atlas
UNDERSTANDING DEEP ATLANTIC ECOSYSTEMS

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

CENTRO OCEANOGRÁFICO DE VIGO
100 años en Vigo
una vida en el mar

Pablo Durán Muñoz, **Ana García-Alegre** & Mar Sacau Cuadrado
Instituto Español de Oceanografía (IEO-Vigo)
Programa de Pesquerías Lejanas
Centro Oceanográfico de Vigo
ESPAÑA

This project has received funding from 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.

WP6 – Case Study No11

Theoretical exercise:

Develop a marine plan to facilitate a scenario of the potential development of a *Blue Economy / Blue Growth*[1]

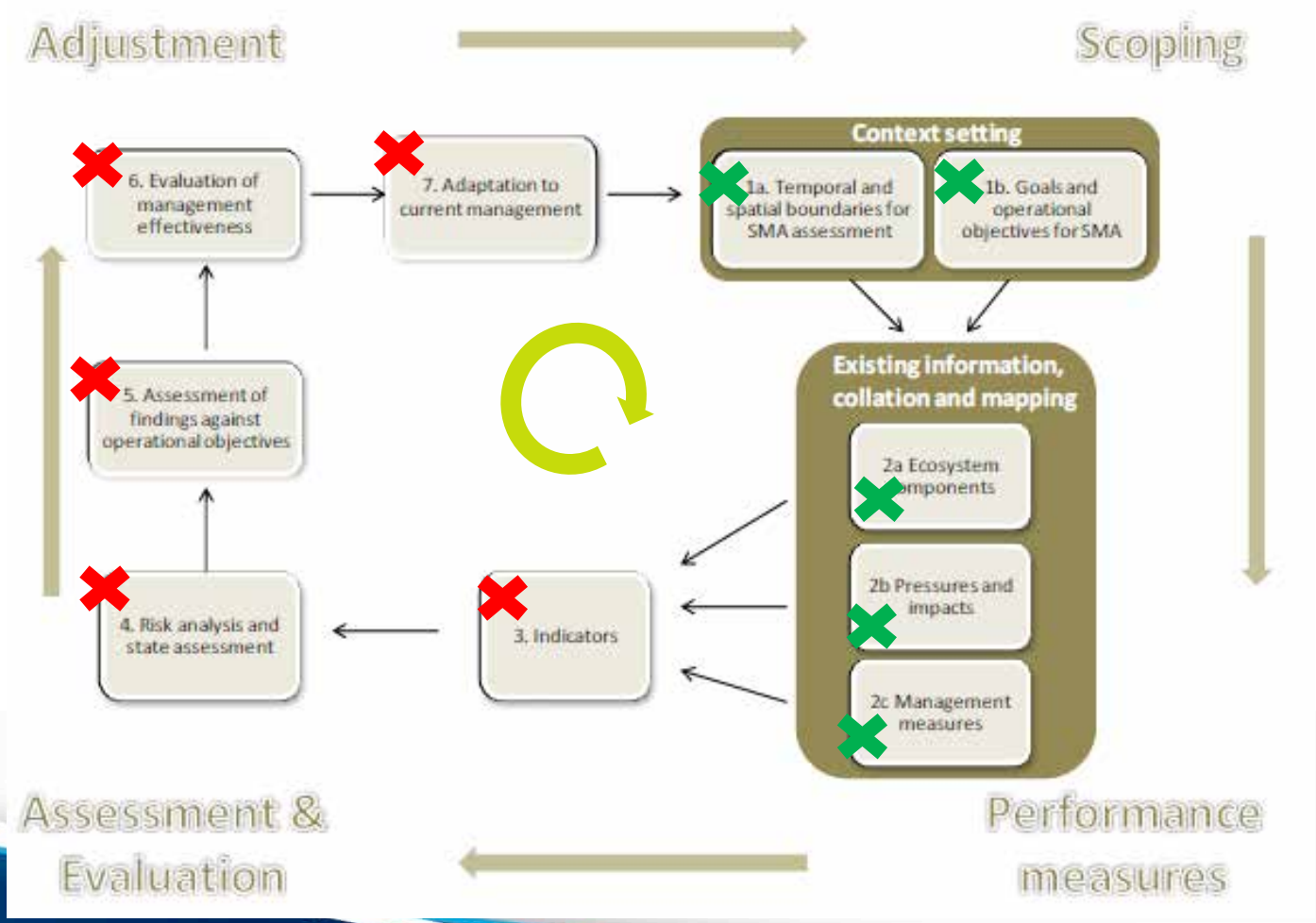
Theoretical *Blue Economy / Blue Growth* scenario:

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*

[1]*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

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

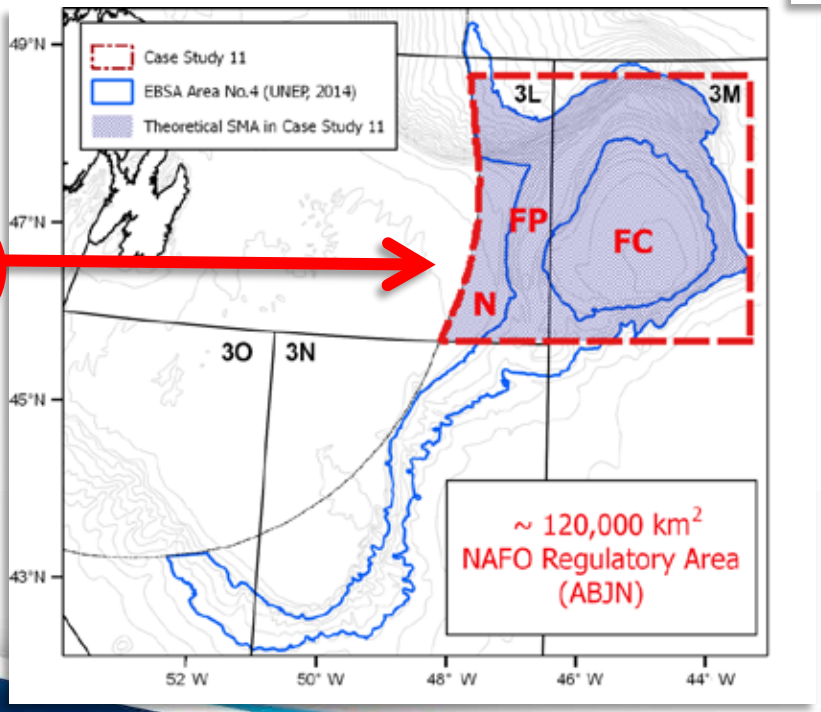
Source: Stelzenmuller et al. (2013)

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

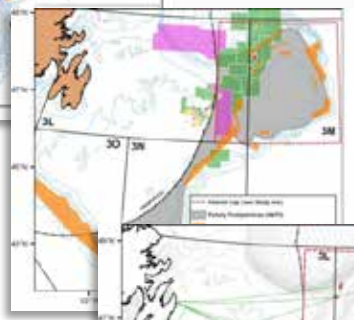
✖ Done! (preliminary)
✖ in progress
✖ Future tasks

Case Study 11, Sectoral Activities & SMA

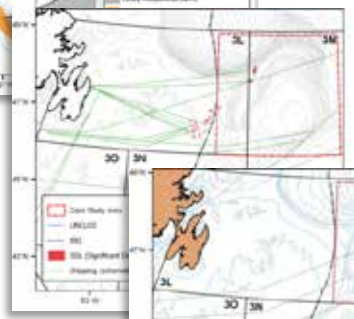


Fisheries & Conservation

BG



Offshore hydrocarbon



Shipping

Cables

Research & education

www.eu-atlas.org

Institutional Landscape & Existing Management Plans

Northwest Atlantic Fisheries Organization

Fisheries

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

C-NLOPB

Offshore oil & gas

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

Water Column

Continental Shelf

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

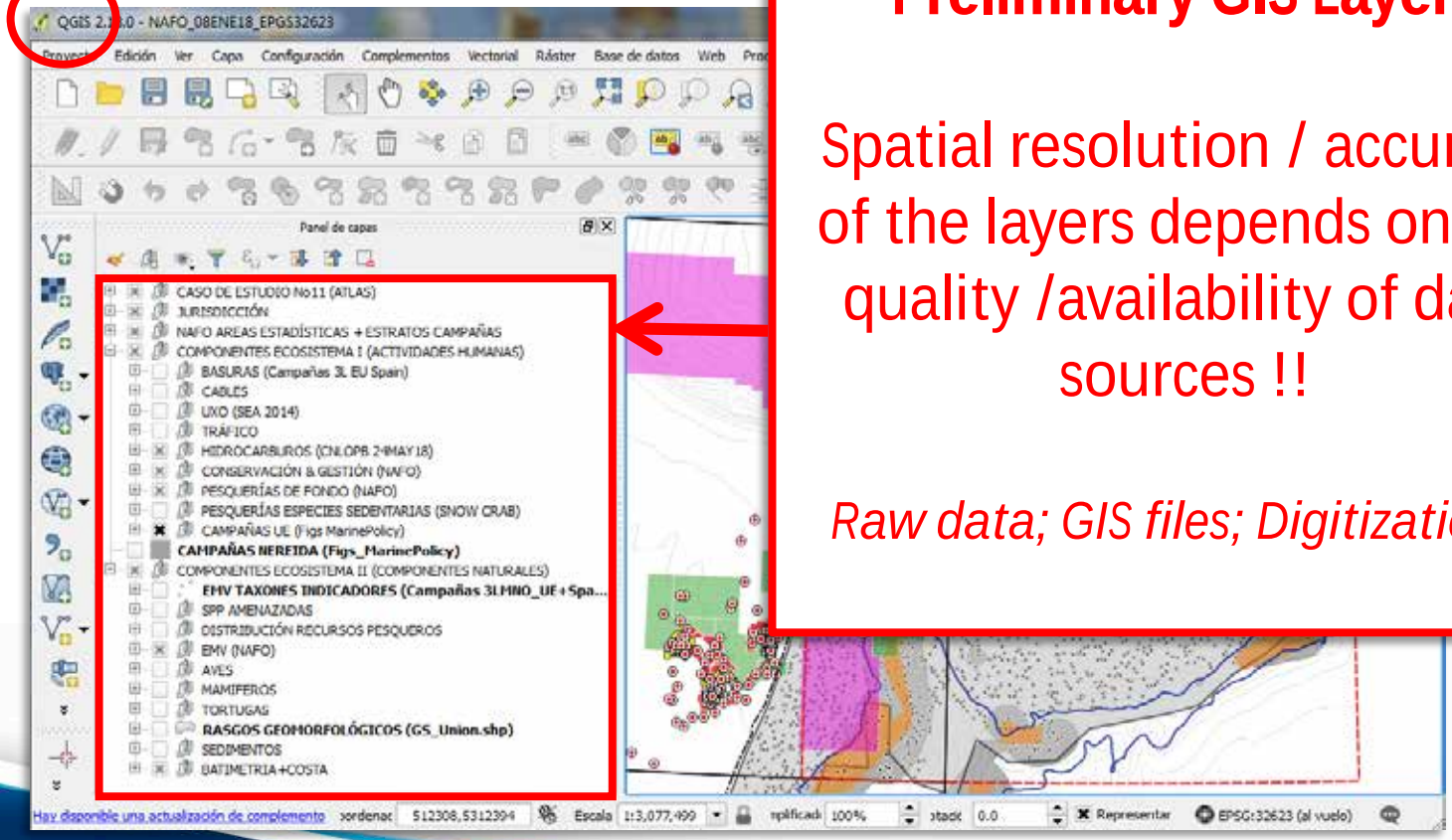
Lists of Human Activities and Natural Components

Potential Sector/Driver	Subsector	Activity	Sector active?	Spatial coverage	Temporal coverage
1. Fisheries	Bottom fisheries	Pots, traps, gilln			
	Pelagic fisheries	Seines, gillnets,			
2.Exploitation and exploration of non living resources & ocean energy	Hydrocarbon (oil & gas)	Exploration (dril activities)			
		Exploitation (sig discoveries/pro			
		Pipelines			
	Offshore renewables	Wind, tidal & cu converters			
		Power cables			
	Mining	Seabed mining			
	Carbon capture and storage	Carbon capture			
3.Transportation	Shipping (passengers and items)	Shipping (passer			
4.Telecomunication	Undersea cables	Laying & mantai			
5. Science	Research & education	Fish stock assess surveys			
6. Conservation	Environmental conservation & protection	Environmental c protection			
7. Biotechnology	Bioprospecting	Search for biolo genetic resourc			
8. Defence	Military activities	Dumping, sonar			
9. External influences	Climate change	Climate change			
	Pollution	Pollution (includ			

Type	Ecosystem component	Relevant objective(s)	Spatial coverage (good/poor)	Temporal coverage (good/poor)
1. Physical and chemical	Geomorphology and bathymetry of the seabed (slope, aspect, rugosity, BPI, etc.)	YES: Prevent SAIs; VME closed areas; Management areas	Good	Good
	Temperature regime	YES: Management areas	Good	Good
	Current velocity (e.g. deep Labrador current)	Management areas	Good	Good
	Salinity	YES: Management areas	Good	Good
	Seabed substrate	YES: Prevent SAIs; VME closed areas; Management areas	Good	Good
	Geological features as physical VME indicator elements	YES: Prevent SAI; VME closed areas; Management areas	Good	Good
2. Habitat types	Predominant habitat types	YES: Prevent SAIs; VME closed areas; Management areas	Good	Intermediate
	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	Intermediate
	Identification of habitats in special areas (e.g. VME closed areas to bottom fishing; nurseries??)	YES: Prevent SAIs; VME closed areas; Management areas	Good	Intermediate
3. Biological features	Biological communities: benthos	YES: Prevent SAIs; VME closed areas; Management areas	Intermediate	Intermediate
	Invertebrate bottom fauna	YES: Prevent SAIs; VME closed areas; Management areas	Good	Intermediate
	Fish populations and target fish stocks (e.g. Greenland halibut, cod, redfish)	YES: Prevent SAIs; Management areas	Good	Good
	Marine mammals (e.g. northern bottlenose, cuvier's and Sowerby's whales; hooded seal, etc.)	YES: Prevent SAIs; Management areas	Good	Good
	Reptiles (e.g. turtles)	YES: Prevent SAIs; Management areas	Good	Good
	Seabirds (e.g. little auk, great skua, etc.)	YES: Prevent SAIs; Management areas	Intermediate	Poor
	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
4. Other features	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



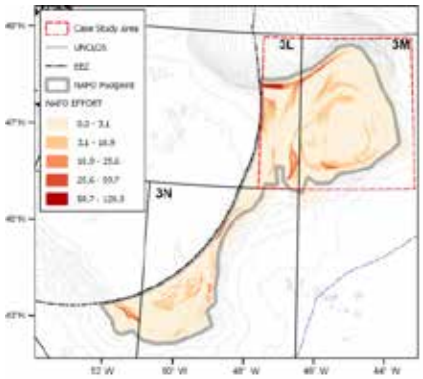
Preliminary GIS Layers

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

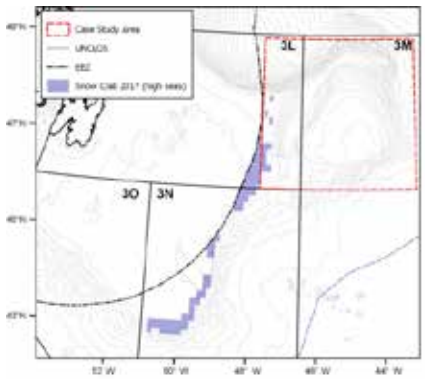
Raw data; GIS files; Digitization…

Mapping of human activities

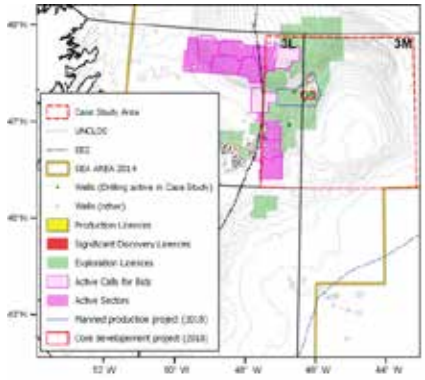
NAFO fisheries



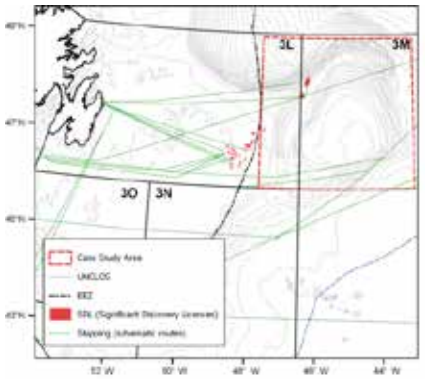
Snow crab fisheries



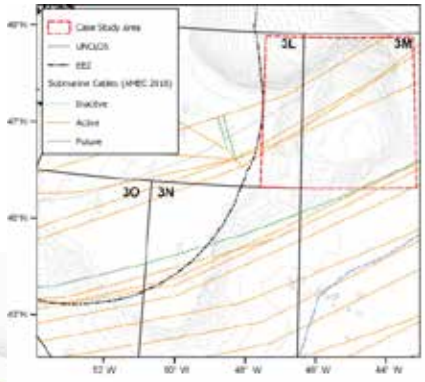
Hiydrocarbon



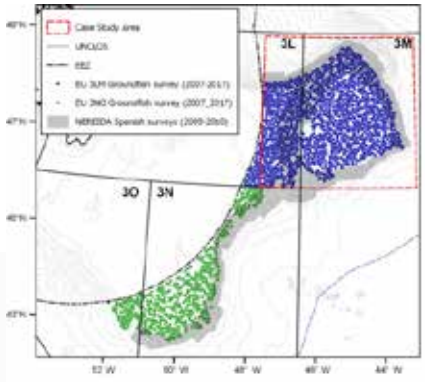
Shipping



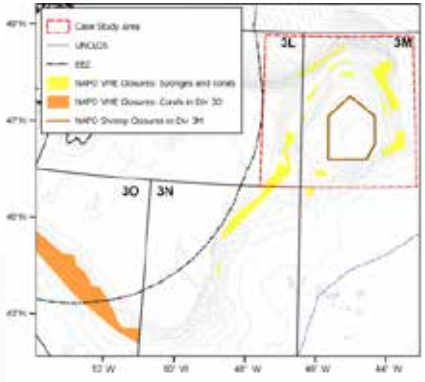
Cables



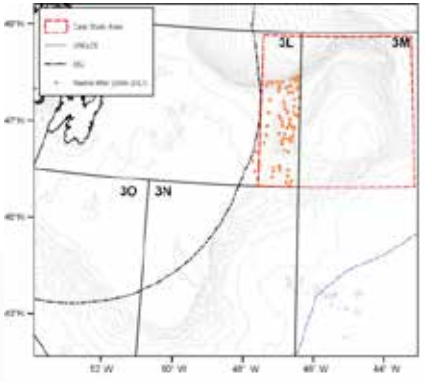
Research



Conservation



Marine litter

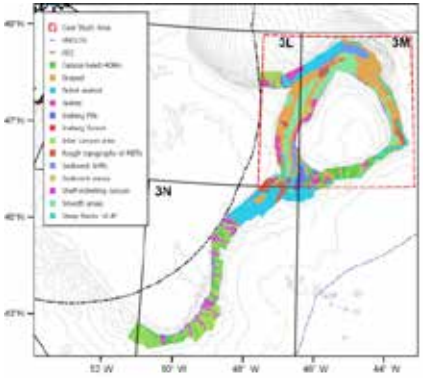


Preliminary maps from different sources (IEO, NAFO, DFO, CNLOPB, OBIS.....)

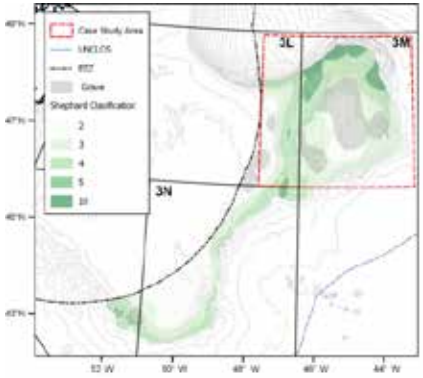
www.eu-atlas.org

Mapping of natural/biophysical components

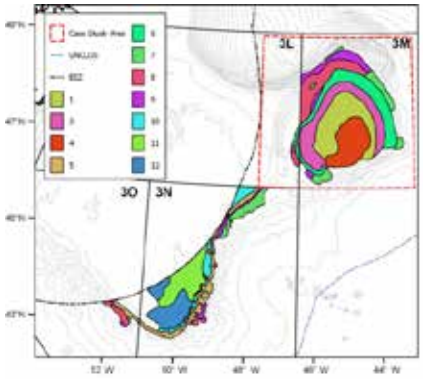
Geomorphology



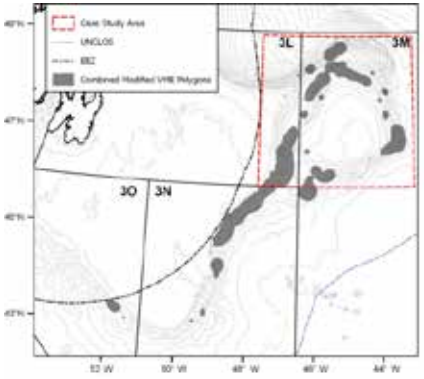
Sediments



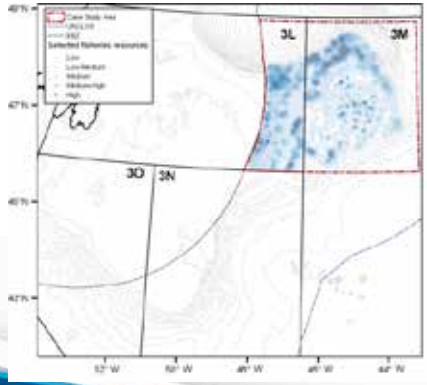
Biological communities



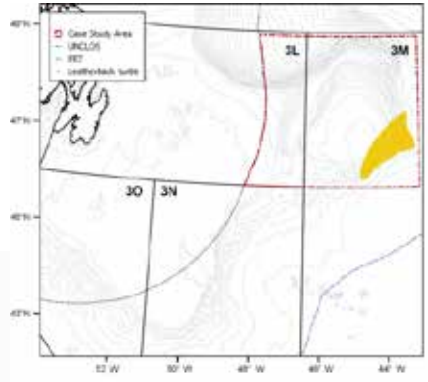
VMEs - Indicator species



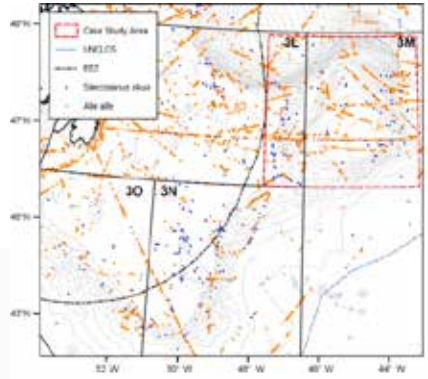
Fisheries resources



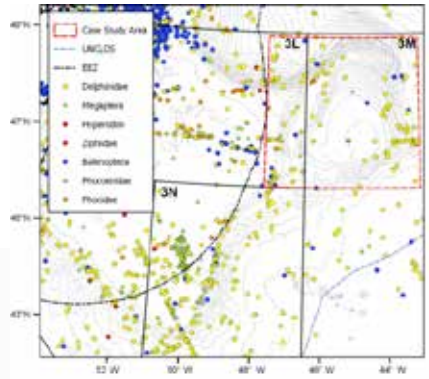
Protected species



Seabirds



Marine mammals



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

www.eu-atlas.org

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 EcoImpactMapper (Stock, 2016).

CENTRO OCEANOGRÁFICO DE VIGO

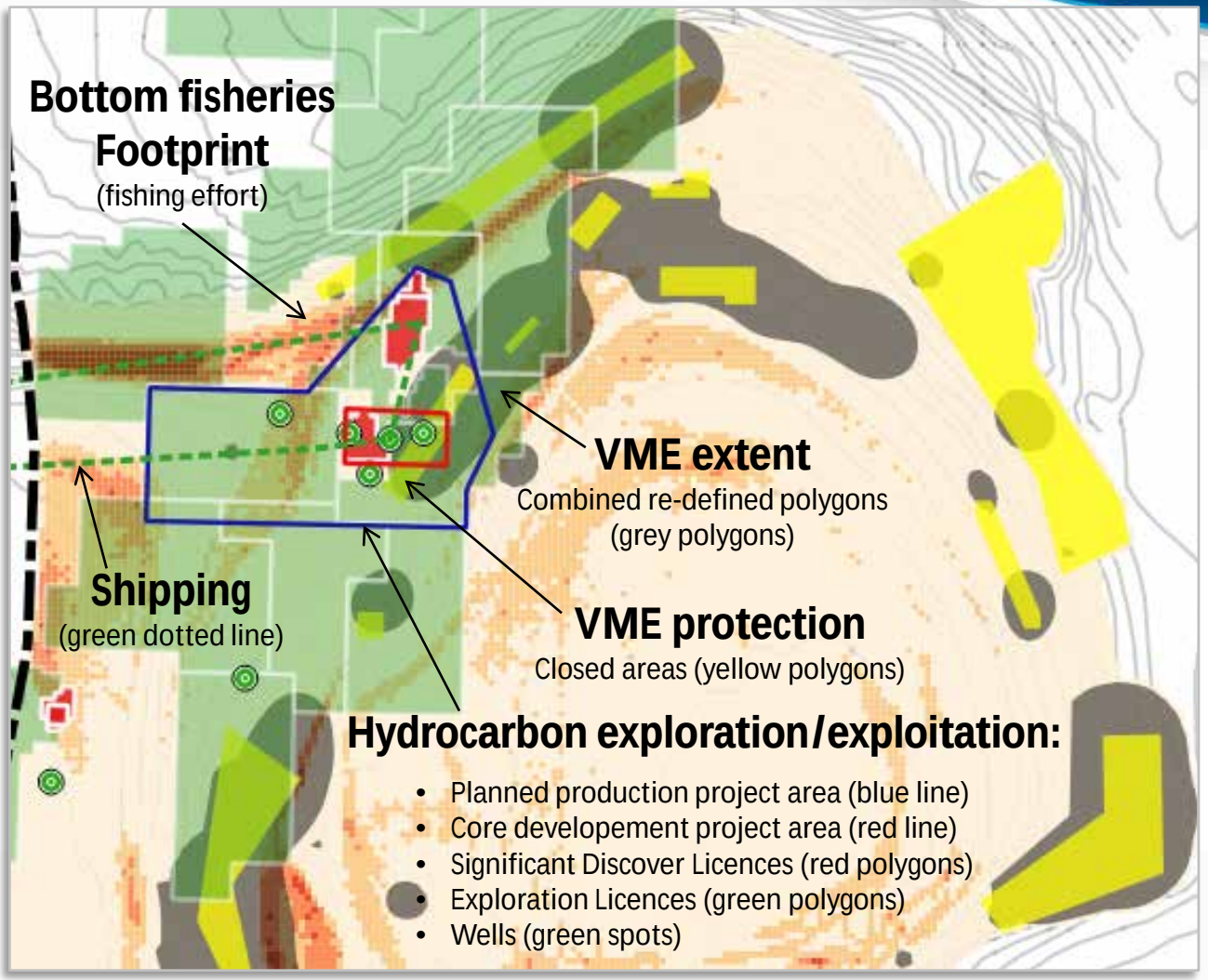
100 años en Vigo una vida en el mar

atlas

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.

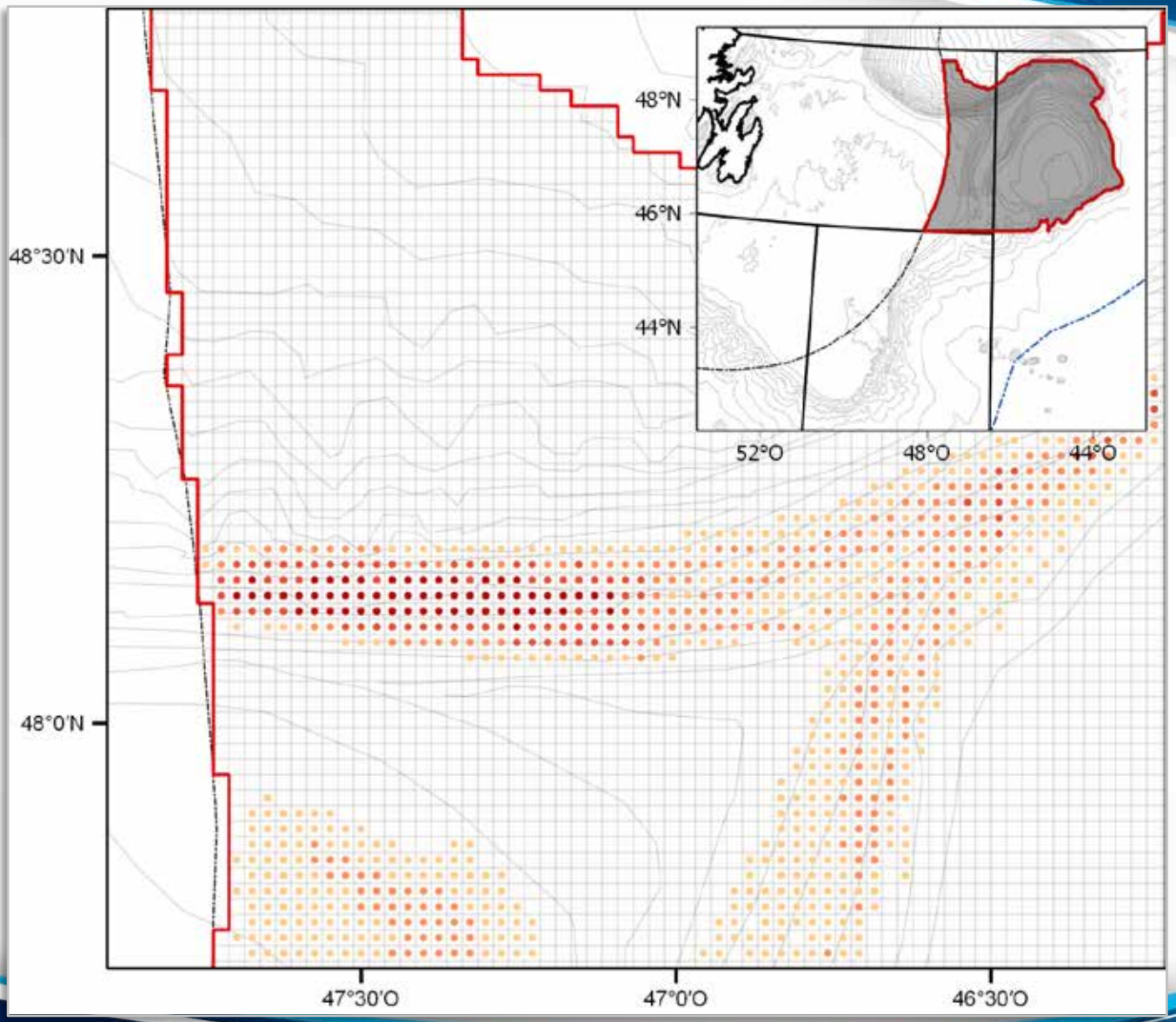
4. **Summing the products** of ecosystem component, stressor, and the sensitivity weights.

EcoImpactMapper (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.



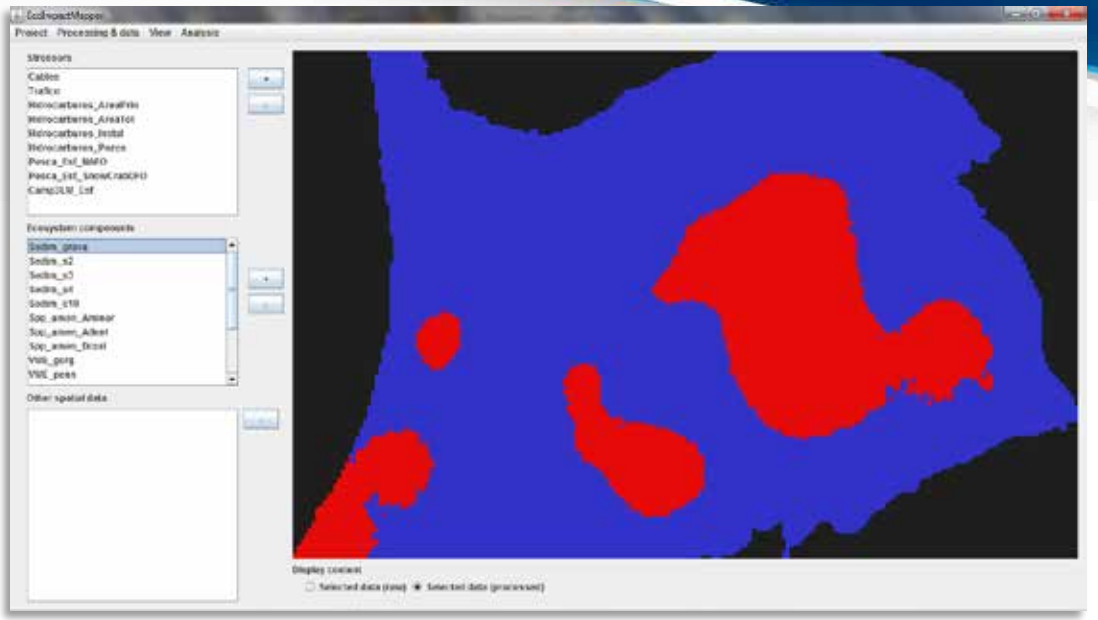
Sensitivity matrix

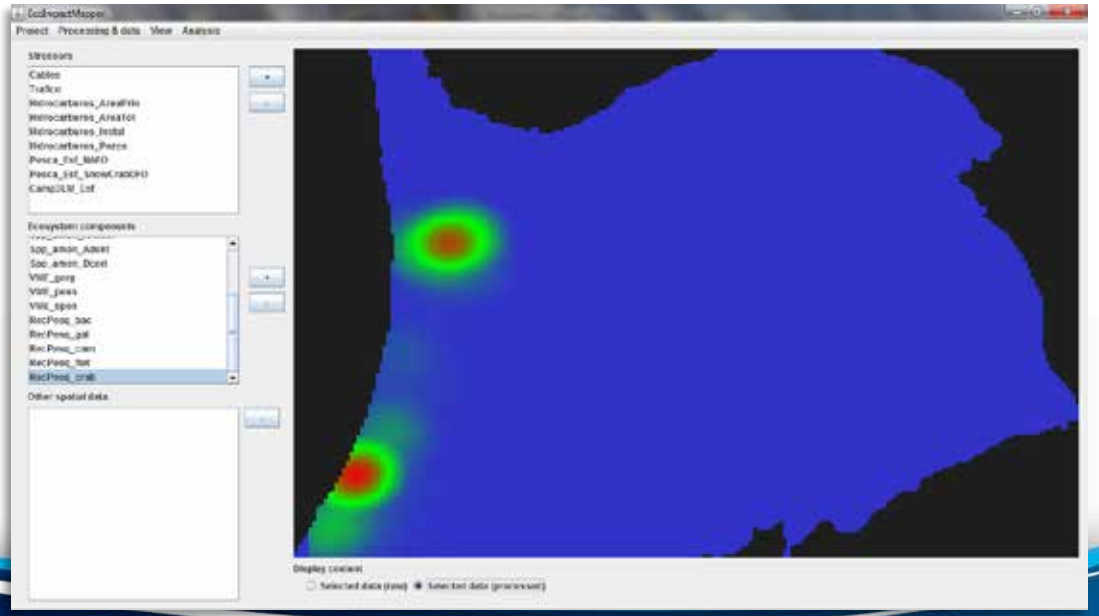
Sensitivy Scores	Natural Component 1	Natural Component 2	Natural Component 3	Natural Component 4	Natural Component 5	Natural Component 6	Natural Component 7	Natural Component 8	Natural Component 9	Natural Component 10	Natural Component 11	Natural Component 12	Natural Component 13	Natural Component 14	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*

CENTRO OCEANOGRÁFICO DE VIGO

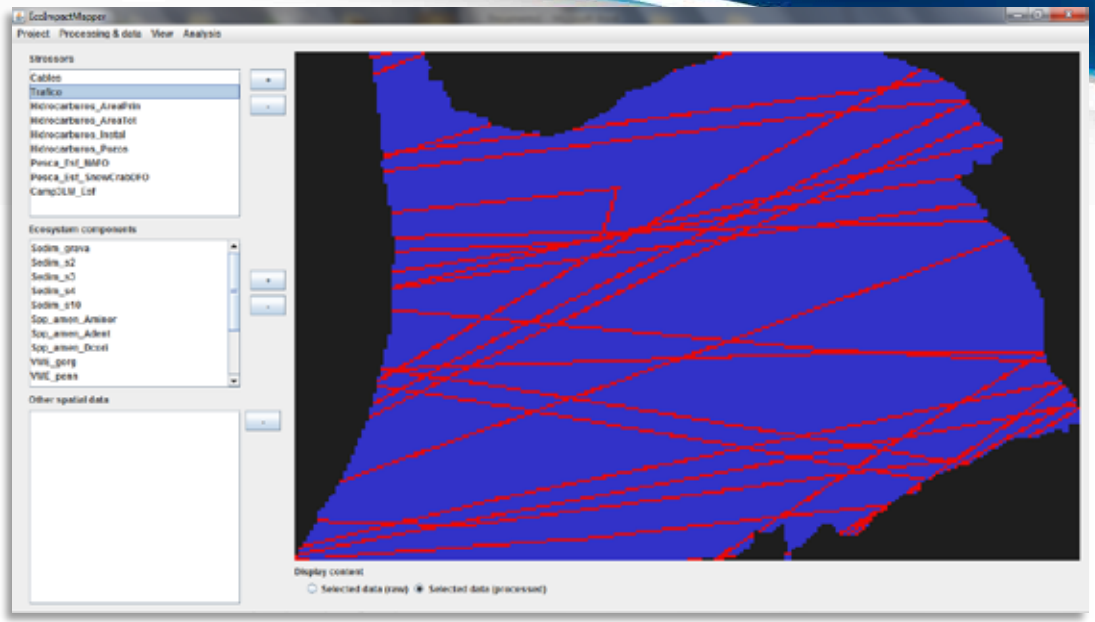
100 años en Vigo una vida en el mar

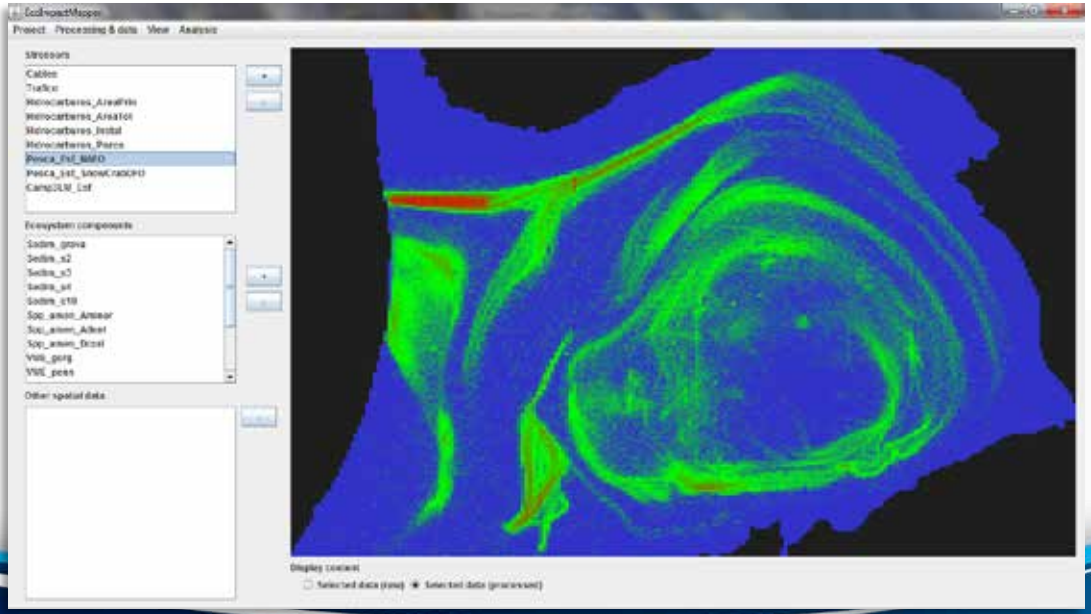
atlas

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*

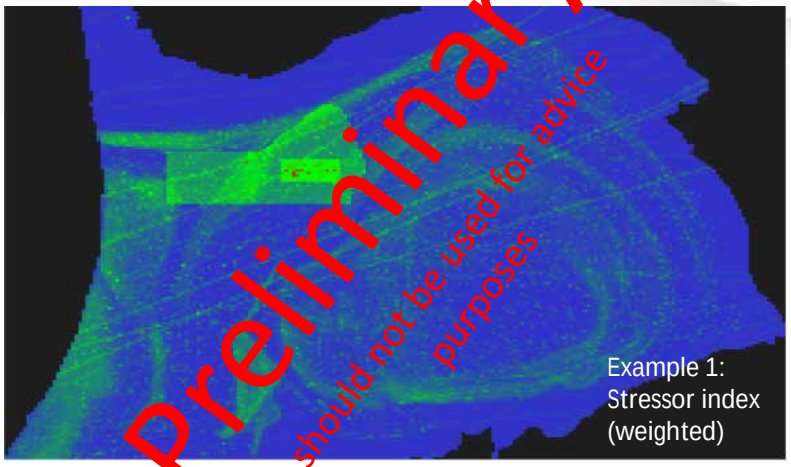
www.eu-atlas.org

Examples of cumulative impact maps

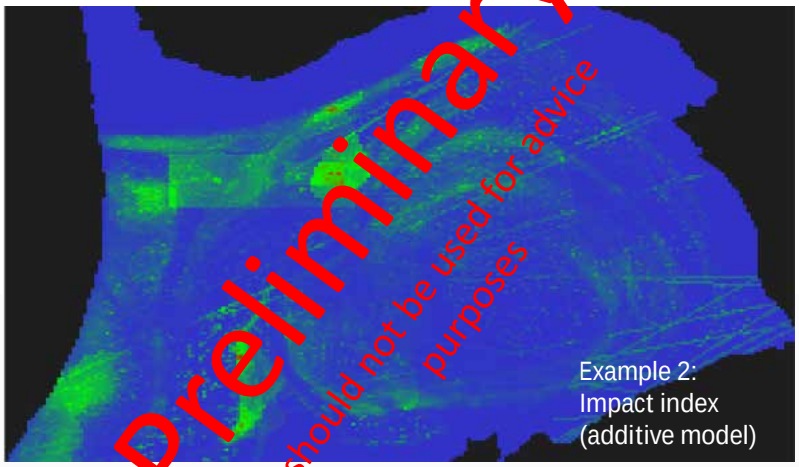
(Preliminary maps: It should not be used for advice purposes)

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



Example 1: Stressor index (weighted)



Example 2: Impact index (additive model)

atlas

Step 2c

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

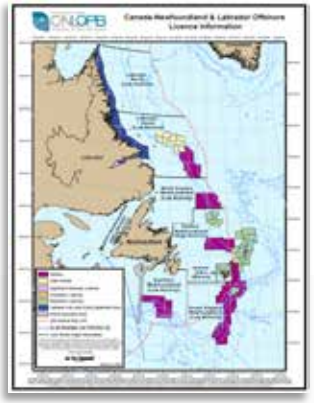
NAFO Conservation and Enforcement Measures

- *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 COMMISION 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)

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

Thank You!

Pablo Durán Muñoz

pablo.duran@ieo.es

Mar Sacau

mar.sacau@ieo.es

Ana García-Alegre

ana.garciaalegre@ieo.es

CENTRO OCEANOGRÁFICO DE VIGO

100 años en Vigo
una vida en el mar

Project Contact Details:

Coordination: Professor Murray Roberts
J.M.Roberts@hw.ac.uk
Project office contact:
EU-Atlas@ed.ac.uk
Communication & Press:
atlas@aquatt.ie

Follow us: @eu_atlas
@EuATLAS
www.eu-atlas.org

This project has received funding from 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.

Image credit: IEO

Template developed by AquaTT