSPAR area. This could be accomplished by analysing satellite tracking of fishing vessels along with data from landings. This would produce the first dataset with real information of catches from seamounts and would help to identify those seamounts and associated communities that are most threatened.

Selection of monitoring locations

A long-term monitoring programme could be established in OSPAR seamounts as a whole or in reference sites subject to different ecological and exploitation regimes. For the latter, focus could be on seamounts where exploitation is more intense but comparison with non-exploited sites shall also be ensured. Selected species should be those more vulnerable and those that are likely to be heavily damaged by fishing activities.

Timing and Frequency of monitoring

At this stage there is an urgent need for baseline studies that cover a reasonable amount of seamounts within the OSPAR area of different shapes and sizes. After that seamounts should be monitored once every 4 years.

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OSPAR's vision is of a clean, healthy and biologically diverse North-East Atlantic used sustainably

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