NOT TO BE CITED WITHOUT PRIOR
REFERENCE TO THE AUTHOR(S)

Northwest Atlantic Fisheries Organization

Serial No. N7068 **NAFO SCR Doc. 20/022**

SCIENTIFIC COUNCIL MEETING – JUNE 2020

A theoretical exercise of Marine Spatial Planning in the Flemish Cap and Flemish Pass (NAFO Divs. 3LM): implications for fisheries management in the high seas

By

Durán Muñoz, P., Sacau, M., Román-Marcote, E. and García-Alegre, A.
Instituto Español de Oceanografía (IEO)
Centro Oceanográfico de Vigo
Subida a Radio Faro, 50
36390 Vigo
ESPAÑA

Abstract

A theoretical exercise of Maritime Spatial Planning (MSP) is currently being conducted within the Regulatory Area of the Northwest Atlantic Fisheries Organization (NAFO), using the MESMA framework to assess whether the existing science base is sufficient to support a potential spatially managed area. The case study is located in the high seas within the Flemish Cap – Flemish Pass area. It includes cold-water coral and deep-sea sponge vulnerable marine ecosystems (VMEs), bottom fishing closed areas, and different blue economy activities, such as high seas fisheries and offshore oil and gas. The paper summarizes the context setting for MSP, in a theoretical scenario to accommodate an emergent offshore hydrocarbon exploration and exploitation, minimizing impacts on VMEs and existing high seas fisheries. Biophysical and socio-economic components of the ecosystem are mapped, including the spatial overlapping between new and traditional uses of the marine space, focused on potential conflicts user-user (e.g. hydrocarbon industry and deep-sea fisheries) or user-environment (e.g. hydrocarbon industry and VMEs) and considering transboundary conflicts (e.g. recent oil spills). Current and potential management measures are described. This is followed by a discussion on the role and challenges of MSP in Areas Beyond National Jurisdiction, as lessons learned from the present exercise. Finally, the future work is briefly outlined.

Keywords: Areas Beyond National Jurisdiction, high seas fisheries, Marine Spatial Planning, NAFO, northwest Atlantic, ocean governance, offshore oil and gas, spatial management, Vulnerable Marine Ecosystems.

1. Introduction

1.1 Marine Spatial Planning in the high seas

According to the UNESCO approach towards ecosystem-based management (Ehler and Douvere, 2009), Marine Spatial Planning (MSP) is a public process of analyzing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic and social objectives that have been specified through a political process. Conflicts user-user (e.g. high fisheries *vs* offshore oil and gas) or user-environment such as offshore oil and gas *vs* vulnerable marine ecosystems (VMEs) weaken the ability of the ocean to provide the necessary ecosystem services. Demands for goods and services from a marine area usually exceed its capacity to meet all of them simultaneously. Some public process, such as MSP, must be used to decide what mix of goods and services will be produced from the marine area.

Despite the fact that the 1982 UN Convention on the Law of the Sea (UNCLOS) remains silent about MSP as management process (Maes, 2008), it could be used to assist states to fulfill their obligations under both UNCLOS and the Convention on Biological Diversity (Ardron *et al.*, 2008). But coordination between management authorities from different sectors and jurisdictions is often limited, which challenges the conservation of VMEs and fisheries resources in the high seas, although there is potential for cooperation (Altvater *et al*., 2019). MSP, as a tool to progress towards an ecosystem-based approach, has a potential to improve decision making by providing a framework to analyse competing human activities and managing their impacts (Buhl-Mortensen *et al.*, 2016). In this context, the implementation of MSP in Areas Beyond National Jurisdictions (ABJN), is a challenge that the international community will need to address to ensure long-term productivity and resilience of high seas ecosystems and services (Ardron *et al.*, 2008).

1.2. Assessment of theoretical spatially managed areas: the ATLAS project

ATLAS (www.eu-atlas.org) is a multidisciplinary international project funded by the EU Horizon 2020 program. ATLAS is testing a generic MSP framework developed by the EU FP7 MESMA project (Stelzenmüller *et al*., 2013) to assess spatially managed areas (SMAs) in all 12 of the ATLAS Case Studies (https://www.eu-atlas.org/about-atlas/atlas-case-study-descriptions). The different ATLAS Case Studies represent a wide range of biogeographic, regulatory and jurisdictional situations encountered across the Atlantic from national deep-waters to ABJN (e.g. Case Study No11 Flemish Cap – Flemish Cap area, located in the high seas[1], NAFO Regulatory Area - NRA). SMAs are discrete geographic regions that can be defined at different spatial scales, but where a spatial management framework (e.g. MSP) is either in place, under development, or potentially being considered. The main focus of ATLAS regarding MSP is to assess whether the existing science base is sufficient to support theoretical regional/local SMAs. It should be made clear at the outset, that the project has no legal competence or mandate to produce a marine spatial plan in the strict application of the term.

1.3 Objective of this document

This document presents a theoretical exercise of MSP that is being conducted under the ATLAS project in the NRA. The goal considered here is the provision of a framework for the sustainable use of goods and services derived from the Flemish Cap – Flemish Cap area (Figure 1), which can accommodate an emergent offshore oil and gas exploration and exploitation, preventing impacts on VMEs (FAO, 2009) and existing high seas activities (e.g. fishing). Methodology is presented, as well as the preliminary maps of ecosystem components (both natural components and human activities) in the study area. In addition, a picture of the spatial overlapping and conflicts between different uses of the marine space, as well as between footprints of human activities and

[1] As was summarized by Long and Rodríguez Chaves (2015), ABNJ is understood to refer to both the "high seas" and the international seabed area, named the "Area". Accordingly, ABNJ are sea areas beyond the limits of coastal state sovereignty and jurisdiction, where two very distinctive jurisdictional frameworks apply under UN Convention on the Law of the Sea (UNCLOS): the "high seas" (all parts of the sea that are not included in the exclusive economic zone, in the territorial sea, internal waters or in the archipelagic waters) defined in article 86, and the "Area" (the seabed and ocean floor, and subsoil thereof, beyond the limits of national jurisdiction) defined in article 1.

VMEs is given. This is followed by a discussion on the role and challenges of MSP in Areas Beyond National Jurisdiction, as lessons learned from the present exercise (e.g. need of an appropriate MSP authority). Finally, the future work is briefly outlined.

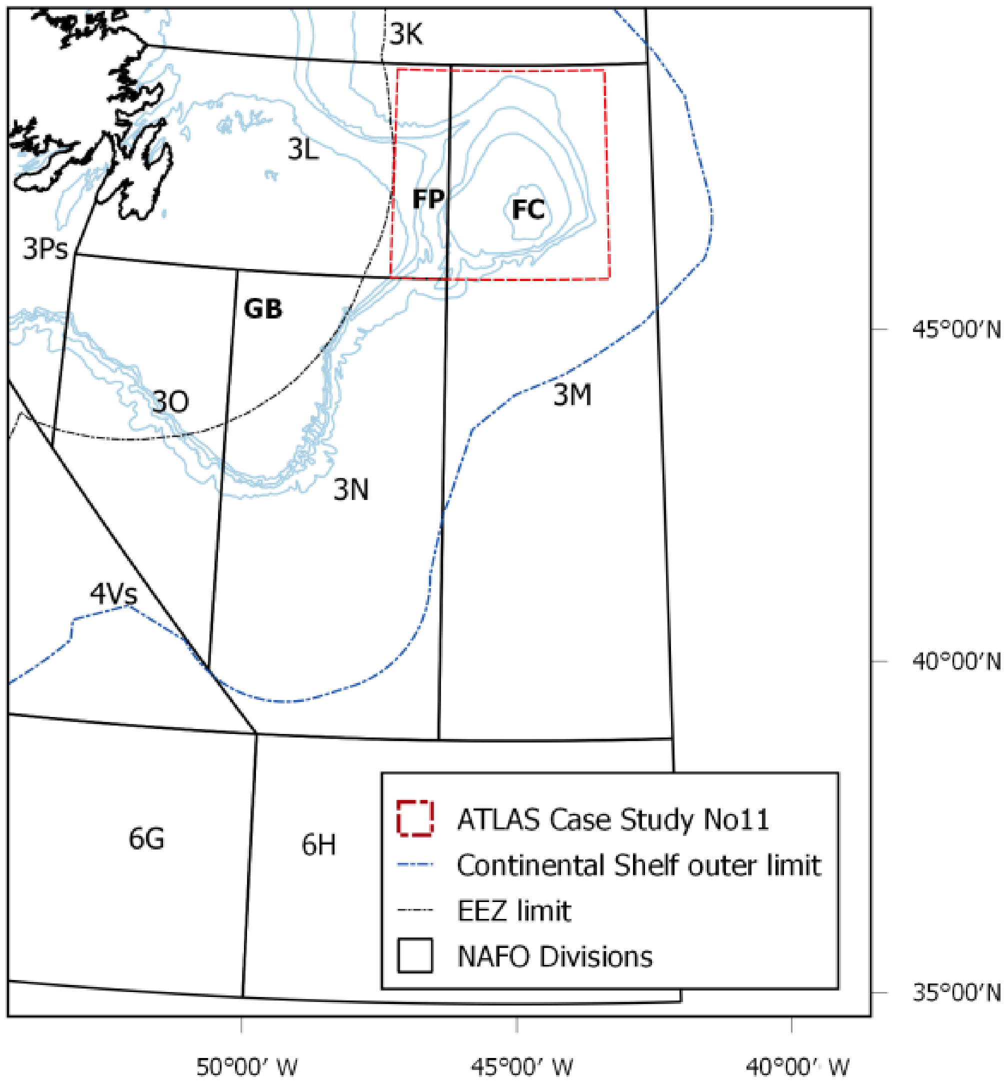


Figure 1. Map of the southern part of the NAFO Regulatory Area (NRA) showing the location of the study area (ATLAS Case Study No11: Flemish cap – Flemish pass). NRA is located in the high seas, with part of the seafloor within the extended continental shelf of the coastal state (FC: Flemish Cap; FP: Flemish Pass; GB: Grand Banks of Newfoundland). Sources GEBCO, NAFO and NESS. QGIS Geographic Information System.

2. Generic framework used to assess a theoretical spatial planning

The generic MESMA framework (Stelzenmüller *et al.,* 2013) for the monitoring and evaluation of a SMA is being tested in the Flemish Cap – Flemish Pass area. This framework (www.mesma.org) comprises seven key steps (Figure 2):

Step 1 requires the definition of spatial and temporal boundaries to specify the context, the boundaries and the high-level goals and operational objectives. *Step 2* comprises the collation and mapping of existing information including all ecosystem components (natural and socio-economic) relevant to the set of operational objectives. The socio-economic components (human activities) must be mapped and the (cumulative) impacts of these on natural ecosystem components assessed. *Step 3* involves the definition of indicators and related thresholds. *Step 4* comprises state assessments of the indicators and/or risk analysis of management scenarios. *Step 5* evaluates the findings against the operational objectives. *Step 6* assesses the effectiveness of the proposed management measures. Finally, *Step 7* collates the outputs from the previous steps leading to recommendations to support adaptive management in the SMA.

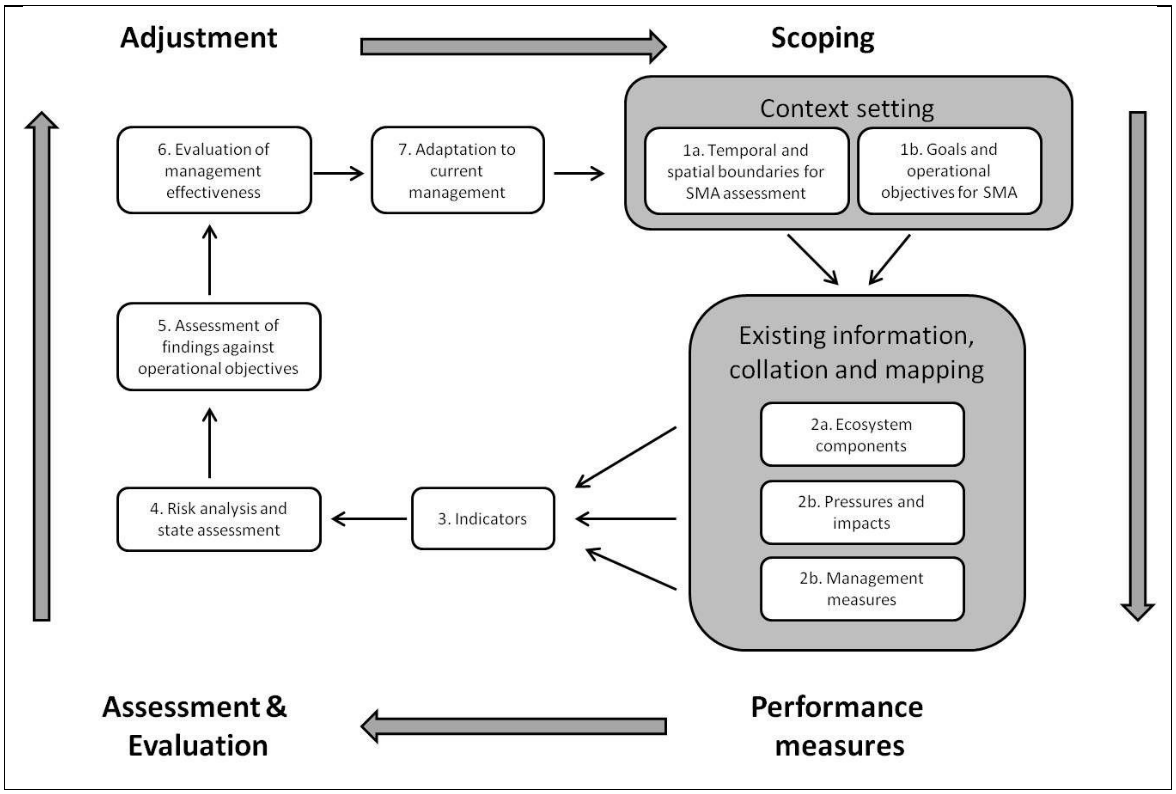


Figure 2. Flowchart of the MESMA framework for the monitoring and evaluation of spatially managed areas (www.mesma.org).

3. Description of the Case Study area

The study area (ATLAS Case Study No11) comprises both the Flemish Cap and the Flemish Pass area. It is located in the high seas (ABNJ) within the NRA (NAFO Divs. 3LM), with the seafloor within the extended continental shelf of the coastal state (Figure 1). The size of the case study area is about 124,000 km^2. Flemish Cap is an Oceanic Bank located about 600 km to the east of Newfoundland and separated from the Grand Banks of Newfoundland by a rift zone known as Flemish Pass, at depths which may reach 1,200 m. The Bank (a plateau of about 200 km in radius) comprises about 4,870 km^2 within the bathymetric contours of 200 m depth (depths range between 125 m and 1,500 m).

The study area includes several types of valuable habitats and ecosystems (e.g. cold-water corals and deep sea sponges, see Kenchington *et al.,* 2014) and several types of existing and potential human activities (Table 1). Currently, the main human activities in the region are fisheries, shipping, undersea cable routes, scientific research and offshore hydrocarbon exploration. There is potential for increased offshore oil and gas exploration leading to exploitation in the area (NAFO, 2019a). However, this will present a potential conflict for (i) existing activities (e.g. high seas fisheries), (ii) management measures such as areas closed to bottom fishing (NAFO, 2020) and (iii) VMEs identified by NAFO.

Table 1. Preliminary list of existing and potential human activities identified in the Flemish Cap – Flemish Pass area (ATLAS Case Study No11).

Sector/Driver	Subsector	Activity
Fisheries	Bottom fisheries	Pots, traps, gillnets, trawls and longlines
	Pelagic fisheries	Seines, gillnets, trawls and longlines
Exploitation and exploration of non-living resources and ocean energy	Offshore oil and gas	Exploration (drilling and seismic activities)
		Exploitation (significant discoveries/production)
		Pipelines
	Offshore renewables	Wind, tidal and current energy converters
		Power cables
	Mining	Seabed mining
	Carbon capture and storage	Carbon capture and storage
Transportation	Shipping	Shipping (passengers and items)
Telecommunication	Undersea cables	Laying and maintain undersea cables
Science	Research and education	Fish stock assessment and ecosystem surveys
Conservation	Environmental conservation and protection	Environmental conservation and protection (including VMEs)
Biotechnology	Bioprospecting	Search for biological compounds and genetic resources
Defence	Military activities	Dumping, sonar, training
External influences	Climate change	Climate change
	Pollution	Pollution (including marine litter and long-distance pollution)

4. Description of the institutional landscape for fisheries and oil and gas sectors

Table 2 presents a summary of the institutional landscape in the study area (fisheries and oil and gas).There is not an integrated spatial management plan in place for the study area. However, there are ongoing independent active sectoral plans for fisheries and hydrocarbon management: (i) fisheries in the high seas are managed by

NAFO, meanwhile (ii) offshore oil and gas resources activities in the extended continental shelf are managed by the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB). Environmental assessments (EAs) of offshore oil and gas projects are managed under C-NLOPB ("project-based" EAs under the *Accord Acts*) or under the Impact Assessment Agency of Canada – IAAC ("designated projects" EA, under the former *Canadian Environmental Assessment Act – CEAA* 2012, or the new *Impact Assessment Act – IAA 2019*).

Table 2. Summary of the institutional landscape in the Case Study area regarding high seas fisheries and offshore oil and gas.

Sector	Fisheries (NAFO Stocks)	Offshore oil and gas (exploration and exploitation)
Management authority	NAFO	C-NLOPB[2] / IAAC[3] former CEAA
Zoning and jurisdiction	High seas (international water column)	Extended continental shelf (seabed and subsoil)
Spatial boundary	NAFO Regulatory Area	Eastern Newfoundland and Labrador offshore Area
Operational level	Intergovernmental, international (12 Contracting Parties): NAFO (Regional Fisheries Management Organization).	Coastal State: C-NLOPB (Board); IAAC (Agency)
Relevant objectives to MSP	NAFO: Long term conservation and sustainable use of the fishery resources and to safeguard the marine ecosystems	C-NLOPB: To facilitate the exploration for and development of the petroleum resources, including safety, environmental protection, resource management and industrial benefits. IAAC: impact assessment process.
Relevant management instruments to MSP	NAFO Conservation and Enforcement Measures, including bottom fishing closures to protect VMEs; NAFO Road Map to Ecosystem Approach Framework.	C-NLOPB management mandate under the *Accord Acts*; Licences and authorizations; Strategic Environmental Assessments (SEA); Regional Assessment under IAAC; Environmental Assessments (EAs): • "Project-based" EAs under the *Accords Acts* • "Designated projects" EAs under *Federal laws*

5. *Blue Growth*[4] *– Blue Economy* hypothetical scenario

The *"accommodation of offshore hydrocarbon exploration and exploitation, minimising impacts on existing activities and VMEs"* in the Case Study area, was identified as *Blue Growth – Blue Economy* hypothetical scenario of the present MSP exercise. The goal of the theoretical spatial planning will be to ensure minimum disruption

[2] The C-NLOPB was initiated in 1985 to manage resources in the Newfoundland Labrador offshore area on behalf of the Newfoundland Labrador and Canadian governments (see: https://www.cnlopb.ca)

[3] Impact Assessment Agency of Canada - IAAC (see: https://www.canada.ca/en/impact-assessment-agency.html)

[4] Long term strategy to support sustainable growth in the marine and maritime sectors as a whole.

of existing activities (e.g. high seas fisheries) and impact on the delivery of ecosystem goods and services (e.g. fish stocks, vulnerable habitats and ecosystems, etc.), including protection of cold- water corals and deep-sea sponges (Armstrong *et al.*, 2010, Thurber *et al.,* 2014).

6. Mapping of ecosystem components

Collation and mapping of existing information are ongoing, with the objective to define and analyze the existing conditions in the Case Study area. Both relevant biophysical (Figure 3) and socio-economic (Figure 4) components of the ecosystem were preliminarily mapped, taking into account the importance of such components and the availability of data in the SMA. All this information was organized and integrated into a GIS using the open source software QGIS (v3.10). Mapping of ecosystem components is in progress. Information will be updated and additional information will be considered as it becomes available.

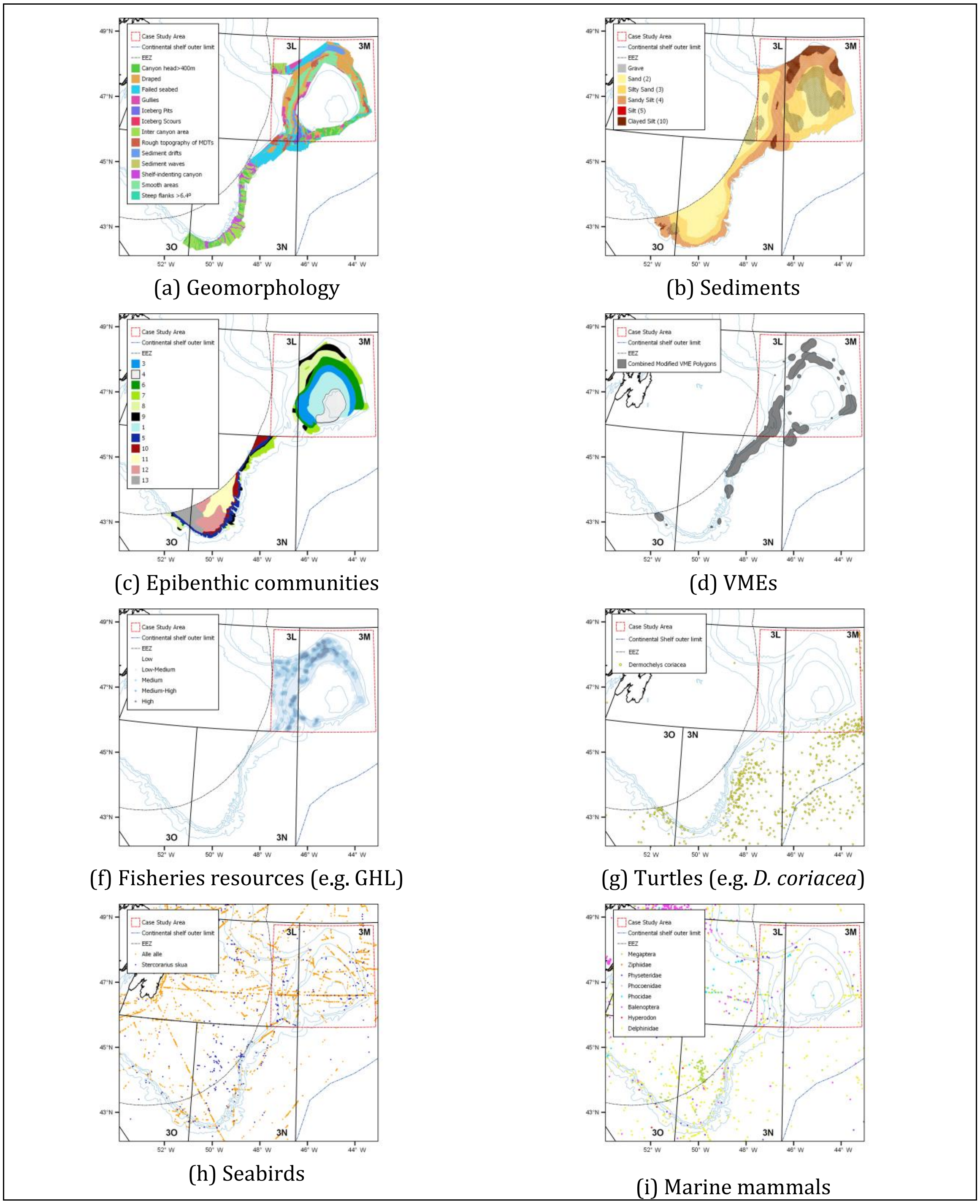


Figure 3. Preliminary mapping of natural components of the ecosystem in ATLAS Case Study No11 (Flemish Cap – Flemish Pass) from several available sources (NEREIDA, IEO, Thesis FJM [USC-IEO], NAFO, OBIS, etc.). QGIS Geographic Information System.

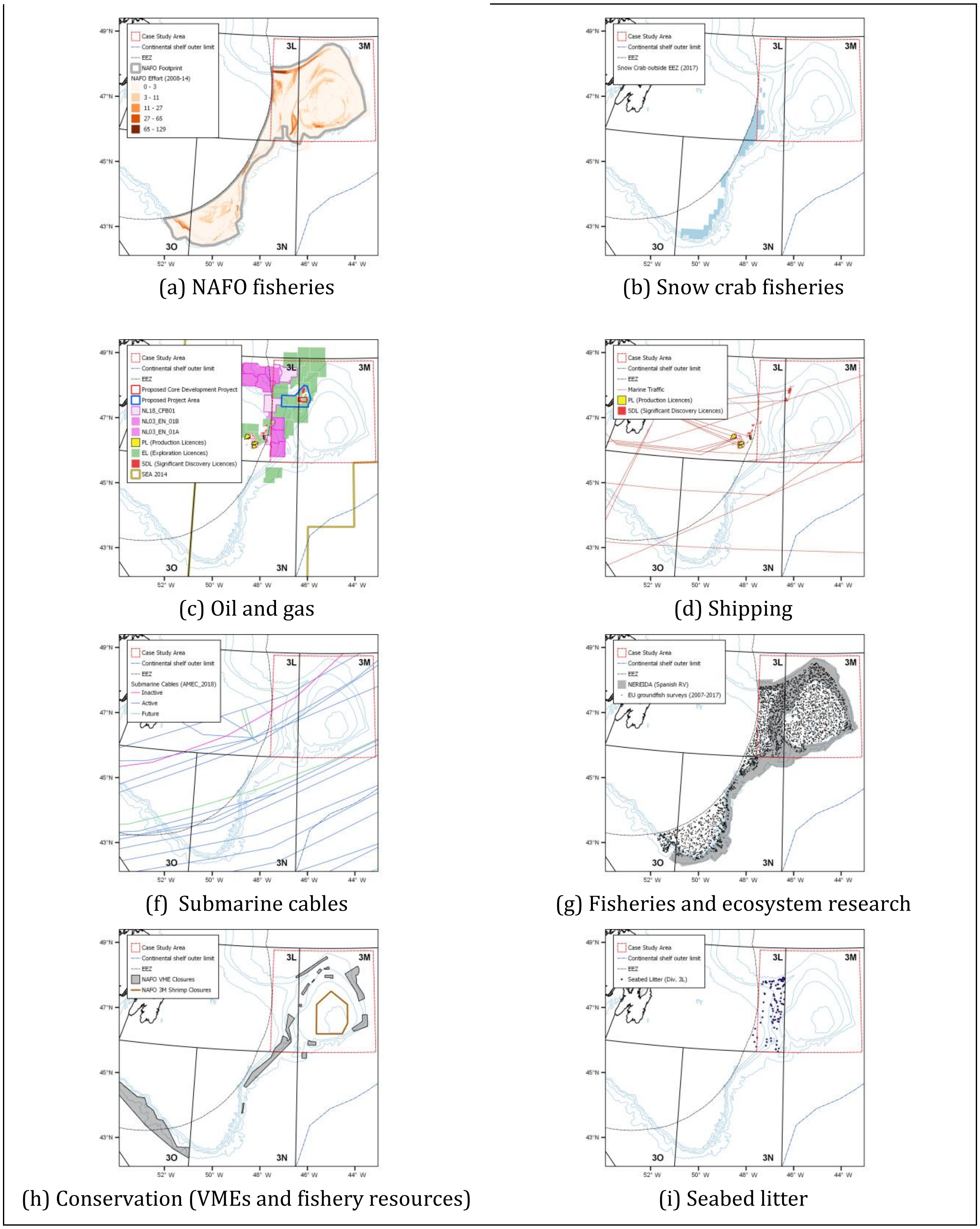


Figure 4. Preliminary mapping of socio-economic components of the ecosystem (human activities) in ATLAS Case Study No11 (Flemish Cap – Flemish Pass) from several sources (IEO, NAFO, DFO, García-Alegre *et al.,* 2020, C-NLOPB, OBIS, etc.). QGIS Geographic Information System.

7. Conflicts user-user and user-environment in the NRA

The present MSP theoretical exercise pays special attention to the spatial overlapping between emergent and existing uses of the marine space - focused on high seas fisheries and offshore oil and gas - as well as between human activities and natural components of the ecosystem, particularly VMEs.

According to Arbo and Thuy (2016), fisheries and oil and gas activities can create negative externalities for each other. Potential conflicts user-user include limited access to valuable areas as fishing grounds, damage of gear, pipelines and other subsea or surface infrastructures, navigational hazards due to installations and increased marine traffic. Moreover, both activities can also have harmful effects on the marine environment (e.g., impacts on VMEs, overfishing, pollution, etc.). Particularly, deep-water oil and gas industry can produce environmental impacts from routine activities and accidental discharges (Cordes *et al.,* 2016) including long-term impacts on deep-sea corals (Girard and Fisher, 2018) and deep-sea sponges and associated habitats (Vad *et al.,* 2016). The application of MESMA framework in the Case Study (Steps 1 & 2) was useful to identify some of the above mentioned conflicts (actual and potential) in the NRA.

7.1. Actual conflicts: pollution from current oil and gas exploitation activities

Pollution incidents are often a source of real conflicts between users of the marine space and between users and the marine ecosystem. Information on recent pollution incidents, including a transboundary one (Figure 5), derived from offshore oil and gas activities in the NW Atlantic, was summarized based on available data. During the period 2015-2019 there have been ten reported incidents of different nature (Table 3), with a major oil spill in 2018 (250,000 L), and one in 2019 that occurred into the EEZ of the coastal state, but was extended outside the EEZ, and into the NAFO Regulatory Area[5]. Another type of incidents, such as the iceberg affaire (a near-miss incident) occurred in March 2017 (Table 3), reveal the potential risks of offshore oil and gas activities in the NW Atlantic.

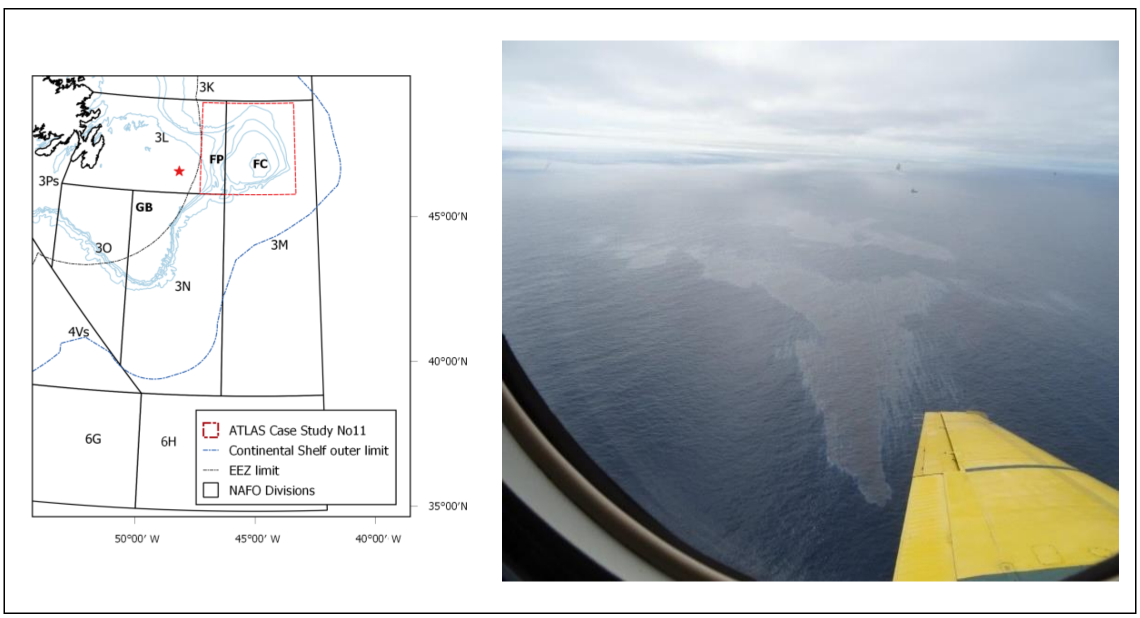


Figure 5. Oil Spill occurred in July 2019. The red star in the map shows the location of the origin of the spill. It occurred inside Canadian EEZ, but the analysis indicated that the oil was extended outside the EEZ and into the NAFO NRA (Photo from C-NLOPB Website). QGIS Geographic Information System.

[5] According to the letter from Fisheries and Oceans Canada sent to NAFO, 23 July 2019 (Ref.NAFO/19-205).

Table 3. List of recent offshore oil spills and other relevant incidents in the NW Atlantic in the last five years, including a transboundary oil spill (source C-NLOPB).

Date	**Incident description**	**Observations**
17/08/2019	Hibernia Oil Spill	Estimated volume of oil on the water was 2,184 L at that time
17/07/2019	Hibernia Oil Spill	Oil expressed on the water could be in the order of 12,000 L. It occurred inside Canadian EEZ, but the analysis indicated that the oil was extended outside the EEZ and into the NAFO NRA (5)
16/10/2018	White Rose Field Oil Spill	250,000 L of oil were released to the environment
27/04/2018	Unauthorized discharge of Synthetic Based Mud (SBM) (Transocean Barents platform)	28,000 L of SBM was released to the environment
29/03/2017	Near Miss - Iceberg Approaches Close to the SeaRose Floating Production, Storage and Offloading (FPSO) Vessel	A medium size iceberg came within 180 meters of the FPSO (about 340,000 barrels of crude oil on board at that time)
15/07/2016	Unauthorized discharge/Impairment of safety critical equipment (Henry Goodrich drilling)	Approximately 1,800 L of hydraulic fluid was released to the environment
15/02/2016	Unauthorized discharge of glycol (West Aquarius)	1,317 L of glycol was released to the sea
30/09/2015	Unauthorized discharge of methanol (Terra Nova field)	3,000 L of methanol was released to the sea
31/08/2015	Major hydrocarbon gas release (Southern drill center)	8,938 kg of natural gas was released to the sea
28/07/2015	Major hydrocarbon gas release (Terra Nova FPSO)	10,000 kg of gas was released

7.2. Potential conflicts in the medium term: the Flemish Pass oil and gas development project

A simple mapping of available spatial information on footprints of human activities, allowed us to identify potential conflicts user-user (e.g. hydrocarbon industry *vs.* deep-sea fisheries) or user-ecosystem (e.g. hydrocarbon industry *vs*. VMEs) in the medium term[6].

[6] *"Discovered in 2013, the* ***Bay du Nord Project*** *is expected to be sanctioned in 2020, with first oil expected in 2025. With reserves of nearly 300 million barrels of oil, Bay du Nord is the first remote, deep water project in the province's offshore (500 kilometres from shore and approximately 1,200 metres deep).* ***It opens a new basin – the Flemish Pass*** *…".* Source: https://www.gov.nl.ca/nr/energy/petroleum/offshore/projects/bay-du-nord/

As a paradigmatic example illustrating such conflicts, the map in Figure 6 shows a proposed development project in the Flemish Pass (*Bay du Nord Project*) overlapping with NAFO fisheries in Div. 3L, as well as with NAFO fisheries, VME closures and VME polygons in Div. 3M.

Moreover, the map reveals the tensions between different management frameworks: areas closed to bottom fishing by NAFO to protect VMEs, are currently open to oil and gas exploration and exploitation.

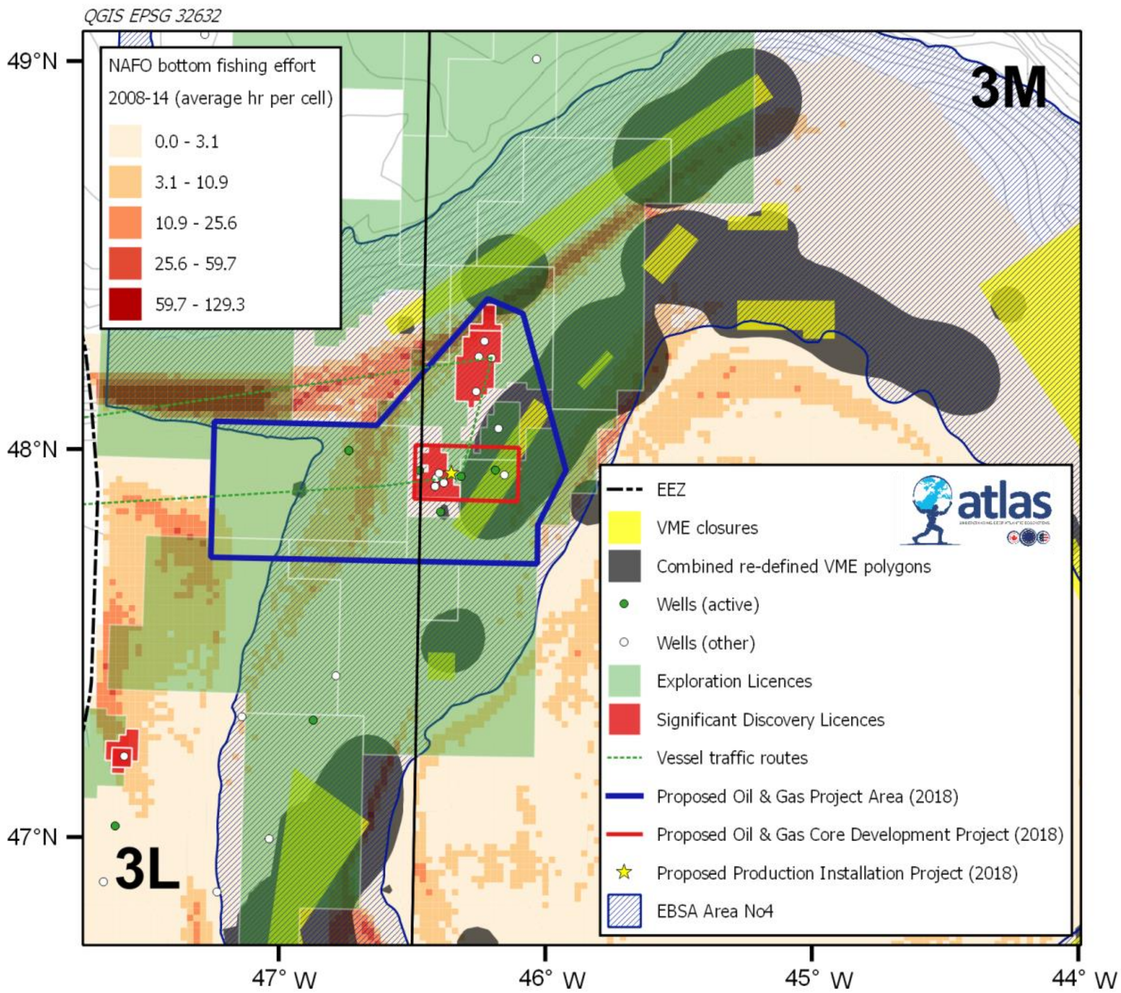


Figure 6. Map of the Flemish Cap – Flemish Pass area (Divs. 3LM) showing the potential conflicts between different users of the marine space (e.g. oil and gas *vs.* fisheries) and between users and environment (oil and gas *vs.* VMEs). The yellow star indicates the location of the proposed production installation. Moreover, the map reveals the tensions between different regulatory frameworks (e.g. areas closed to bottom fishing are currently open to oil and gas exploration and exploitation). Sources (2018): NAFO, C-NLOPB and CBD. QGIS Geographic Information System.

7.3. Potential conflicts in the long term: future oil and gas exploration drilling projects

NAFO (2019a) summarized a comprehensive synthesis of trends in offshore petroleum exploration activities in Divs. 3KLMN. According to this synthesis, it is expected (based on current exploration leases and development projections) that offshore oil and gas exploration activities may increase in the NRA until at least 2030. As of 2019, there are four offshore production fields on the Grand Banks, in the Jeanne d'Arc basin area (Div. 3L), and intense exploration activities along the eastern shelf break and Flemish Pass (Divs. 3LM). In 2019-2020, environmental assessments of several Exploration Drilling Projects were completed and these projects can proceed[7].

The total area of Licences[8] has increased from 2014 to 2019. Figure 7 from NAFO (2019a) shows cumulative well counts and Licence areas over time in Divs. 3KLMN. Recent growing in offshore activity is reflected by the steady rise in the number of wells starting in the early 2000s and Licence areas starting in early 2010s.

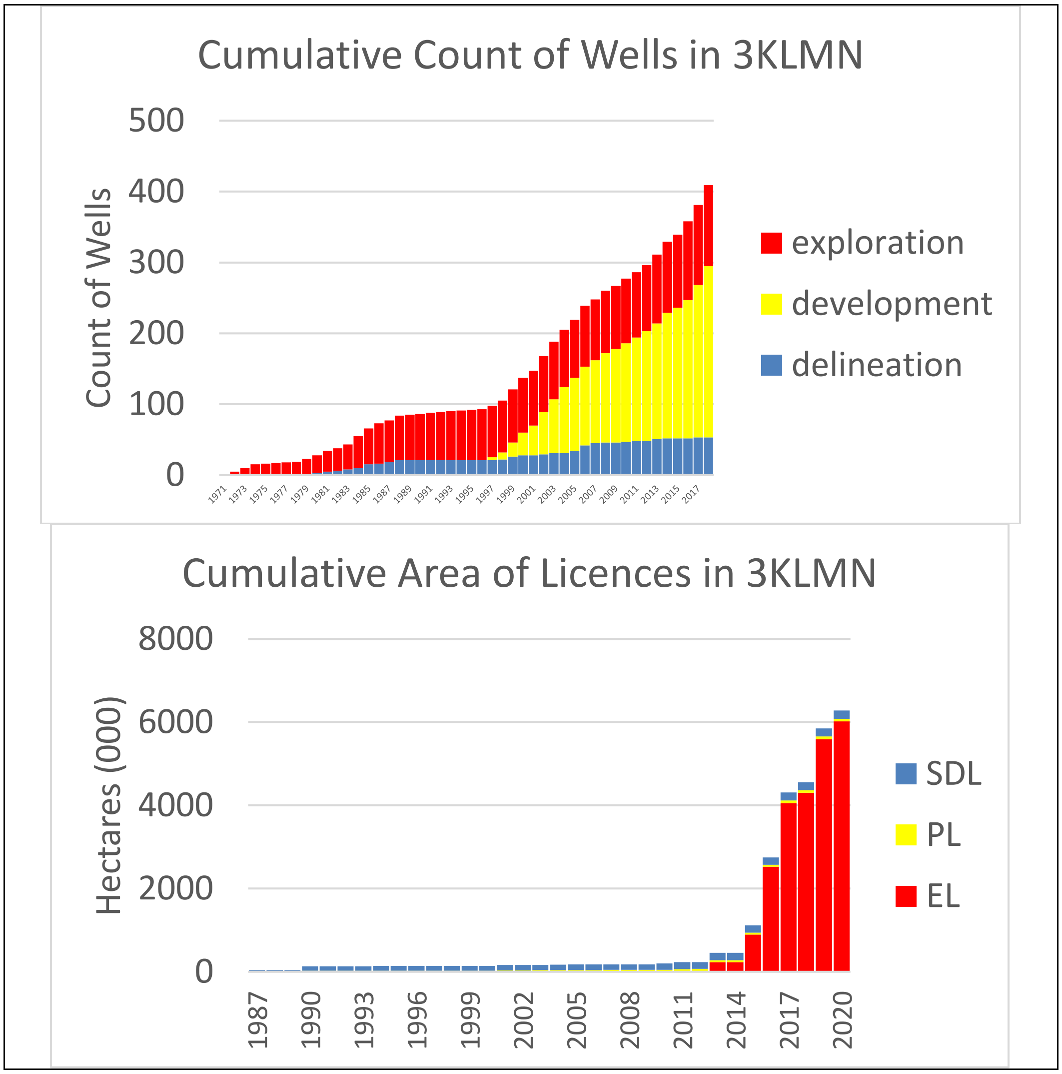


Figure 7. Trends in offshore oil and gas activities in Divs. 3KLMN. Cumulative number of wells (top panel) and cumulative area of licences (bottom panel). EL (exploration licences), PL (production licences), SDL (significant development licences). Figure from NAFO (2019a), based on C-NLOPB data (www.cnlopb.ca)

[7] As an example, in December 2019 was announced that a proposed Flemish Pass Exploration Drilling Project can proceed. This project involves exploration drilling within two offshore Exploration Licences located in the Flemish Pass Basin (see: https://www.canada.ca/en/impact-assessment-agency/news/2019/12/cnooc-international-flemish-pass-exploration-drilling-project--environmental-assessment-decision.html).

[8] Licence types: Exploration, Significant Discovery and Production

Table 4 presents the list of oil and gas projects (different Exploration Drilling Projects and one Development Project) proposed within the NW Atlantic. Figure 8 presents the location of the correspondent areas of these proposed projects. The map shows the overlapping of different projects with NAFO fisheries, VME closures and VME polygons in Divs. 3LMN. Despite that the ATLAS exercise on MSP is focused specifically on the Flemish Cap – Flemish Pass area, the map suggests that beyond Case Study No11, there are some other areas of interest in the NRA regarding the potential impact of activities other than fishing, particularly human activities linked to hydrocarbon exploration and exploitation (e.g. southern part of Div. 3K, northern slopes of Div. 3N)

Moreover, in February 2020, the Regional Assessment Committee for Exploratory Drilling East of Newfoundland and Labrador of the IAAC[9] reported on Regional Assessment of the effects of existing and anticipated exploratory drilling in the eastern Newfoundland and Labrador offshore. The purpose of the new Regional Assessment is to make it easier for future individual oil and gas exploratory drilling proposals to get their respective environmental approvals for their projects (NAFO, 2019a). The Committee's Report (Bangay *et al.,* 2020) contains recommendations on requirements for future projects, providing a basis for a new regulatory framework for future offshore oil and gas exploratory activities in the area (https://iaac-aeic.gc.ca/050/evaluations/exploration?projDocs=80156).

Table 4. List of offshore oil and gas projects proposed within the NW Atlantic. Source: IAAC (April 2020).

Location	**Type of project**	**Status of the Environmental Assessment**	**Reference in the map of Figure 8**
Newfoundland Orphan Basin	Exploration Drilling Project	Completed (*Decision on Environmental Effects: Feb 2020*)	1
Newfoundland Orphan Basin	Exploration Drilling Project	In progress	2
West Flemish Pass	Exploration Drilling Project	In progress	3
Flemish Pass Basin	Exploration Drilling Project	Completed (*Decision on Environmental Effects: Apr 2019*)	4
Flemish Pass Basin - Bay du Nord	Development Project [6]	In progress	5
Flemish Pass Basin	Exploration Drilling Project	Completed (*Decision on Environmental Effects: Dec 2019*)	6
Jeanne d'Arc Basin and Flemish Pass Basin	Exploration Drilling Project	Completed (*Decision on Environmental Effects: Apr 2019*)	7
Flemish Pass - Central Ridge Area	Exploration Drilling Project	In progress	9
Grand Banks	Exploration Drilling Project	Completed (*Decision on Environmental Effects: Mar 2020*)	10
Jeanne d'Arc Basin - Grand Banks	White Rose Extension Project	Completed (*Decision on Environmental Effects: Sep 2013*)	11
Jeanne d'Arc Basin - Grand Banks (Tilt Cove)	Exploration Drilling Project	In progress	12
Southeastern Newfoundland (Carson Basin)	Exploration Drilling Project	In progress	13

[9] A meeting between the IAAC Regional Assessment Committee and NAFO (WGESA) was held on 26th November 2020, with the aim to present information/input from NAFO on its VMEs (NAFO, 2019a).

Cordes *et al.* (2016) summarized the different steps involving deep-water exploration. According to these authors, exploration activities start with (i) *seismic surveys* to understand the subsurface geology and potential hydrocarbon reservoirs. If suitable targets are detected, (ii) *exploration wells* are drilled to ground-truth the interpretation of the acoustic data. If economically recoverable hydrocarbon reserves are located, the site may advance to production. Development of the production, typically involves the drilling of (iii) *appraisal wells* followed by (iv) *production wells* and the (v) *installation of various infrastructure*, in the surface (e.g. drill ships as FPSO vessels) and subsea (e.g., manifolds, control cables, and export lines). In a deep-sea production field, the various wells are connected together with a series of pipes and control cables (Hyne, 2001).

The expected increase demand for oil and gas in the NRA (Figures 7 and 8, Table 3) suggests that potential high seas and transboundary conflicts - related to process described above - could arise in the future. Moreover, as was noted by Cordes *et al.* (2016), oil and gas activities can have detrimental environmental effects during each of the main phases of exploration, production, and decommissioning.

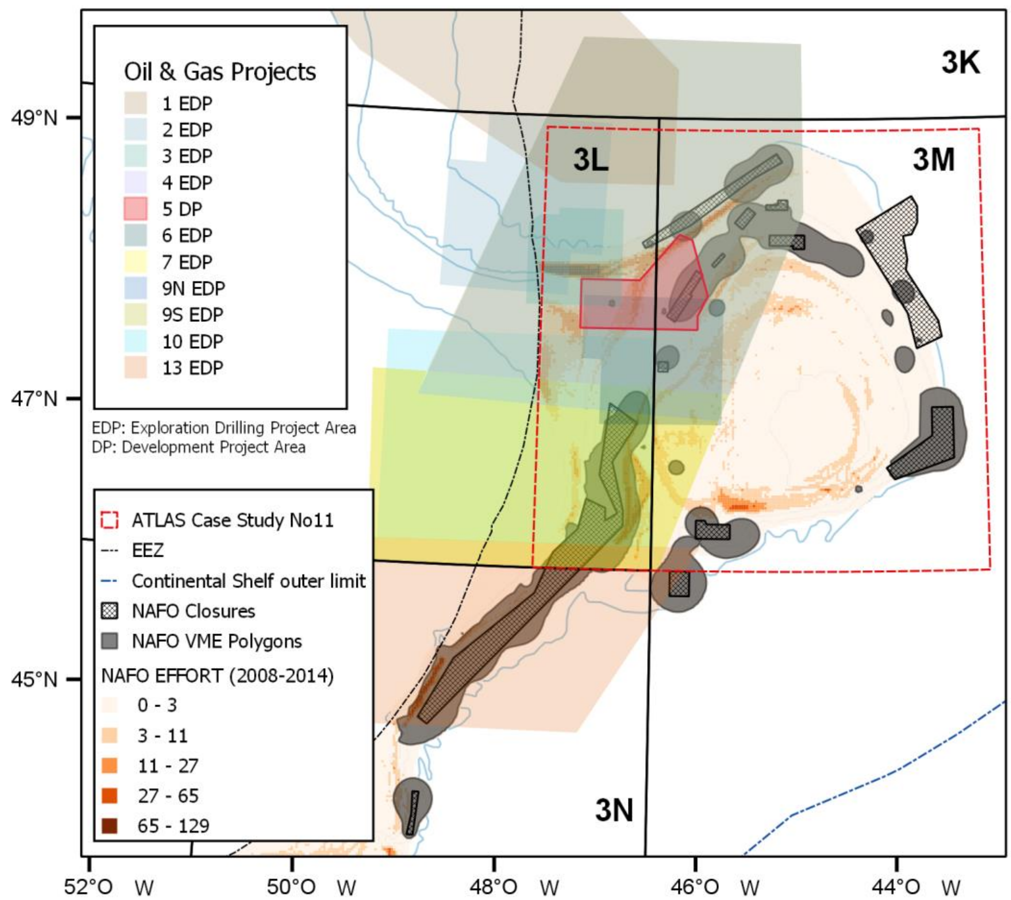


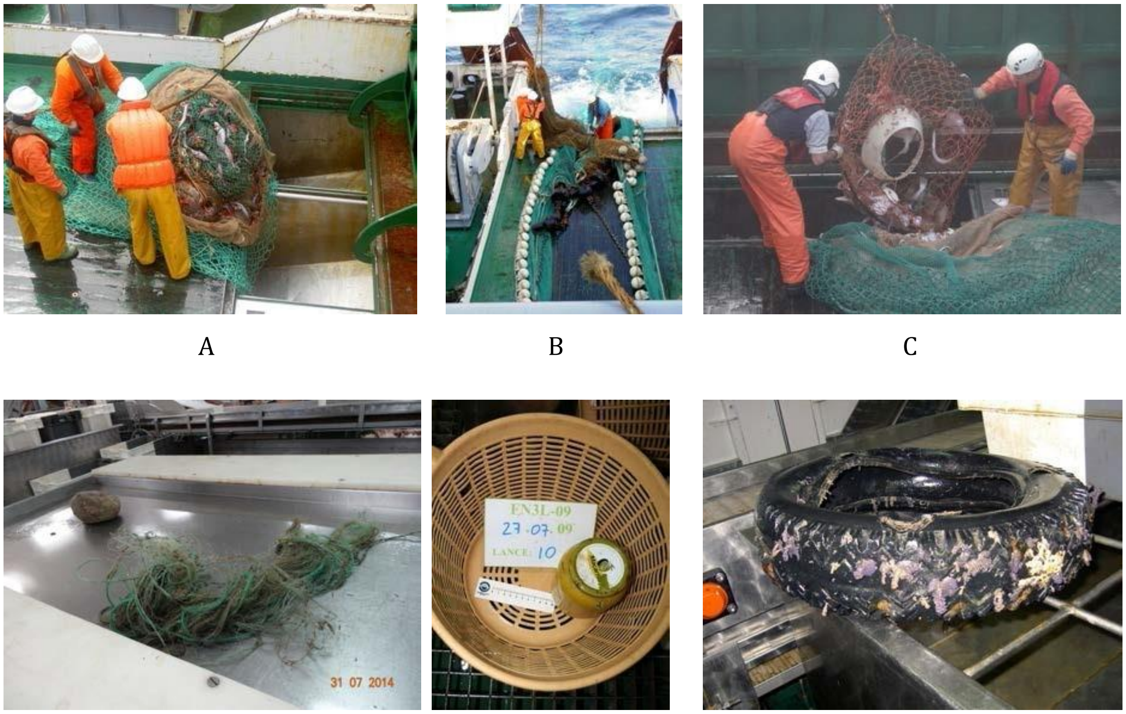
Figure 8. Map of the NAFO Regulatory Area (Divs. 3KLNM), showing the location of the proposed Oil and Gas Project Areas listed in Table 4, and the overlapping with NAFO fisheries, VME closures and VME polygons in Divs. 3LNM. The red polygon in Divs. 3LM, indicates the location of the Flemish Pass Basin - Bay du Nord Development Project. EDP (Exploration Drilling Project Area), DP (Development Project Area). Sources (2019): NAFO and C-NLOPB website. QGIS Geographic Information System.

7.4. Seabed litter

Marine litter has been recognized as a worldwide problem affecting the marine environment in several ways: economic loss, degradation of habitats and impact on biota. Marine litter is distributed throughout the marine environment (coastal areas, water column and seabed). Despite an important increase in the number of studies on marine litter in recent years, there are still gaps in the knowledge, especially related to the high-seas and deep waters. To address the concerns about seabed litter in NAFO Regulatory Area, a pilot study (García-Alegre *et al.,* 2020) was conducted by the IEO-Vigo, under ATLAS Project, analysing an extensive database based on EU-Spain groundfish surveys (Durán Muñoz *et al.,* 2019) in Div. 3L. This study shows a low occurrence and density of seabed litter in the Flemish Pass, Div. 3L (Table 5), for which NAFO-managed and non-NAFO managed fisheries are the primary sources (Figures 9 to 11). In most cases, litter consisted of small fragments of rope but in some, litter consisted of entire traps or nets (Figure 9). The highest densities of seabed litter were found in the deepest areas located in the Flemish Pass channel and down the northeastern flank of the Grand Bank.

This pioneering study is relevant to improve our knowledge on MSFD[10] Descriptor 10 in the deep-sea and ABJN. It is worth to note that based on this study, NAFO WG-ESA recommended to Scientific Council that standardized protocols for marine litter data collection should be implemented by all Contracting Parties as part of their groundfish surveys conducted in NAFO Regulatory Area (NAFO, 2019a). Implementation of such protocols would allow monitoring the spatial and temporal distribution of marine litter, contributing to improve knowledge of their characteristics in the NRA. Seabed litter studies contribute to the current knowledge on Good Environmental State (GES) of deep-sea ecosystems in Div. 3L, being useful to GES monitoring regarding predictions and future scenarios.

[10] European Union Marine Strategy Framework Directive



A B C

D E F

Figure 9. Several examples of seabed litter items found in the Flemish Pass, Div. 3L. (A-D) Abandoned, Lost or otherwise Discarded Fishing Gears (ALDFG) items. A and B (nets found in two trawl hauls in 2007 with weight of 400 kg and 250 respectively), C (trap), E (mustard pot), F (tire). Photos from García-Alegre *et al.,* 2020

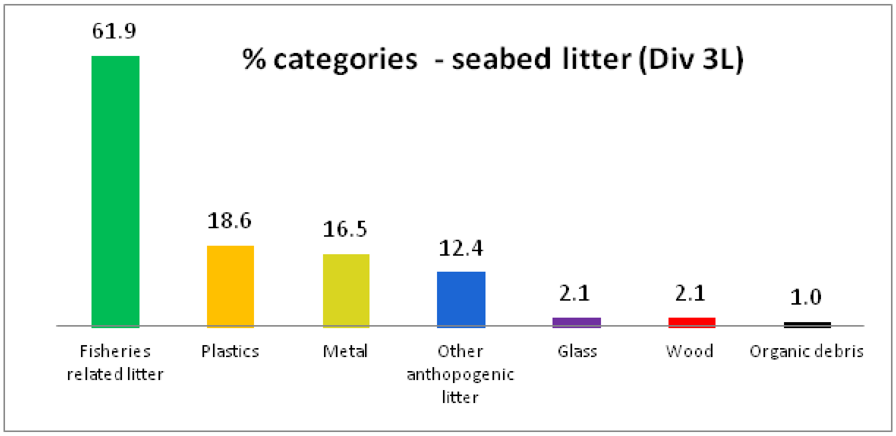


Figure 10. Percentage of the occurrence of the different litter categories by trawls with litter presence. Flemish Pass, Div. 3L. Source García-Alegre *et al.,* 2020.

Table 5. Mean values of marine litter densities estimated by kg/km^2 and number of items/km^2 by year and in the total period (N, number of valid trawls performed; %, percentage of valid trawls with litter presence). Flemish Pass, Div. 3L. Source García-Alegre *et al.,* 2020.

Year	N	%	kg/km²	Item/Km²
2006	100	19.0	3.8 ± 2.1	4.1 ± 1
2007	94	17.0	97.6 ± 63.5	3.1 ± 0.9
2008	100	7.0	1.9 ± 1.1	1.4 ± 0.6
2009	98	6.1	0.4 ± 0.2	0.8 ± 0.3
2010	97	4.1	0.2 ± 0.1	0.8 ± 0.4
2011	89	3.4	0.9 ± 0.8	0.6 ± 0.3
2012	98	8.2	8.1 ±5.9	1.3 ± 0.5
2013	100	4.0	3.5 ± 2.4	0.9 ± 0.5
2014	99	5.1	6.7 ± 4.2	0.9 ± 0.5
2015	97	5.2	1.1 ± 0.6	0.6 ± 0.3
2016	98	12.2	4.5 ± 2.2	1.5 ± 0.4
2017	99	8.1	1.9 ± 1.1	1.2 ± 0.4
2006-2017	**1169**	**8.3**	**10.6 ± 5.2**	**1.4 ± 0.4**

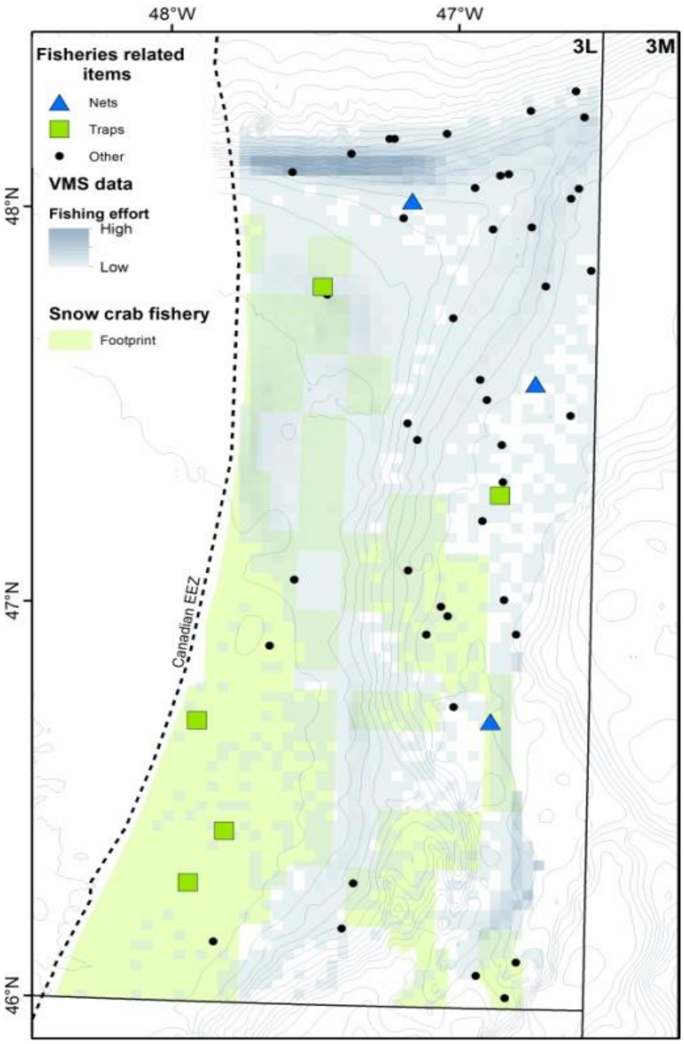


Figure 11. Distribution of fisheries related seabed litter items (ALDFG) found in the Flemish Pass area (NAFO Div. 3L) showing in blue scale the NAFO fishing effort (2008-2014) and in green the snow crab fishery footprint (2007-2017) (blue triangles, nets; green squares, traps; black dots, other fisheries related items). Flemish Pass, Div. 3L. Source García-Alegre *et al.,* 2020.

8. Lessons learned: Challenges facing MSP in the NRA

8.1. Utility of MSP in the NRA

ATLAS work developed in Flemish Cap – Flemish Pass addresses, for the first time in the NAFO context, the current challenges facing MSP in the NRA, including the issue of the seabed litter (NAFO, 2018; 2019a; 2019b). Moreover, following the recommendations from NAFO Commission (NAFO, 2019c), ATLAS research on the impact of human activities other than fishing has been incorporated into Ecosystem Summary Sheets (ESSs) (NAFO, 2019a). ESSs are part of NAFO Roadmap for an Ecosystem Approach to Fisheries, and will be used to inform decision making, by both managers and industry, as well as help identify objective hazards in the NRA (e.g. oil and gas exploration and exploitation). The ESSs will be presented to the Commission in September 2020 and are intended to provide a synoptic perspective on the state of NAFO ecosystems and their management regime. They constitute a tool for strategic assessment, advice, and planning for the Northwest Atlantic Ocean in ABNJ. ATLAS results (i.e. maps) show the potential spatial conflicts from different human activities. These results have contributed to several sections of the ESS including (i) VME status, (ii) oil and gas activities and (iii) pollution, specifically marine litter. Additionally, seabed litter pilot study in Flemish Pass

(García-Alegre *et al.,* 2020) could be a start point to marine litter monitoring in the NRA (NAFO, 2019a), contributing to the knowledge on GES. All this work contributes to explore the feasibility of MSP in the NRA.

As Wright *et al.* (2019) suggested the emergence of MSP as a key tool for ecosystem-based management of marine spaces provide a clear impetus for developing MSP in ABNJ. In the case of NRA, besides the ATLAS efforts to address the challenges of integrated spatial management, interest in MSP seems to be growing. On this regard, a Webinar ATLAS-DFO on MSP was held on 5th March 2020. During the meeting, ATLAS Scientists presented (i) ATLAS regional MSP studies, (ii) MSP decision support tools and workflow developed by the project, and (iii) an overview of the MSP exercise conducted in Flemish Cap – Flemish Pass.

8.2. MSP as a potential tool to help resolve conflicts: connection with Blue Economy - Blue Growth

As pointed out by Arbo and Thuy (2016), environmental and resource use conflicts are frequently about the access to and use of natural resources and marine space and the distribution of the associated benefits and costs. They can also be about the harm that different co-located activities inflict upon each other through operational or ecosystem impact. Moreover, the conflicts can involve both actual and potential users. The authors conclude that resolving use conflicts is a central issue in the context of ecosystem-based management. For the industries involved, this is important for avoiding intractable conflicts, but it is also important for the health of the ecosystems.

Preliminary mapping of human activities and natural components in the Flemish Cap – Flemish Pass area shows that some of the potential use conflicts mentioned by Arbo and Thuy (2016) could arise in the future in this area (Figures 6 and 8). Moreover, information on a recent transboundary oil spill (Table 3) suggests that actual conflicts already occurred.

In an expected scenario of increasing oil and gas exploration activities in the NRA (NAFO, 2019a), a comprehensive spatial management plan could help to maximize compatibility between traditional and emerging activities, reducing conflicts between users and between users and the marine environment.

MSP could be used as a framework to achieve better management and spatial use of marine environment in ABJN and several options could be adopted to properly implement MSP in ABJN, as Altvater *et al.* (2019) suggested. MSP could help to resolve specific conflicts, contributing to the objective of ensuring that ecosystems continue to perform their functions (Thurber *et al.,* 2014), providing, in addition to oil and gas, goods and services as important as fish, habitats and VMEs (Armstrong *et al.,* 2010). This highlights the benefits of spatial management, making explicit the connection between MSP and *Blue Economy - Blue Growth*[11].

8.3. Reflections on ocean governance: VMEs are closed to fishing but open to oil and gas

Mapping exercise from ATLAS project in the Flemish Cap – Flemish Pass Case Study (Figures 6 and 8), revealed the tensions between different management frameworks. Areas closed to bottom fishing by NAFO to conserve VMEs, are currently open to offshore oil and gas exploration and exploitation. It is worth to note that the VME concept arose in the context of the management of deep-sea bottom fisheries in the high seas (FAO, 2009) and it does not apply to other human activities. NAFO VME closures are currently protected against significant adverse impacts from bottom fishing, but they are unprotected regarding potential threats from human activities other than fishing, including the potential impacts from offshore oil and gas (Cordes *et al.,* 2016; Girard and Fisher, 2018; Vad *et al.,* 2016). This seems an inconsistency in terms of VME conservation and ocean governance. The tensions mentioned above, are related to the institutional landscape (see Chapter 4). High seas fisheries occur in the international water column and they are managed by NAFO, in a collaborative multilateral framework, according to the International Guidelines for the Management of Deep-Sea Fisheries in the High Seas (FAO, 2009), while offshore oil and gas activities on the extended continental shelf are managed by the coastal state. Each sector has its own independent management process and the coordination between management authorities is often limited. In this case, MSP as a participatory process involving stakeholders, could help to resolve conflicts and inconsistencies.

[11] Long term strategy to support sustainable growth in the marine and maritime sectors as a whole.

8.4. Lack of an appropriate authority needed to undertake MSP in ABJN

Besides governance issues (see section 8.3) and technical difficulties (see section 8.5), the lack of an appropriate authority needed to undertake MSP in ABJN (see description of the institutional landscape in Chapter 4) was identified as the principal practical problem in the NRA. According to the UNESCO, one of the first tasks of MSP is the identification and establishment of the appropriate kind of authority needed to undertake MSP. Ehler *et al*. (2009) suggest that while planning without implementation is sterile, implementation without planning is a recipe for failure. Therefore MSP requires two types of authority: (i) authority to plan for MSP; and (ii) authority to implement MSP. Both types are equally important. They could be combined in one organization, but in most MSP initiatives around the world, new authority is often established for MSP, while implementation is carried out through existing authorities and institutions. One suggested way to establish authority for MSP planning is through the creation of new legislation. Therefore, in order to develop and implement a spatial management plan integrating fishing and hydrocarbon activities in the NRA, as it is located in ABNJ, an international agreement on what type of authority is most appropriate, should be necessary. This is the case of all MSP initiatives in ABJN.

8.5. Future work

At present, we are exploring methods and tools to assess the cumulative impacts of human activities in the Case Study No11, using GIS. This work is still ongoing. Results from cumulative impact assessment could be useful as input to the ESS (section on human activities other than fishing).The additive spatial model proposed by Halpern *et al.* (2008) was tested in the study area using preliminary data and the open source software *EcoImpactMapper* (Stock, 2016). The additive spatial model process comprises several steps: (i) identification of relevant ecosystems components (e.g. habitats and species) and anthropogenic stressors (e.g. human activities and pressures), (ii) mapping their spatial distribution using the same regular grid, (iii) obtaining a “sensitivity matrix" of semi-quantitative sensitivity weights, quantified using expert judgment (sensitivity of the ecosystem components to the stressors) and (iv) summing the products of ecosystem component, stressor, and the sensitivity weights. Two main challenges were identified from this test: (i) the need to improve some data layers (spatial coverage, etc.) and to obtain additional spatial information on stressors and ecosystem components, and (ii) the need to improve the sensitivity matrix using expert judgment. In this regard, it is noted that ATLAS WP6 is trying to produce a sensitivity matrix for deep-water to be applied to all ATLAS case studies. Additionally, a new work flow in R to assess the cumulative impacts is being developed by the project that will be also available to all case studies.

9. Conclusions

- ATLAS is developing a theoretical exercise of MSP in the Flemish Cap – Flemish Pass area, Divs. 3LM (NRA – ABJN), using MESMA framework: the first time that MSP issue is discussed in NAFO.
- Natural components of the ecosystem and human activities have been preliminarily mapped in a GIS.
- Potential and real conflicts between different users of the marine space (traditional *versus* emergent) and between users and ecosystems have been identified in the NRA.
- MSP is a potential tool to help resolve conflicts. Moreover, the present exercise is useful to the advice on the impact of human activities other than fishing in the NRA (e.g. Ecosystem Summary Sheets).
- Reflections and practical problems: VME are closed to bottom fishing, but open to other human activities; According to the UNESCO an appropriate authority is needed for developing and implement MSP in ABJN (water column *vs* extended continental shelf).
- Future work: exploration of methods and tools to assess the (cumulative) impacts. Several relevant challenges were identified (e.g. sensitivity matrix, data layers).

Funding

This work contributes to the European Union's Horizon 2020 research and innovation programme under grant agreement No 678760 (ATLAS). This output reflects only the author's view and the European Union cannot be held responsible for any use that may be made of the information contained therein. EU NAFO groundfish surveys has been co-funded by the European Union through the European Maritime and Fisheries Fund within the National Program of collection, management and use of data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy. The authors were supported by ATLAS (PDM, MS & AGA), NEREIDA grant agreement SI2.770786 (PDM & MS) and IEO-BIOPESLE-4 (ER).

Acknowledgements

We are especially grateful to all people (from IEO and foreign institutions) that helped us to compile information on ecosystem components.

References

Altvater S., Fletcher R., Passarello C. (2019) The Need for Marine Spatial Planning in Areas Beyond National Jurisdiction. *In:* Zaucha J., Gee K. (eds) Maritime Spatial Planning. Palgrave Macmillan, Cham.

Arbo, P. and Thuy P.T.T. (2016). Use conflicts in marine ecosystem-based management — The case of oil versus fisheries. Ocean & Coastal Management. 122. 77-86. 10.1016/j.ocecoaman.2016.01.008.

Ardron, J., Gjerde, K., Pullen, S. and Tilot, V. (2008). Marine Spatial Planning in the High Seas. Marine Policy 32: 832-839. doi.org/10.1016/j.marpol.2008.03.018.

Armstrong, C. W., Foley, N., Tinch, R., and v.d. Hove, S. (2010) Ecosystem Goods and Services of the Deep Sea, HERMIONE (Hotspot Ecosystem Research and Man's impact on European Seas), Deliverable D6.2: Ecosystem Goods and Services of the Deep Sea, WP6: Socioeconomics, Ocean Governance and Science-Policy Interfaces, 2010.

Bangay G., Foote, W., Anderson G.,Murphy Rustad M., and Storey K. (2020) Committee's Report on the Regional Assessment of Offshore Oil and Gas Exploratory Drilling East of Newfoundland and Labrador. 196 pp. Accessed on 13 May 2020 from https://iaac-aeic.gc.ca/050/documents/p80156/134068E.pdf

Buhl-Mortensen, L., Galparsoro, I., Vega Fernandez, T., Johnson, K., D'Anna, G., & Badalamenti, F., Garofalo, G., Carlström, J., Piwowarczyk, J., Rabaut, M., Vanaverbeke, J., Schipper, C., van Dalfsen, J. Vassilopoulou, V., Issaris, Y., Van Hoof, L., Pecceu, E., Hostens, K., Zammit Pace, M. L., and Doncheva, V. (2016) Maritime ecosystem-based management in practice: Lessons learned from the application of a generic spatial planning framework in Europe. Marine Policy. 10.1016/j.marpol.2016.01.024.

Cordes, E.E., Jones, D.O.B., Schlacher, T.A., Amon, D.J., Bernardino, A.F., Brooke, S., Carney, R., DeLeo, D.M., Dunlop, K.M., Escobar-Briones, E.G., Gates, A.R., Génio, L., Gobin, J., Henry, L.-A., Herrera, S., Hoyt, S., Joye, M., Kark, S., Mestre, N.C., Metaxas, A., Pfeifer, S., Sink, K., Sweetman, A.K., Witte, U. (2016). Environmental impacts of the deep-water oil and gas industry: a review to guide management strategies. Frontiers in Environmental Science 4. 10.3389/fenvs.2016.00058.

Durán Muñoz, P., Sacau, M., García-Alegre, A. and Román, E. (2020) Cold-water corals and deep-sea sponges by-catch mitigation: Dealing with groundfish survey data in the management of the northwest Atlantic Ocean high seas fisheries, Marine Policy 116, 103712. 10.1016/j.marpol.2019.103712.

Ehler, C. y Douvere, F. (2009). Planificación espacial marina: una guía paso a paso hacia la Gestión Ecosistémica. Comisión Oceanográfica Intergubernamental y el Programa del Hombre y la Biosfera. COI manuales y guías nº 53. París, UNESCO. 2009 (inglés). 2013 (español).

FAO (2009) International Guidelines for the Management of Deep-Sea Fisheries in the High Seas, Food and Agriculture Organization of the United Nations, Rome, 2009.

García-Alegre A., Román-Marcote E., Gago J., González-Nuevo G., Sacau M., Durán Muñoz P. (2020). Seabed litter distribution in the high-seas of the Flemish Pass area (NW Atlantic). Sci. Mar. 84(1): 93-101. https://doi.org/10.3989/scimar.04945.27A.

Girard, F. and Fisher, C. (2018) Long-term impact of the Deepwater Horizon oil spill on deep-sea corals detected after seven years of monitoring. Biological Conservation 225, 117-127. 10.1016/j.biocon.2018.06.028.

Halpern, B.S., Walbridge, S., Selkoe, K.A., Kappel, C.V., Micheli, F., D'Agrosa, C., Bruno, J.F., Casey, K.S., Ebert, C., Fox, H.E., Fujita R., Heinemann, D., Lenihan, H.S., Madin, E.M.P., Perry, M.T., Selig, E.R., Spalding, M., Steneck, R., and Watson, R. (2008). A global map of human impact on marine ecosystems. Science 319 (5865): 948–952, doi.org/10.1126/science.1149345.

Hyne, N.J. (2001) Non technical Guide to Petroleum Geology, Exploration, Drilling and Production. PennWell Corporation, Tulsa: OK.

Kenchington, E., Murillo, F.J., Lirette, C., Sacau, M., Koen-Alonso, M., Kenny, A., Ollerhead, N., Wareham, V., Beazley, L. (2014) Kernel density surface modelling as a means to identify significant concentrations of vulnerable marine ecosystem indicators, PLoS One 9 (10) (2014), e109365, https://doi.org/10.1371/journal. pone.0109365.

Long, R. and Rodriguez Chaves, M. (2015) Anatomy of a new international instrument for conservation and biodiversity beyond national jurisdiction. Environmental Liability — Law, Policy and Practice 23: 213–229.

Maes, F. (2008) The international framework for marine spatial planning. Marine Policy 32: 797-810.

NAFO (2018) Report of the 11th Meeting of the NAFO Scientific Council Working Group on Ecosystem Science and Assessment (WG-ESA). Northwest Atlantic Fisheries Organization. 13-22 November 2018, Dartmouth, Canada. Serial No N6900 NAFO SCS Document 18/23.

NAFO (2019a) Report of the 12th Meeting of the NAFO Scientific Council Working Group on Ecosystem Science and Assessment (WG-ESA). Northwest Atlantic Fisheries Organization. 19-28 November 2019, Dartmouth, Canada. Serial No. N7027 NAFO SCS Document 19/25.

NAFO (2019b) Report of the NAFO Joint Commission-Scientific Council Working Group on the Ecosystem Approach Framework to Fisheries Management (WG-EAFFM). Northwest Atlantic Fisheries Organization. 16-18 July 2019, Dartmouth, Canada. Serial No. N6971 NAFO COM-SC Document 19-03.

NAFO (2019c) Report of the NAFO Commission and its Subsidiary Bodies (STACTIC and STACFAD). Northwest Atlantic Fisheries Organization. 41st Annual Meeting of NAFO. 23-27 September 2019 Bordeaux, France. Serial No. N7021 NAFO/COM Doc. 19-34.

NAFO (2020) Conservation and Enforcement Measures, Northwest Atlantic Fisheries Organization, 2020. Serial No. N7028. NAFO/Com Document 20-01.

QGIS Development Team (2019). QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org.

Stelzenmüller *et al.* (2013). Monitoring and evaluation of spatially managed areas: A generic-framework for implementation of ecosystem based marine management and its application. Marine Policy 37: 149–164. doi.org/10.1016/j.marpol.2012.04.012.

Stock, A., 2016. Open Source Software for Mapping Human Impacts on Marine Ecosystems with an Additive Model. Journal of Open Research Software, 4(1), p.e21. doi.org/10.5334/jors.88.

Thurber, A. R., Sweetman, A.K., Narayanaswamy, B. E., Jones, D. O. B., Ingels, J., and, Hansman R. L. (2014) Ecosystem function and services provided by the deep sea. Biogeosciences, 11, 3941–3963, doi.org /10.5194/bg-11-3941-2014

Vad, J., Kazanidis, G., Henry, L.A., Jones, D.O.B., Tendal, O.S., Christiansen, S., Henry, T.B. and Roberts, JM (2016) Potential Impacts of Offshore Oil and Gas Activities on Deep-Sea Sponges and the Habitats They Form. *in* Advances in Marine Biology 79, Elsevier, pp. 33-60. 10.1016/bs.amb.2018.01.001

Wright, G., Gjerde, K., Johnson, D., Finkelstein, A., Ferreira, M.A., Dunn, D.,Chaves, M. And Grehan, A. (2019) Marine spatial planning in areas beyond national jurisdiction. Marine Policy. 10.1016/j.marpol.2018.12.003.