JOINT RAC FOCUS GROUP ON DEEP-SEA HABITATS AND SPECIES. CNPMEM (Paris)

21 November 2012

Seabed mapping for identification of VMEs in the high seas:

Contribution to the management of deep-sea fisheries in the north Atlantic

Pablo Durán Muñoz[1] & Mar Sacau[2]

ECOVUL/ARPA[1], NEREIDA[2] Projects

Instituto Español de Oceanografía

Programa de Pesquerías Lejanas

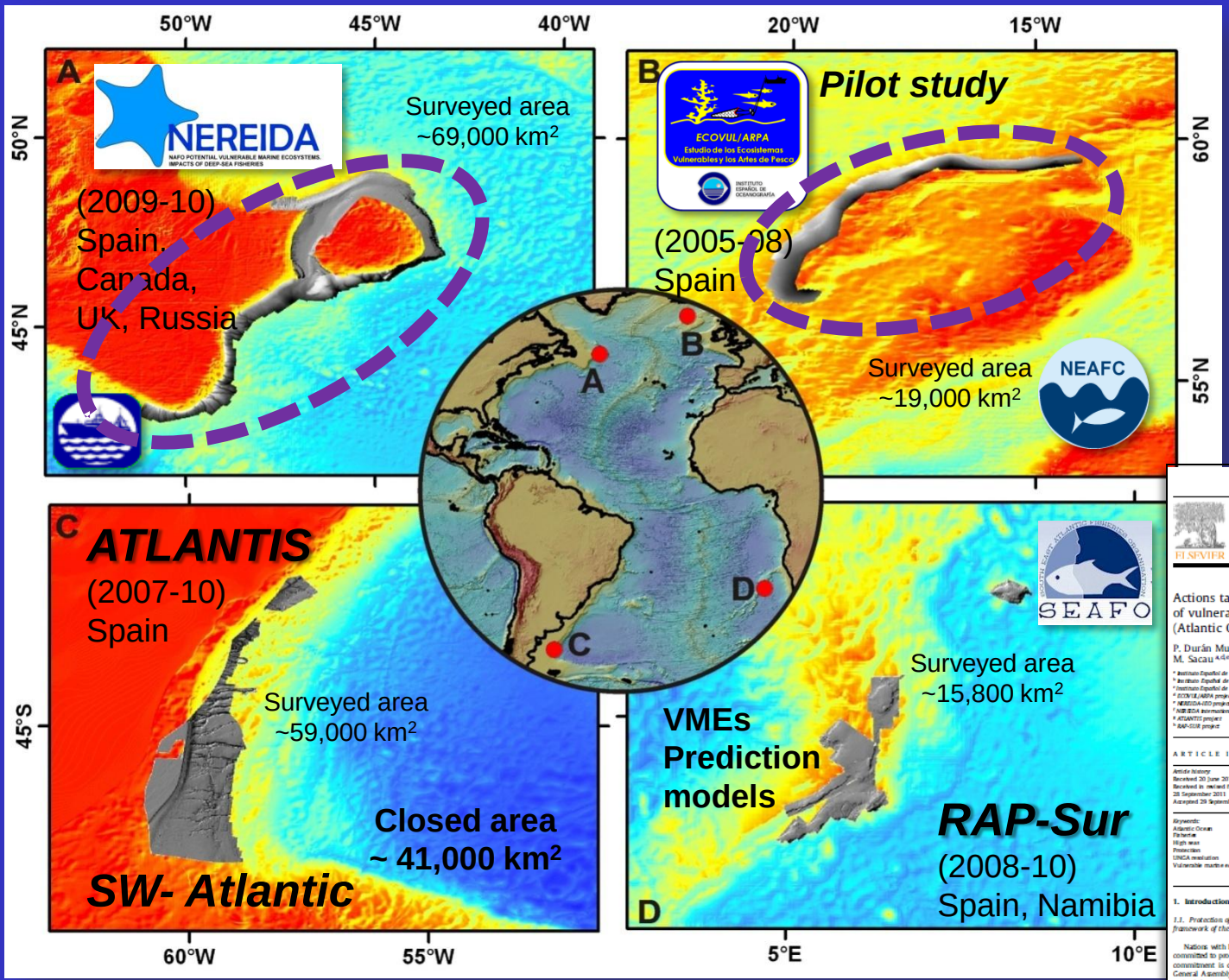
Centro Oceanográfico de Vigo

ESPAÑA

GOBIERNO DE ESPAÑA
MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD
INSTITUTO ESPAÑOL DE OCEANOGRAFÍA

INTRODUCTION: Recent surveys

INSTITUTO ESPAÑOL DE OCEANOGRAFÍA



Source: Weaver *et al.*, 2011

4 projects focused on high seas fisheries

Marine Policy 36 (2012) 536–543

Contents lists available at SciVerse ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

Actions taken by fishing Nations towards identification and protection of vulnerable marine ecosystems in the high seas: The Spanish case (Atlantic Ocean)

P. Durán Muñoz[a,d,e,*], M. Sayago-Gil[b,d], F.J. Murillo[a,d,e,f], J.L. Del Río[a,g], L.J. López-Abellán[c,h], M. Sacau[a,d,e,f,g], R. Sarralde[c,h]

ARTICLE INFO

ABSTRACT

1. Introduction

1.1. Protection of vulnerable marine ecosystems within the framework of the United Nations

1.2. Spanish research on VMEs and international collaboration

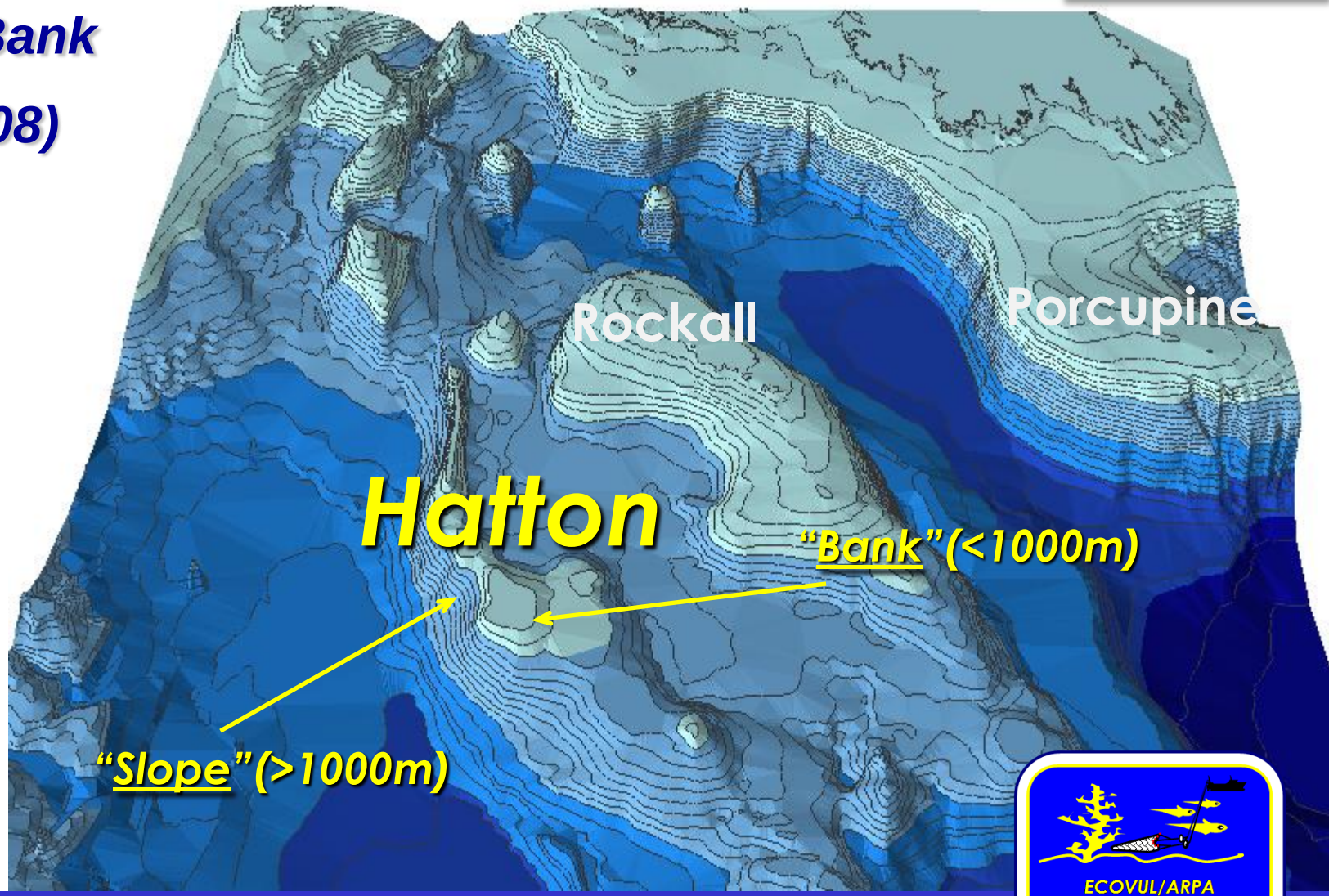
UNGA resolution 66/68 (2011): Recognized the utility of the seabed mapping programmes (paragraph 131)!!

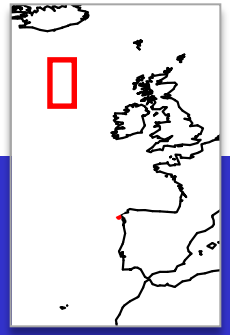
ECOVUL/ARPA: Study area

Hatton Bank

(2005-2008)

N





NE Atlantic

High seas (NEAFC Regulatory Area)

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ECOVUL/ARPA
Estudio de los Ecosistemas Vulnerables y los Artes de Pesca

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MULTIDISCIPLINARY PILOT STUDY

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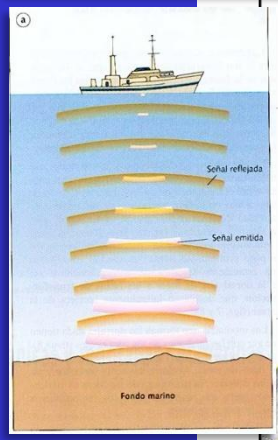
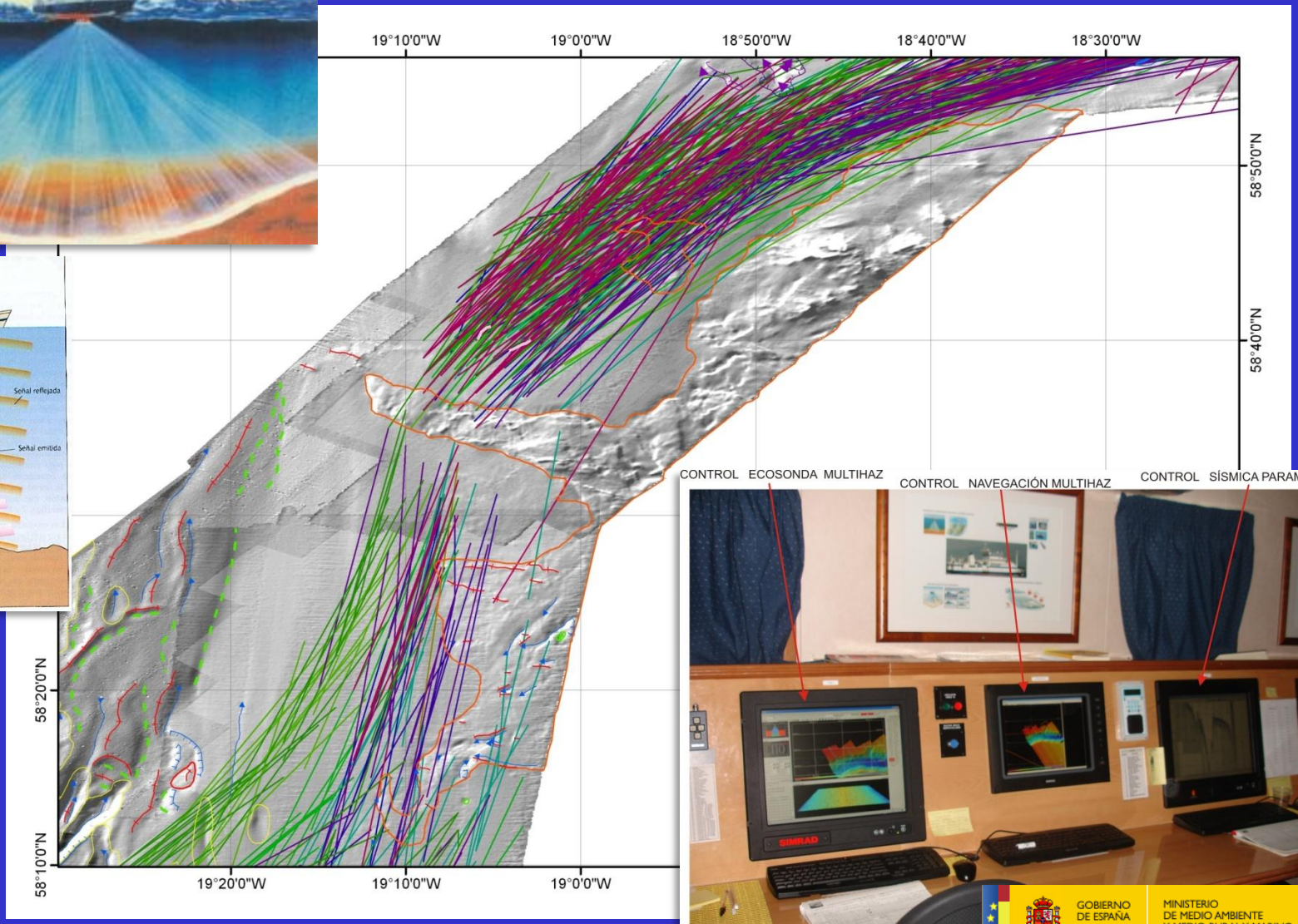


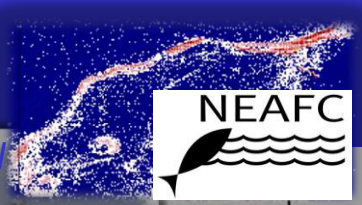


MULTIDISCIPLINARY PILOT STUDY

INSTITUTO ESPAÑOL DE OCEANOGRAFÍA

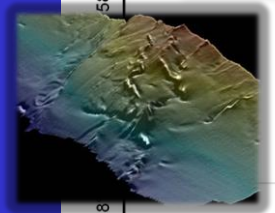
Observers (1996-2006)

Graphics of VMS



Commercial trawl

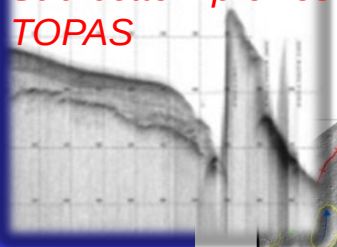
Commercial longline



Multibeam

Three cooperative surveys (2005-2008)

Sub-bottom profiles TOPAS



Dredge

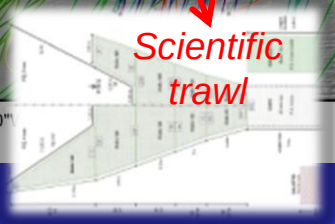
GOBIERNO DE ESPAÑA

MINISTERIO DE MEDIO AMBIENTE Y MEDIO RURAL Y MARINO

Boxcorer

Three multidisciplinary surveys (2005-2007)

Scientific trawl



ECOVUL/ARPA: Fishery footprint?

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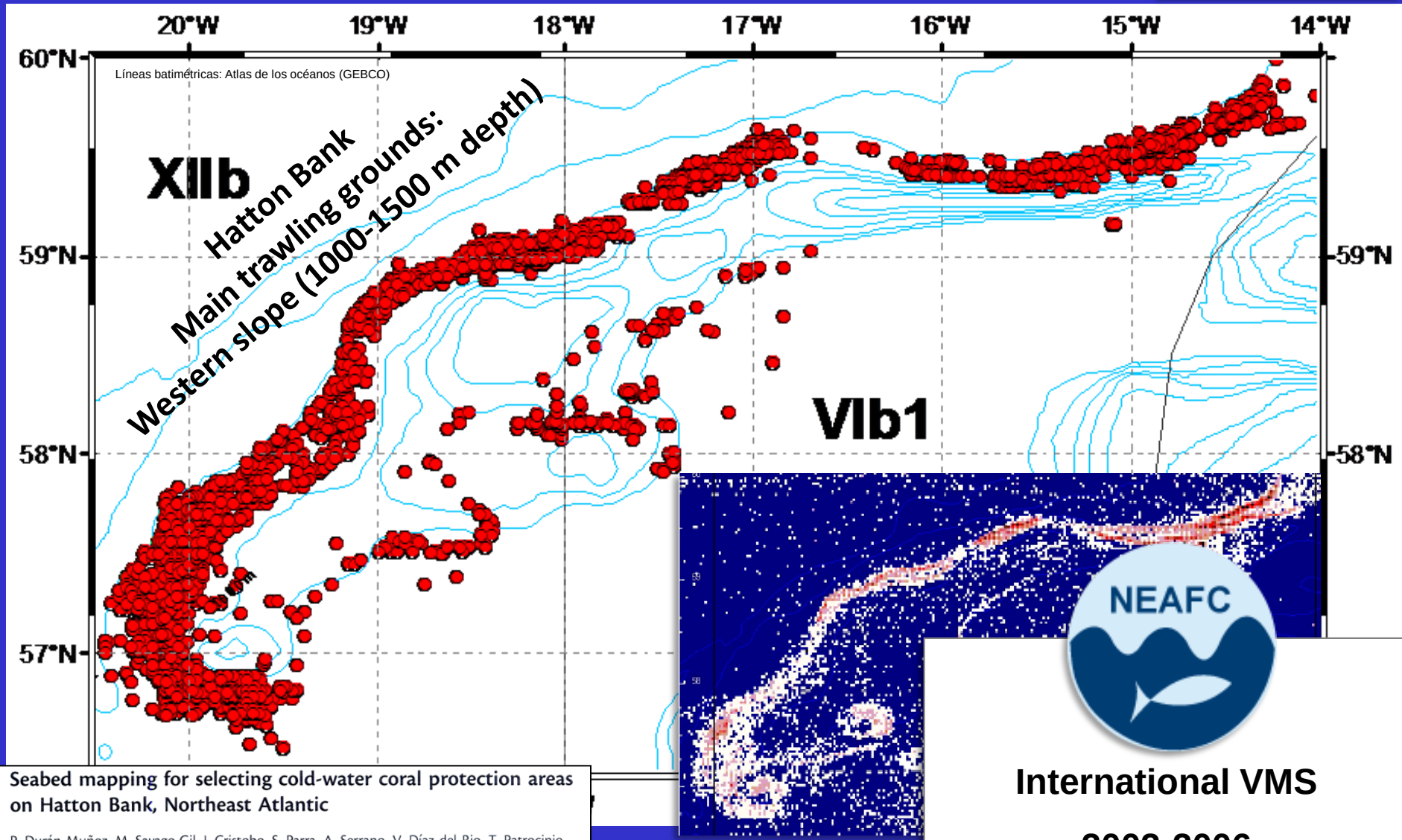


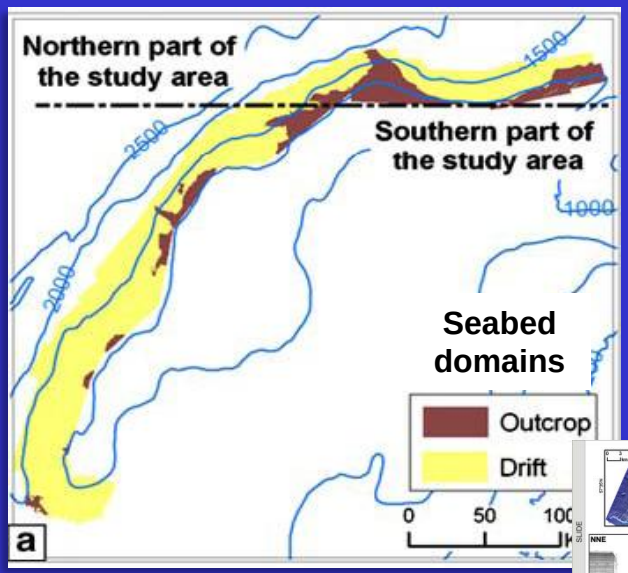
Seabed mapping for selecting cold-water coral protection areas on Hatton Bank, Northeast Atlantic

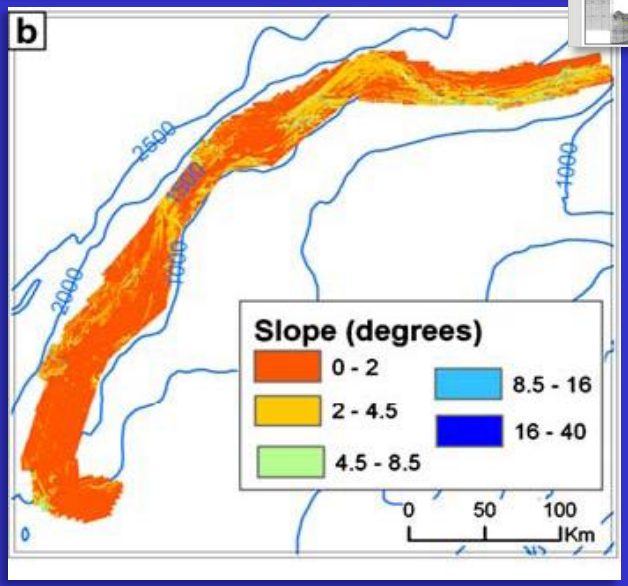
P. Durán Muñoz, M. Sayago-Gil, J. Cristobo, S. Parra, A. Serrano, V. Díaz del Rio, T. Patrocinio, M. Sacau, F. J. Murillo, D. Palomino, and L. M. Fernández-Salas

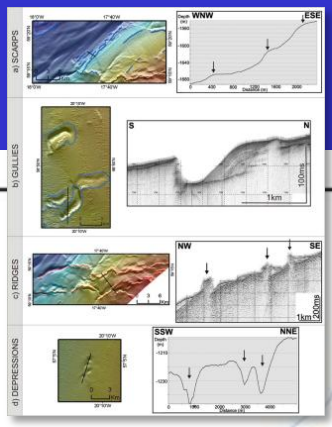
Durán Muñoz, P., Sayago-Gil, M., Cristobo, J., Parra, S., Serrano, A., Díaz del Rio, V., Patrocinio, T., Sacau, M., Murillo, F. J., Palomino, D., and Fernández-Salas, L. M. 2009. Seabed mapping for selecting cold-water coral protection areas on Hatton Bank, Northeast Atlantic. – ICES Journal of Marine Science, 66: 2013–2025.

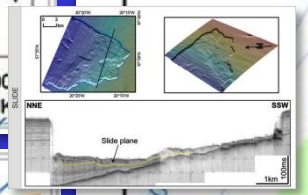
Research into vulnerable marine ecosystems (VMEs) on the high seas and the impacts of bottom fishing and *ad hoc* management measures are high priority today thanks to UN General Assembly Resolution 61/105. An interdisciplinary methodology (specifically

ECOVUL/ARPA: Seabed?









Features

Geo-Mar Lett
DOI 10.1007/s00367-009-0163-5

ORIGINAL

Evidence for current-controlled morphology along the western slope of Hatton Bank (Rockall Plateau, NE Atlantic Ocean)

Miriam Sayago-Gil · David Long · Kenneth Hitchen · Víctor Díaz-del-Río · Luis Miguel Fernández-Salas · Pablo Durán-Muñoz

Received: 20 March 2009 / Accepted: 26 August 2009

Abstract A multibeam bathymetric and high- (airgun and sparker) to very high-resolution (Topas) seismic study of sediment waves, edges of contourite deposits, p deposits, scarps, gullies, ridges, depressions, slide

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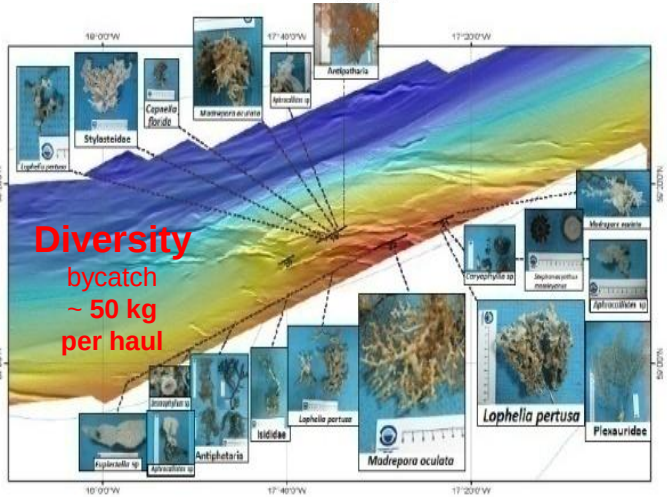
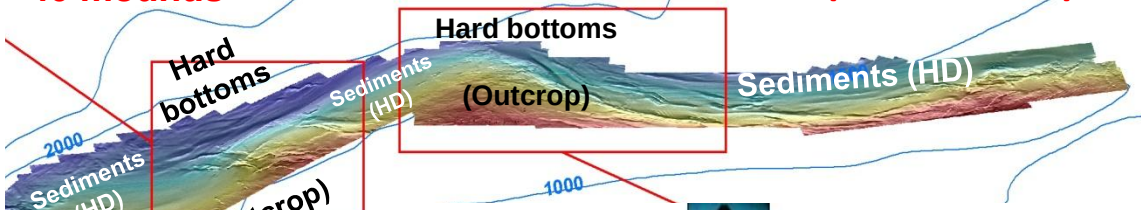
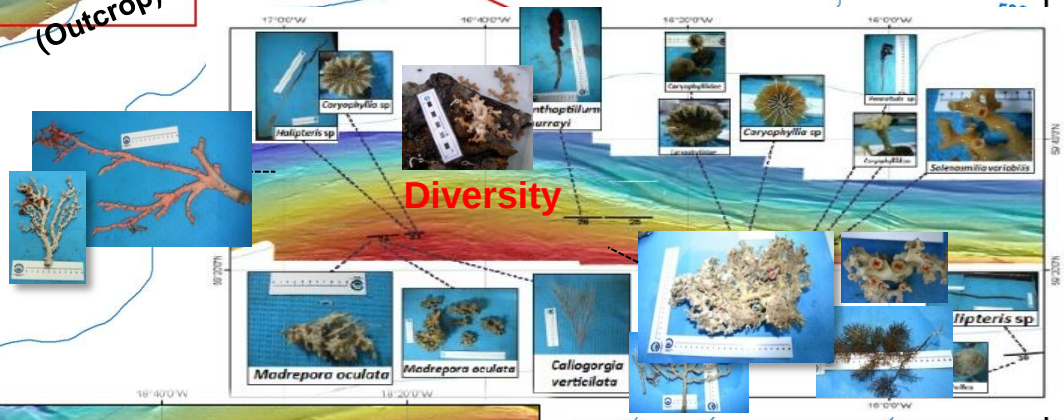
ECOVUL/ARPA: Megahabitats?

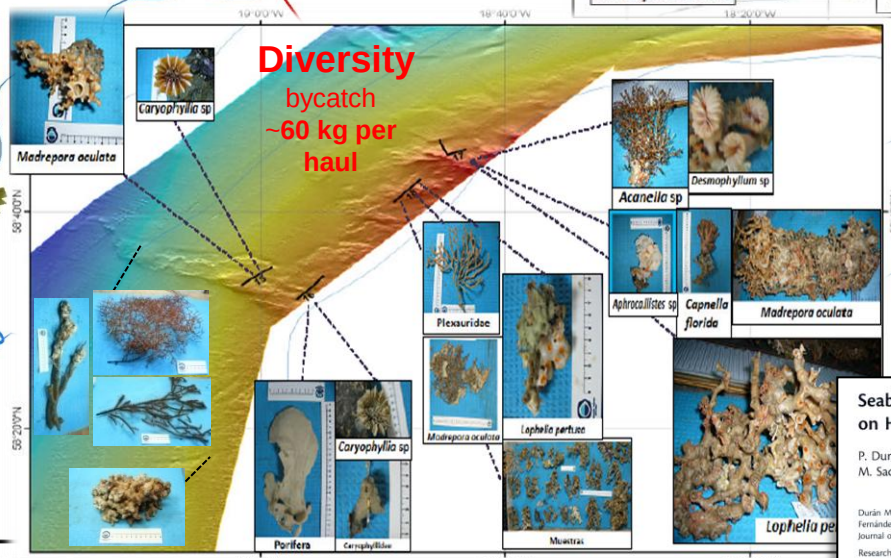


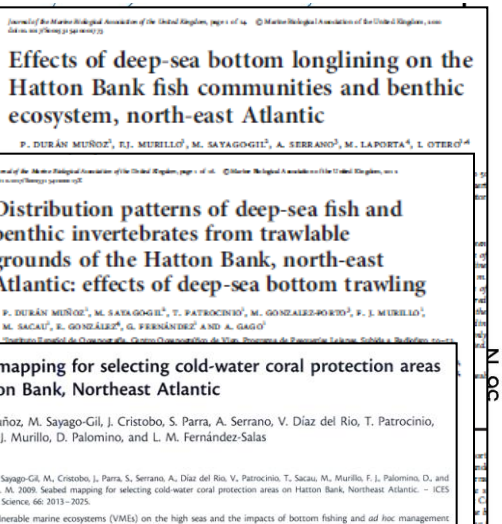
Ridges
&
>40 mounds ★

Multibeam bathymetry
(18,760 km²)









Effects of deep-sea bottom longlining on the Hatton Bank fish communities and benthic ecosystem, north-east Atlantic

P. DURÁN MUÑOZ[1], F.J. MURILLO[2], M. SAYAGOGIL[2], A. SERRANO[3], M. LAPORTA[4], I. OTERO[2,4]

Distribution patterns of deep-sea fish and benthic invertebrates from trawlable grounds of the Hatton Bank, north-east Atlantic: effects of deep-sea bottom trawling

P. DURÁN MUÑOZ[1], M. SAYAGOGIL[2], T. PATROCINIO[3], M. GONZALEZ-PORTO[3], F. J. MURILLO[1], M. SACAU[2], E. GONZÁLEZ[4], G. FERNÁNDEZ[2] AND A. GAGO[1]

Seabed mapping for selecting cold-water coral protection areas on Hatton Bank, Northeast Atlantic

P. Durán Muñoz, M. Sayago-Gil, J. Cristobo, S. Parra, A. Serrano, V. Díaz del Río, T. Patrocinio, M. Sacau, F. J. Murillo, D. Palomino, and L. M. Fernández-Salas

Durán Muñoz, P., Sayago-Gil, M., Cristobo, J., Parra, S., Serrano, A., Díaz del Río, V., Patrocinio, T., Sacau, M., Murillo, F. J., Palomino, D., and Fernández-Salas, L. M. 2009. Seabed mapping for selecting cold-water coral protection areas on Hatton Bank, Northeast Atlantic. – ICES Journal of Marine Science, 66: 2013–2025.

Research into vulnerable marine ecosystems (VMEs) on the high seas and the impacts of bottom fishing and *ad hoc* management measures are high priority today thanks to UN General Assembly Resolution 61/105. An interdisciplinary methodology (specifically designed for selecting cold-water coral protection areas) and a case study focused on the Hatton Bank (NE Atlantic) are presented.

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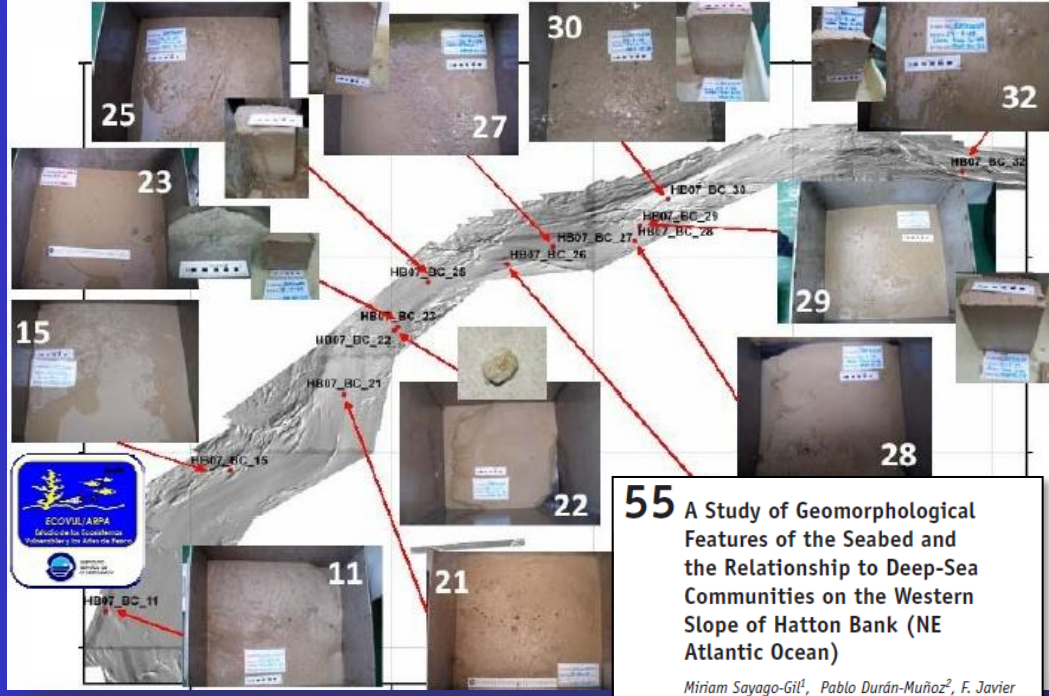
18°W 16°W 14°W 20°W
60°N 58°N 56°N

Hatton Drift:

- *Flat and soft seabed*

(sedimentary drift; sand; mud)

- *Nowadays extensive coral reef structures are unlikely to occur*
- *Easy to trawl: Intensive trawling since 1990'*



55 **A Study of Geomorphological Features of the Seabed and the Relationship to Deep-Sea Communities on the Western Slope of Hatton Bank (NE Atlantic Ocean)**

Miriam Sayago-Gil[1], Pablo Durán-Muñoz[2], F. Javier Murillo[2], Víctor Díaz-del-Río[1], Alberto Serrano[3], L. Miguel Fernández-Salas[1]

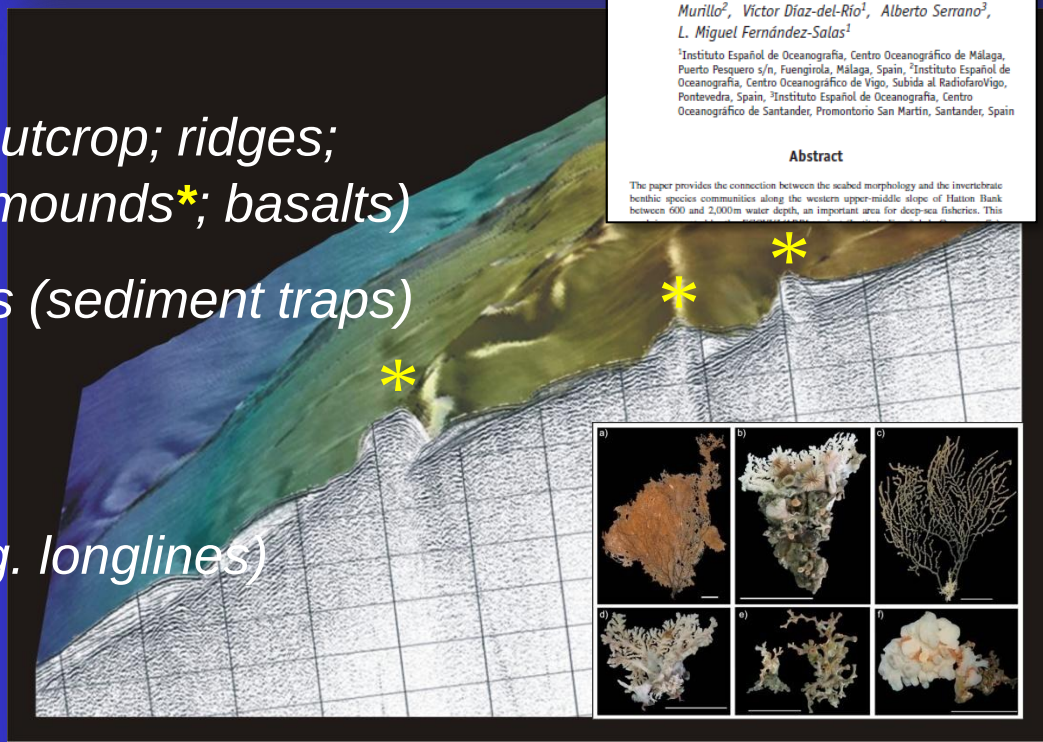
[1]Instituto Español de Oceanografía, Centro Oceanográfico de Málaga, Puerto Pesquero s/n, Fuengirola, Málaga, Spain, [2]Instituto Español de Oceanografía, Centro Oceanográfico de Vigo, Subida al RadiofaroVigo, Pontevedra, Spain, [3]Instituto Español de Oceanografía, Centro Oceanográfico de Santander, Promontorio San Martin, Santander, Spain

Abstract

The paper provides the connection between the seabed morphology and the invertebrate benthic species communities along the western upper-middle slope of Hatton Bank between 600 and 2,000m water depth, an important area for deep-sea fisheries. This

Hatton Outcrop:

- *Uneven and hard seabed (rocky outcrop; ridges; carbonate mounds*; basalts)*
- *Not / slightly covered by sediments (sediment traps)*
- *Coral diversity (reefs; gardens)*
- *Dificult to trawl: few trawling*
  Feasible to static fishing gears (e.g. longlines)



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ECOVUL/ARPA: Utility

INSTITUTO ESPAÑOL DE OCEANOGRAFÍA

MANAGERS → **CONSERVATION MEASURES**

NEAFC, EC….

Advice Goups/Committes

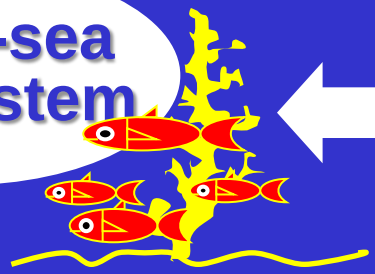
[give the advice]

Review Group [reviews the WG reports]

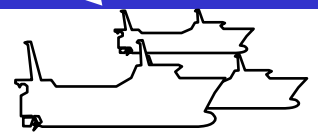
Working Groups

[collect the data]

Deep-sea ecosystem

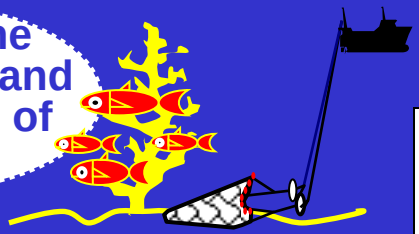


Fishing



SCIENTIFIC SURVEYS

View of the ecosystem and the effects of fishing



DATA

OBSERVERS; COOPERATIVE SURVEYS

VESSEL MONITORING SYSTEM

Interdisciplinary analysis

Conventional Fishery Science; Geology; Ecology;Sedimentology…

LITERATURE

ADVISERS

Source: Durán Muñoz & Sayago-Gil, 2011. An overview of cold-water coral protection on the High seas: The Hatton Bank (NE Atlantic) - a case study. *Marine Policy* 35, 615-622.

CURRENT SITUATION: *Management measures*

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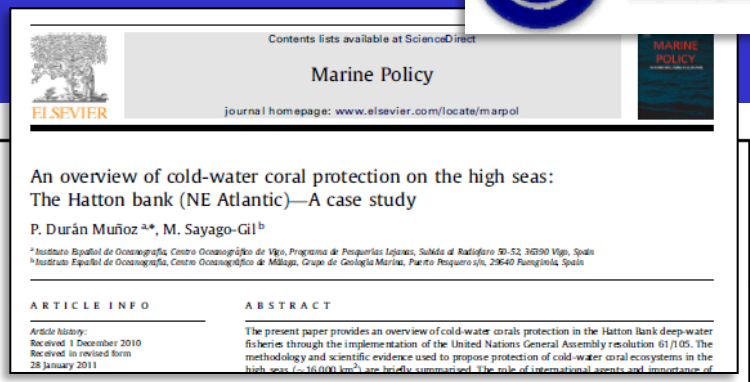

Contents lists available at ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

An overview of cold-water coral protection on the high seas: The Hatton bank (NE Atlantic)—A case study

P. Durán Muñoz [a,*], M. Sayago-Gil [b]

[a] Instituto Español de Oceanografía, Centro Oceanográfico de Vigo, Programa de Pesquerías Lejanas, Subida al Radiofaro 50-52, 36390 Vigo, Spain
[b] Instituto Español de Oceanografía, Centro Oceanográfico de Málaga, Grupo de Geología Marina, Puerto Pesquero s/n, 29640 Fuengirola, Spain

ARTICLE INFO

Article history:
Received 1 December 2010
Received in revised form
28 January 2011

ABSTRACT

The present paper provides an overview of cold-water corals protection in the Hatton Bank deep-water fisheries through the implementation of the United Nations General Assembly resolution 61/105. The methodology and scientific evidence used to propose protection of cold-water coral ecosystems in the high seas (~16,000 km²) are briefly summarised. The role of international agents and importance of

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" Western slope" (2009)

"Top of the Bank" (2007- 08)

2012: New advice!!

Current closed area: ~16,000 km²

NEAFC recommendation 8: 2012

EC regulation 1288/2009

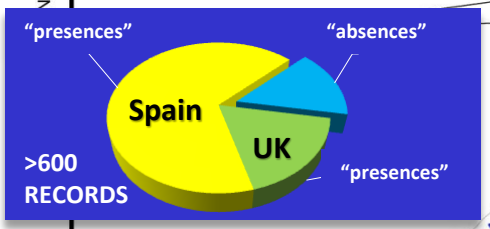
- Special Morphologies Contour
- Strict Protection Area
- Strict Protection Area + 1 nautical mile
- NEAFC 2007 and 2008

19°0'0"W 18°0'0"W 17°0'0"W 16°0'0"W 15°0'0"W

60°0'0"N 59°0'0"N 58°0'0"N

CURRENT SITUATION: Data

INSTITUTO ESPAÑOL DE OCEANOGRAFÍA



+

Absence of cold-water corals and/or sponges in the bycatch

HATTON BANK (March 2012)

- **ICES DATABASE**
  [Established in 2012]

  Corals & sponges (in a broad sense), mounds, etc;

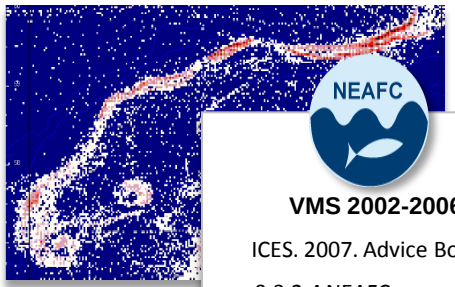
  "Absences" of corals / sponges

- **MAPS**

  Multibeam bathymetry (images)

- **FISHING**

  e.g. VMS not updated



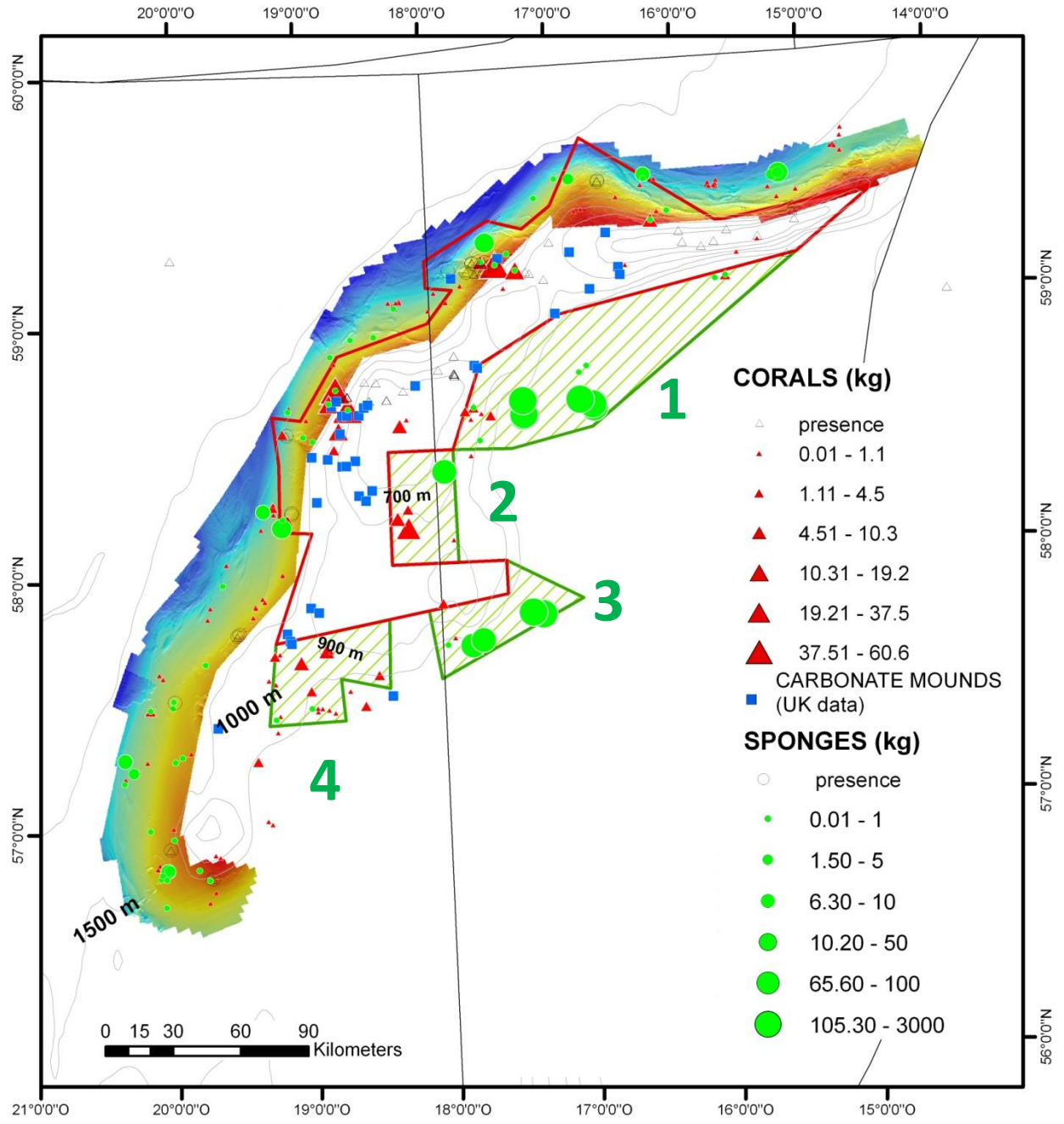
NEAFC

VMS 2002-2006

ICES. 2007. Advice Book 9 9.3.2.4 NEAFC request to evaluate the use and quality of VMS data.

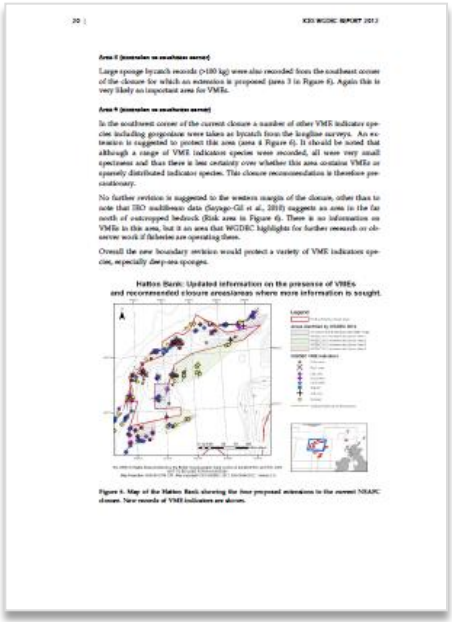
ADVICE 2012: Working Group

INSTITUTO ESPAÑOL DE OCEANOGRAFÍA



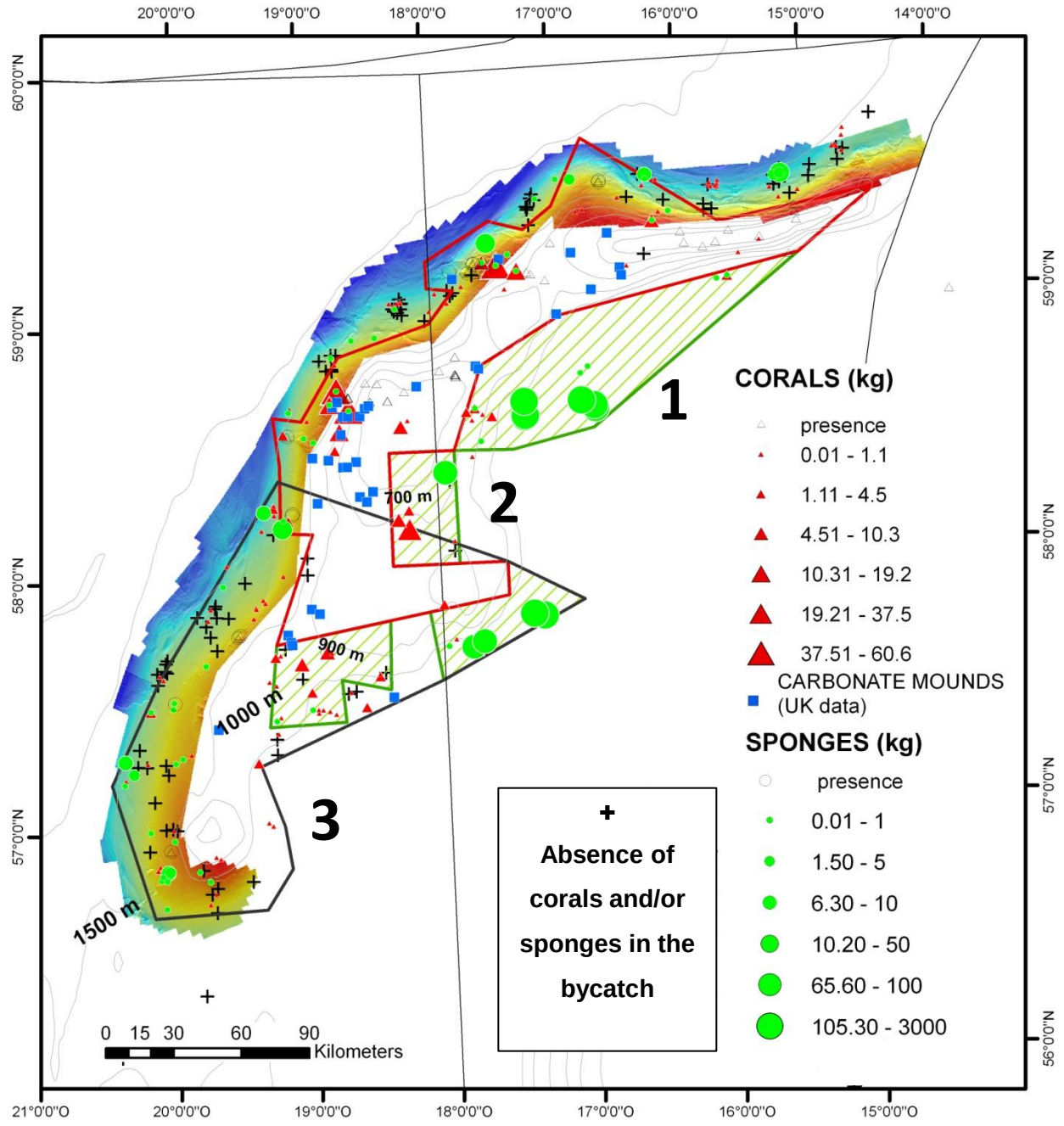
ICES-NAFO WGDEC (March 2012)

- **Area 1**: Sponge grounds
- **Area 2**: Corals & sponges
- **Area 3**: Sponge grounds
- **Area 4**: Corals



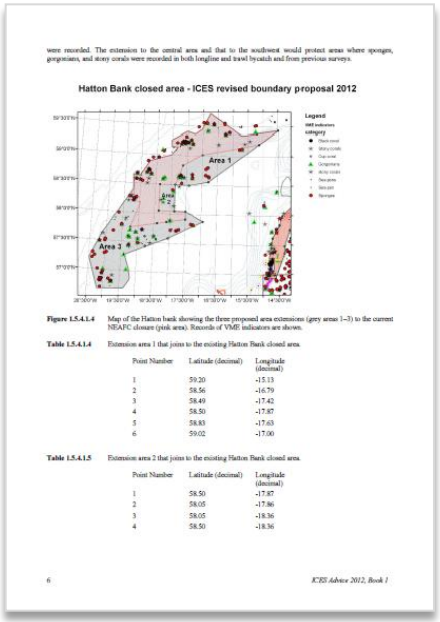
ADVICE 2012: ICES

INSTITUTO ESPAÑOL DE OCEANOGRAFÍA



ICES (June 2012)

- **Area 1**: Sponge grounds
- **Area 2**: corals & sponges
- **Area 3**: corals & sponges



were recorded. The extension to the central area and that to the southwest would protect areas where sponges, gorgonians, and stony corals were recorded in both longline and trawl bycatch and from previous surveys.

Hatton Bank closed area - ICES revised boundary proposal 2012

Figure 1.5.4.1.4 Map of the Hatton bank showing the three proposed area extensions (grey areas 1–3) to the current NEAFC closure (pink area). Records of VME indicators are shown.

Table 1.5.4.1.4 Extension area 1 that joins to the existing Hatton Bank closed area.

Point Number	Latitude (decimal)	Longitude (decimal)
1	59.20	-15.13
2	58.56	-16.79
3	58.49	-17.42
4	58.50	-17.87
5	58.83	-17.63
6	59.02	-17.00

Table 1.5.4.1.5 Extension area 2 that joins to the existing Hatton Bank closed area.

Point Number	Latitude (decimal)	Longitude (decimal)
1	58.50	-17.87
2	58.05	-17.86
3	58.05	-18.36
4	58.50	-18.36

Station	BC	CC	GO	LC	SP	SF	SG	SC
A05-L107		0.01						
A05-L109		0.01						
A05-L111		0.01						
A05-L112		0.01					1.7	
A05-L113		0.1					6.4	
A05-L169					0.1			
A05-L171		0.4						
A05-L19							1.5	
A05-L198		0.01						
A05-L201					0.1			
A05-L202		0.01			0.1			
A05-L203		0.01						
A05-L231	0.01				0.1			0.1
A05-L234							0.7	
A05-L29								0.9
A05-L33					0.01			
A05-L61							6.3	
A05-L63								0.2
A05-L64		0.01					0.1	
A05-L65		0.01						
A05-L76		0.2						2.8
A05-L77							25.1	0.6
A05-L78					0.01			0.1
A05-L81		0.1						
HB05-L10					0.01		0.1	
HB05-L12					0.01		0.01	
HB05-L13			0.01				0.01	1.6
HB05-L9					0.01			
HB07-DB-03							+	
HB07-DB-05		+	+				+	
HB07-DB-06		+		+			+	
HB07-L3					0.01		0.01	
HB07-L4							0.01	
HB07-L5							0.01	
HB07-L6							0.01	
HB07-L7					0.01			

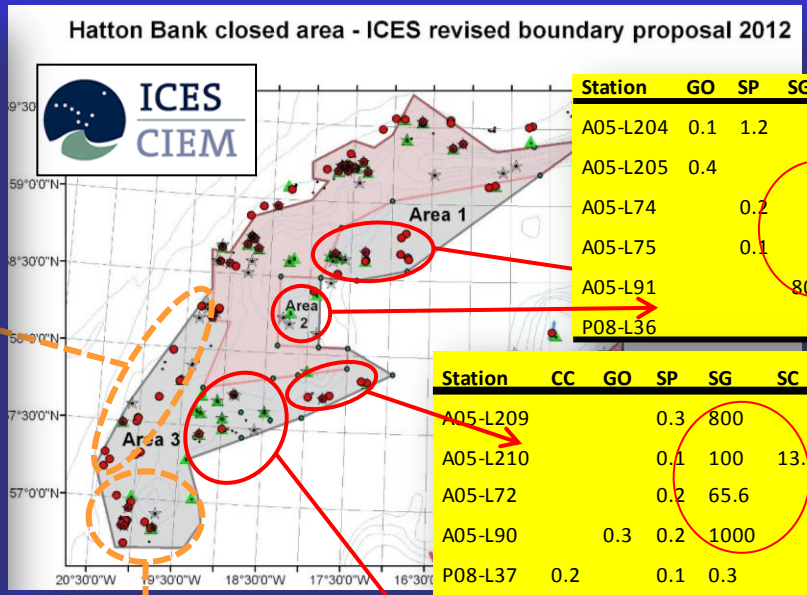
Existing fishing area

Mapped area (Hatton Drift)

bycatch of indicators (low)

--

Thresholds (ICES, 2012)
240–560 kg (sponges)
18–42 kg (live corals)



Station	GO	SP	SG	SC
A05-L204	0.1	1.2		
A05-L205	0.4			
A05-L74		0.2		25.7
A05-L75		0.1		8.5
A05-L91			80	
P08-L36				0.5

Station	CC	GO	SP	SG	SC
A05-L209			0.3	800	
A05-L210			0.1	100	13.9
A05-L72			0.2	65.6	
A05-L90		0.3	0.2	1000	
P08-L37	0.2		0.1	0.3	
P08-L38	0.1		0.1		

Station	CC	GO	SP	SF	SG	SC
A05-L100			0.2		106.4	
A05-L206		0.01	1			0.2
A05-L207		0.1	0.5		404	
A05-L208			0.2		3000	
A05-L95		0.7	0.1			1.2
A05-L96		0.01	0.1			0.8
A05-L97			0.1		105.3	0.1
A05-L98			0.2		130.7	
A05-L99			0.1		283.5	
P05-L61	0.1		0.01			3
P05-L62					0.3	
P05-L63						1.1
P08-L29	0.3	0.3	0.9		1	
P08-L30			0.2		0.1	
			0.01	0.01	0.7	
			0.01		0.4	
			0.3			0.4
					0.2	2.1

Station	BC	CC	GO	LC	SP	SF	SG	SC
A05-L132							0.4	
A05-L172							1	
A05-L20					1			
A05-L233		0.01						
A05-L83							8	
A05-L85					0.1			
HB05-L14							0.01	0.01
HB05-L15					0.01			
HB06-DB-02	+	+	+	+			+	+
HB06-L2			0.01			0.01	0.01	
HB06-L3							0.01	
HB07-DB-01							+	+
HB07-L1							0.01	
HB07-L2							0.01	
P05-L20		0.01						
P05-L21	0.01	0.01						0.4
P05-L25			0.1					
P08-L10	0.01	0.01						
P08-L9		0.1	0.01					

Station	BC	CC	GO	LC	SP	SG	SC
A05-L211			0.8		0.2		0.4
A05-L212					0.1		
A05-L213					0.1		
A05-L214			2.2		0.1		
A05-L71					0.4		
P05-L27		0.2	3.5		0.6		3.4
P05-L28		0.1			0.1		
P05-L29		0.5	1.5		0.2		2.1
P05-L30		0.01			0.01		
P05-L31		0.1					1.8
P05-L33					0.1		
P05-L34					0.2		
P05-L35					0.2		
P05-L36		0.01	0.01		0.4	0.1	
P05-L37		0.01	0.5				0.01
P05-L38		0.01			0.01		
P05-L42		0.2	1.6		0.2		
P05-L43		0.2	0.1		0.1		
P08-L11		0.1					
P08-L12		0.2	0.01			0.1	0.01
P08-L13							0.01
P08-L14	0.01					0	4.5

Data sources (2005-08)
EU (Spain)

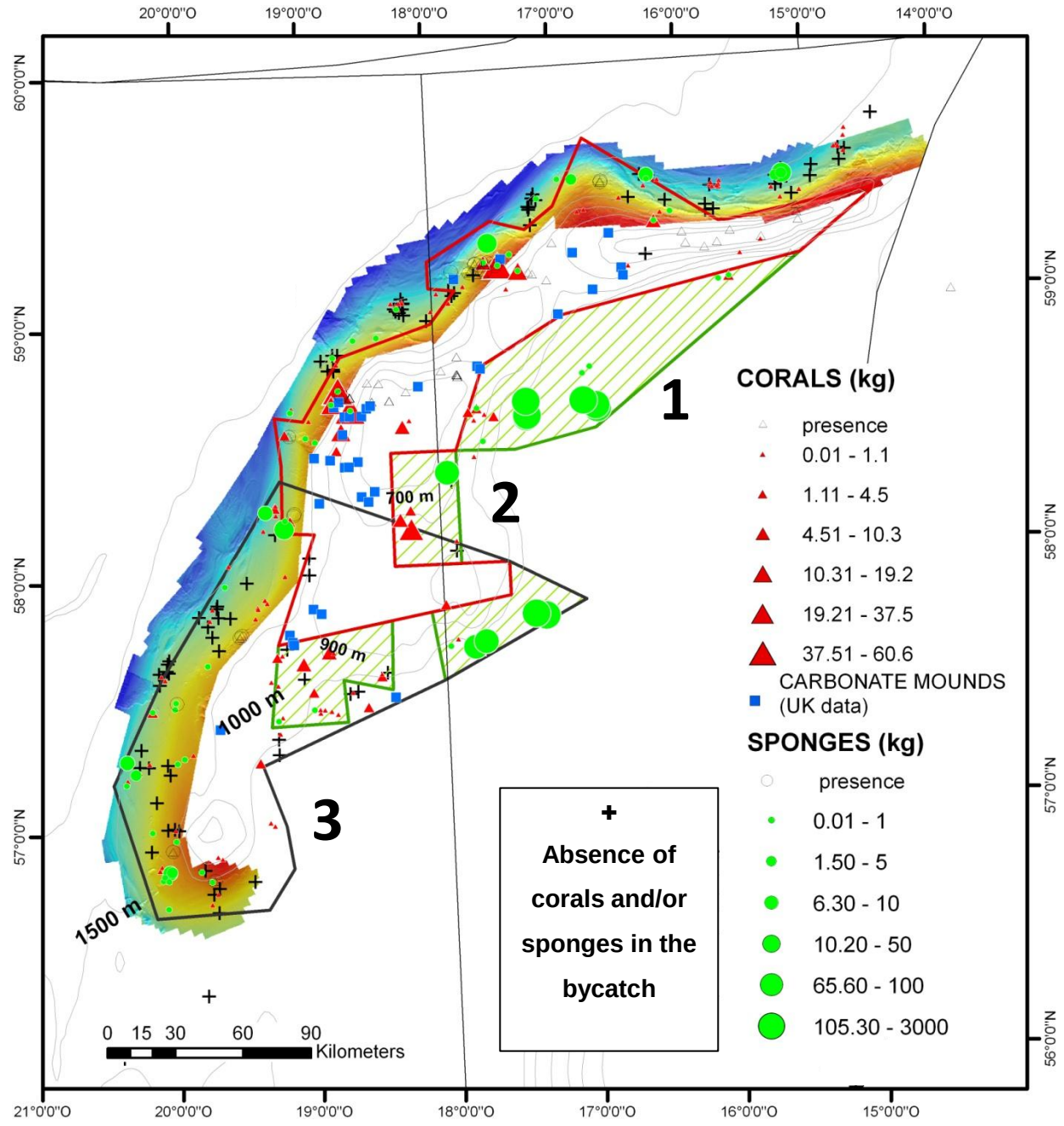
P	*Commercial longline*
A	*Commercial trawl*
HB-L	*Scientific trawl*
HB-DB	*Scientific dredge*

Bycatch (Kg)

BC	*Black corals*
CC	*Cup corals*
GO	*Gorgonians*
LC	*Lace corals*
SP	*Sea pens*
SF	*Soft corals*
SG	*Sponges*
SC	*Stony corals*

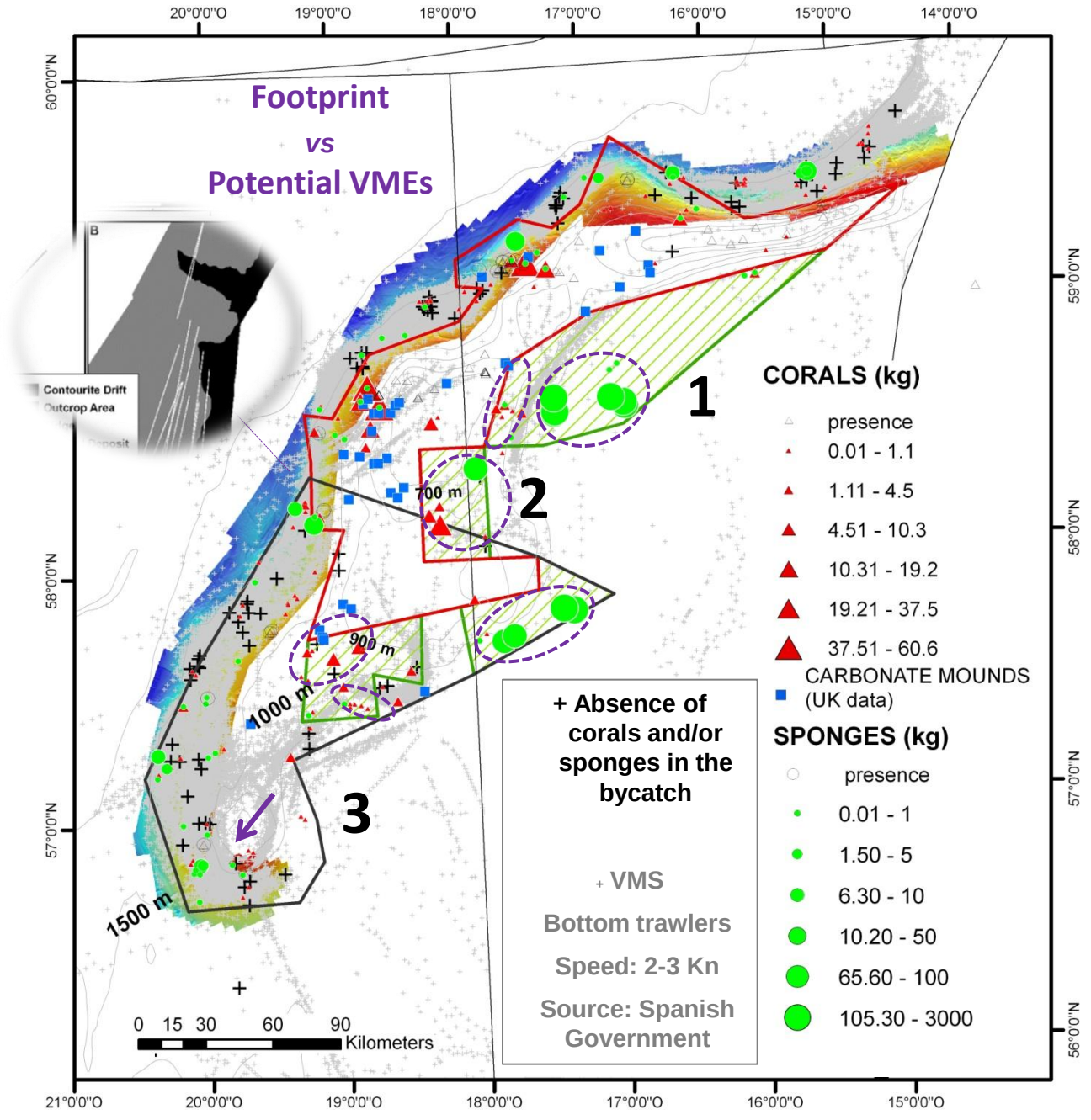
OTHER DATA

INSTITUTO ESPAÑOL DE OCEANOGRAFÍA



OTHER DATA

INSTITUTO ESPAÑOL DE OCEANOGRAFÍA

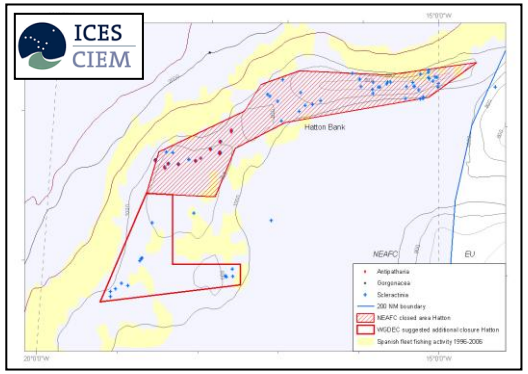


HATTON BANK

Historic fishery footprint (Spain)

2000-2011

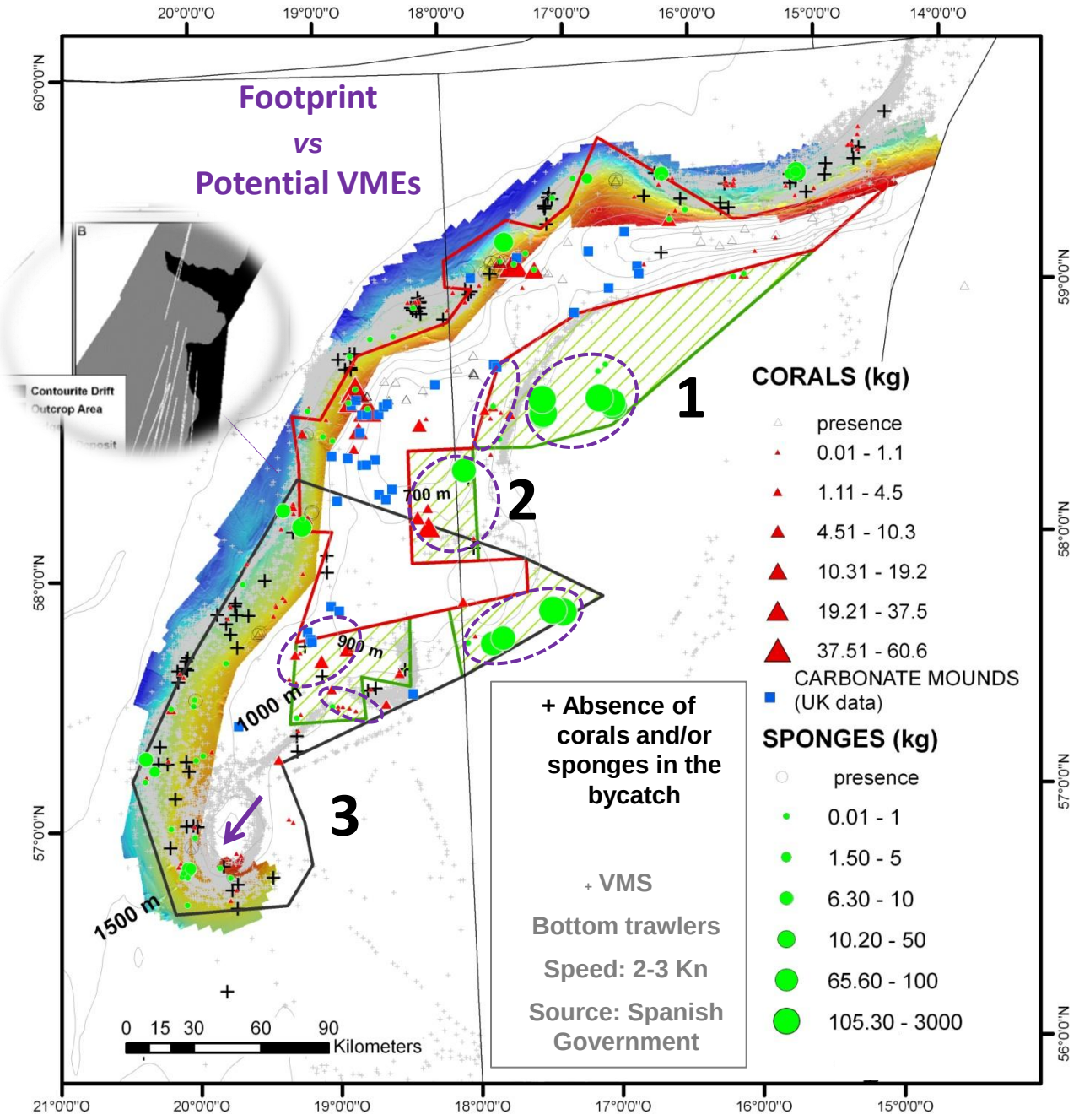
Fishery footprint based on Spanish observers (1996-2006)



Source: ICES 2007. Report of the 2007 ICES Working Goup on Deep-water Ecology (WGDEC). ICES CM 2007/ACE:01 ref. LRC.

OTHER DATA

INSTITUTO ESPAÑOL DE OCEANOGRAFÍA



HATTON BANK

Recent fishery footprint (Spain)

2007-2011

Besides bycatch of corals and sponges, other data are important to produce the advice about closed areas:

- ***Effort data (e.g. VMS);***
- ***Mapping data (e.g. multibeam);***
- ***Surveys;***
- ***Absence data***

NW Atlantic: NEREIDA Project (2009-2010)

INSTITUTO ESPAÑOL DE OCEANOGRAFÍA

NEREIDA: Study area & surveys

INSTITUTO ESPAÑOL DE OCEANOGRAFÍA

6 MULTIDISCIPLINARY SURVEYS

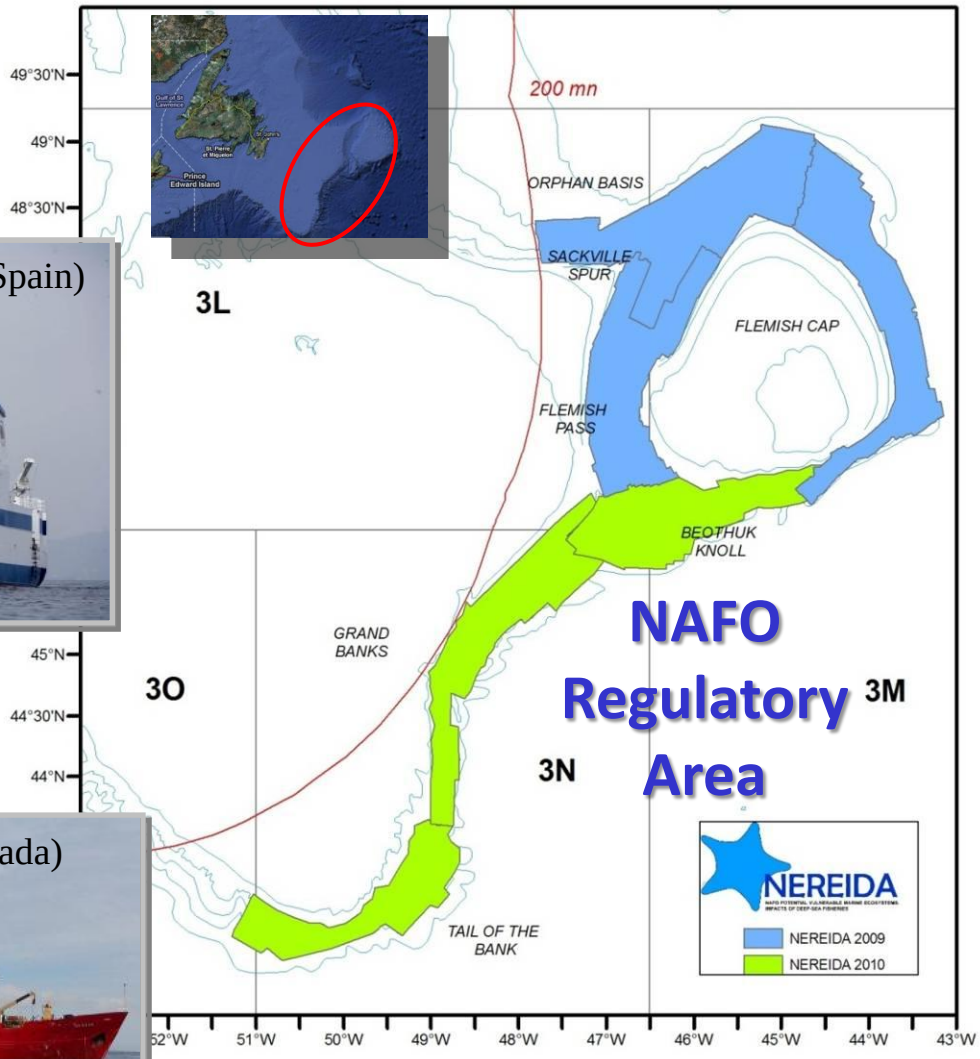
368 Box Corer
105 dredges
414 CTD

RV Miguel Oliver - SGM (Spain)

2 VISUAL SURVEYS

2143 photos
116 hr (video)

RV Hudson - DFO (Canada)

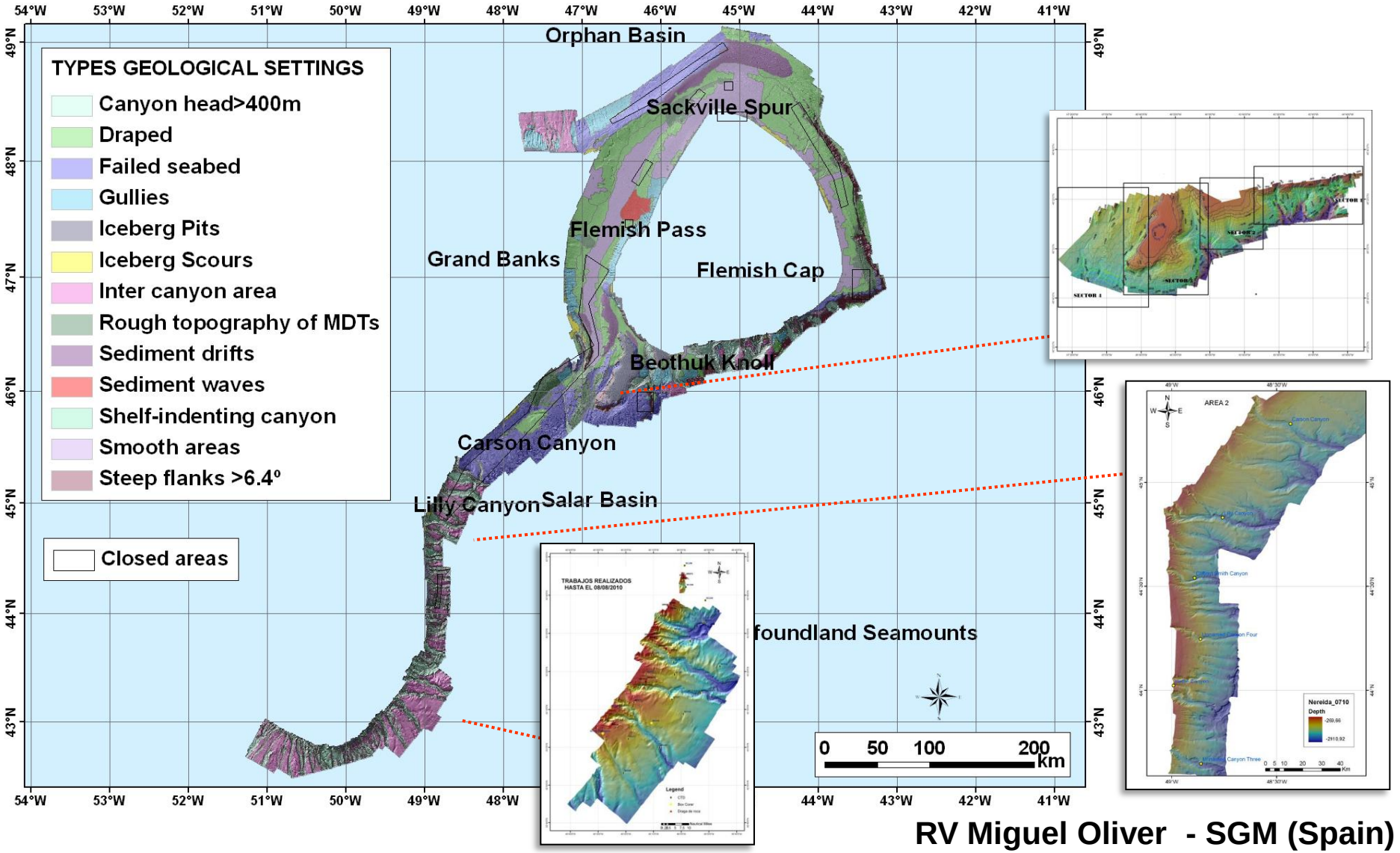


Total surveyed area: ~69.000 km^2

NEREIDA: Seabed maps

INSTITUTO ESPAÑOL DE OCEANOGRAFÍA

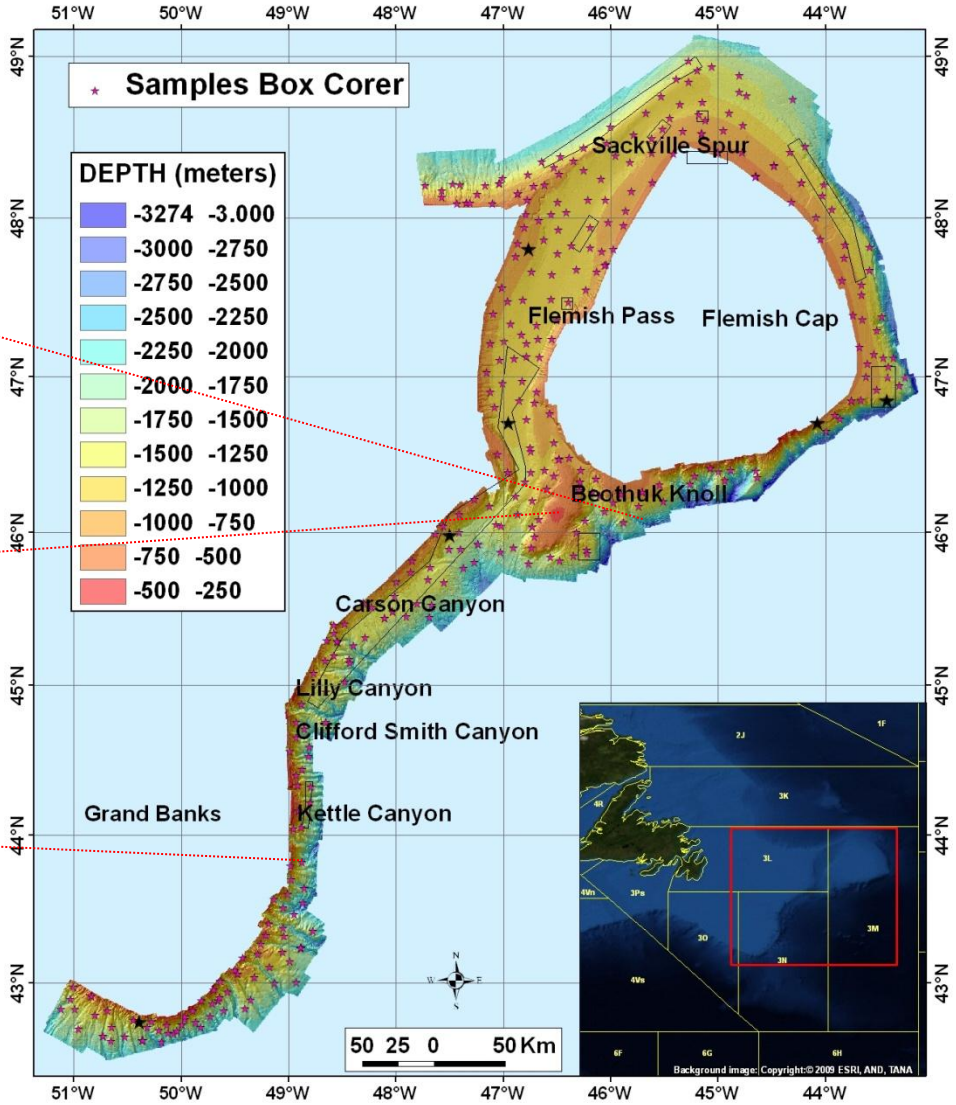
Multibeam bathymetry (68,950 km²) & Sub-bottom profiles (28,113 km)

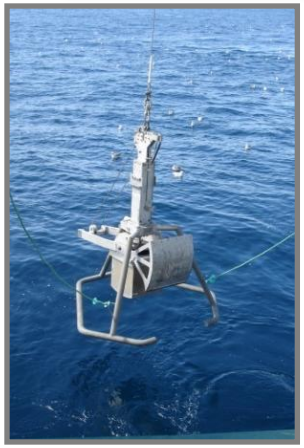


RV Miguel Oliver - SGM (Spain)

NEREIDA: Box Corer

INSTITUTO ESPAÑOL DE OCEANOGRAFÍA





368 samples

RV Miguel Oliver - SGM (Spain)

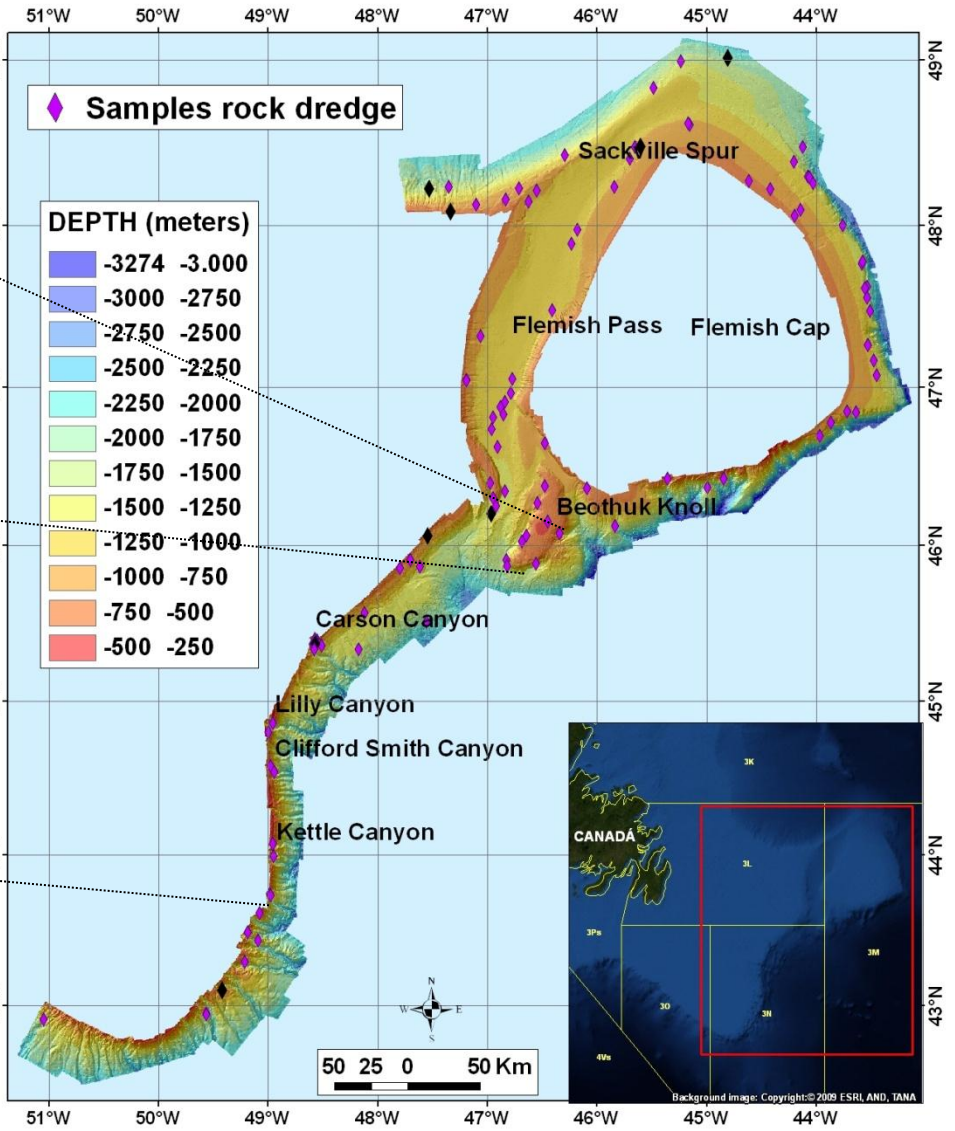
NEREIDA: Dredges

INSTITUTO ESPAÑOL DE OCEANOGRAFÍA

Acanella arbuscula

Geodia macandrewi

Mediaster bairdi

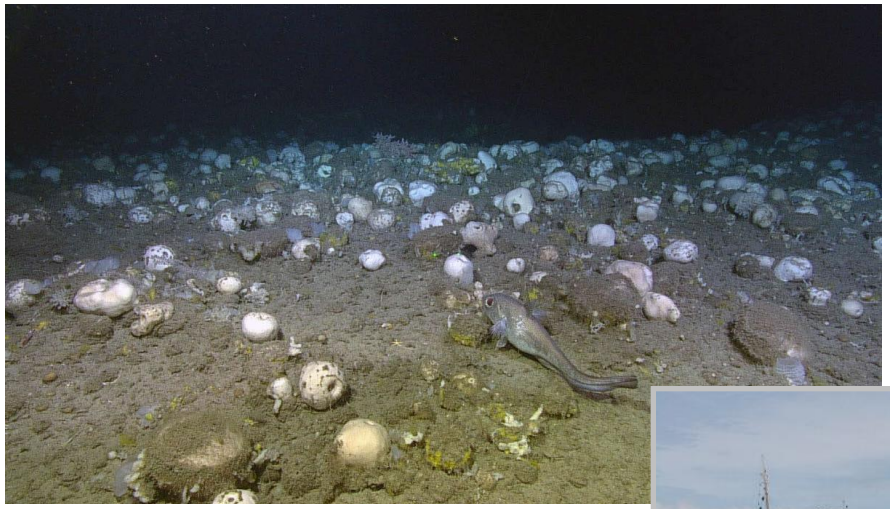


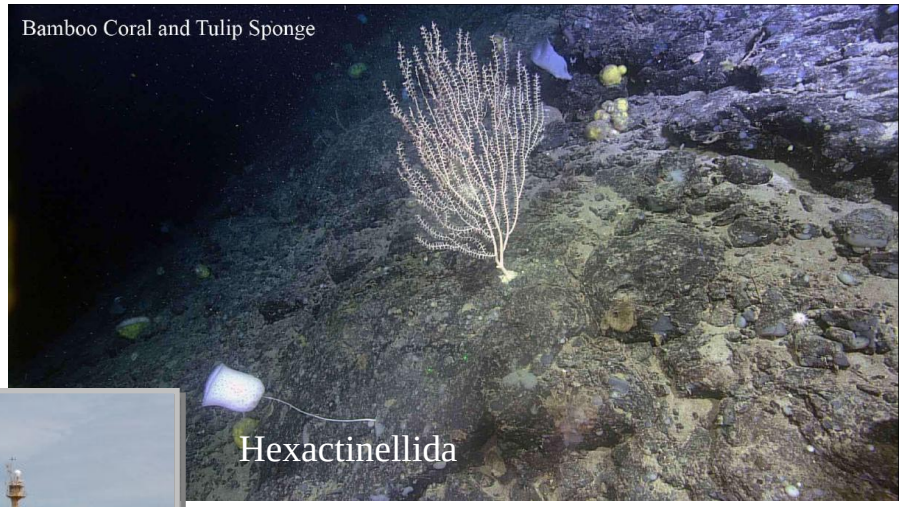
105 samples

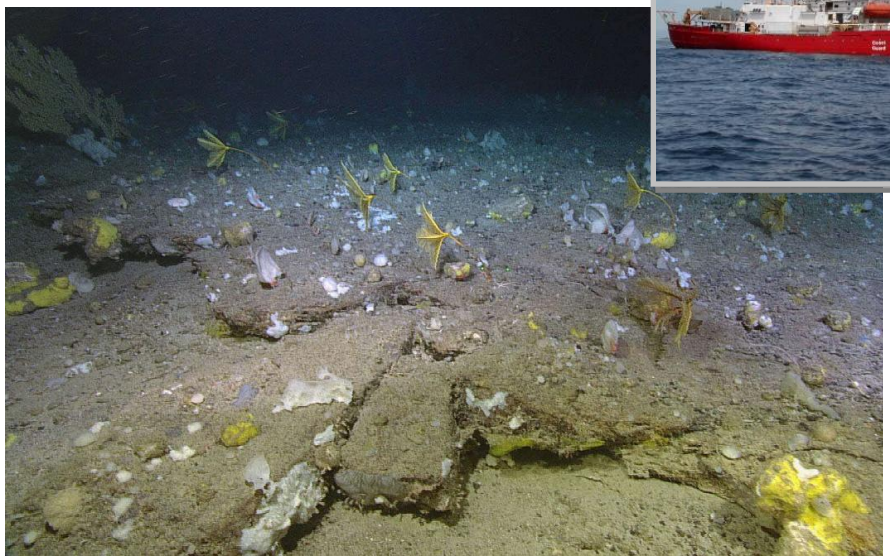
RV Miguel Oliver - SGM (Spain)

NEREIDA: visual surveys

Photos (2,143) & Video footage (116 hr)







RV Hudson - DFO (Canada)

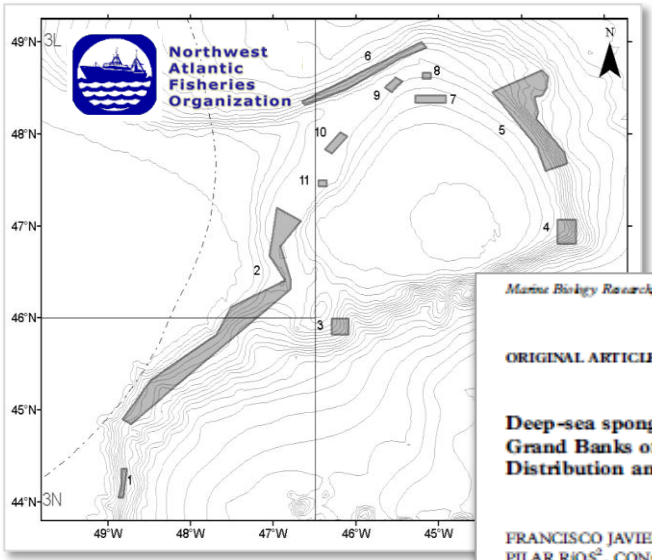
NEREIDA: Management measures

INSTITUTO ESPAÑOL DE OCEANOGRAFÍA

2009 - 2010

NAFO closed 11 areas identified by groundfish surveys (UE, Spain and Canada)

Protection of "concentrations" of corals/sponges



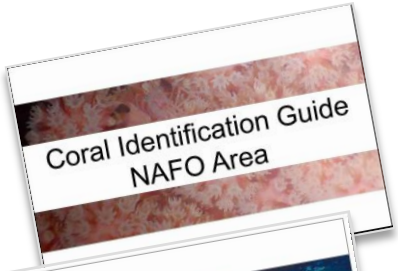
"Significative catches"

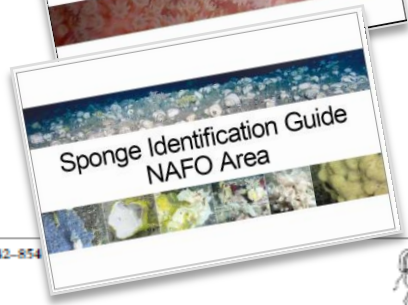
Large gorgonians = 2 kg

Small gorgonians = 0.2 kg

Seapens = 1.6 kg

Sponges = 75 kg





Marine Biology Research, 2012; 8: 842–854

ORIGINAL ARTICLE

Deep-sea sponge grounds of the Flemish Cap, Flemish Pass and the Grand Banks of Newfoundland (Northwest Atlantic Ocean): Distribution and species composition

FRANCISCO JAVIER MURILLO[1]*, PABLO DURÁN MUÑOZ[1], JAVIER CRISTOBO[2], PILAR RIOS[2], CONCEPCIÓN GONZÁLEZ[1], ELLEN KENCHINGTON[3] & ALBERTO SERRANO[4]

ICES Journal of Marine Science (2011), 68(2), 319–332. doi:10.1093/icesjms/fsq071

Distribution of deep-water corals of the Flemish Cap, Flemish Pass, and the Grand Banks of Newfoundland (Northwest Atlantic Ocean): interaction with fishing activities

F. J. Murillo[1]*, P. Durán Muñoz[1], A. Altuna[2], and A. Serrano[3]

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[2]INSUB, Museo de Oleiros, Zamora, 12, Apartado 3223, 20113 Donostia-San Sebastián, Spain
[3]Instituto Español de Oceanografía, Centro Oceanográfico de Santander, Promontorio San Martín s/n, 39004 Santander, Spain

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CURRENT SITUATION

11 closed areas

~ 8,500 km²

(Review: December 2014)

NEREIDA
NAFO POTENTIAL VULNERABLE MARINE ECOSYSTEMS. IMPACTS OF DEEP-SEA FISHERIES

UTILITY

- **Suitability of the current closed areas?**
- **Refine the boundaries?**
- **New areas?**

Conclusions

- UNGA resolution 66/68 adopted in 2011, has recognized the utility of seabed mapping programmes for the management of high seas fisheries (VMEs protection areas);

- In recent years, several multidisciplinary mapping programmes have been developed in the Atlantic Ocean;

- Such programmes have resulted in the identification of VMEs within the NEAFC & NAFO Regulatory Areas (as well as within other high seas areas) and in the adoption of conservation and management measures to prevent SAIs on such ecosystems (in accordance with paragraph 119b of UNGA resolution 64/72):

NEAFC Recommendation 8:2012 - EC Regulation 1288/2009

Hatton Bank closed area (~ 16,000 km^2)

NAFO Enforcement measures

Grand Banks, Flemish Pass & Flemish Cap closed areas (~ 8,500 km^2)

Spanish regulations

SW Atlantic closed area (~ 41,000 km^2)

- Some Nations are making efforts to compile information with the aim to feed the new international databases on VMEs indicators (e.g.: 2012 ICES coral/sponge Database; NAFO coral/sponge Database);

- Bycatch data (coral and sponges) are insufficient to produce the advice about closed areas: fishing effort (e.g. VMS), mapping data (e.g. multibeam), surveys and “absence” data are also recommended.

Acknowledgements

Funding:

IEO (Spanish Ministry of Economy & Competitiveness), **SGM-SGP** (Spanish Ministry of Agriculture, Food & Environment), **EU**.

Thanks to the staff of:

- ***ECOVUL/ARPA***
- ***NEREIDA***
- ***ATLANTIS***
- ***RAP-SUR***
- ***SGM-SGP***
- ***BGS*** *(UK),* ***IPIMAR*** *(Portugal),* ***UVigo*** *(Spain),* ***NatMIRC*** *(Namibia).*

General Secretariat of the Sea (SGM). Ministry of Enviroment and Rural and Marine Affairs. Spain
Spanish Institute of Oceanography. Spain
Geological Survey of Canada – Natural Resources Canada
Canadian Hydrographic Service – Fisheries and Ocean Canada
Ecosystem Research Division – Fisheries and Ocean Canada
Centre for the Environment Fisheries and Aquaculture Science (Cefas). UK
P.P. Shirshov Institute of Oceanology (RAS). Russia
Polar Research Institute of Marine Fisheries and Oceanography. Russia

& Crews of the research vessels and SGM staff on board *(RV Vizconde de Eza & RV Miguel Oliver),* ***observers*** *and* ***fishers:*** *they help us to collect the data*.