



# atlas

UNDERSTANDING DEEP ATLANTIC ECOSYSTEMS



## Mapping ecosystem components and stressors in the Northwest Atlantic Ocean: implications in the high-seas fisheries management



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ESPAÑA



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## WP6 – Case Study No11

### Theoretical exercise:

Develop a marine plan to facilitate a scenario of the potential development of a *Blue Economy / Blue Growth*<sup>1</sup>

### Theoretical *Blue Economy / Blue Growth* scenario:

Accommodate hydrocarbon exploration and exploitation, minimising impacts on existing activities (particularly fishing) and VMEs

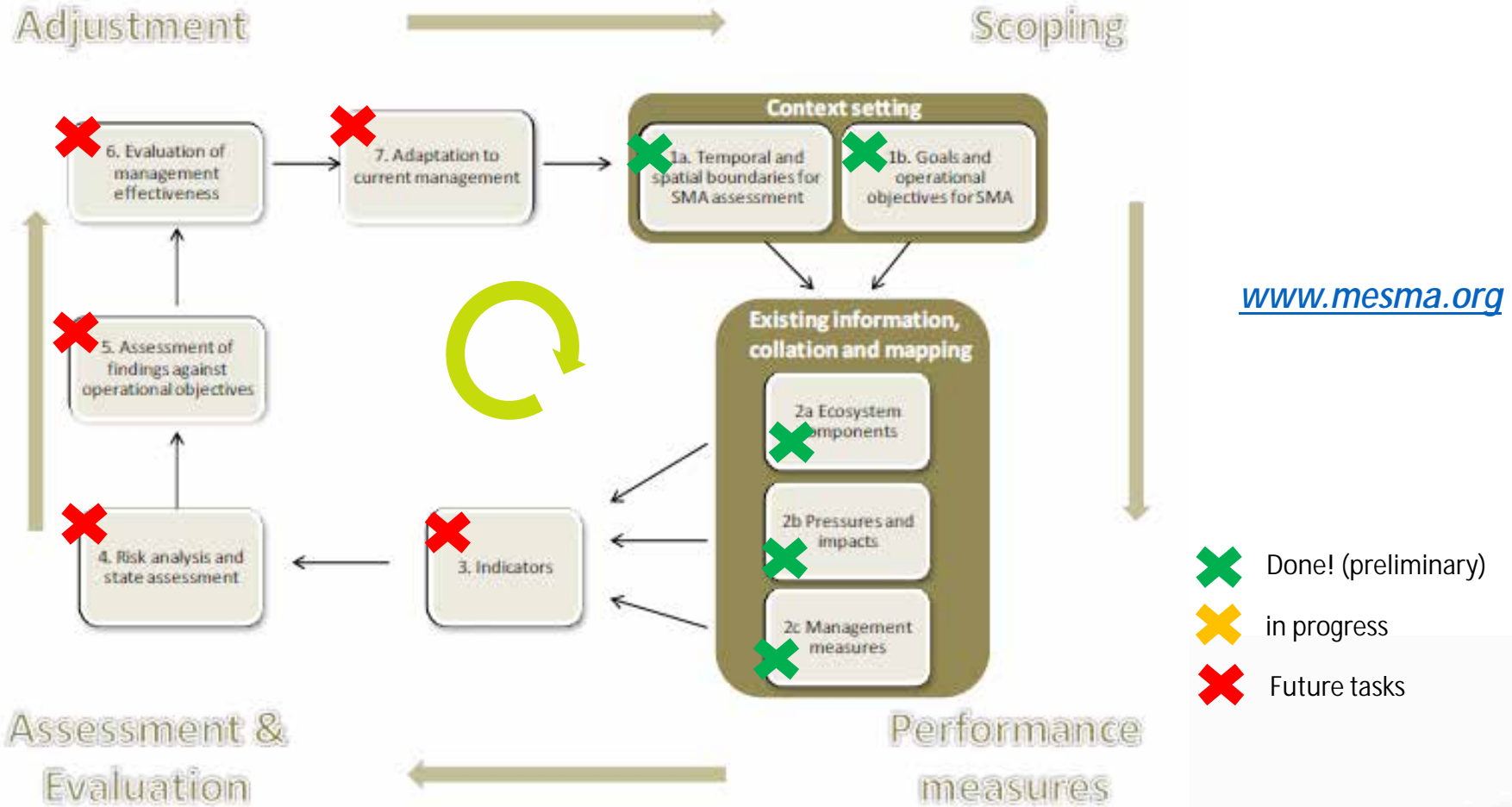
- *Increase demand for oil exploration and exploitation*
- *Potential conflict/interaction with other uses of the marine space*
- *Potential conflict between uses and ecosystems*

<sup>1</sup>*Blue Growth: long term strategy to support sustainable growth in the marine and maritime sectors as a whole*





# MESMA framework to monitor-evaluate SMAs



[www.mesma.org](http://www.mesma.org)

Source: Stelzenmuller et al. (2013)

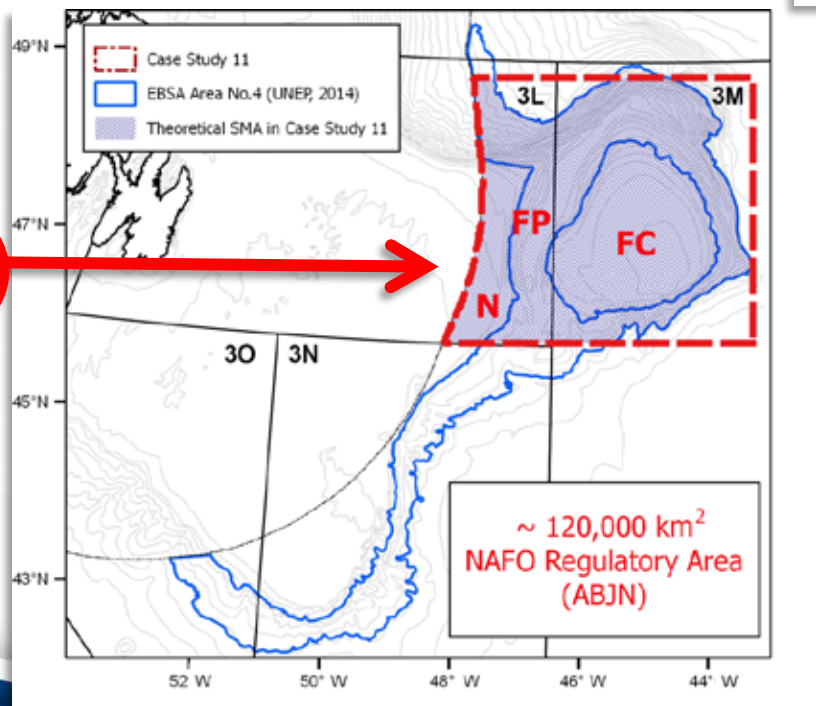
# Step 1 - Summary

- ✘ Description of Case Study 11
- ✘ Sectoral activities - Blue Growth opportunities
- ✘ Setting spatial boundaries for SMA assessment
- ✘ Institutional landscape
- ✘ Existing management plans
- ✘ Goals and operational objectives for the SMA

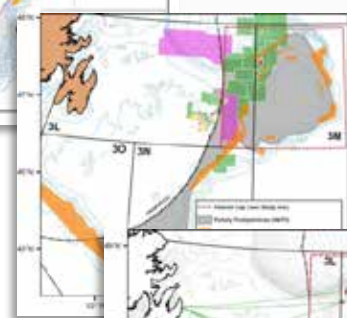
- ✘ Done! (preliminary)
- ✘ in progress
- ✘ Future tasks



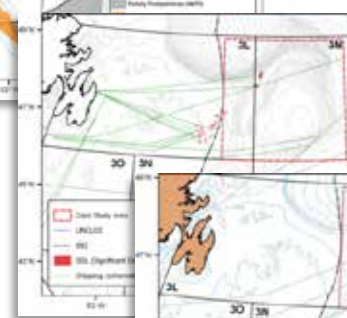
# Case Study 11, Sectoral Activities & SMA



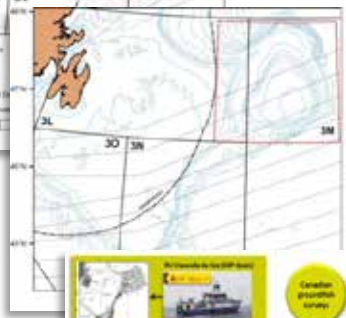
Fisheries & Conservation



Offshore hydrocarbon



Shipping



Cables



Research & education



# Institutional Landscape & Existing Management Plans



RFMO  
 Intergovernmental,  
 Multilateral.  
 12 Contracting  
 Parties.

Long term  
 conservation and  
 sustainable use of  
 the fishery  
 resources and to  
 safeguard the  
 marine ecosystems.

NAFO Conservation  
 and Enforcement  
 Measures; NAFO  
 Road Map to EAF.

[www.nafo.int](http://www.nafo.int)

Water Column



BOARD  
 National (federal),  
 Local (provincial).  
 Governments of  
 Canada,  
 Newfoundland and  
 Labrador.

To facilitate the  
 exploration for and  
 development of the  
 petroleum  
 resources, including  
 safety,  
 environmental  
 protection, resource  
 management and  
 industrial benefits.

C-NLOPB Management  
 mandate under the  
 "Accords" (Atlantic  
 Accord/Atlantic AI Acts);  
 Environmental  
 Assessments under the  
 "Accords" and the  
 Canadian Environmental  
 Assessment Act (CEAA  
 2012).

[www.cnlopb.ca](http://www.cnlopb.ca)

Continental Shelf



atlas

## Goals and operational objectives for the SMA

**Blue Growth goal:** Accommodate hydrocarbon exploration and exploitation, minimising (i) disruption to existing activities (particularly high seas fishing) and (ii) impact on delivery of ecosystem goods and services (including protection of VMEs and biodiversity)



| Operational Objectives |
|------------------------|
| Ecological             |
| Social                 |
| Economic               |
| Other/Mixed            |

# Step 2 - Summary

- ✘ Collation and mapping of existing information on ecosystem components relevant to the objectives defined in Step 1.
- ✘ Assessment of the (cumulative) impacts.
- ✘ List of management measures.

- ✘ Done! (preliminary)
- ✘ in progress
- ✘ Future tasks





## Step 2a

### IDENTIFY ECOSYSTEM COMPONENTS

- ✘ List of relevant ecosystem components: human activities; natural components.
- ✘ GIS maps of their coverage where possible.
- ✘ Check relevance of components (*ad hoc* conclusions)



- ✘ Done! (preliminary)
- ✘ in progress
- ✘ Future tasks



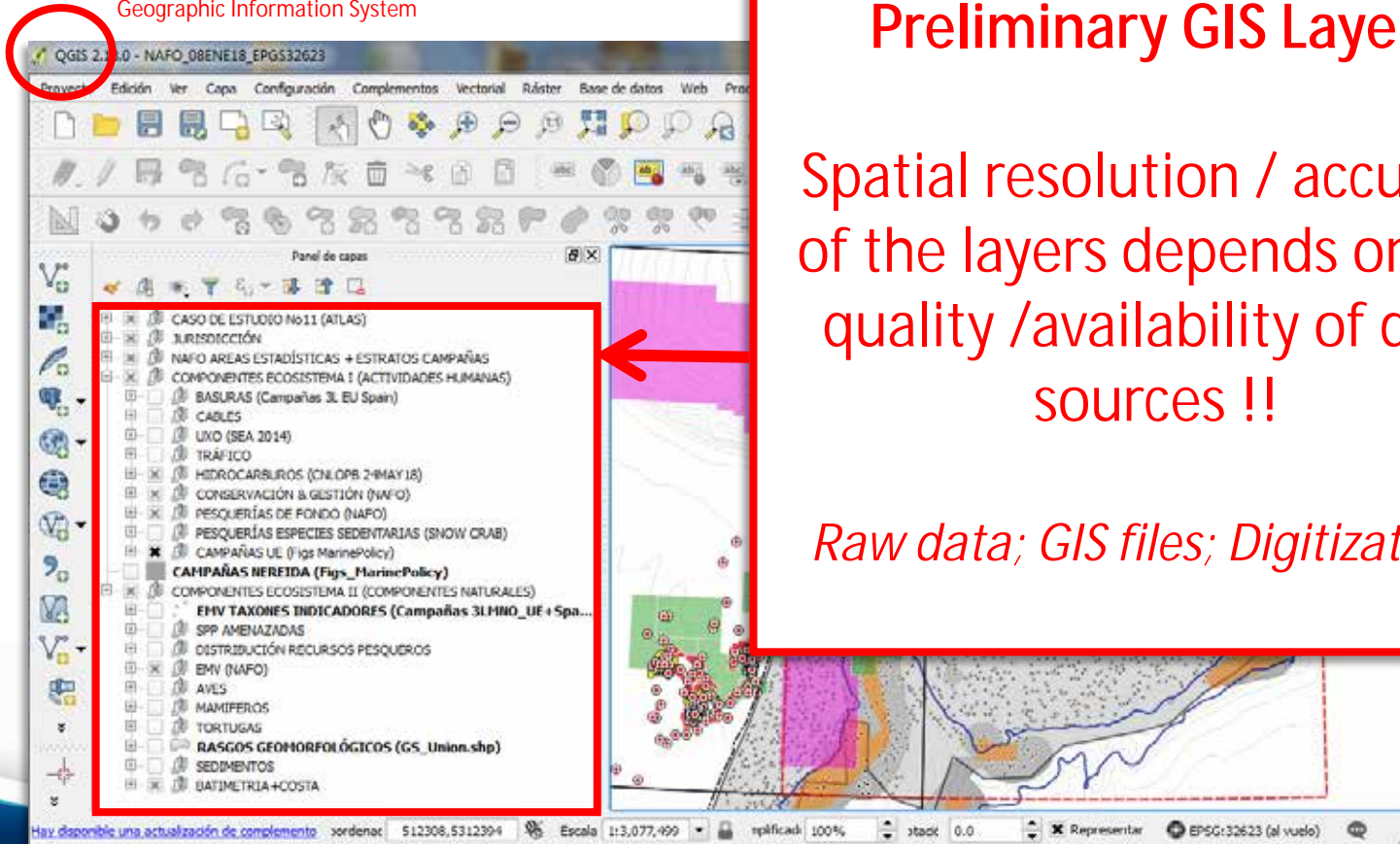
# Lists of Human Activities and Natural Components

| Potential Sector/Driver                                | Subsector                       | Activity                                     | Sector active?           | Spatial coverage                    | Temporal coverage           |  |   |   |   |   |  |
|--|---------------------------------|--|--------------------------|-------------------------------------|-----------------------------|--|---|---|---|---|--|
| 1. Fisheries   | Bottom fisheries                | Pots, traps, gillnets                        | 1. Physical and chemical | Ecosystem component                 | Relevant objective(s)       | Spatial coverage (good/poor)   | Temporal coverage (good/poor)                                     |   |   |   |  |
|  | Pelagic fisheries               | Seines, gillnets,                            |                          |                                     |                             |  |   | Geomorphology and bathymetry of the seabed (slope, aspect, rugosity, BPI, etc.) | YES: Prevent SAIs; VME closed areas; Management areas   | Good  | Good   |
| 2. Exploitation of non living resources & ocean energy | Hydrocarbon (oil & gas)         | Exploration (drill activities)               |                          |                                     |                             |  |   | Temperature regime  | YES: Management areas   | Good  | Good   |
|  |                                 | Exploitation (sig discoveries/pro pipelines) |                          |                                     |                             |  |   | Current velocity (e.g. deep Labrador current)                                   | Management areas  | Good  | Good   |
|  | Offshore renewables             | Wind, tidal & converters                     |                          |                                     |                             |  |   | Salinity  | YES: Management areas   | Good  | Good   |
|  |                                 | Power cables                                 |                          |                                     |                             |  |   | Seabed substrate  | YES: Prevent SAIs; VME closed areas; Management areas   | Good  | Good   |
|  | Mining                          | Seabed mining                                |                          |                                     |                             |  |   | Geological features as physical VME indicator elements                          | YES: Prevent SAIs; VME closed areas; Management areas   | Good  | Good   |
|  | Carbon capture and storage      | Carbon capture                               |                          |                                     |                             |  |   | 2. Habitat types  | Predominant habitat types   | YES: Prevent SAIs; VME closed areas; Management areas | Good   |
| 3. Transportation                                      | Shipping (passengers and items) | Shipping (passenger)                         |                          |                                     |                             |  |   |   | Special habitat types (VME habitat types: cold water corals, coral gardens, sea pen fields, deep-sea sponge aggregations) | YES: Prevent SAIs; VME closed areas; Management areas | Good   |
|  |                                 |  |                          |                                     |                             |  |   | 4. Telecommunication  | Undersea cables   | Laying & maintenance                                  | Identification of habitats in special areas (e.g. VME closed areas to bottom fishing; nurseries??) |
| 5. Science   | Research & education            | Fish stock assessment surveys                |                          |                                     |                             |  |   |   |   |   | Biological communities: benthos  |
|  |                                 |  |                          |                                     |                             |  |   | 6. Conservation   | Environmental conservation & protection   | Environmental protection                              |  |
| 7. Biotechnology                                       | Bioprospecting                  | Search for biological genetic resources      |                          |                                     |                             |  |   |   |   |   | Fish populations and target fish stocks (e.g. Greenland halibut, cod, redfish)                     |
|  |                                 |  |                          |                                     |                             |  |   | 8. Defence  | Military activities   | Dumping, sonar  |  |
| 9. External influences                                 | Climate change                  | Climate change                               | Reptiles (e.g. turtles)  | YES: Prevent SAIs; Management areas | Good                        | Good   |   |   |   |   |  |
|  |                                 |  |                          | Pollution                           | Pollution (including noise) | Seabirds (e.g. little auk, great skua, etc.)                                 | YES: Prevent SAIs; Management areas                               | Intermediate  | Poor  |   |  |
|  | 4. Other features               |  |                          |                                     |                             |  | VME indicator species (cold water corals, deep-sea sponges, etc.) | YES: Prevent SAIs; VME closed areas; Management areas                           | Good  | Intermediate  |  |
|  |                                 |  |                          |                                     |                             | Protected species (e.g. leatherback turtle, northern and spotted wolffishes) |   | YES: Prevent SAIs; Management areas   | Good  | Intermediate  |  |
|  |                                 |  | Chemicals and others     |                                     |                             |  | Prevent SAIs; Management areas                                    | Poor  | Poor  |   |  |
|  |                                 |  |                          |                                     |                             |  | Biochemical and genetic resources                                 | Management areas  | ?   | ?   |  |



Once ecosystem components are identified for the area, they should be mapped using GIS tools

Open Source  
Geographic Information System



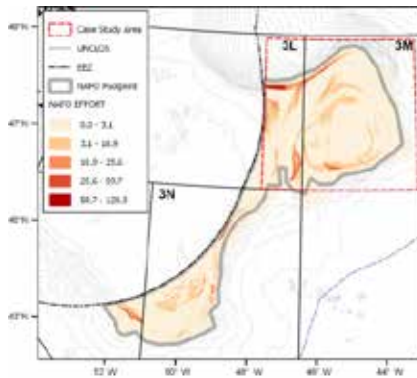
## Preliminary GIS Layers

Spatial resolution / accuracy of the layers depends on the quality / availability of data sources !!

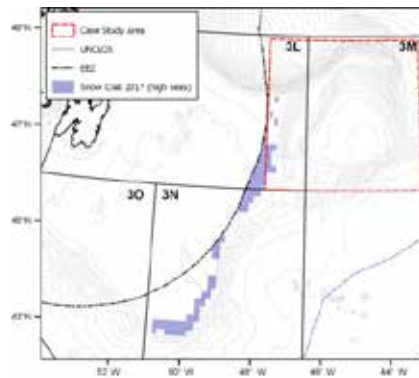
*Raw data; GIS files; Digitization...*

# Mapping of human activities

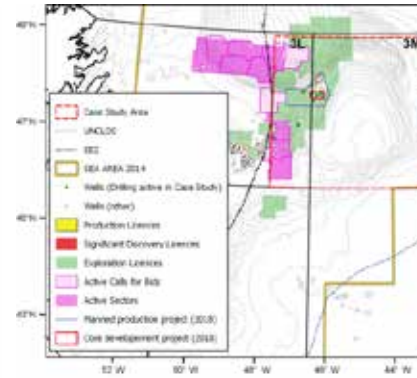
NAFO fisheries ★



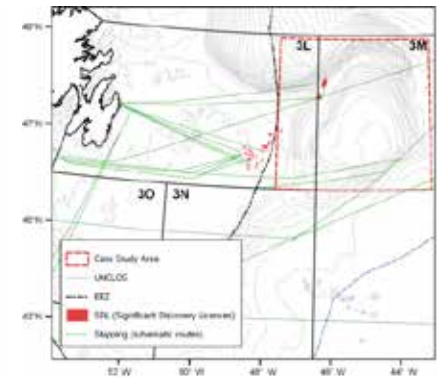
Snow crab fisheries ★



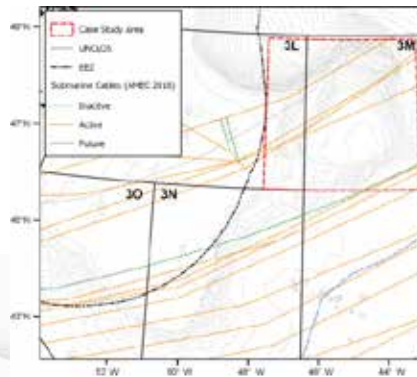
Hydrocarbon ★



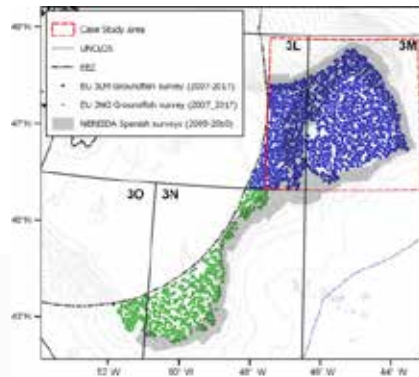
Shipping ★



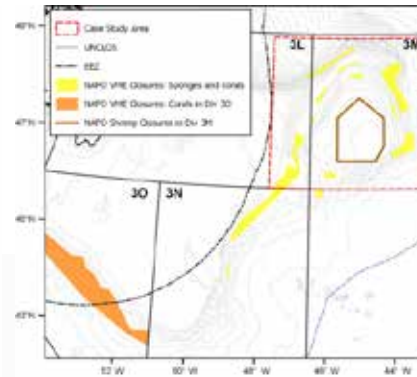
Cables ★



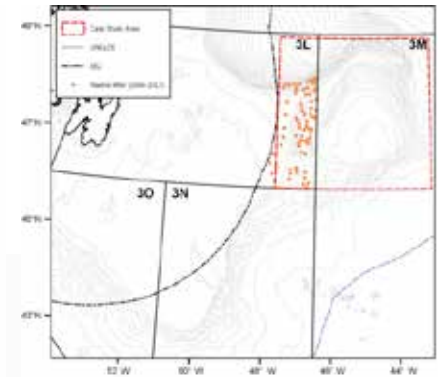
Research ★



Conservation ★



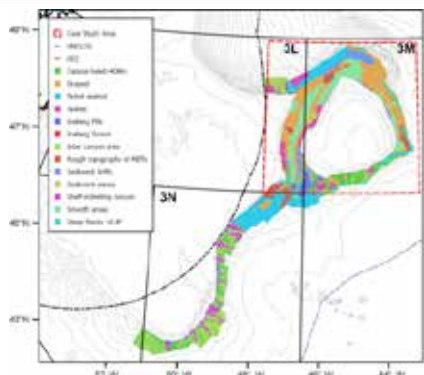
Marine litter



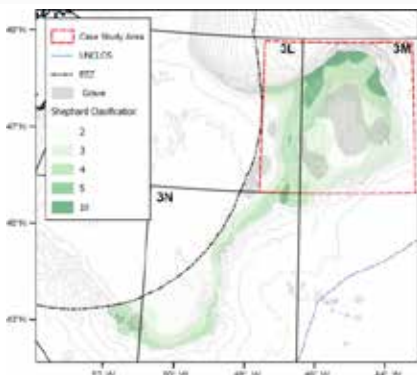
Preliminary maps from different sources (IEO, NAFO, DFO, CNLOPB, OBIS.....)

# Mapping of natural/biophysical components

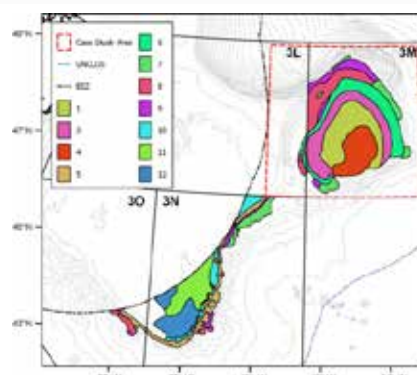
### Geomorphology



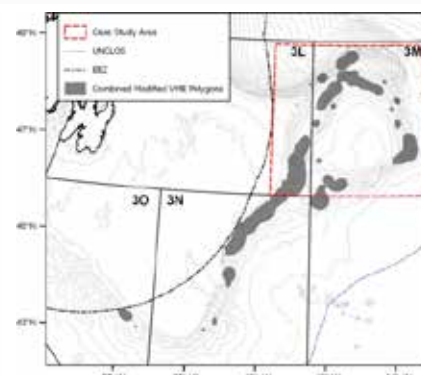
### Sediments



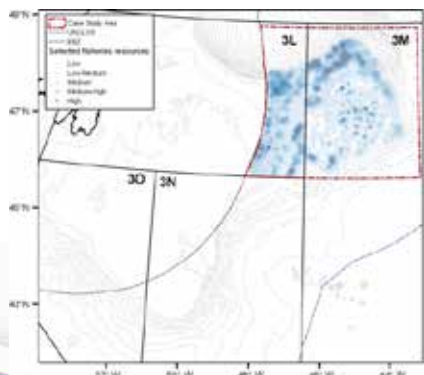
### Biological communities



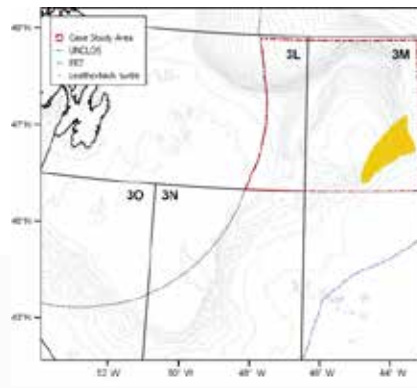
### VMEs - Indicator species



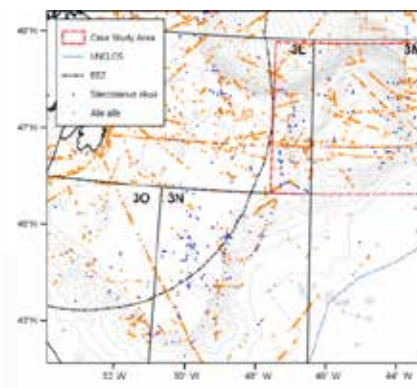
### Fisheries resources



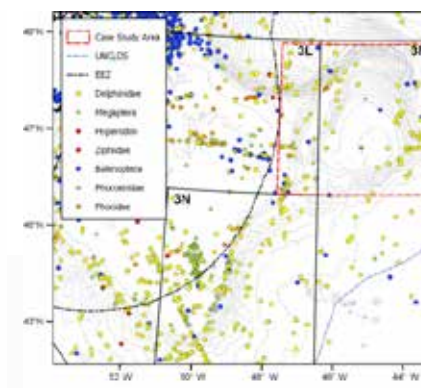
### Protected species



### Seabirds



### Marine mammals



Preliminary maps from different sources (Nereida, IEO, Murillo, NAFO, OBIS.....)



## Step 2b

### IDENTIFY PRESSURES AND IMPACTS

- ✗ Identification of sectors, future uses and pressures these exert on the ecosystem components identified in step 2a.
- ✗ Mapping pressures and impacts using GIS considering cumulative impacts of pressures.



- ✗ Done! (preliminary)
- ✗ in progress
- ✗ Future tasks

## Step 2b requires:

Analysis of the **spatial and temporal overlap** of the distribution pattern of the identified natural ecosystem components and human activities.

This implies the **identification of existing or potential conflicts between different users, or between users and nature.**

At present, we are **exploring methodologies / tools to assess the (cumulative) impacts of the human activities in the area using GIS:**

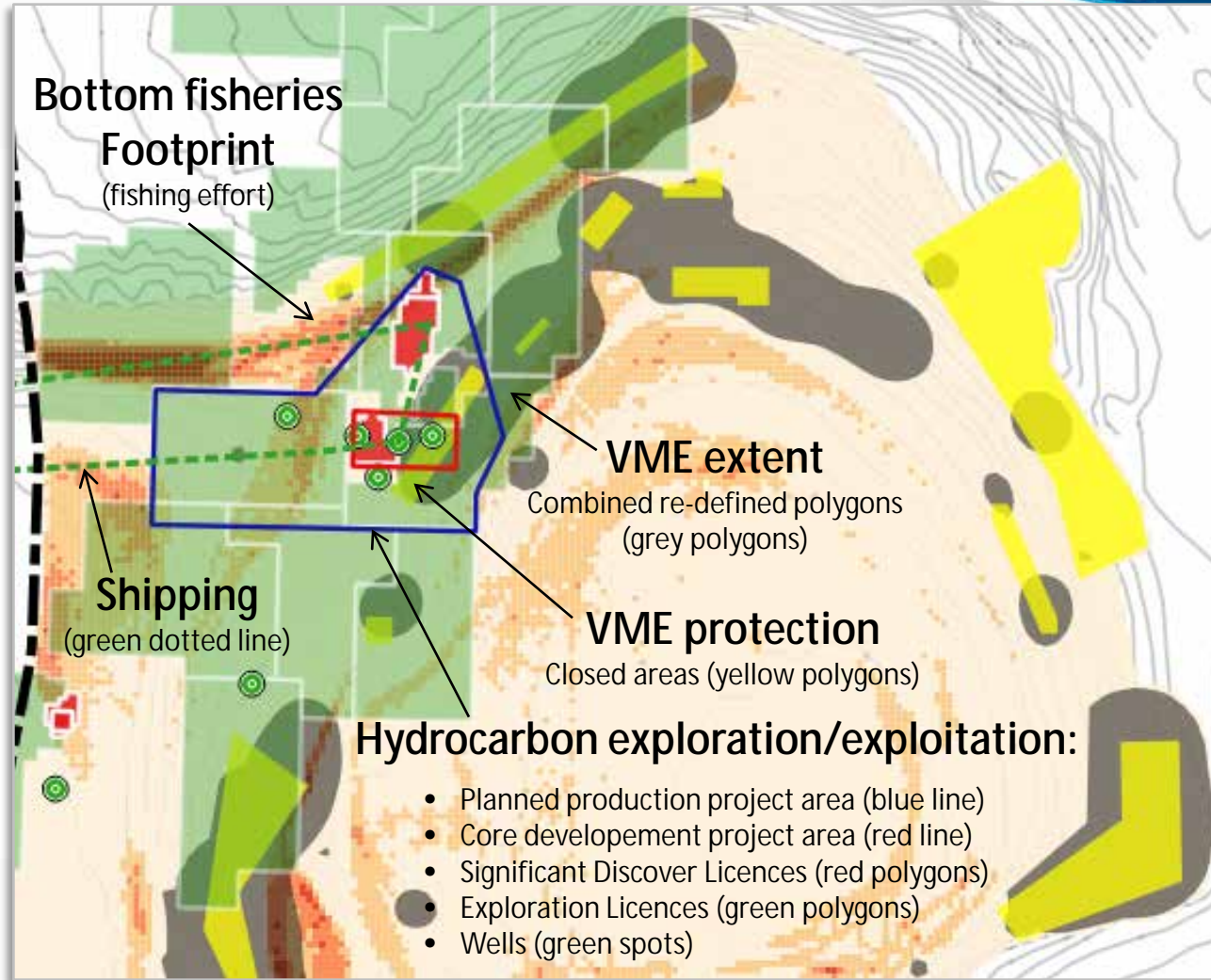
- Additive spatial model (Halpern *et al.*, 2008).
- Open source software EcolImpactMapper (Stock, 2016).



An example of potential conflicts between different users of the marine space, or between users and natural ecosystem components:

Traditional activities  
 vs  
 New activities

New activities  
 vs  
 Natural ecosystem components



Preliminary map





## Implementation of the “*Halpern et al.*” additive model

1. **Identification** of relevant **ecosystems components** (e.g. habitats and species) and **anthropogenic stressors** (e.g. human activities and pressures).
2. **Mapping their spatial distribution** using the **same regular grid**:
  - Ecosystem components are generally mapped as presence-absence [0,1].
  - The intensity of stressors (e.g. fishing effort) is  $\log[x+1]$ -transformed and normalized to [0,1].
3. **Semi-quantitative “sensitivity weights”**: Sensitivity of the ecosystem components to the stressors, quantified using expert judgment.
4. **Summing the products** of ecosystem component, stressor, and the sensitivity weights.

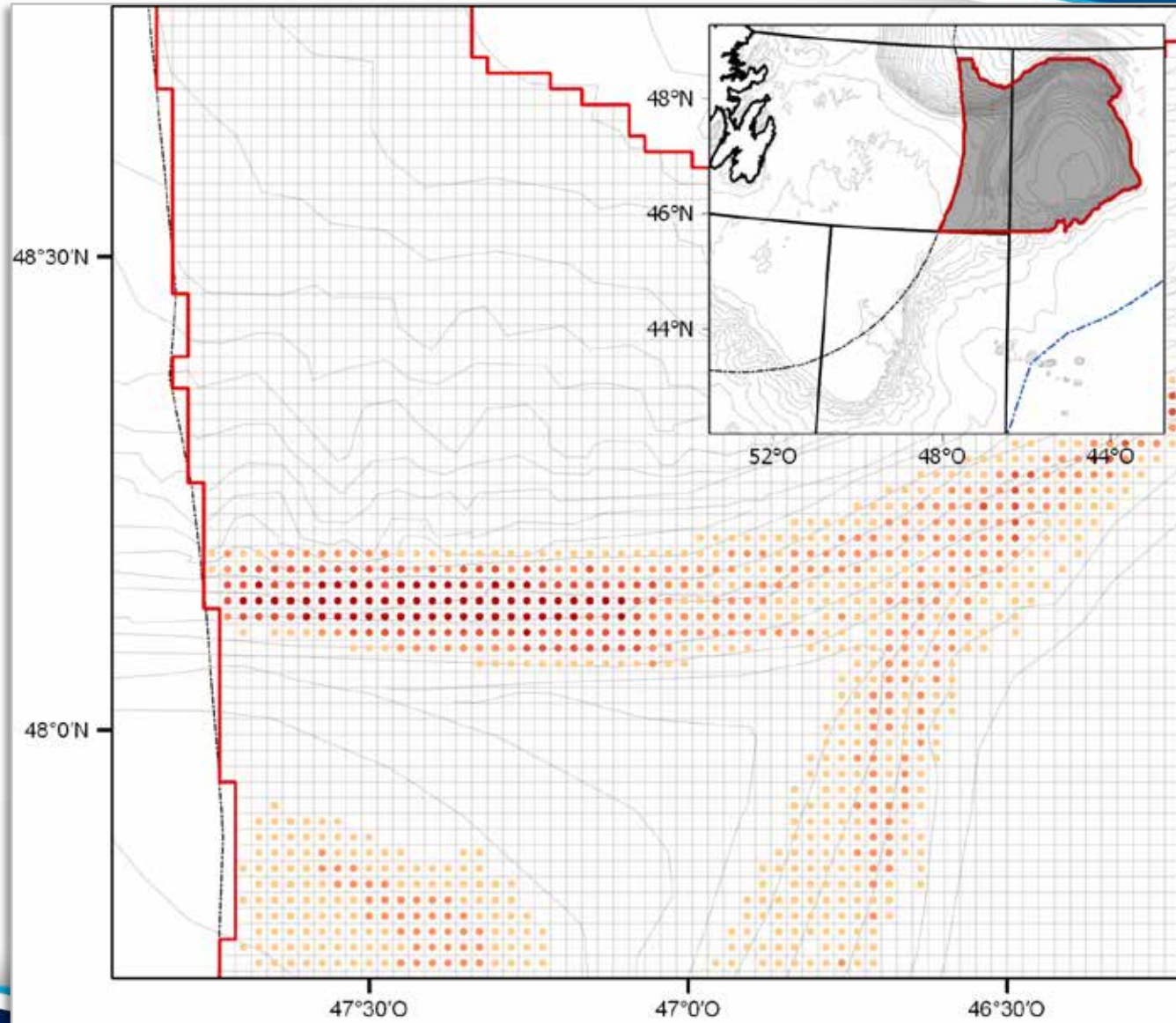
**EcolImpactMapper** ( Stock, 2016) is an available open source software tool to implement the *Halpern et al.* additive model with a simple user interface.



## Study Area and Grid

All spatial input data must have the same spatial resolution, extent and coordinate reference system (Stock, 2016):

- All spatial data used were transferred to a regular grid (1 nautical mile x 1 nautical mile).
- All cells outside of the Study Area were removed from this grid.



## Sensitivity matrix

| Sensitivity Scores  | Natural Component 1 | Natural Component 2 | Natural Component 3 | Natural Component 4 | Natural Component 5 | Natural Component 6 | Natural Component 7 | Natural Component 8 | Natural Component 9 | Natural Component 10 | Natural Component 11 | Natural Component 12 | Natural Component 13 | Natural Component 14 | Natural Component 15 | Natural Component 16 |
|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| Stressor/Activity 1 |                     |                     |                     |                     |                     |                     |                     |                     |                     |                      |                      |                      |                      |                      |                      |                      |
| Stressor/Activity 2 |                     |                     |                     |                     |                     |                     |                     |                     |                     |                      |                      |                      |                      |                      |                      |                      |
| Stressor/Activity 3 |                     |                     |                     |                     |                     |                     |                     |                     |                     |                      |                      |                      |                      |                      |                      |                      |
| Stressor/Activity 4 |                     |                     |                     |                     |                     |                     |                     |                     |                     |                      |                      |                      |                      |                      |                      |                      |
| Stressor/Activity 5 |                     |                     |                     |                     | X                   |                     |                     |                     |                     |                      |                      |                      |                      |                      |                      |                      |
| Stressor/Activity 6 |                     |                     |                     |                     |                     |                     |                     |                     |                     |                      |                      |                      |                      |                      |                      |                      |
| Stressor/Activity 7 |                     |                     |                     |                     |                     |                     |                     |                     |                     |                      |                      |                      |                      |                      |                      |                      |
| Stressor/Activity 8 |                     |                     |                     |                     |                     |                     |                     |                     |                     |                      |                      |                      |                      |                      |                      |                      |
| Stressor/Activity 9 |                     |                     |                     |                     |                     |                     |                     |                     |                     |                      |                      |                      |                      |                      |                      |                      |

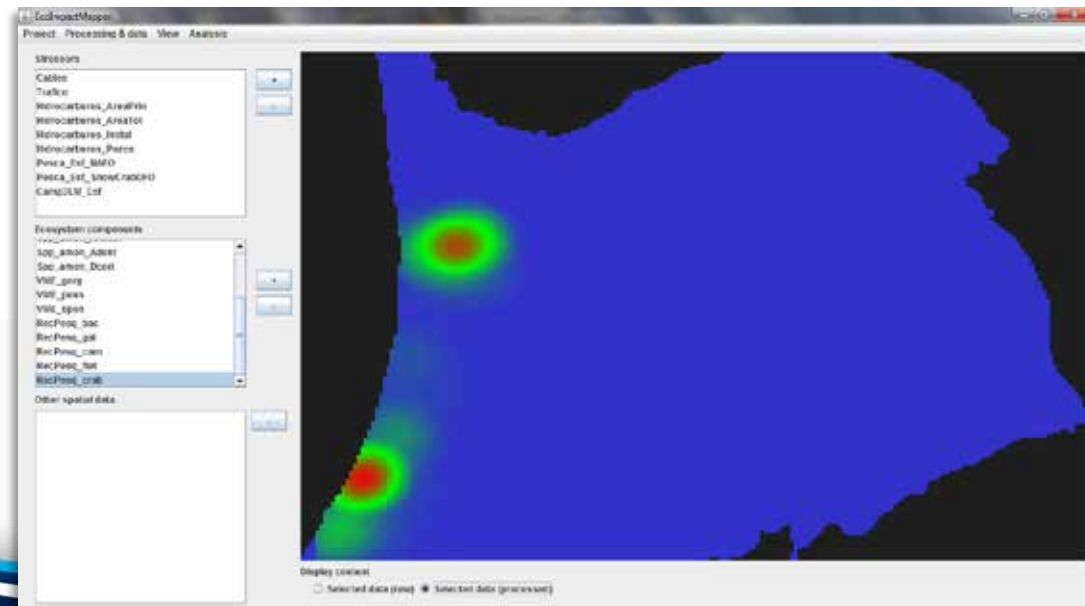
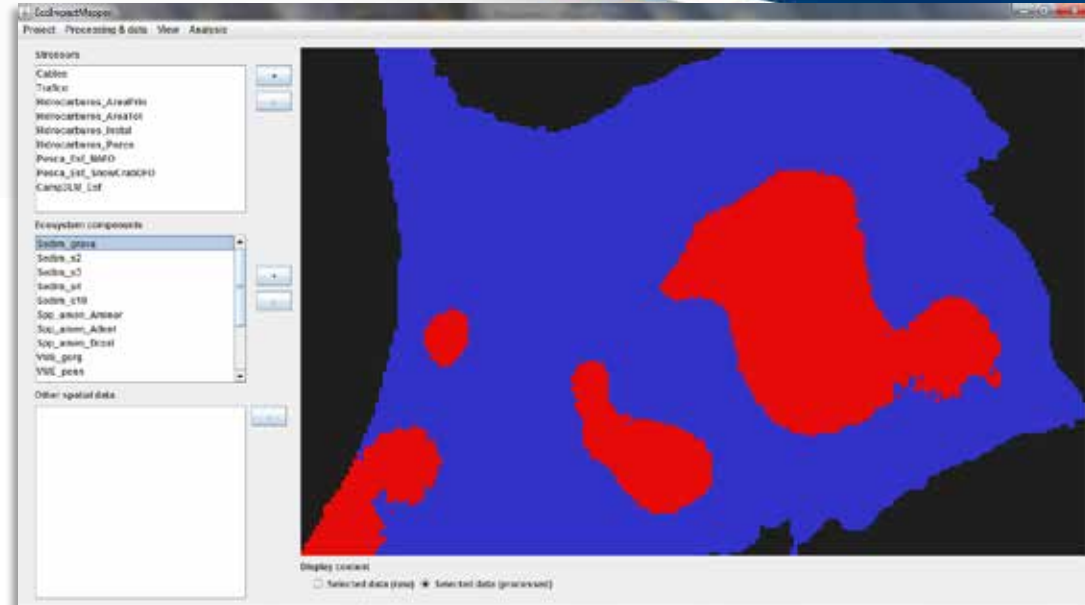
X = Sensitivity of the ecosystem component to the stressor, quantified using expert judgment



## Ecosystem Components\*

- 5 sediment substrate types
- 5 commercial species: fishes, shrimp and snow crab.
- 3 VME indicator species: seapens, gorgonians and sponges.
- 3 vulnerable species: fishes and turtles.

*\* Components were excluded of the analysis, when no spatial data were available or the spatial coverage was incomplete*



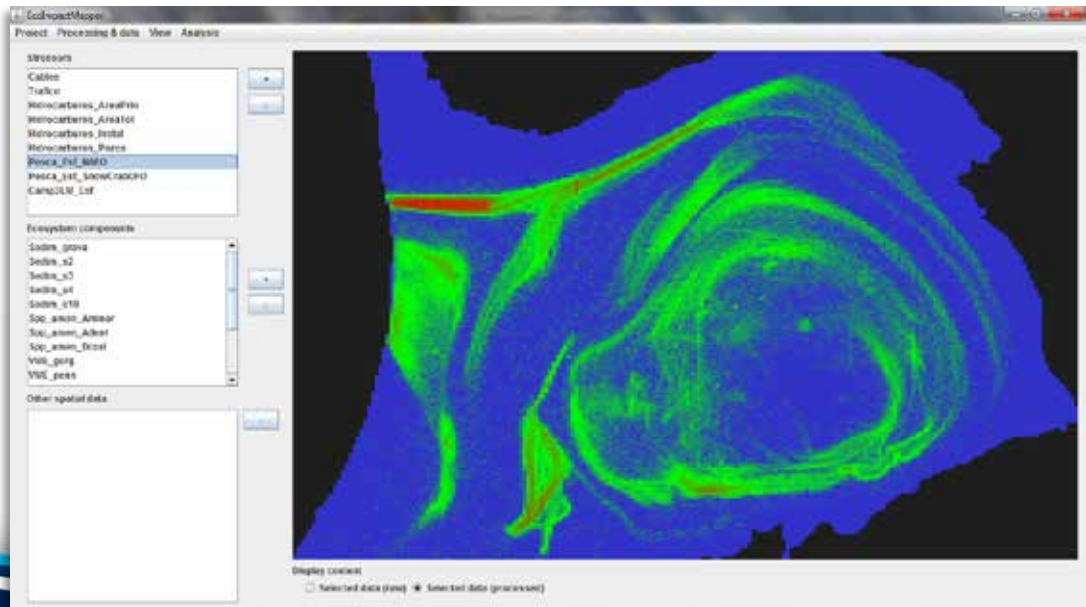
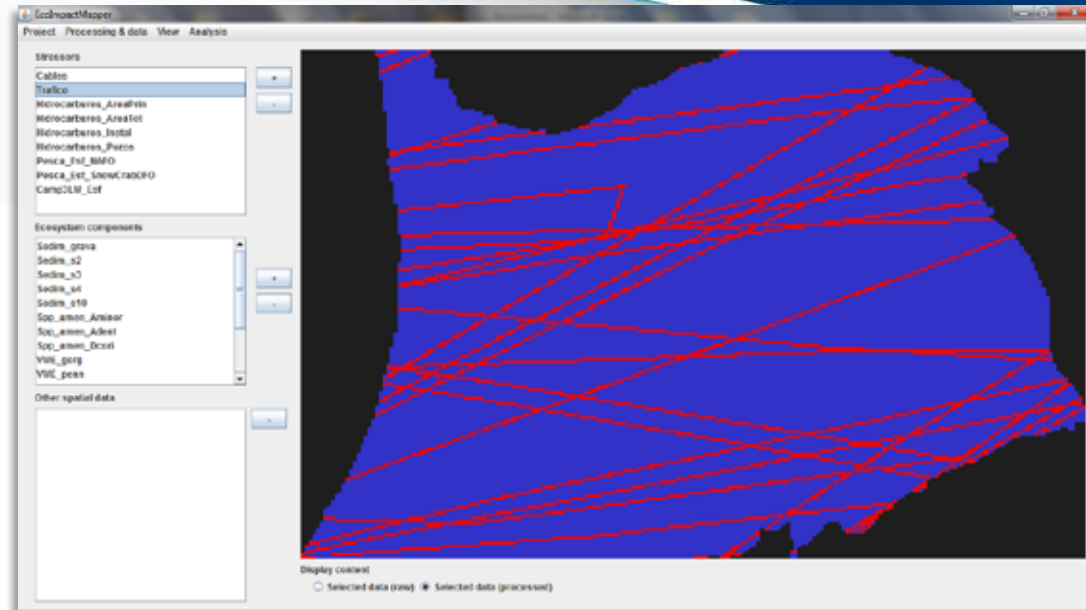


## Anthropogenic Stressors\*

9 relevant anthropogenic potential stressors, considering both human activities/uses of marine space and pressures (Halpern *et al.*, 2008):

- Shipping.
- Undersea cables.
- Offshore oil & gas developments: projected areas, projected production installation and wells.
- NAFO bottom fisheries.
- Snow Crab pot fishery.
- Groundfish surveys.

\* Stressors were excluded of the analysis, when no spatial data were available or the spatial coverage was incomplete



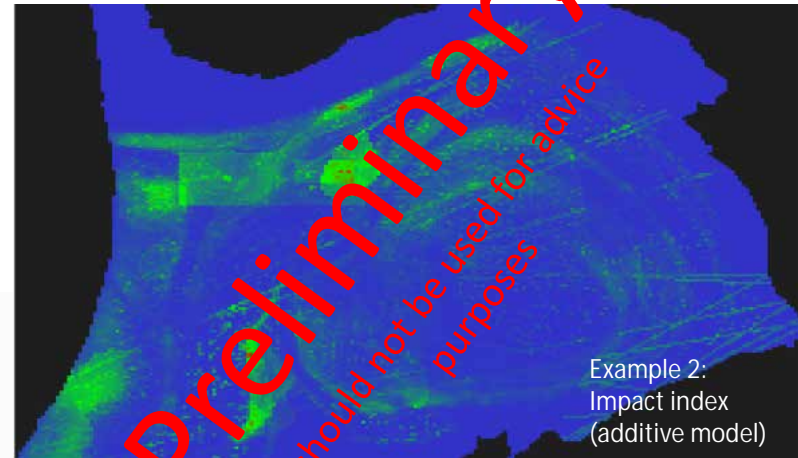
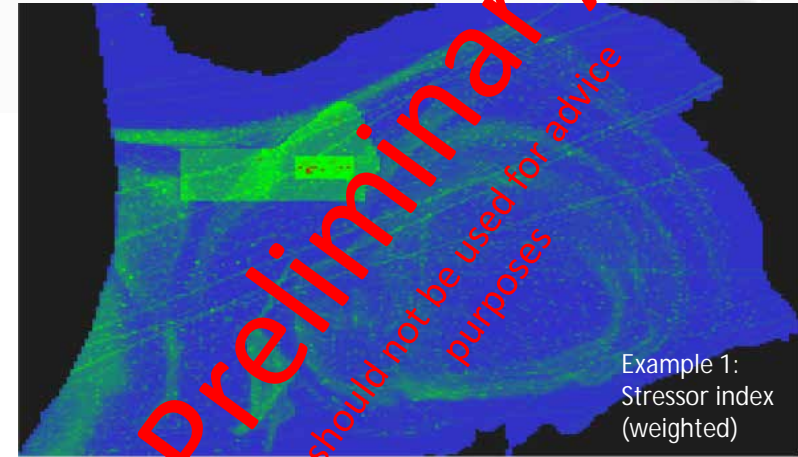


## Examples of cumulative impact maps

(Preliminary maps: It should not be used for advice purposes)

Challenges:

- Improve the sensitivity matrix.
- Improve the data layers (spatial coverage, etc.).
- Add other relevant spatial information on stressors and ecosystem components.
- Calculate different indices.
- Final Assessment





Step 2c

# Listing existing management measures relevant to the SMA and operational objectives



## NAFO Conservation and Enforcement Measures

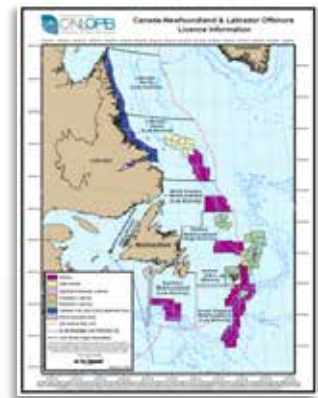
- Catch and effort limitations
- Bycatch measures
- Recovery and rebuilding plans
- Conservation and management of sharks
- Vessel and gear requirements
- Protection of VMEs – Closed Areas
- Fisheries monitoring
- Fisheries footprint
- ...



## NAFO Road Map to EAF

- Framework to develop an Ecosystem Approach Framework (EAF)
- Guiding set of ideas
- Scientists & Managers

## Oil & gas Environmental Assessments, SEA, Accord Acts & CEAA



## CNLOPB Oil & gas Licence Management

- Exploration Licences
- Significant Discovery Licences
- Production Licences
- ...

Go to Step 3

- ✗ Done! (preliminary)
- ✗ in progress
- ✗ Future tasks

# ATLAS work in the NAFO context: Implications to the high-seas fisheries management

## *NAFO COMMISSION Request # 13*

*“The Commission requests Scientific Council to monitor and provide regular updates on relevant research related to the potential impact of activities other than fishing in the Convention Area, such as oil exploration, shipping and recreational activities, and how they may impact the stocks and fisheries as well as biodiversity in the Regulatory Area”*

NAFO Working Group on Ecosystem  
Science and Assessment  
(NAFO WGESA)







# atlas

## Outreach activities

Information on ATLAS MSP CS11 works, has been presented to the fishing sector:

Industrias Pesqueras, 2132 abril 2018

Industrias Pesqueras, 2144 abril 2019

Industrias Pesqueras is a leading non-peer reviewed Spanish sectoral publication

www.eu-atlas.org



### Gestión espacial integral en el Atlántico noroeste: ¿Es posible compatibilizar las pesquerías de alta mar, la explotación de hidrocarburos offshore y la conservación de los ecosistemas?

**PAOLO DURÁN MUÑOZ**  
Investigador Titular  
Instituto Español de Oceanografía, Centro Oceanográfico de Vigo



El pasado mes de noviembre de 2018 se publicó un número de *Industrias Pesqueras* en el que se abordó el tema de la explotación offshore de hidrocarburos en aguas canchales del Gran Banco de Terranova, en aguas canchales del noroeste del Atlántico. En abril de este año se publicó un artículo de opinión en el que se abordó el tema de la explotación offshore de hidrocarburos en aguas canchales del Gran Banco de Terranova, en aguas canchales del noroeste del Atlántico. En abril de este año se publicó un artículo de opinión en el que se abordó el tema de la explotación offshore de hidrocarburos en aguas canchales del Gran Banco de Terranova, en aguas canchales del noroeste del Atlántico.

Estos incidentes nos alertan de los riesgos de la explotación de hidrocarburos en alta mar. Además de los potenciales conflictos con las pesquerías y la conservación, nos muestran la necesidad de una gestión espacial integral que contemple las distintas componentes socioeconómicas y naturales del ecosistema.

"Disponer de un plan integral de gestión espacial, en el marco de una estrategia de Crecimiento Azul, podría contribuir a maximizar la compatibilidad entre las actividades tradicionales y las emergentes, reduciendo los conflictos entre los usuarios y entre estos y la naturaleza"

La figura 1 muestra en detalle las pesquerías de la NAFO, los ecosistemas vulnerables y las zonas cercadas a la pesca. El mapa muestra las posibles áreas de conflicto con el futuro desarrollo offshore. Resumir brevemente el contenido del artículo de Planificación Espacial Marina que el Centro Oceanográfico de Vigo del IEO realiza dentro del proyecto internacional ATLAS ([www.eu-atlas.org](http://www.eu-atlas.org)), financiado por el programa Horizonte 2020. Se trata de un ejercicio técnico de alto nivel, ya que para poder hacer un plan integral de gestión espacial sería necesario, entre otros asuntos, poner de acuerdo a los distintos actores, designar una autoridad competente e integrar dos compartimentos estancos que actualmente se gestionan por separado. Conforme a la ley del mar (UNCLOS), por un lado tenemos la columna de agua que forma parte del patrimonio de la zona económica exclusiva de la NAFO y por otro lado la plataforma extendida con los hidrocarburos, gestionada directamente por el estado canchero en base a su legislación.

Mucho quedará todavía por hacer la decisión sobre la importancia de la planificación espacial en alta mar y qué se quiere en esta dirección. Como primer resultado se catalogaron los componentes más relevantes

### Pesquerías profundas y prospección de hidrocarburos en el Atlántico Noroeste: Un ejercicio de Planificación Espacial Marina del proyecto ATLAS



**PAOLO DURÁN MUÑOZ**  
Investigador Titular  
Instituto Español de Oceanografía  
Centro Oceanográfico de Vigo

"La prospección de hidrocarburos es una actividad emergente que podría competir por la utilización del espacio marino con las actividades tradicionales, por ejemplo la pesquería del fletán negro, y entrar en conflicto con las medidas de conservación de la NAFO"

Cap-Flemish Pass, sistemas Marinos los corales de aguas frías. Es un ecosistema prodador gallega de la Organización para el Noroeste (NAFO), y la conservación a la de los recursos de los ecosistemas. Mover los recursos, es de protección de las resoluciones de riba. Parte de estas áreas de protección mundialmente en las el Instituto Español colaboración con otros marinas para alcanzar objetivos ecológicos, económicos y sociales que normalmente se especifican por medio de un proceso político. Está enfocada al futuro. Justamente en esta dirección se trabaja actualmente en el Centro Oceanográfico de Vigo del IEO en el marco de ATLAS ([www.eu-atlas.org](http://www.eu-atlas.org)), un proyecto internacional financiado por el programa Horizonte 2020, que estudia los ecosistemas productores del Atlántico Norte en el contexto de la actividad pesquera.



Figura 1. Mapa del área de estudio del proyecto ATLAS en el norte de Fletán Negro y Fletán Negro. Se muestran las zonas de explotación de hidrocarburos y las zonas de protección de los recursos de los ecosistemas. Fuente: ATLAS, NAFO y IEO, 2018.

Plan está en la Planificación Espacial Marina (PEM). Según la UNESCO, es un proceso público para analizar y asignar la distribución espacial y temporal de las actividades humanas en zonas marinas para alcanzar objetivos ecológicos, económicos y sociales que normalmente se especifican por medio de un proceso político. Está enfocada al futuro. Justamente en esta dirección se trabaja actualmente en el Centro Oceanográfico de Vigo del IEO en el marco de ATLAS ([www.eu-atlas.org](http://www.eu-atlas.org)), un proyecto internacional financiado por el programa Horizonte 2020, que estudia los ecosistemas productores del Atlántico Norte en el contexto de la actividad pesquera.

Fletán Negro y Gran Banco, identificada previamente por la Convención de Responsabilidad. Se seleccionaron los objetivos operacionales de la gestión espacial y se inventarió la información espacial para analizarla.



Figura 2. Mapa del Gran Banco de Terranova en el noroeste del Atlántico y zona de explotación de hidrocarburos. Se muestran las zonas de explotación de hidrocarburos y las zonas de protección de los recursos de los ecosistemas. Fuente: ATLAS, NAFO y IEO, 2018.

en el marco de una estrategia de Crecimiento Azul, podría contribuir a maximizar la compatibilidad entre las actividades tradicionales y las emergentes, reduciendo los conflictos entre los usuarios y entre estos y la naturaleza. Se trata de garantizar que los ecosistemas de alta mar puedan seguir realizando sus funciones y proporcionar, además de hidrocarburos, bienes renovables y servicios tan importantes como el pescado, los NAFO y las zonas protegidas.

en completar en la se trata de un ejercicio de alto nivel, ya que para poder hacer un plan integral de gestión espacial sería necesario, entre otros asuntos, poner de acuerdo a los distintos actores, designar una autoridad competente e integrar dos compartimentos estancos que actualmente se gestionan por separado. Conforme a la ley del mar (UNCLOS), por un lado tenemos la columna de agua que forma parte del patrimonio de la zona económica exclusiva de la NAFO y por otro lado la plataforma extendida con los hidrocarburos, gestionada directamente por el estado canchero en base a su legislación.

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# Thank You!



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100 años en Vigo  
Una vida en el mar



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