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Report of the ICES-NAFO Joint Working Group on Deep Water Ecology (WGDEC)

10–14 March 2008

Copenhagen, Denmark

ICES International Council for the Exploration of the Sea

CIEM Conseil International pour l'Exploration de la Mer

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Contents

Executive Summary

Highlights

- Continued descriptions of the distributions of structure-forming sponges and soft corals in the North Atlantic and development of maps
- The continuation of a building (meta) database of scientific survey/cruise results with benthic habitat information in the North Atlantic and the development of maps
- Reviewed the "Guidelines for the management of deep-sea fisheries on the high seas" being considered by FAO and COFI in 2008 and developed possible guidelines that could be implemented by ICES and NAFO
- Examined vessel monitoring system (VMS) data with the objective of examining patterns of fishing in deep-water areas such as around seamounts and the continental slope to determine where intensive fishing is occurring and evaluate the likelihood of sensitive habitats being present in those areas

The work of describing areas of the North Atlantic containing structures such as coldwater corals and sponges continued this year. An important addition to the working group this year was the naming of a NAFO-Canadian representative. In an effort to increase participation and discussion of issues important to the Northwest Atlantic and truly make the working group purview the entire North Atlantic, NAFO became a co-sponsor of the working group this past year, joining ICES. The GIS expertise of the new member was invaluable in updating many of the habitat and sampling location maps. Chapters 1–3 highlight the Terms of Reference being assessed by the working group in 2008 and the expert members who were available to contribute to this report. Because of time and financial restraints, only 10 members were able to make it to ICES Headquarters this year to participate in the discussions. As the ICES SharePoint online portal continues to grow in sophistication and capability, 5 more members were able to make significant contributions to this report through their electronic participation. We look forward to increasing this electronic participation of the members in the future.

The fourth chapter reviewed the effects of fishing in the OSPA Area V with special emphasis paid to Azorean demersal and deep-water fisheries. Many areas in the OSPAR region have been targeted by fishing fleets over the past 3–4 decades and impacts of fishing, lost fishing gear, and high bycatch and discard rates have undoubtedly caused some impact to the ecology of the area. Recent regulations imposed on the European fleet such as gear and spatial restrictions attempt to decrease the pressure on many deep-water habitats and species and allow these areas to recover. The fifth chapter reviewed the proposed guidelines for the management of deep-water fisheries on the high seas with the aim of assessing how might ICES and NAFO adopt or modify these guidelines in the future for their own purposes. If these guidelines or a modification of them were adopted, what types of advice would fisheries clients seek from ICES and NAFO was the focus of the sixth chapter. Chapter 7 assessed the types of information necessary to examine patterns of fishing in deep-water areas to determine where intensive fishing is occurring and evaluate the likelihood of sensitive habitats being present, with Chapter 8 considering how this information might be obtained if it didn't original already. Chapters 9–11 and 14 continued our efforts to describe areas known to contain habitats formed by these

coldwater corals and sponges, further compile the appropriate databases, and develop accurate maps depicting these areas along with research sampling locations.

Using available vessel monitoring system (VMS) data, Chapter 12 examines the patterns of fishing (e.g., locations and intensity) in deep-water areas and evaluates the likelihood of sensitive habitats being present in these areas. Overlays of VMS data and habitat maps may shed some light on the habitat occurring below the fishing fleets. Chapter 13 reviews available codes of conduct for carrying out scientific research in sensitive deepwater habitats and makes recommendations on how ICES may develop and/or modify codes of conduct to best fit their needs.

Much effort over the last couple of years has gone into describing areas of coldwater coral and sponge habitat around Hatton Bank and what areas are outside the closed areas that offer protection from fishing. Chapter 15 makes recommendations on where future multibeam and/or sidescan sonar surveys should be undertaken in the Rockall and Hatton Bank areas and adjacent seamounts. When considering closed areas and proximity of fishing fleet intensity (obtained from VMS data), the consideration of suitable sized buffer zones around these closed areas constitute the efforts of Chapter 16.

As always, the amount and level of advice requested from the WGDEC Terms of Reference represented a challenge to the working group members. What follows are the working group members response to this challenge. Where scientific data is not available or inadequate to thoroughly respond to a request for advice, recommendations such as efforts to obtain the required data or to forward the request to another year were usually the norm.

1 Introduction

1.1 Participation

The following members of the ICES-NAFO Working Group on Deep Water Ecology (WGDEC) participated in producing this report (see Annex 1 for contact info).

Annabelle Aish	UK
Jeff Ardron*	Germany
Peter Auster*	USA
Robert Brock (Chair)	USA
Bernd Christiansen*	Germany
Sabine Christiansen	Germany
Ellen Kenchington	Canada
Pablo Durán Muñoz	Spain
Graham Johnston*	Ireland
Gui Menezes*	Portugal
Pål Mortensen	Norway
Francis Neat	UK
Mark Tasker	UK
Ole Tendal	Denmark
Vladimir Vinnichenko	Russia

* Unable to be in Copenhagen, but contributed from afar via ICES SharePoint portal.

1.2 Terms of Reference

The 2007 Statutory meeting of ICES gave the Working Group on Deep Water Ecology the following terms of reference:

a) provide a review of the effects of fishing in OSPAR Area V;

b) review the 'Guidelines for management of deep-sea fisheries on the high seas' that will be considered by FAO COFI in 2008 and consider for reflection by ICES and NAFO;

c) the types of advice that fisheries clients may request of ICES and NAFO, should the guidelines be implemented;

d) the types of information and terms of reference that WGDEC and any other relevant expert groups may need in order to respond to requests as identified in i);

e) if the information in ii) is not thought to be available currently, consider a plan of action to acquire and organise the necessary information;

f) continue to collate information on habitats (research and survey results) and fisheries use (VMS and fisher's information) on Hatton Bank in order to refine the advice for closed areas;

g) update compilations and maps of occurrence of structural habitats (hard and soft corals, large sponges) in the North Atlantic specifically identifying major coral concentrations in the Northwest Atlantic;

h) identify or confirm the existence of coral concentrations in a specific area of NAFO Div. 30, which roughly coincides with the zone between 400 and 2000 m deep (detailed map to be supplied by NAFO) and using the results of d), evaluate whether this zone is the most important for coral in the Northwest Atlantic;

i) examine patterns of fishing in deep-water areas other than Rockall and Hatton banks, such as the seamounts and continental slope, to determine where intensive fishing is occurring and evaluate the likelihood of sensitive habitats being present in those areas;

j) review codes of conduct for carrying out scientific research in sensitive deep-water habitats with a view to developing an ICES code of conduct;

k) Continue to develop and compile a database and map of areas where biological research/survey has occurred in the deep water area (>200m) of the North Atlantic and considering the report of the Planning Group on the North-east Atlantic continental slope survey (PGNEACS), make recommendations for future work in this area;

l) determine priority areas for multibeam or sidescan sonar survey on Rockall, Hatton Bank and adjacent seamounts;

m) consider suitable sized buffer zones around closed areas, taking into account ability to detect closed area infringements.

A joint meeting with WGDEEP will be held on the afternoon of 10 March.

WGDEC will report by 31 March for the attention of ACOM and report on ToR a) for the attention of WGECO by that date. WGDEC will report to NAFO Sc. C. for its June meeting.

Supporting Information

a) A contribution to a response to a request from OSPAR on the effects of fishing on the marine ecosystem.

b) A way of answering a request from NAFO that will be of more general applicability and will be of relevance more widely in the near future.

c) Certain survey information was not available to ICES in 2007; advice given then will be re-examined in the light of new evidence.

d) This is to answer a request from NAFO and the wider data is useful in answering future advisory requests.

e) A specific request from NAFO.

f) One of the likely outcomes of ToR b is that this activity may be required more widely. This ToR should allow a test of the approach and will be useful in advising fishery managers proactively.

g) An examination of an issue of interest to both scientists and conservation groups.

h) A start was made on this task in 2007; and this data will be useful in co-ordinating surveys needed in future as well as providing a resource to draw upon for answering future requests. PGNEACS plans to co-ordinate surveys.

i) Following on from ToR c) and related to advice provided in 2007.

j) Of great relevance to ICES in providing advice on appropriate boundaries to closed areas.

A further term of reference requested that the Chairs of WGDEC and WGDEEP cooperate to ensure that expertise on cold-water corals and on deep-water fishing was available at the meeting.

1.3 Justification of Terms of Reference

a) A continuation of work to meet requests from both OSPAR (past) and NEAFC (current), with an addition from NEAFC.

b) Essential to understand the geographic limits of knowledge.

c) Large structural sponge fields are a habitat believed sensitive to fishing.

d) Soft corals are also sensitive to fishing-information from c) and d) will be useful in providing advice to fisheries managers wishing to avoid damaging these habitats.

e) This is in support of a request from NEAFC.

f) This is a request from OSPAR.

g) This is a request from Consultative Committee following an external suggestion.

1.4 Acknowledgements

We would like to thank the ICES Secretariat for hosting this year's meeting in an excellent working environment. Several members of the ICES Secretariat were their usual very helpful selves especially Helle Gjeding Jorgensen. A special thanks to all.

2 Opening of the Meeting

The meeting of the ICES-NAFO Working Group on Deepwater Ecology began at 1400 on March 10, 2008. The purpose of the first afternoon was to reacquaint members with each other, discuss the ToRs and agree on what exactly is being requested, discuss the assignments of each WG member in relation to the ToRs, and agree on the proposed timelines that was put forth. It was very important that working group members understood exactly what was being asked and to agree on a Lead person for each Term of Reference where other working group members could channel their narratives and discussion. Folders were set up on the ICES SharePoint online portal and Leads managed the information input into each folder.

3 Adoption of the agenda

All in attendance agreed upon the agenda addressing how and when WGDEC would address and complete the ToRs on March 10, 2008.

4 Effects of fishing in OSPAR Area V

Term of Reference (a): Provide a review of the impacts of fishing in OSPAR area V.

4.1 Introduction

Fishing affects demersal marine communities via the following ways; the selective removal of target species, the selective removal of larger individuals, the bycatch of non-target species and habitat modification. The end result can be changes in overall biomass, species composition, size structure and integrity of structural habitat. Unless regular monitoring and research is undertaken is often difficult to formally assess any impact of fishing. This is a particular problem for high seas fisheries (areas beyond national jurisdiction) and therefore it is difficult to address the problem for much of the area in OSPAR V. Nevertheless for a few areas there is detailed enough information (e.g. Azores and the Rockall/Hatton area) to make some assessment of the likely impact. Here we first review the fisheries that are known to have occurred in the region and then assess their likely impact on the ecosystem. Detailed advice on the effects on the fish stocks themselves is an issue best dealt with the relevant expert working group (ICES, WGDEEP).

4.2 Categories of Fishing

There are two main categories of deep-water fisheries in region V (OSPAR, 2000):

a) Longline, trawl and gillnet fisheries in deep-waters on continental slopes, on the Mid Atlantic Ridge (MAR) and some seamounts. Target species are: ling (*Molva molva*), tusk (*Brosme brosme*), argentine (*Argentina sphyraena*), grenadiers (*Macrourus berglax* and *Coryphaenoides rupestris*), alfonsinos (*Beryx splendens*), orange roughy (*Hoplostethus atlanticus*), cardinal fish (*Epigonus telescopus*), black scabbard fish (*Aphanopus carbo*), wreckfish (*Polyprion americanus*), deep-water redfish (*Sebastes mentella*) and several deep-water sharks among others. Fishing fleets are composed by large-scale distant-water trawl vessels, which are able to fish on remote places as the MAR.

b) A fishery using traditional handlines and longline operating around the Azores and adjacent seamounts that have small impacts on deep-water habitats. This is a multispecies fishery where more than 20 fish species are normally caught and commercialized. Main species are the black-spot seabream (*Pagellus bogaraveo*), bluemouth (*Helicolenus dactylopterus*), alfonsinos (*Beryx splendens* and *Beryx decadactylus*), conger eel (*Conger conger*), wreckfish (*Polyprion americanus*), common mora (*Mora moro*), and cardinal fish (*Epigonus telescopus*), among others. Small open deck boats, and small to median longliners that operates within the Portuguese Z.E.E, mainly compose the fishing fleet.

4.3 Stock dynamics and patterns of abundance

Detailed assessments on the impacts of these fisheries on OSPAR Region V are difficult due to the lack of information. With the exception of the Azorean fisheries whose impacts are small due to the fishing gears use, the information is relatively scarce for most of the other fisheries, (in particular those that operate in international waters). Cpue data based on landings and from scientific surveys suggest declining abundance in many species especially the sharks (ICES 2007). ICES WGDEEP advises

that most species are outside safe biological limits and it seems likely that quotas for several species, e.g. orange roughy will be completely phased out over the next few years. The situation is further complicated by the facts that there is little correspondence between the areas adopted by the ICES for reporting the catches and the OSPAR Region V (OSPAR, 2000). Due to recent EU regulations and to the general observed declines on deep-water fish stocks, most of these activities have decrease in recent years (ICES 2007).

4.4 Description of fishing activities

4.4.1 The MAR and northern part of OSPAR region V

The area covered by the OSPAR Region V is dominated by the continental slope areas, the Rockall and Hatton plateau, the Porcupine bank, the MAR and several peaks, side ridges and individual seamounts (Clark *et al*., 2007). The exploitation of the deep sea area in the north-eastern sector of the OSPAR area V goes back to the mid 1960s when Russian fisheries investigation began to explore the Hatton bank region (Vinnichenko, 2000). At the same time significant haddock grounds were being explored on the shallower parts of the Rockall plateau. By the 1970s German trawlers were targeting spawning aggregations of blue ling in the Rockall Trough followed by the French who also established a year-round bottom trawl fishery for roundnose grenadier, black scabbardfish and deepwater sharks. Currently the main trawl fishery is French and Spanish with minor landings of deep-water species being made by UK and Irish vessels. A significant component of the Spanish and French trawl fishery is focussed on the western slopes of Hatton Bank where roundnose grenadier is targeted. In addition to the deep-water bottom trawl fishery there is also a static gear fishery. Norwegian long-liners fish along the edge of the shelf slope for ling and tusk and to the north of Hatton bank Greenland halibut has also been targeted. There is also a UK and Spanish long-line fishery for hake, ling and tusk with a bycatch of other deep-water species, such as blue ling and sharks. In the late 1990's a number of vessels operated extensive deep-water gillnets targeting monkfish and sharks. This practice was highly criticized for its indiscriminate bycatch and high discard rate and has now been banned in European waters. In the other regions of the area, monkfish is targeted on the deeper slopes of Rock-all bank. Deep-water redfish and blue ling are targeted on Rosemary bank. French trawlers discovered large aggregations of orange roughy on the Hebridean seamount in the early 1990s. It is likely the other seamounts were also targeted, but little information on this fishery was ever documented. Orange roughy is now mainly confined to areas to the west of and north of the Porcupine Bank where it has been targeted by Irish trawlers.

There as been intense fishery pressure on seamounts North Azores area of MAR (see Clark *et al*., 2007). Fisheries on peaks of the northern MAR started in 1973, when dense concentrations of roundnose grenadier were discovered. The greatest annual catch (almost 30 000 t) in that area was taken by the Soviet Union in 1975, and in subsequent years the catch varied substantially from several hundred tonnes to over 20 000 t. The fishery declined after the dissolution of the Soviet Union in 1992, and since then there has been a sporadic fishery by vessels from Russia, Poland Latvia and Lithuania (Clark *et al*., 2007, ICES 2004). Grenadier has also been taken as bycatch in the Faroese orange roughy and Spanish blue ling fisheries. USSR data indicated that roundnose grenadier aggregations may have occurred on 70 seamount peaks of the Ridge between 46–62° N but only 30 of them were commercially important and subsequently exploited. The fishery is mainly conducted using pelagic trawls although on some seamounts it is possible to use bottom gear. Deepwater redfish

orange roughy, black scabbardfish and deepwater sharks are caught as bycatch in the fishery (Clark *et al*., 2007).

In 1992 the Faroe Islands began a series of exploratory cruises for orange roughy beginning in their own waters and later extending into international waters. Exploitable concentrations were found in late 1994 (annual catch 260 t) and early 1995 (1040 t), mostly on the Mid-Atlantic Ridge (MAR) and Hatton Bank. In the 1980s a bottom longline fishery developed for tusk and northern wolffish (*Anarhichas denticulatus*) on some of the northern MAR seamounts. Spanish vessels explored several seamounts on the MAR between 1997–2000 and a longline survey was conducted in 2004 but except for sporadic fisheries in the northern area (ICES Division XIVb) there has been a decline in interest (Duran Muñoz *et al*., 2000; ICES 2006). The MAR to the north of the Azores has over 20 seamounts with a depth of less than 1000 m. A commercial pelagic trawl fishery for alfonsino developed on "Spectr" seamount in 1977 and this and other seamounts were exploited in 1978. In recent years there have been no indications of fishable concentrations of alfonsino.

Along with deepwater demersal fishes, some epi- and mesopelagic species are of commercial interest on the northern MAR seamounts. During the 1970s and 1980s north of the Azores (43–52° N), tuna were regularly taken by Soviet research and exploratory vessels. Albacore (*Thunnus alalunga*) occurred most frequently, with catch rates up to 20 t/haul. Bluefin tuna (*Thunnus thynnus*) and swordfish (*Xiphias gladius*) were also found. Atlantic saury (*Scomberesox saurus*), shortfinned squid (*Illex illecebrosus*) and Bartrami squid (*Ommastrephes bartrami*) were also of commercial interest in this area (Clark *et. al*., 2007). These fishery activities have no direct impact on bottom communities and are not of major concern at present.

Fisheries on MAR are subject to additional difficulties and increased commercial risk compared to fishing on the continental shelf and slope. Most seamounts are offshore, and located a great distance from the coast. Large vessels are generally required to fish these grounds, and running costs can be high. Catches and catch rates in these areas can show sharp fluctuations; fishing operations are difficult because of hard ground, complex water circulation, and unstable and dynamic fish concentrations (Clark *et al*., 2007).

Many of the seamount fisheries have shown similar trends. The highest catches and catch rates are typically observed during the first years of the fishery. Subsequently these substantially decrease and can remain low over a long period. Often, even relatively small catches (in the range of 500–1000 t) cause lower density and stability of aggregations and consequently reduced catches (Clark *et al*., 2007).

4.4.2 Azores demersal and deep-water fisheries

Azorean fisheries that can be considered a small-scale fishery use mainly handlines and longlines, targeting many different species (e.g. *Beryx splendens, Conger conger, Mora moro, Helicolenus dactylopterus, Epigonus telescopus*). The fishing fleet operate within the Z.E.E. and the fishing grounds are limited to the islands slopes and seamounts. There are more than 300 seamount like features in the Azores area (> than 100 m elevations) and about 63 large seamounts. The latter are regularly visited by the local fishing fleets, mainly the larger longliners and some impacts are expected to occur, namely the sporadic bycatch of invertebrates or the lost of gear ropes due to the rough nature of the seabed. The Azores region has several local fisheries regulations aimed to minimize the impacts of the gears in several areas. This is the

case for example of the 3-mile zone buffer around the islands slopes that only allow the use of handlines and the operation of vessels of certain sizes.

Recent EU regulations also define a large area occupying almost all the Azorean Z.E.E. since 2004 (Council Regulation (EC) No. 1811/2004) which was later extended one year later to protect deep-water corals reefs in the Azores, Madeira and Canary islands (Council Regulation (EC) No. 1568/2005) where it is not allowed the use of trawl gear and deepwater gillnets. This large area of about 545 310 km was mainly implemented to protect deep-water sensible habitats of the Azores region, in particular deep-water corals, sponges and other vulnerable organisms (see Figure 1).

Thus most areas in the OSPAR region down to depth of approximately 1500 m have been targeted over the past 30 to 40 years (Figure 1). Some areas are targeted heavily and consistently and there will have undoubtedly been an impact by the fishing on the fish stocks and the habitat.

4.5 Potential impacts of fishing in the region

The habitat of the banks and seamounts of the northeast Atlantic is well known to contain coldwater coral reefs and other sensitive deepwater sessile organisms such as soft corals. Sponge fields also occur in more Northerly regions especially around the Faroe Islands and are very susceptible to trawl damage. WGDEC has documented the evidence for the occurrences of such habitat and extensive reviews can be found in the reports of 2005, 2006, 2007 and this report.

The impacts of the fishing gears that contact the seafloor may be very different and should take into account the intensity and frequency of fishing operations. Direct physical impacts of trawl gears on epifauna and infauna are considered the most damaging/destructive and are well documented elsewhere. Longlines may also produce impact on the seabed (particularly on hard and soft corals) by means of anchoring and loss of rope (Krieger and Wing, 2002). This potential impact varies with the longline design (e.g., with or without buoys), materials used, and largely is dependent upon fishing effort.

Lost fishing gear, particularly gillnets and traps, creates the problem of 'ghost-fishing' whereby fish and crustaceans continue to be caught for many months. The nature of materials used in fishing gear may persist for many years in the marine environment before it is rendered harmless.

Deepwater fisheries are typically associated with high discard levels. As yet the short and long-term ecosystem effects of large 'food falls' of discarded species is at present unknown. However given the large effects discarding has had on shelf ecosystems such as increased numbers of scavenging species it could be having some effects.

Considering in general that most of the main target species occur above 1500 m, we can anticipate all the potential areas within the OSPAR Region V likely to have been highly affected by deep-water fisheries (Figure 1 shows the depth contour up to the 1500 m depth superimposed by the ICES areas). The MAR to the North of the Azores has over 20 seamounts with depth of less than 1000 m, and it is likely that all have been heavily fished and impacted in the past.

Recent regulations imposed to deep-water fisheries and to the European fleets (e.g. gear restrictions, close areas to trawl and gillnet gears, TACs, etc.) are likely to have a positive impact in decreasing the pressure on many of the deep-water habitats of the OSPAR Region V, however for most of the places the previous negative impacts may be difficult to reverse and take a long time to recover.

4.6 References

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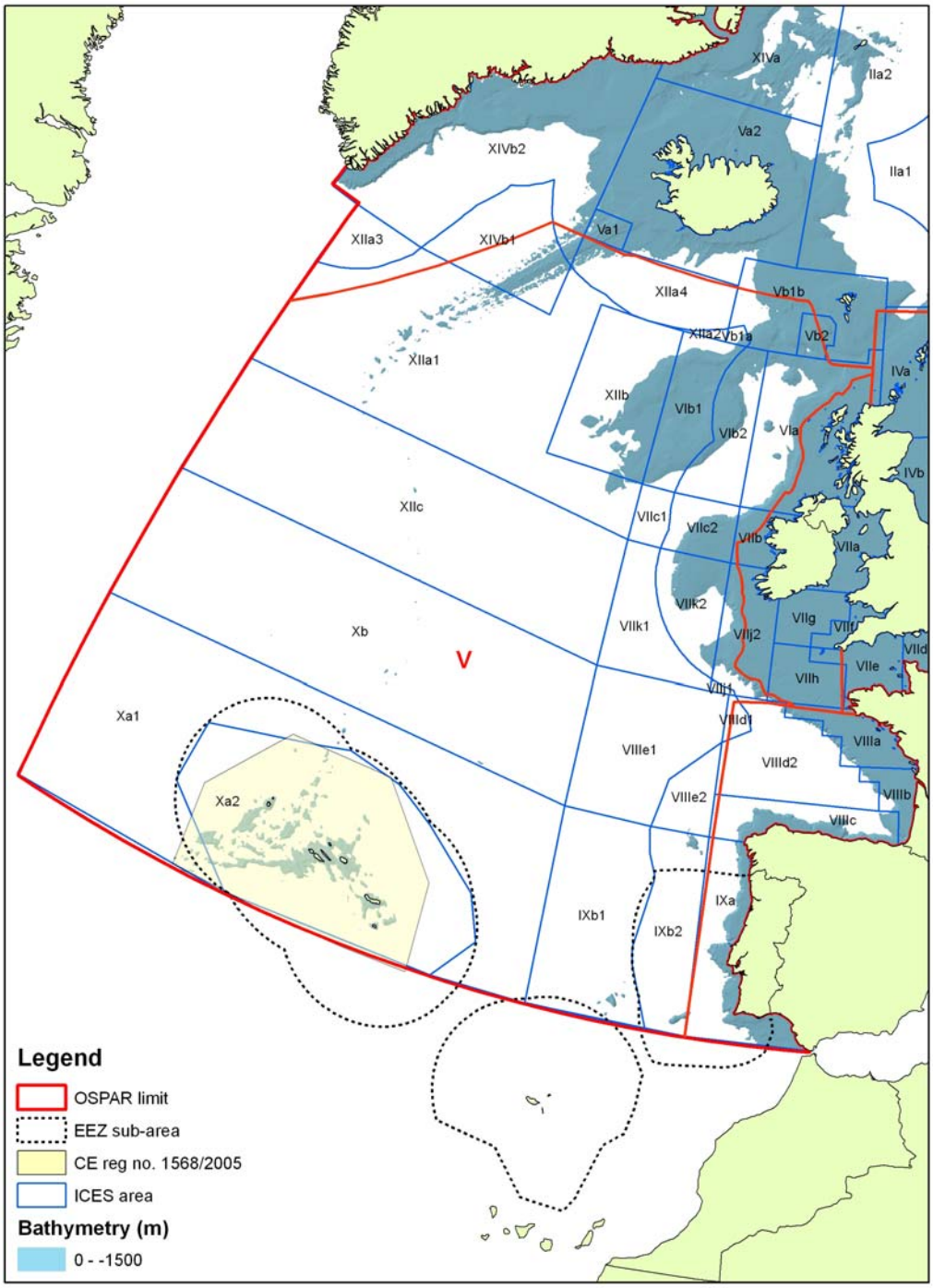

Figure 1 Depth contours at 1500 m of the OSPAR Region V potentially impacted by deep-water fisheries, with the delimitations several regulatory areas. (by Ricardo Medeiros, Department of Oceanography and Fisheries of the University of the Azores).

Table 1 Effects of fishing in OSPAR Area V.

			EFFECTS OF FISHING							
			Direct impacts		Target fisheries in OSPAR V		Non-target fish bycatch	Indirect effects		
	Fishing activities on OSPAR V	ICES Areas within OSPAR V	Physical impact	Effects on infauna	Deep-water Finfish fisheries	Deep-water Invertebrate fisheries	Benthic invertebrates	Sediment-re-suspension	Chemical composition of sediments	Discards from fish processing
Fishing gears										
Handlines	Yes	Area X	No	No	*Beryx spp.* *Pagellus bogaraveo* *Mora moro* *Phycis blennoides*		Almost non-impacts	No	No	No

					EFFECTS OF FISHING				
Bottom otter trawl		Area	Severe	Severe			High	Highly probable	High
Bottom longlines	Not allowed within the 3 miles buffer zone at the Azores islands	Area X (not allowed) Hebridean seamountWest north Porcupine Bank Area X and XII (past rRussioan fisheries at MAR)	Small	Small	Orange roughy (by-cacth cardinal fish) Alfonsinos, cardinal fish Roudnose granadier	Sporadic: Porifera, Cnidaria (Anthozoa Hydrozoa) Crustácea, Equinoderms, cephalopoda	No	No	Moderate
Sink/anchor gillnets	European fleets not allowed below the 200 m depth		High plus ghost fishing	Small	Tusk, ling and blue ling (Rosemary bank		Minimum	Minimum	High
Pots and traps		Sporadic in Area X (Azores)	Moderate	Small					
Tanglenets	European fleets not allowed below the 200 m depth		Moderate	Moderate					

5 Review guidelines for deep-sea fisheries.

Term of Reference (b). Review the 'Guidelines for management of deep-sea fisheries on the high seas' that will be considered by FAO COFI in 2008 and consider for reflection by ICES and NAFO.

The 2006 United Nations General Assembly Resolution 61/105 "calls upon States to take action immediately, individually and through regional fisheries management organizations and arrangements, and consistent with the precautionary approach and ecosystem approaches, to sustainably manage fish stocks and protect vulnerable marine ecosystems, including seamounts, hydrothermal vents and cold water corals, from destructive fishing practices, recognizing the immense importance and value of deep sea ecosystems and the biodiversity they contain" (Appendix 1) contains key provisions of the UNGA resolution). Perhaps most importantly, the resolution requires that by 31 December 2008, RFMOs regulate fisheries to prevent significant adverse impacts to areas designated as vulnerable marine ecosystems.1 To provide States and RFMOs with guidance for implementing the resolution, FAO sponsored an Expert Consultation in Bangkok, Thailand in September 2007 which resulted in a draft set of "International Guidelines for the Management of Deep-Sea Fisheries in the High Seas" (Appendix 2) contains the final draft from this meeting).

A subsequent Technical Consultation that involved delegations from 53 Nations, as well as inter- and non- governmental NGOs, met in Rome during February 2008 to negotiate, clarify and approve the text. A number of key provisions were "tentatively adopted" regarding the scope and principles for the guidelines, definitions for vulnerable marine ecosystems (VMEs) and significant adverse impacts (SAIs), fundamental approaches for identifying VMEs and where the may be found or likely to be found, and how to conduct environmental impact assessments to determine and classify impacts. However, significant work remained by the end of the session and a subsequent technical consultation is now scheduled for August 2008. (Despite agreement to the tentative language adopted at the first meeting in Rome, the text remains fully open for additional negotiation until the entire document is finalized.)

The guidelines apply to "fisheries that occur in areas beyond the limits of national jurisdiction and have the following characteristics: (i.) the total catch (everything brought up by the gear) includes species that can only sustain low exploitation rates, and (ii.) that fishing gear is likely to contact the seafloor during the normal course of fishing operations" [from tentatively adopted text]. The overall objective of the guidelines is to ensure the long-term sustainable use deep sea resources and prevent impacts to VMEs from harvest activities.

The key concepts for designating a VME and defining a SAI are as follows (reproduced below directly from adopted text; text below in [brackets] still under discussion):

Vulnerable Marine Ecosystems

Vulnerability is related to the likelihood that a population, community, or habitat will experience substantial alteration from short-term or chronic disturbance, and to the likelihood that it would recover and in what time

1 (§83.) Further, §85 notes that in areas where RFMOs are not in place, interim measures consistent with paragraph 83 should have been already implemented no later than 31 December 2007.

frame. These are, in turn, related to the characteristics of the ecosystems themselves, especially biological and structural aspects. VME features may be physically or functionally fragile. The most vulnerable ecosystems are those that are both easily disturbed and are very slow to recover, or may never recover.

The vulnerabilities of populations, communities and habitats must be assessed relative to specific threats. Some features, particularly ones that are physically fragile or inherently rare may be vulnerable to most forms of disturbance, but the vulnerability of some populations, communities and habitats may vary greatly depending on the type of fishing gear used or the kind of disturbance experienced.

The risks to a marine ecosystem are determined by its vulnerability, the probability of a threat occurring and the mitigation means applied to the threat.

Significant Adverse Impacts

Significant adverse impacts are those that compromise ecosystem integrity (i.e. ecosystem structure or function) in a manner that impairs the ability of affected populations to replace themselves and that degrades the long-term natural productivity of habitats, or causes on more than a temporary basis significant loss of species richness, habitat or community types. Impacts should be evaluated individually, in combination and cumulatively.

When determining the scale and significance of an impact, the following six factors should be considered:

i) the intensity or severity of the impact at the specific site being affected;

ii) the spatial extent of the impact relative to the availability of the habitat type affected;

iii) the sensitivity/vulnerability of the ecosystem to the impact;

iv) the ability of an ecosystem to recover from harm, and the rate of such recovery;

v) the extent to which ecosystem functions may be altered by the impact; and

vi) the timing and duration of the impact relative to the period in which a species needs the habitat during one or more life-history stages.

Temporary impacts are those that are limited in duration and that allow the particular ecosystem to recover over an acceptable time frame. Such time frames should be decided on a case-by-case basis and should be on the order of 5–20 years, taking into account the specific features of the populations and ecosystems.

In determining whether an impact is temporary, both the duration and the frequency with which an impact is repeated should be considered. If the interval between the expected disturbance of a habitat is shorter than the recovery time, the impact should be considered more than temporary. [In circumstances of limited information, States and RFMOs should be precautionary in their determinations regarding the nature and duration of impacts.]

The draft guidelines contain (as will adopted text) recommendations for States and RFMOs to meet management and conservation requirements including data acquisition needs, reporting, population assessments, identifying VMEs and assessing SAIs, enforcement and compliance, application of management and

conservation tools, processes for the application of management tools, developing environmental assessments and harvesting plans, and fishery management plans, as well as assessment and review of effectiveness of measures/adjustment of measures (Appendix 2).

It is worth noting that despite the delay in completing the guidelines, delegates at the Technical Consultation reminded the plenary that States and RFMOs still have an obligation to meet the deadline set by the UNGA resolution.

Therefore, WGDEC recommends that both ICES and NAFO utilize the draft guidelines, based on the scope and definitions above, in their ongoing work. While details from the subsequent negotiations in Rome will "fine tune" this advice, WGDEC finds the draft results of the Expert Consultation are already sufficient to provide important guidance for meeting the intent of the UNGA resolution.

Appendix 1. Key Provisions of UNGA Resolution 61/105

> 80. Calls upon States to take action immediately, individually and through regional fisheries management organizations and arrangements, and consistent with the precautionary approach and ecosystem approaches, to sustainably manage fish stocks and protect vulnerable marine ecosystems, including seamounts, hydrothermal vents and cold water corals, from destructive fishing practices, recognizing the immense importance and value of deep sea ecosystems and the biodiversity they contain;
>
> 81. Reaffirms the importance it attaches to paragraphs 66 to 69 of its resolution 59/25 concerning the impacts of fishing on vulnerable marine ecosystems;
>
> 82. Welcomes the important progress made by States and regional fisheries management organizations or arrangements with the competence to regulate bottom fisheries to give effect to paragraphs 66 to 69 of its resolution 59/25, to address the impacts of fishing on vulnerable marine ecosystems, including through initiating negotiations to establish new regional fisheries management organizations or arrangements, but on the basis of the review called for in paragraph 71 of that resolution, recognizes that additional actions are urgently needed;
>
> 83. Calls upon regional fisheries management organizations or arrangements with the competence to regulate bottom fisheries to adopt and implement measures, in accordance with the precautionary approach, ecosystem approaches and international law, for their respective regulatory areas as a matter of priority, but not later than 31 December 2008:

a) To assess, on the basis of the best available scientific information, whether individual bottom fishing activities would have significant adverse impacts on vulnerable marine ecosystems, and to ensure that if it is assessed that these activities would have significant adverse impacts, they are managed to prevent such impacts, or not authorized to proceed;

b) To identify vulnerable marine ecosystems and determine whether bottom fishing activities would cause significant adverse impacts to such ecosystems and the long-term sustainability of deep sea fish stocks, interalia, by improving scientific research and data collection and sharing, and through new and exploratory fisheries;

c) In respect of areas where vulnerable marine ecosystems, including seamounts, hydrothermal vents and cold water corals, are known to occur or are likely to occur based on the best available scientific information, to close such areas to bottom fishing and ensure that such activities do not proceed unless conservation and management measures have been established to prevent significant adverse impacts on vulnerable marine ecosystems;

d) To require members of the regional fisheries management organizations or arrangements to require vessels flying their flag to cease bottom fishing activities in areas where, in the course of fishing operations, vulnerable marine ecosystems are encountered, and to report the encounter so that appropriate measures can be adopted in respect of the relevant site;

84. Also calls upon regional fisheries management organizations or arrangements with the competence to regulate bottom fisheries to make the measures adopted pursuant to paragraph 83 of the present resolution publicly available;

85. Calls upon those States participating in negotiations to establish a regional fisheries management organization or arrangement competent to regulate bottom fisheries to expedite such negotiations and, by no later than 31 December 2007, to adopt and implement interim measures consistent with paragraph 83 of the present resolution and make these measures publicly available;

86. Calls upon flag States to either adopt and implement measures in accordance with paragraph 83 of the present resolution, mutatis mutandis, or cease to authorize fishing vessels flying their flag to conduct bottom fisheries in areas beyond national jurisdiction where there is no regional fisheries management organization or arrangement with the competence to regulate such fisheries or interim measures in accordance with paragraph 85 of the present resolution, until measures are taken in accordance with paragraph 83 or 85 of the present resolution;

87. Further calls upon States to make publicly available through the Food and Agriculture Organization of the United Nations a list of those vessels flying their flag authorized to conduct bottom fisheries in areas beyond national jurisdiction, and the measures they have adopted pursuant to paragraph 86 of the present resolution;

88. Emphasizes the critical role played by the Food and Agriculture Organization of the United Nations in providing expert technical advice, in assisting with international fisheries policy development and management standards, and in collection and dissemination of information on fisheries-related issues, including the protection of vulnerable marine ecosystems from the impacts of fishing;

89. Commends the Food and Agriculture Organization of the United Nations for its work on the management of deep sea fisheries in the high seas, including the expert consultation held from 21 to 23 November 2006 in Bangkok, and further invites the Food and Agriculture Organization of the United Nations to establish at its next Committee on Fisheries meeting a time frame of relevant work with respect to the management of the deep sea fisheries in the high seas, including enhancing data collection and dissemination, promoting information exchange and increased knowledge on deep sea fishing activities, such as through convening a meeting of States engaged in such fisheries, developing standards and criteria for use by States and regional fisheries management organizations or

arrangements in identifying vulnerable marine ecosystems and the impacts of fishing on such ecosystems, and establishing standards for the management of deep sea fisheries, such as through the development of an international plan of action;

90. Invites the Food and Agriculture Organization of the United Nations to consider creating a global database of information on vulnerable marine ecosystems in areas beyond national jurisdiction to assist States in assessing any impacts of bottom fisheries on vulnerable marine ecosystems and invites States and regional fisheries management organizations or arrangements to submit information to any such database on all vulnerable marine ecosystems identified in accordance with paragraph 83 of the present resolution;

91. Requests the Secretary-General, in cooperation with the Food and Agriculture Organization of the United Nations, to include in his report concerning fisheries to the General Assembly at its sixty-fourth session a section on the actions taken by States and regional fisheries management organizations and arrangements in response to paragraphs 83 to 90 of the present resolution, and decides to conduct a further review of such actions at that session in 2009, with a view to further recommendations, where necessary;

Appendix 2. Copy of the title page of the technical consultation undertaken at FAO

TC:DSF/2008/2

November 2007

منظمة الأغذية والزراعة للأمم المتحدة | 联合国粮食及农业组织 | Food and Agriculture Organization of the United Nations | Organisation des Nations Unies pour l'alimentation et l'agriculture | Organización de las Naciones Unidas para la Agricultura y la Alimentación

TECHNICAL CONSULTATION ON THE INTERNATIONAL GUIDELINES FOR THE MANAGEMENT OF DEEP-SEA FISHERIES IN THE HIGH SEAS

Rome (Italy), 4-8 February 2008

DRAFT INTERNATIONAL GUIDELINES FOR THE MANAGEMENT OF DEEP-SEA FISHERIES IN THE HIGH SEAS

The full document can be accessed at: ftp://ftp.fao.org/FI/DOCUMENT/tc-dsf/2008/2e.pdf

6 Types of advice for fisheries clients

Term of Reference (c). The types of advice that fisheries clients may request of ICES and NAFO, should the guidelines be implemented.

ICES and NAFO will need to delineate areas as vulnerable marine ecosystems (VMEs) based on the distribution or predicted distribution of VME indicator species (e.g., deepwater corals, sponges), determine the level of fishing effort by particular gear types or fisheries that produce SAIs, as well as produce population assessments and biological reference points for exploited and bycatch species in bottom fisheries not currently managed. Reporting and communications needs regarding notification of VME locations, review of encounter protocols and methods for enforcement by flag States will also need to be addressed. Here WGDEC also recommends use of the current draft guidelines to provide a foundation for ICES and NAFO to develop specific approaches to meet the goals of the UNGA resolution. It is important to acknowledge that the "Guidelines" are not requirements per se and the flexibility to utilize other approaches, whether ultimately negotiated in the FAO Technical Consultation and implemented by COFI, remain.

Perhaps the biggest constraint in the process to protect VMEs will be the uncertainties in the distribution and abundance of VME indicator species and similar uncertainties in the link between fishing effort and SAIs. Precautionary approaches will be the overarching requirement. Much remains to be understood about the taxonomy, population biology, reproductive biology, functional role, and resilience of species that compose VMEs. In fact, comprehensive studies of such communities in areas of the high seas have only just begun in many areas and syntheses with broad geographic applicability are few (but see Pitcher *et al*., 2007).

While research focused on coral communities in the Northeast Atlantic have been conducted at significant pace in the past decade, studies of the biological attributes of seamount coral communities have only been conducted in the recent past (2001–2005) in the NAFO area (i.e., New England and Corner Rise Seamounts-Orphan Knoll and the Newfoundland Seamounts have not yet been characterized). While analyses in multiple laboratories are ongoing, recent results indicate that coral communities across these seamount chains and across depth ranges within seamounts vary in terms of composition and distribution. That is, all seamounts within a region are not equal and management of impacts should consider spatial variation at relatively small spatial scales such as within seamount chains (these basic patterns are consistent with analyses of the distribution of coral communities across the Northeast Atlantic; Hall-Spencer *et al*., 2007).

For example, preliminary analyses of seafloor fauna from 210 hrs of video transects at Corner Rise and New England Seamounts (10 seamount peaks, 5 in each region from 2005) indicate that there are unique communities that are limited by depth and geographic range (Walter Cho and Tim Shank, Woods Hole Oceanographic Institution, personal communication). Multivariate analyses reveal unique communities for shallow (700–1300 m), medium (1300–2300 m), deep (2300–2600 m), and very deep (2600–2700 m) survey areas. Further, community composition based on individual seamounts indicated that Corner Rise and NES had significantly different faunas. There was a total of 270 species across all seamounts surveyed with approximately 70 species unique to Corner Rise, approximately 60 unique to NES, and more than 130 shared amongst seamounts. Associations between a range of

echinoderm and crustacean species with specific corals were evident from this and previous data, suggesting obligate relationships.

The geographic relationships within and between coral species across seamounts are also complex. Molecular approaches have revealed that there are four "types" of octocorals in the genus *Paramuricea* collected from 16 locations across the western North Atlantic (New England and Corner Rise seamounts, submarine canyons along the continental margin of North America, and deep basins in the Gulf of Maine) at depths between 200–2200 m. Eighty-nine of the sampled specimens could not be distinguished at a species level based on morphology but genetic data show there are at least four types, corresponding to three or four species (J.N. Thoma and S.C. France, University of Louisiana at Lafayette, unpublished data). Two of these (types B and C) are evolutionarily older lineages, and the other two (A and D) are more recently derived and closely related. All types were found on at least some seamounts, but only type 'A' was found on the continental margin (canyons and Gulf of Maine). Types B and C were widely distributed on seamounts across the sampled region, although type C was absent from the four easternmost locations in the Corner Rise Seamounts, and type B was absent from the two westernmost locations (Bear and Retriever seamounts). All four types were observed only on Kelvin Seamount. No pattern of distribution with depth was evident but no samples were collected from seamount summits shallower than about 1100 m.

Recently, Watling (2007) described four new species and one new genus of chrysogorgiids from specimens collected across the New England Seamount Chain. Work is ongoing regarding new descriptions of bamboo corals with the validity of two genera in question (*Lepidisis* and *Keratoisis*). Some coral species are known from only a single location (e.g., Cairns, 2006). Further, fifteen species of black coral were also collected, including 7 species that have not previously observed on the seamounts (S. France, personal communication).

Interestingly, observations of fishes on seamounts at 900–2500 m depth suggest that while multiple species interact with seamount habitats only *Neocyttus helgae* has at least a facultative relationship with fan and whip octocoral habitats (Auster *et al.*, 2005, Moore *et al.*, in press). Associations of species of economic importance with coral habitats are more common in other regions (e.g., Stone 2006 for the North Pacific-Bering Sea region) so caution is needed for interpreting linkages between corals and sustainability of exploited populations (Auster, 2005, 2007).

Effort-response information in regards to particular gear types in particular deep-sea habitats is also limited (but see Roberts *et al.*, 2000; Hall-Spencer *et al.*, 2002; Fossa *et al.*, 2002; Krieger, 2001; Wheeler *et al.*, 2005; Koslow, Smith, Waller *et al.*, 2007; Freese *et al.*, 1999; Freese, 2000). However, the types and directions of impacts are well known from a global literature on the subject (e.g., Collie *et al.*, 2000; Kaiser *et al.*, 2006) and significant damage to both scleractinian, soft coral, and sponge communities are known from single impacts of mobile gear. Such information will need to be synthesized in order to make first-order assessments of the potential for particular types of fishing operations to produce SAIs to VMEs.

Population assessments and biological reference points will be required for exploited and bycatch species not currently managed (at least in the NAFO area), like alfonsino, orange and Mediterranean roughy, and other taxa targeted or that occurs as bycatch in fisheries (e.g., based on catch detailed in Murillo *et al.*, 2008ms; Vinnichenko, 1997).

Given the time frame for advice provided by WGDEC to reach managers, it appears to be necessary to utilize a high degree of precaution given the timeline for

implementing the UNGA resolution. As information is produced and synthesized, more preventive and corrective approaches may be utilized (sensu Auster, 2001).

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7 Types of advice for examining patterns of fishing

Term of Reference (d). The types of information and terms of reference that WGDEC and any other relevant expert groups may need in order to respond to requests as identified in ToR (i). ToR (i) addresses information needed in order to examine patterns of fishing in deep-water areas to determine where intensive fishing is occurring and evaluate the likelihood of sensitive habitats being present in those areas.

Assessing vessel monitoring system data (VMS) can help gain valuable insight into many questions pertaining to fishing pressure in specific locations if the data quality is good and can be used to address several important questions. One of the ways that fishing patterns can be assessed is by examining vessel monitoring system (VMS) records. VMS is used in commercial fishing to allow environmental and fisheries regulatory organizations to monitor fishing vessel activities. Each VMS unit is assigned to a particular vessel and is required to be secured and operating effectively. Typically the information transmitted through VMS includes identity information (e.g., vessel), location at the time the vessel is polled and time of signal from the VMS. Vessel speed is computed as the distance covered between locations. It is usually assumed that fishing is occurring when the computed vessel speed is less than about 3 knots. However, this could vary by country and gear type being used. Gear information may or may not be included in the VMS record but could possibly be implied by vessel speed. This information is not always accurate, however, as the vessel may be drifting because of malfunction, processing the catch, or experiencing other problems. It is typically assumed that catch is proportional to time fishing and thus could be assigned based on time and distance between polling points. This assumption may not always be accurate, however. In some circumstances (e.g., northeast US/Canada areas in the Gulf of Maine) some scallop fisheries such as those operating in special access areas (Nantucket Lightship Closed Area), catch information are also transmitted for a suite of species (cod, haddock, and yellowtail flounder) as well other than just the target species (e.g., scallops).

VMS is a key part of monitoring control and surveillance programs at the national and international levels. VMS may be used to monitor vessels in the territorial waters of a country or a subdivision of a country, or in the Exclusive Economic Zones (EEZ) that extend 200 nautical miles (370.4 km) from the coasts of many countries. Details of VMS approved equipment and operational use will vary with the requirements of the nation of the vessel's registry, and the regional or national water in which the vessel is operating. Analyzing VMS records is vital to be able to assess fishing activities in relation to regulatory actions involving fishing quotas, harvesting limits, position in relation to areas closed to fishing, special management of fishing zones, and license limitations. The use of VMS data has become an important assessment tool to effectively manage our depleting ocean resources.

Complementary data collections that can add value to VMS records can be found in Vessel Trip Reports (VTR). In the northeast region (NE) of North America, VTRs contain trip specific information such as gear type used, amount of gear, fish kept by species, and discards. All federally permitted vessels in the NE are required to submit VTRs for each trip. Unfortunately, however, only groundfish, scallop and monkfish vessels are required to have VMS. Hence, this additional information may not be fully realized. Quality assurance value is greatly added if one can link and compare these VTR reports back to the VMS records. Similarly, onboard observer reports

complement both the VMS and VTR records and can add another layer of reliability of vessel activities. The observer reports are likely the most accurate source of information on discards. Vessels are supposed to report discards on their VTRs but historically there may have been little confidence in the reliability of this information. In addition, observers are required to include the unique VTR number in their reports. Thus this is an important key that links all of these three reports.

Linking the VMS records, VTR reports, and onboard observer assessments, one might conceivably be able to overlay this information on a map of the seafloor and/or oceanographic conditions to examine patterns of fishing, intensity of fishing effort, and the association of fishing efforts to bathymetry, oceanographic conditions (e.g., temperature, salinity, currents) and habitat (e.g., areas of coldwater corals). If all of this information is consistently collected and reported, one may be able to make educated and accurate assessments on why vessels fish where they do along with the intensity trends as it relates to catch. More importantly, comparing vessel fishing activities with known or hypothesized sensitive habitats may lead to the development of informed regulatory actions that strive to protect these sensitive and ecologically important areas.

In summary, the types of information WGDEC/other relevant groups may need to include:

- VMS records that clearly depict vessel location, speed, gear type being used, catch record at every VMS record.
- VTR reports that includes trip-specific information such as gear type used, amount of gear, fish kept by species, and discards.
- Maps characterizing fish activities by numbers and gear types as well as catch records.
- Maps of high resolution depicting known benthic habitat types as well as those areas hypothesized to likely contain areas of sensitive habitats.
- Adopt a definition of "sensitive habitat" and "vulnerable marine ecosystem".
- Adopt a definition of "vulnerable fish species" in the North Atlantic.
- Onboard observer reports that provide reliability and consistency of information gathering and reporting.

7.1 Acknowledgements

The Working Group would like to thank John Witzig of NOAA's Northeast Regional Office (USA) for his help in assessing the use of available VMS data.

8 Planning and organizing information

Term of Reference (e): If the information in (i) is not thought to be available currently, consider a plan of action to acquire and organise the necessary information. Term of Reference (i) requests examination of patterns of fishing in deep-water areas other than Rockall and Hatton banks, such as the seamounts and continental slope, to determine where intensive fishing is occurring and evaluate the likelihood of sensitive habitats being present in those areas;

In order to enable ICES to provide scientifically well-founded advice on the distribution of VMEs and likely management solutions, several activities will have to be initiated at ICES level:

1) A central repository for data on the distribution, abundance and if possible quality of habitats and species considered to be VMEs is required (covering deep water areas inside and outside national jurisdiction). This should include a photographic reference database.

2) GIS mapping facilities need to be installed, and licences for the best-available bathymetry and EEZ information will need to be purchased.

3) A central VMS database is required, if possible annually updated from NEAFC and EC/national sources. It is important to be able to distinguish between transit/fishing and the métiers, or at least gear types used. Over the years, it should be possible to analyse the fishing patterns of present day fishing activities.

4) Data recovery from lost sources, e.g. Russian files, on fishing places

5) Seek access to sectoral knowledge

6) Based on the known fishing gear application, a map of potential deep-water fishing areas by (bottom touching) gear type needs to be compiled.

7) Based on available knowledge of the occurrence and distribution of some of VME species and habitats in relation to environmental variables, as a first step, data on the distribution of seamounts, offshore banks and island/continental slopes need to be added. As soon as possible this rough indicator of hard bottom fauna presence should be refined by predictive habitat and species occurrence maps as a proxy to the likely distribution of VMEs, i.e.

   - Cold water coral reefs-this information is available from Clark *et al.*, 2007
   - Coral gardens/dense stands of soft corals-this information is partly available for the NW Atlantic Canadian Shelf from e.g. Bryan and Metaxas, 2007, but might be extended
   - Deep water sponge grounds
   - Hydrothermal vents and cold seeps
   - Structurally complex hard bottom epifauna
   - Seamount aggregating fish species in relation to summit/slope of the elevations

8) Determine different certainty layers to the information available and use adapted strategies in the advice process, considering the precautionary approach as promoted by FAO as a guiding principle to the ecosystem

approach to fisheries (FAO COFI 2006) and to the implementation of UNFGA Res. 61/105 (FAO TC:DSF/2008/2**).**

These tasks should be accompanied by the position for a permanent staff member at ICES, with the idea to build up, continuously update and improve the database and mapping facilities, as well as to supply with maps/information the various ICES working groups and committees over the year. This should enable ICES to respond flexible to requests from customers on this subject.

A cumulative impact matrix of different fishing patterns (métiers, intensity, frequency) in relation to VMEs will be required which can easily be used for the assessment of "significant adverse effects".

In addition, a plan of action is needed on how to prioritise the advice process in order to respond to the needs of the customers: ICES will need to define several advice patterns-from limited knowledge/large scale/precautionary to a more detailed advice on individual areas which are relatively well known (compare Rockall and Hatton Bank area).

Another field where expertise from ICES might be requested is that of the required Environmental impact assessments of fishing activities. Working groups under ICES should take up this subject to be able to provide advice.

9 Collating information of Hatton Bank

Term of Reference (f): Continue to collate information on habitats (research and survey results) and fisheries use (VMS and fisher's information) on Hatton Bank in order to refine the advice for closed areas.

9.1 Background

In 2005, ICES reviewed current knowledge of *Lophelia pertusa* distribution on Hatton Bank (ICES, 2005) following the request made by NEAFC. Subsequent to this review NEAFC made a decision to prohibit bottom trawling and fishing with static gear (including bottom gillnets and longlines) on part of the bank from 1 January 2007 (http://www.neafc.org/measures/measures-2007/docs/rec-9-2007_hatton-rockall-closures.pdf). In 2007, ICES took the opportunity to update and correct the location of early records *Lophelia pertusa* on Hatton Bank (Durán Muñoz *et al.,* 2007a). ICES also examined new information on cold-water corals on Hatton Bank provided by surveys undertaken by the UK Government in 2005 and 2006 (Narayanaswamy *et al*., 2006; Howell *et al*., 2007) and the fishing effort distribution of Spanish trawlers based on the analysis of data provided by the Observer Program of the Spanish Institute of Oceanography (IEO) (Duran Muñoz *et al,* 2007b; Duran Muñoz *et al,* 2007c). It subsequently reported on suitable areas to close (ICES, 2007) to the south of the existing closure. In 2007, NEAFC decided to extend the Hatton closure to include this southern section of the bank from 1 January 2008 (NEAFC Recommendation IX-2007 and IX-2008, EC Regulation No 40/2008) (http://www.neafc.org/measures/current_measures/docs/09-rec_corals.pdf).

It is recognized that an interdisciplinary approach is appropriate when studying the interactions between fisheries and habitats (FAO, 2008). Besides the knowledge on seabed geology and benthic ecology, knowledge about the fishery footprint and their relationship with the seabed geohabitats is necessary to produce appropriate advice on closed areas. In this report, WGDEC present new interdisciplinary data from the Spanish Institute of Oceanography (IEO) on the distribution of vulnerable habitats (particularly coldwater corals) on Hatton Bank in order to further refine the advice for closed areas.

9.2 Recent research and surveys

Since 2005, the ECOVUL/ARPA interdisciplinary research project (Durán Muñoz *et al.,* 2007b) has been undertaken by the Spanish Institute of Oceanography (IEO) with funding from the Spanish Government. This study is focused on investigating the deep-sea vulnerable ecosystems/habitats in the Hatton Bank area between the 1000–1500 m depths on the western and northwestern flanks of bank. The IEO programme has undertaken multibeam survey (using a multibeam EM300) and high resolution seismic profiles (TOPAS PS 018 parametric echosounder) of large areas of the Western flank of the bank, supported by biological survey in the form of bottom trawl, dredge and box core sampling. The project has also drawn on data from observers on board commercial trawlers and cooperative surveys with the fishing industry. In summer 2007, a third multidisciplinary survey was carried out as part of this project. New data from this survey are presented here (Durán Muñoz *et al.,* 2008). An updated map showing the sampling carried out on the Hatton Bank by Spain during the period 2005–2007 is shown in Figure 1.

9.3 Results of research and surveys

Information on the distribution of fishing effort provided by the IEO Observers Program (Durán Muñoz *et al.*, 2007c), was superposed onto multibeam bathymetry, and added to the preliminary results of the surface sediment sampling, both obtained during the Spanish surveys. This data indicated that trawl fishing grounds are generally located on flatter, sandy zones of the sedimentary deposits located on the Western Slope of the Hatton Bank. This sedimentary deposit, called Hatton Drift, is mainly composed of fine sands or very fine sands (Figure 2). Moreover, survey hauls carried out over the Drift, show that in this sedimentary region, the bycatch of coldwater corals was very scarce and limited to those hauls carried out accidentally over rock outcrops. This suggests that corals may be found in the sedimentary area but commonly associated to outcrops, distributed in small patches, never forming substantial reef structures. According to the available information, the sedimentary seabed supports intense trawling activity and at present, reef structures are unlikely to occur (Durán Muñoz *et al.*, 2008).

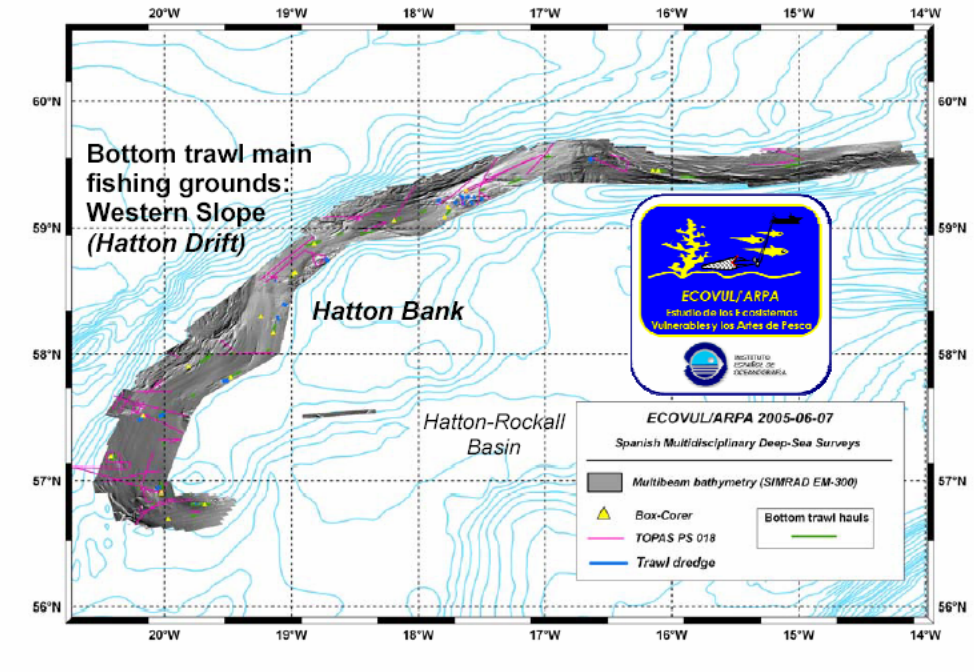

Figure 1 Updated map showing the sampling carried out during the ECOVUL/ARPA Spanish Multidisciplinary Deep-Sea Surveys (2005–07) on the Hatton Bank. The study area covers main trawl fishing grounds. These grounds are located on western slope of the Bank, between 1000–1500 m depth, mostly over the soft sedimentary deposits called Hatton Drift.

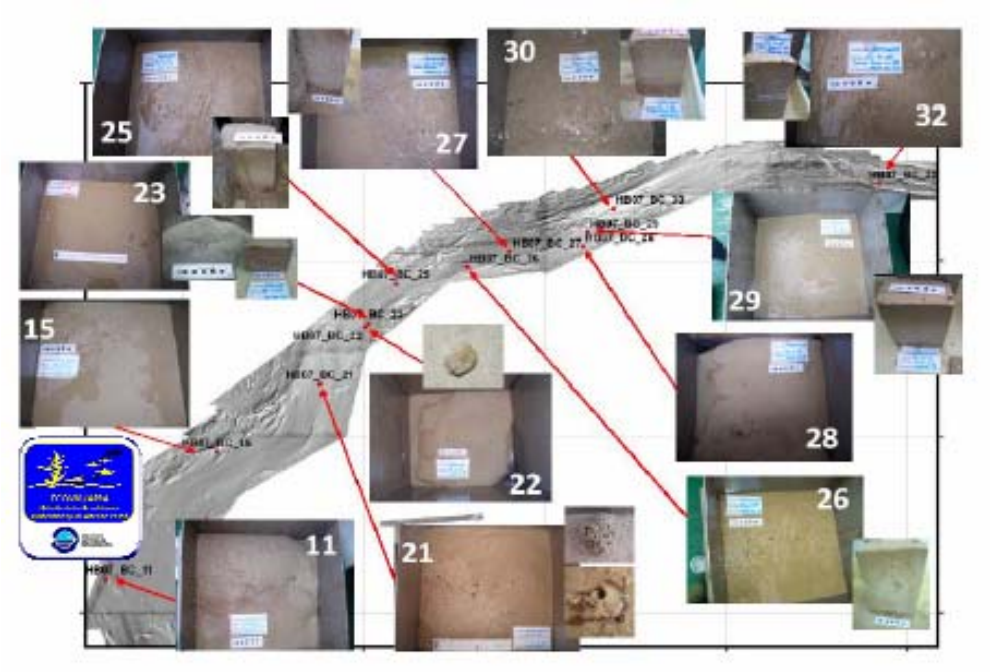

Figure 2 2007 Spanish Multidisciplinary Summer Survey. Photos and location from the multibeam bathymetry of the surface sediment, obtained within the trawling fleet fishing area (Hatton Drift) by means of a Box-Corer dredge. Samples are made up of fine sediments, with scarce presence of epifauna. Corals were not found in these samples.

Analysis of new IEO data **(**Durán Muñoz *et al.,* 2008) has revealed three areas of cold water coral occurrence in the Western slope of the bank, associated with outcrops and other geological features like ridges and mounds (Sayago-Gil *et al,* 2006; Sayago-Gil *et al,* 2007). These areas are termed as follows:

A North-western Area

B Ridges and mounds Area

C Central Area

Coral rubble and other biogenic debris with high associated biodiversity were also observed in the above areas. This degradation of coral reefs could be due to either natural or anthropogenic factors (Mortensen *et al*., 2007).

The outcrops described above are located outside of the current NEAFC/EU protection area (NEAFC Recommendation IX–2007 and IX–2008, EC Regulation No 40/2008). According to the available information, the *Northwest Hatton Bank outcrops* (A, B and C) seem not to have been subjected to intense bottom trawl fishing and as such, it is expected that fishing activity has not seriously disturbed outcrop habitats.

In the North-western Area (named as "A" on the map of the Figure 6), multibeam data shows an uneven relief along the curve of the bank. This area of irregular topography occurs at 700–1740 m depth. It covers an area of approximately 1240 km^2 and an extension of 70 km (approx.) in the shallowest depth (upslope). Seismic data indicates the presence of hard outcrops on the bank (probably basalts), which are progressively covered by sediments, probably of the Drift. From benthic trawl/dredge samples within this area, (Figure 3) we can deduce that these outcrops act as a suitable substratum for settlement of cold water corals: live colonial scleractinians (small colonies of *Solenosmilia variabilis*) and dead octocorals skeletons were found. Information obtained from 2005 surveys (Durán Muñoz *et al*., 2007c) also

corroborates the evidence for coral presence within the area: fishing hauls carried out in the area as part of cooperative and multidisciplinary surveys yielded live fragments of *Lophelia pertusa*, *Madrepora oculata*, gorgonians and black corals) as well as dead fragments with high associated biodiversity. These areas are far from habitual fishing grounds.

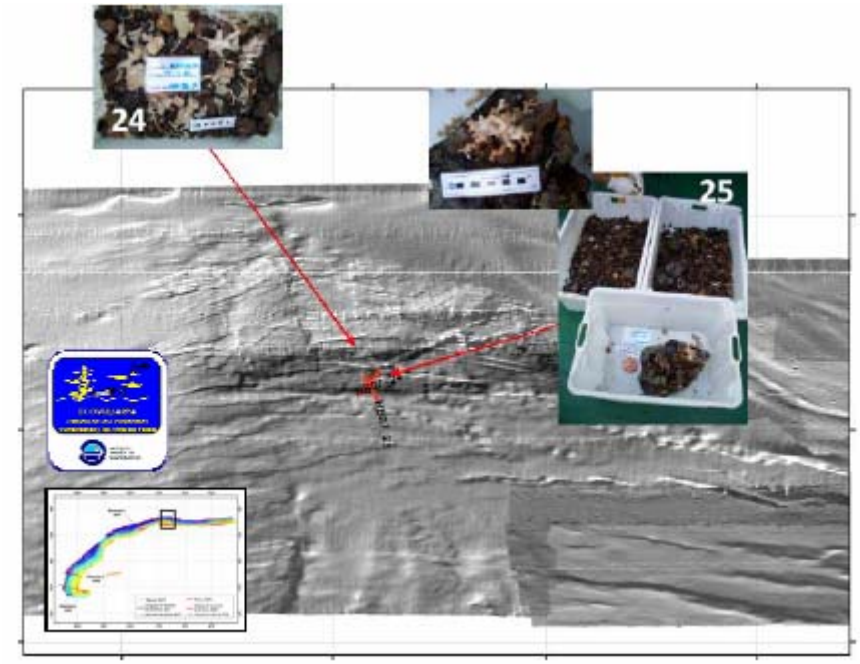

Figure 3 2007 Spanish Multidisciplinary Summer Survey. North-west Area ("A"). Photos and location of the substratum samples (shown on underlying multibeam bathymetry) from the surface of the seabed, obtained outside regular trawling area by means of a trawl dredge. In sample 25, most of the corals were alive. In sample 24 only dead coral (octocorals skeletons) was found. In both samples rich associated fauna, particularly small sponges, was found.

In the Ridges and Mounds Area (named as "B" on the map of the Figure 6), the multibeam data revealed elongate and parallel ridges, 5 km apart with sections between 2–7 km and extend overall more than 40 km. These segments follow four principal directions: N90ºE, N78ºE, N67ºE and N53ºW. Their height varied between 5–45 m, generally with maximum gradients downslope (up to 17º). They are located at depths of between 700–1600 m. Dozens of small mounds (carbonate reefs) have been identified on the crest of the ridges. Areas of sediment (composed of Drift sediment and coral remains) exist in the ridge zone upslope, as these barriers act as a sediment trap (Sayago-Gil *et al*., 2006; Sayago-Gil *et al*., 2007). Below the mounds, the seismic signal is often chaotic and sometimes opaque possibly because of sound attenuation due to the mound composition. The carbonate mounds are located on hard surfaces (the top of basalts in this case), and analyses of the trawl dredge samples (Figure 4) confirm that this type of substratum is suitable for coldwater coral settlement. Small colonies of live cold water corals were found in these samples (scleractinians and black corals) as well as skeletons of dead specimens (scleractinians, octocorals, etc.) with a rich associated biodiversity, together with remains of cirripeds and molluscs. Considerable amounts of dead coral were found near to the regular fishing grounds, as well as far from the fishing grounds, which could indicate that diverse non-anthropogenic factors (natural factors, like environmental changes, etc.) could be also affecting the coral viability.

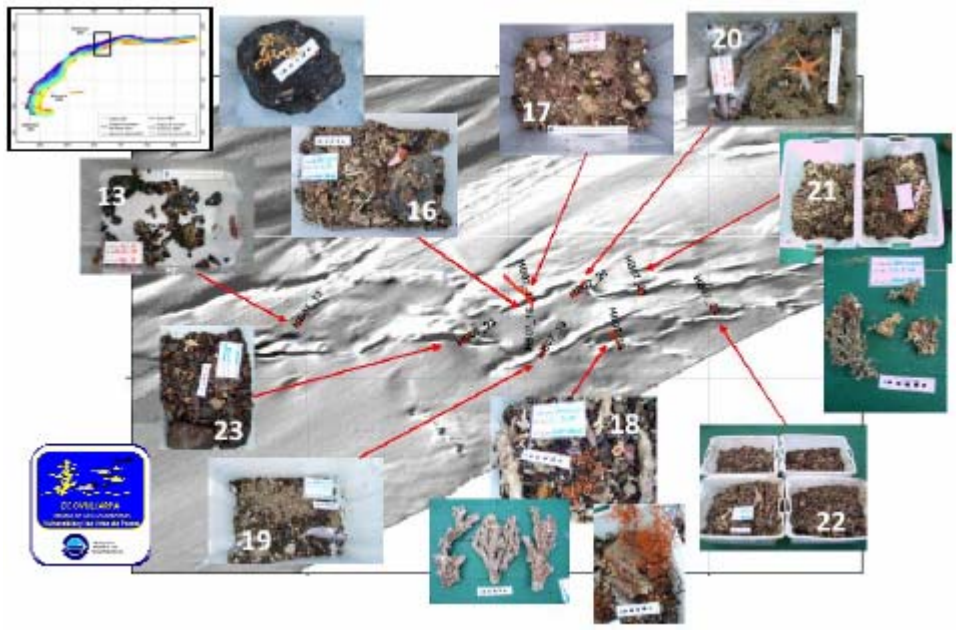

Figure 4 2007 Spanish Multidisciplinary Summer Survey. Ridges and mounds Area ("B"). Photos and location of the substratum samples (shown on underlying multibeam bathymetry) from the surface of the seabed, obtained outside regular trawling area by means of a trawl dredge. In samples 16, 18 and 21, dead corals and live corals were observed. Samples 17, 19, 20, 22 and 23 contained only dead coral (Coral skeleton pieces together with remains of cirripeds and molluscs). In all of them, a rich associated fauna was observed (sample 18 showed a special abundance and diversity of organisms). Dead coral was found both in locations close to regular fishing grounds and also far from the fishing grounds. The final sample yielded no coral and the associated fauna was scarce.

In the Central Area (named "C" on the map in Figure 6) multibeam data revealed an area of irregular topography approximately 600 km^2, in size, covering an extension of 80 km (approx.) in the shallowest depth of the study area. The area is located between 800–1600 m water depth. The area boundary includes an elongate morphological feature which cuts into the Drift. Seismic information suggests this is an outcrop (probably basalt), which may be (partially) covered by sediments of the Drift. Trawl dredge samples within this area (Figure 5) confirm the presence of live cold water corals (small pieces of *Solenosmilia* sp) on the outcrops. Moreover, as well as in Area "B", the Central Area contained significant amounts of dead coral skeletons (colonial scleractinians), with high associated biodiversity. In the samples taken far from regular trawling areas, with the exception of few solitary scleractinians, all the observed coral was dead. This could indicate that non-anthropogenic factors may be affecting the viability of coral.

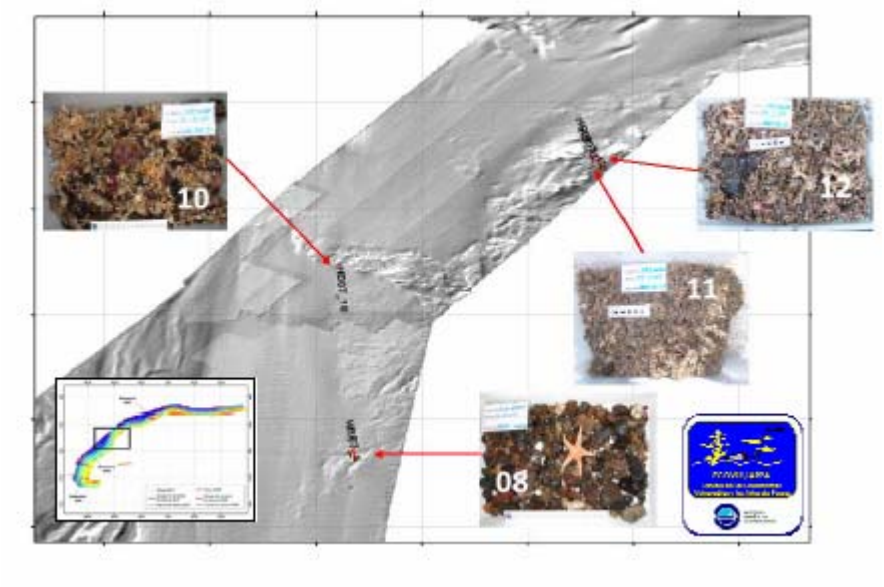

Figure 5 2007 Spanish Multidisciplinary Summer Survey. Central Area ("C"). Photos and location of the substratum samples (shown on underlying multibeam bathymetry) from the surface of the seabed, obtained outside regular trawling area by means of a trawl dredge. In sample 10 dead and alive corals were observed. In samples 11 and 12, although distant from regular trawling areas and with the exception of some solitary scleractinians (sample number 12) all the coral was dead (pieces of coral skeletons with remains of cirripeds and gastropods). In all samples, a rich fauna associated with coral pieces was observed. Sample 08 had no coral and the associated fauna is scarce.

9.4 Further area suitable for closure

The evidence available to WGDEC supports the current closure. However, new data on the distribution cold-water corals (and outcrops likely to support cold water corals), leads WGDEC to recommend that the area known as the north west Hatton Bank outcrops be closed to bottom fishing. The boundaries of this recommended extension are presented in Figure 6 and table 1. The proposed extension is a simple polygon, and entirely encloses the vulnerable habitats identified during the IEO surveys. A precautionary margin or 'buffer zone' of one mile (or greater) around the coral records (and topographic features likely to support corals) has been incorporated within this boundary delineation (ICES 2007b). It should be noted that this proposed boundary extension is based solely on scientific survey data. This is on account of the high quality and detailed resolution of the acoustic and biological survey undertaken by the Spanish institute of Oceanography between 2005 and 2007, which has allowed WGDEC to map vulnerable habitats at a high level of accuracy in this area.

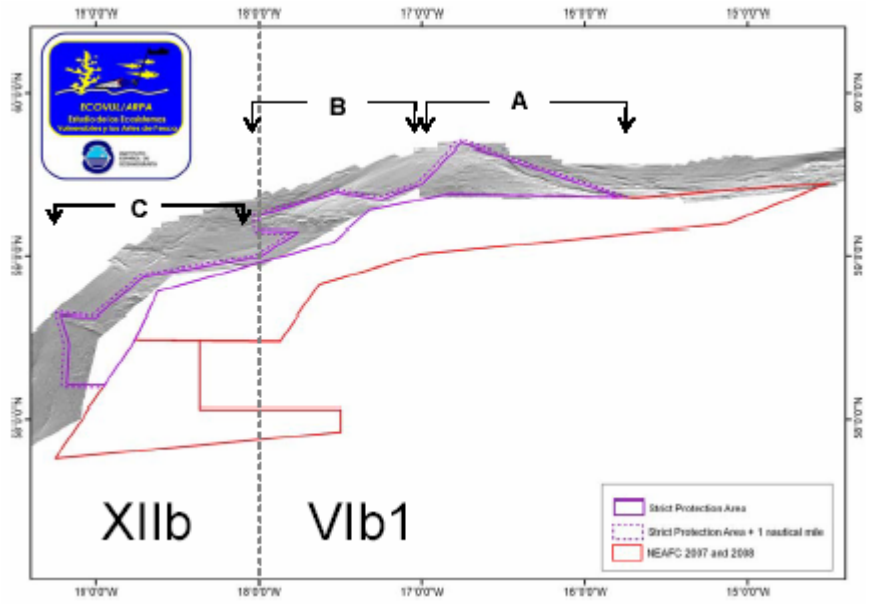

Figure 6 Map of the Hatton Bank showing the multibeam bathymetry obtained from ECOVUL/ARPA project and the boundaries of the additional area suggested for closure (purple dot line) in order to protect vulnerable habitats, particularly cold-water corals, in the main outcrops identified in the Western slope of the bank (A = Northwest Area; B = Ridges and mounds Area; C = Central Area).

Table 1 Corner points of suggested extension to closed area on Hatton Bank.

POINT	LATITUDE (N)	LONGITUDE (W)
1	58º 11.15	18º 57.51
2	58º 30.00	18º 45.00
3	58º 47.00	18º 37.00
4	59º 05.00	17º 32.00
5	59º 16.00	17º 20.00
6	59º 22.00	16º 50.00
7	59º 21.57	15º 44.75
8	59º 42.69	16º 45.96
9	59º 26.91	17º 01.66
10	59º 21.77	17º 15.36
11	59º 24.17	17º 31.22
12	59º 15.16	18º 01.56
13	59º 08.75	18º 01.47
14	59º 08.01	17º 49.31
15	59º 00.29	18º 01.31
16	58º 53.14	18º 43.54
17	58º 38.11	19º 01.29
18	58º 39.09	19º 14.28
19	58º 27.75	19º 11.65
20	58º 11.57	19º 11.97

9.5 NW Extension to the North West Rockall Closure

In 2007, the ICES WGDEC proposed a revision to the NW Rockall closure (NEAFC Recommendation IX-2008, EC Regulation No 40/2008), on the basis on new cold-water coral data collected by the Joint Nature Conservation Committee in collaboration with the Scottish Government Fisheries Research Services (FRS) and the University of Plymouth (UoP). No new data have been acquired in since then, however, it should be noted that all the analysis of this data has now been finalised and the data submitted for review and subsequent publication. WGDEC would therefore like to reiterate its recommendation for a north-west extension to the existing NW Rockall fishing closure (Figure 7).

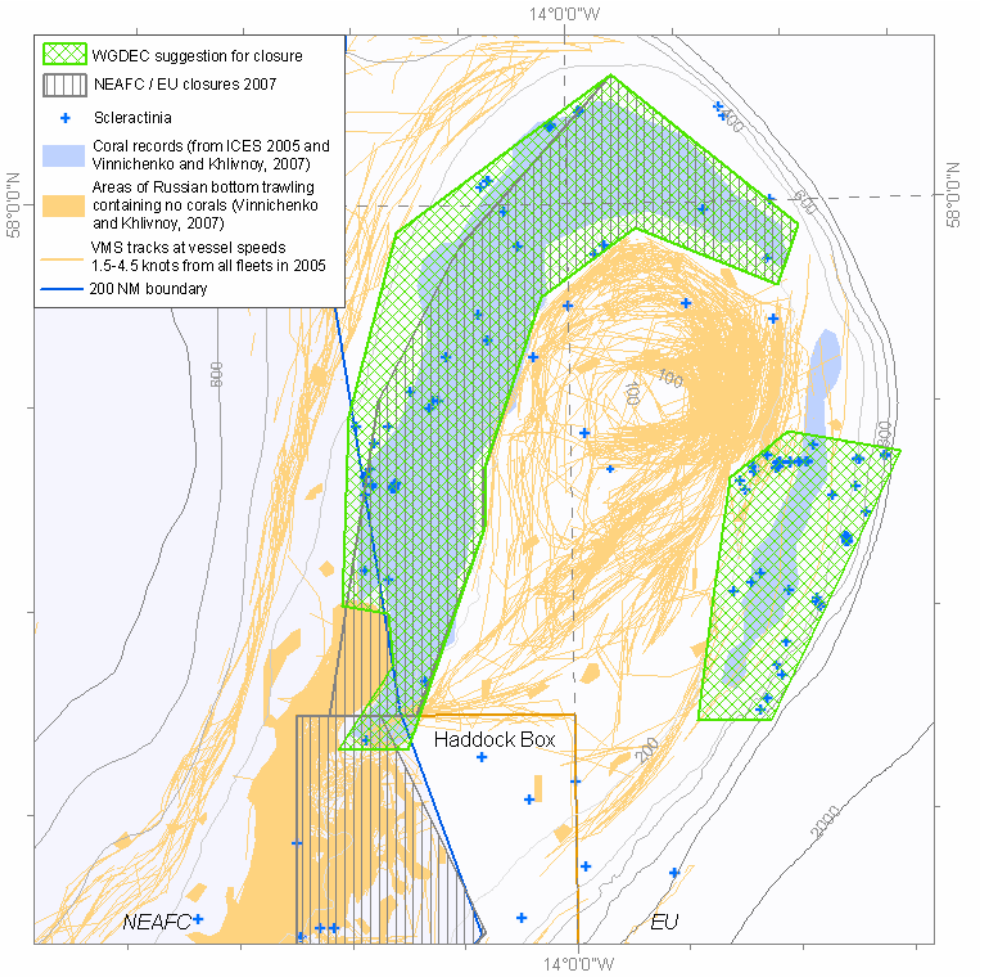

Figure 7 WGDEC 2007 proposed closure to protect coral on west Rockall Bank and a suggested closure on east Rockall Bank.

However, should the north-west boundary be considered for modification on the basis of these coral records, WGDEC would advise that the extension be revised according to the most up-to-date knowledge of coral distribution and fishing activity. This is because; (a) further data on cold water coral distribution may become available in 2009, following surveys by the Scottish Government Fisheries Research Services (FRS) on Rockall. (b) There is a proposal from Russia for a modification to the Rockall Haddock box which may have implications for revising the boundary of the NW Rockall closure (Two variants of the revised closed area are given in Figure 8). However the proposal for the Rockall haddock box first needs to be considered by

the relevant expert group (ICES Northern Shelf Working Group) before any consequential revision of the NW Rockall closure is made.

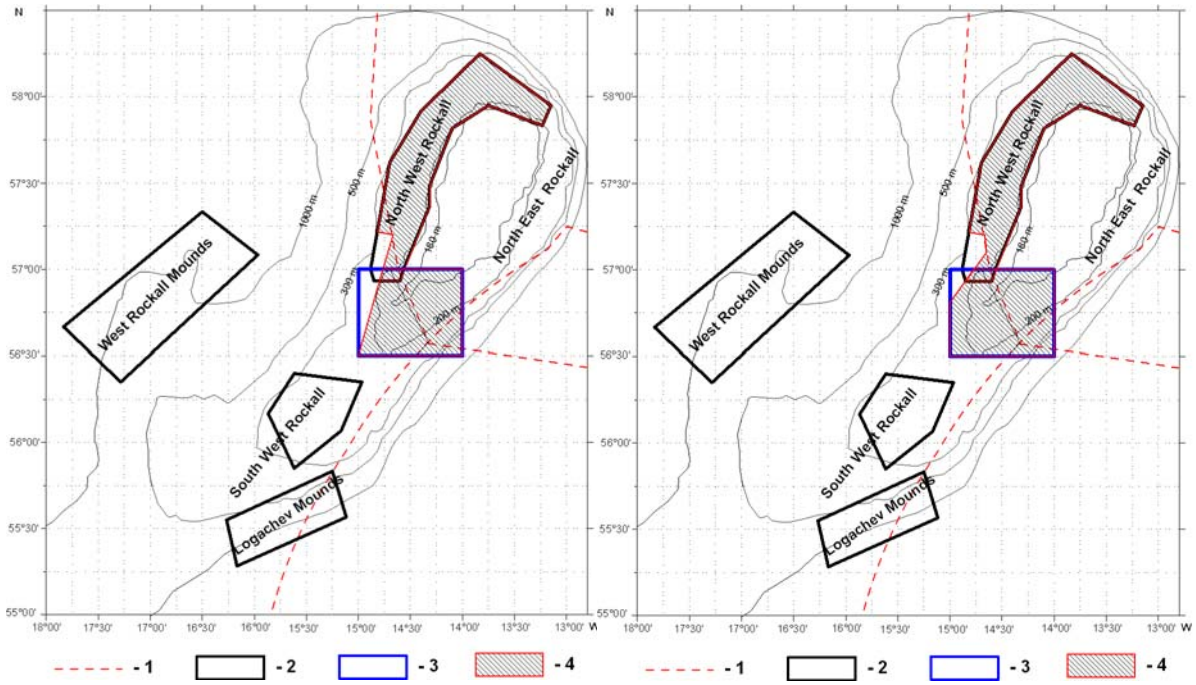

Figure 8 Two variants of proposal to adjust boundaries of the existing closures and new closed areas on the Rockall Bank (from Vinnichenko and Khlinoy, 2008). 1) 200 mile zone limit; 2) areas recommended by NEAFC for closure to bottom fishery from 1 January 2008 in order to protect deep-water corals; 3) the area closed to protect juvenile haddock; 4) proposals for change the limits of the currently closed area.

9.6 References

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10 Update maps on structural habitats

Term of Reference (g): Update compilations and maps of occurrence of structural habitats (hard and soft corals, large sponges) in the North Atlantic specifically identifying major coral concentrations in the Northwest Atlantic.

10.1 Introduction

Many corals and sponge species constitute structural habitats for a wide array of associated species, both invertebrates and fish.

Organism size is an important aspect of the structural habitat concept because it contributes to vertical relief and increases the availability of microhabitats. For example, redfish *Sebastes* spp. may use both corals and sponges as a "resting" place or a vantage point to prey upon small fishes (Mortensen *et al.*, 1995; Krieger and Wing, 2002).

Marine megafauna over 5 cm in height have been considered as structure-forming and can have a strong influence biodiversity (Tissot *et al*., 2006), and species greater than 1 m in height can profoundly affect benthic community structure (Lissner and Benech, 1993 in Tissot *et al*., 2006). However, factors such as complexity of morphology and population density in addition to size determine whether a species can be considered habitat-forming (Tissot *et al*., 2006).

In addressing this ToR, data were obtained from a number of sources including scientific surveys (both targeted, e.g., ROV surveys, and non-targeted, e.g., demersal fish assessment surveys), records from fisheries observers and published literature.

10.2 Maps of Occurrence of Coral Structural Habitats in the North Atlantic

WGDEC was able to compile data from across the North Atlantic on the occurrences of coral taxa. The Northwest Atlantic has greater coverage than the Northeast Atlantic as data for the former were collected prior to the meeting to address ToR h. During the meeting we were only able to obtain data on the occurrence of *Lopehlia* reefs from the Northeast Atlantic with the exception of some mid-Atlantic ridge and European data provided courtesy of P. Buhl-Mortensen. The distribution of records is indicated in Figure 10.2.1.

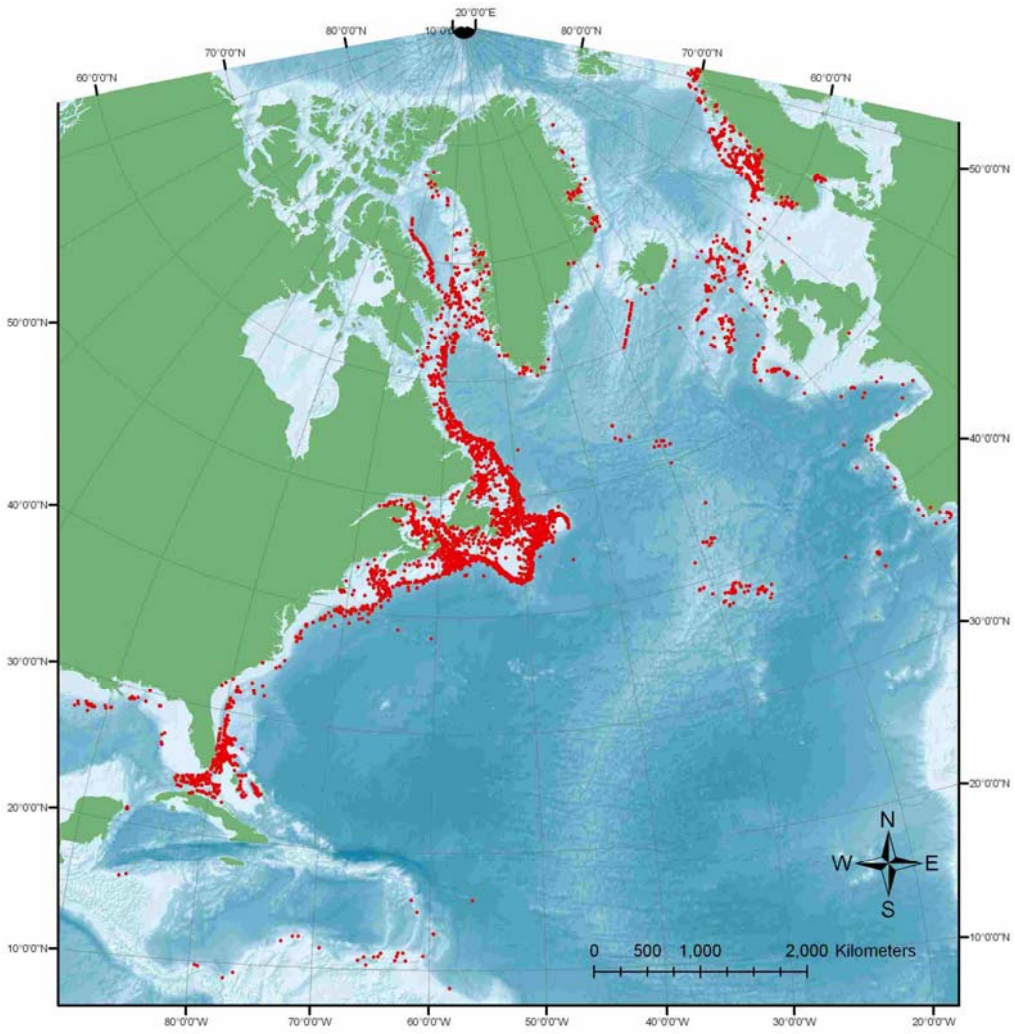

Figure 10.2.1 Location of deep water coral occurrences in the North Atlantic compiled by WGDEC.

10.2.1 Distribution of Selected Genera

10.2.1.1 Lophelia

In the North Atlantic *Lophelia pertusa* is the major structure-forming scleractinian coral. This species forms extensive reef complexes. The distribution of this species is well covered by the WGDEC database. Updated contributions were provided by the United States of America and Canada, providing a broad picture of its distribution (Figure 10.2.1.1).

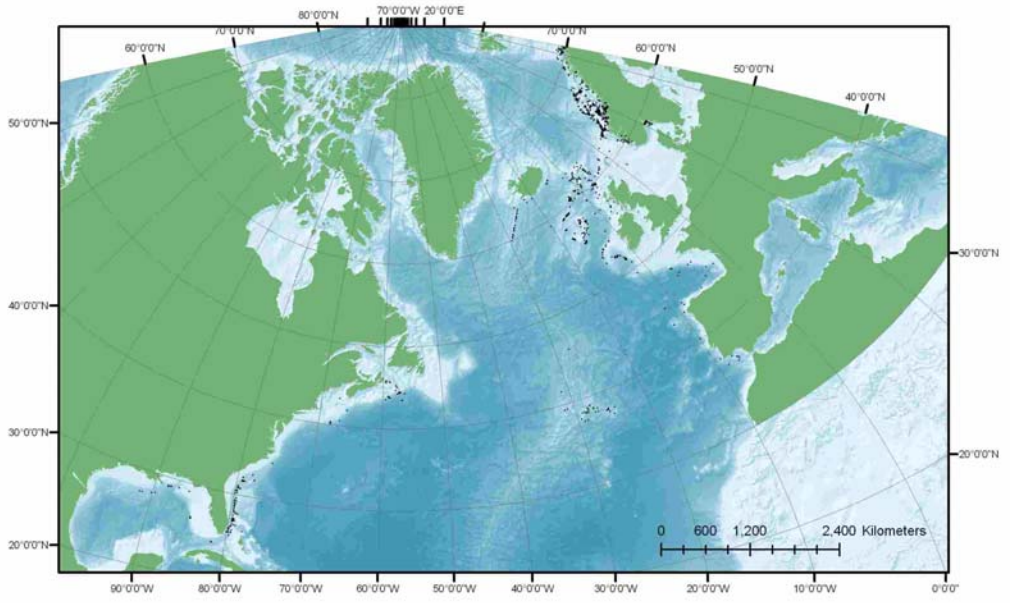

Figure 10.2.1.1 Occurrences of the reef forming scleractinian coral *Lophelia pertusa*.

10.2.1.2 Paragorgia

The gorgonian genus *Paragorgia* is one of the largest marine invertebrates with individual colonies reaching 1 m and more in height (reports of exist of 10 m). This genus can form dense aggregations and is also structurally complex, with the colony heavily branched to form a fan when larger. This genus is considered one of the major structure-forming corals in the Northwest Atlantic where the reef-forming coral *Lophelia* has not been observed along much of the coastline (Figure 10.2.1.1 above).

The distribution of *Paragorgia* species provided in Figure 10.2.1.2 is known to incomplete as this species is also present in European and Scandinavian waters. However, the distribution in the Northwest Atlantic is likely representative, except for the seamount areas where the data available were not disaggregated to the level of genus.

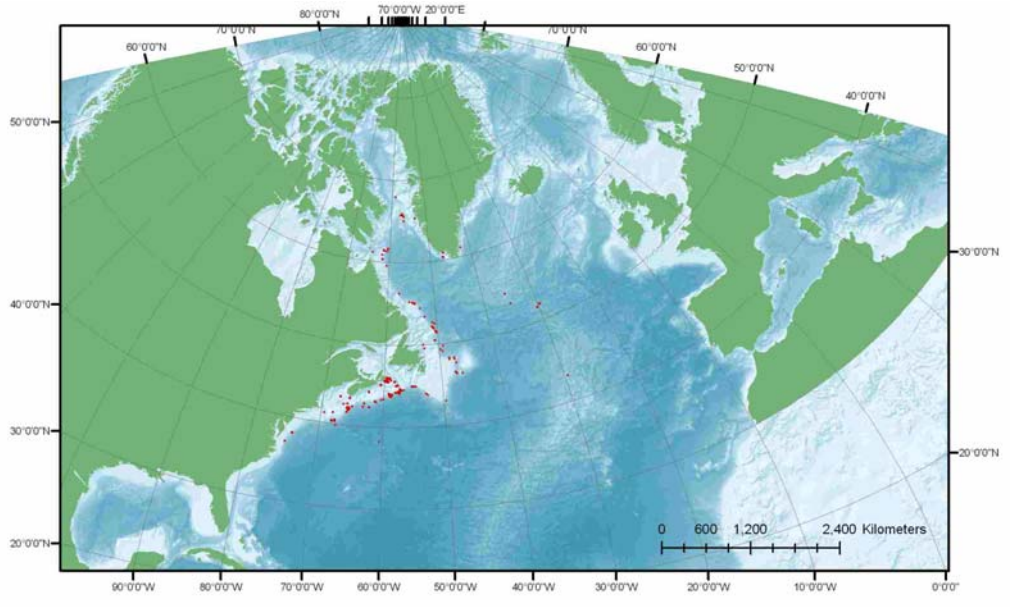

Figure 10.2.1.2.1 Occurrences of the large gorgonian coral *Paragorgia* spp. This genus is known to also occur in the Northeast Atlantic but data were not available for mapping.

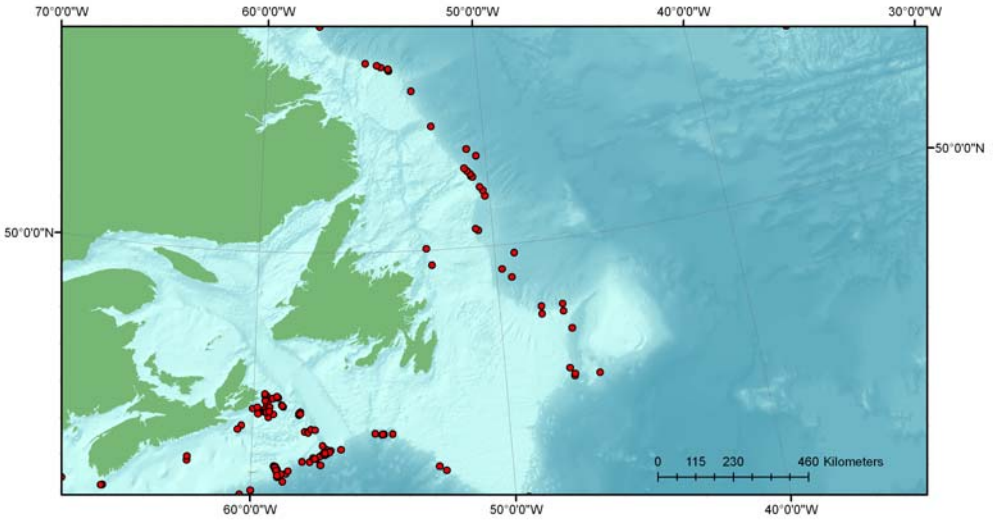

Figure 10.2.1.2.2 Occurrences of the large gorgonian coral *Paragorgia* spp. along a portion of the Canadian continental slope (detail of Figure 10.2.1.2.1 above).

10.2.1.3 Primnoa

The genus *Primnoa* is also considered structure-forming. It approaches or exceeds 1 m in height, is bushy and branched and can occur in dense aggregations. Along with *Paragorgia* with which it is commonly associated, this genus is one of the major habitat-forming corals in the Northwest Atlantic.

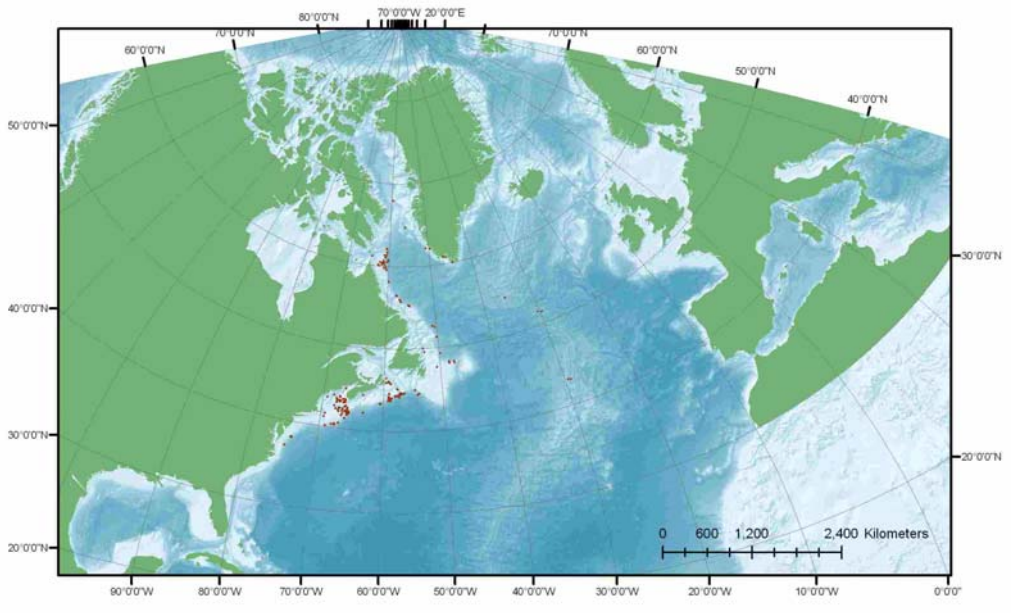

Figure 10.2.1.3.1 The occurrences of the gorgonian coral *Primnoa* spp. in the North Atlantic. This genus is known to also occur in the Northeast Atlantic but data were not available for mapping.

10.2.2 Distribution of Structure-Forming Taxa by Latitude

The data in this section focus on the Northwest Atlantic as the only data available for the Northeast Atlantic were for the genus *Lophelia*. The distribution of *Lophelia* is mapped in Figure 10.2.1.1 above.

10.2.2.1 Above 60 degrees North Latitude

The map illustrated in Figure 10.2.2.1.1 shows the distribution of selected coral taxa (Ordinal level) in the Northwest Atlantic.

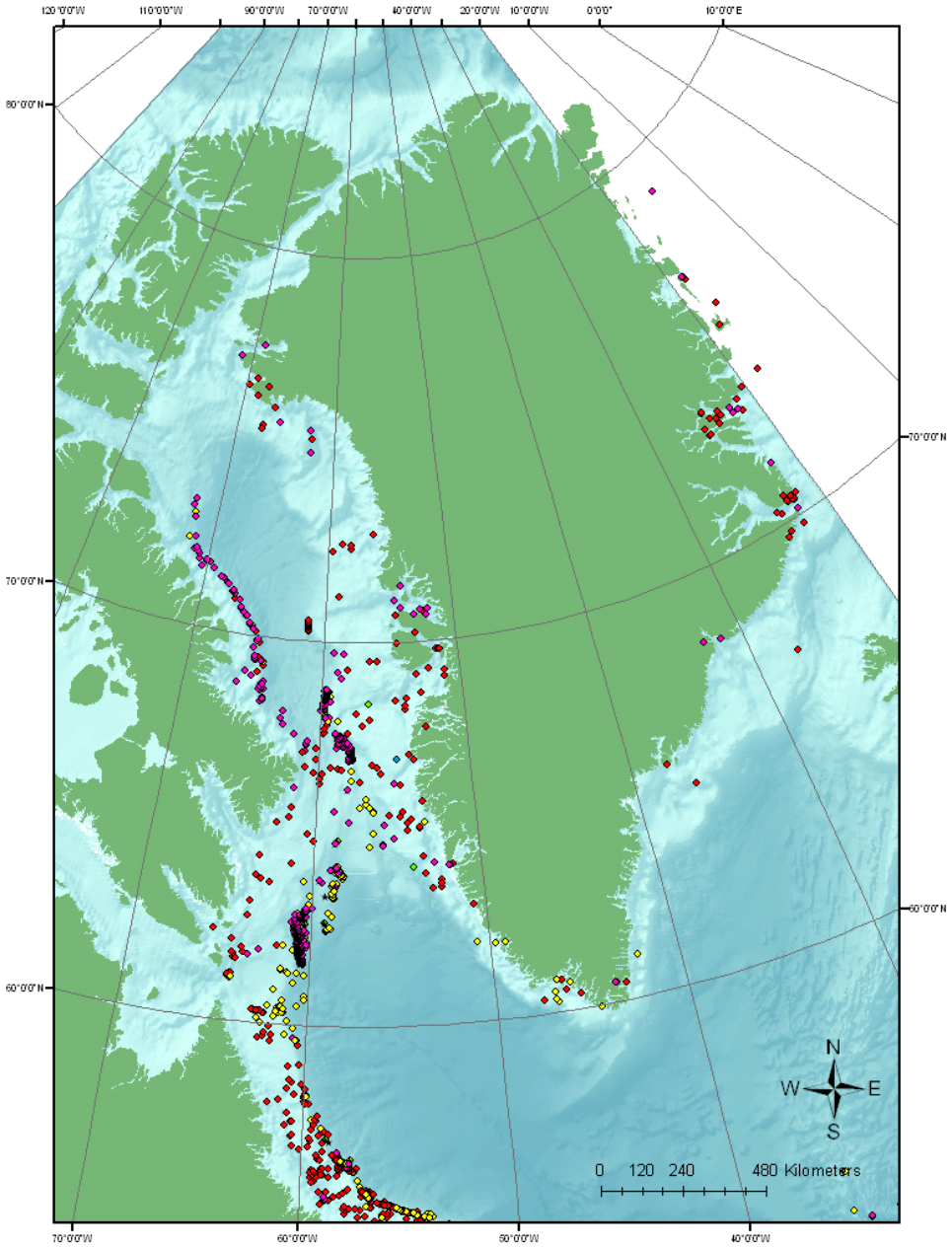

Figure 10.2.2.1.1 Occurrences of structure forming coral taxa above 60 degrees North Latitude in the western Atlantic. Corals are identified by Order: Red: *Alcyonacea*; Yellow: *Gorgonacea*; Pink: *Pennatulacea*; Green: *Antipatharia*.

10.2.2.2 Latitude 50 to 60 degrees North

The distribution of selected genera of structure forming coral in the latitudes between 50 and 60 degrees are illustrated in Figure 10.2.2.2.1.

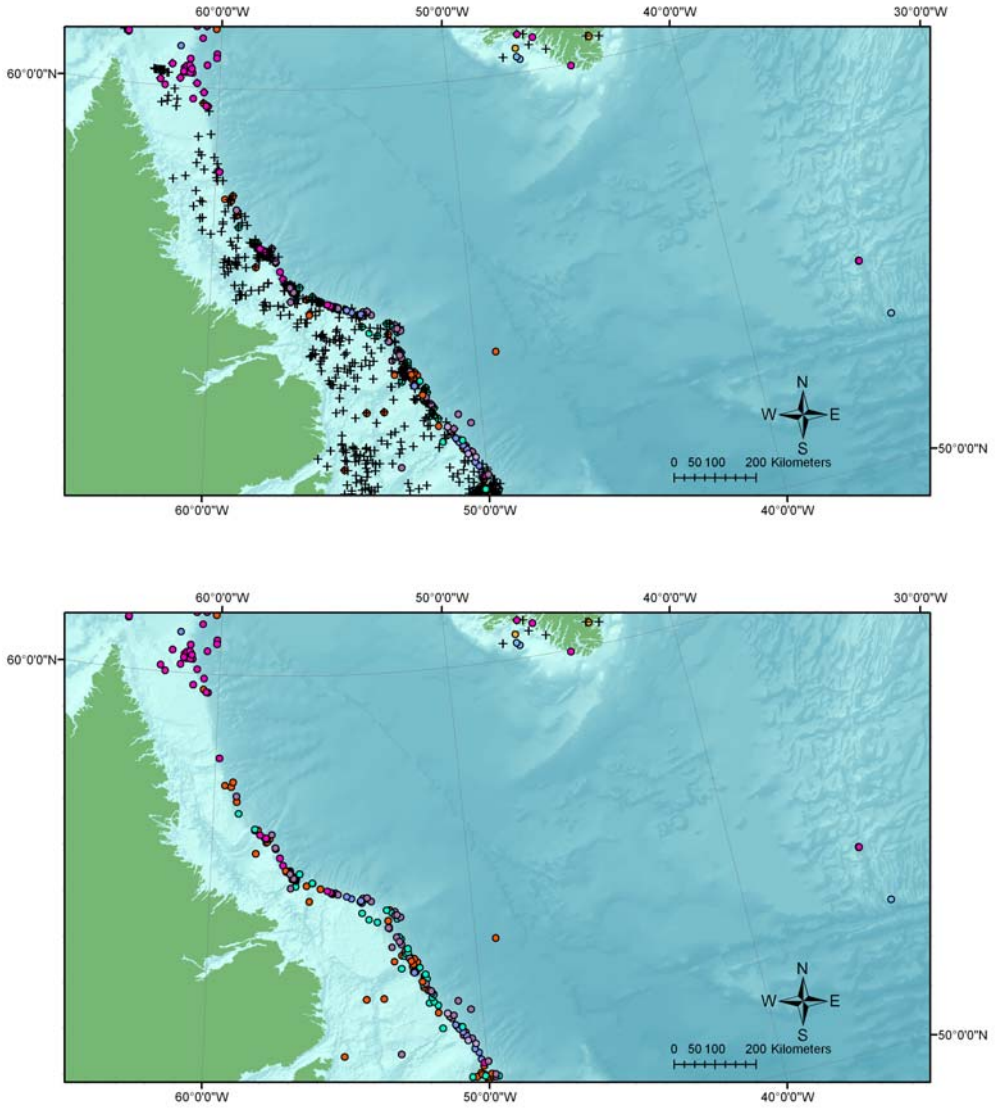

Figure 10.2.2.2.1 The occurrences of all coral taxa (upper panel) and of selected structure forming species (lower panel) in the 50 to 60 degree North latitude range in the Northwest Atlantic. Coral genera: Pink: *Primnoa;* Light Blue: *Acanthogorgia;* Dark Blue: *Paragorgia;* Purple: *Paramuricea;* Red: *Acanella;* Gold: *Stenogorgia*. + indicates other coral species present.

10.2.2.3 Latitude 40 to 50 degrees North

The distribution of selected genera of structure forming coral in the latitudes between 40 and 50 degrees are illustrated in Figure 10.2.2.3.1–10.2.2.3.4.

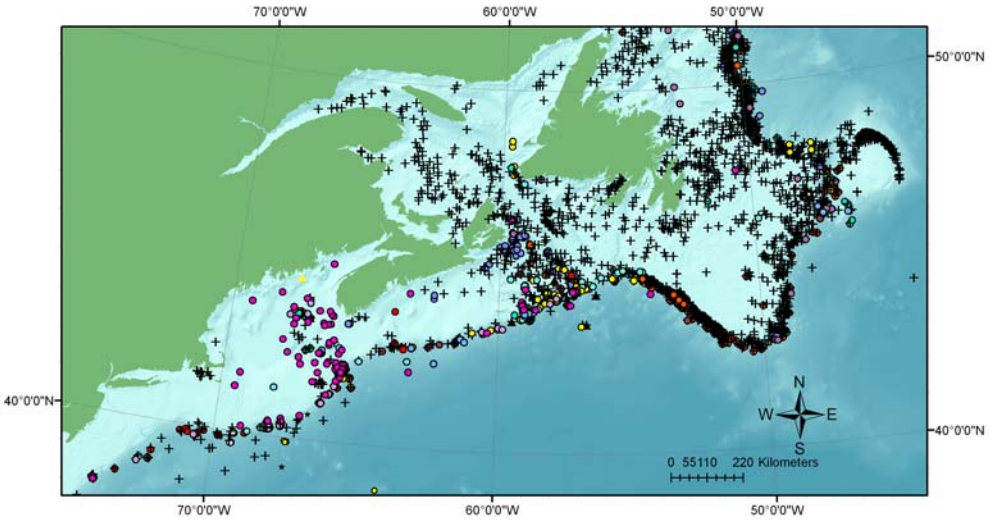

Figure 10.2.2.3.1 The occurrences of all coral taxa (+) and of selected structure forming species in the 40 to 50 degree North latitude range in the Northwest Atlantic. Coral genera: Pink: *Primnoa;* Light Blue: *Acanthogorgia;* Dark Blue: *Paragorgia;* Purple: *Paramuricea;* Red: *Acanella;* Yellow: *Keratoisis;* Black triangle: *Lophelia*.

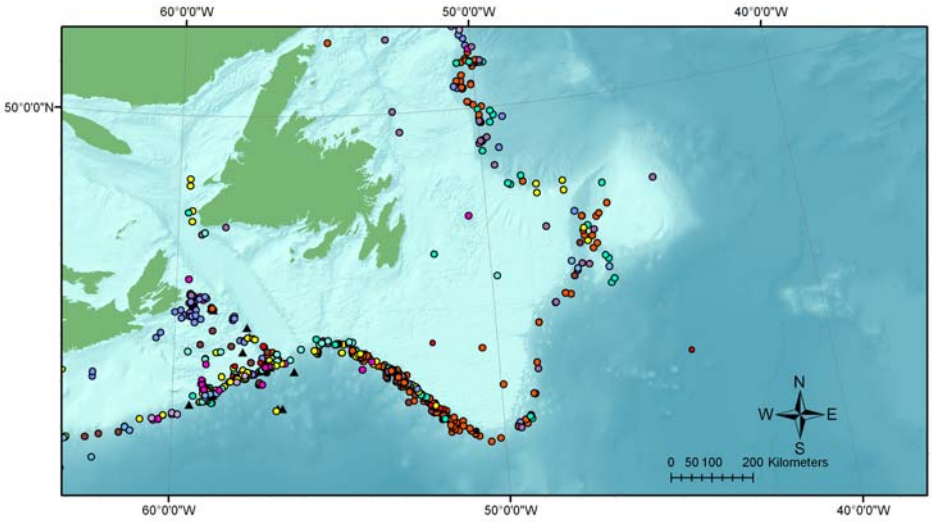

Figure 10.2.2.3.2 The occurrences of selected structure forming species in the 40 to 50 degree North latitude range in the Northwest Atlantic. Coral genera: Pink: *Primnoa;* Light Blue: *Acanthogorgia;* Dark Blue: *Paragorgia;* Purple: *Paramuricea;* Red: *Acanella;* Yellow: *Keratoisis;* Black triangle: *Lophelia*.

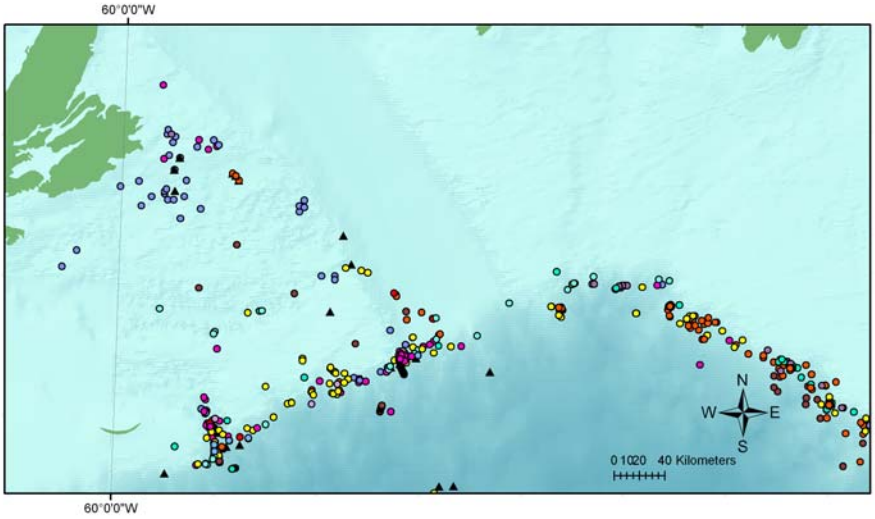

Figure 10.2.2.3.3 The occurrences of selected structure forming species in the 40 to 50 degree North latitude range in the Northwest Atlantic with a focus on the slope waters either side of the Laurentian Channel. Coral genera: Pink: *Primnoa;* Light Blue: *Acanthogorgia;* Dark Blue: *Paragorgia;* Purple: *Paramuricea;* Red: *Acanella;* Yellow: *Keratoisis;* Black triangle: *Lophelia*.

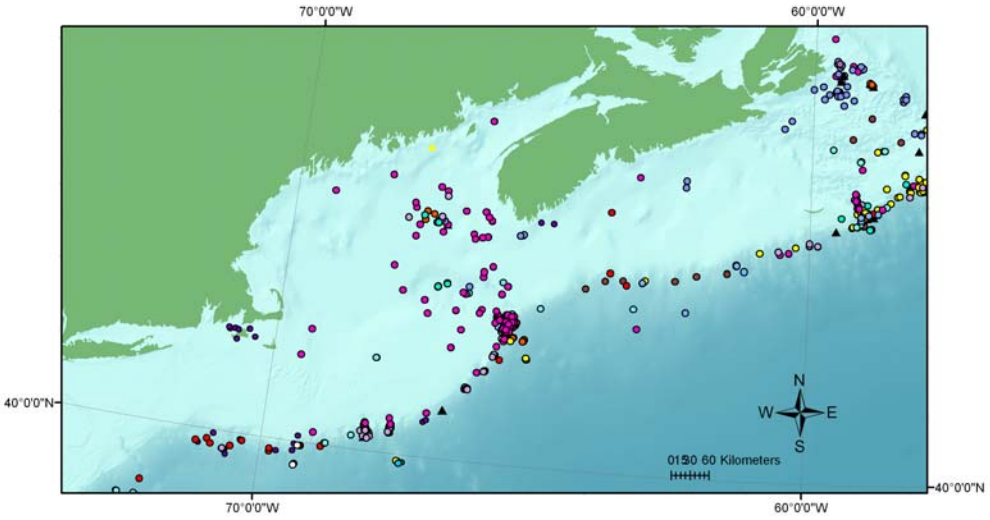

Figure 10.2.2.3.4 The occurrences of selected structure forming species in the 40 to 50 degree North latitude range in the Northwest Atlantic with a focus on the Gulf of Maine and Scotian Slope. Coral genera: Pink: *Primnoa;* Light Blue: *Acanthogorgia;* Dark Blue: *Paragorgia;* Purple: *Paramuricea;* Red: *Acanella;* Yellow: *Keratoisis;* Black triangle: *Lophelia*.

10.2.2.4 Latitude 30 to 40 degrees North

The distribution of selected genera of structure forming coral in the latitudes between 30 and 40 degrees are illustrated in Figure 10.2.2.4.1.

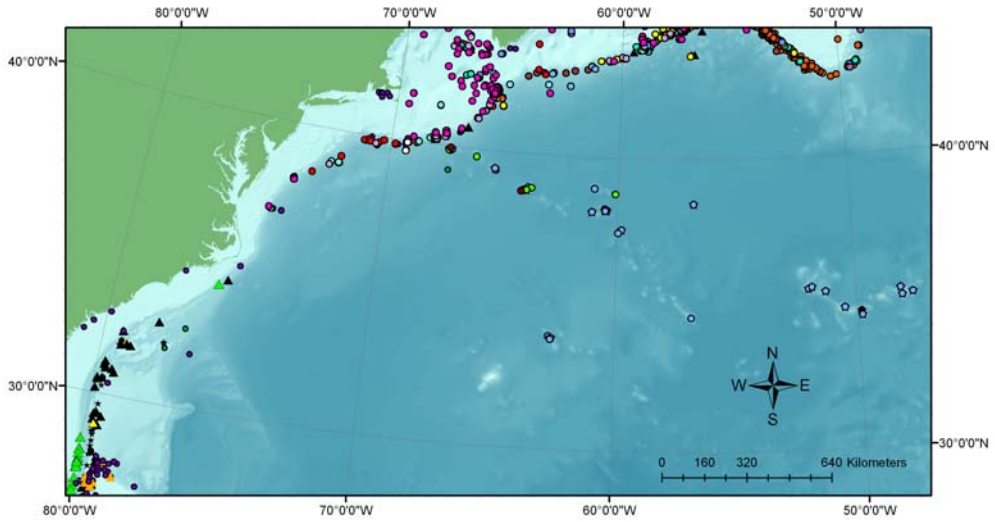

Figure 10.2.2.4.1 The occurrences of selected structure forming species in the 30 to 40 degree North latitude range in the Northwest Atlantic. Coral genera: Pink: *Primnoa;* Light Blue: *Acanthogorgia;* Dark Blue: *Paragorgia;* Purple: *Paramuricea;* Red: *Acanella;* Yellow: *Keratoisis;* Black triangle: *Lophelia*. Sponge records (seamounts only): Pale Purple.

10.2.2.5 Latitude 20 to 30 degrees North

The distribution of selected genera of structure forming coral in the latitudes between 20 and 30 degrees are illustrated in Figure 10.2.2.5.1.

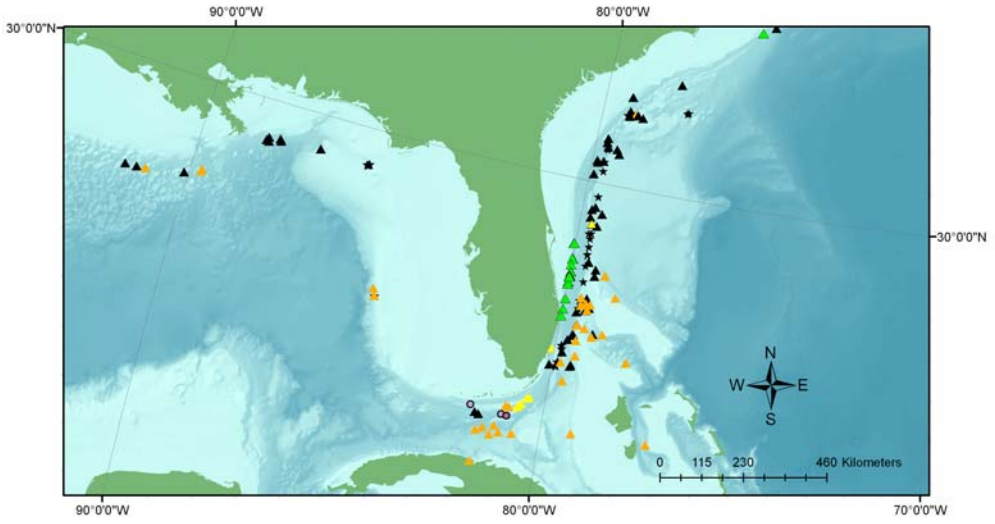

Figure 10.2.2.5.1 The occurrences of selected structure forming species in the 20 to 30 degree North latitude range in the Northwest Atlantic. Coral genera: Black: *Lophelia;* Yellow: *Placogorgia;* Gold: *Madropora;* Green: *Oculina*.

10.3 Sponges as structural habitats

10.3.1 The ICES WGDEC Report 2007

Our knowledge has not been significantly extended since the 2007 report summarized the general situation of known sponge mass occurrences in the North Atlantic. It emphasized an overview of geographical distribution and high level taxonomic composition and briefly added statements on characteristic environmental conditions, biological importance and sensitivity to human activities.

10.3.2 Sponges as habitat-forming structures

Growth forms of sponges in the North Atlantic range from permanently or temporarily thinly encrusting (<1 mm thick) to more or less irregularly platy, funnel-shaped or lumpy, up to about 1 m in diameter. Some, mostly shallow water forms, are boring in calcareous substrates, living in a more or less complicated system of galleries. A small number of species live buried in sandy or gravelly substrates, mostly on outer shelf depths. In deeper water some forms are stalked, the main part of the body being elevated some centimetres above the bottom.

The surface of a sponge can be smooth, even slimy, or hispid from protruding large spicules or spicule bundles. It is perforated by openings of various sizes and arrangements representing the incurrent and excurrent canal systems. Depending on its size, the degree of irregularity and the size of natural openings a given sponge can house an appreciable associated fauna, both as to abundance and diversity of species (Klitgaard, 1995).

10.3.3 Sponge-dominated biotopes

Sponge dominance and sponge mass occurrence are not unambiguous terms and any definition circumscribing them is by nature vague. Klitgaard and Tendal (2004) coined the term *ostur* for the widely distributed North Atlantic *Geodia*- and *Stryphnus*-dominated localities, and *sponge grounds* for a wider array of so far more poorly defined other kinds of sponge dominated biotopes.

Sponge ground. This is an area where the dominating taxon of the given catch is sponges, estimated on deck to comprise at least 90% of the biomass, excluding fish. Most often there are few, but abundant large-sized sponge-species, sometimes also an appreciable amount of their siliceous skeleton remains.

The catch can be heavily loaded with spicules from dead sponges, either as scattered, free spicules, as spicule balls or in a more consolidated form as mat-like accumulations. The spicules are generally autochtonous, but a certain transport either by currents or by sliding down a nearby slope can occur as an additional accumulation (Barthel and Tendal, 1993a). The dominating sponges can hang more or less together, supported by the masses of spicules they sit in. The interstices of the lower layer of spicule mats are often filled with muddy or sandy sediment from the underlying bottom, giving the whole formation a peculiar texture offering many microhabitats.

Different kinds of sponge grounds. A kind of sponge ground can be formed by any species very abundant in a given area. To be considered a structural habitat of any importance a certain geographical extent is demanded, although for the time being it is not possible to outline details. As also pointed out in the 2007 report, sponge grounds differing from each other as to physical environment, taxonomic composition, structure, extension and supposed age have now been found in many parts of the world ocean.

In the northern Atlantic the following kinds seem to emerge on the basis of preliminary scrutiny of the information so far available: 1) The *Geodia-Stryphnus* grounds (ostur) mostly on gravelly bottoms, in some geographic areas seemingly distinguishable into two facies, *Geodia* grounds and *Stryphnus-Aplysilla* grounds (Kligaard and Tendal, 2004). 2). *Thenea* grounds, mostly on muddy bottoms and often resting on appreciable amounts of dead spicules (Henrich *et al*., 1992; Klitgaard and Tendal, 2004). 3) *Pheronema* grounds (birds nest sponge) on deep muddy bottoms, resting on large amounts of spicule mats (Rice *et al*., 1990; Barthel *et al*., 1996). 4) The

deep Norwegian Sea sponge association, dominated by small-sized species of *Thenea* and *Tentorium.* This seems to be characteristic for this kind of deep-sea sponge ground that small calcareous sponges are abundant and large specimens of *Caulophacus* occur here and there (Barthel and Tendal, 1993b). The sediment under the sponges contains large amounts of scattered spicules and numerous stalks from dead *Caulophacus* form hard substrates at the cm-scale. 5) Two possible other kinds of sponge grounds which are restricted, however, in geographic extension, seems for one to be dominated by *Asconema* and other hexactinellids, and for the other by stalked sponges of the genera *Stylocordyla*, *Chondrocladia* and *Asbestopluma*, the two lastmentioned being unusual among sponges by their carnivorous life style (Tendal, unpubl.).

10.3.4 Gaps in our knowledge on North Atlantic sponge grounds

No sponge grounds have so far been identified off western Greenland, off Nova Scotia and Newfoundland, and along the deeper parts of the Mid-Atlantic Ridge. This may be due to lack of investigations or reporting, since species elsewhere known to form mass occurrences are represented in the local faunas.

10.4 References

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10.5 Acknowledgements

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11 Existence of coral concentrations in NAFO Div. 30

Term of reference (h): identify or confirm the existence of coral concentrations in a specific area of NAFO Div. 30, which roughly coincides with the zone between 400 and 2000 m deep (detailed map to be supplied by NAFO) and using the results of d), evaluate whether this zone is the most important for coral in the Northwest Atlantic.

11.1 Introduction

The United Nations Convention on the Law of the Sea adopts a broad approach in dealing with ecosystems requiring special protection. The Convention [article 194 (5)] requires States to take the necessary measures to protect and preserve rare or fragile ecosystems, as well as the habitat of depleted, threatened or endangered species and other forms of marine life.

The process of incorporating ecosystem advice into the Northwest Atlantic Fisheries Organization (NAFO) scientific process began with the 1982 United Nations Convention on the Law of the Sea and the 1995 United Nations Fish Stocks Agreement. However, it was the 2006 United Nations General Assembly (UNGA) Sustainable Fisheries Resolution 61/105 which prompted NAFO to close areas in international waters to protect vulnerable marine ecosystems (VMEs).

This UNGA Resolution (paragraph 83 a, b, c and d) requires a response from Regional Fisheries Management Organizations (RFMO) not later than 31 December 2008:

a) To assess, on the basis of the best available scientific information, whether individual bottom fishing activities would have significant adverse impacts on vulnerable marine ecosystems, and to ensure that if it is assessed that these activities would have significant adverse impacts, they are managed to prevent such impacts, or not authorized to proceed;

b) To identify vulnerable marine ecosystems and determine whether bottom fishing activities would cause significant adverse impacts to such ecosystems and the long-term sustainability of deep sea fish stocks, inter alia, by improving scientific research and data collection and sharing, and through new and exploratory fisheries;

c) In respect of areas where vulnerable marine ecosystems, including seamounts, hydrothermal vents and cold water corals, are known to occur or are likely to occur based on the best available scientific information, to close such areas to bottom fishing and ensure that such activities do not proceed unless conservation and management measures have been established to prevent significant adverse impacts on vulnerable marine ecosystems;

d) To require members of the regional fisheries management organizations or arrangements to require vessels flying their flag to cease bottom fishing activities in areas where, in the course of fishing operations, vulnerable marine ecosystems are encountered, and to report the encounter so that appropriate measures can be adopted in respect of the relevant site;

NAFO considers seamounts, hydrothermal vents, coldwater corals and sponge fields amongst others as vulnerable marine ecosystems (NAFO 2007). In response to the UNGA resolutions, as of January 1, 2007, and until December 31, 2010, NAFO closed four areas (defined by connecting the coordinates in Table 11.1.1 in numerical order

and back to coordinate 1) to all fishing activities involving demersal fishing gears. The closures are to be reviewed in 2010 by the NAFO Fisheries Commission, based on the advice from the Scientific Council, and a decision shall be taken on future management measures which may include extending the application of the current measures for an additional period or making the closure(s) permanent.

Table 11.1.1 Co-ordinates of NAFO closure areas on Northwest Atlantic Seamounts.

AREA	COORDINATE 1	COORDINATE 2	COORDINATE 3	COORDINATE 4
Orphan Knoll	50°00'30"N 45°00'30"W	51°00'30"N 45°00'30"W	51°00'30"N 47°00'30"W	50°00'30"N 47°00'30"W
Corner Seamounts	35°00'00"N 48°00'00"W	36°00'00"N 48°00'00"W	36°00'00"N 52°00'00"W	35°00'00"N 52°00'00"W
Newfoundland Seamounts	43°29'00"N 43°20'00"W	44°00'00"N 43°20'00"W	44°00'00"N 46°40'00"W	43°29'00"N 46°40'00"W
New England Seamounts	35°00'00"N 57°00'00"W	39°00'00N 57°00'00"W	39°00'00N 64°00'00"W	35°00'00"N 64°00'00"W

The closures were designed to provide access to a small-scale and restricted exploratory fishery, effective January 1, 2008, not to exceed 20% of the fishable area of each seamount (NAFO 2007).

Additionally, as of January 1, 2008, and until December 31, 2012, a Coral Protection Area in Division 30 along the continental slope of the southwest Grand Banks was closed to all fishing activity involving bottom contact gear. The closed area is defined by connecting the coordinates (in numerical order and back to coordinate 1) in Table 11.1.2. For the most part it follows the 800 m depth contour at its shallowest; however, towards the southeast, the upper boundary takes a sharp drop to the 1500 m contour (at Point No. 2 in Table 11.1.2). The maximum depths vary from 2000 to 3500 m as the lower boundary forms a more or less straight line across the depth contours (Figure 11.2.1).

Table 11.1.2 Coordinates of the NAFO Coral Conservation Area in Division 30 on the Southwest Grand Banks of the Northwest Atlantic

POINT NO.	LATITUDE	LONGITUDE
1	42°53'00"N	51°00'00"W
2	42°52'04"N	51°31'44"W
3	43°24'13"N	51°58'12"W
4	43°24'20"N	51°58'18"W
5	43°39'38"N	52°13'10"W
6	43°40'59"N	52°27'52"W
7	43°56'19"N	52°39'48"W
8	44°04'53"N	52°58'12"W
9	44°18'38"N	53°06'00"W
10	44°18'36"N	53°24'07"W
11	44°49'59"N	54°30'00"W
12	44°29'55"N	54°30'00"W
13	43°26'59"N	52°55'59"W
14	42°48'00"N	51°41'06"W
15	42°33'02"N	51°00'00"W

Article 15 Sections 2 to 4 of the NAFO Conservation and Management Measures further states that:

1) Contracting Parties shall provide the Executive Secretary, in advance of the June 2009 Scientific Council meeting, all existing data from surveys and commercial fisheries that have taken place in this area. The Executive Secretary will forward this information to the Scientific Council for its review in determination of a data gathering program for corals.

2) The measures referred to in this Article shall be reviewed in 2012 by the Fisheries Commission, based on the advice from the Scientific Council and a decision shall be taken on future management measures.

3) Contracting Parties shall establish/incorporate a coral monitoring program into government and/or industry research programs.

The Fisheries Commission is holding an intercessional meeting on the Protection of Vulnerable Marine Ecosystems from Significant Adverse Impacts in Montreal, Canada in May 2008, where more comprehensive consideration of strategies and measures to address VME will be considered.

Here, we review the scientific information available on the distribution of coral taxa from the vicinity of the Coral Conservation Closure Area in NAFO Division 30 and consider other areas in the Northwest Atlantic where significant coral concentrations occur. In undertaking this ToR data from Canada, United States and Greenland were obtained from a variety of sources including scientific surveys (both targeted, e.g., ROV surveys, and non-targeted, e.g., demersal fish assessment surveys), records from fisheries observers and published literature. Further data from Spain was not available at the time of the meeting but can be incorporated next year should the ToR be carried forward.

11.2 Known Distribution of Coral Taxa in the NAFO Coral Conservation Closure Area in Division 30

Canadian scientists have compiled 1394 records of corals in NAFO Division 30 (Table 11.2.1). Thirty-four taxa are represented with only 6 not resolved to at least the level of Genus. The gorgonian corals *Keratoisis ornata* and *Acanella arbuscula* were the most frequently recorded species, with 13.5 and 12% of the records respectively. Corals were not reported from large areas on the top of the bank and it is likely that these null reports in many cases reflect the absence of coral taxa.

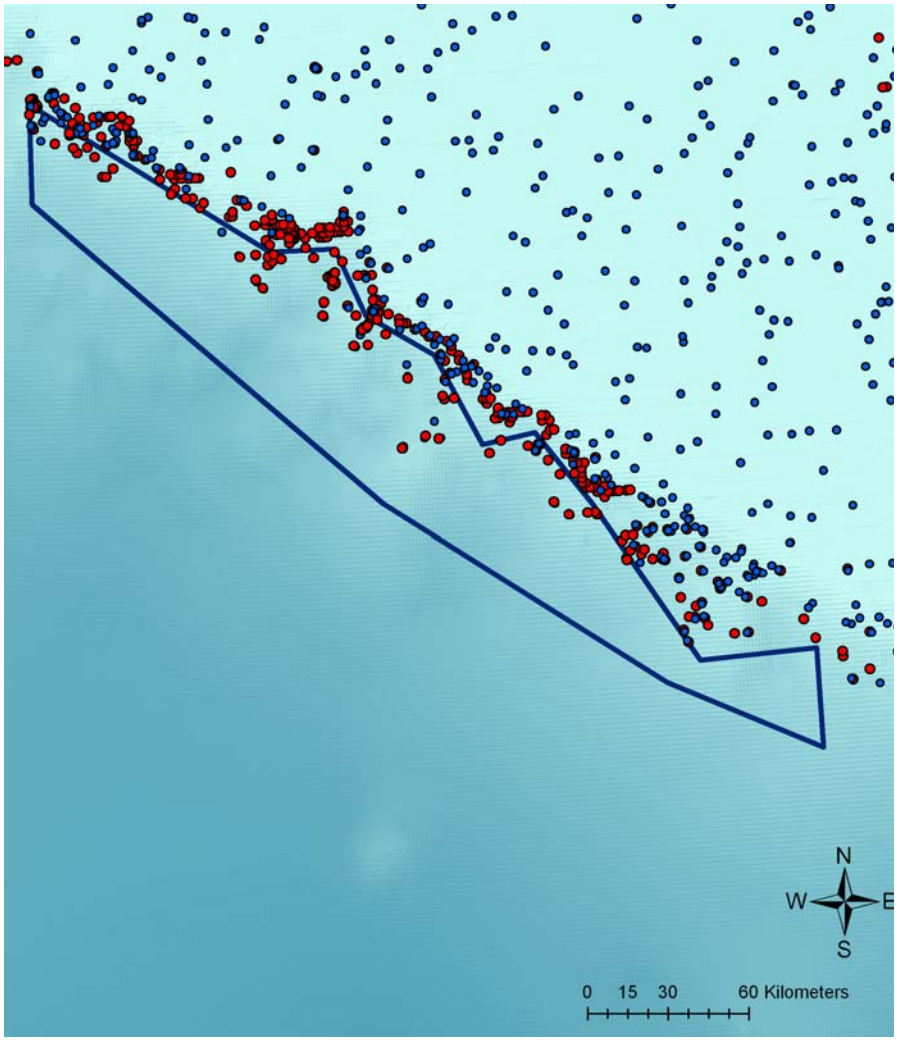

Figure 11.2.1 Known occurrences of coral taxa (red circles) and areas where coral was not reported (blue circles) in the vicinity of the NAFO Division 30 Coral Conservation area.

Table 11.2.1 Breakdown of records of occurrence of coral taxa in NAFO Division 30 (including areas outside the Coral Closure).

TAXON	COUNT	FREQUENCY
Acanella arbuscula	167	0.11980
Acanthogorgia armata	78	0.05595
Anthomastus grandiflorus	56	0.04017
Anthoptilum grandiflorum	51	0.03659
Anthothela grandiflora	1	0.00072
Anthozoa spp.	3	0.00215
Antipatharia spp.	2	0.00143
Dasmosmilia lymani	1	0.00072
Desmophyllum cf. dianthus	2	0.00143
Distichoptilum gracile	3	0.00215
Duva florida	49	0.03515
Flabellum spp.	93	0.06671
Funiculina sp.	51	0.03659
Gersemia rubiformis	22	0.01578
Gorgonacea spp.	2	0.00143
Halipteris sp.	48	0.03443
Keratoisis ornata	188	0.13486
Kophobelemnon sp.	21	0.01506
Kophobelemnon stelliferum	16	0.01148
Nephtheidae spp.	51	0.03659
Paragorgia arborea	3	0.00215
Paramuricea spp.	7	0.00502
Pennatula aculeata	1	0.00072
Pennatula borealis	110	0.07891
Pennatula sp.	48	0.03443
Pennatulacea sp. 11	1	0.00072
Pennatulacea sp. 12	2	0.00143
Pennatulacea spp.	249	0.17862
Primnoa resedaeformis	2	0.00143
Radicipes gracilis	10	0.00717
Radicipes spp.	22	0.01578
Scleractinia cf. Javania sp.	10	0.00717
Scleractinia spp.	2	0.00143
Umbellula sp.	22	0.01578
Total	1394	1.00000

The recently published *State of Deep Coral Ecosystems of the United States: Introduction and National Overview* (Hourigan *et al.*, 2007) classifies deep-water corals as those occurring deeper than the continental shelf (generally around 200 m), while recognizing that significant populations of some species occur at much shallower depths. They further use the ordinal level of classification to distinguish structure-forming corals, which provide habitat for other species. The records of coral grouped into Orders for NAFO Division 30 are summarized in Table 11.2.2. The majority of records belong to the *Gorgonacea* (sea fans) and *Pennatulacea* (sea pens). The

distribution of these higher level taxa in the vicinity of the Division 30 closure is illustrated in Figure 11.2.2. The taxa on the banks are members of the *Alcyonacea* or soft corals and are primarily *Nephtheidae* or *Alcyoniidae* soft corals such as *Gersemia rubiformis* and *Duva florida*. The broad distribution of sea pens (*Pennatulacea*) over the shelf break and to the greatest depths from which data were available (approx. 1900 m) indicate a soft substrate as these species anchor into the soft sediment with their peduncle. The Scleractinian corals are the only ones forming hard external skeletons and they are broadly distributed along the continental margin. The black corals (*Antipatharia*) are relatively rare and there are only 2 records for this region.

Table 11.2.2 Breakdown of records of occurrence of major coral groupings in NAFO Division 30 (including areas outside the Coral Closure).

TAXON	COUNT	FREQUENCY
Alcyonacea	178	0.12797
Antipatharia	2	0.00144
Gorgonacea	480	0.34508
Pennatulacea	623	0.44788
Scleractinia	108	0.07764
Total	1391	1.00000

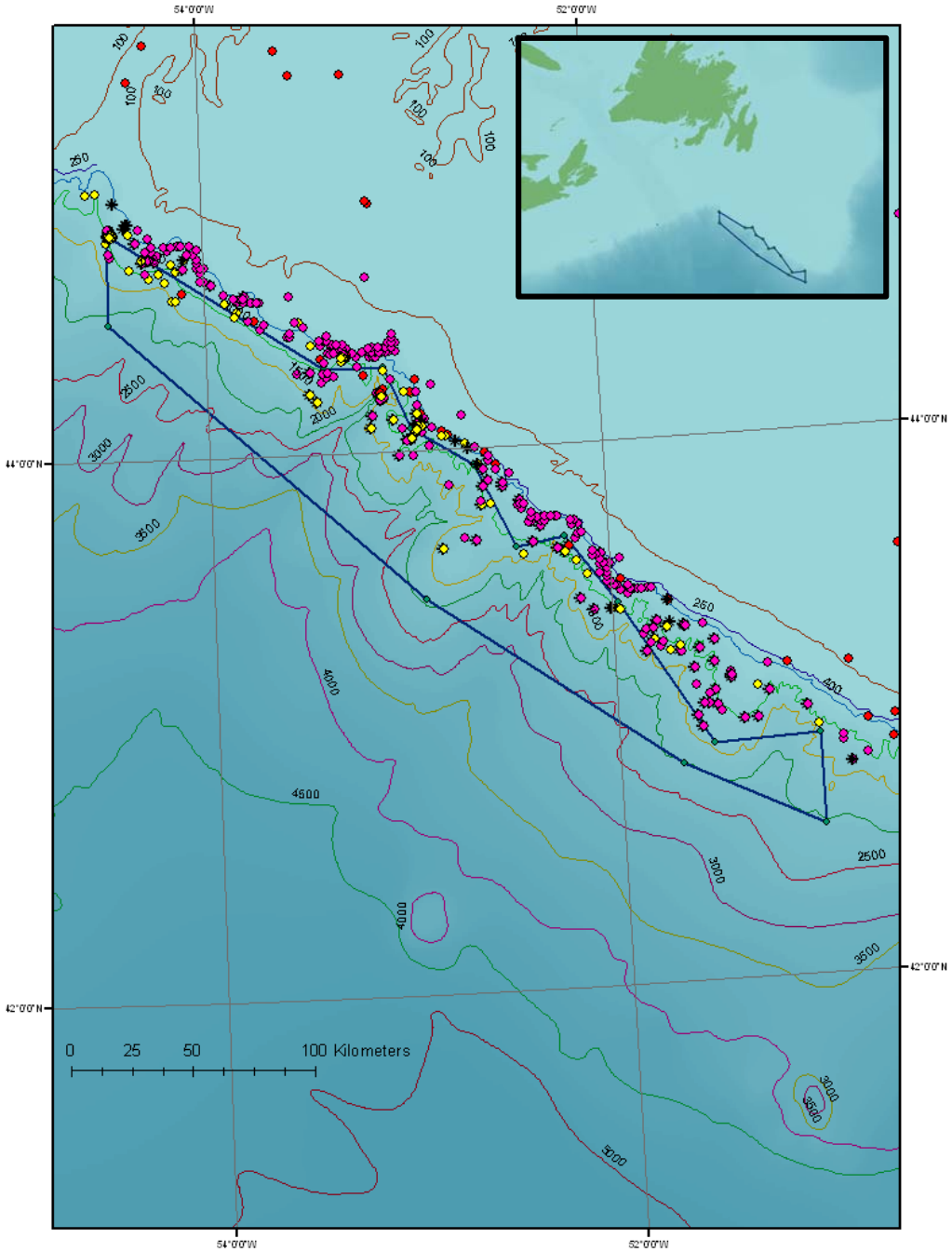

Figure 11.2.2 Geographic position of coral records in the vicinity of the NAFO Division 30 closure (dark blue line). Corals are grouped by Order: Pink: *Pennatulacea*; Yellow: *Gorgonacea*; Red: *Alcynonacea*; Black: *Scleractinia* following Hourigan *et al.*, 2007.

The data set was reduced to include only records from depths greater than 200 m so as to represent only deep-water corals as defined by Hourigan *et al.*, 2007. This eliminated 13% of the data, although all but 2 taxa were retained. The ordinal level *Alcyonacea spp.* and *Gorgonacea spp*. did not have depth data associated with them and so were excluded by this process.

This subset confirms the presence of coral in the NAFO Coral Closure area (Figure 11.2.3) and illustrates the known occurrence of deep water coral in the shallower water above the closure area.

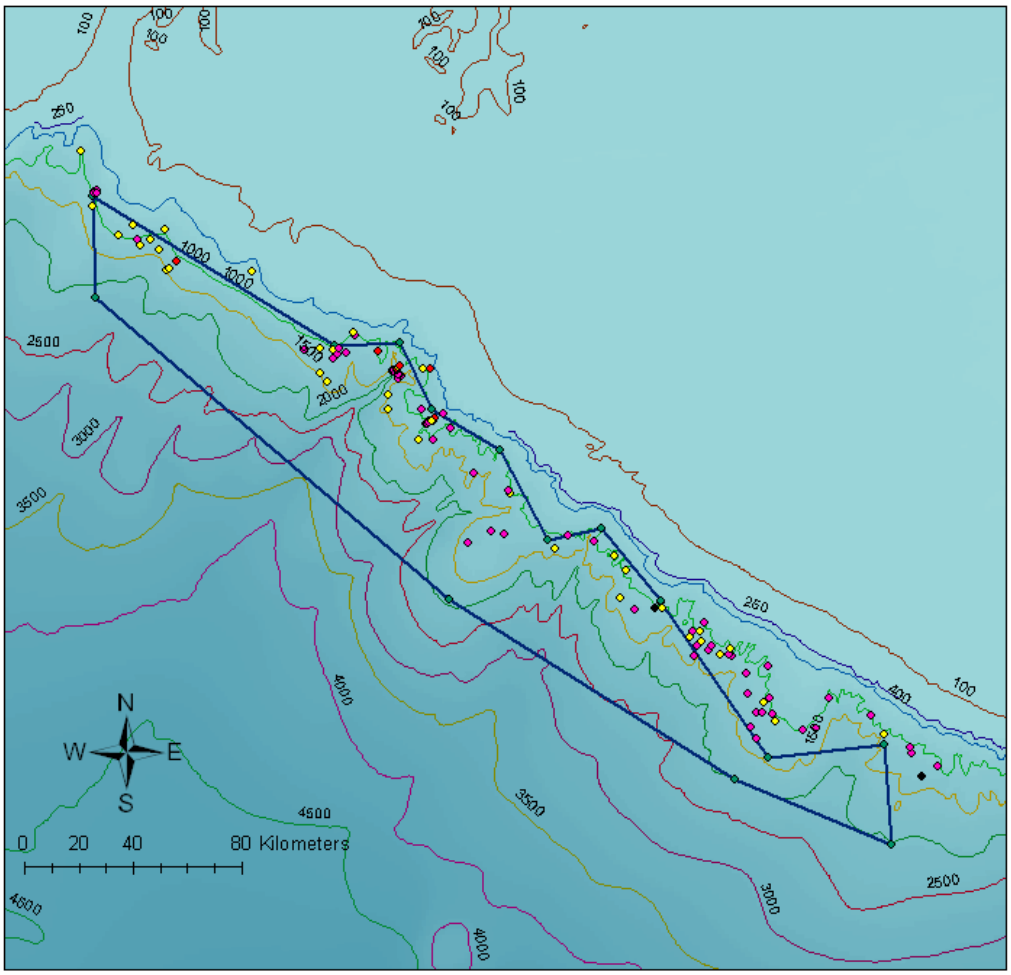

Figure 11.2.3 Known geographic position of coral in the vicinity of the NAFO Division 30 closure (dark blue line) below 800 m depth. Corals are grouped by Order: Pink: *Pennatulacea*; Yellow: *Gorgonacea*; Red: *Alcynonacea*; Black: following Hourigan *et al.*, 2007.

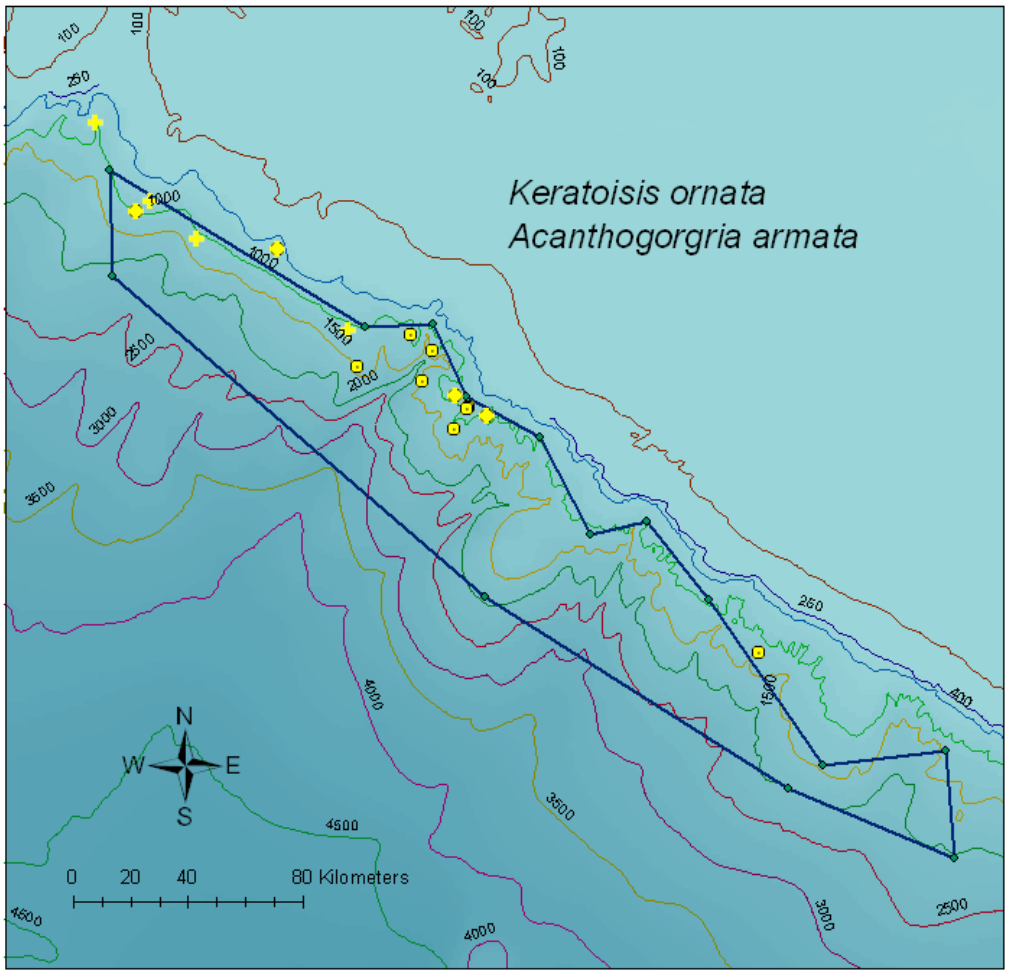

Figure 11.2.4 Known geographic position of large structure-forming gorgonian corals in the vicinity of the NAFO Division 30 closure (dark blue line). *Keratoisis ornata* indicated by yellow crosses, *Acnathogorgia armata* by yellow squares.

Within the Coral Protection area there are records of two large gorgonian corals that are considered structure-forming (Edinger *et al*., 2007; Hourigan *et al*., 2007), the bamboo coral *Keratoisis ornata* and the sea fan *Acanthogorgia armata* (Figure 11.2.4). Also occurring is the smaller gorgonian, *Acanella arbuscula*, which is known to occur in significant stands on sandy bottoms (Lawson, 1991) and is considered to be habitat-forming (Edinger *et al*., 2007) (Figure 11.2.5). The known occurrences of sea pens are illustrated in Figures 11.2.6 and 11.2.7. Sea pen fields are recognized as important habitat (ESSIM 2006) for both fish and invertebrates. Lastly, the only Scleractinian coral in the closure area is the cup coral *Flabellum* spp. (Figure 11.2.8).

There are 268 coral records for the Coral Protection Area proper (Table 11.2.3), collected from depths of 800 to 1897 m. Fifty-five percent of the records are of sea pens (Order *Pennatulacea*) and 24% are sea fans and bamboo corals (Order *Gorgonacea*). The distribution of these records by 100 m depth intervals is provided in Figure 11.2.9. Data below 1300 m are sparse and are largely drawn from observations made with a deep-water submersible in 2007 at one location in Debarres Canyon.

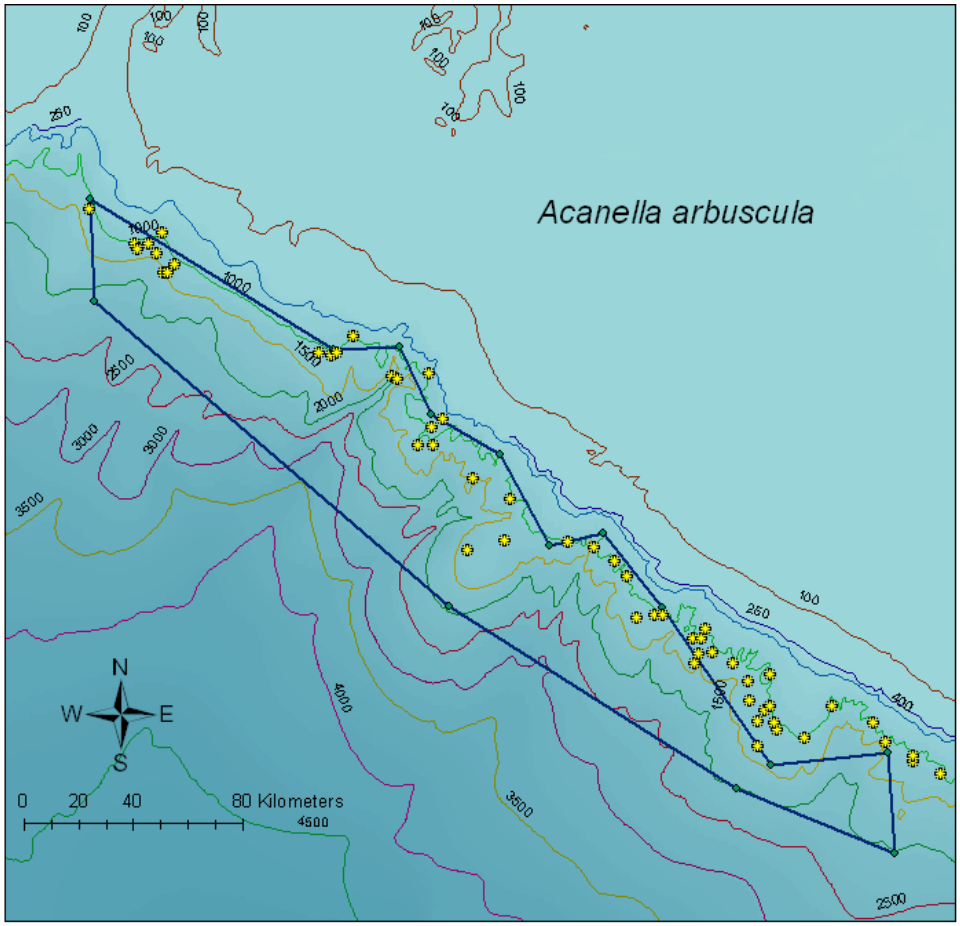

Figure 11.2.5 Known geographic position of the small bush-like structure-forming gorgonian *Acanella arbuscula* in the vicinity of the NAFO Division 30 closure (dark blue line).

Table 11.2.3 Breakdown of records of occurrence of coral taxa in the NAFO Division 30 Coral Protection Area.

TAXON	ORDER	COUNT	FREQUENCY
Acanella arbuscula	*Gorgonacea*	28	0.10448
Acanthogorgia armata	*Gorgonacea*	12	0.04478
Anthomastus grandiflorus	*Alcyonacea*	24	0.08955
Anthoptilum grandiflorum	*Pennatulacea*	19	0.07090
Anthothela grandiflora	*Gorgonacea*	1	0.00373
Distichoptilum gracile	*Pennatulacea*	1	0.00373
Duva florida	*Alcyonacea*	4	0.01493
Flabellum spp.	*Scleractinia*	19	0.07090
Funiculina sp.	*Pennatulacea*	26	0.09701
Gersemia rubiformis	*Alcyonacea*	2	0.00746
Halipteris sp.	*Pennatulacea*	12	0.04478
Keratoisis ornata	*Gorgonacea*	6	0.02239
Kophobelemnon sp.	*Pennatulacea*	15	0.05597
Kophobelemnon stelliferum	*Pennatulacea*	11	0.04104
Nephtheidae spp.	*Alcyonacea*	7	0.02612
Paramuricea spp.	*Gorgonacea*	1	0.00373
Pennatula borealis	*Pennatulacea*	22	0.08209
Pennatula sp.	*Pennatulacea*	14	0.05224
Pennatulacea sp. 12	*Pennatulacea*	2	0.00746
Pennatulacea spp.	*Pennatulacea*	13	0.04851
Radicipes gracilis	*Gorgonacea*	1	0.00373
Radicipes spp.	*Gorgonacea*	15	0.05597
Umbellula sp.	*Pennatulacea*	13	0.04851

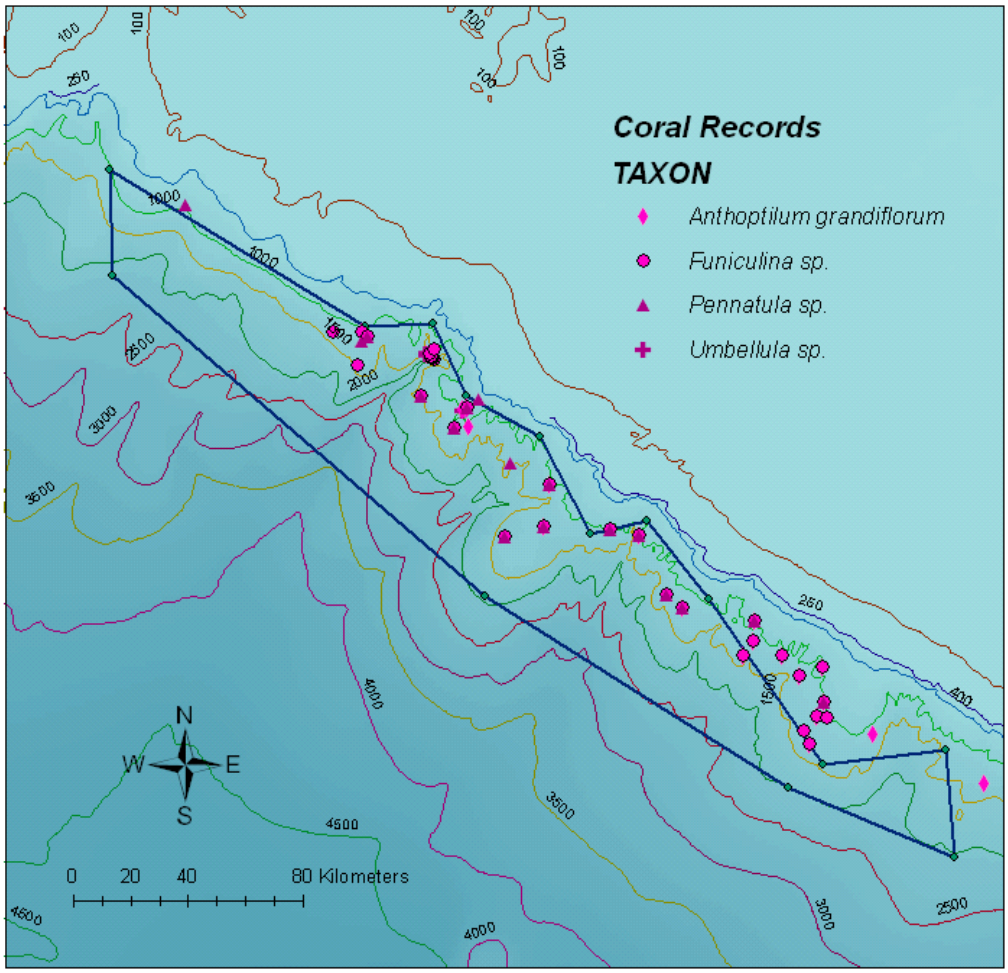

Figure 11.2.6 Known geographic position of selected seapens in the vicinity of the NAFO Division 30 closure (dark blue line).

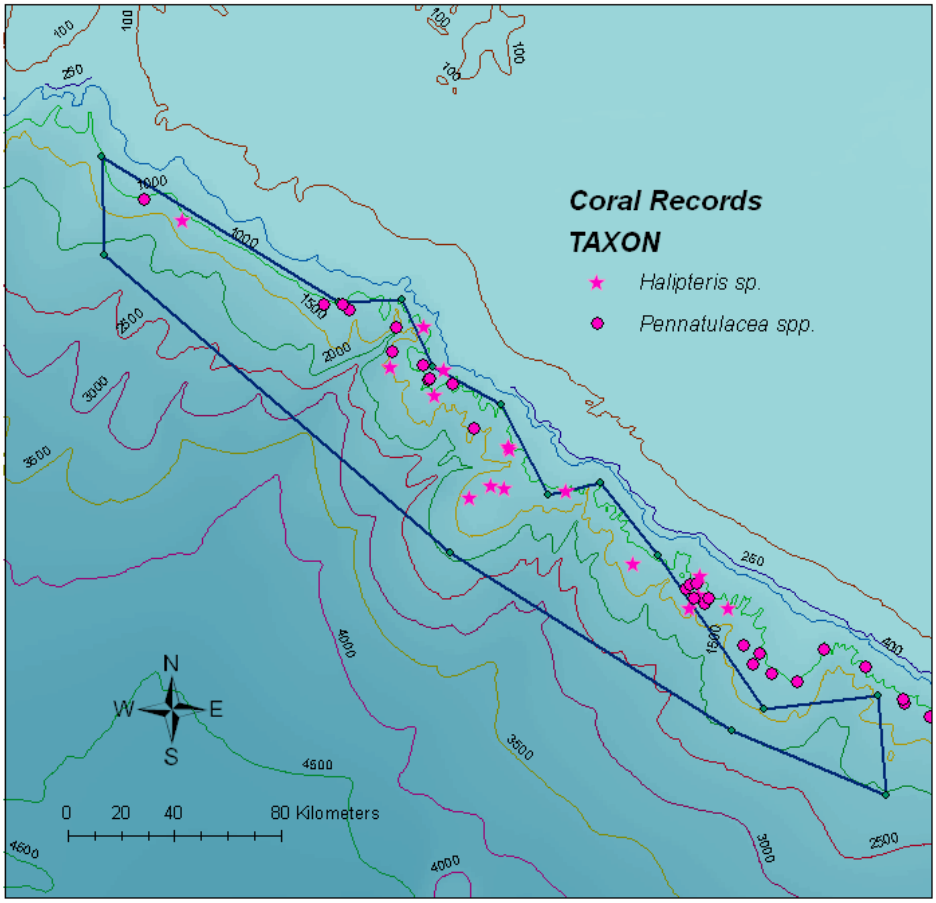

Figure 11.2.7 Known geographic position of selected seapens in the vicinity of the NAFO Division 30 closure (dark blue line).

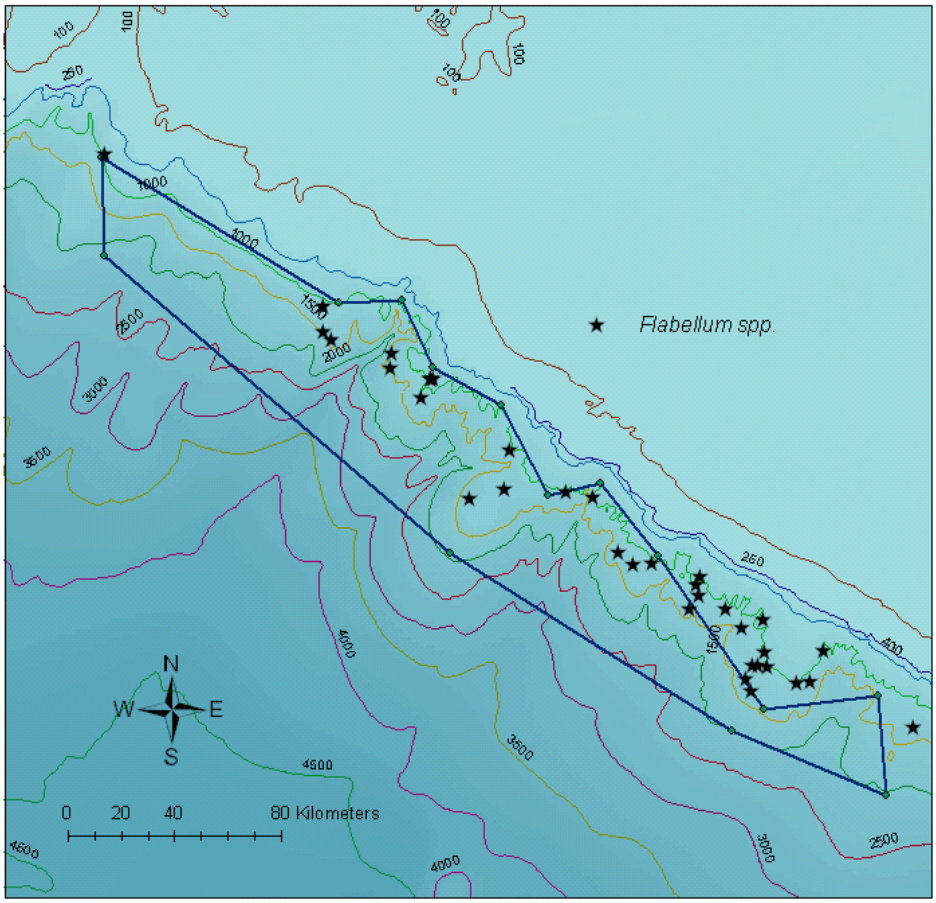

Figure 11.2.8 Known geographic position of the Scleratinian coral *Flabellum* spp. in the vicinity of the NAFO Division 30 closure (dark blue line).

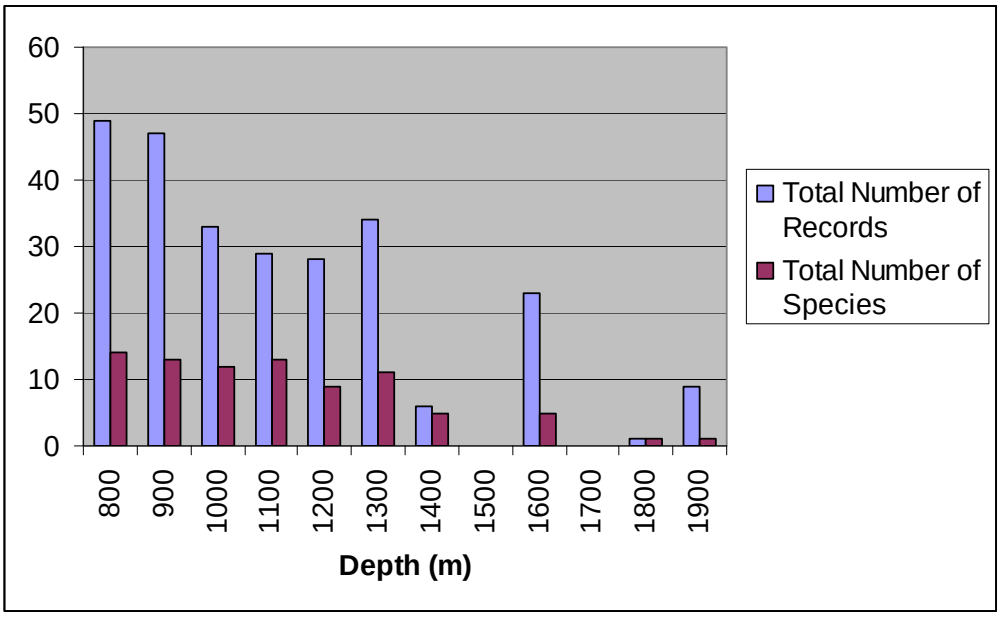

Figure 11.2.9 The number of observations and corresponding number of species for 100 m depth intervals for the available data within the NAFO Division 30 Coral Conservation Area.

11.3 Comments on the placement of the closure area relative to other locations in the Northwest Atlantic

The precise placement of closure areas for the protection of deep water corals and other VMEs is problematic in the absence of data. Durán Muñoz *et al*. (2007) have proposed that the target area be surveyed with multibeam acoustics and that precise fishing locations be overlain on the multibeam bathymetry along with any available data on benthic organisms. Such interdisciplinary approaches have been very useful in delineating VMEs for reef-building corals on Hatton Bank (Durán Muñoz *et al.*, 2007) and optimizing the competing interests of coral protection and trawl fishing. It is recognized that this methodology is appropriate when studying the interactions between fisheries and habitats in order to produce appropriate advice on closed areas (FAO 2008). However the timelines imposed by the UNGA resolutions and the limits of multibeam acoustics in very deep water such as the depths at which seamounts occur (2000+ m) preclude the widespread use of this approach.

This does not mean that informed decisions cannot be made in the absence of such data. The NAFO seamount closures are an example of a decision being made based on the high probability of VMEs occurring on the seamounts based on global literature observations and in some cases, bycatch data to confirm the presence of deep water corals. Subsequent research (see ToRc and Figure 11.3.1) will further circumscribe the biological characteristics of individual seamounts within the closure areas and allow for further refinement of the closures based on such characteristics as the degree of endemism, the recoverability of the taxa, etc.

Along the continental margins of the Northwest Atlantic, the surficial geology is a good indicator of the types of coral communities (amongst other taxa) that can be expected. Coral records obtained from observer, research and other data sources are generally restricted to depths less than 1000 m where these activities are concentrated. However, experience to date has shown that where concentrations of coral occur at shallow locations it is a good indicator of the coral communities at greater depths as evidenced by the results obtained from deep water submersibles. Figure 11.3.1 summarizes the location of coral and sponge communities from the New England and Corner Rise Seamounts based on collections from submersibles (Mountains in the Sea and Deep Atlantic Stepping Stones Research Groups; unpublished data courtesy Peter Auster, University of Connecticut). Hard substrates and steep topography are optimal conditions for suspension feeding species like coral and sponges. In combination these data sources can be used as indicators of deep water coral VMEs.

Following this approach, all available data on the occurrence of corals in the Northwest Atlantic were compiled (see ToRg). The early availability of data from the Canadian EEZ and adjacent international waters allowed for this portion of the NAFO area to be examined in more detail during the WGDEC meeting.

Finally, in regards to the allowance of 20% of seamount closures to be open to exploratory fishing, WGDEC suggests that the 20% should be restricted to areas above 2000 m versus 20% of the entirety of each closure area. It is erroneous to assume that communities across each of the closure designations are equivalent ecologically based on variation in depth alone. We know from preliminary analyses that there are depth related differences in coral and sponge communities although exact boundaries remain to be determined. Hence it would be precautionary to consider 20% of the seafloor above 2000 m in each of the closures as available for exploratory activities.

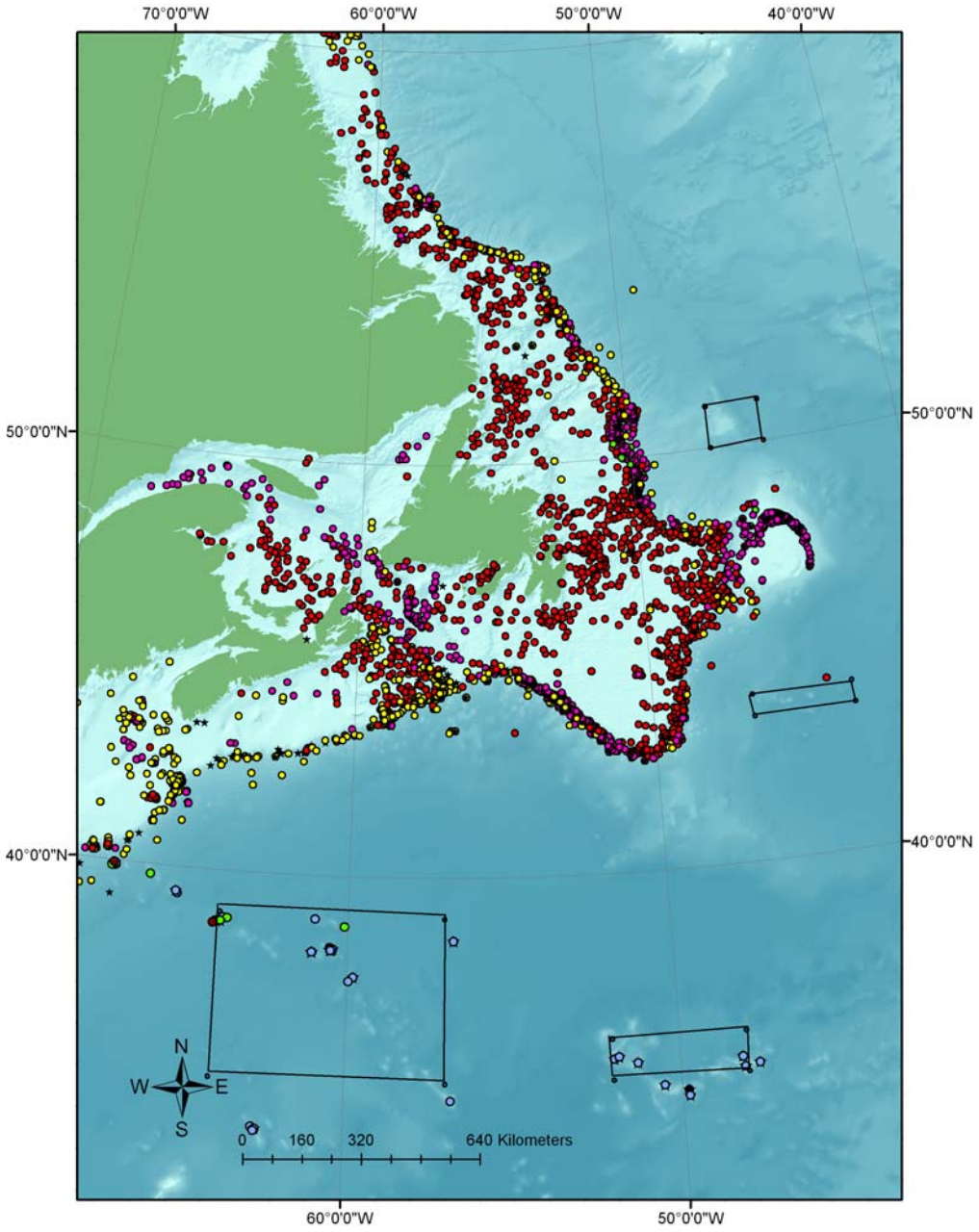

Figure 11.3.1 Location of the seamount closure areas under NAFO and of known records of coral occurrence. Corals are grouped by Order: Pink: *Pennatulacea*; Yellow: *Gorgonacea*; Red: *Alcynonacea;* Black star: *Scleractinia*; Mauve: *Porifera* (New England and Corner Rise seamount chains only); Dark Circles: *Octocorallia* (New England and Corner Rising seamount chains only).

11.3.1 Comments on the Boundary of the Closure Area in Division 30

The data on the distribution of coral taxa in the vicinity of the Closure Area in Division 30 (above) argues for altering the boundaries to include the 800 m contour throughout (see Figure 11.2.3). This would offer protection to sea pen fields, *Acanella* and *Flabellum* in the southeast portion of the closure area. Further extending the upper limit of this boundary to the 200 m shelf break would protect the entire "deep sea" stratum as defined by Hourigan *et al*. (2007). Edinger *et al*. (2007) have compiled maps of fishing effort and coral bycatch data for Newfoundland and Labrador and

these shallower areas above the present closure have high effort and a high incidence of coral bycatch, particularly of the large gorgonian corals.

11.3.2 Comments on other areas as candidates for closures

On the Scotian Shelf and Slope, Canada has closed 3 areas for the protection of cold-water corals. Since 2002, Fisheries and Oceans Canada (DFO) has implemented conservation measures under both the Fisheries Act and the Oceans Act to protect key coral habitats. The greatest known abundance of deep-water gorgonian corals found off Nova Scotia is in the Northeast Channel, located between Browns and Georges Banks. Two species are predominant, *Paragorgia arborea* (bubble gum coral) and *Primnoa resedaeformis* (sea corn). In 2002 a Coral Conservation Area was established in the Northeast Channel in co-operation with industry. The conservation area is approximately 424 square kilometres in size, and is located in NAFO Divisions 5ZE and 4X. In September 2003, mounds of the reef building coral *Lophelia pertusa* (spider hazards) were discovered at the Stone Fence, southeast of Cape Breton, Nova Scotia. This area is the only known location with living *Lophelia pertusa* colonies on Canada's Atlantic coast. The corals and nearby seabed were reduced to rubble in many areas presumably due to bottom fishing gear. The 15-square kilometre Lophelia Coral Conservation Area was put in place in June 2004 and closed a small area surrounding the entire reef to all bottom fisheries. Lastly, the Gully Marine Protected Area (MPA) was designated by regulation in May 2004 under Canada's Oceans Act. One of the objectives of the MPA is to protect the high diversity of coral species found there. Corals are present in many parts of the canyon and the Gully remains the most diverse location for deepwater corals yet discovered in Atlantic Canada.

Edinger *et al*. (2007) reviewed the available data for Newfoundland and Labrador and suggested 2 other locations as having a high priority for conservation in addition to the area in part closed by the NAFO Coral Conservation Closure. These are 1) the area along the continental margin known as Funk Island Spur and Tobin's Point, due west of Orphan Knoll, and 2) Cape Chidley and Eastern Hudson Strait on the Eastern Baffin Shelf (Edinger *et al*., 2007). Data in Figures 11.3.2.1 and 11.3.2.2 produced from a slightly larger data set gathered for WGDEC supports these two areas in addition to the NAFO Coral Conservation Closure as being areas of high coral diversity. In addition Flemish Pass, the slope waters between Flemish Cap and the Grand Banks also have a high diversity of coral (dashed circle Figure 11.3.2.1; place names on Figure 11.3.2.3).

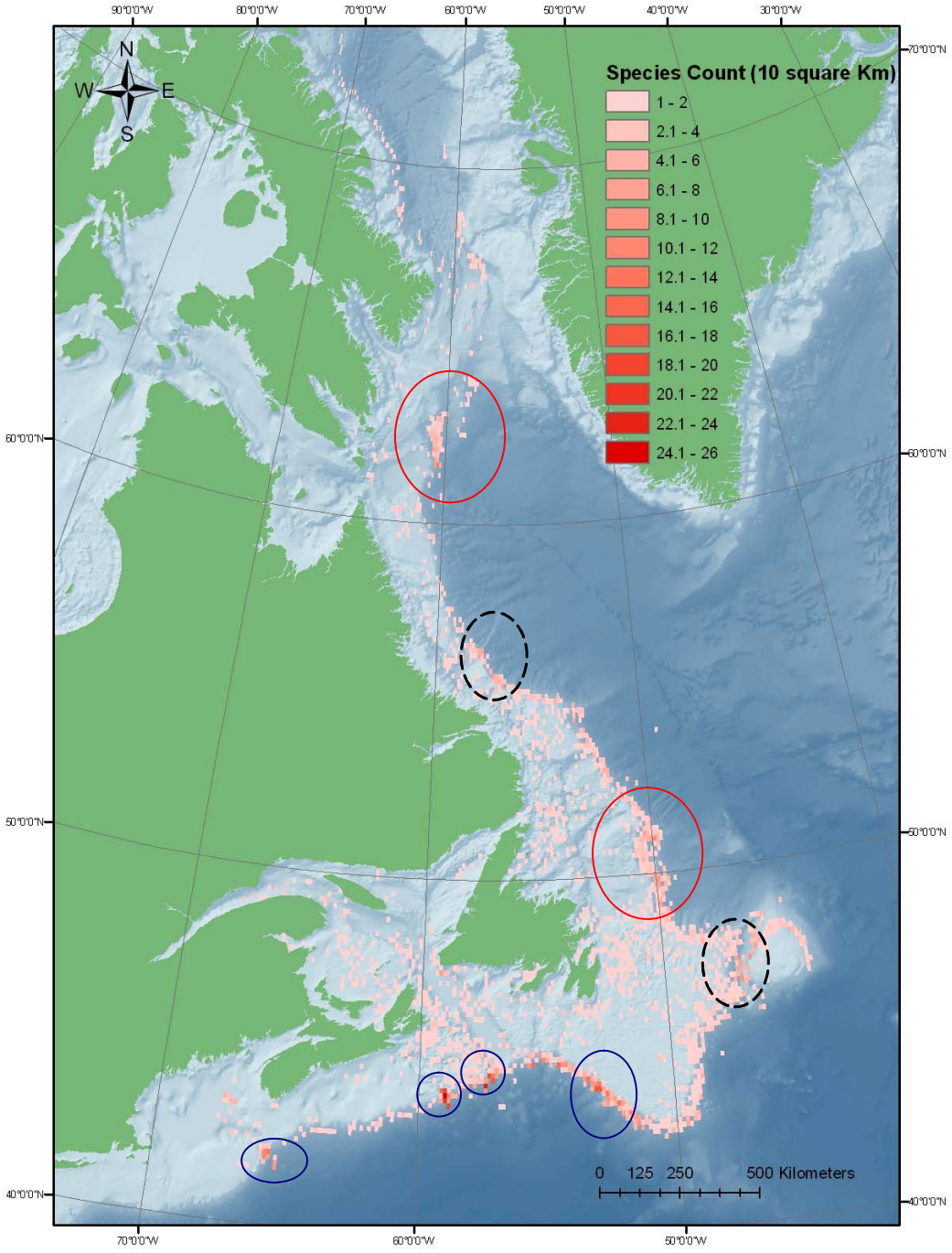

Figure 11.3.2.1 Number of coral species recorded per 10 square kilometre box in Atlantic Canada. Red circles indicate priority areas for coral conservation suggested by Edinger *et al.* (2007), blue circles indicate areas currently closed to protect corals and black dashed line circles indicate other potential areas of coral VMEs.

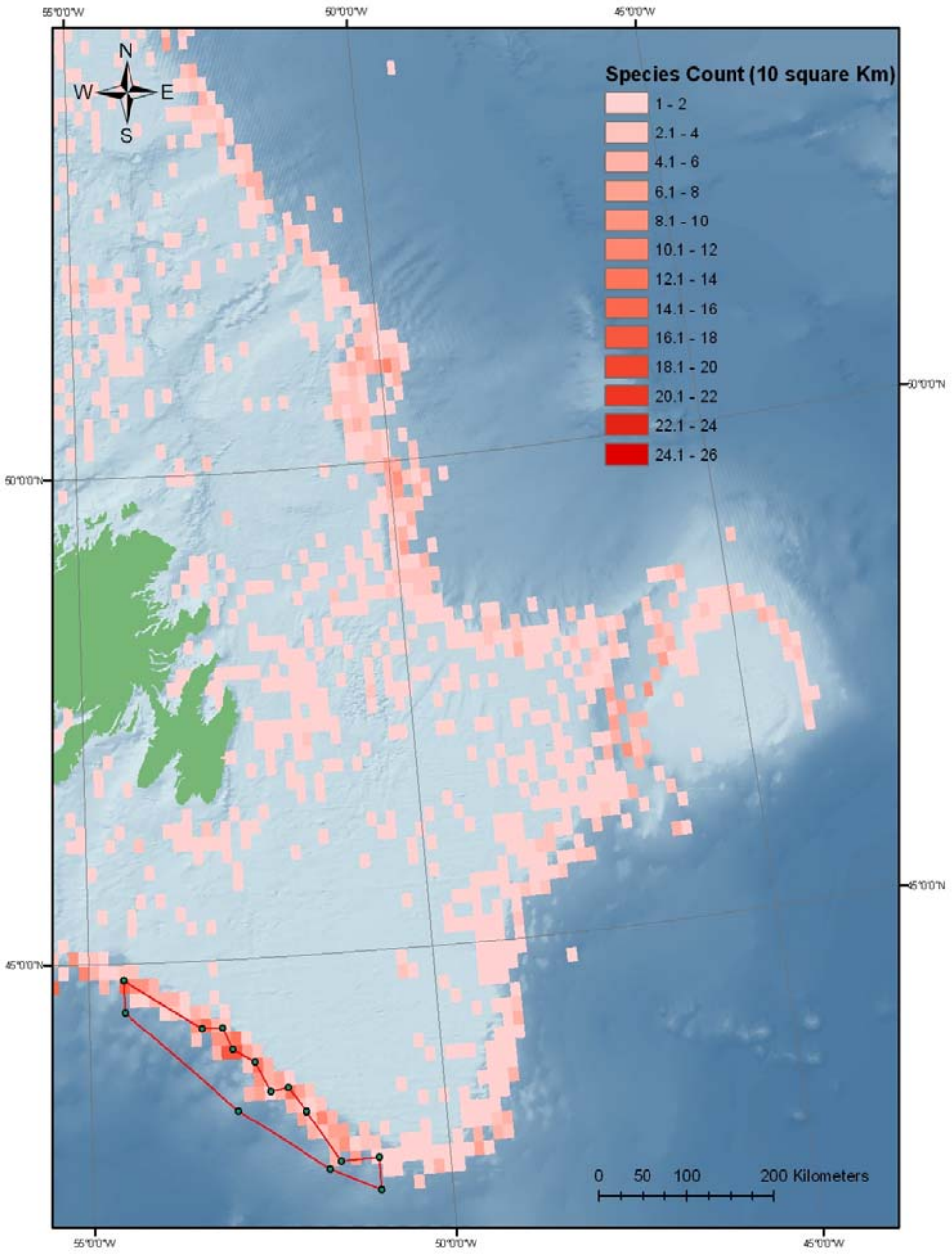

Figure 11.3.2.2 The number of coral species recorded per 10 square kilometre box on the Grand Banks of Newfoundland. The NAFO Coral Conservation Closure Area is indicated in red.

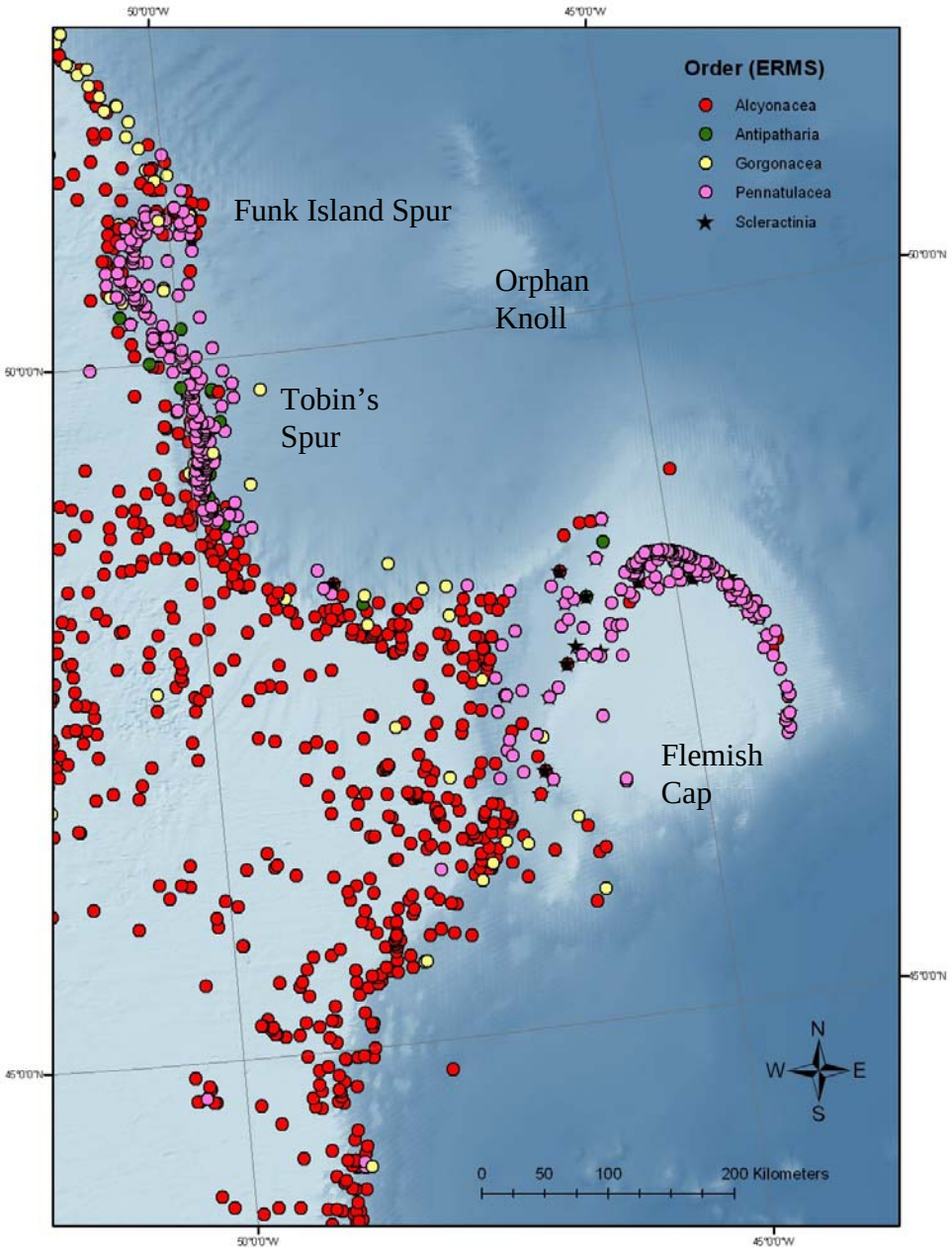

Figure 11.3.2.3 The distribution of coral taxa by order (red circles: Pink: *Pennatulacea;* Yellow: *Gorgonacea;* Red: *Alcynonacea;* Black: *Scleractinia;* Green: *Antipatharia*.

Funk Island Spur and Tobin's Point have a large number of records of black coral (Figures 11.3.2.3; 11.3.2.4) with areas of gorgonian coral concentrations to the north (primarily *Acanella arbuscula*).

Further north, in the area around Cape Chidley and north to the Davis Strait, there is a high incidence of structure forming corals (Figure 11.3.2.4) occurring. This area is also interesting with respect to ocean circulation patterns and should be considered in more detail as a prospective area for closure.

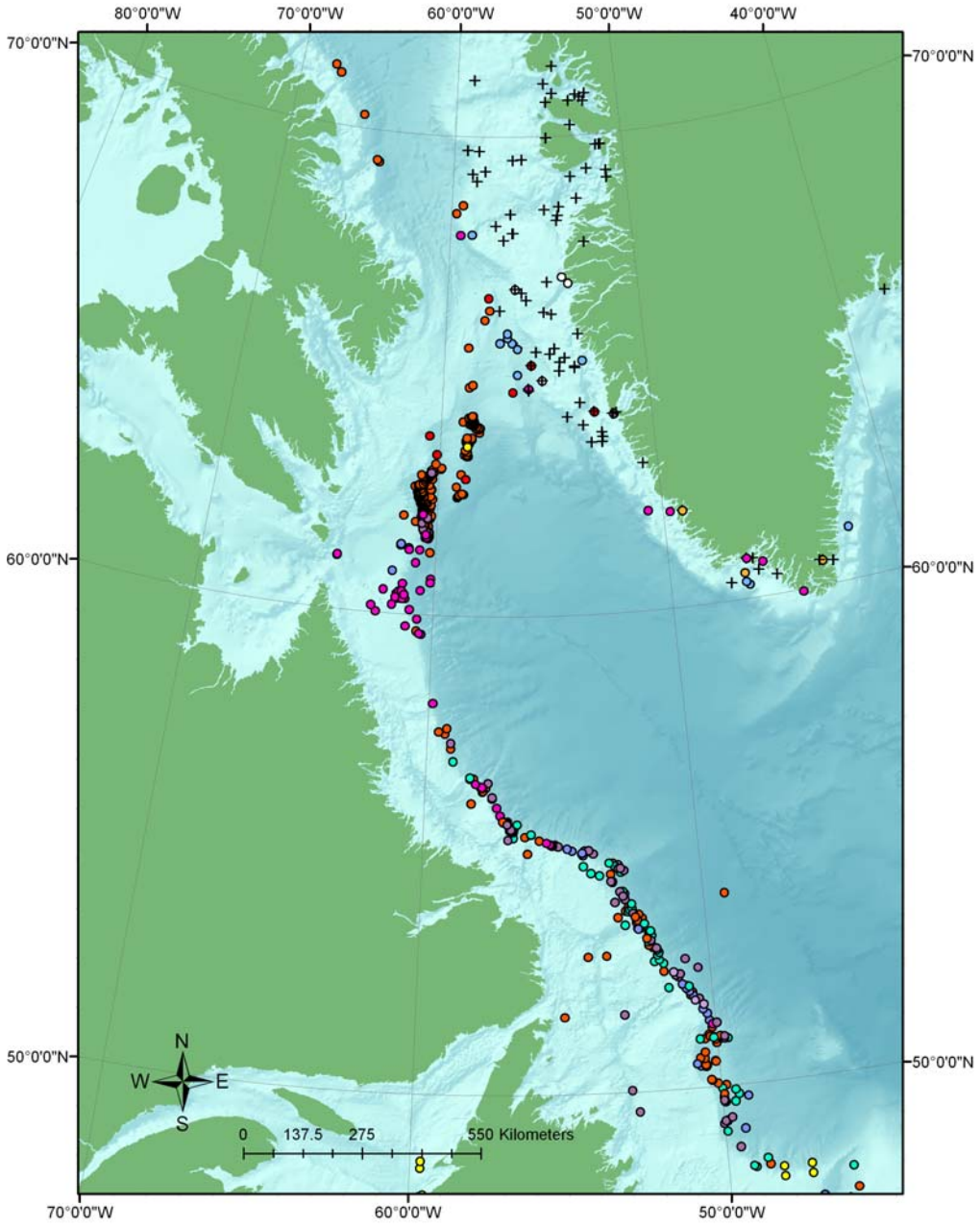

Figure 11.3.2.4 Location of known records of habitat forming coral taxa in the northern portions of the Northwest Atlantic. Coral taxa are indicated as follows: Pink: *Primnoa*; Red: *Acanella*; Yellow: *Keratoisis*; Purple: *Paramuricea*; Light Blue: *Acanthogorgia*; Dark Blue: *Paragorgia*; White: *Clavularia*; Gold: *Stenogorgia*. Crosses indicate other coral taxa for the Greenland waters only (too many data points to display on the Canadian coast).

Comments regarding the importance of the NAFO 30 Closure for coral in the Northwest Atlantic.

The question of the role that the NAFO 30 Closure plays in the conservation of coral communities in the Northwest Atlantic is difficult to answer, given a lack of knowledge regarding population connectivity across the NAFO region. However, regional scale oceanographic patterns suggest that while connectivity along the continental margin may occur at ecologically relevant time scales (and may vary at least in part on NAO conditions and movement of Labrador Shelf Water),

connectivity across seamount chains is limited. The results of population genetics studies for species in the genus *Paramuricea*, summarized ToR c provide a useful example of taxa with distinct geographic affinities at sub-regional spatial scales.

11.4 References

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11.5 Acknowledgements

The working group would like to thank the following people for providing data to us for the purposes of mapping: USA: Tom Hourigan, Peter Auster; Canada: Vonda Wareham, Evan Edinger, Kent Gilkinson, Pal Buhl-Mortensen, Ellen Kenchington, Derek Fenton, Kevin MacIsaac, Andrew Cogswell, Robert Benjamin, Megan Best, Jaime Vickers, Susan Gass, Deanna Fergueson, Lindsay Beazley; Greenland: Ole Tendal; Mid-Atlantic: Pal Buhl-Mortensen.

12 Patterns of fishing

Term of Reference (i): examine patterns of fishing in deep-water areas other than Rockall and Hatton banks, such as the seamounts and continental slope, to determine where intensive fishing is occurring and evaluate the likelihood of sensitive habitats being present in those areas.

12.1 Introduction

VMS (Vessel Monitoring System) data is GPS (geographical positioning system) information sent from the vessel via satellite at regular intervals (normally every 2 hours). It can be used to estimate potential impacts of fishing on sensitive marine habitats. It is important however to realise the limitations of VMS data and apply it at the appropriate geographic scale. At broad scales it can identify the regions that are most vulnerable to being impacted (Figure 1), however, areas that contain sensitive habitats may often occur in close proximity to areas that do not. Equally importantly is the fact that different fishing practices have greater or lesser impact than others, for example the impact of bottom trawl is far more detrimental to the seabed than static gear such as gillnets and non-contact operations such as pelagic trawling. It is thus important to a) have finely resolved spatial information in particular areas of interest in relation to known occurrences of sensitive habitats, and b) have the data carefully filtered with respect to the speed and 'behaviour' of the vessel. The likelihood that the vessel was travelling between fishing grounds, dodging in poor weather, bottom trawling, or pelagic trawling can all be estimated based on the average speed profile of the boat that is calculated from the distance between two consecutive points. Further validation checks can be made by analysing the vessel's path in relation to the seabed contours (usually isobathic for bottom trawling, but not for pelagic) and the patterns of movement-for example the vessel will return to the exact same spot to retrieve pots or anchored gillnets. In this term of reference we take advantage of recent advanced in the processing of VMS data (Alfonso Dias *et al*., 2006) with a view to developing a methodology for making detailed inferences about the likely impact of fishing activities on sensitive habitats. We illustrate the method with the use of 2 case study areas that are known to be important fishing grounds as well as areas for which there is data suggesting the presence of sensitive habitats such as hard and soft corals.

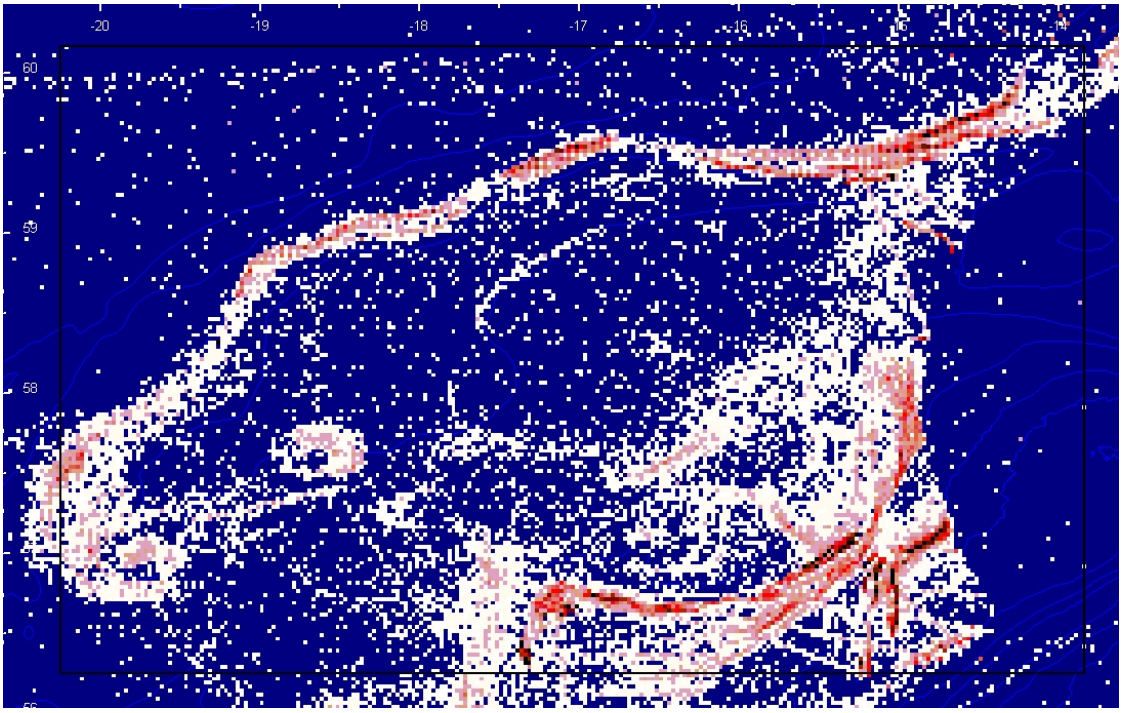


Figure 12.1 Map of the Rockall/Hatton region showing a density function of VMS data (black and red areas = highest density of fishing vessels) over the years 2002–2006.

12.2 VMS data sources and analysis

All vessels greater than 24 m are required to carry VMS transmitters if they are to be permitted to fish in NEAFC waters. NEAFC provided ICES with VMS data for the period 1998–2006. Data prior to 2002, however, are sparse and were not used in the present analysis. No reference to a vessel's true identity was provided in the data. Analysing the frequency of time spent at varying speeds can assess the type of activity being undertaken by the vessel. The following speed criteria were used to help assign a type of fishing activity:

a) if the vessel was moving at speeds in excess of 5 knots per hr, it was deemed to be travelling between fishing grounds

b) if the vessel was travelling between 4–5 knots per hr, it was deemed to be pelagic trawling

c) if the vessel was travelling at speeds between 2–3 knots, it was bottom trawling

d) if the vessel was travelling between 1–2 knots, it could either be dodging in poor weather, laying gillnets or laying longlines.

If none of the above criteria were clearly reached, investigation of the vessel's path in relation to the seabed contours (usually isobathic for bottom trawling, but not for pelagic) and the movement pattern were undertaken. For example, if the vessel returned to the exact same positions it was likely to be retrieving pots or anchored gillnets.

12.3 Sensitive habitat data sources

Data sources available to WGDEC that contain data on the occurrence either of species considered sensitive (e.g. the coldwater coral, *Lophelia pertusa*) or general categories of habitat were the OSPAR database for *Lophelia pertusa* and WGDEC's

database on soft-corals (P. Mortensen). Two case study sites were considered in which there was both evidence of fishing activity and the presence of sensitive deepwater habitat to illustrate how the approach can be developed in the future and extended to larger areas.

12.4 Case study 1: Lousy Bank

Lousy Bank or 'Outer Bailey' Bank as it is sometimes referred, is a seamount that lies approximately at 60º 25.02' N and 12º 34.98' W, to the north east of Hatton Bank. It lies at the limits of the EEZ, Faroese and NEAFC areas and has been fished for Blue ling that aggregate to spawn on its lower flanks in early spring (Vinnichenko, 2008). There are a number of historical records of *Lophelia pertusa* across the seamount (Figure 12.2). We believe an early study was made of the sessile fauna of the bank in the 1930s. It therefore is highly likely to still contain sensitive deepwater habitats and organisms. NEAFC VMS data from the period of 2002 to 2006 show that fishing activity is still occurring on the bank. Data for three vessels was examined. The first vessel a (Figure 12.3a) is highly likely to be operating a bottom trawl based on its speed profile which shows peaks of movement at around 1.5 knots (typical 'dodging' speed in poor weather) and around 3.2 knots (typical bottom trawling speed). The second vessel (Figure 12.3b) is likely to be operating gillnets, as their speed was mainly at less than 2 knots. The activity of third vessel (Figure 12.3c) is more difficult to interpret, as there is a broad peak in speeds between 1 and 4 knots, suggesting it was unlikely to be bottom trawling. It is possibly it was longlining. All the vessels were clearly targeting a small area within a narrow depth band. It is highly likely that the target was spawning aggregations of blue ling (WGDEEP, 2008). Such intense fishing activity in such a small area would undoubtedly have an impact on a sensitive habitat such as coral reefs if that's what the ground was. However, based on the records for *Lophelia*, there appears to be very little overlap between the fishing activities.

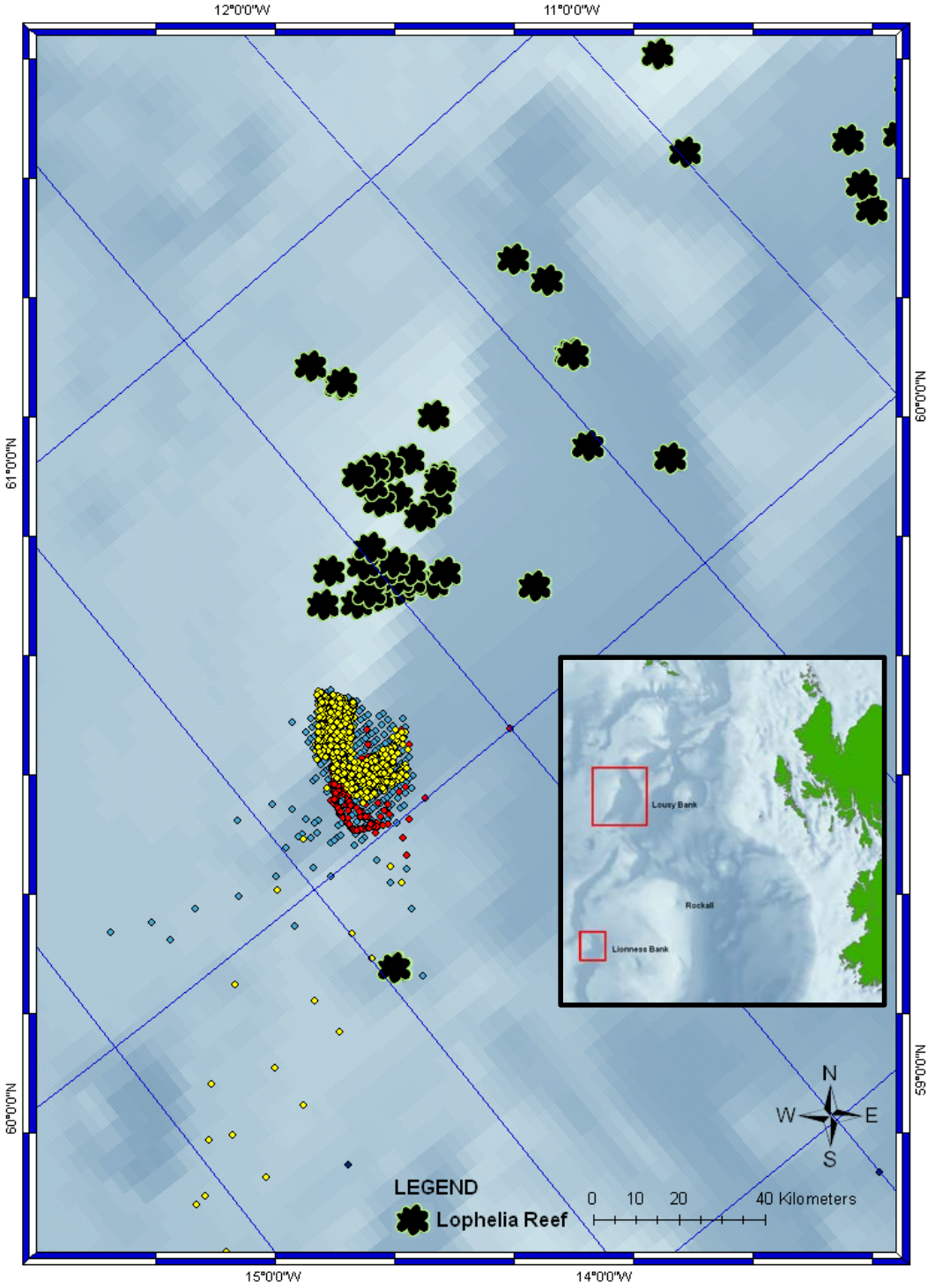
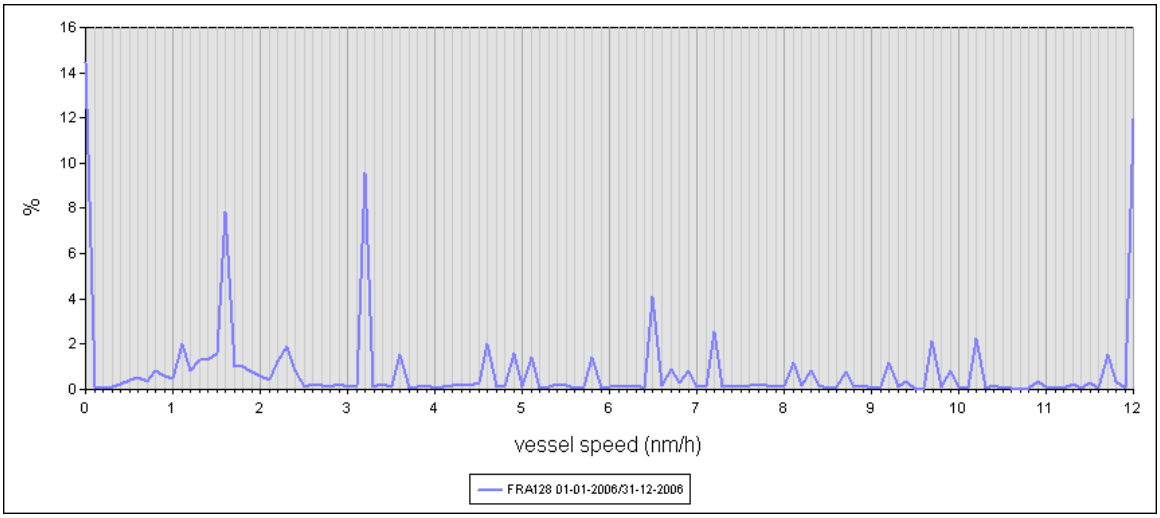


Figure 12.2 Fishing activity and the historical locations of coral reefs on Lousy Bank. Positions of three fishing vessels (different coloured dots) are shown in relation to historical records of *Lopheila pertusa* (black symbols) on the bank. It can be seen there is very little overlap between the intensely fished grounds and the reefs.

(a)


16
14
12
10
8
6
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2
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vessel speed (nm/h)
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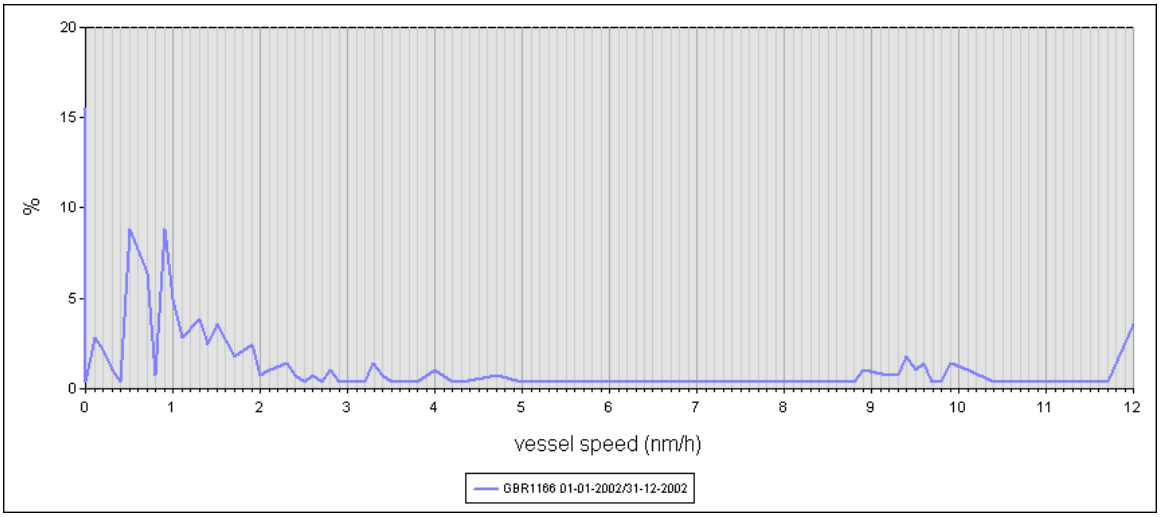
(b)


20
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vessel speed (nm/h)
GBR1166 01-01-2002/31-12-2002

(c)

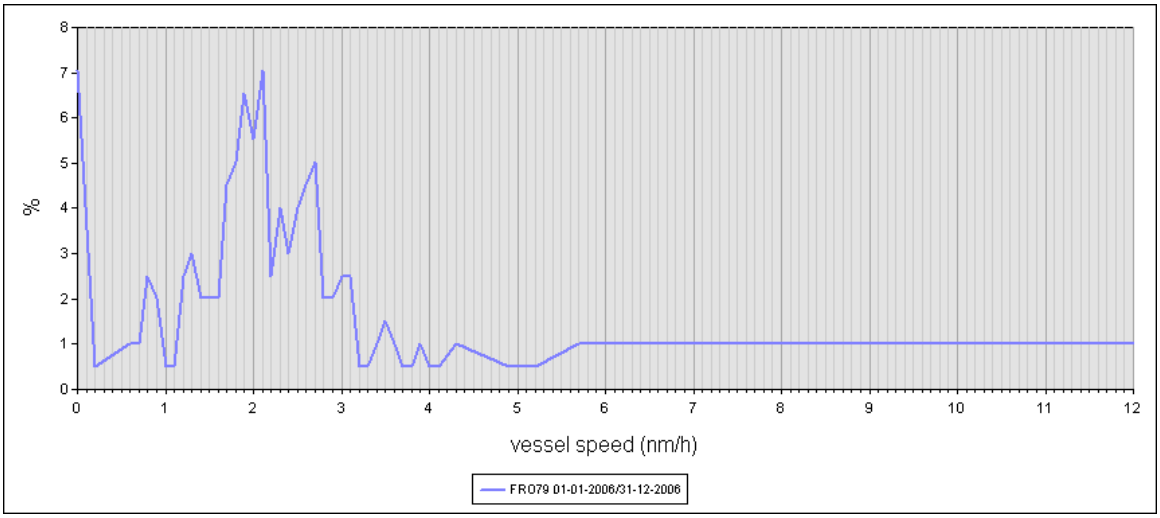


Figure 12.3 Lousy Bank fishing vessels-(a) Vessel 1-bottom trawler, (b) Vessel 2-gillnetter, (c) Vessel 3-possible longliner.

12.5 Case Study 2: Lyoness Bank (East Hatton)

Lyoness is a volcanic rock outcrop that rises out of the Rockall-Hatton basin to the south west of Hatton bank (approximate position 56 ° N, 18 ° W). The igneous centre forms a dome, covered with a veneer of sediment, through which igneous rocks outcrop-forming pinnacles that stand 100–140 m above the surrounding sea floor (Stewart and Davies, 2007). Two recent surveys took place in 2006; one by the DTI and JNCC (Howell *et al.*, 2007 and the other by the BGS/NOC (Stewart and Davies, 2007)). They involved multibeam bathymetry mapping and biological groundtruthing using video and still photography. The seabed was typically coarse sand, with extensive areas of bedrock and boulder reef (Howell *et al.*, 2007). The rock was colonised by encrusting fauna such as sponges, sessile sea cucumbers (*Psolus squamatus*), Serpulid worms, saddle oysters and occasional anemones. A diverse range of corals including scleractinians (*Lophelia pertusa* and *Madrepora oculata*), antipatharian corals (*Stichopathes* sp., *Leiopathes* sp.), stylasterid corals, soft corals (*Anthomastus grandiflorus*) and gorgonians were also frequently observed (Howell *et al.*, 2007). Extensive areas of dead coral framework and coral rubble were also observed, with characteristic associated epifauna as described above (Howell *et al.*, 2007).

VMS data indicated that fishing vessels visit the area on numerous occasions (Figure 12.4). The vessels often tended to follow the contour around the base of the bank with the vessel tracks forming a crescent shape. The VMS records of 2 vessels were chosen for detailed analysis. Upon investigation the 2 vessels can clearly be identified as not bottom trawling. The first appears to be operating gillnets (peak speeds at less than 1 knot) while the other vessel is likely to be operating pots for deepwater crabs. This conclusion was reached by on the basis that the vessel always returned to exactly the same spot in order to set and retrieve the pots. However, although we did not find evidence for bottom trawling in this area it is likely that bottom trawling does occur around the base of the bank also (Scottish landings data report large catches of blue ling by bottom trawl in the statistical rectangle that contains this bank).

It can be seen there is very little overlap between the vessel operating crab pots grounds and the reefs, however it would appear that there is overlap with the vessel thought to be operating gillnets. While not as damaging as bottom trawling, the dragging of anchors and retrieval of gillnets can cause substantial damage and the overlap of coral records with gillnet fishing activity is a cause for concern for this area.

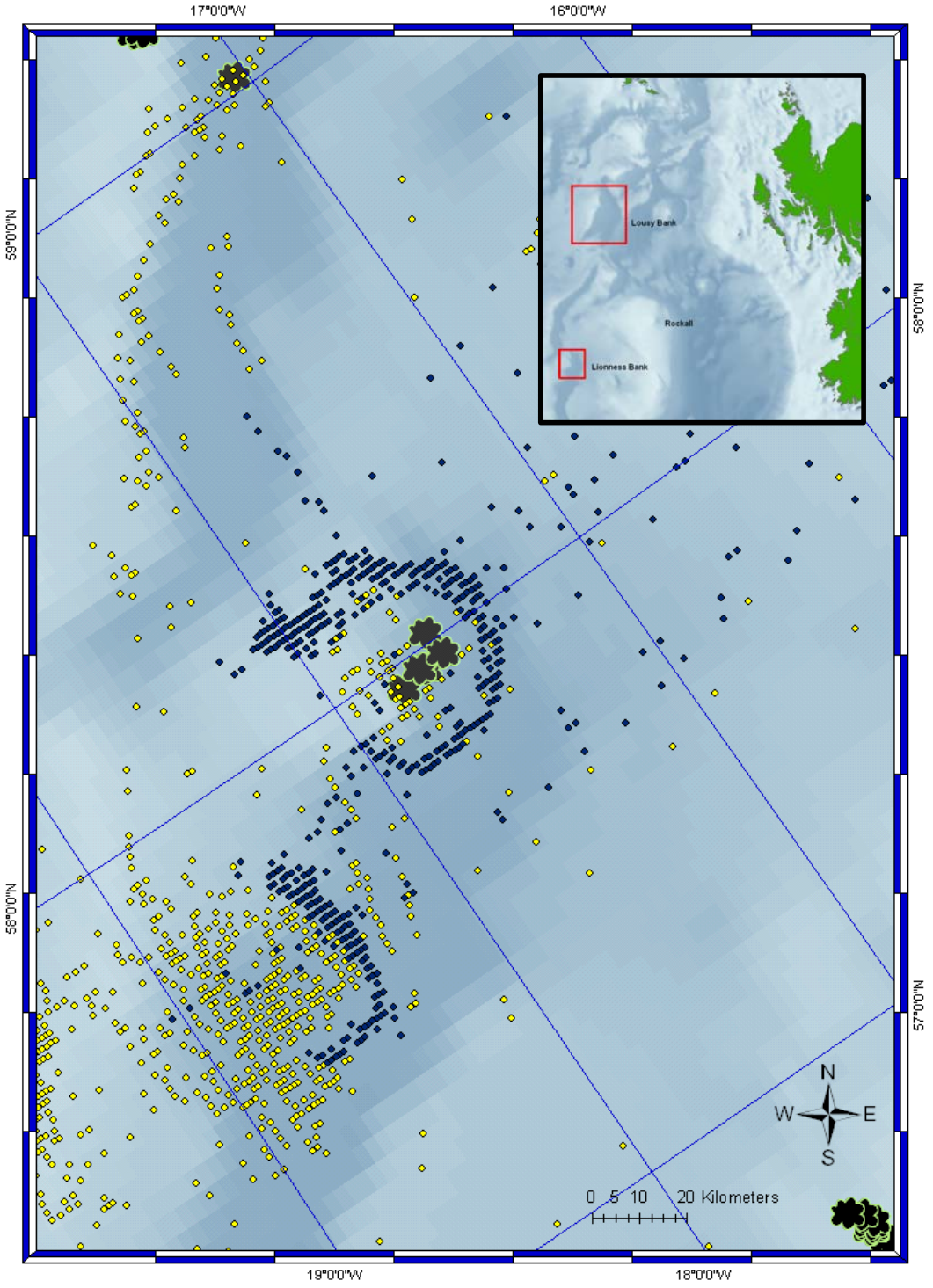
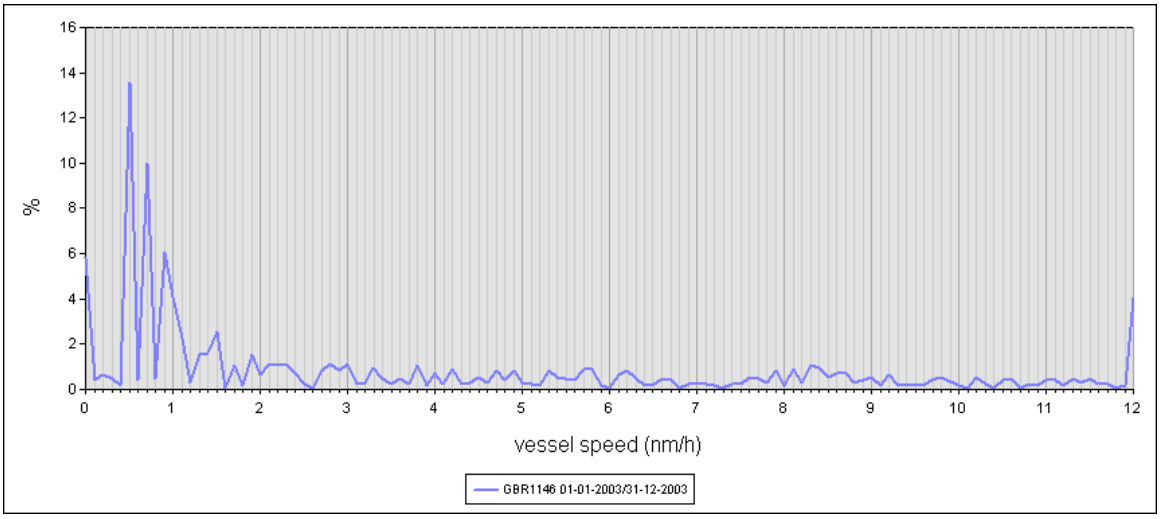


Figure 12.4 Positions of two fishing vessels (blue dots = vessel fishing with crab pot, yellow dots = fishing thought to be gillnetting) are shown in relation to recent records of *Lophelia pertusa* on Little Bank.

(a)



(b)

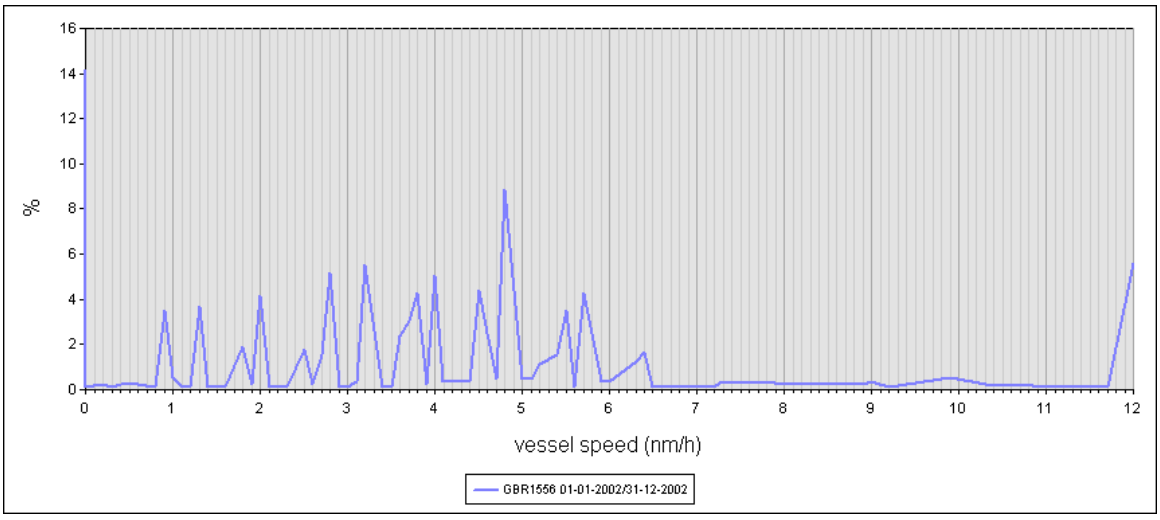


Figure 12.5 Lyoness Bank (a) vessel-likely to be a gillnetter (b) vessel 2 likely to be operating crab pots.

12.6 Discussion

The recent advances in the analysis of VMS data provide a much more detailed and objective assessment of fishing activity and its likely impact on sensitive deepwater habitats. It is only by looking in detail and in fine scale that one can get an accurate estimate of the amount of overlap between areas known to contain sensitive habitats and potentially damaging fishing activity. Of course we cannot assume that a lack of information equates to a lack of sensitive habitat and this is a shortfall of this approach. WGDEC recommends that the approach begun in this ToR is developed further over the coming year. In particular the set of the criteria for assigning types of fishing activity needs to be refined and expanded. Progress in this task will be reviewed at the next meeting of WGDEC.

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13 Review of the codes of conduct

Term of Reference (j): review codes of conduct for carrying out scientific research in sensitive deep-water habitats with a view to developing an ICES code of conduct;

13.1 Background

Certain deep-water habitats, such as coral reefs, coral gardens, seapen meadows, hydrothermal vents, and sponge grounds are recognised by international advisory organisations (e.g. ICES and OSPAR) as being sensitive to disturbance, including anthropogenic impacts.

Scientific understanding of the marine environment often requires active sampling in the field. Any sampling activity has a potential to damage associated species and habitats at which it targets. In general, the potential impact of many scientific activities on the marine environment is low compared to the potential for disturbance by other human activities (e.g. mining, fisheries, and installation of oil and gas infrastructure). However, in certain areas scientific activities represent the only anthropogenic factor that potentially could damage sensitive habitats. There are examples of Swedish and Norwegian coral reefs that have been damaged by sampling activities. In Bergen, the reef at Bratthomen in Hjeltefjorden was a popular target for sampling with triangular dredge. The traditional sampling practice with dredge is destructive and has provided little information about the environment and factors controlling the corals' biology (i.e. growth and reproduction) and diversity of associated fauna. Fortunately, the sampling at Brattholmen was stopped through a personal initiative by Professor Hans Brattström (University of Bergen) in the 1960s. Reefs in the vicinity of Trondheim Marine Biological station were also regularly sampled for scientific and educational purposes. Similarly, one reef off the coast of Sweden was also intensely sampled with dredge (Tomas Lundälv, pers. comm.). In the Mediterranean destructive sampling has occurred on *Lophelia* reefs, for instance off Malta.

The ICES definition (ICES Advisory Committee on Ecosystems, 2002) of habitat sensitivity states:

> Habitat sensitivity can be defined in relation to the degree and duration of damage caused by a specified external factor. Sensitivity may refer to structural fragility of the entire habitat in relation to a physical impact, or to intolerance of individual species comprising the habitat to environmental factors such as exposure, salinity fluctuations, or temperature variation.

Sensitivity also depends on the time taken for the species or habitat's subsequent recovery and must be assessed relative to change in a specific factor. External factors that can potentially impact sensitive habitats are not only represented by fishing activities, but also include scientific research such as bottom sampling.

Related to sensitivity is the concept of "significant adverse impacts" to "vulnerable marine ecosystems" which has become relevant in the implementation of United Nations General Assembly (UNGA) 2006 Resolution 61/105 related to bottom fishing activities. It can also be considered relevant in the discussion of scientific codes of conduct, particularly with regard to of scientific fisheries research. The FAO in its draft international guidelines for the management of deep-sea fisheries in the high seas notes:

> Vulnerability is related to the likelihood that a population, community, or habitat will experience substantial alteration from short-term or chronic disturbance, and to the length of time required to recover after a disturbance. The most vulnerable marine ecosystems are ones that are both easily disturbed and are very slow to recover, or may never recover. Vulnerable ecosystem features may be physically or functionally fragile. (FAO 2008, §19).

Significant adverse impact, which is also relevant to all scientific activities, is elaborated upon in the same FAO document:

> Adverse impacts caused by fishing gear or other anthropogenic disturbances are impacts on populations, communities, or habitats that are more than minimal and not temporary in nature. The impact will be adverse if its consequences are spread in space or through ecosystem interactions and are not temporary, even if the ecosystem feature that is directly impacted shows rapid recovery.
>
> Adverse impacts become significant when the harm is serious or irreversible. Impacts that are likely to take two or more generations of the impacted populations or communities or more than 20 years (whichever is shorter) to reverse are considered irreversible. Impacts that are likely to reduce the productivity of any population impacted by the fishery (whether intentional or accidental); or the productivity, species richness, or resilience of an impacted community or ecosystem; or the structural complexity of a habitat are considered serious. In this context productivity is intended to mean all aspects of a population's capacity to maintain itself. In circumstances of limited information the assumption should be that impacts will be serious or irreversible unless there is evidence to the contrary. (ibid, §§19–20)

The aim of a code of conduct is to minimize the significant adverse impacts of scientific activities, while maintaining scientific value of the research. Codes of conduct can be developed and applied as a measure in the absence of laws and management plans, but may also be used to enhance the implementation of an existing legal framework or used as self-regulatory measures. However, without any incentive by which to encourage adherence and monitoring, codes of conduct can be "toothless" and their value may be called into question. OSPAR suggests that agreement to its [draft] code of conduct should be a prerequisite for the granting of research funds and ship time.

13.2 Overview of relevant regulations and codes of conduct

There are already some codes of conduct or guidelines developed to mitigate possible negative effects on sensitive marine habitats. Some present general principles for responsible science, while others give more detailed advice for how to perform field activities in particular marine habitats. Here we briefly highlight five different codes of conduct and one set of regulations. The core parts of these are attached as Appendices 1–6.

OSPAR Code of Conduct for Responsible Marine Research in the Deep Seas and High Seas of the OSPAR Maritime Area

OSPAR is in the process of developing an overarching statement on principles for responsible marine research (Appendix 1). Together with technical annexes on specific applications (e.g. research in cold-water coral habitats) this will constitute an OSPAR Code of Conduct for Responsible Marine Research in the Deep Seas and High

Seas of the OSPAR Maritime Area. In this context *deep sea* will follow the FAO definition, meaning areas deeper than 200 metres, and *high seas* mean areas beyond national jurisdiction. The overarching text is based on the InterRidge Statement of Commitment to Responsible Research Practices at Deep-Sea Hydrothermal Vents (Appendix 2), and an unofficial translation of the German Senatskommission für Ozeanographie/German Marine Consortium KDM, Commitment to Responsible Marine Research (Appendix 3), and comments from members of the group and the chair of ICG-MPA.

InterRidge statement of commitment to responsible research practices at deep-sea hydrothermal vents and Endeavour Hydrothermal Vent regulations

Research activities represent the largest existing impact on deep-sea hydrothermal vents. However, there are prospects of commercial activities such as mineral mining on vent sites. Effects of the research are visible at locations where research has been carried out repeatedly (Glowka, 2003). The InterRidge (International Cooperation in Ridge-Crest Studies) statement of commitment to responsible research practices at deep-sea hydrothermal vents (Appendix 2) consists of six general principles similar to those presented by OSPAR.

The Endeavour Hydrothermal Vents (NE Pacific Ocean) were designated a Marine Protected Area through regulations under the Canadian Oceans Act (Endeavour Hydrothermal Vents Marine Protected Area Regulations (SOR/2003–87), Appendix 3). These regulations were formally accepted in 2003.

13.3 General principles for responsible German marine research

The principles presented by The German Senatskommission für Ozeanographie and the German Marine Consortium and OSPAR (Appendix 4) cover impacts on different levels ranging from species and habitat to organization and collaboration between scientific projects. These influenced the OSPAR [draft] code of conduct noted above.

13.4 Guidelines for coral reef research

Due to the high natural heterogeneity both in habitat elements and composition of associated fauna, detecting statistically valid patterns requires a high number of samples and replication. In addition, for faunistic studies, sampling needs to be above a minimum size to capture mobile animals. With increased public and research interest the sampling effort may also increase. The two codes of conduct for research on coral reefs (Appendices 5 and 6) provide guidance on how to perform operations with remotely operated vehicle (ROV), different benthic sampling gears, moorings, and seismic with minimal impact on the habitat and organisms. The Irish Department of the Environment, Heritage & Local Government has produced a Code of Practice for Marine Scientific Research at Irish Coral Reef Special Areas of Conservation (sCACs). These guidelines therefore don't apply for coral reefs outside sCACs. This code of practice also presents a risk assessment wherein they rank benthic sampling using nets, traps and near-bottom towing as the highest risk (Table 1). An initial draft of technical guidelines on in-situ research and bioprospecting on cold-water coral reefs within the OSPAR region was presented by Norway to the OSPAR working group on Marine Protected Areas, Species And Habitats (MASH) in 2006. It was based on the Irish Code of Practice mentioned above, and at the meeting it was agreed that this should become a technical annex to the above-mentioned overarching OSPAR code of conduct, but it has not yet been completed.

Table 1 Assessment of MSR-related risk to deep-water coral reefs (source: Code of Practice for Marine Scientific Research at Irish Coral Reef Special Areas of Conservation).

Risk	Potential Category of MSR	Impact[2] (1–5)	Probability[3] (1–5)	Rank[4]
Equipment projecting beyond an ROV damages reef structures	ROVs	3	1	Low
Poor control of ROV leading to increased physical contact with reefs	ROVs	3	1	Low
Accidental deployment of benthic equipment (including landers) or moorings onto reefs causing breakage/abrasion	Benthic sampling Moorings deployment	3	4	Medium
Targeted removal of species impinges population/reef integrity	Benthic sampling ROVs Fishing gear	4	3	Medium
Complete loss of equipment onto reef due to mechanical failure	General	3	1	Low
Physical impact on reef structures using sampling gear	Benthic sampling Fishing gear Near-bottom towing	4	4	High
Smothering of reefs through sedimentation	Benthic sampling Fishing gear	4	3	Medium
Snagging of umbilical/warp on reefs causing breakage/abrasion	ROVs Moorings deployment Fishing gear	3	1	Low
Disturbance or injury of marine mammals	Seismic survey	4	3	Medium
Sampling equipment or moorings being accidentally towed across a reef	Benthic sampling Moorings deployment Near-bottom towing	4	3	Medium
Research results are not published leading to repetition of sampling effort over time	General	3	3	Medium

13.5 Discussion

Codes of conduct for research activities are voluntary measures meant to reduce the risk of adverse effects biota and environment. Increasing research on deep-water features such as coral reefs may lead to physical damage or reduce local abundances of species. Many deep-water habitats are sensitive and vulnerable to disturbance, and thus should be managed accordingly; codes of conduct offer one promising approach, though their efficacy is yet to be fully demonstrated. The codes of conduct reviewed here fall into two general categories, either overarching general principles for marine research or practical guidelines for specific types of research, particularly on *Lophelia* reefs.

The overarching principles are ones that should easily be agreed upon by scientists and advisory organizations. However, the specific details are highly dependent upon

2 Impact: 1 Insignificant, 2 Minor, 3 Moderate, 4 Major, 5 Catastrophic
3 Probability: 1 Rare, 2 Unlikely, 3 Possible, 4 Likely, 5 Almost certain
4 Rank (= Impact * Probability): > 14 High, 5 - 14 Medium, < 5 Low

organisms and ecosystems being studied and the state of biological knowledge and in the absence of a technical annex may leave a lot to interpretation. Therefore, the general principles are best accompanied by technical annexes that describe the research activities in more detail relevant for the characteristic features of different sensitive habitats. Furthermore, the likely impact of a given sampling protocol can in many cases be impossible to assess when planning the details of scientific field activities, particularly for poorly studied ecosystems, species and habitats. For instance, at the species level, whether the scientific research activities would not lead to long-lasting changes in regional populations or substantially reduction to the number of individuals present may be difficult to determine, particularly when the number of individuals or regional population size is not known. Nonetheless, specified precautionary good practices can reduce the risk of such changes occurring.

The risks associated with marine research in sensitive habitats, as contained in the codes of conduct and regulations attached to this report can be grouped into:

1) Disturbance or damage to structural habitat features
2) Smothering of filter feeders or suspension feeders through sedimentation
3) Reduction of regional population size
4) Reduction of local number of individuals
5) Disturbance or damage to threatened or declining species/habitats
6) Disturbance or damage to protected features
7) Introduction of alien species
8) Ghost fishing (by lost fishing gear)
9) Disturbance or injury of marine mammals

These risks have associated with them differing potential impacts and probabilities of occurrence, and are not unique for any of the sensitive habitats mentioned above. The ranking of the risks in table 1 illustrates that physical impact by sampling gears on the habitat is a central issue when developing codes of practice. Special characteristics of the habitats may however make it necessary to describe the performance of research activities separately for the different habitats.

Codes of conduct cannot be expected to cover all eventualities and will require sound professional judgement in their implementation. For example, the Initial draft of guidelines on in-situ research and bioprospecting on cold-water coral reefs (Appendix 6) suggest that "Coral habitats with a limited extension (e.g. < 10 m in longest direction) should not be sampled with more than 5 grabs at one single occasion or repeatedly over time involving more than 5 grabs." Even so, the guidelines may fail to prevent over-sampling (significant reduction of local number of individuals) of small coral reefs if their size is not known, or if multiple visits occur over the course of a few years. In this example, adherence to good professional practices can mitigate these risks. Thus, reefs selected for sampling should be inspected or mapped to document their spatial extension. National registries for such activities could avoid the risk for repeated sampling by different research groups, which could cause accumulating damage.

Although coral reefs and hydrothermal vents have to date received the most attention, other habitats can also be threatened by research activities; such habitats include other biogenic reefs, sponge grounds, coral gardens, sea pen meadows, etc. These have their own special characteristics that can suggest specific technical guidelines for research activities.

13.6 Recommendations

1) **Overarching Principles:** WGDEC recognises the work done to date on developing overarching principles and codes of conduct. WGDEC recommends that ICES does not ”re-invent” these overarching principles, but rather that it support and endorse this existing work, including the [draft] overarching code of conduct developed by OSPAR, which incorporates earlier work by InterRidge and German scientific institutions.

2) **Technical Guidance:** WGDEC recognises the work begun in this area, but would like to highlight the need to develop broadly agreed-upon technical guidance for research in particularly sensitive habitats, such as coral communities. WGDEC recommends that this technical guidance be developed as soon as possible to avoid long lasting or permanent damage to these sensitive habitats.

References

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Annex 13.1 [Draft] OSPAR code of conduct for responsible marine research in the deep seas and high seas of the OSPAR maritime area (excerpted)

a) **Species**: avoid, in the course of scientific research, activities that could lead to long-lasting changes in regional populations or substantially reduce the number of individuals present.

b) **Habitats:** avoid, in the course of scientific research, activities which could lead to substantial physical, chemical, biological or geological changes or damage to marine habitats.

c) **Threatened and/or declining features:** When working in areas of particular ecological vulnerability, including, *inter alia*, the features listed in the OSPAR "List of Threatened and/or Declining Species and Habitats" utmost care should be taken not to disturb or damage the features as far as possible.

d) **Management areas/marine protected areas:** When working in areas of particular ecological importance and/or sensitivity, including, *inter alia*, OSPAR marine protected areas, care has to be taken not to disturb or damage the protected features, and that activities are in compliance with regulations for the area. Further, scientists are requested to respect the importance of management areas like marine protected areas and are asked to assist in their implementation through the use of the best scientific knowledge.

e) **Notification and research planning:** Avoid activities which could disturb the experiments and observations of other scientists. This requires that scientists: a) make themselves familiar with the status of current and planned research in an area; and b) that they ensure that their own research activities and plans are known to the rest of the international research community via appropriate public domain data bases and web sites.

f) **Methods:** Use the most environmentally-friendly and appropriate study methods which are reasonably available.

g) **Transport of biota:** Ensure that transport of biota between different marine regions, which could lead to changes in the environment or the composition of marine communities, does not occur.

h) **Collections:** Avoid collections that are not essential to the conduct of the scientific research, and reduce the number of samples to the necessary minimum.

i) **Collaboration and cooperation:** Ensure the fullest possible use of all biological, chemical and geological samples through collaborations and cooperation within the global community of scientists. Samples which can be archived should be placed in accessible repositories for future use.

j) **Data-sharing**: Practise international sharing of data, samples and results in order to minimize the amount of unnecessary sampling and to further a global understanding of the marine environment.

Annex 13.2 InterRidge statement of commitment to responsible research practices at deep-sea hydrothermal vents (excerpted)

1) Avoid, in the conduct of scientific research, activities that will have deleterious impacts on the sustainability of populations of hydrothermal vent organisms.

2) Avoid, in the conduct of scientific research, activities that lead to long lasting and significant alteration and/or visual degradation of vent sites.

3) Avoid collections that are not essential to the conduct of scientific research.

4) Avoid, in the conduct of scientific research, transplanting biota or geological material between sites.

5) Familiarize yourself with the status of current and planned research in an area and avoid activities that will compromise experiments or observations of other researchers. Assure that your own research activities and plans are known to the rest of the international research community through InterRidge and other public domain data bases.

6) Facilitate the fullest possible use of all biological, chemical and geological samples collected through collaborations and cooperation amongst the global community of scientists.

Annex 13.3 Endeavour Hydrothermal Vents Marine Protected Area Regulations (SOR/2003-87)

http://laws.justice.gc.ca/en/showtdm/cr/SOR-2003-87

Oceans Act

Endeavour Hydrothermal Vents Marine Protected Area Regulations

P.C. 2003–283 March 4, 2003

Her Excellency the Governor General in Council, on the recommendation of the Minister of Fisheries and Oceans, pursuant to subsection 35(3) of the *Oceans Act*[a], hereby makes the annexed *Endeavour Hydrothermal Vents Marine Protected Area Regulations*.[a] S.C. 1996, c. 31.

Designation

1. The area of the Pacific Ocean-the seabed, the subsoil and the waters superjacent to the seabed-that is bounded by a line drawn from a point at 47°54′N, 129°02′W, from there west to a point at 47°54′N, 129°08′W, from there north to a point at 48°01′N, 129°08′W, from there east to a point at 48°01′N, 129°02′W, and from there south to the point of beginning, is hereby designated as a marine protected area to be known as the Endeavour Hydrothermal Vents Marine Protected Area (the "Area").

Prohibitions

2. No person shall

(*a*) disturb, damage or destroy, in the Area, or remove from the Area, any part of the seabed, including a venting structure, or any part of the subsoil, or any living marine organism or any part of its habitat; or

(*b*) carry out any underwater activity in the Area that is likely to result in the disturbance, damage, destruction or removal of anything referred to in paragraph (*a*).

3. (1) No person contravenes Section 2 if

(*a*) the disturbance, damage, destruction or removal is for scientific research for the conservation, protection and understanding of the Area;

(*b*) subject to subsection (3), a research plan described in subsection (2) is submitted to the Minister at least 90 days before the start of the scientific research in the Area; and

(*c*) all licences, authorizations or consents required under the *Oceans Act*, the *Coastal Fisheries Protection Act*, the *Coasting Trade Act* or the *Fisheries Act* in respect of the scientific research have been obtained.

(2) A research plan shall include the following information:

(*a*) the name, nationality, overall length, maximum draught, net tonnage, propulsion type, call sign, registration number and port number of each ship to be involved in the scientific research in the Area, and the name of the captain of each ship;

(*b*) the names and positions of the persons who are responsible for the development of the scientific research, and the scientific research personnel who will be on board each ship;

(*c*) the date on which the scientific research in the Area is to start, and the itinerary for each ship while it is involved in the research; and

(*d*) a summary of the scientific research to be conducted in the Area, together with a detailed map of the research area, which summary shall specify:

(i) the data to be collected and sampling protocols to be used,

(ii) the other techniques, if any, to be used, such as those involving explosives, radioactive labelling or remotely operated vehicles,

(iii) the equipment to be moored and the method of mooring, and

(iv) the substances, if any, that are intended to be discharged.

(3) A research plan is not required to be submitted under Paragraph (1)(*b*) if the information required under Subsection (2) has previously been submitted in writing to obtain a consent under the *Coasting Trade Act* to conduct the scientific research.

(4) A person who submits a research plan shall immediately notify the Minister in writing of any subsequent changes to the plan.

4. No person contravenes section 2 by carrying out an activity in the Area

(*a*) by means or under conditions that are authorized under Subsection 35(2) of the *Fisheries Act*;

(*b*) for which they have a consent under the *Coasting Trade Act*; or

(*c*) for which they have a licence or authorization under the *Oceans Act*, the *Coastal Fisheries Protection Act* or a provision of the *Fisheries Act* other than Subsection 35(2).

5. No person contravenes Section 2 by carrying out any movement or other activity of ships or submarines if

(*a*) the movement or other activity is carried out for the purpose of public safety, law enforcement, or Canadian sovereignty or national security; and

(*b*) the ships or submarines, as the case may be, are owned or operated by or on behalf of Her Majesty in right of Canada or by foreign military forces acting in cooperation with, or under the command or control of, the Canadian Forces.

Coming into force

6. These Regulations come into force on the day on which they are registered.

Annex 13.4 Commitment to responsible German marine research (translation of the German Senatskommission für Ozeanographie of the DFG and the German Marine Consortium KDM) (excerpted)

1) Avoid, in the course of scientific research, activities which could lead to long-lasting changes in regional populations or substantially reduce the number of individuals present.

2) Avoid, in the course of scientific research, activities which could lead to substantial physical, chemical, biological or geological changes or damage to marine ecosystems.

3) When working in areas of particular ecological sensitivity (for the North Atlantic and Baltic, for example, the areas listed in the OSPAR and HELCOM "List of Threatened and/or Declining Species and Habitats") or in national or international marine protected areas, care should be taken not to disturb or damage the protected areas (and especially protected species and biotopes) as far as possible.

4) Avoid collections that are not essential to the conduct of the scientific research.

5) Use the most appropriate and environmentally-friendly study methods which are reasonably available.

6) Ensure that transport of biota between different marine regions, which could lead to changes in the environment or the composition of marine communities, does not occur.

7) Avoid activities which could disturb the experiments and observations of other scientists. This requires that scientists make themselves familiar with the status of current and planned research in an area and that they ensure that their own research activities and plans are known to the rest of the international research community via public domain data bases.

8) Ensure the fullest possible use of all biological, chemical and geological samples through collaborations and cooperation within the global community of scientists. Samples which can be archived should be placed in accessible repositories for future use.

9) Make a commitment to the international sharing of data, samples and results in order to minimize the amount of unnecessary sampling and to further a global understanding of the marine environment.

Annex 13.5 Code of practice for marine scientific research at Irish Coral Reef Special Areas of Conservation version 1.1 (excerpted)

General

1) MSR consents must be carried aboard research vessels and presented for inspection upon request by a member of An Garda Síochána, the Irish Naval Service, or an Authorised Officer for the purposes of the EC (Natural Habitats) Regulations, 1997 (S.I. No. 94 of 1997).

2) Approved operations must be conducted in a manner consistent with consent specifications, the provisions of the United Nations Convention on the Law of the Sea, 1982, and this code of practice.

3) Authorised Officers must be provided with full access to ensure compliance with consent specifications.

4) Authorised Officers may immediately suspend, amend or revoke consents if, in their view, MSR operations will adversely affect the conservation status of the cSAC.

5) Where equipment is being deployed within cSACs, every effort should be made to avoid equipment loss or stranding. This includes the use of well-maintained, high quality materials, incorporating as many backups as possible into sampling systems and ensuring all knots/splices/shackles are checked by experienced personnel.

Remotely Operated Vehicles (ROVs)

6) ROVs may only be utilised in cSACs when controlled by operators with at least 1 year of direct ROV experience.

7) Nothing may be allowed to hang freely or protrude unduly from the ROV during operations.

8) The accumulation of ROV umbilical or warp close to or on the seafloor should be avoided.

Benthic sampling

9) Use of towed bottom sampling equipment or drilling technologies are not specifically precluded in the sites. However, researchers are strongly encouraged to contact the National Parks and Wildlife Service of the Department at the earliest possible opportunity (contact details are set out in Appendix 1) to discuss the (i) proposed sampling techniques, (ii) likely impacts that may arise and (iii) available biological and physical knowledge of the proposed target site. In acknowledging the range of sampling technologies available and their differing impacts, such discussions will inform whether a prior site assessment is necessary and, if so, the appropriate scale and content of such an assessment.

10) Physical contact between benthic sampling equipment (including landers) and coral reefs should be minimised. To that end, all available measures necessary to ensure accurate navigation on known coral habitats should be adopted.

11) Numbers of extractive samples or specimens should be kept to a minimum and retrieved using visually assisted methodologies, where feasible.

12) Opportunities to maximise the value of samples collected should be fully exploited including the lodgement of specimens in natural history museums, collaboration with other workers, etc.

13) Where specimens are lodged in a natural history museum the National Parks and Wildlife Service of the Department must be notified of what was lodged, the location and the catalogue number (contact details are set out in Appendix 1).

14) Where particular species of fauna are being targeted, consideration should first be given to the use of alternative sites outside cSACs where possible.

Moorings deployment

15) Avoid the accumulation of mooring warp close to or on the seafloor.

16) Physical contact between moorings and coral reefs should be minimised. To that end, all available measures necessary to ensure accurate navigation on known coral habitats should be adopted.

Fishing gears

17) Use of fishing gears for scientific purposes is not specifically precluded in the sites. However, researchers are strongly encouraged to contact the National Parks and Wildlife Service of the Department at the earliest possible opportunity (contact details are set out in Appendix 1) to discuss the (i) proposed fishing techniques, (ii) likely impacts that may arise and (iii) available biological and physical knowledge of the proposed target site. In acknowledging the range of fishing techniques available and their differing impacts, such discussions will inform whether a prior site assessment is necessary and, if so, the appropriate scale and content of such an assessment.

Seismic survey[5]

18) The minimum acoustic source level to achieve the desired results should be used. The acoustic frequencies should be chosen to minimise impacts on marine mammals. Use of pulsed as opposed to continuous sounds should be employed, where possible.

19) A qualified and experienced marine mammal observer (MMO) should be present on board the research vessel during seismic survey operations. The MMO should survey the area for 60 minutes before the onset of soft start. If marine mammals are seen within 2000 metres of the centre of the sound source the start of the sound source(s) should be delayed until they have moved away, allowing adequate time after the last sighting for the animals to leave the area (60 minutes). If the cetaceans do not leave the area, it is recommended that the survey vessel alter course to ensure that the animals are outside the 2000 metre exclusion zone when soft start commences.

20) Soft starts should achieve the maximum (or desired) output after 40 to 60 minutes. Power should be built up slowly from a low energy start-up (e.g., starting with the smallest airgun in the array and gradually adding in others) over at least 20 minutes to give adequate time for marine mammals

5 Possible impacts of other acoustic survey techniques (e.g., multibeam, side scan sonar) are currently being reviewed with a view to developing mitigation measures, where necessary.

to leave the vicinity. This build up of power should occur in uniform stages to provide a constant increase in output from the sound source.

21) There should be a 'soft start' every time the sound source(s) is used, even if no marine mammals have been seen. Soft starts must occur during daylight hours so that MMO's can carry out the required pre-soft start scan.

22) If, for any reason, firing of the sound source has stopped and not restarted for at least 5 minutes a full 'soft start' should be carried out. After any break in firing of any duration a visual check should be made for marine mammals within the 'exclusion zone' for that depth. If a marine mammal is present then re-commencement of shooting should be delayed as per the instructions above.

23) Once the sound source has achieved its maximum output (post-soft start) the survey need not be halted should cetaceans approach the vessel.

24) With the sound source running, if the turn-around time between sample lines or stations is greater than the start-up time then a soft start should be used.

25) If a break in output greater than 5 minutes is required whilst sampling then a full startup is required.

Near-bottom towing

26) Any towed near-bottom equipment must be flown at a sufficient height so as to avoid accidental impacts with the reef. Tows should be parallel or shallow oblique to slopes.

Reporting

27) Access to all data and imagery, both in a processed and unprocessed form, collected during a research cruise must be provided to National Parks & Wildlife Service of the Department upon request (contact details are set out in Appendix 1).

28) Where a MMO is utilised, a short report from the MMO summarising activities undertaken, positions, and sightings should also be included with the preliminary report of the Chief Scientist.

29) Research results must be published and/or made internationally available within 3 years of the relevant cruise unless otherwise agreed with National Parks & Wildlife Service of the Department. National Parks & Wildlife Service will utilise (and not publish) such knowledge/information for management purposes as necessary thereafter whilst fully acknowledging the data collectors/processors entitlements.

30) Research publications should acknowledge the co-operation of the Irish Government in providing access to the sites and a copy of all publications arising from research conducted in cSACs must be provided free of charge to National Parks & Wildlife Service of the Department (contact details are set out in Appendix 1).

Annex 13.6 Initial draft of guidelines on *in-situ* research and bioprospecting on cold-water coral reefs

General

1) MSR consent must be carried aboard research vessels and presented for inspection upon request by an Authorised Officer.

2) Approved operations should be conducted in a manner consistent with consent specifications and the code of practice.

3) Authorised Officers must be provided with full access to ensure compliance with consent specifications.

4) Authorised Officers may immediately suspend, amend or revoke consent if, in their view, MSR operations will adversely affect the conservation status of the local coral habitats.

5) Where equipment is being deployed within a coral habitat, all available measures necessary to ensure accurate navigation should be adopted.

Remotely Operated Vehicles (ROVs)

6) ROVs may only be utilised by experienced professional operators.

7) Nothing may be allowed to hang freely under or protrude unduly from the ROV during operations.

8) The accumulation of ROV umbilical or warp close to or on the seafloor should be avoided.

Benthic sampling

9) The use of towed bottom sampling equipment is not permitted.

10) Drilling/coring? Application process for permission?

11) Physical contact between benthic sampling equipment and coral reefs should be minimised. To that end, all available measures necessary to ensure accurate navigation on known coral habitats should be adopted.

12) Numbers of extractive samples or specimens should be kept to a minimum and retrieved using visually assisted methodologies, where feasible.

13) Coral habitats with a limited extension (e.g. <10 m in longest direction) should not be sampled with more than 5 grabs at one single occasion or repeatedly over time involving more than 5 grabs.

14) Opportunities to maximise the value of sample samples collected should be fully exploited including the lodgement of specimens in natural history museums, collaboration with other workers, etc.

15) Where particular species of fauna are being targeted, consideration should first be given to the use of alternative sites outside the coral habitat.

Mooring deployments

16) Avoid accumulation of mooring warp close to or on the seafloor.

17) Physical contact between moorings and coral reefs should be minimised. To that end, all available measures necessary to ensure accurate navigation on known coral habitats should be adopted.

Near-bottom towing

18) Any towed near-bottom equipment must be flown at a sufficient height so as to avoid accidental impacts with the reef. Tows should be parallel or shallow oblique to slopes.

14 Compile and update map databases

Term of Reference (k): Continue to develop and compile a database and map of areas where biological research/survey has occurred in the deep water area (>200 m) of the North Atlantic and considering the report of the Planning Group on the North-east Atlantic continental slope survey (PGNEACS), make recommendations for future work in this area;

The database produced by WGDEC in 2007 was updated and some additional information was included. The map was updated and extended to cover surveys in the NAFO area. EEZ boundaries have been added. The new map is GIS based and data can now be provided in shape file format.

14.1 The following new datasets were included in the database and in the map

- MAR-ECO-MAR benthic surveys. Results published in Marine Biology Research 4(1). Survey data communicated by B. Christiansen.
- Russian benthos studies 1982/2001. Survey data and results published in Martynov and Litvinova 2008. Survey data communicated by B. Christiansen.
- Deep-water corals from Josephine Bank (Nordatlantische Kuppenfahrten). Results published in Grasshoff 1985. Survey data communicated by B. Christiansen.
- Russian deepwater surveys 2000–2007. Survey data provided by V. Vinnichenko.
- Irish Deepwater survey 2007. Survey data provided by G. Johnston and B. O'Hea.
- Spanish Porcupine IBTS survey 2007. Survey data provided by P. Duran.
- North Spain IBTS Survey. Survey data provided by P. Duran.
- US ROV and submersible dives. Survey data provided by P. Auster and E. Kenchington.
- FRS Marine Laboratory (UK) May 2007 survey on Rockall, Anton Dohrn Seamount and Rosemary bank (data provided F. Neat).

14.2 Remarks on new data entered

Only surveys targeting benthos and/or demersal or pelagic fish at depths >200 m have been considered in the database. Some of the surveys cover large areas or transects. In the map, they are represented by diamonds at the approximate centre locations. This may be misleading in some cases, in particular if the survey area was not rectangular, or the transect was not straight. The US dive locations are shown separately both in the map and in the table. Dives were conducted with multiple submersible vehicles (e.g., Alvin, Johnson-Sea-Link, Delta, multiple ROVs) for a diversity of projects and purposes and there is no central database of coral taxa or associated organisms. However, copies of original imagery and navigation reside in image archives (i.e., Woods Hole Oceanographic Institution, Harbor Branch Oceanographic Institution, National Undersea Research Centers at University of Connecticut and University of North Carolina at Wilmington). Positions of the Spanish IBTS surveys were taken from the maps provided and are therefore only approximate. Some of the Russian survey data have been pooled because they covered the same area. No geographical positions were given for the Spanish Hatton

and Cadiz surveys provided by P. Duran; these surveys have not been included at this stage. References for the survey data are missing in several cases; in other cases they refer to internal papers that are not publicly available.

14.3 PGNEACS and recommendations for future work on deepwater survey database

PGNEACS (Planning Group for North East Atlantic Continental Shelf Surveys) formed in Galway Ireland in January 2008. The aim of the PG is to coordinate the sampling methods and area coverage of deepwater fisheries surveys along the European continental slope. Countries involved are UK (FRS Scotland), Ireland (Marine Institute), France (IFREMER), Portugal () and Norway (IMR).

The database held by WGDEC is still a simple spreadsheet; transferring the data to a relational database is highly recommended and advice should be sought prior to the next meeting about how best to do this. In Section 5.6 of the PGNEACS report it is recommended to produce a combined geo-database that can be interrogated using Geographic Information Systems software (e.g. ARC GIS). This would allow different information sources to be cross-referenced and linked across whatever spatial scale is required for investigation and research. With respect to this it may useful to link the WGDEC database on deepwater surveys to the PGNEACS geo-database.

It is also recommended that a future development would be to link papers resulting from the surveys to the database. These could either be directly attached or stored in a separate database (probably in EndNote or RIS format) linked to the survey database. Currently linkage to external databases like OBIS or Pangaea is not possible since not all data are held in electronic databases.

A similar effort for the NAFO area is also recommended. Data mining of papers, museum collections, and image archives could yield important site-specific information for managers. Further, such information will point to gaps in information that would make best use of limited funds for ship time and new surveys.

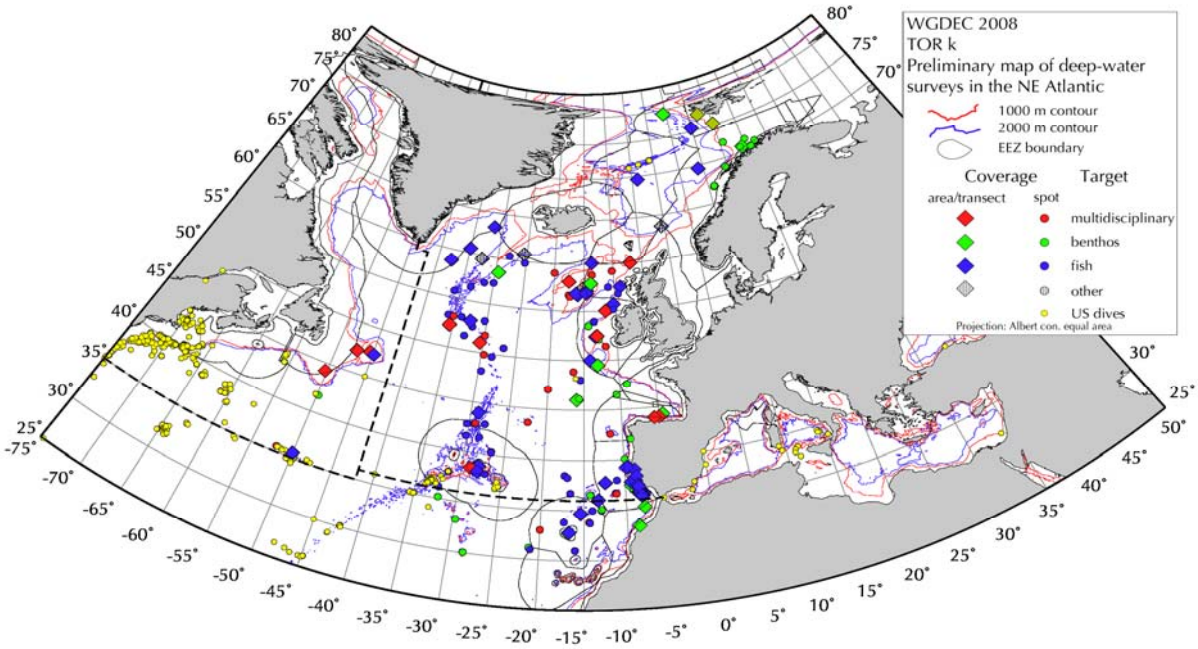


Figure 1. A map showing the geographical coverage of the surveys held in the WGDEC deepwater survey database.

15 Identifying priority areas for multibeam

Term of Reference (l): Determine priority areas for multibeam or sidescan sonar survey on Rockall, Hatton Bank and adjacent seamounts;

Geomorphological survey techniques, such as multibeam and sidescan sonar, have been used widely in the North East Atlantic to determine the shape, extent and distribution of seabed features at varying degrees of resolution. Certain areas of Rockall Bank, Hatton Bank and George Bligh Bank, as well as adjacent seamounts (such as Anton Dorhn and Rosemary Bank) have now been mapped in significant detail using acoustic data, supporting the identification of vulnerable marine habitats (such as cold water coral reefs) by WGDEC. However, significant gaps remain in acoustic data coverage and resolution. We list priority areas for multibeam and sidescan sonar survey in this section. These broad priority areas can be further refined using: i) indications of coral presence (from biological survey, fishermen's records etc.) and ii) predicted patterns of coral distribution (using high resolution bathymetric data and information on substratum types). Comprehensive VMS data for demersal trawling in the NE Atlantic region would also help refine priority areas for acoustic survey by identifying areas of seabed with minimal fishing disturbance.

Note that the areas listed have been identified as high priority for multibeam survey in the first instance. Following comprehensive multibeam coverage, smaller areas of interest may be studied in more depth using sidecan sonar.

Potential multibeam surveys need to consider the resolution of data required to map cold water coral occurrences. In areas of deeper water, the area of seabed ensonified (the acoustic footprint) is much larger when compared to shallower areas; the density of reflected signals is also reduced (depending on the type of equipment used). WGDEC suggest that multibeam data at a resolution of <2 m would be required to map individual coral records; lower resolution data (10 m) would be sufficient to identify coral aggregations or reefs. Sidescan sonar (SSS) can identify seabed relief and substratum types at a finer scale (footprint <1 m) than multibeam. Biological sampling is also recommended in the priority areas, both to ground-truth features identified from acoustic data, and to describe the biological communities present (in particular, cold-water coral communities).

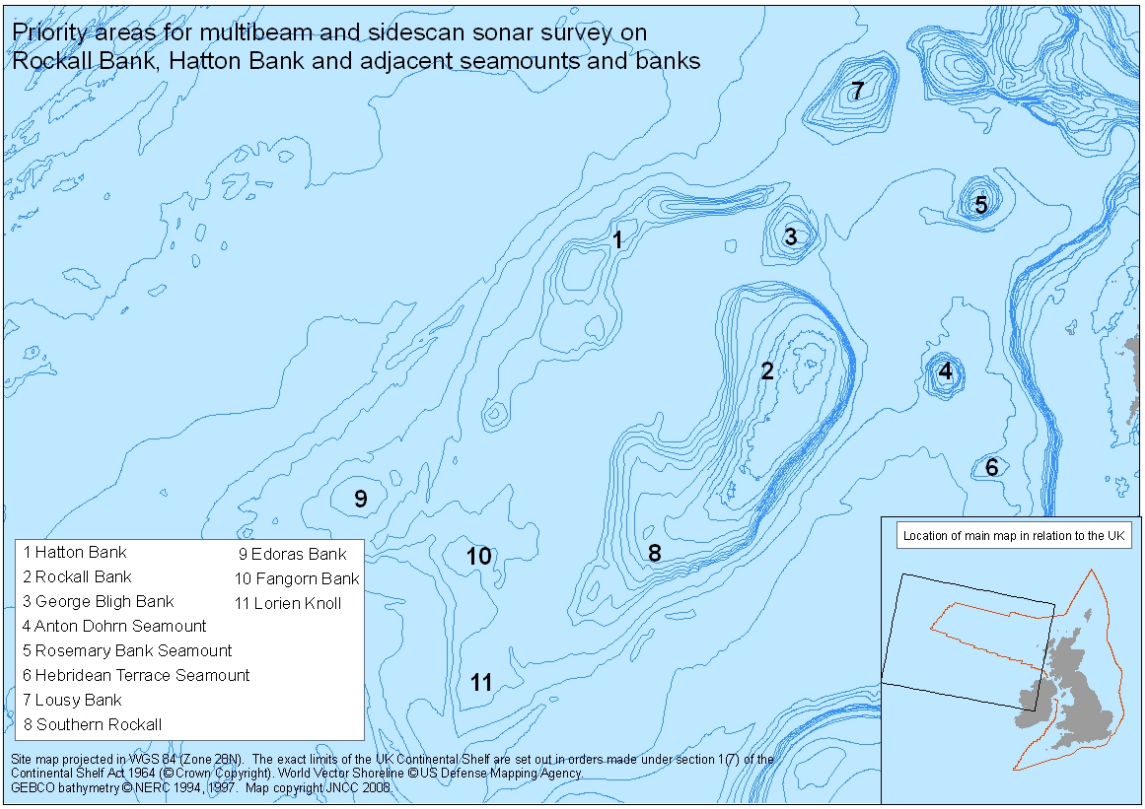


Figure 15 Priority areas for multibeam and sidescan sonar survey.

15.1 Hatton Bank region (including Lyonesse)

The entire western flank of Hatton Bank was subject to a comprehensive multibeam survey by the Spanish IEO in 2005–2007 (Figure 15.1.1). UK Government multibeam surveys (in 2005 and 2006) have been undertaken in discrete areas of the north, central and southern regions of Hatton Bank (including Lyonesse) to a depth of approximately 1000 m, though coverage remains limited given the size of the bank.

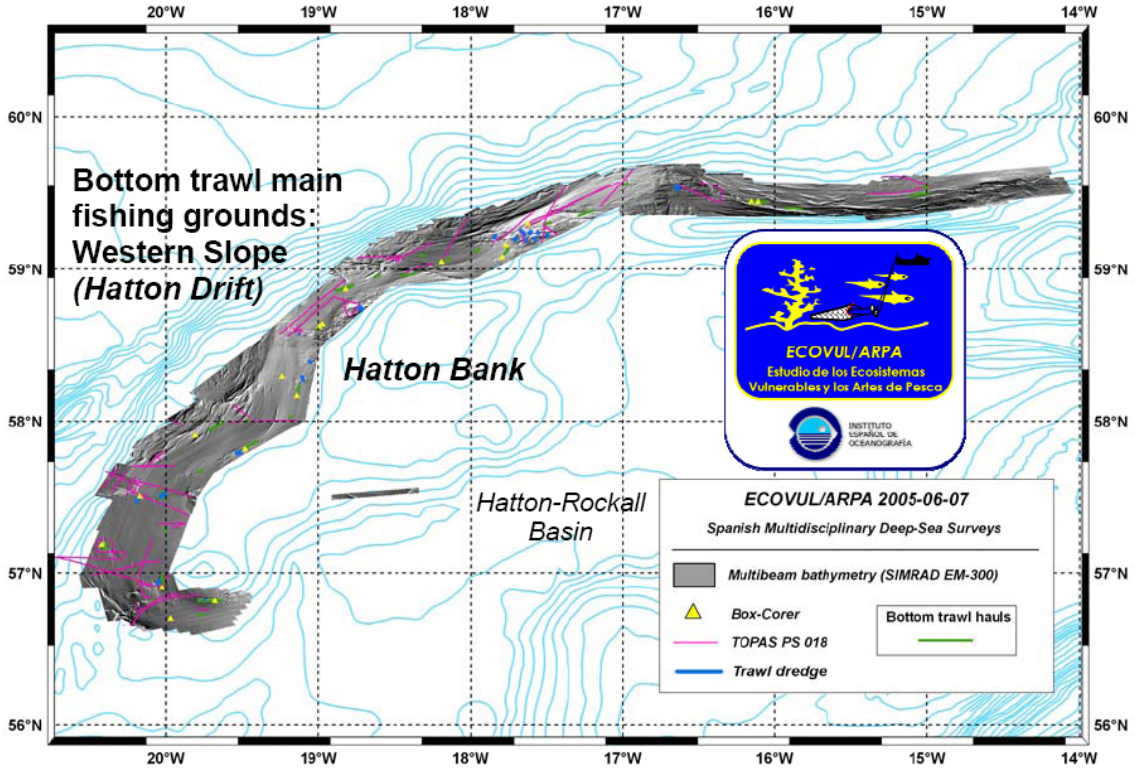


Figure 15.1.1 Hatton Bank: Spanish multibeam data coverage.

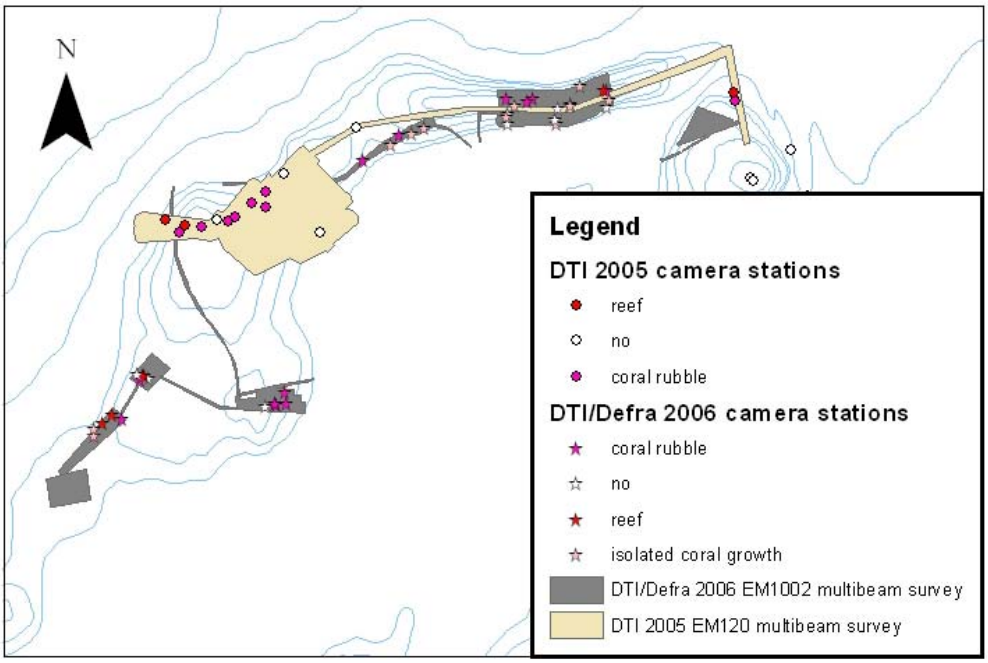


Figure 15.1.2 Hatton Bank: UK multibeam data coverage.

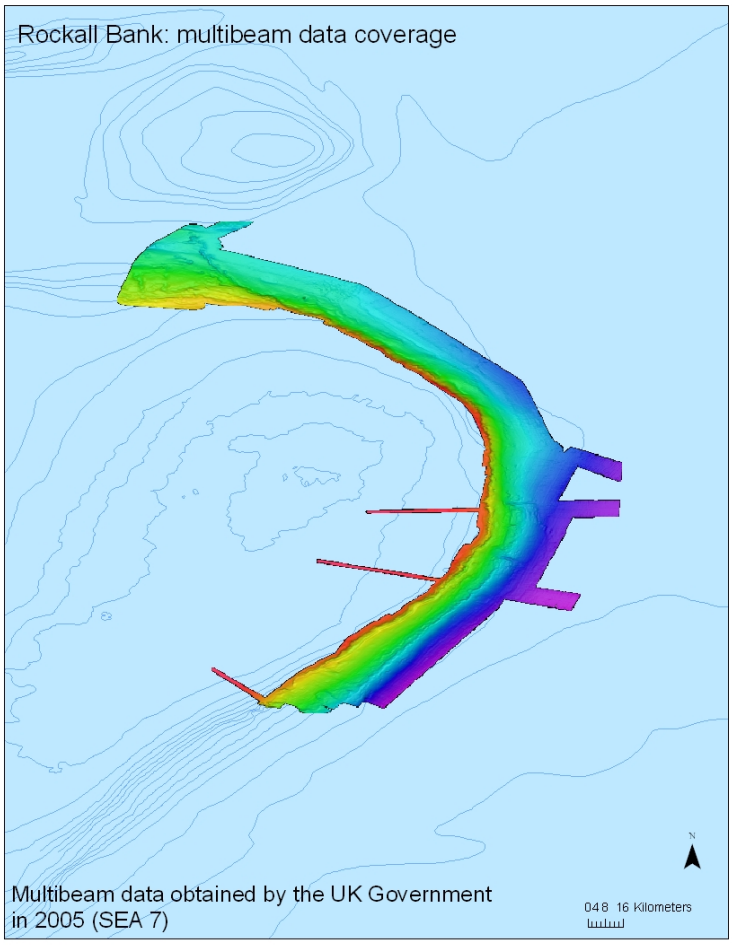
Priority areas for acoustic survey on Hatton Bank region are therefore:

- Areas between 500 m and 1000 m water depth (focusing on the flanks of the bank).
- Deeper waters (>1000 m) along the flanks of the bank (including the Hatton Drift and deeper waters along the northern section of the western flank).
- The southern flanks of the bank adjacent to the current closed area.
- The eastern flanks of the Bank.

15.2 Rockall Bank

The majority of the eastern flank of Rockall Bank has been surveyed with multibeam as part of the UK Government surveys in 2005, to a depth of 1850 m. The following priority areas remain for acoustic survey:

- Areas between 500 m and 1000 m water depth across the whole of the bank (excluding eastern areas already surveyed).
- Deeper waters (>1000 m) along the southern and western flanks of the bank.



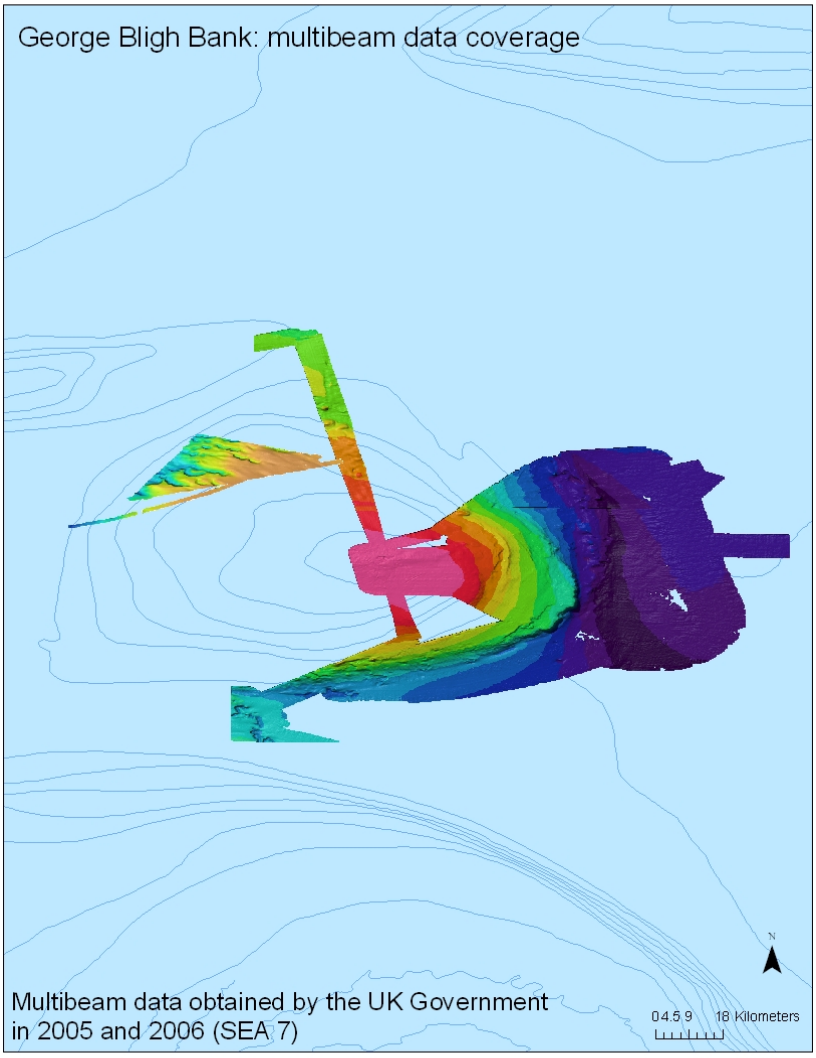
Site map projected in WGS 84 (Zone 28N). The exact limits of the UK Continental Shelf are set out in orders made under section 1(7) of the Continental Shelf Act 1964 (© Crown Copyright). World Vector Shoreline © US Defense Mapping Agency. GEBCO bathymetry © NERC 1994, 1997. Map copyright JNCC 2008.

Figure 15.2.1 Rockall Bank: UK Multibeam data coverage.

15.3 George Bligh Bank

During 2005 and 2006, multibeam data was obtained by the UK Government for much of the eastern side of the George Bligh Bank and a smaller part of the northwest corner of the bank (Figure 15.3.1). Areas that still require acoustic survey include:

- Northern and western flanks of the bank.



Site map projected in WGS 84 (Zone 28N). The exact limits of the UK Continental Shelf are set out in orders made under section 1(7) of the Continental Shelf Act 1964 (© Crown Copyright). World Vector Shoreline © US Defense Mapping Agency. GEBCO bathymetry © NERC 1994, 1997. Map copyright JNCC 2008.

Figure 15.3.1 George Bligh Bank: UK Multibeam data coverage.

15.4 Anton Dohrn

The entire seamount was surveyed with multibeam to a depth of approximately 2000m by the UK Government in 2005. The acoustic survey priorities at the Anton Dohrn seamount are as follows:

- High resolution acoustic survey focusing on features of interest such as pinnacles and outcrops that can be identified from the existing multibeam data.

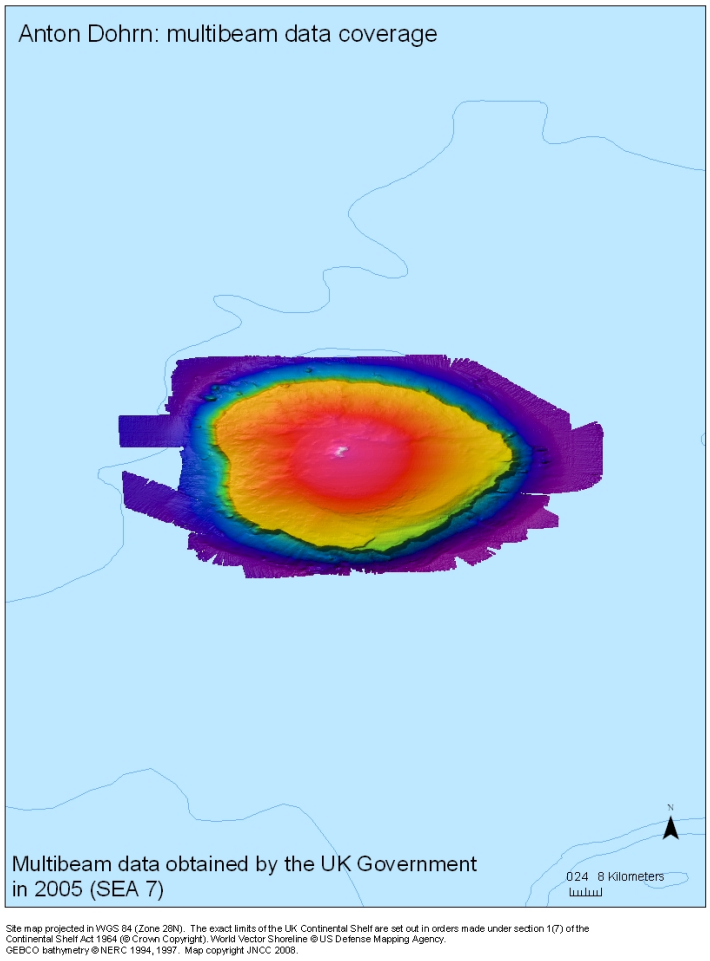


Figure 15.4.1 Anton Dohrn: UK Multibeam data coverage.

15.5 Rosemary Bank seamount

The summit of Rosemary Bank has been surveyed with multibeam to a depth of approximately 1000 m by the UK Government in 2005 and 2006 (Figure 15.5.1). Additional multibeam survey has been undertaken by the British Antarctic Survey on the flanks of the bank (to a depth of about 2000 m) (Figure 15.5.2). Numerous pinnacles are present on the upper summit of the seamount and recent TV deployments by FRS reveal significant areas of exposed bedrock and the presence of gorgonians. Acoustic survey priorities at Rosemary Bank are therefore:

- Sidescan sonar survey of the upper pinnacles of the seamount.

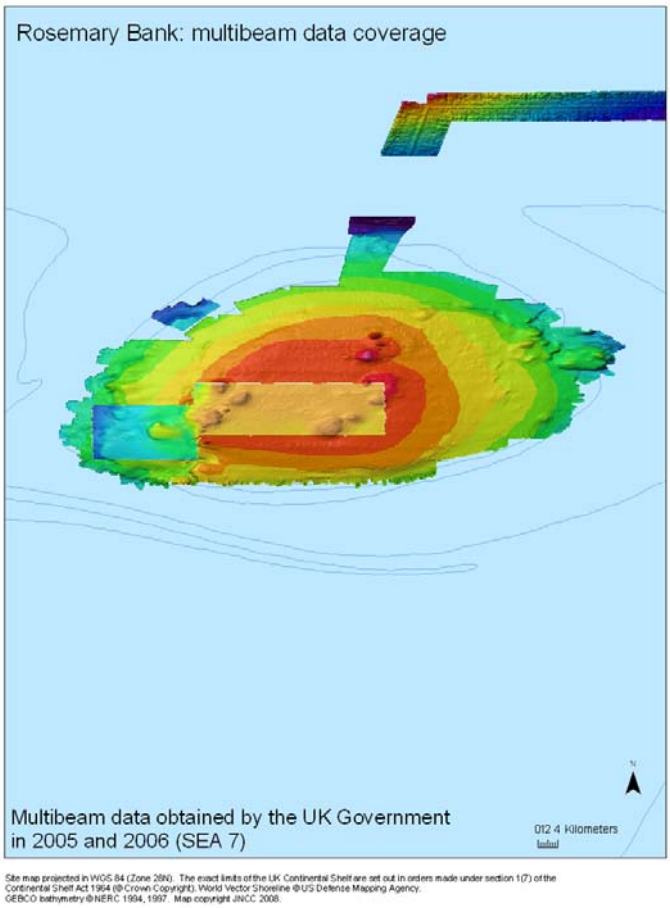


Figure 15.5.1 Rosemary Bank: UK Multibeam data coverage.

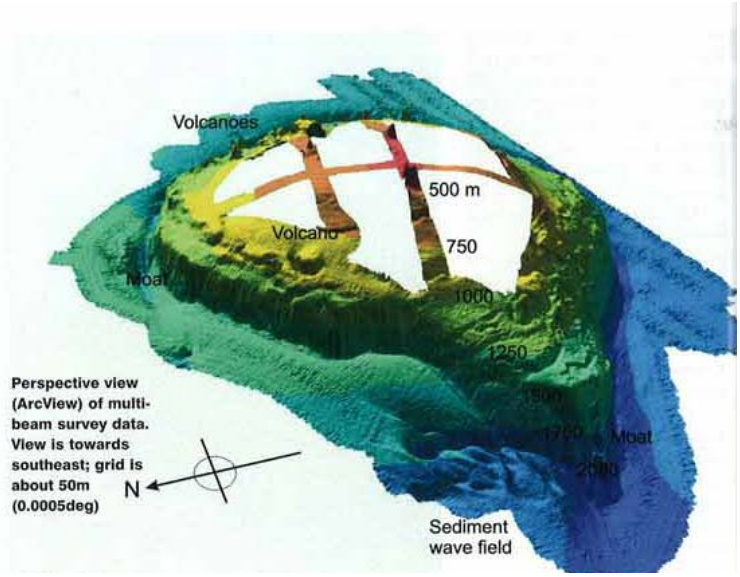


Figure 15.5.2 Rosemary Bank: Multibeam data obtained by the British Antarctic Survey (Pudsey *et al.*, 2004).

15.6 The Hebridean Terrace seamount

No acoustic information is available for this potentially interesting seamount. It is quite different from the other seamounts in the region being deeper at the summit and closer to the continental shelf. As with Anton Dohrn and Rosemary it would be very useful to have a complete multibeam survey of this seamount.

15.7 Lousy Bank

There is no multibeam or sidescan survey data available for this site. However, there are strong indications of coral habitat on this seamount (see ToR i) as well as signs that it is an important spawning ground for Blue Ling. It would therefore be useful to prioritise the following:

- Multibeam survey of the south east corner of this seamount from its summit to depths of approximately 1500 m (this would cover the area in ToR i).

15.8 Southern Rockall

No known acoustic survey has been undertaken at this site to date. Given the recent coral closures on the Empress of Britain (WGDEC 2007) it would desirable to assess the state of the these reefs. Both multibeam and sidescan information would be useful for this area.

15.9 Further areas for multibeam for which no acoustic data is available

There are several additional seamounts and banks (see map) for which no information is available but which would be predicted as sites of sensitive deepwater habitats. These areas, which should be considered priority sites for acoustic survey, include;

- Lorien Knoll
- Edoras Bank
- Fangorn Bank

15.10 Additional considerations

WGDEC notes that backscatter (reflectivity) data from multibeam survey also represents valuable information about the hardness of the surface sediments of the seabed. Together with topographical indices, MBE backscatter has been used for habitat mapping (such as MAREANO) of large areas. Since the strength of the backscatter data is not only related to sediment hardness but also to the angle of the seabed, signals need to be filtered before the data can be successfully used. This issue has not yet been completely resolved, but useful algorithms have been developed by Robert Courtney (Geological Survey of Canada Atlantic division) to reduce the so-called 'grazing effects' so that classification into coarser geological classes is possible. Supervised GIS analyses of raster layers provide good predictions of sediment classes. Coral reefs are characteristic structures that in most cases will be identified as a separate class in such analyses.

References

Pudsey, C., Morris, P. and Larter, R (2004) Rosemary: Visually stunning. *Marine Scientist*, No. 6 IQ 2004.

16 Buffer zones

Term of Reference (m): Consider suitable sized buffer zones around closed areas, taking into account ability to detect closed area infringements.

"Buffer zones" shall be understood as a spatial margin of safety around the features that are to be protected. This buffer zone should be based on two considerations, as explain below: a) accuracy of the survey data; and, b) accuracy of the monitoring & enforcement methods.

16.1 Survey data

Scientific advice from ICES (or other scientific bodies) regarding areas for possible protection is usually based on the coordinates of sampling locations i.e. certain records of vulnerable species and habitats. Areas where no records are available because no sampling has yet taken place are usually not considered for the boundary delimitation unless included within the area covered by sampling records. Therefore, the ICES advice for closing an area of vulnerable habitat to fishing usually outlines the minimum known boundaries, and thus these will need to be supplemented by an appropriate safety margin to prevent unintentional harm to vulnerable habitat lying outside of this minimum "convex hull" (i.e. area created by joining the data points). Without additional data, often this becomes a matter of expert judgement. However, various analytical methods can be employed to aid in this expert judgement. The two most common approaches are data interpolation and habitat modelling:

- **Data interpolation**: there are a variety of techniques available. A GIS linear decay density analysis, for example is straight-forward, and can be used with the minimum of data, but is also likely more conservative (i.e. producing larger buffers) than other methods. Kriging is recognised as potentially the most accurate family of spatial interpolation techniques, but requires expert geostatistical background and cannot yield its benefits unless there are a fairly large number of good data points.
- **Habitat modelling**: like interpolation, there are a number of habitat modelling techniques. Two techniques are the use of General Additive Models (GAM) and Ecological Niche factor Analysis (ENFA). Both require habitat information accompanying the data points. ENFA is somewhat more flexible in that it does not require absence data.

Poor quality data or low sampling will require larger buffers than good quality data and more intensive sampling. While it is impossible to provide any general advice on this issue, without considering the actual data, it would be expected that for most data sets, a minimum of 15% aerial enlargement could be expected, though this could vary considerably with data quality.

16.2 Monitoring and enforcement data

Monitoring and enforcement data are the data used to prevent accidental or intentional fishing within a given protected area. Recognising that this is primarily a management and control issue that should be dealt with by a competent authority outside WG DEC, our comments will be limited to some general observations and recommendations.

Currently, most port states receive VMS signals from their fishing vessels at 2-hourly intervals. At an average towing speed for bottom trawls of 2–4 knot, this suggests that the vessel can work 2–4 nautical miles (n.m.) within the closed areas and move

out again without being noticed by control authorities. Likewise, the edges of a closed area can be crossed without leaving a VMS sign. In this case of "cutting a corner," the hypotenuse of the triangle could therefore be up to about 8 n.m., meaning that a boat could enter and exit up to 5.6 nautical miles into a protected area. Therefore, a safety margin of at least 5 miles around the feature to be protected would be prudent, plus an appropriate further margin depending on water depth, and warp length deployed. Assuming that the maximum warp length deployed corresponds to twice the water depth, this would mount to a further 1.7 (i.e. square root of 3) times the water depth. At depth of 1000 m, this would equate to 1700 m or 0.9 n.m. Thus as a rule of thumb, **6 nautical miles buffer** would appear to be appropriate for current VMS monitoring in waters up to 1000 m depth.

In order to reduce the extent of the buffer zone, it will be necessary to improve the control and enforcement options for preventing infringements of the boundaries of the closed area.

16.3 Recommendations on way forward

- Establish expert group to advise on suitable extent of buffer zones around vulnerable areas in different water depths, based on fishing gear type.
- Increase VMS signal frequency (e.g. 30 minutes) and encourage strict control and enforcement by métier.
- Include a gear type code in the VMS signal so that, for example, bottom trawls can be separated from mid-water trawls.
- Collect and inventory non-fish bycatch of fishing operations near closed areas and if possible in overall fishing area.
- If possible place observers on board of fishing vessels.

Annex 1: List of participants

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*** Participating from afar via ICES SharePoint online portal.**

Annex 2: WGDEC proposed Terms of Reference for the next meeting

The ICES-NAFO **Working Group on Deepwater Ecology** [WGDEC] (Chair: Robert J. Brock, USA) will meet in Copenhagen, Denmark, in XXX 2009 to:

1) Review and consider recent research into unaccounted mortality in commercial fisheries (in conjunction with WGDEEP).

2) Review ongoing work for reducing unintended effects on the seabed and associated communities of fishing operations and gears, including ghost fishing (in conjunction with WGDEEP).

3) Consider the nature of threats such as fish farming and eutrophication to coastal coral reef areas, for example those in Norway, Sweden, and Scotland. This may be more an issue for 'inshore' benthic/ecosystem groups.

4) Assess broader distribution patterns of species diversity of corals and sponges across the North Atlantic with a view to identifying 'hotspots' and variation in biodiversity and understanding biogeographic affinities.

5) Consider request from OSPAR on the status of biodiversity of deepwater ecosystems and how it could be measured, for example by using diversity indices (in conjunction with WGDEEP).

6) Define and map sponge associations based on taxonomic information and survey data. Assess the association of sponge fields with fish and other fauna. Provide a summary of sensitivity of different sponge species to impact and disturbance. Assess priorities areas for sponge distribution data and target areas for future surveys.

7) Consider the impact of deepwater fisheries in areas for which information has not been analysed to date, for example the orange roughy fishery on the shelf slope of the Porcupine bank and the roundnose grenadier fishery to the north of Hatton bank by using VMS and historic data. (In conjunction with WGDEEP).

8) Provide a list of structural habitats for the North Atlantic and assess the status of species such as *Filograna* (a *polychaete*) that are not currently considered as structural habitat forming organisms.

9) Review the development of fine scale VMS analysis in relation to habitats and assess vulnerability of deepwater banks, shelf slope and seamounts (in conjunction with WGDEEP).

10) Address the issue of scale: Advice giving when the scale of records does not match the scale of the feature/the scale of the activities to be regulated.

11) How to best incorporate precaution/uncertainty in the advisory process.

12) Criteria for boundary limitation and buffer zones of closed areas.

WGDEC will report by DATE to the attention of the Advisory Committee.

Supporting Information

Priority:	The current activities of this Group will lead ICES into issues related to the ecosystem affects of fisheries, especially with regard to the application of the Precautionary Approach. Consequently, these activities are considered to have a very high priority.
Scientific justification and relation to action plan:	Action Plan No: 1. Term of Reference a) Several countries are conducting or have recently completed significant studies in this area and the subject would benefit from a review of progress and an evaluation of the results obtained. The last review of significant studies occurred in 1996 by the ICES Study Group on Unaccounted Mortalities. A review of more recent work will determine the need for revision and update on planning and methodology for studying this subject. Term of Reference b) All fishing activities have influences that extend beyond removing target species. The approach recommended by FAO is that responsible fisheries technology should achieve management objectives with a minimum of side effects and that they should be subject to ongoing review. WGFTFB members and others are currently undertaking a range of research programmes to provide the means to minimize side effects.
Resource requirements:	The research programmes which provide the main input to this group are already underway, and resources are already committed. The additional resource required to undertake additional activities in the framework of this group is negligible.
Participants:	The Group is normally attended by some 10–15 members and guests.
Secretariat facilities:	None.
Financial:	No financial implications.
Linkages to advisory committees:	There are no obvious direct linkages with the advisory committees.
Linkages to other committees or groups:	There is a very close working relationship with all the groups of the Fisheries Technology Committee. It is also very relevant to the Working Group on Ecosystem Effects of Fisheries.
Linkages to other organizations:	The work of this group is closely aligned with similar work in FAO and in the Census of Marine Life Programme.

Annex 3: Recommendations

RECOMMENDATION	FOR FOLLOW UP BY:
1. It is anticipate that NEFC and NAFO will make requests that will need the expertise of both WGDEC and WGDEEP. It is therefore recommended that WGDEC meet alongside WGDEEP in 2009 to allow expertise (particularly with respect to certain ToRs-see below) to be pooled. It is further recommended for this reason that WGDEC and WGDEEP meet in Copenhagen in 2009 as ICES HQ can accommodate both groups easily.	
2. Provide advice to EU and NEAFC on revision of closed areas on Hatton Bank and other areas if necessary.	
3. It is recommended that for next year a central database of VMS, coral/sensitive habitat occurrences, bathymetry, etc. be developed (to be held at ICES?).	
4. OSPAR to consider WGDEC's review of Code of conduct 2008. Actions.	
5. Provide advice on areas considered as priority for multibeam survey (ToR L) to Institutes and organisations planning to undertake deepwater surveys.	
6. Continue to update coral and sensitive habitats database and deepwater survey database.	
7. Consider the feasibility of extracting information on habitats and corals from reports on Russian submersible observations in the 1980's on the MAR seamounts.	