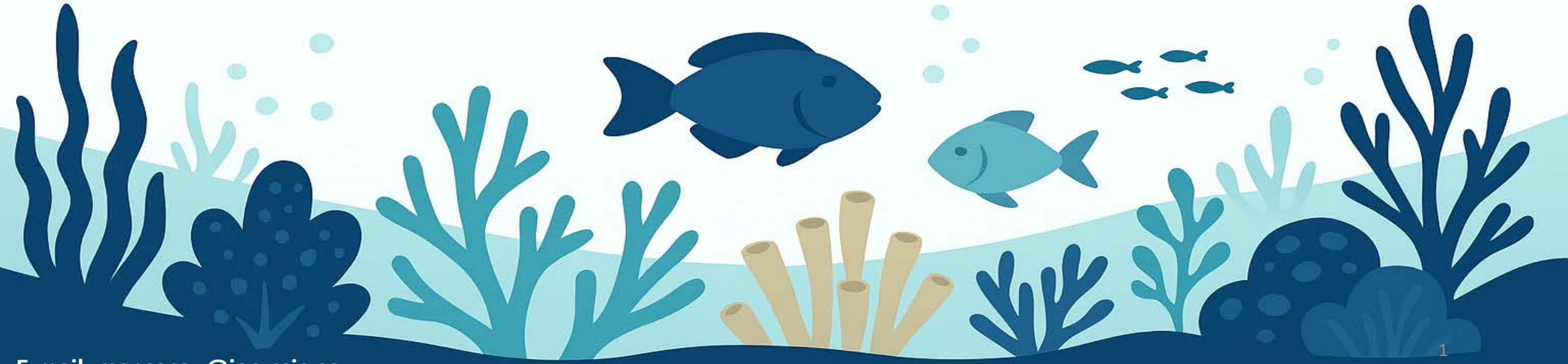
11 March, 2026

LDAC WG2 on Atlantic and Pacific RFMOs and Access Arrangements

Protection of Deep-Sea Ecosystems in NAFO

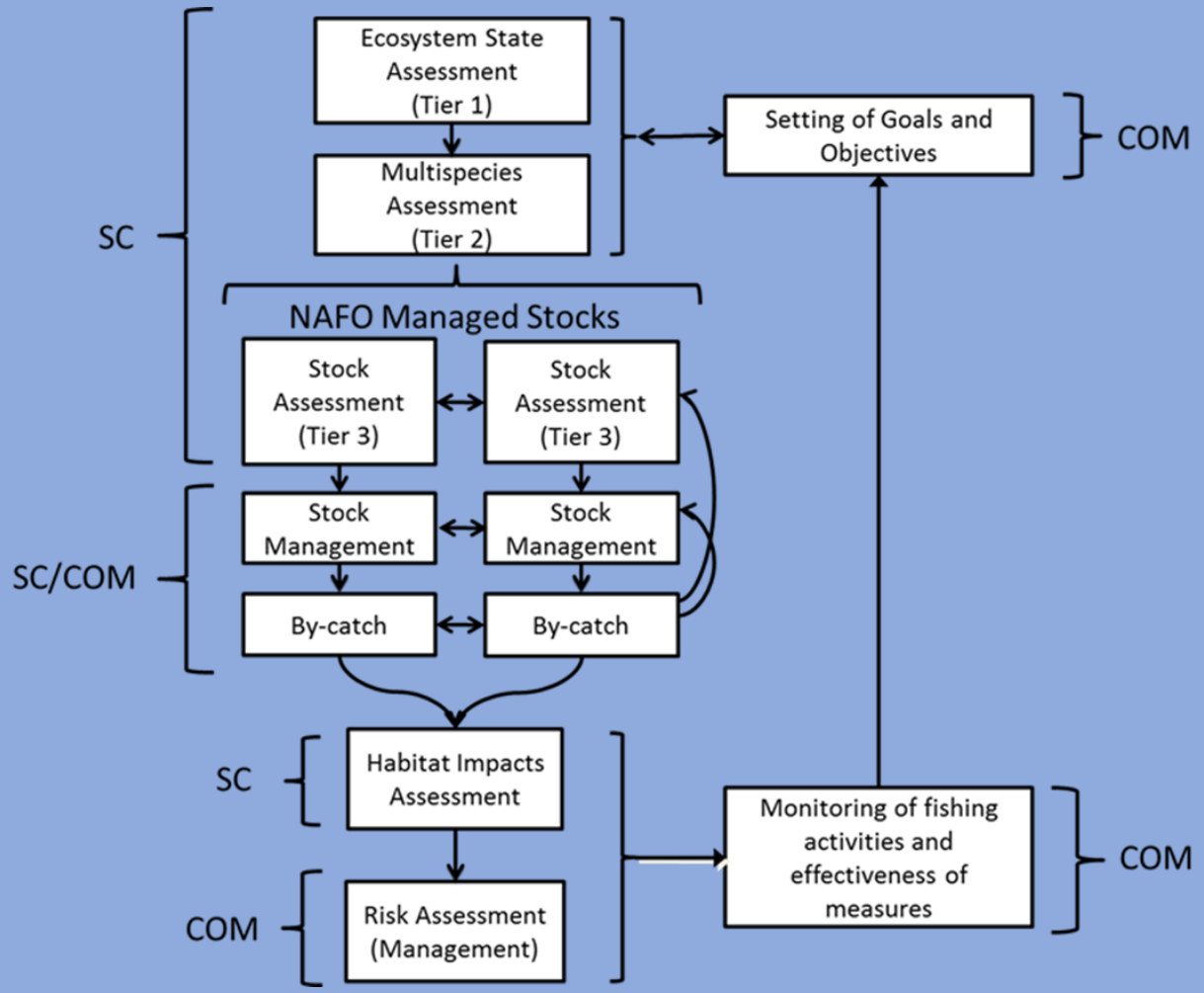
Mar Sacau Cuadrado, Pablo Durán Muñoz, Sara Abalo Morla and Santiago Palas Otero

Centro Oceanográfico de Vigo (COV-IEO), CSIC. Subida a Radio Faro, 50.
36390 Vigo. Spain.



E-mail: mar.sacau@ieo.csic.es

1 NAFO Roadmap



1

NAFO Roadmap

2

VMEs and impact of bottom fisheries

1 NAFO Roadmap

2 VMEs and impact of bottom fisheries

3 **Activities other than fishing**

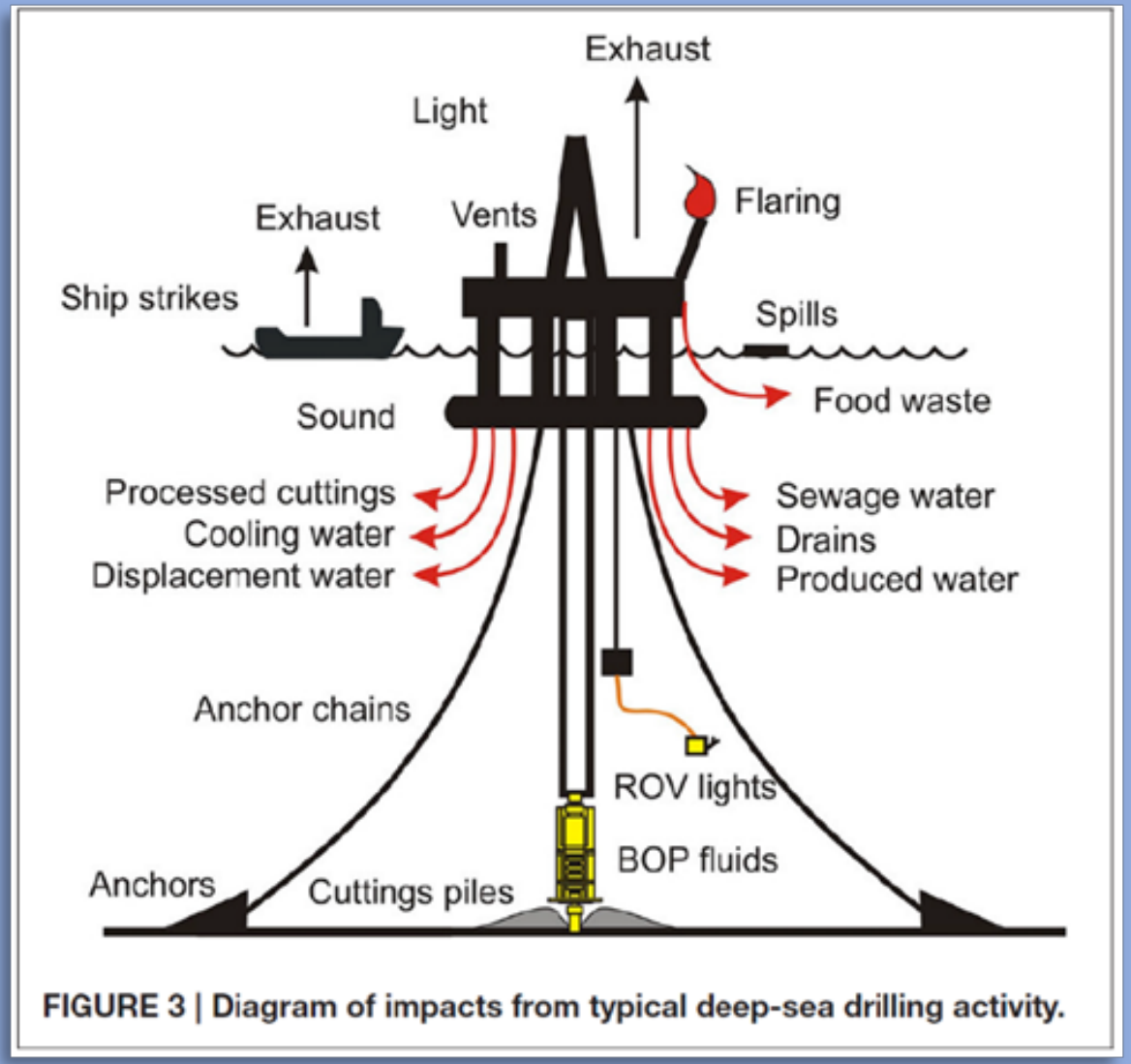
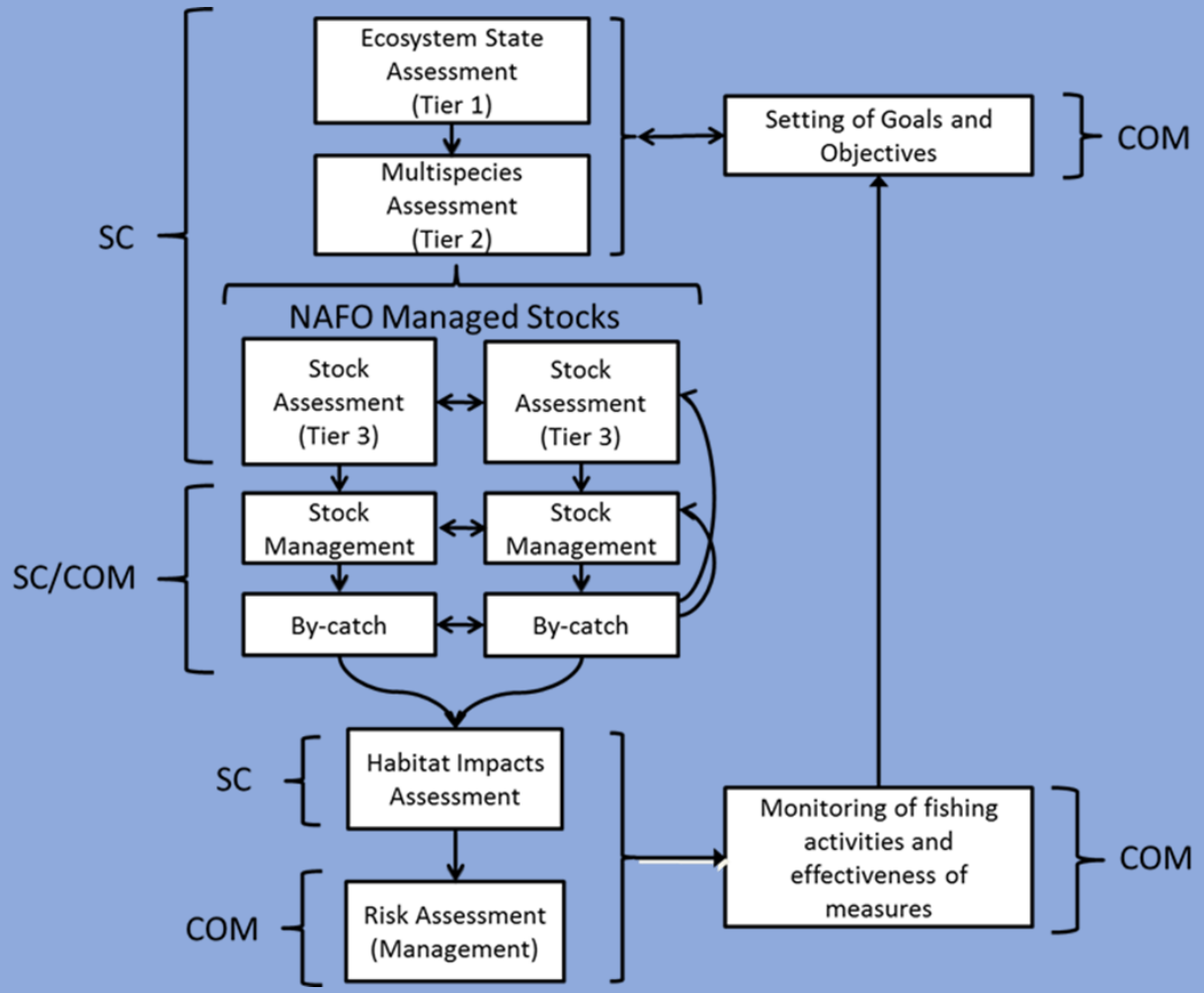


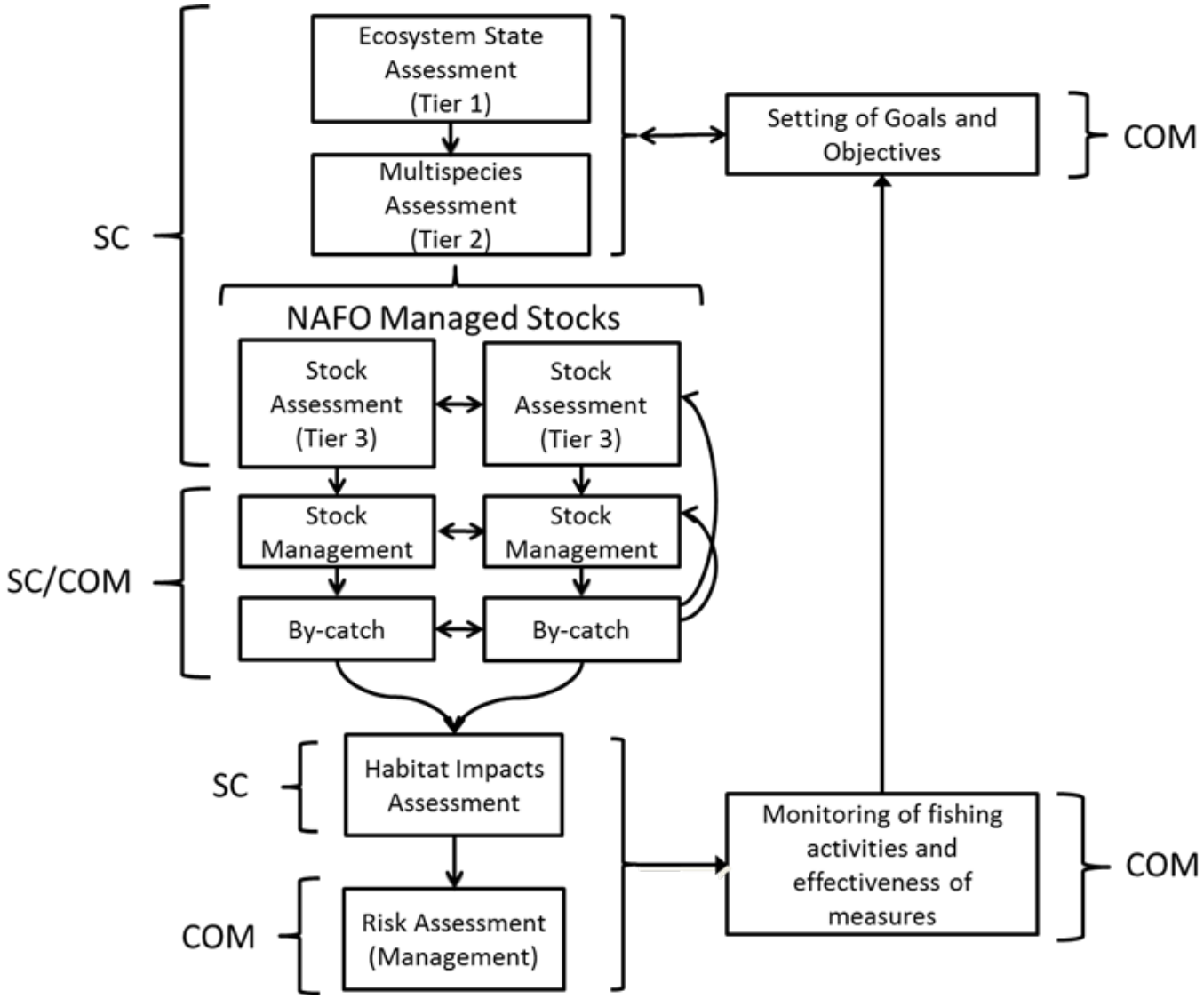
FIGURE 3 | Diagram of impacts from typical deep-sea drilling activity.

Cordes *et al.* (2016)

1 NAFO Roadmap



What is the NAFO Roadmap ?



M. Koen-Alonso *et al*. (2019)

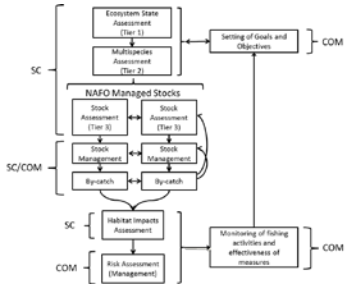
What is it?

- It is a guiding set of ideas and principles to implement an Ecosystem Approach to Fisheries (EAF)
- It lays out an organizing framework
- It includes both Science and Management
- It is pragmatic
- It is modular

Core premises

- Objective-driven
- Long-term ecosystem sustainability
- Place-based framework
- Trade-offs in managing human activities explicitly defined

What is the NAFO Roadmap ?



IDENTIFY FUNCTIONAL ECOSYSTEM UNIT

Tier 1 — Productivity State Assessment

Tier 2 — Multispecies Assessment

Tier 3 — Stock Assessment

HABITAT IMPACTS ASSESSMENT

Update on NAFO Roadmap reference document

COM-SC EAFFM-WP 25-01

COM-SC EAFFM-WP 25-01
[Agenda item 06]

Northwest Atlantic Fisheries Organization

NAFO JOINT COMMISSION-SCIENTIFIC COUNCIL WORKING GROUP ON ECOSYSTEM APPROACH FRAMEWORK TO FISHERIES MANAGEMENT (WG-EAFFM) MEETING, 14–16 JULY 2025

The NAFO Roadmap for an Ecosystem Approach to Fisheries

1. Policy context
2. General structure of the Roadmap
3. Current implementation

CPs

ADDITIONAL COMMENTS

The NAFO **Secretariat compiled the comments** and forwarded them to the SC for **discussion at the September 2025 meeting**.

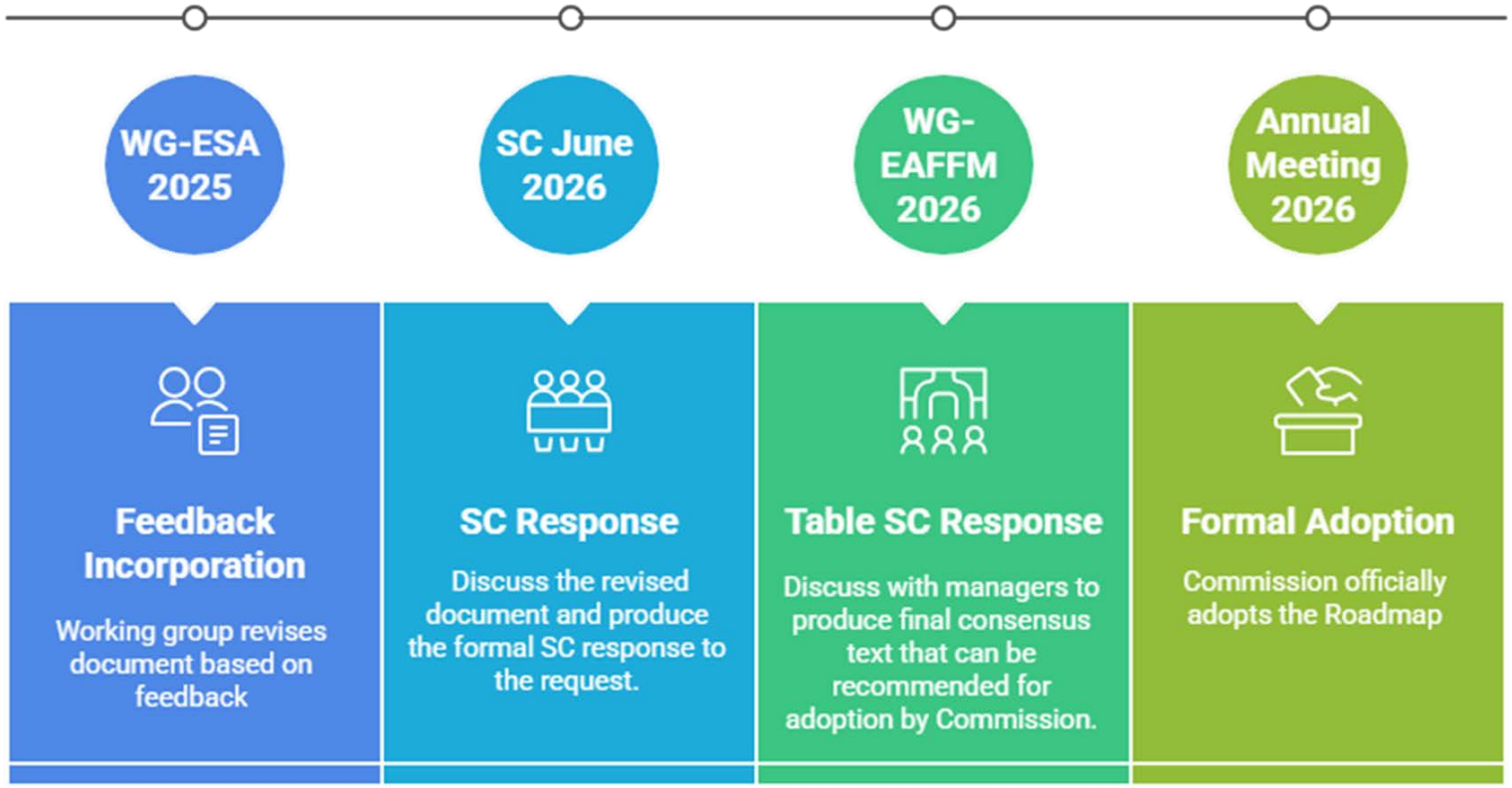
- **Removal** of the **"Current implementation"** section
- **Emphasis** on the **adaptive nature** of the Roadmap
- **Inclusion** of a more explicit reference to **climate change**
- **Revision** of the document to ensure that the quotes of the **NAFO Convention** fully respect the original text, and intent.

Update on NAFO Roadmap reference document

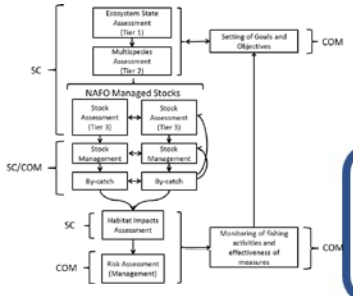
1st DRAFT
Revised by WGESA 2025

2nd DRAFT
WGESA

WP-SC June 2026 Meeting



What is the NAFO Roadmap ?



IDENTIFY FUNCTIONAL ECOSYSTEM UNIT

Tier 1 — **Productivity State Assessment**

Tier 2 — **Multispecies Assessment**

Tier 3 — **Stock Assessment**

HABITAT IMPACTS ASSESSMENT

- **Ecosystem Reference Point based on 2TCI**

- **Ecosystem Summary Sheet (ESS)**

Tier 1: Ecosystem Reference Point based on 2TCI

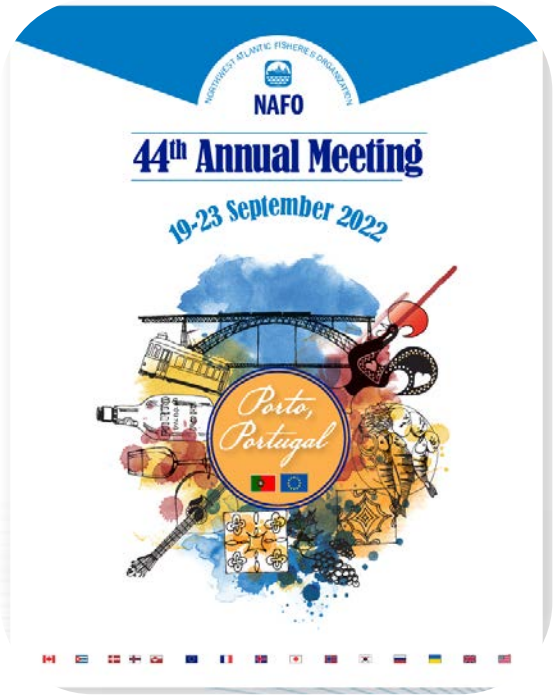
NAFO STATLANT 21A database

CATCH

TCI

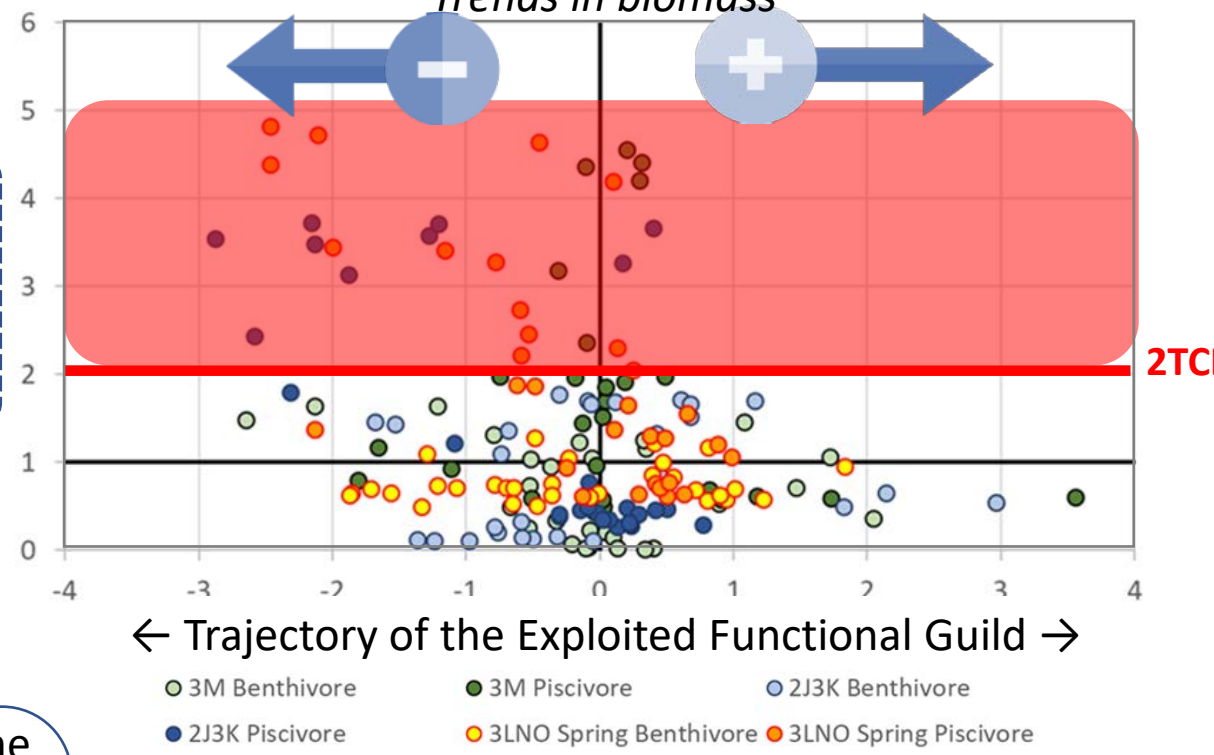
Catch/TCI (5 yr moving avg)

Estimation of the upper limit of sustainability



At the 2022 Annual Meeting, the Commission adopted the **"2TCI" as an ECOSYSTEM REFERENCE POINT** to **help inform management decisions** regarding the **potential risk of ecosystem overfishing.**

Trends in biomass



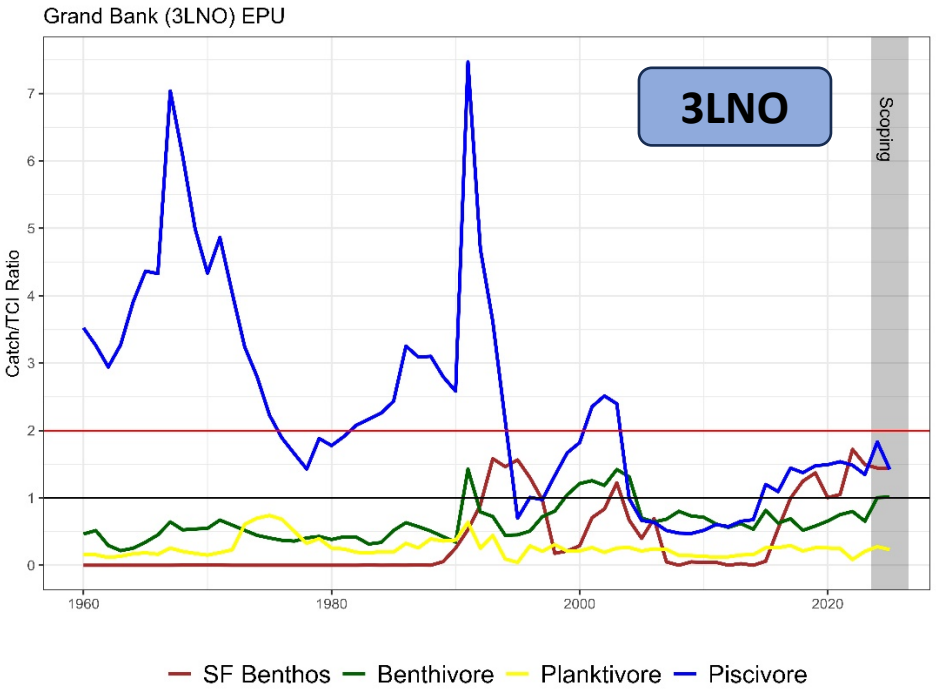
> 2

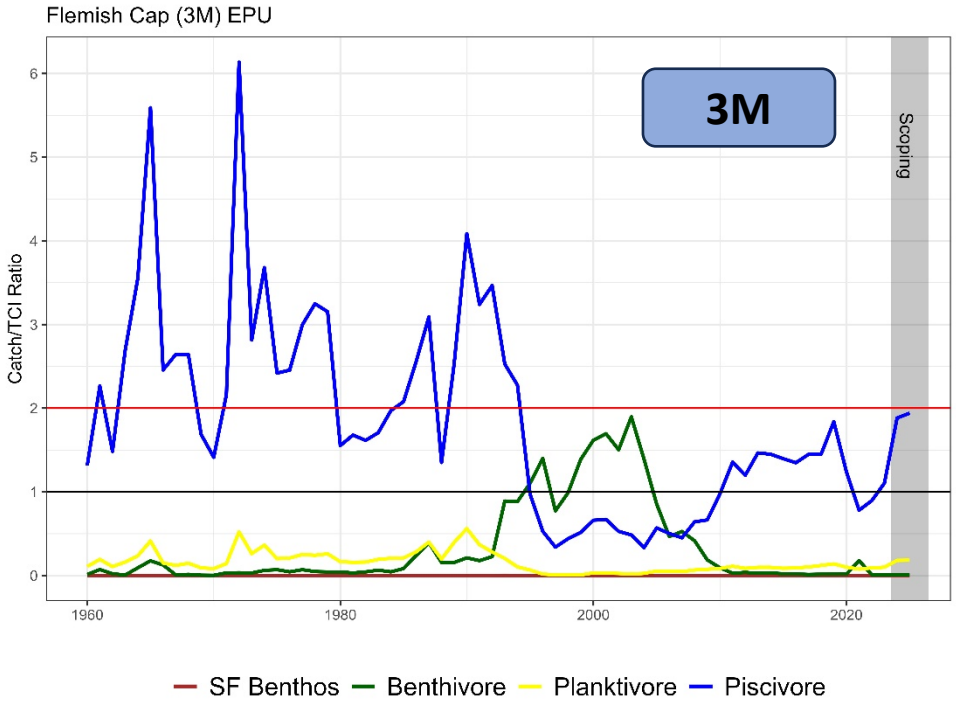
NEGATIVE trends in biomass

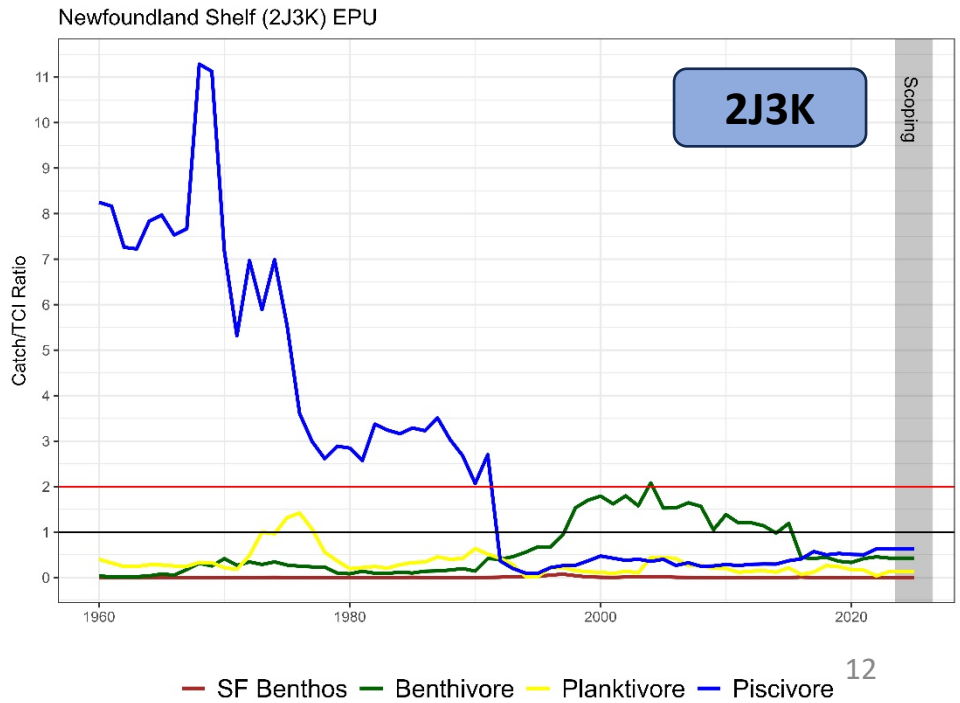
Ecosystem Overfishing

Catches and TCI ranges

- **All EPUs** have been **under ecosystem overfishing** conditions in the **past**.
- Since the **collapses** in the **1990s**, sustained catches **above 2TCI** have been **limited**, but have **happened**.
- In **recent times**, EPUs have typically been at an **intermediate risk of Ecosystem Overfishing**, but **creeping up in 3M** and **3LNO**.







Tier 1: Ecosystem Reference Point based on 2TCI

DFO CSRF Project (2025-2028)

Title: ***An Ecosystem Reference Point for the risk of ecosystem overfishing: Development of an operational framework for the regular delivery of Total Catch Index-related information within NAFO standard stock advice***

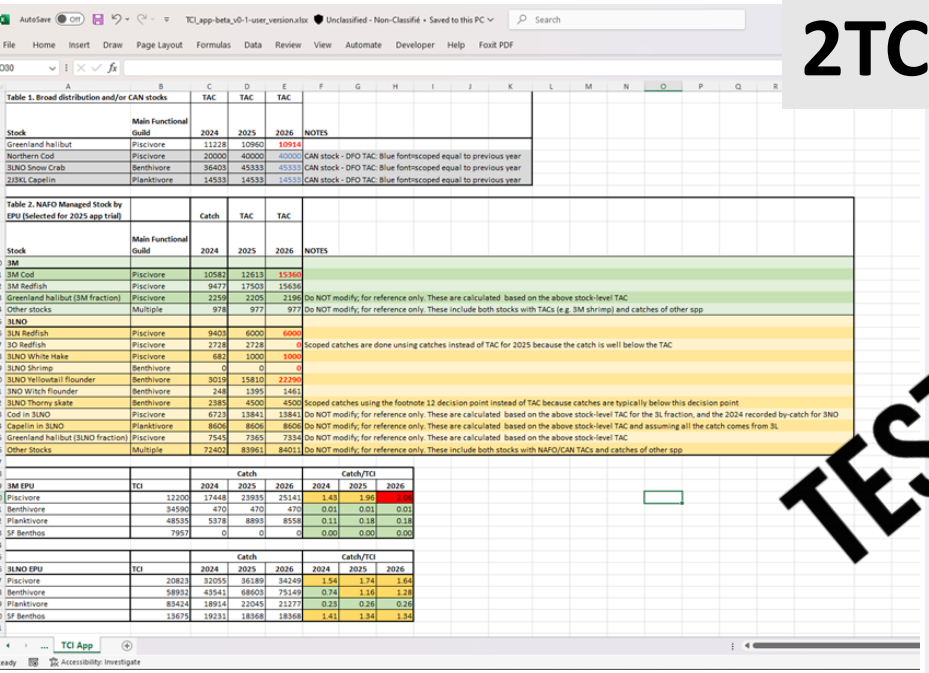


Table 1. Broad distribution and/or CAN stocks

Stock	Main Functional Guild	TAC 2024	TAC 2025	TAC 2026	NOTES
Greenland halibut	Piscivore	11228	10960	10914	
Northern Cod	Piscivore	20000	40000	40000	CAN stock - DFO TAC: Blue fontinscoped equal to previous year
3LNO Snow Crab	Benthivore	36403	45333	45333	CAN stock - DFO TAC: Blue fontinscoped equal to previous year
2J3KL Capelin	Planktivore	14533	14533	14533	CAN stock - DFO TAC: Blue fontinscoped equal to previous year

Table 2. NAFO Managed Stock by EPU (Selected for 2025 app trial)

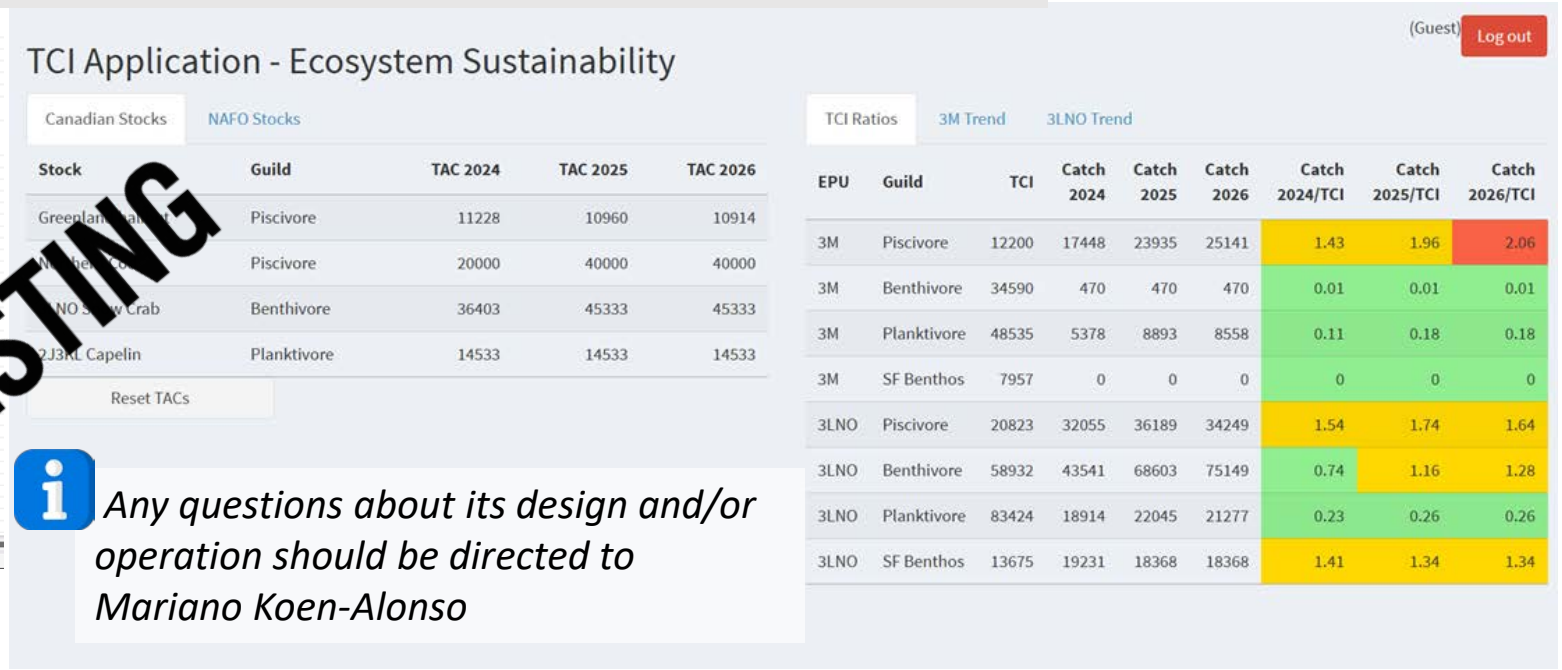
Stock	Main Functional Guild	Catch 2024	TAC 2025	TAC 2026	NOTES
3M					
3M Cod	Piscivore	10582	12613	15360	
3M Redfish	Piscivore	9477	17503	15636	
Greenland halibut (3M fraction)	Piscivore	2259	2205	2196	Do NOT modify; for reference only. These are calculated based on the above stock-level TAC
Other stocks	Multiple	978	977	977	Do NOT modify; for reference only. These include both stocks with TACs (e.g. 3M shrimp) and catches of other spp
3LNO					
3LN Redfish	Piscivore	9403	6000	6000	
3O Redfish	Piscivore	2728	2728	0	Scoped catches are done unsing catches instead of TAC for 2025 because the catch is well below the TAC
3LNO White Hake	Piscivore	682	1000	1000	
3LNO Shrimp	Benthivore	0	0	0	
3LNO Yellowtail flounder	Benthivore	8019	15810	22290	
3NO Witch flounder	Benthivore	248	1395	1461	
3LNO Thorny skate	Benthivore	2385	4500	4500	Scoped catches using the footnote 12 decision point instead of TAC because catches are typically below this decision point
Cod in 3LNO	Piscivore	6723	13841	13841	Do NOT modify; for reference only. These are calculated based on the above stock-level TAC for the 3L fraction, and the 2024 recorded by-catch for 3NO
Capelin in 3LNO	Planktivore	8606	8606	8606	Do NOT modify; for reference only. These are calculated based on the above stock-level TAC and assuming all the catch comes from 3L
Greenland halibut (3LNO fraction)	Piscivore	7545	7365	7334	Do NOT modify; for reference only. These are calculated based on the above stock-level TAC
Other Stocks	Multiple	72402	83961	84011	Do NOT modify; for reference only. These include both stocks with NAFO/CAN TACs and catches of other spp

3M EPU	TCI	Catch 2024	Catch 2025	Catch 2026	Catch/TCI 2024	Catch/TCI 2025	Catch/TCI 2026
Piscivore	12200	17448	23935	25141	1.43	1.96	2.06
Benthivore	34590	470	470	470	0.01	0.01	0.01
Planktivore	48535	5378	8893	8558	0.11	0.18	0.18
SF Benthos	7957	0	0	0	0.00	0.00	0.00

3LNO EPU	TCI	Catch 2024	Catch 2025	Catch 2026	Catch/TCI 2024	Catch/TCI 2025	Catch/TCI 2026
Piscivore	20823	32055	36189	34249	1.54	1.74	1.64
Benthivore	58932	43541	68603	75149	0.74	1.16	1.28
Planktivore	83424	18914	22045	21277	0.23	0.26	0.26
SF Benthos	13675	19231	18368	18368	1.41	1.34	1.34

TCI App

2TCI Checking Tool for managers



TESTING

Any questions about its design and/or operation should be directed to Mariano Koen-Alonso

Initial App Version <u>intended</u> to be available for Managers at the 2026 NAFO Annual Meeting

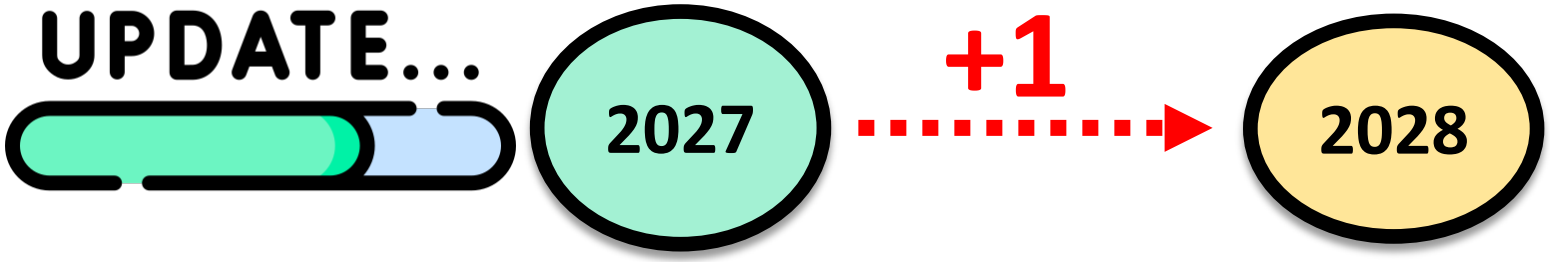
<u>Intended</u> to help managers to evaluate if a given set of TACs under consideration may lead to exceed the 2TCI Ecosystem Reference Point

Tier 1: Ecosystem Summary Sheet (ESS)

Grand Bank (3LNO)

Flemish cap (3M)

Update every 5 years with interim monitoring in the intervening years



<u>2024-2025</u>
Not meet the "significant ecological changes" criterion

Detection of "***significant ecological changes***"

a) trends in ocean climate and oceanographic features

b) trends and structure of the fish community and

c) trends in trophic relationships

1

NAFO Roadmap

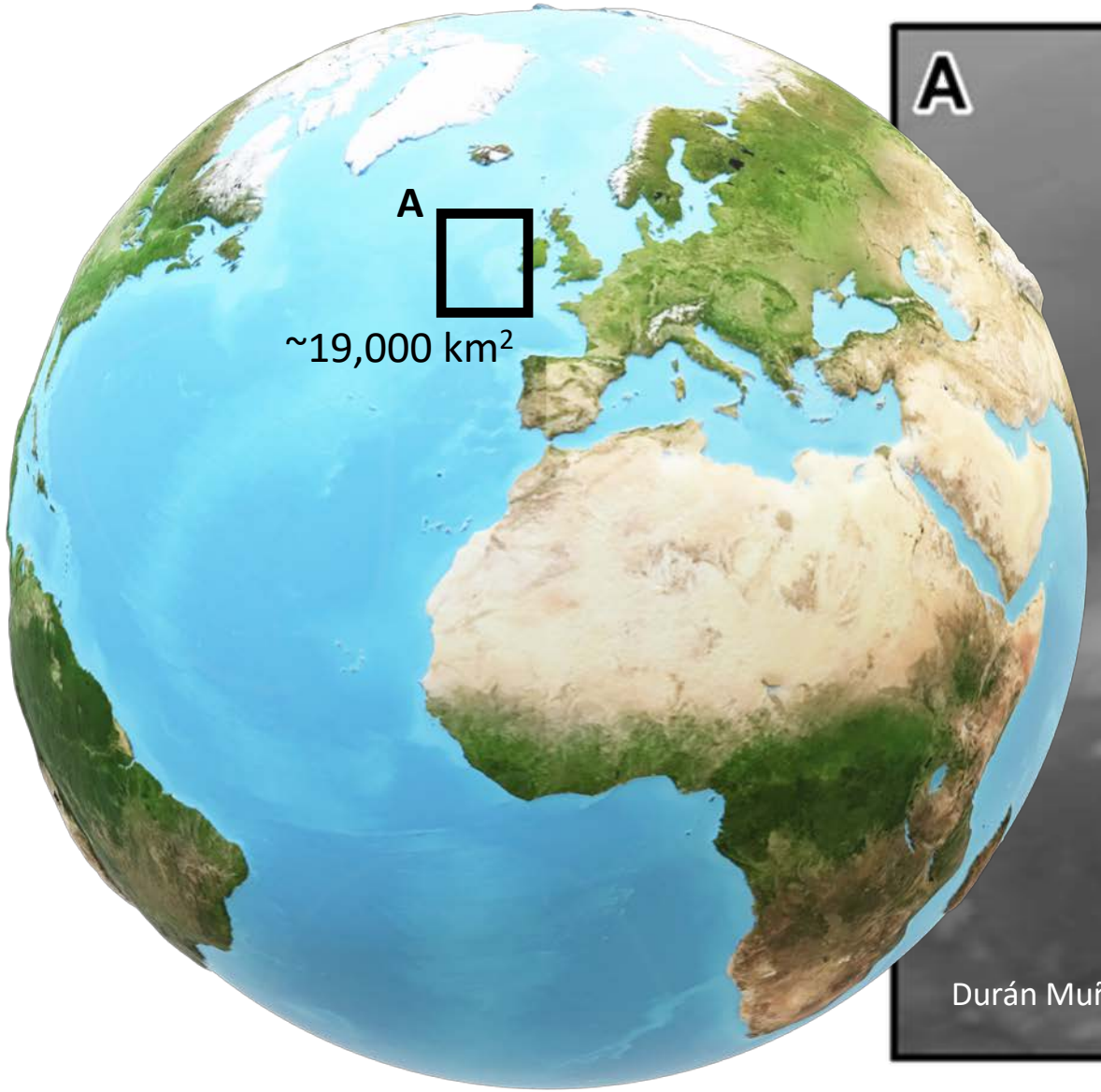
2

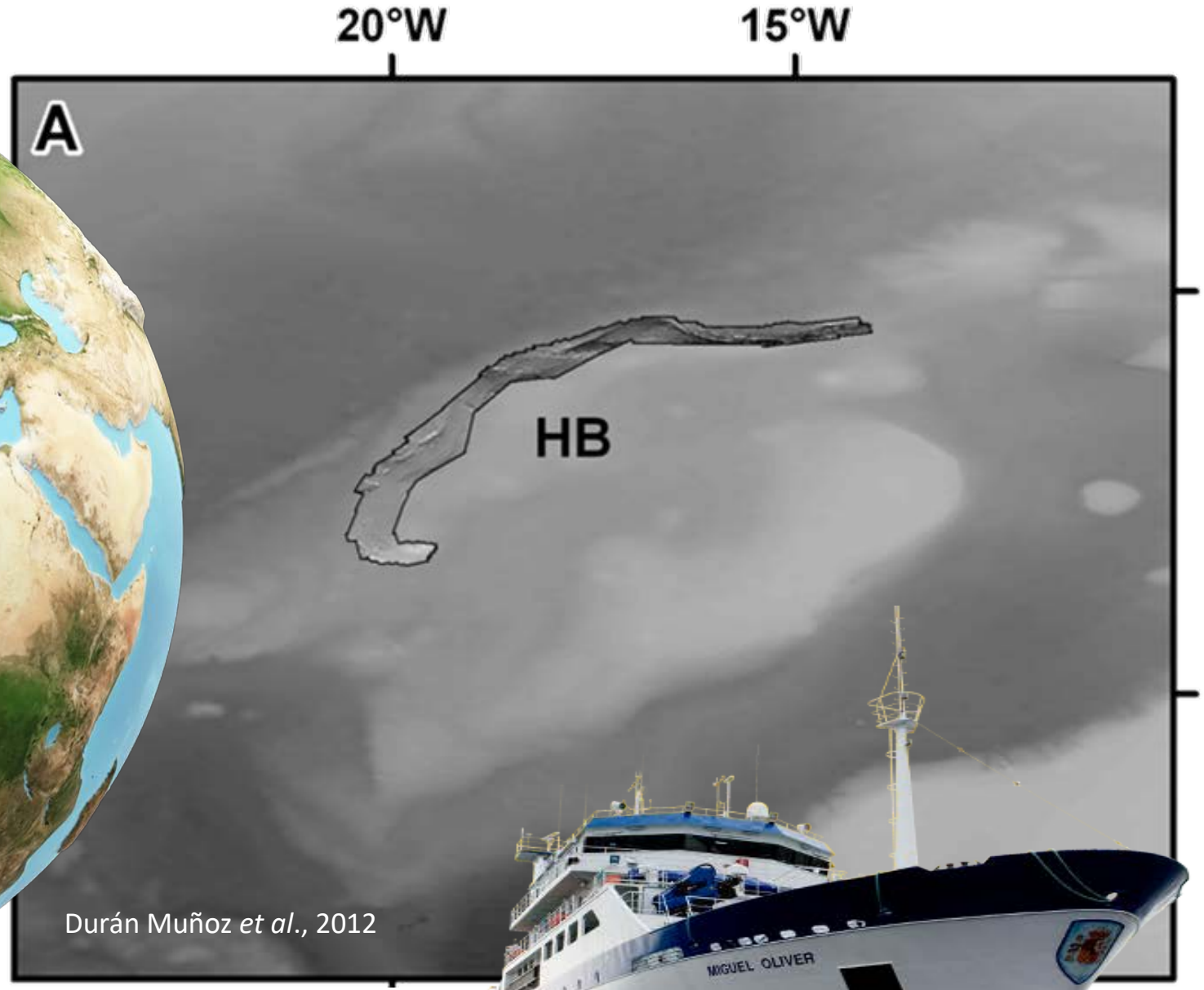
VMEs and impact of bottom fisheries


Image Credit: NOAA Ocean Exploration

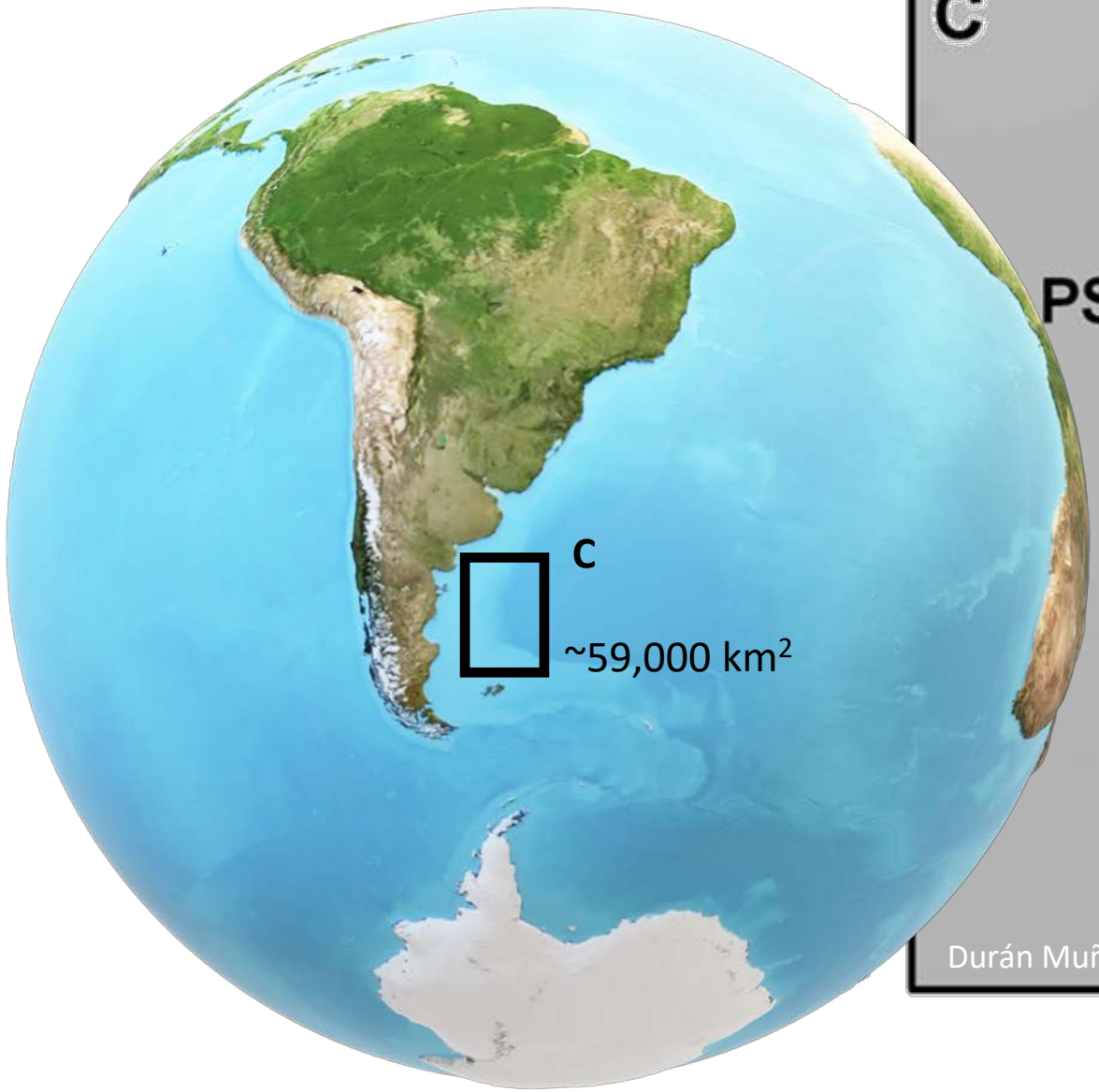
The UNGA urges the **protection** of vulnerable marine ecosystems on the high seas.

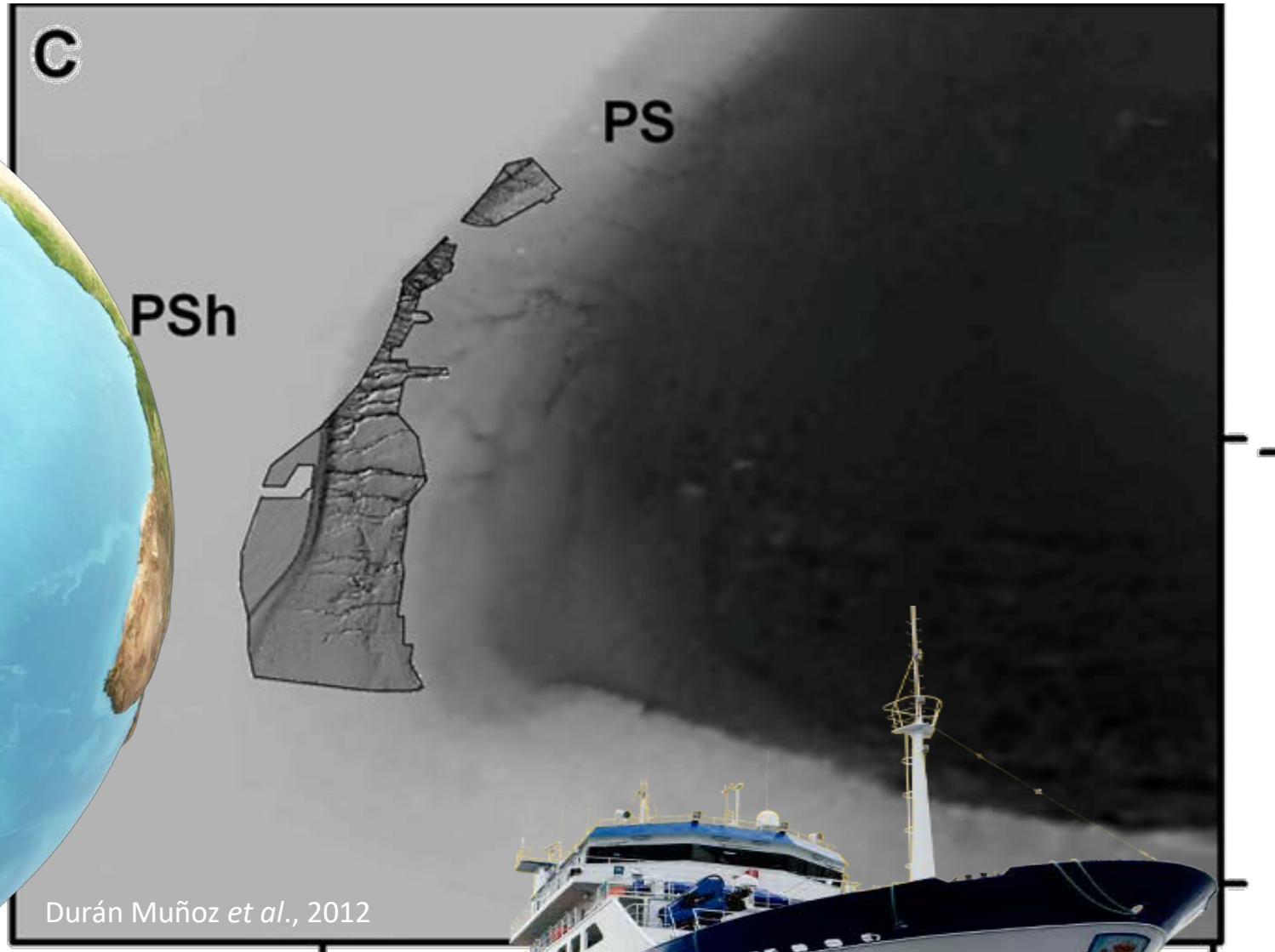
Resolution 61/105


A
~19,000 km²

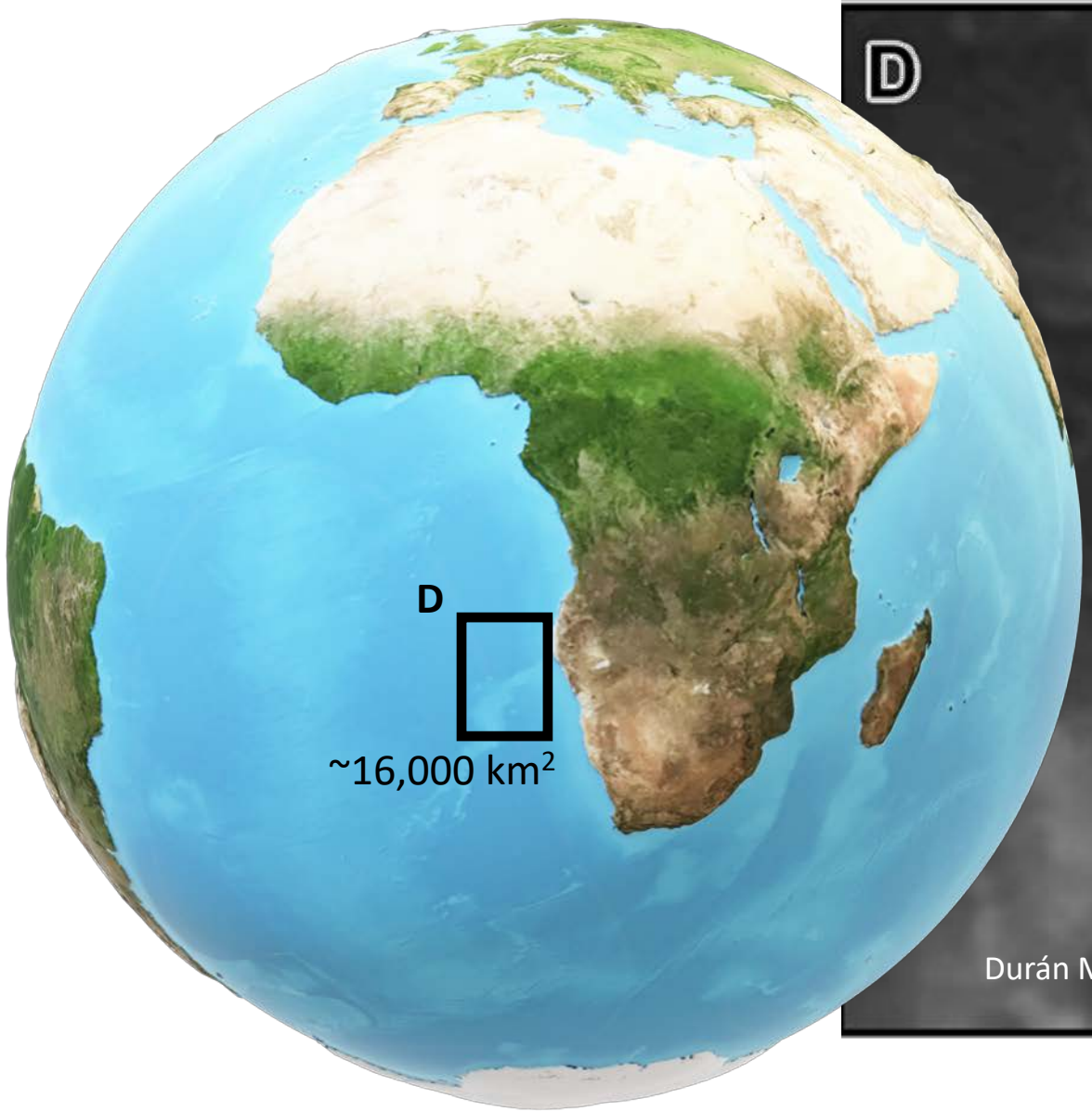

20°W
15°W
A
HB
60°N
55°N
Durán Muñoz *et al*., 2012

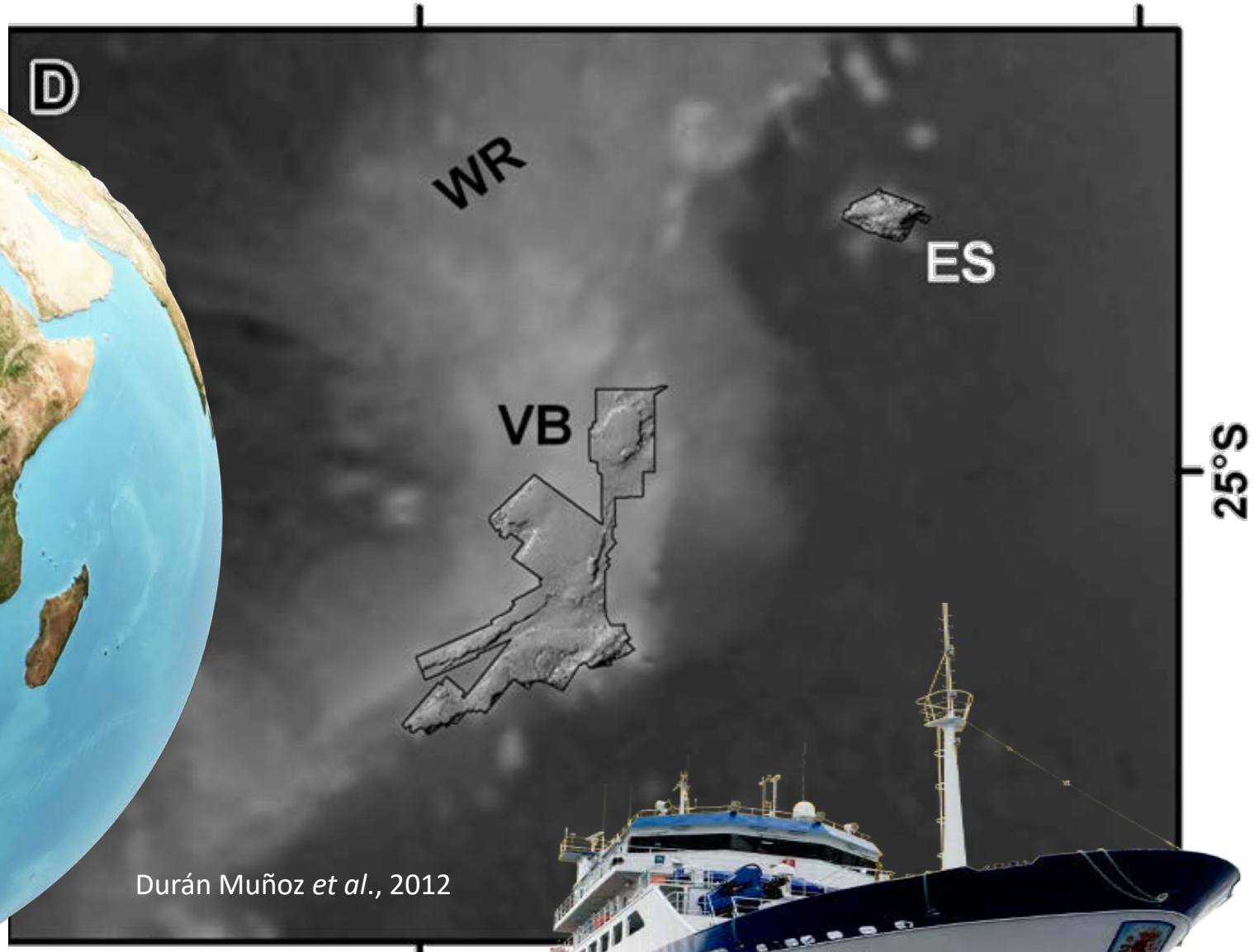

MIGUEL OLIVER


C
~59,000 km2

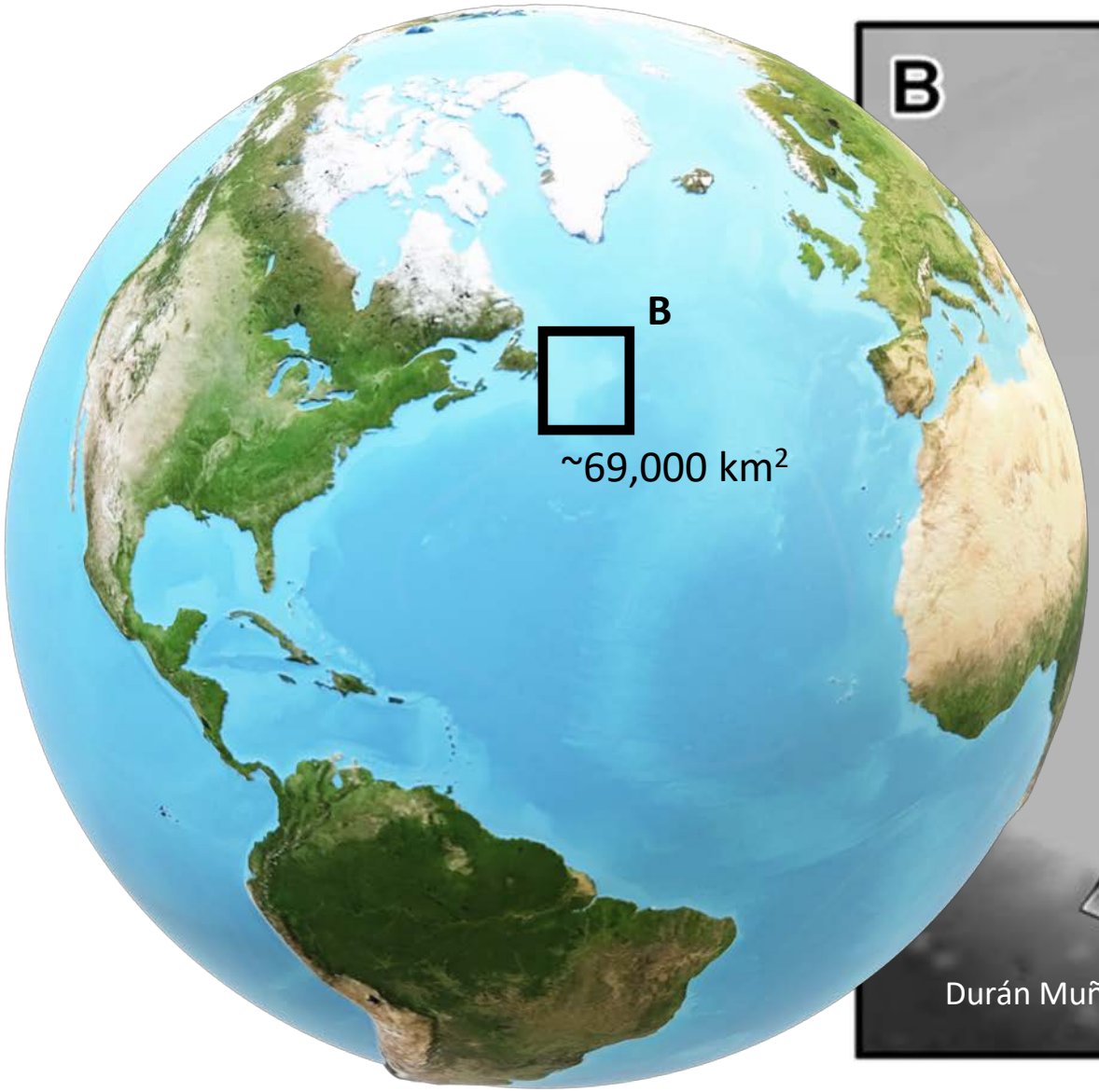

C
PS
PSh
Durán Muñoz *et al*., 2012
60°W
50°W

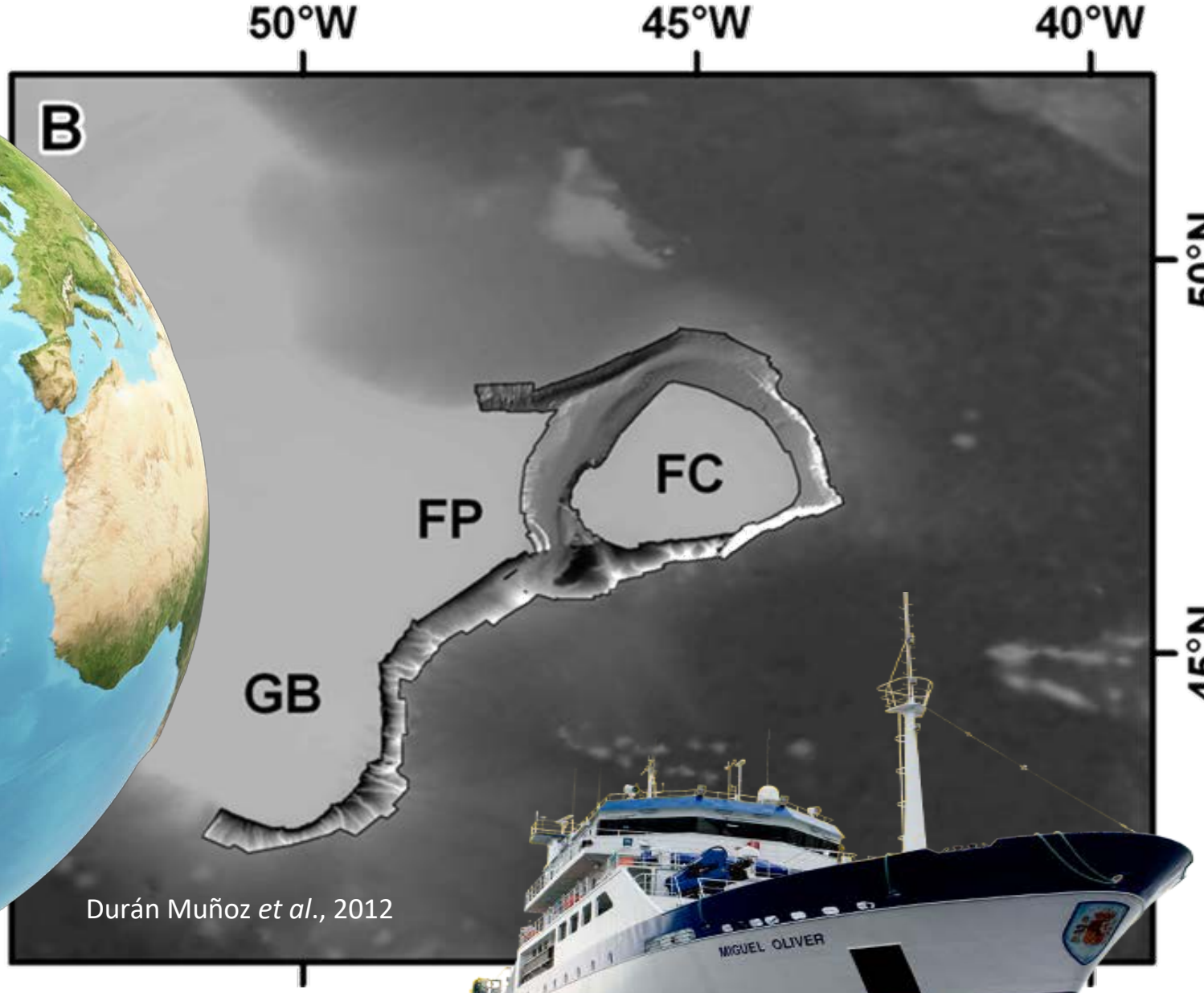

MIGUEL OLIVER


D
~16,000 km²


D
WR
ES
VB
25°S
5°E
Durán Muñoz *et al*., 2012


MIGUEL OLIVER


B
~69,000 km²


50°W
45°W
40°W
B
50°N
45°N
FC
FP
GB
Durán Muñoz *et al*., 2012

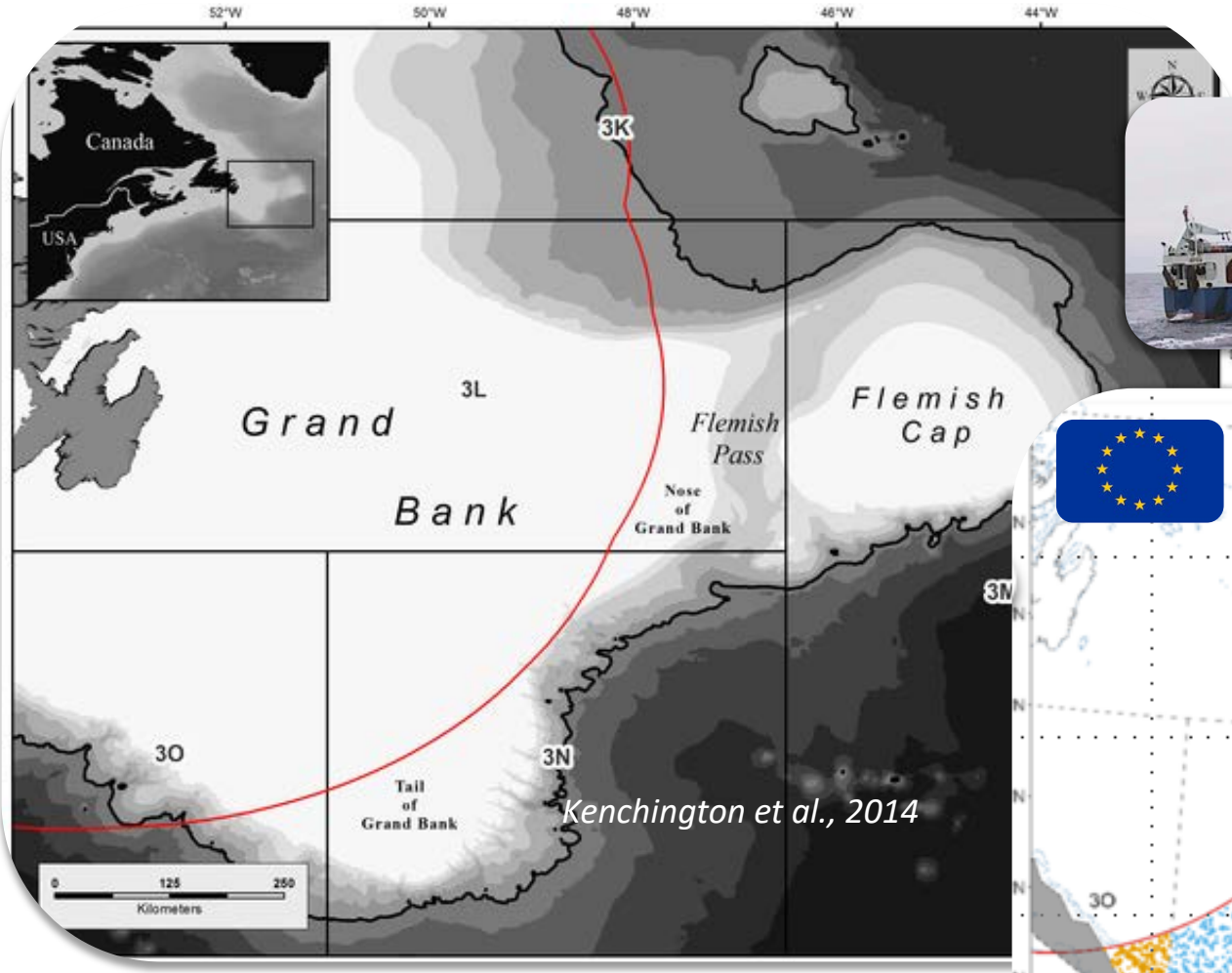

MIGUEL OLIVER

Vulnerable Marine Ecosystems (VMEs)

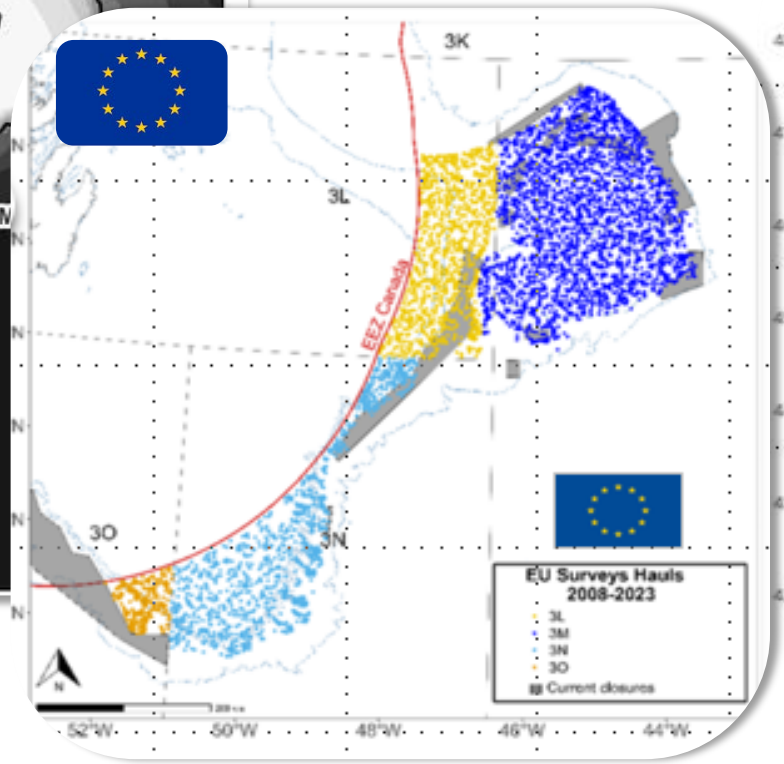
Northwest Atlantic Fisheries Organization

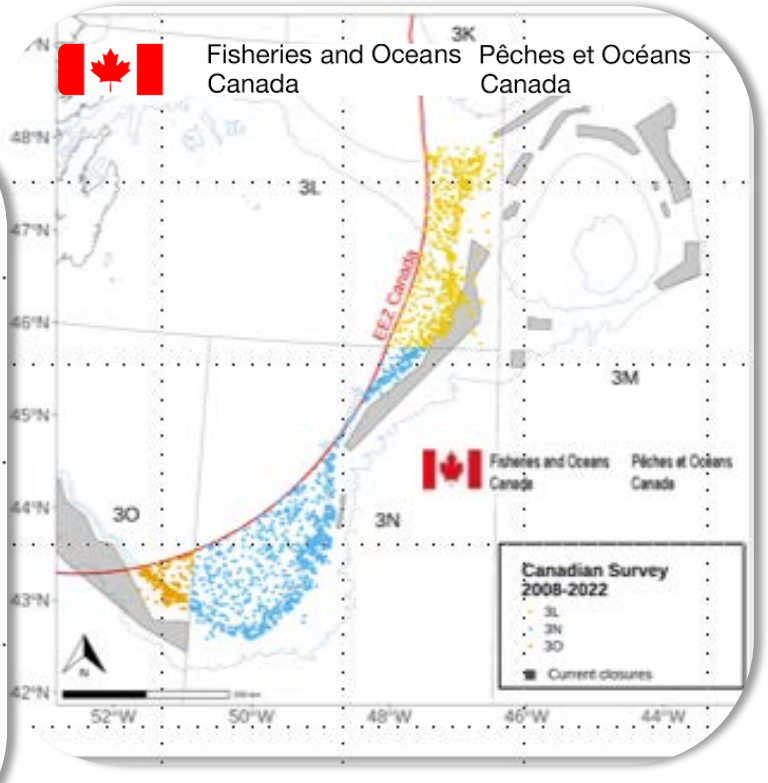
R/V groundfish surveys

VME Indicator species catches



Kenchington et al., 2014





Review of VMEs

Northwest Atlantic Fisheries Organization

VME indicator taxa

- Black Corals
- Small Gorgonians
- Large Gorgonians
- Large Sponges
- Sea Pens
- Sea Squirts
- Bryozoans

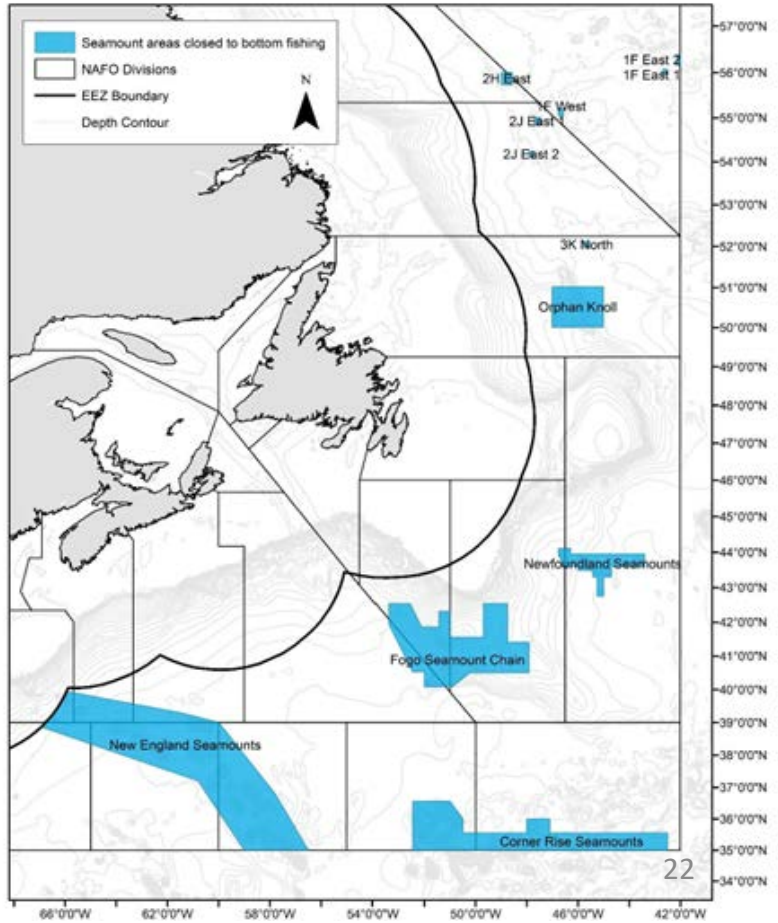
1 **Kernel Density Analysis**
Identification of significant concentrations of VME indicator species from survey data

2 **Species Distribution modeling**
Predict species distribution using environmental variables.

VME indicator elements

12 seamount areas

New England, Corner Rise, Fogo and Newfoundland Seamount Chains, the Orphan Knoll and a cluster of 7 individual seamounts in the northern part of the NRA



Significant impact assessment (SAI) on VMEs

1st SAI Assessment 2016

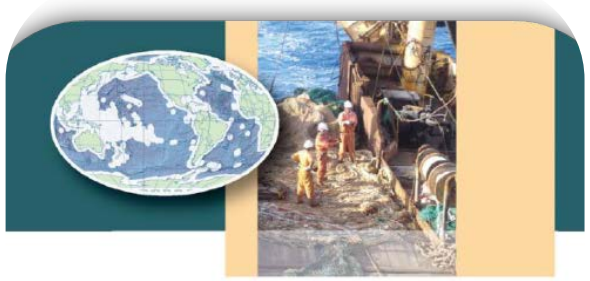
SCS Doc. 16-14 REV

2nd SAI Assessment 2021

SCS Doc. 20-23
SCS Doc. 21-14 REV

3rd SAI Assessment 2027

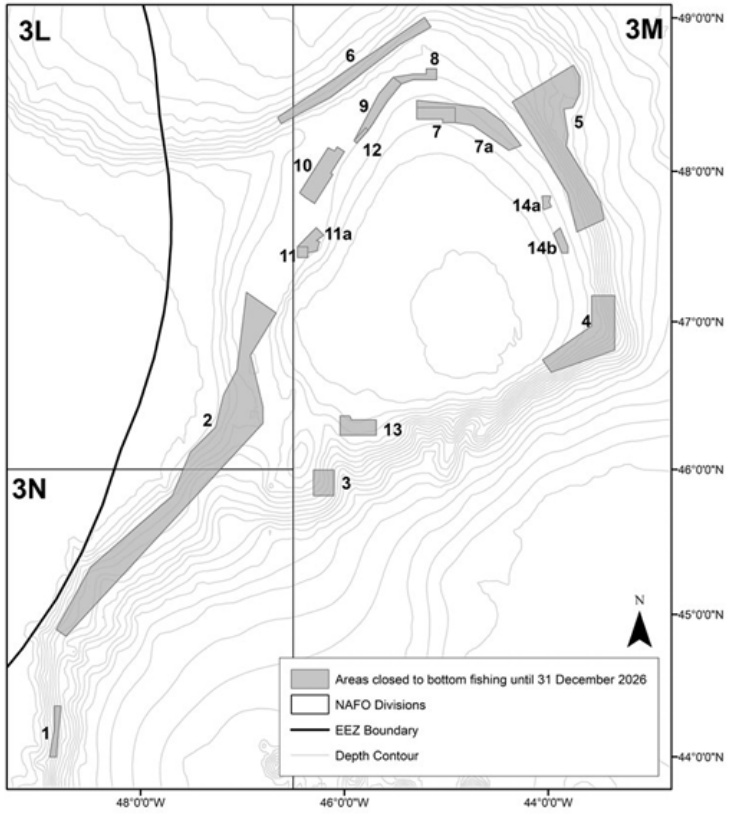
SCS Doc. 25-XX
In progress



INTERNATIONAL GUIDELINES
FOR THE MANAGEMENT OF DEEP-SEA FISHERIES
IN THE HIGH SEAS

DIRECTIVES INTERNATIONALES
SUR LA GESTION DE LA PÊCHE PROFONDE
EN HAUTE MER

DIRECTRICES INTERNACIONALES
PARA LA ORDENACIÓN DE LAS PESQUERÍAS
DE AGUAS PROFUNDAS EN ALTA MAR



Northwest Atlantic Fisheries Organization

Conservation and Enforcement Measures 2026

Until 31 December 2026, no vessel shall engage in bottom fishing activities in areas 1-14b

Polygons Delineating VME Area Closures.

Significant impact assessment (SAI) on VMEs

Same approach as 2021

3rd SAI Assessment 2027

DATA LAYERS

- **VMS Fishery Data**
  2011 to 2024 effort as tracks
- **Integrated VMS and Log-Book Data**
  Catch and landings data from 2016 to 2024.
- **Updated VME Biomass Grid**
- **Updated VME Polygons**

Trade-off Analysis
Maximize VME biomass protection
Minimize impact on bottom fisheries

Information on the Ecological significance of the proposed closures

1. Proposed area climate sensitivity, refugia status and connectivity

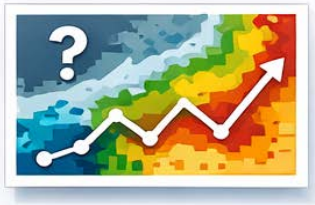
2. Longer-term fishing patterns in the NRA

What is being done by NAFO SC (WGESA) ?

REVIEW OF VMEs

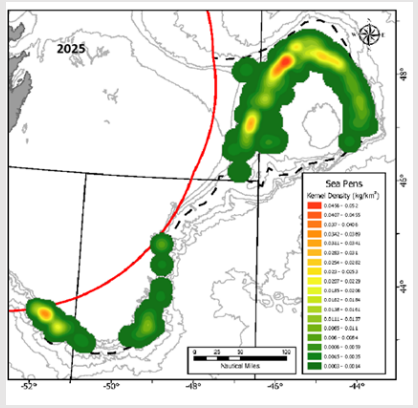
1. **Up-date VME Species Distribution Models (SDMs) and Kernel Density Analyses (KDE)** on the 7 VME functional groups with the addition of subgroups of some of these functional groups which have sufficient data to warrant their independent analyses.

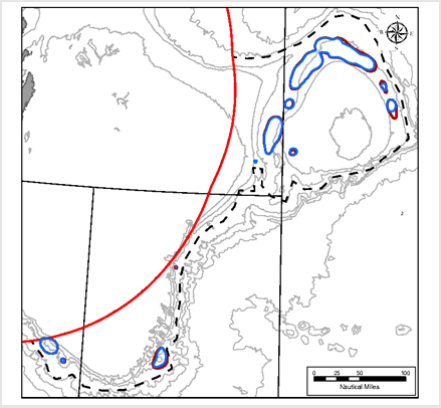
2. **Creation of new SDM predictions** for each taxon and for the first time inclusion of model uncertainty maps.

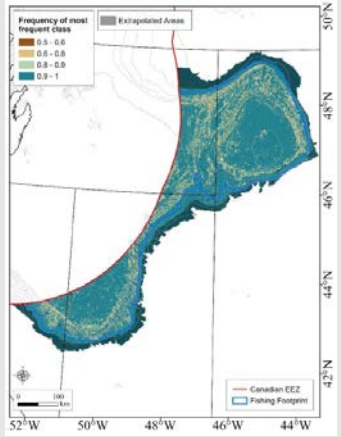


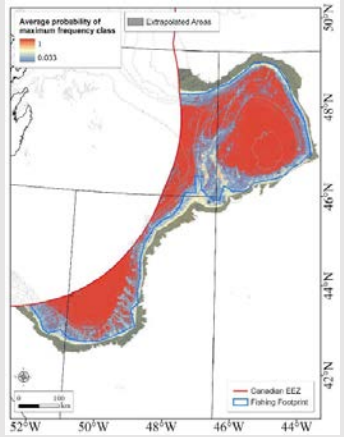
3. **For November 2026, SDMs** using climate projection data will be performed to determine if and where there are VME refugia in response to climate change, and identify vulnerable taxa and closures.

Examples of SDMs, KDE and uncertainty maps









Related NAFO Scientific Contributions

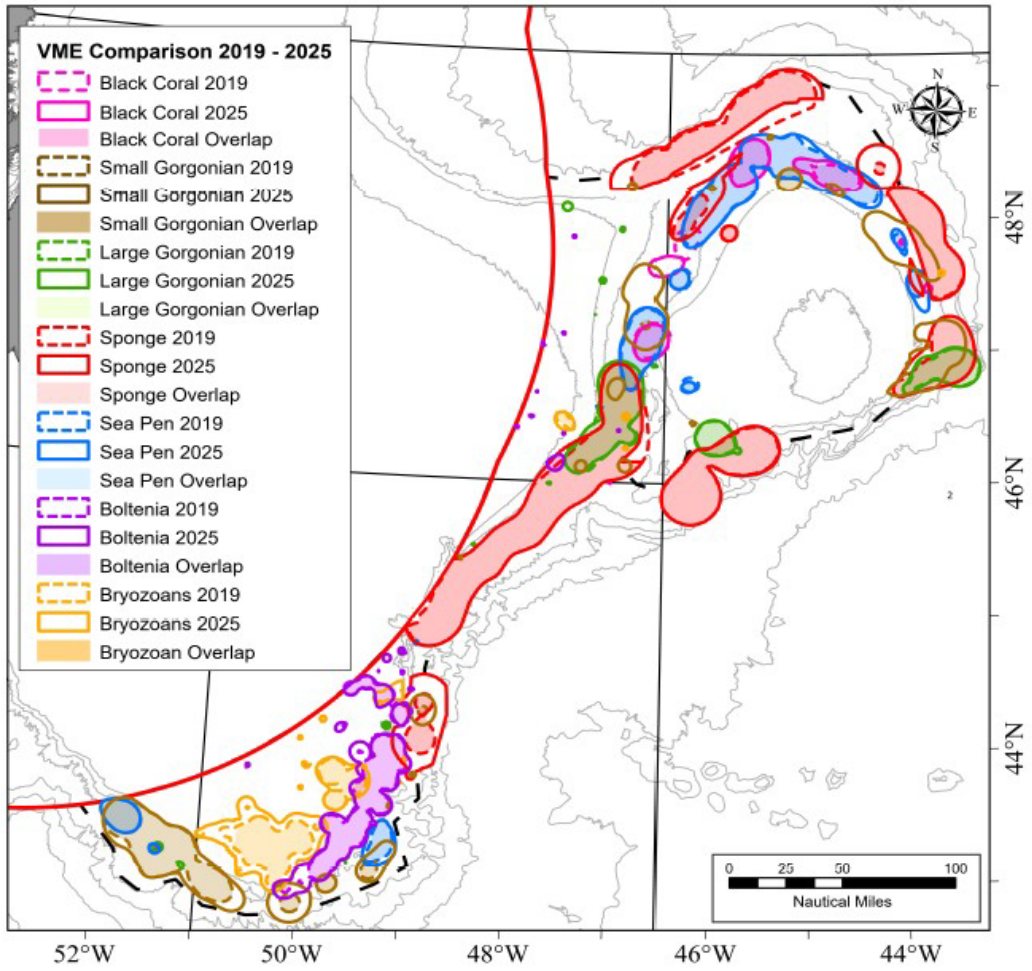
SCR 25/035 – *Updated SDM of VME Indicators*
SCR 25/036 – *Updated KDE of VME Indicators*

Location of VME Indicator taxa

Identification of Vulnerable Marine Ecosystems in the NAFO Regulatory Area Combining Kernel Density Analyses, Species Distribution Modeling and Empirical Data

by

E. Kenchington[1], C. Lirette[1], M. Sacau[2], F.J. Murillo[1], and Z. Wang[1]



SCR 25/047

Identification of VME polygons combining KDE and SDM

	Review KDE VME polygons (Kenchington et al., 2025) with their associated SDMs (Murillo et al., 2024; 2025) • Identify polygons that cross into the Canadian EEZ • Identify polygons that have large overlap with areas of predicted absence
	Zoom in on identified polygons and evaluate uncertainty in the SDM models • Identify polygons that overlap with areas where there is a high probability of predicted absence
	Propose modifications to the VME polygons • Clip polygon edges to areas where there is a high probability of predicted presence • Clip polygon edges to the border with the Canadian EEZ
	Map the proposed modifications to the VME polygons • Map the locations of the VME polygons including ones that have been modified and ones that have not • Calculate the area of each polygon
	Document decisions • Document the changes and the rationale followed in making the modifications
	How are decisions made? • Decisions are made by balancing empirical evidence with predictive models

1 NAFO Roadmap

2 VMEs and impact of bottom fisheries

3 **Activities other than fishing**

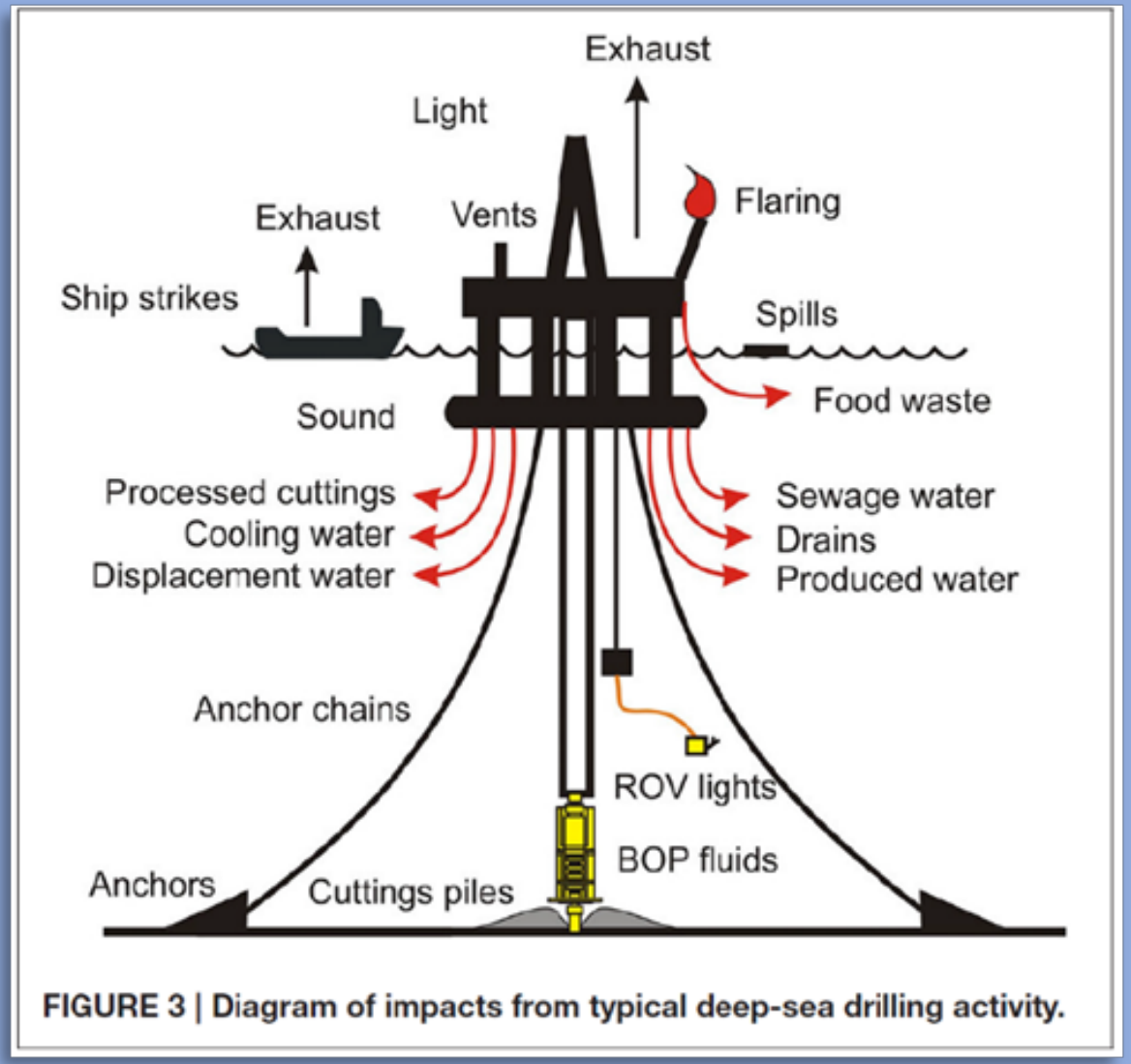


FIGURE 3 | Diagram of impacts from typical deep-sea drilling activity.

Cordes *et al*. (2016)

VIGO

CSIC

mar.sacau@ieo.csic.es

We would like to express our gratitude to the crews of the research vessels, and to the staff participating in the NAFO Groundfish Surveys. The data collection of the EU Groundfish Surveys has been funded by the EU through the European Maritime, Fisheries and Aquaculture Fund (EMFAF) within the Spanish Work Plan for the collection of data in the fisheries and aquaculture sectors in relation to the Common Fisheries Policy. This document reflects only the views of the authors, and the EU is not responsible for any use that may be made of the information contained herein.