Extracted from Report of the Scientific Council, June 2014, SCS Doc. 14/17

(http://archive.nafo.int/open/sc/2014/scs14-17.pdf)

x) Summary of data available for identification of VMEs (Item 13a)

Considering that the current closures for VME indicators (i.e. species and elements in Annex I.E VI and VII) established under Chapter II of the NAFO Conservation and Enforcement Measures (NCEM) are due for revision in 2014, the Fisheries Commission requests the Scientific Council to:

a. Summarize and assess all the data available collected through the NEREIDA project, CP RV surveys, and any other suitable source of information, to identify VMEs in the NRA, in accordance to FAO Guidelines and NCEM.

Scientific Council responded:

Summary of Data Sources

Data available were obtained from research vessel trawl surveys, benthic imagery collected through the NEREIDA program, and from NEREIDA box cores samples, and rock and scallop dredges.

The data available to Scientific Council are listed below. This included research vessel trawl surveys (Table 1), benthic imagery collected through the NEREIDA program (Table 2 and Table 3) and from NEREIDA box cores samples (

Table 4) and rock and scallop dredges (Table 5).

Table 1. Data sources from contracting party research vessel surveys; EU, European Union; DFO, Department of Fisheries and Oceans; NL, Newfoundland and Labrador; IEO, Instituto Español de Oceanografia; IIM, Instituto de Investigaciones Marinas; IPMA, Instituto Português do Mar e da Atmosfera.

Programme	**Period**	**NAFO Division**	**Gear**	**Mesh size in codend liner (mm)**	**Trawl duration (min)**	**Average wingspread (m)**
Spanish 3NO Survey (IEO)	2002 - 2013	3NO	Campelen 1800	20	30	24.2 – 31.9
EU Flemish Cap Survey (IEO, IIM, IPMA)	2003 - 2013	3M	Lofoten	35	30	13.89
Spanish 3L Survey (IEO)	2003 - 2013	3L	Campelen 1800	20	30	24.2 – 31.9
DFO NL Multi-species Surveys (DFO)	1995 - 2012	3LNO	Campelen 1800	12.7	15	15 - 20

Table 2 Summary of the benthic imagery collected and analyzed from the CCGS *Hudson* NEREIDA 2009 cruise to the Flemish Cap area

Location	Transect ID	Inside closure?	Gear	Transect length (m)	Depth range (m)	# Photos
Sackville Spur	11	Mostly	4KCam	6 211	1080 – 1545	167
	12	Yes	4KCam	6 343	1313 – 1723	172
	18	Yes	4KCam	5 238	1336 – 1478	92
	24	Yes	4KCam	4 974	1290 – 1427	145
	26	Yes	4KCam	3 212	1381 - 1409	38
Flemish Pass area	28	No	Campod	2 431	461 - 479	92
	29	No	Campod	3 197	444 - 471	132
	30	No	4KCam	6 101	455 - 940	174
	38	Yes	4KCam	2 978	1328 - 1411	75

Table 3. Summary of the benthic video collected and analyzed using the ROV ROPOS in 2010 during the CCGS *Hudson* NEREIDA cruise to the Flemish Cap (FC) area.

Location	Transect ID	Inside closure?	Transect length (m)	Depth range (m)	Analysis details
Southern FC slope	1335	No	8,292	873 – 1,853	Explorer mode. Analyzed in detail; frame by frame.
	1336	No	11,555	2,212 – 2,970	Explorer mode. Transect not analyzed in detail ('live' recordings summarized).
Southeast FC slope	1337	No	14,475	1,011 – 2,191	Transect and explorer mode. Explorer mode analyzed frame by frame; every 10 m analyzed for transect modes.
	1338	Yes	11,195	1,029 – 1,088	Explorer and transect. Three lines were analyzed (1 trawled, 2 untrawled) every 10 m for the abundance of sponges and corals. Non-coral and sponge observations extracted from 'live' recordings.
Northeast FC slope	1339	Yes	8,624	1,344 – 2,462	Explorer mode. Data extracted from 10 m intervals.

Table 4. Summary of the box cores samples collected and analyzed from the NEREIDA Programme on board the RV *Miguel Oliver*.

Programme	Period	NAFO Division	Gear	Data extracted	Number of samples
NEREIDA	2009-2010	3LMN	Box-corer	Epibenthos visible on box-corer surface photograph	331

Table 5. Summary of the rock dredge and scallop gear sets collected and analyzed from the NEREIDA Programme on board the RV *Miguel Oliver*.

Programme	Period	NAFO Division	Depth range (m)	Gear	N valid sets	Trawl duration (min)
NEREIDA	2009 – 2010	3LMN	502 - 1991	Rock dredge	88	15
NEREIDA	2009	3M	870 - 1137	Scallop gear	7	15

Review of Current Closures

Using all available information Scientific Council determined VME areas in the NRA, and compared these areas with the current sponges, corals, and seamount protection zones. The coverage of the VMEs provided by the protection zones varied depending on location and VME taxa. VMEs inside and outside existing closures were identified. Based on the characteristics of the VMEs, the overall coverage provided by existing protection zones, and the threat level inferred from current fishing effort patterns, a set of priorities for management consideration by WGEAFFM is provided as requested.

Definitions: Distributions, VMEs, VME Indicators and VME elements

The FAO *International Guidelines for the Management of Deep-sea Fisheries in the High Seas* (FAO, 2009) provide general tools and considerations for the identification of Vulnerable Marine Ecosystems (VMEs).

In relation to VMEs, the FAO Guidelines indicate that vulnerability is related to the likelihood that a population, community, or habitat will experience substantial alteration from short-term or chronic disturbance, and the likelihood that it would recover and in what time frame.

Although no formal definitions for VMEs, VME indicators, or VME elements are provided, the FAO Guidelines indicate that VMEs should be identified based on the characteristics they possess, providing criteria that should be used, individually or in combination, for the identification process.

When identifying VMEs, the FAO Guidelines indicate that species groups, communities, habitats, and features often display characteristics consistent with possible VMEs, but they clearly state that merely detecting the presence of an element itself is not sufficient to identify a VME. This has two related and important implications:

a) the full spatial distribution of a species that meet the VME criteria does not constitute a VME

b) actual VMEs must possess a level of organization larger than the scale of a singular/individual presence.

Another important consideration is that areas where VMEs are likely to occur should also be identified. These VME elements are topographical, hydrophysical or geological features, including fragile geological structures, that potentially support species groups or communities that qualify as VMEs.

In this general context, NAFO has followed the FAO guidelines in defining and identifying:

- ***VME indicator species***. These are species that met one or more of the FAO Guidelines criteria for possible VMEs. Their simple presence is not an automatic indication of VMEs, but when found in significant aggregations with conspecifics, or other VME indicator species, can constitute a VME. NAFO has approved a list of taxa that qualify as VME indicator species (NCEM Annex I.E.VI).
- ***VME elements***. These are topographical, hydrophysical or geological features which are associated with VME indicator species in a global context and have the potential to support VMEs. NAFO has approved a list of features that qualify as physical VME indicator elements (NCEM Annex I.E.VII).
- ***Higher concentration observations of VME indicator species (a.k.a. "Significant concentrations")***. These are specific locations where there are individual records of VME indicator species at densities at or above a threshold value that, for that specific VME indicator species, is associated with the formation of highly aggregated groups of that species. These higher concentration locations have been the basis for the delineation of the polygons referred as "Areas of higher sponge and coral concentrations" in NCEM Article 16.5, which are closed to bottom fishing activities. Although NAFO has protected areas containing higher concentration observations of VME indicator species, it has not defined VMEs proper. Furthermore, all VME indicator species to date have been identified under the structure-forming criterion, in that they create structural habitats for other species and are thought to enhance biodiversity.
- ***Vulnerable Marine Ecosystem (VME).*** Under the structure-forming criterion, a VME is a regional habitat that contains VME indicator species at or above significant concentration levels. These habitats are structurally complex, characterized by higher diversities and/or different benthic communities, and provide a platform for ecosystem functions/processes closely linked to these characteristics.

NAFO Scientific Council has used the quantitative methods todetermineVMEs. The spatial scale of these habitats is often larger than the footprint of a higher concentration observation. VMEs occur throughout the NRA and their spatial arrangement may be important to recruitment processes and to overall ecosystem function.

Method used to determine VME Areas

The primary tool used to quantitatively determine VMEs is kernel density analysis. This analysis identifies "hotspots" in the biomass distribution derived from research vessel trawl survey data, by looking at natural breaks in the spatial distribution associated with changes in local density. These natural breaks allow defining of significant area polygons.

What does the method show?

- Potential Areas of VMEs according to the definition.

What are the limitations?

- The method has limited spatial resolution, in particular, the delineation of borders for the VME areas are uncertain.

If to be used as a basis for making management decisions *e.g.* on the closing or opening of areas, these results are to be regarded as a first step.

It would be expected that depth contours, type of substrate, current and temperature fields, etc. will shape the fine scale boundary. The general locations given by the kernel method is our current best approach to determining the VME.

For some VME indicator species, new models of species distribution are in development and in some instances, these models could help inform the discussion on fine scale boundaries. Further refinement of these models is necessary.

Application

Although for most VME indicator species analytical methods were used, in some cases, the data available only allowed simple distribution maps to be produced.

The base analyses used for each VME indicator species were:

1. Sponge grounds: kernel analyses
2. Large gorgonian corals: kernel analyses
3. Small gorgonian corals: kernel analyses
4. Sea pens: kernel analyses
5. Erect Bryozoans: kernel analyses
6. Large sea squirts: kernel analyses
7. Cerianthid Anemones: distribution
8. Crinoids: distribution

Black Coral is not a VME indicator species in NAFO, but has been used as such in other regions.

Review of Closed Areas in the NRA

For each of the existing closed areas in the NRA an evaluation of the existing VMEs in the neighbouring region is provided. To assist in this process three maps are presented for each general area. In the first map all VMEs (VME polygons with associated catches within them for sponges, large and small gorgonian corals and sea pens), significant concentrations of other VME taxa (erect bryozoans, large sea squirts) and presence of biological VME indicator taxa (Crinoidea, tube dwelling anemones). This same map is reproduced with the available VMS data (2010 – mid 2013) overlain to show the current fishing patterns. The last map shows the location of the VME elements and NEREIDA multibeam data where available.

Division 3O Coral Closure

Comment: Only the portion of Div. 3O in the NRA has been considered in the analyses based on the request from Fisheries Commission. Kernel density analyses for sponges, large and small gorgonian corals and sea pens has been done within the Canadian EEZ; this information has been published.

Summary (Fig. 7): Sea pen and small gorgonian VME are found immediately adjacent to the existing closure.

VME elements: shelf indenting canyons and canyons with heads > 400 m in the closed area have potential to have VME; Only a partial picture of the canyons is available due to the extent of the NEREIDA multibeam bathymetric data coverage.

VMS data show high density of fishing activity close to the VME areas outside the closure.

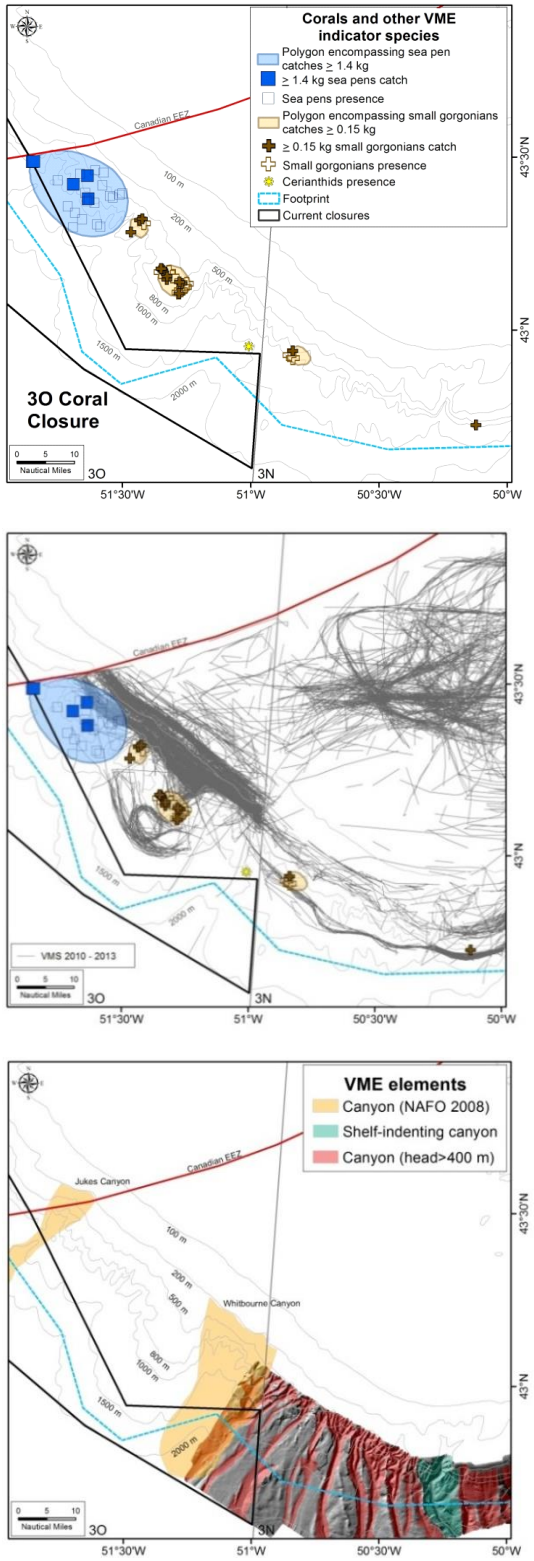

Fig. 7. Area of 3O Coral Closure. VMEs and VME indicator species (top) from kernel analysis, VMS data (middle), and VME elements and NEREIDA multibeam (bottom).

Area 1 Tail of the Bank

Summary (Fig. 8): A portion of sponge VME is inside the closed area.

Relatively uncommon in the NRA, but locally spatially extensive, areas of significant concentrations of stalked tunicates (large sea squirts) and bryozoans are found in an area adjacent to significant fishing activity. The close proximity of the large gorgonian coral VME, small gorgonian VME and presence of crinoids with the significant concentrations of sea squirts and bryozoans is an assemblage of features not observed elsewhere in the NRA. This area also appears to have a different geomorphology in that there is a high concentration of canyons indenting the shelf than in other areas along the slope.

VME Elements: Physical VME elements in the area are the Southeast Shoal, canyons and shelf-indenting canyons.

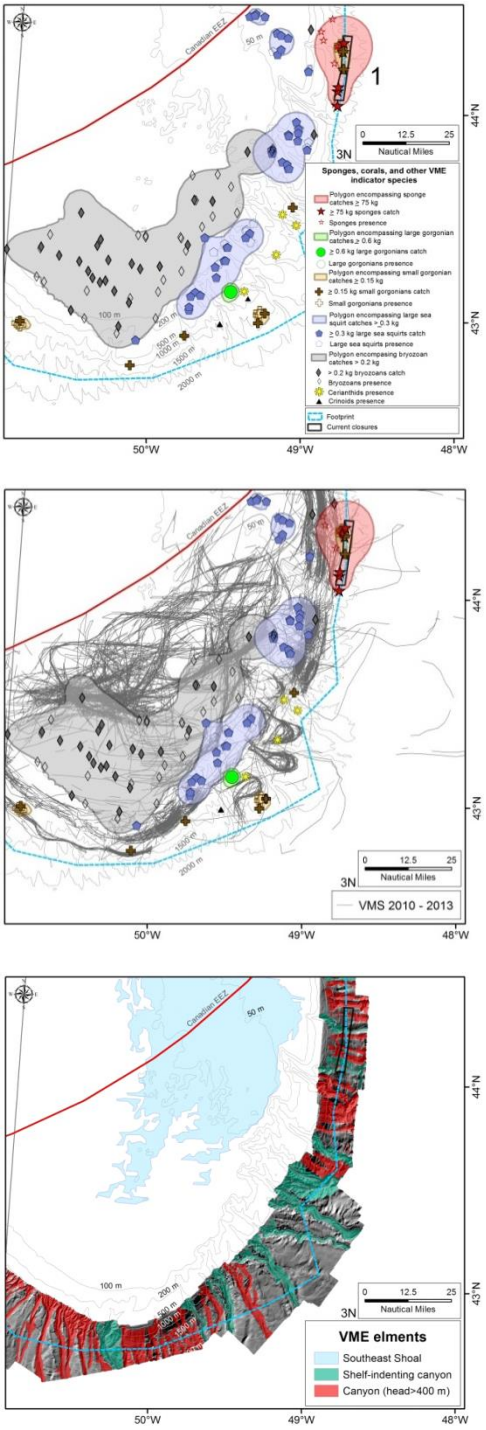

Fig. 8. Area 1. VMEs and VME indicator species (top) from kernel analysis, VMS data (middle), and VME elements and NEREIDA multibeam (bottom).

Area 2 Flemish Pass/Eastern Canyon Southern Portion

Summary (Fig. 9): The closure is capturing most of high concentration locations within the broader sponges ground VME. Sponge catches and, high concentration locations of large gorgonians and sea pen catches occur outside the closed area.

VME Elements: Physical VME elements in the area are canyons, and shelf-indenting canyons.

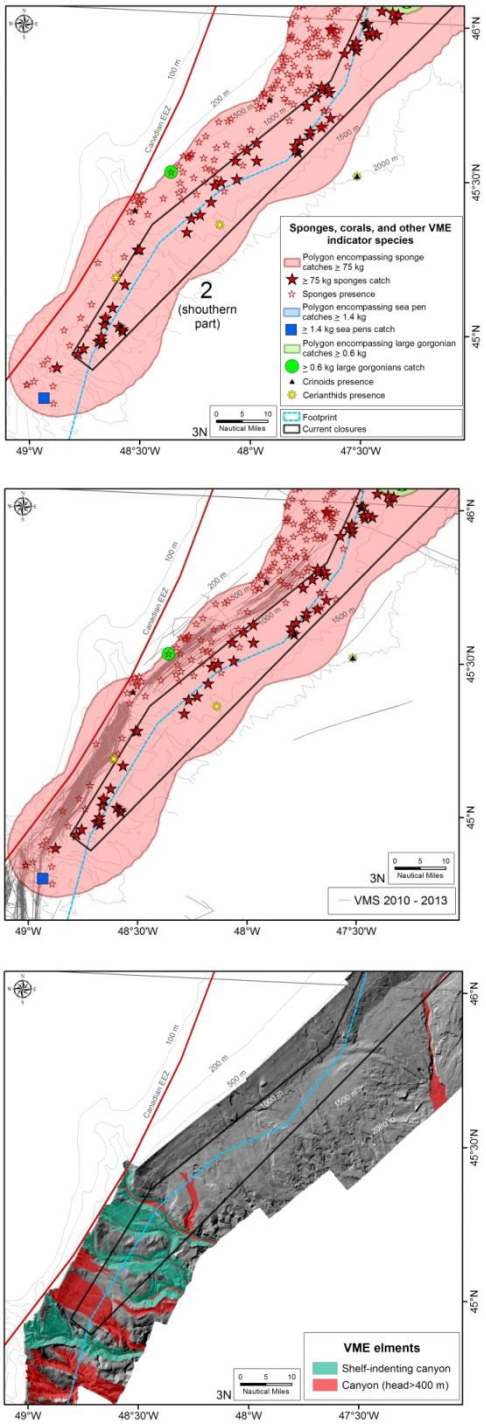

Fig. 9. Area 2 Southern Portion. VMEs and VME indicator species (top) from kernel analysis, VMS data (middle), and VME elements and NEREIDA multibeam (bottom).

Area 2 Upper Flemish Pass Portion and Area 3 Beothuk Knoll

Summary for Area 2 Upper Flemish Pass Portion (Fig. 10): Large gorgonian coral areas are covered by the closure. VME of large gorgonians, sponges and seapens have been identified outside of the closure.

VME of large gorgonians and sponges have been identified outside the closure.

VME Elements: Physical VME elements include the Beothuk Knoll, steep flanks, and canyons with heads greater than 400 m.

Summary Area 3 Beothuk (Figure 4): High concentrations of sponges are covered by the closure.

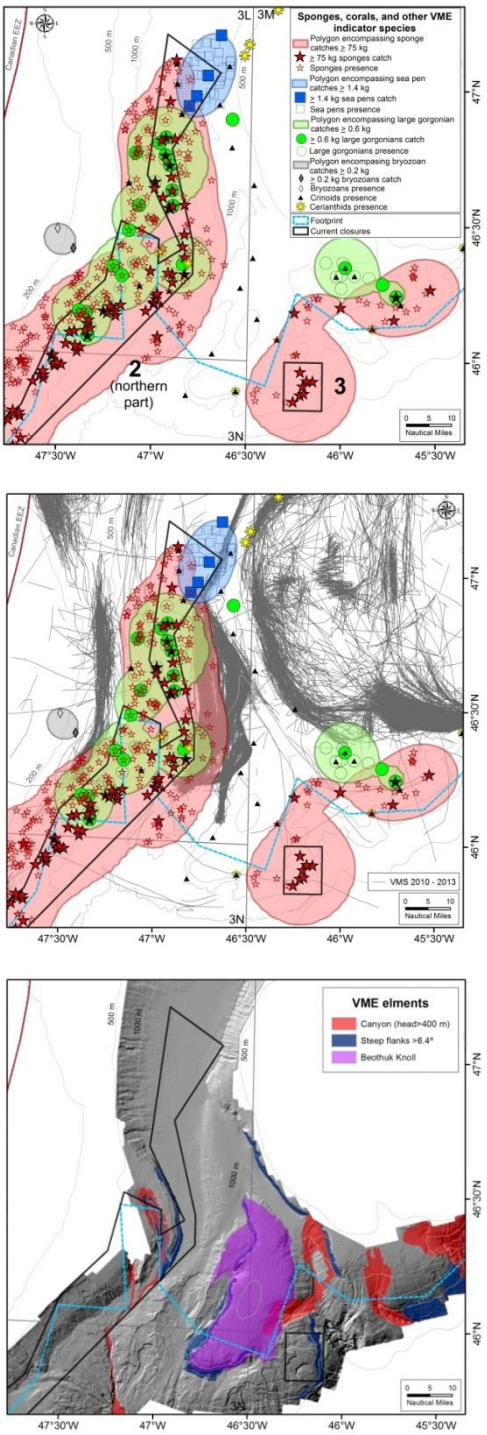

Fig. 10. Area 2 northern portion and Area 3 Beothuk Knoll. VMEs and VME indicator species (top) from kernel analysis, VMS data (middle), and VME elements and NEREIDA multibeam (bottom).

Area 4 Eastern Flemish Cap

Summary (Fig. 11): High concentrations of large gorgonians and sponge grounds are covered by the closure. Large gorgonians and sponge ground also extend beyond the closed area.

VME Elements: Physical VMEs identified in this area are steep flanks, and canyons.

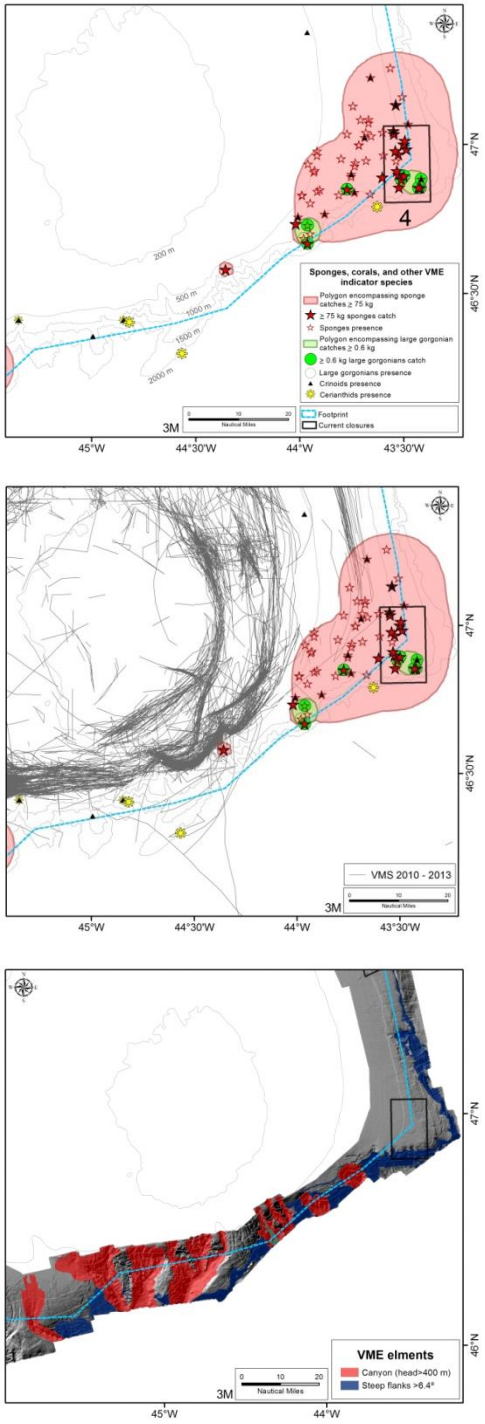

Fig. 11. Area 4 Eastern Flemish Cap. VMEs and VME indicator species (top) from kernel analysis, VMS data (middle), and VME elements and NEREIDA multibeam (bottom).

Area 5 Northeast Flemish Cap

Summary: This closure covers sponge ground VMEs (Fig. 12). The extension of the closure into deeper water also covers a gradient of benthic communities with depth, transitioning from coral dominated communities at ~2450m depth, to corals intermixed with sponges around 2000m, to sponge dominated grounds at 1500m, and to a diverse community of corals, sponges and other benthic taxa at ~1300m depth. This gradient of communities was identified using a Remote Operated Vehicle; hence this data cannot be easily incorporated into the kernel analysis.

VME Elements: Steep flanks are the physical VME element in the closed area.

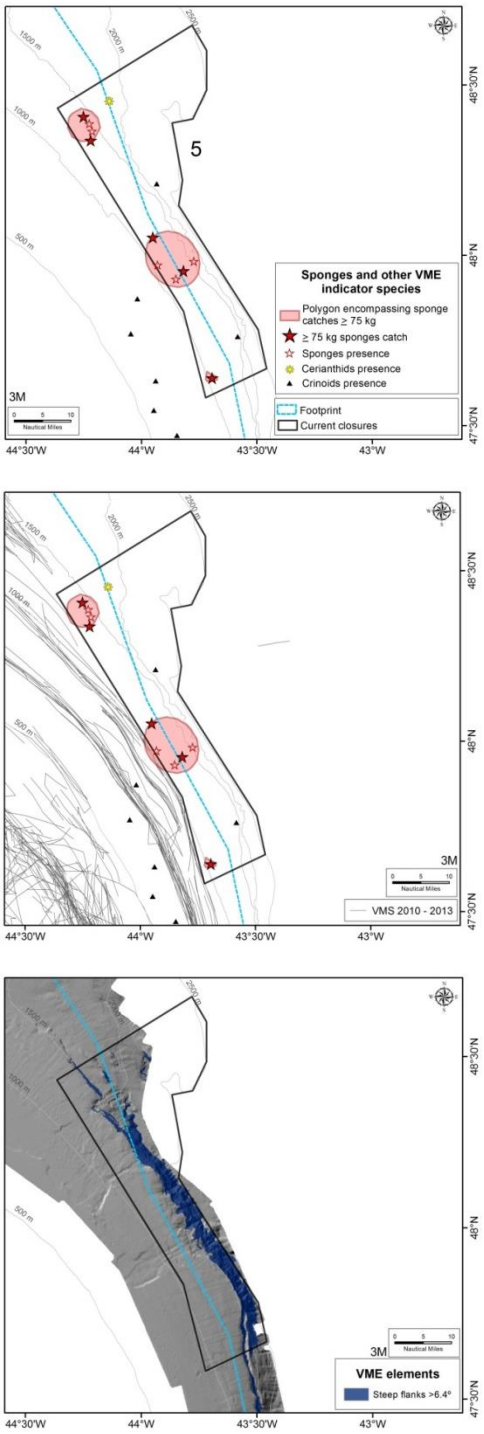

Fig. 12. Area 5 Northeast Flemish Cap. VMEs and VME indicator species (top) from kernel analysis, VMS data (middle), and VME elements and NEREIDA multibeam (bottom).

Area 6 Sackville Spur

Summary (Fig. 13): This closure covers important sponge grounds. The sponge ground VME extends beyond the current closure. No significant concentrations have been found outside the closed area.

VME Elements: There are no physical VME elements in this area.

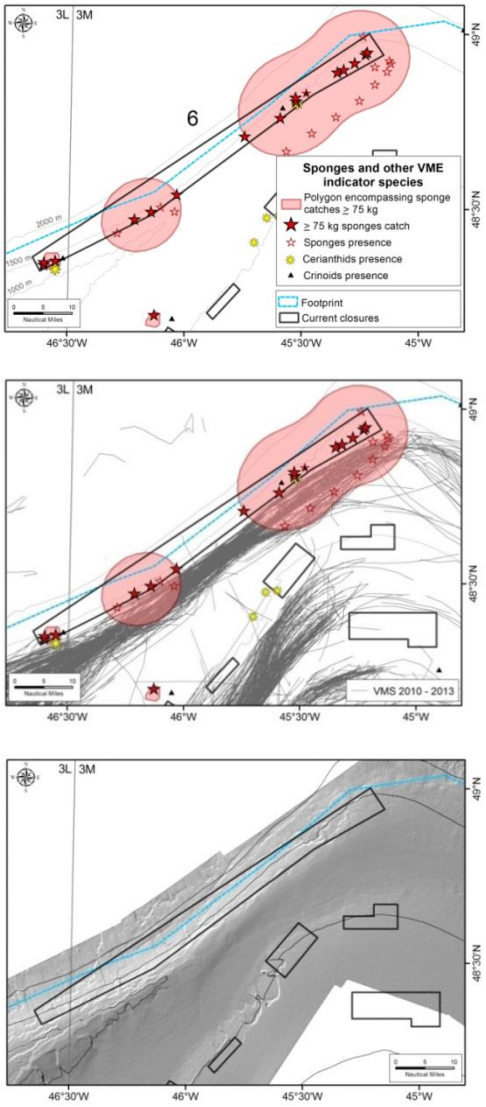

Fig. 13. Area 6 Sackville Spur**.** VMEs and VME indicator species (top) from kernel analysis, VMS data (middle), and VME elements and NEREIDA multibeam (bottom).

Areas 7, 8, 9, 10, 11, 12 Northern and Northwestern Flemish Cap Including Candidate Areas 13, 14

Summary (Fig. 14): Areas 7 – 12 and Candidate Areas 13 and 14 cover seapen VME areas, however the seapen VME area extends beyond all of these areas. There is a system of seapen VMEs extending around the edge of the bank. The VME encompassing Areas 8 – 10 and 12 also contains sponges, crinoids and cerianthids.

VME Elements: There are no physical VME elements in this area.

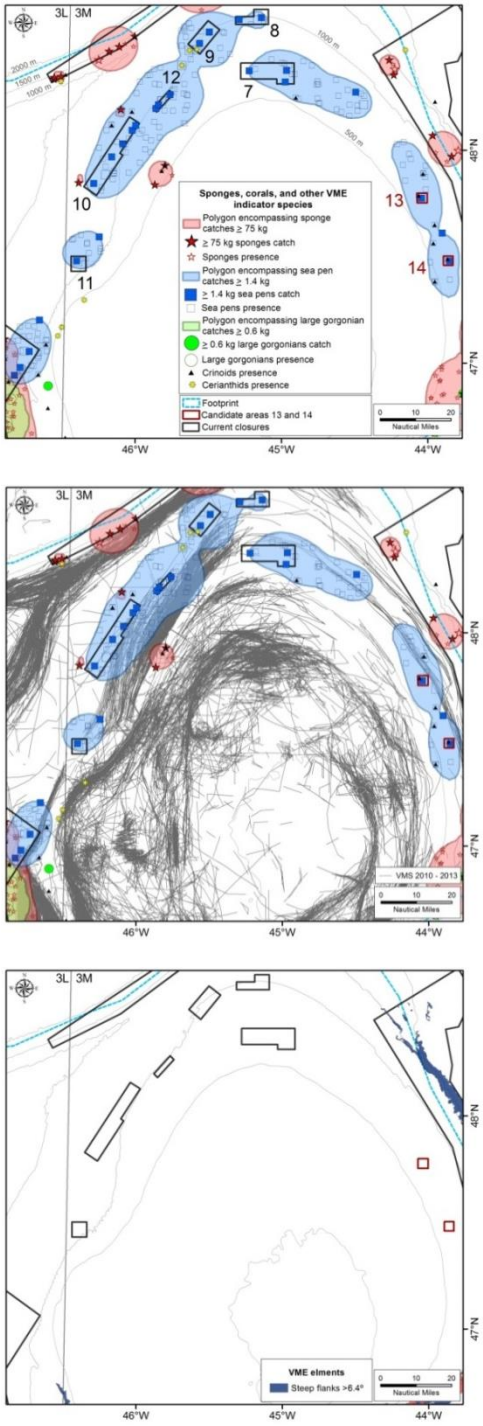

Fig. 14. Areas 7-12 and candidate 13 and 14 Northern and Northwestern Flemish Cap Including Candidate Areas 13, 14**.** VMEs and VME indicator species (top) from kernel analysis, VMS data (middle), and VME elements and NEREIDA multibeam (bottom).

Review of Seamount Closed Areas in the NRA

A review of information pertaining seamounts was done in 2010 when the seamount protection zones were revisited by Fisheries Commission. At that time it was concluded that the seamounts were properly classified as VME elements given the available knowledge on the ecology of seamounts in terms of structure and function, as well as the effects of human impacts on them, including midwater trawling and fishing with bottom gears. The information available since then, continues to support the notion that seamounts should be considered VMEs. Scientific Council reiterates its advice from September 2013 (NAFO Scientific Council Reports, 2013, p311).

Scientific Council advises:

1) The polygons of the closures for both the New England and Corner Rise seamounts be revised to the north, east and west in the NAFO Convention Area to include all the peaks that are shallower than 2000 metres (as shown by green dots in Fig. 15).

2) For seamount fisheries in areas where fishing has not historically taken place, the Exploratory Fishing protocol be expanded to include all types of fishing, specifically the current mid-water trawl gears.

3) Precautionary regulations of the mid-water trawl fishery on splendid alfonsino be put in place. The regulations can include simple measures such as limiting spatially and temporally (i.e. outside the spawning season which is reported to be in July/August (Vinnchenko,1997)) the activity with a close monitoring (i.e. include 100% scientific observer coverage in order to collect data for these less-known areas) including prior notifications, and effort or catch limitation. These regulations would only apply to areas where fishing has taken place historically as shown in Fig. 2, and only using a mid-water trawl (i.e. bottom trawl would remain under the Exploratory Protocol). Outside these areas, the expanded Exploratory fishing protocol would apply

Current seamount closures cover most of the shallow seamounts (less than 2000 m deep) in the NRA, but not all. Scientific Council has identified peaks in the Corner Rise and New England Seamount chains that are not currently included in NAFO seamount protection zone. It was also noted that the New England Seamount protection zone includes a portion of the Bermudan EEZ.

Corner Rise Seamounts: Not all sea mount peaks in this chain are closed. There are shallower peaks outside the protection zone that are potentially under threat. Corner Rise seamount protection zone could be revised to the north, east and west in the NAFO Convention Area to include all the peaks that are shallower than 2000 metres (Figure 10).

New England Seamounts: Not all sea mount peaks in this chain are closed. The New England seamount protection zone should be revised by extending the existing protection zone area north, and northwesterly to coincide with the boundary of the the EEZ of the United States of America and thereby encompass the shallower peaks in that area (Figure 10). Also the boundary requires adjustment in the southwest corner to exclude the EEZ of Bermuda.

At the present time, seamount protection zones provide no additional protection to these areas than the ones afforded by the exploratory fishing protocol for all areas outside the NAFO fishing footprint.

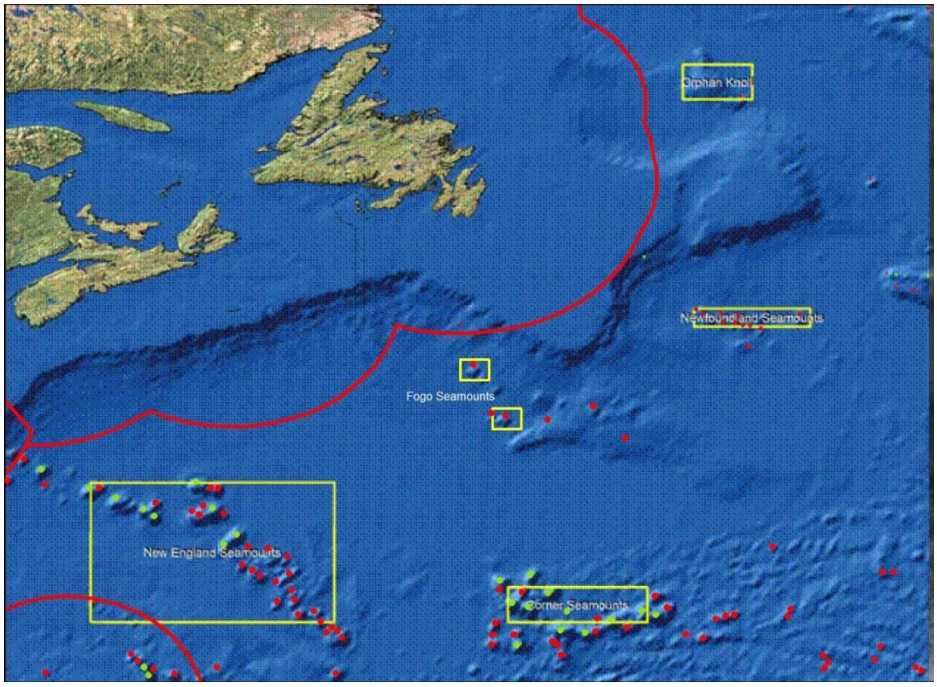

Fig. 15. Seamounts chains in the NRA and NAFO Seamount protection zones. Seamounts shallower than 2000m are indicated by green dots, and deeper seamount peaks by red dots. EEZs are indicated in red lines; note that the New England Seamount protection zone includes part of the Bermuda EEZ.