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New VME indicator species (excluding corals and sponges) and some potential VME elements of the NAFO Regulatory Area

by

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Abstract

A review of over 500 taxa known to occur in the NRA revealed three additional faunal groups (additional to NAFO 2008a) that meet the criteria for a VME indicator based on traits related to functional significance, fragility, and the life-history traits of component species that produce a slow recovery to disturbance. These are crinoids, erect bryozoans and large sea squirts. For each group it is the dense aggregations (beds/fields) that are considered to be VME in order to establish functional significance. Although each group is present in the NRA, data to date have not revealed any concentrations of note with the exception of one catch of the stalked tunicate *Boltenia ovifera* (large sea squirt).

Black corals were considered to be VME indicators by NAFO based on what was then known of their distribution. These were included based on the uniqueness/rarity criterion of habitats of rare, threatened or endangered species that occur only in discrete areas, however evaluation of their distribution using trawl survey, rock dredge and underwater video has indicated that they have widespread occurrence at low densities in the NRA and along the continental slopes off Labrador. However, because they are thought to be extremely long-lived and therefore 'iconic' if not rare, we have identified where the highest frequency of occurrence is for this taxon.

Lastly, based on NEREIDA multibeam bathymetry we have identified more canyon heads, steep flanks and new seamounts in the NRA as possible VME elements.

1.1 Introduction and review of previous work

The 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".

To provide States and Regional Fisheries Management Organizations with guidance for implementing Resolution 61/105, FAO sponsored an Expert Consultation in Bangkok, Thailand in September 2007 which resulted in a set of "International Guidelines for the Management of Deep-Sea Fisheries in the High Seas"

(FAO 2009) – hereafter referred to as the FAO Guidelines. In this context, vulnerability is assessed with respect to species and habitats that come into contact with bottom-contact fishing gears.
It is important to reiterate that vulnerability is not based on physical characteristics alone. The FAO Guidelines, following the UNGA resolution, explicitly refer to interactions that cause significant adverse impacts: “Significant adverse impacts are those that compromise ecosystem integrity (i.e. ecosystem structure or function) in a manner that: (i) impairs the ability of affected populations to replace themselves; (ii) degrades the long-term natural productivity of habitats; or (iii) 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.” The FAO Guidelines view non-significant or temporary impacts as those that allow ecosystem recovery to occur in less than 20 years. However, “if the interval between the expected disturbance of a habitat is shorter than the recovery time, the impact should be considered more than temporary” (FAO 2009).

Vulnerable marine ecosystems (VMEs) can be identified by such properties as functional significance, uniqueness, fragility, structural complexity and the life-history traits of component species that produce a slow recovery to disturbance. These traits are expanded upon in the FAO Guidelines which also provide examples of species groups, communities and habitat-forming species which may contribute to forming vulnerable marine ecosystems. With respect to life history traits of component species that make up vulnerable marine ecosystems, identifying traits include “(i) maturation at relatively old ages; (ii) slow growth; (iii) long life expectancies; (iv) low natural mortality rates; (v) intermittent recruitment of successful year classes; and (vi) spawning that may not occur every year”.

NAFO has closed areas to protect VMEs in accordance with the FAO Guidelines. All or parts of the Fogo Seamounts, Orphan Knoll, Newfoundland Seamounts, Corner Seamounts, and New England Seamounts have been closed to bottom-contact fishing gear. In these cases, the *topographical feature*, that is the seamount or seamount chain, represents the vulnerable marine ecosystem. The Working Group on the Ecosystem Approach to Fisheries Management (WGEAFM) has previously (NAFO 2008a) provided justification for including seamounts as VME with respect to traits referred to above and in the FAO Guidelines. It also identified canyon heads as VME elements.

NAFO has further closed 12 areas within its fishing footprint to protect coral and sponge dominated VMEs. These were identified by life history traits and recovery to disturbance trajectories of component species by the WGEAFM (NAFO 2008a) on the basis of a NAFO Scientific Council Research Document (Fuller et al. 2008). Significant concentrations of these taxa were identified by a cumulative catch distribution method for corals (NAFO 2008b) and quantitative spatial analysis method for sponges (Kenchington et al. 2009, NAFO 2009). This latter method exploited the aggregation properties of this taxon which underpins their role as ecosystem engineers, providing structural complexity and altering the physical habitat through their presence. The broader habitats formed by these taxa are referred to as sea pen fields, gorgonian forests and sponge grounds and host a wide range of associated species (Klitgaard 1995, Brodeur 2001, Klitgaard and Tendal 2004, Buhl-Mortensen and Mortensen 2005, Metaxas and Davis 2005, Bell 2008).

Fuller et al. (2008) also identified tube dwelling anemone fields (Ceriantharia) as habitat which should be considered as a VME following similar justification as for the sea pen fields.

Black corals (Antipatharia) are the only benthic taxon identified thus far in the NRA (Fuller et al. 2008) which were identified under the FAO Guidelines criterion of uniqueness/rarity: “ – an area or ecosystem that is unique or that contains rare species whose loss could not be compensated for by similar areas or ecosystems. These include: habitats that contain endemic species; habitats of rare, threatened or endangered species that occur only in discrete areas; or nurseries or discrete feeding, breeding, or spawning areas”. Black corals occur at low density in the NRA and elsewhere in the northwest Atlantic and are believed to be one of the longer lived corals in the area (Fuller et al. 2008). In considering the areas to close to protect coral and sponge habitats, the NAFO Working Group of Fisheries Managers and Scientists noted the occurrence of black coral and adjusted boundaries for the sponge grounds and gorgonian forests to maximize their protection. However, with new information on the regional distributions of Antipatharia (Kenchington et al. 2010, Murillo et al. 2011) and data collected through NEREIDA in the NRA, it appears that the taxon is not spatially restricted. We provide further comment on this below (see 1.2.2).

In the General Council, 33rd Annual Meeting, held in September 2011, in Halifax (Canada), the Fisheries commission requested to the Scientific Council to provide a list of VME indicator species and other vulnerable marine ecosystem elements. We have elaborated this document to answer part of this request related to benthic invertebrate and vulnerable marine ecosystem elements. We interpret this to mean *additional* examples of species groups, communities and habitat-forming species and elements which may contribute to forming vulnerable marine ecosystems. Consequently we will not repeat the work of the previous WGEAFM report (NAFO 2008a) and supporting documents (Fuller et al. 2008), which is reiterated herein, but will revisit the cases made for black coral, Cerianthid anemones and "other benthic taxa" listed in their report where we feel new information is available for assessment. We will consider *additional* species groups, communities and habitat-forming species and elements which may contribute to forming VMEs in the context of *additional* to the seamounts, corals and sponges already protected by NAFO. These new VME indicator species and Potential VME elements are provided in Annex I and II, respectively.

The following sections describe potential new biotic (species) and abiotic (physical habitat) elements characteristic of VMEs in the NRA.

1.2 Potential benthic invertebrate vulnerable marine ecosystem indicators

We have organized our work to reflect the different VME criteria detailed in Section 1.1. above. Section 1.2.1 highlights the *functional significance* where as 1.2.2 highlights the *uniqueness and rarity* of component species of these ecosystems.

1.2.1 Vulnerable marine ecosystem indicators based on *functional significance*, fragility, and the life-history traits of component species that produce a slow recovery to disturbance

In order to provide a systematic assessment of whether there are additional benthic invertebrate species, communities or habitat-forming species in the NRA that should be considered VME indicators, a list of traits which could be evaluated, was produced against the taxa known to occur in the NRA. Known taxon lists were created from records from Spanish/EU bottom trawl groundfish surveys and from rock dredge records from the NEREIDA Programme. Samples are still being processed so more taxa are likely to be added to the list in the coming years, however for this assessment approximately 500 taxa were considered. The traits against which these were assessed are indicated in Table 1.2.1. Benthic invertebrate megafaunal taxa were classified initially into broad taxonomic groupings and considered against the criteria. Those which appeared to have potential for meeting the criteria were crinoids, tube anemones, large sea anemones, erect hydrozoans, erect bryozoans, large sea squirts (ascidians), large sea stars (Brisingidae), sea urchins, brittle stars, large holothurians, large gastropods and barnacles. Each of those groups was assessed against the criteria listed in Table 1.2.1 to the extent possible using relevant literature. In many cases biological traits were inferred from other similar species. Of these, only three different groups were considered to be indicators of VMEs. These are the crinoids, the erect bryozoans and the large sea squirts.

Table 1.2.1. Biological traits for vulnerable marine ecosystem components used to evaluate the benthic invertebrate taxa known to occur in the NAFO regulatory area and the faunal groups which possess those traits. Traits reflect the three pillars of the FAO Guidelines (FAO 2009): Vulnerability, Recoverability and Ecosystem Function.

Biological Traits Relevant to FAO Guidelines	**Faunal Group**		
	Crinoids	**Erect Bryozoans**	**Large Sea Squirts**
Fragility, Vulnerability and Recoverability			
Fragility	yes	yes	yes
height off bottom > 5 cm	yes (stalked)	yes	yes
lifespan (> 20 yr)	yes	some cases	?
slow growth rates	no	?	?
late age of maturity	?	?	?
irregular or episodic recruitment	?	?	?
poor regeneration ability (> 20 years)	no	?	yes
low fecundity	?	?	no
Significant Role in Ecosystem (Function)			
structural engineer	X	X	X
Predator			
Bioturbator			
carbon sequester			
benthic pelagic coupling			
benthic production			

1.2.1.1 Crinoids. Phylum Echinodermata. Class Crinoidea

Crinoids are fragile organisms that in some cases live attached to the sea bottom by a stalk that raises them off the sea floor (Figure 1.2.1.1.1) and consequently are vulnerable to bottom-contact fisheries. Although limited information exists about their longevity or growth rates, Roux (1976) estimated mean age in a population of *Endoxocrinus wyvillethomsoni* as greater than 15 years, with some individuals older than 20 years, and Messing, (unpublished data, in Messing et al. 2007) indicated a longevity exceeding 20 yr for *Cenocrinus asterius* in 215 m depth.

Some species are highly aggregated in deep water (Conan et al. 1981) and they can provide refuge and substrata for a wide variety of small fishes and invertebrates (Lissner and Benech 1993 and Puniwai 2002 cited in Tissot et al. 2006). Direct evidence of fish predation on stalked crinoids is likewise rare, as the deep-water habitats of living stalked crinoids make observations difficult (Baumiller 2008) however, submersible observations provide some evidence that fishes do interact with these crinoids (Conan et al. 1981, Messing et al. 1988, Baumiller et al. 1991) as well as other invertebrates (Baumiller et al. 1999).

Some species of unstalked crinoids form dense aggregations or beds. In the Mediterranean *Leptometra phalangium* is a dominant species on the shelf break and appears to be critical habitat to juvenile and spawning benthopelagic fish (Colloca et al. 2004, Ordines and Massutí 2009). The crinoid beds are heavily damaged by trawling and recovery does not take place at least within a season (Smith et al. 2000). However, unstalked crinoids are one of only a few taxa that had significantly higher abundance five to ten years after trawling on New Zealand and Australian seamounts (Williams et al. 2010). It was suggested that this may have resulted from protection in natural refuges inaccessible to trawls followed by a rapid recolonization of cleared substrate (Williams et al. 2010).

Conclusion: The fragility, long lifespan, and capacity to provide habitat for other organisms when they are aggregated to form beds make crinoids VME indicator species.

Comments on presence of crinoid VME in the NRA

Data from Spanish/EU groundfish surveys (2007-2010 data), rock dredge samples (NEREIDA Programme 2009-2010) and a proportion of the *in situ* images (NERIDA Programme 2009-2010) were reviewed and 3 species of crinoid that could be VME indicators were identified (Table 1.2.1.1.1.). From the groundfish surveys only 11 records were found each with only 1 – 6 individuals per trawl. These were located mainly around Flemish Cap between 600 and 1200 m depth. The 94 valid rock dredge samples which were taken from approximately 500 to 2000 m depth, provided 24 records with crinoids. The maximum abundance was 41 individuals in a single dredge. The most important concentrations were observed through video images in the 2010 NEREIDA-Canadian ROPOS Survey along the East of Flemish Cap, where high densities of the stalked crinoid *Gephyrocrinus grimaldii* were observed together with several structure-forming sponges at 2148 m depth (Figure 1.2.1.1.1). These data are still being processed and may provide indication of crinoid VME areas within the NRA.

Figure 1.2.1.1.1. *Gephyrocrinus grimaldii*, East of Flemish Cap (NAFO 3M Div.). Photo courtesy of DFO (NEREIDA Programme).

Beds of unstalked crinoids (Table 1.2.1.1.1) have not been observed in the NRA, although more data on these may emerge as the NEREIDA data are analyzed in the coming year.

Table 1.2.1.1.1. Examples of crinoids known to occur in the NRA considered VME indicator species.

TAXON	FAMILY	Morphology	VME Indicator
Gephyrocrinus grimaldii	Hyocrinidae	Stalked	yes
Conocrinus lofotensis	Bourgueticrinidae	Stalked	potentially
Trichometra cubensis	Antedonidae	Not stalked	potentially

1.2.1.2 Erect Bryozoans. Phylum Bryozoa

Erect bryozoans form ramified structures in a variety of marine environments that can be ecologically important in providing substrata for epizoans and hiding places for motile organisms, including ophiuroids and small fish (Smith et al. 2001). Although most bryozoans are short-lived and studies of growth rate and colony age in large erect bryozoan species are few, some colonies can reach twenty years old (Smith et al. 2001). Fenestrate or reteporiform cheilostomate bryozoans are some of the erect bryozoans that constitute hard structures (Figure 1.2.1.2.1) and are popularly known as lace corals (Hayward and Ryland 1996).

Figure 1.2.1.2.1. Reteporiform bryozoan. "Tail" of the Grand Banks of Newfoundland, (NAFO 3N Div.). Photo courtesy of IEO. Note the other species associated with it.

Their fragility and exposure above the bottom means that bottom trawling of the seabed can damage bryozoan beds. Saxton (1980) and Bradstock and Gordon (1983) recorded the effects of the systematic destruction by trawlers of the bryozoan beds in Tasman Bay, New Zealand, which provided habitat for juvenile snapper and tarakihi. It was also noted that the abundance of juvenile fish subsequently declined (Saxton 1980). These bryozoan beds had not recovered 10 years later and the loss was believed to be permanent (Jones 1992). However less dense aggregations have been shown to be relatively unaffected by trawling, with large interannual variability in recruitment greater than impact effects (Henry et al. 2006).

Conclusion: Based on their life history traits and empirical evidence on their vulnerability to bottom trawling we recommend that the conservation unit be **bryozoan beds**, rather than less dense aggregations of these species.

Comments on presence of erect bryozoan VME in the NRA

Spanish/EU groundfish survey bycatch data revealed that in some areas of the NRA ("Tail" of the Grand Banks of Newfoundland) it is common to find the erect bryozoan *Eucratea loricata* together with others bryozoans including some with reteporiform shape. This species forms a tall, dense clump (Figure 1.2.1.2.2), commonly around 10 cm, but up to 25 cm tall, buff or light-brown, resembling a miniature poplar tree (Ryland and Hayward 1991). The catches found in 2007 ranged from 0.001 to 1.45 kg per 30 minute research trawl. All the catches were shallower than 100 m depth. The catches found do not seem to be representative of bryozoan beds, but in order to make a complete assessment more research in the area with visual ground truthing is required.

Figure 1.2.1.2.2. *Eucratea loricata*. “Tail” of the Grand Banks of Newfoundland, (NAFO 3N Div.). Photo courtesy of IEO.

Table 1.2.1.2.1. Examples of erect bryozoans known to occur in the NRA and with the potential to form beds or dense aggregations. This group has not been fully processed and other species are known to occur but they have not yet been identified (e.g., Figure 1.2.1.2.1).

TAXON	**FAMILY**
Eucratea loricata	Eucrateidae

1.2.1.3. Large Sea squirts. Phylum Chordata. Class Ascidiacea

Boltenia ovifera and other large species such as *Halocynthia aurantium* are often found in groups where they form significant habitat (Figure 1.2.1.3.1). Kenchington et al. (2007) identified *Boltenia ovifera* as one of a number of species which significantly declined in the Bay of Fundy, Canada, over a 30 year period and attributed this decline to the cumulative impacts of trawling in the area. In the North Pacific, they are known to provide habitat to small juvenile red king crab (*Paralithodes camtschaticus*) (McMurray et al. 1984, Stevens and Kittaka 1998). Some sea squirts (i.e. *Boltenia ovifera*) support other invertebrate fauna attached to the stems and holdfasts.

Figure 1.2.1.3.1. *Boltenia ovifera*, Bay of Fundy, Canada. Photo courtesy of Mike Strong and Maria Buzeta-Innes, DFO.

Comments on presence of large sea squirt VME in the NRA.

Two species of large sea squirt were identified from the data sources (Table 1.2.1.3.1). Spanish/EU groundfish survey bycatch data (2007-2010) revealed fifty records of *Boltenia ovifera* from the "Tail" of the Grand Banks between 50 and 320 m depth. More than 75 % of the catches were lower than 1 kg and 10 individuals; however a catch of 4.55 kg (65 individuals, Figure 1.2.1.3.2) was recorded at 200 m depth. The larger catch of *B. ovifera* which may constitute the location of a VME indicated by this species was found at: 43°21'50.4''N 49°25'19.2''W (start of tow) 43°23'09''N 49°24'17.4''W (end of tow). There were only a few individuals of *Halocynthia aurantium* present in these data.

Figure 1.2.1.3.2. *Boltenia ovifera*, "Tail" of the Grand Banks of Newfoundland, (NAFO 3N Div.). Photo courtesy of IEO.

Table 1.2.1.3.1. Examples of large sea squirts known to occur in the NRA considered VME indicator species.

TAXON	**FAMILY**
Boltenia ovifera	Pyuridae
Halocynthia aurantium	Pyuridae

1.2.1.4. Tube-dwelling Anemones. Phylum Cnidaria. Order Ceriantharia

Justification to include tube dwelling anemone fields (Ceriantharia) as habitat which should be considered as VME were provided in Fuller et al. (2008). We present new information about their presence in the NRA based on Spanish/EU groundfish surveys and preliminary data from the NEREIDA Programme.

From the period analyzed (2007-2010) no tube dwelling anemone fields have been observed and only two single records of tube-dwelling anemones (*Pachycerianthus borealis* Table 1.2.1.4.1) were register in the "Tail" of the Grand Banks based on Spanish/EU groundfish surveys and around 20 records of other small Ceriantharia species with a maximum of 11 small specimens (11 g) taken in one sample station based in rock dredges from the NEREIDA Programme (2009-2010).

These sampling gears do not provide accurate estimates of the abundance of these organisms, because bottom trawls are expected to have a low catchability for them, as they can burrow in the sediments when disturbed. Rock dredges are used for sampling hard bottoms and these tube dwelling anemones form dense aggregations on sandy or muddy bottoms.

At this time for the area studied (NRA, Divs. 3 LMNO, 50-1500 m) no tube dwelling anemone fields have been observed but analysis of the *in situ* photographic images and video collected during NEREIDA is necessary to complete this assessment.

Table 1.2.1.4.1. Examples of tube dwelling anemones known to occur in the NRA and with potential to form fields or dense aggregations. This group has not been fully processed and other species are known to occur but they have not yet been identified.

TAXON	FAMILY
Pachycerianthus borealis	Cerianthidae

1.2.2 Vulnerable marine ecosystem indicators based on *uniqueness/rarity*, fragility, and the life-history traits of component species that produce a slow recovery to disturbance

Based on data from Spanish/EU groundfish surveys (2007-2010 period), rock dredge samples (NEREIDA Programme) and preliminary analysis of images from the NEREIDA-Canadian photographic surveys (2009-2010) no other rare/endemic species have been identified in the NRA. NEREIDA data are currently being analyzed and new information may emerge in the coming years.

1.2.2.1 Black Corals. Phylum Cnidaria. Order Antipatharia

As noted in Section 1.1 above, black corals meet the vulnerability and recoverability criteria for vulnerable marine ecosystems as described in the FAO Guidelines. However, because they are solitary and rare they have little impact on ecosystem functioning. They are broadly distributed at low density in the northwest Atlantic and so do not meet the uniqueness/rarity criterion of habitats of rare, threatened or endangered species that occur only in discrete areas. If they were removed from the fishing footprint of the NRA they would still be present along the continental slopes of Canada (Kenchington et al. 2010). Figure 1.2.2.1.1 illustrates the records of black coral per 10 x 10 nautical mile cell sizes based in Spanish/EU and Canadian groundfish surveys (2005-2010), NEREIDA Programme (2009-2010) and NEREIDA-Canadian 2010 ROPOS survey superposed with the current closures in the NRA (Divs. 3LMNO). While broadly distributed, black corals are more prevalent in four areas near to the current fishery closed areas. These higher density areas could be considered for further protection given the iconic nature of these species (Fuller et al. 2008) and their extraordinary life-history traits. However, it is not clear at what density they would meet the VME criteria for functional significance.

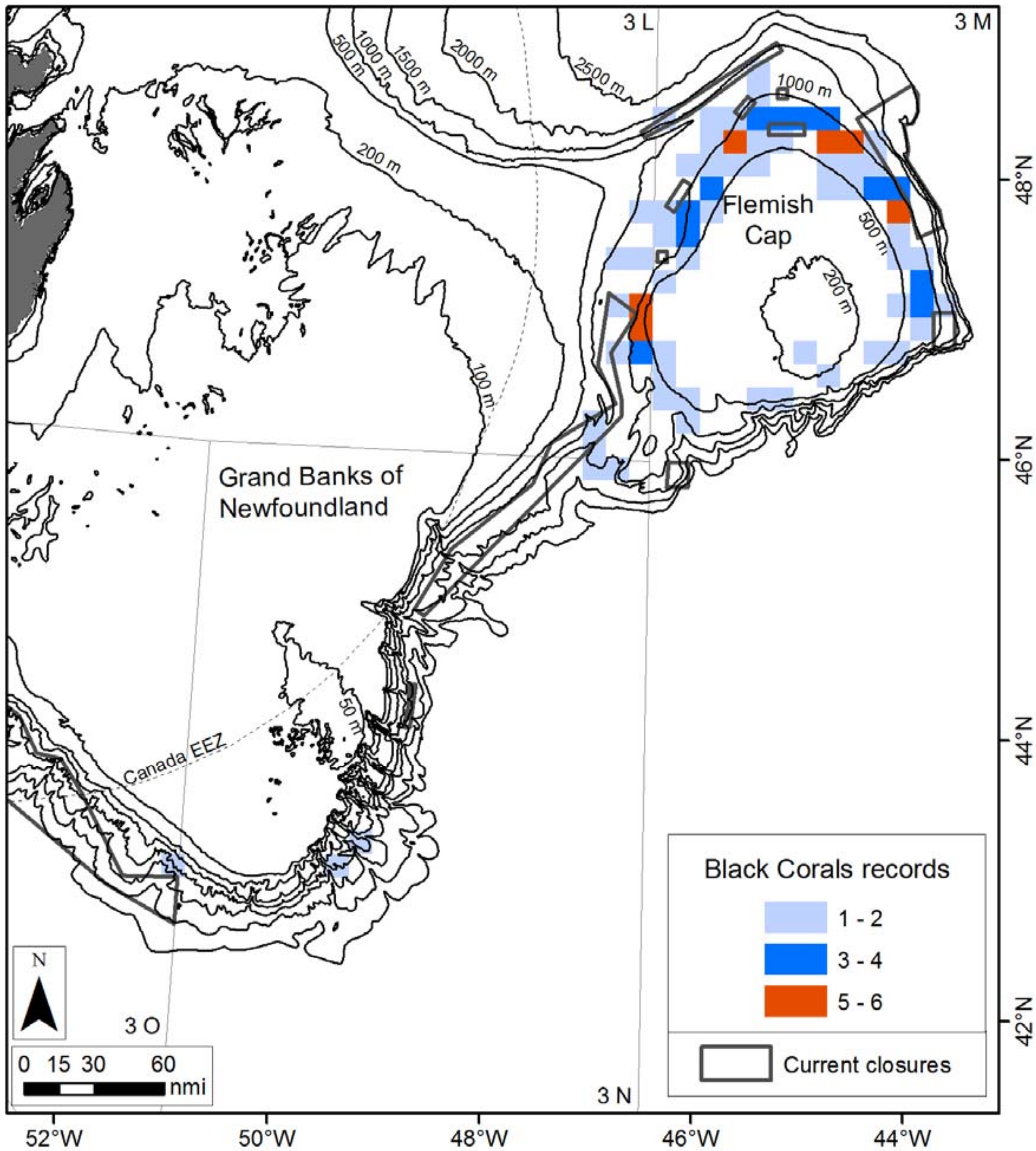

Figure 1.2.2.1.1. Map of Black Corals records in the NRA (Divs. 3LMNO) per 10 x 10 nautical mile cell sizes based in Spanish/EU and Canadian groundfish surveys (2005-2010), NEREIDA Programme (2009-2010), and NEREIDA-Canadian 2010 ROPOS Survey superimposing the current closed areas.

1.3. Potential VME elements

1.3.1. Canyons

As noted previously, the Working Group on the Ecosystem Approach to Fisheries Management (WGEAFM) provided justification for including seamounts as VME elements with respect to traits referred to above and in the FAO Guidelines as well as canyon heads, spawning areas and other knolls (NAFO 2008a).

NEREIDA work has allowed the identification of new canyons along the south of Flemish Cap and the redefinition of those which previously were identified by the WGEAFM. The WGEAFM previously identified canyons using the 200 m depth contour as the upper limit, whereas NEREIDA geologists have identified two different types of canyons based in the location of the canyon head; namely: 1) shelf-indenting canyons whose heads indent the shelf of the Grand Banks and 2) canyons whose heads are at > 400 m water depth and occur on the upper slope. As NEREIDA work was not able to map the Division 3O outside the Canadian EEZ, the previously identified canyons of this area (Jukes and Whitbourne canyons) have not been classified. The map with the new canyons is presented in Figure 1.3.1.1.

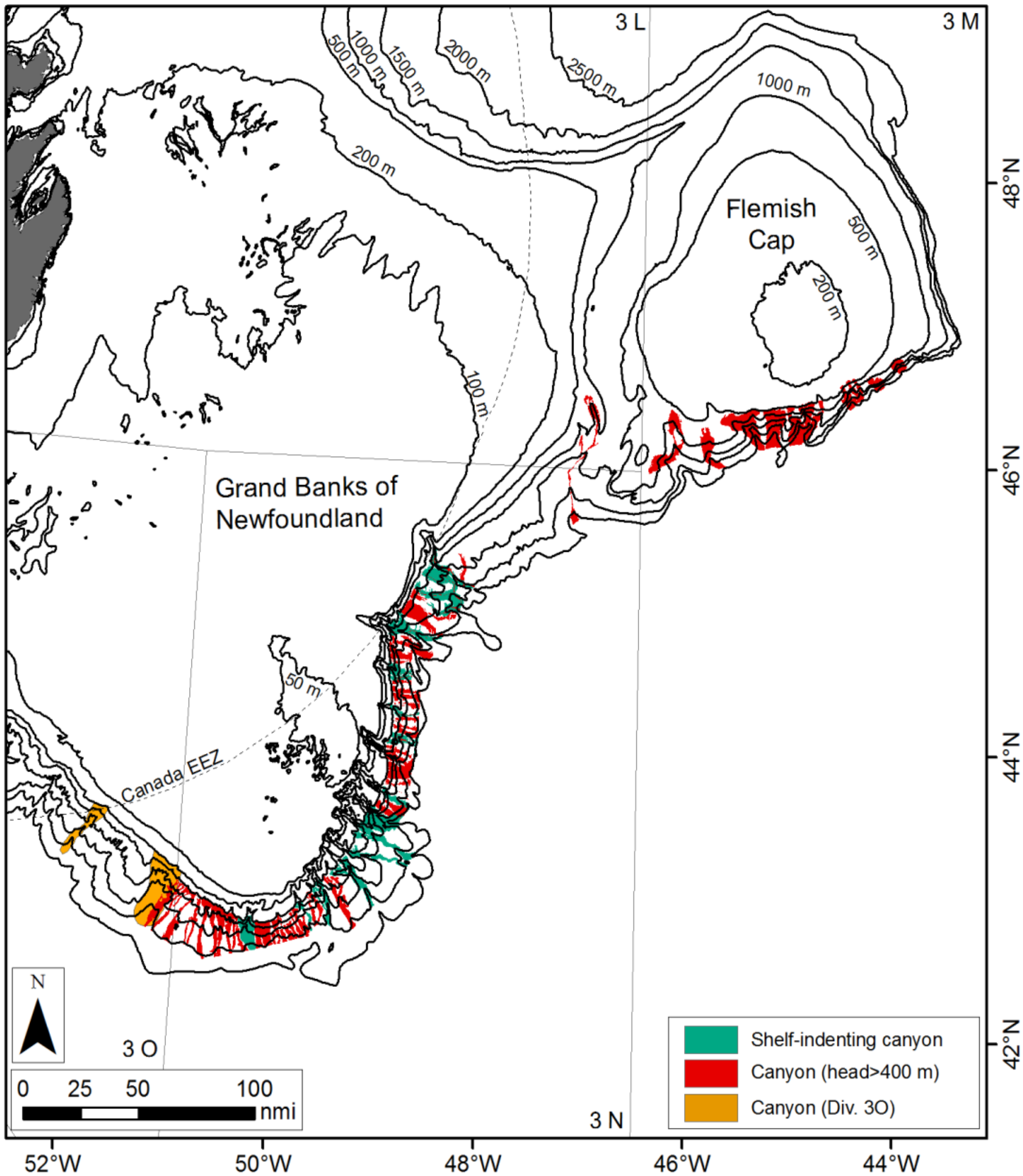

Figure 1.3.1.1. Map of canyons in the NRA (Divs. 3 LMNO).

1.3.2 Steep flanks

Submerged edges and slopes are recognized geological features that potentially support vulnerable species groups or communities such as corals and sponges (FAO 2009), and so could be considered potential VME elements.

NEREIDA work has allowed the geologists to identify areas of steep seafloor on the continental slope commonly with sub-parallel intervals of slopes >6.4° alternating with less steep intervals. These areas could be potential VME elements and are represented in the Figure 1.3.2.1. They occur around Flemish Cap and on smaller bedrock highs such as Beothuk Knoll and “Hudson prong”.

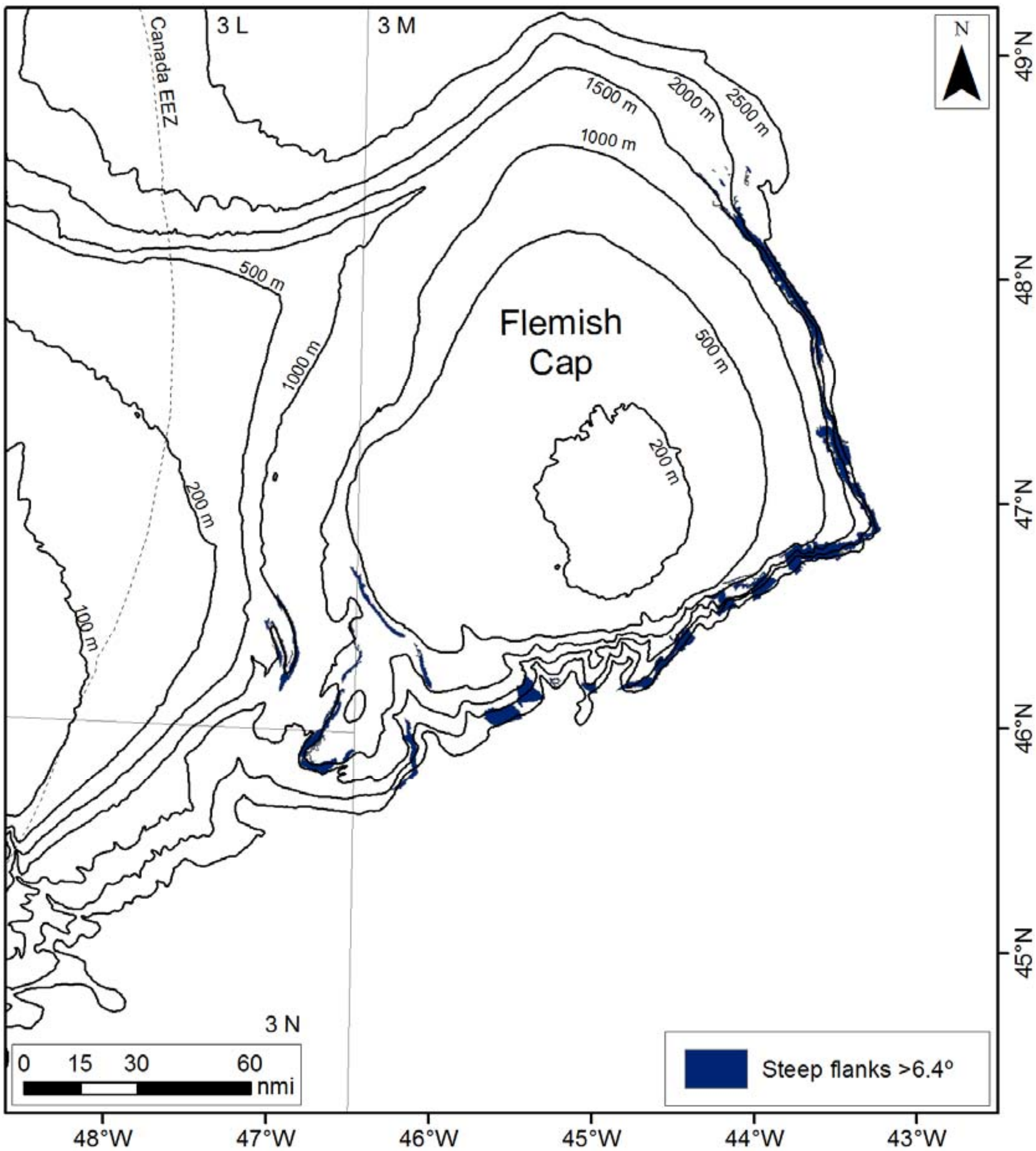

Figure 1.3.2.1. Map of the Steep flanks >6.4° canyons in the NRA (Divs. 3 LM).

1.3.3 Seamounts. The Fogo Seamounts.

The Fogo Seamounts are located on oceanic crust in the central North Atlantic Ocean, southwest of the Grand Banks of Newfoundland and form a broad zone of volcanoes that parallels the transform margin (Figure 1.3.3.1). This zone is narrowest in the northwest and widens to 200 km in the southeast. This pattern differs from the narrow linear arrangement of a typical seamount channel, such as the Newfoundland and New England Seamounts (Pe-Piper et al. 2007).

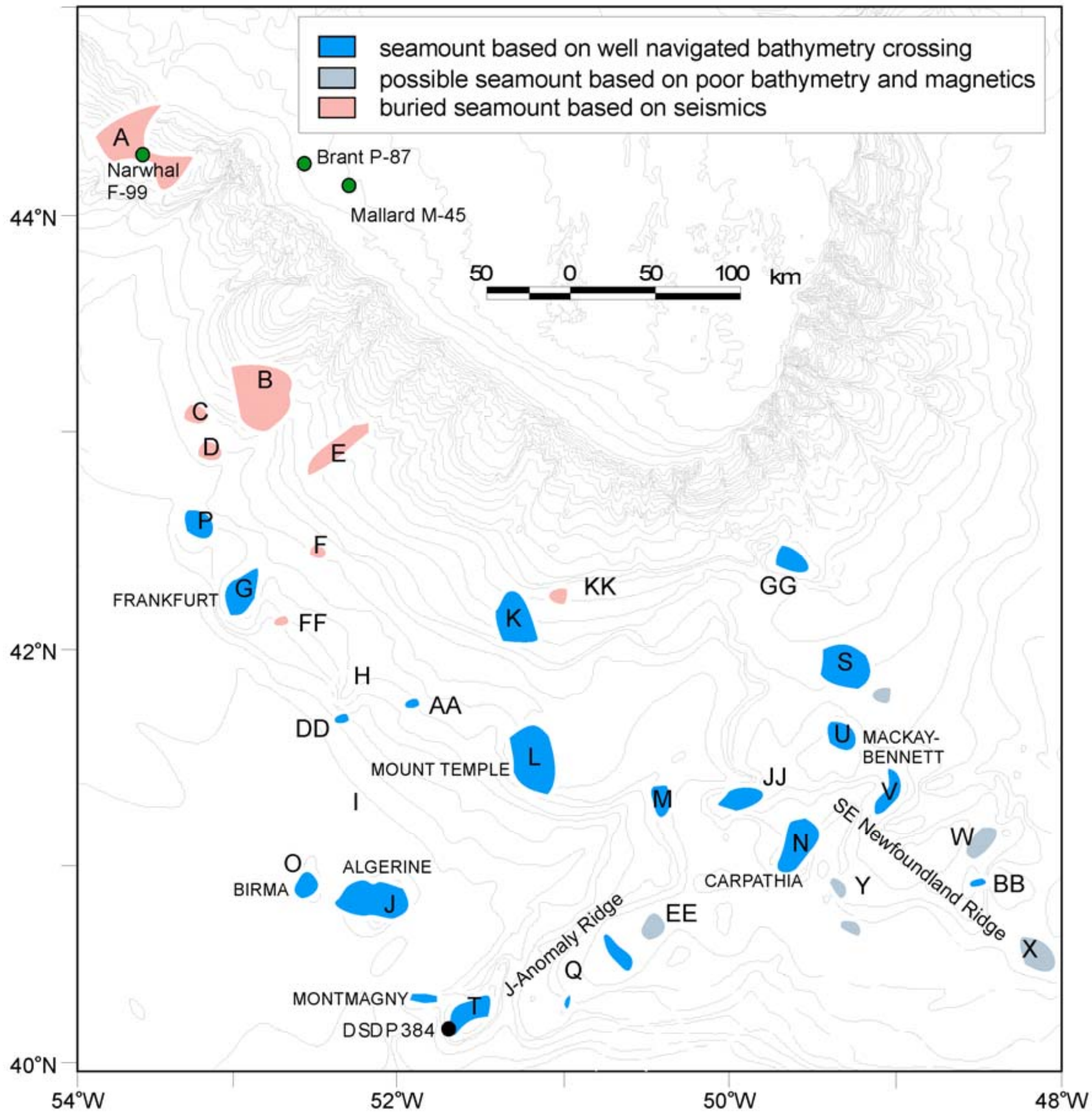

Figure 1.3.3.1. Map of the Fogo Seamounts and other seamounts south of the Tail of the Banks. Modified from Pe-Piper et al. (2007). Largest seamounts have official names (after the ships that came to the aid of the Titanic). Other geological seamounts may be buried or are otherwise low features. Letter codes refer to Table 2 of GSC Open File 5182 which lists sources of data.

Since January 1, 2007, two areas to protect the Fogo Seamounts were closed to all bottom fishing activities (NAFO 2010). At this point only a small part of the area was closed (Figure 1.3.3.2) and several seamounts remained outside of the closures. Most of the seamounts are deeper than 2000 m depth and outside of the current fishery footprint, so interactions with fishery activities and seamounts at this moment is quite improbable. However, since new information on distribution of Fogo Seamounts is available (Pe-Piper et al. 2007) that should be considered when these areas are revised together with the other seamounts closures in 2014 (NAFO 2012).

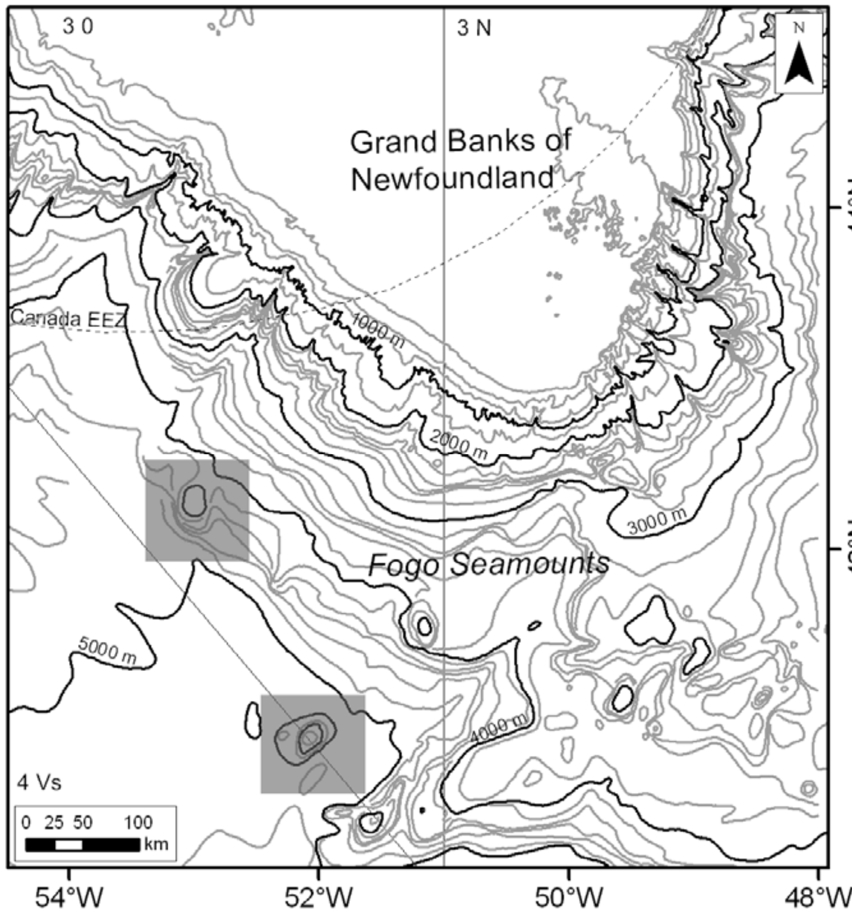

Figure 1.3.3.2. Map of the localization of the Fogo Seamounts current closures.

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1.5 Annex I. New VME indicator species in the NAFO Regulatory Area.

COMMON NAME	TAXON	FAMILY	PHYLLUM
Tube-dwelling anemones	*Pachycerianthus borealis*	Cerianthidae	Cnidaria
Erect bryozoans	*Eucratea loricata*	Eucrateidae	Bryozoa
Sea lilies	*Gephyrocrinus grimaldii*	Hyocrinidae	Echinodermata
	Conocrinus lofotensis	Bourgueticrinidae	Echinodermata
	Trichometra cubensis	Antedonidae	Echinodermata
Sea squirts	*Boltenia ovifera*	Pyuridae	Chordata
	Halocynthia aurantium	Pyuridae	

1.6 Annex II. New Potential VME elements in the NAFO Regulatory Area

- Fogo Seamounts (Divs. 3O, 4Vs)

- Canyons;

    - Shelf-indenting canyon; Tail of the Grand Banks of Newfoundland (Div. 3N).
    - Canyons with head > 400 m depth; South of Flemish Cap and Tail of the Grand Banks of Newfoundland (Divs. 3MN).

- Steep flanks > 6.4º; South and Southeast of Flemish Cap. (Divs. 3 LM).