



# atlas

UNDERSTANDING DEEP ATLANTIC ECOSYSTEMS



## D3.3 Part 3: Develop case study HSM models for VME indicator taxa and key deep-sea fish species under current environmental conditions

5<sup>th</sup> ATLAS GA, Edinburgh, 9<sup>th</sup> March 2020

David Stirling & too many to list (credits given on slides)

marinescotland  
science

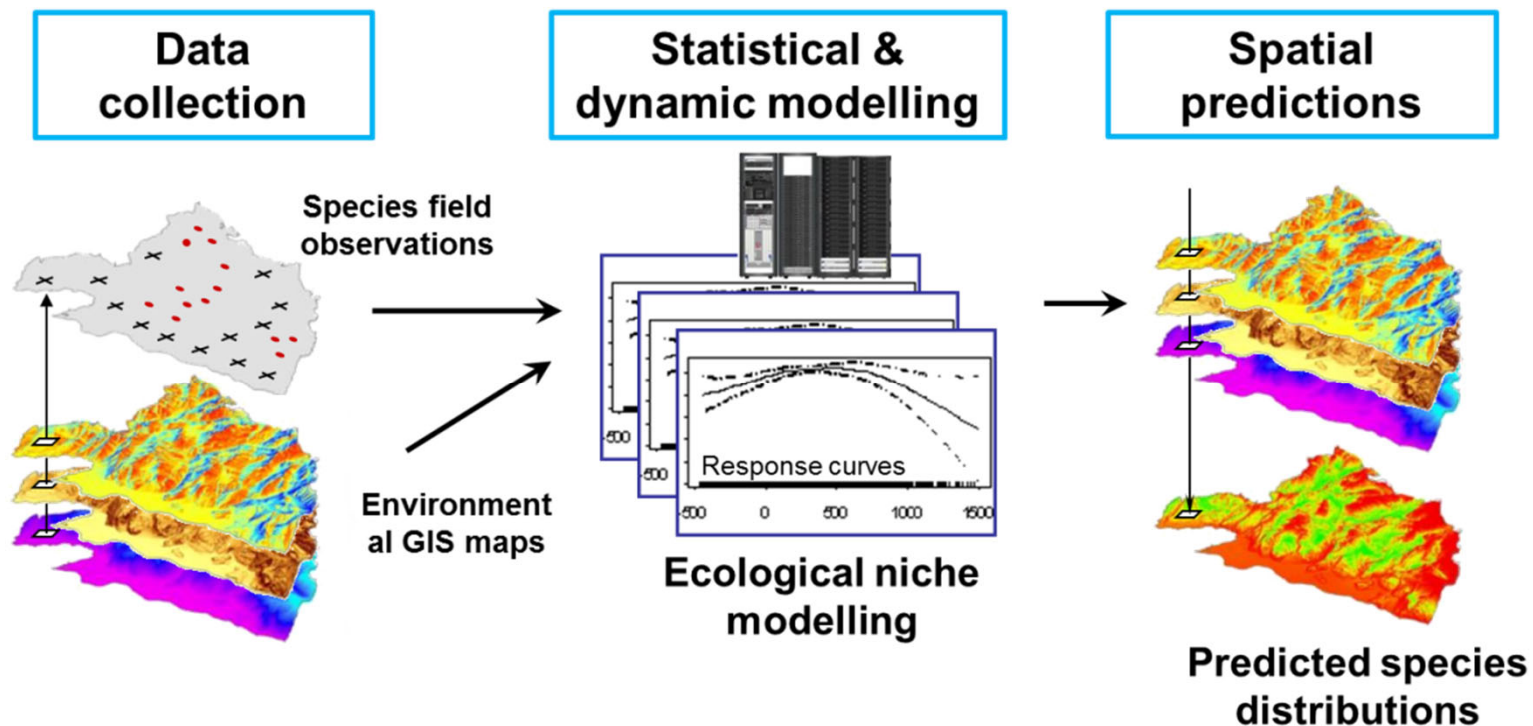


This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 678760 (ATLAS). This output reflects only the author's view and the European Union cannot be held responsible for any use that may be made of the information contained therein.

[www.eu-atlas.org](http://www.eu-atlas.org)



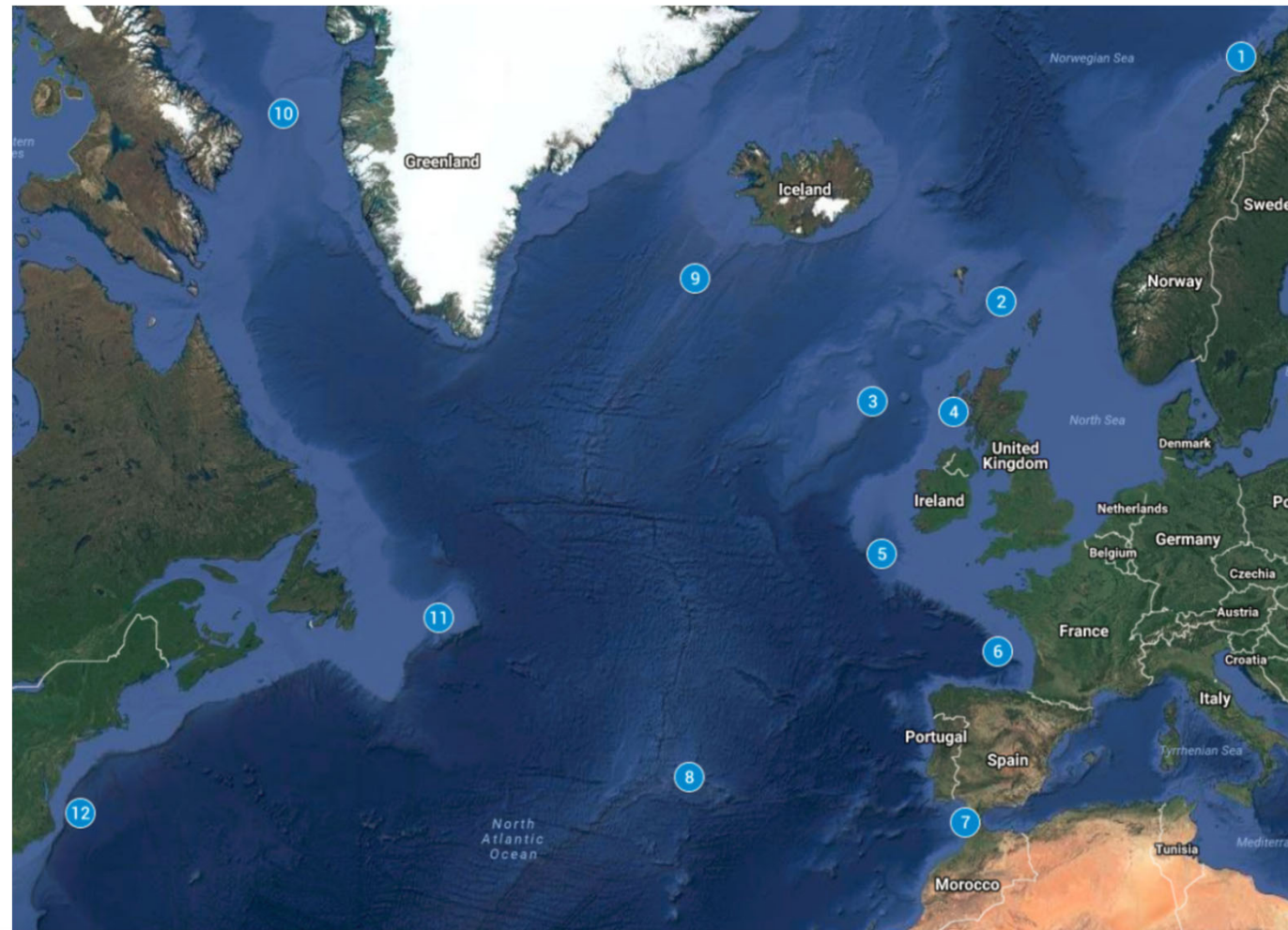
## Predictive distribution models



<http://www.unil.ch/idyst/en/home/menuinst/research-poles/geoinformatics-and-spatial-m/predictive-biogeography/advancing-the-science-of-eco.html>

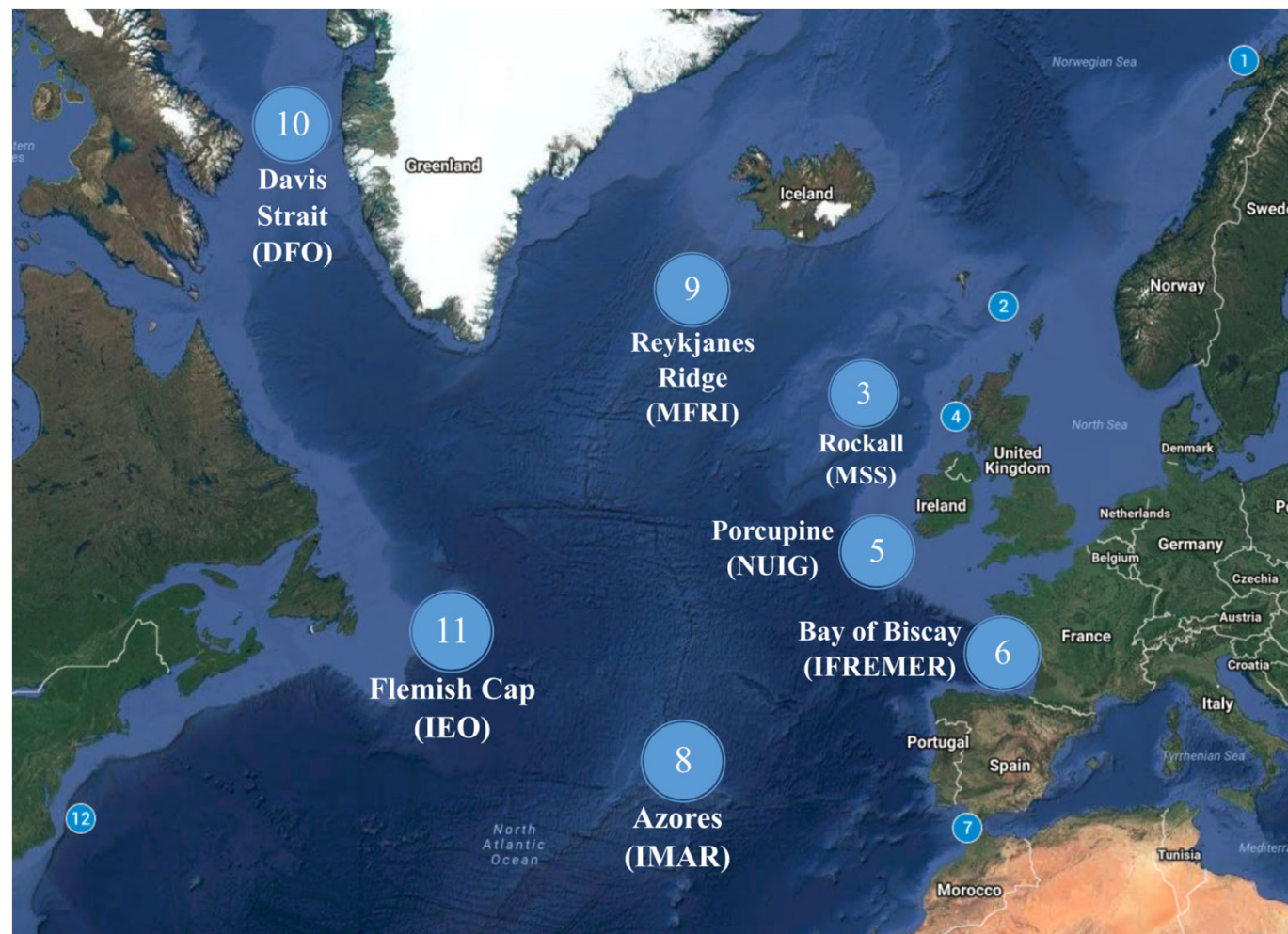


# atlas Case studies



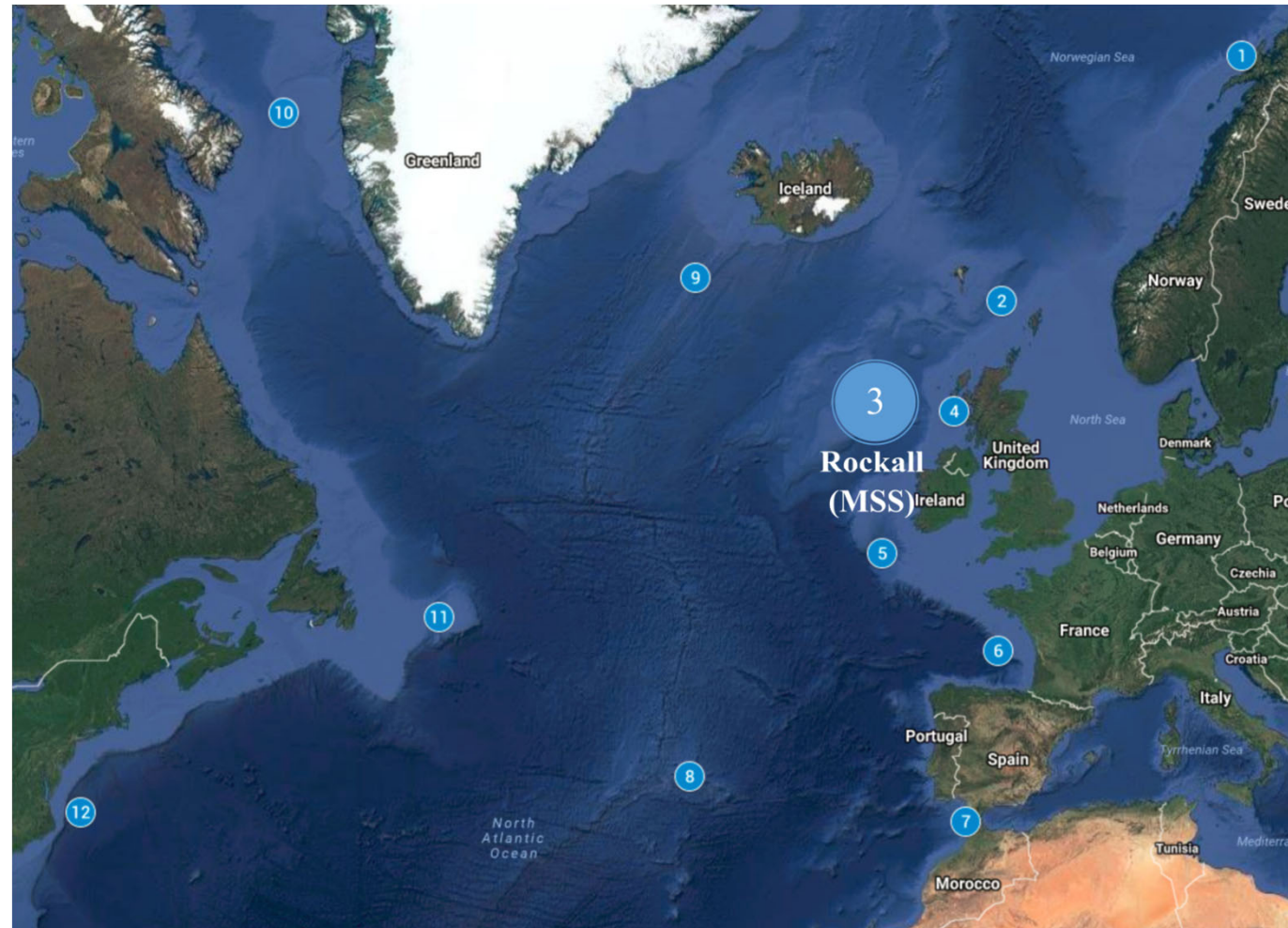


# atlas Case studies





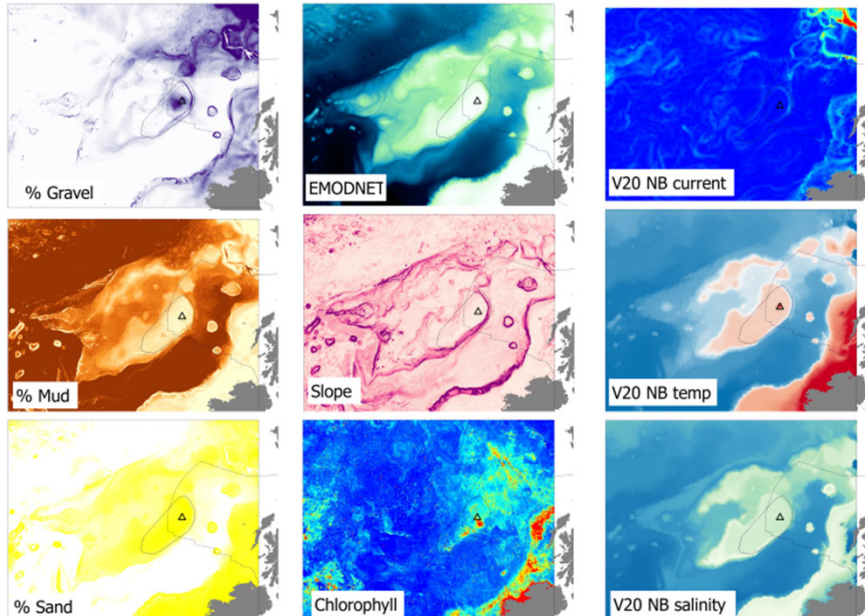
# atlas CS3 Rockall (MSS)



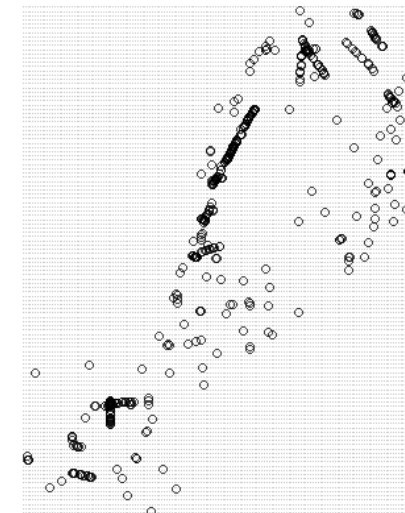
David Stirling



# atlas CS3 Data sources & Methods



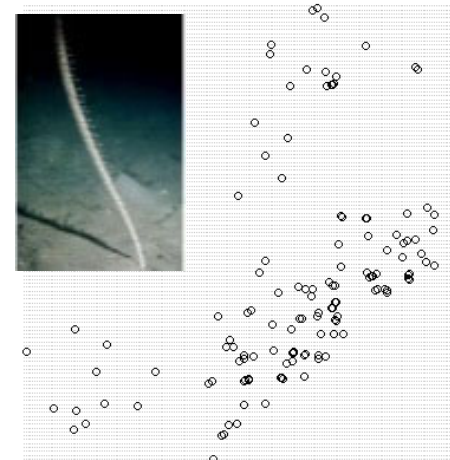
**Environmental variables:** 1<sup>st</sup> order polynomials & crosses & 2<sup>nd</sup> order polynomials (n = 67)



*L. Pertusa*  
Presences  
& quad  
scheme

**Species:** *L. pertusa*, *F. quadrangularis*, *P. greyi*

**Modelling methods:** Point Process Models



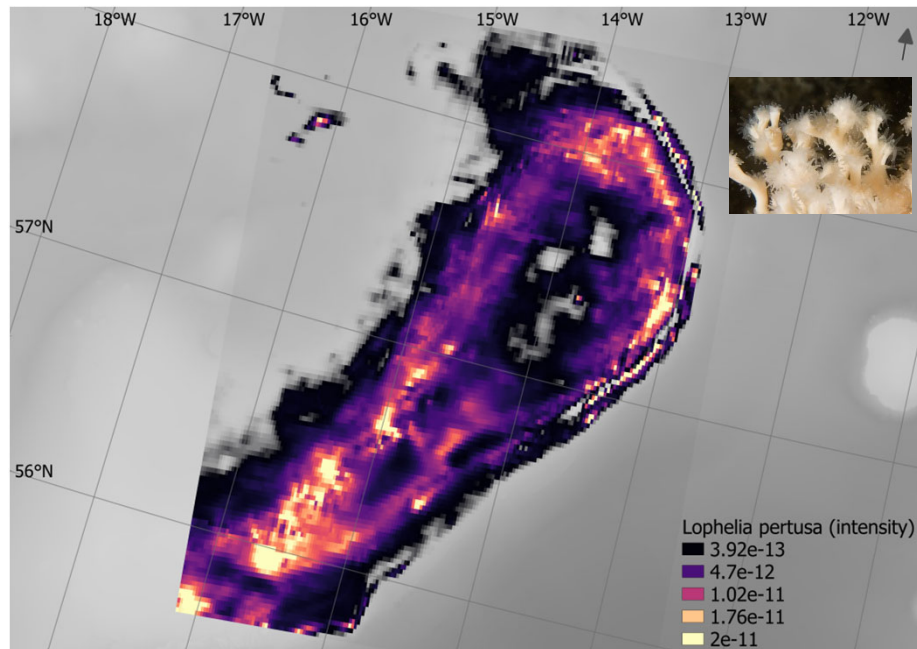
*F. quadrangularis*  
Presences & quad  
scheme

**Occurrences from**  
ICES and OSPAR VME  
DBs (PO)

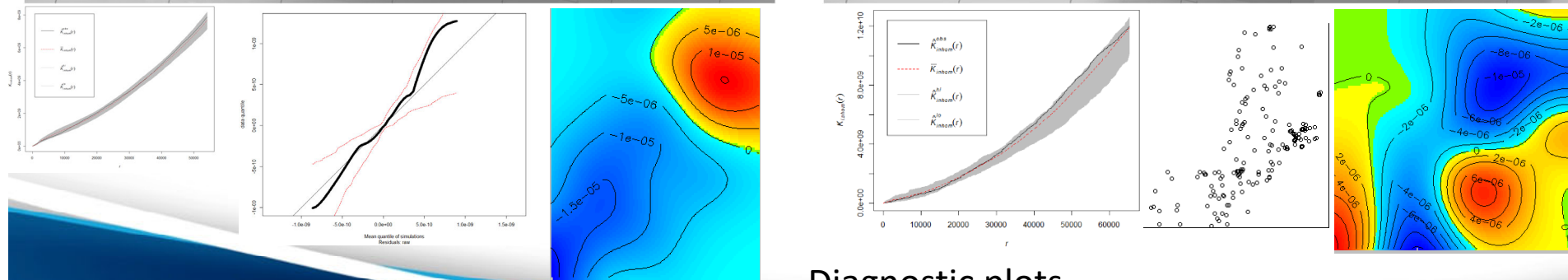
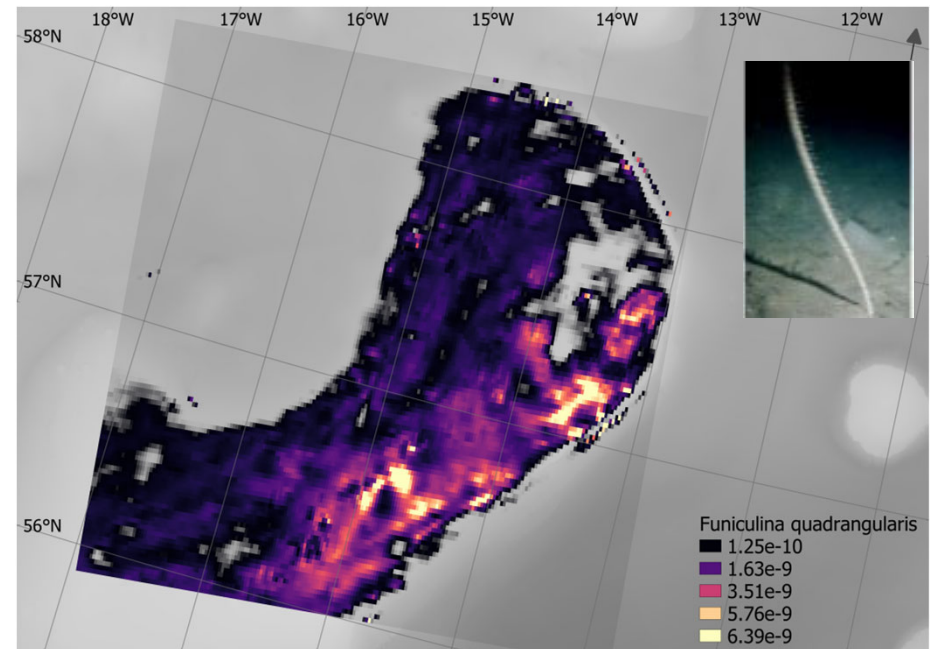


# atlas CS3 Maps & Results

*Lophelia pertusa* predicted intensity

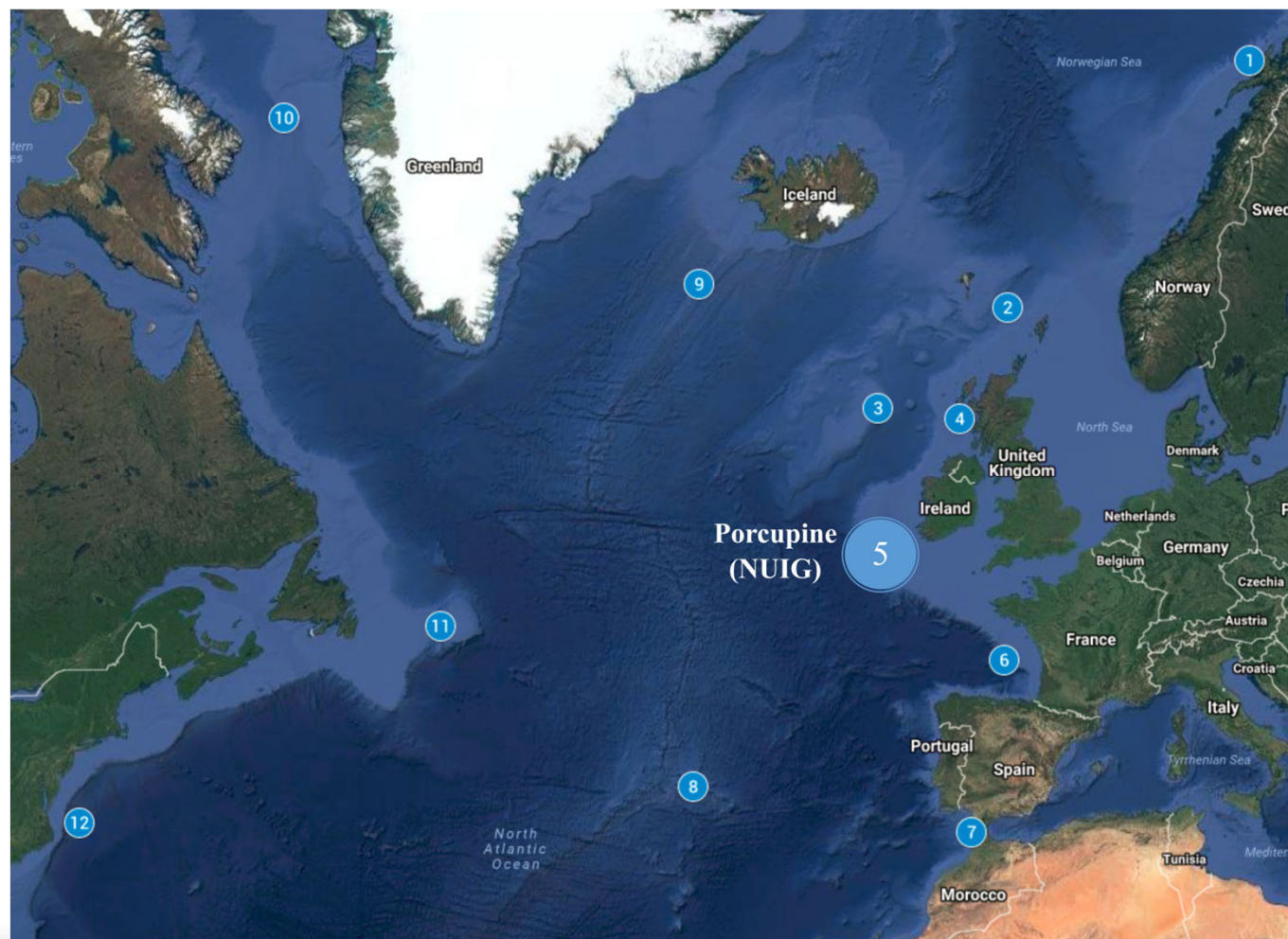


*Funiculina quadrangularis* predicted intensity





# atlas CS5 Porcupine (NUIG)

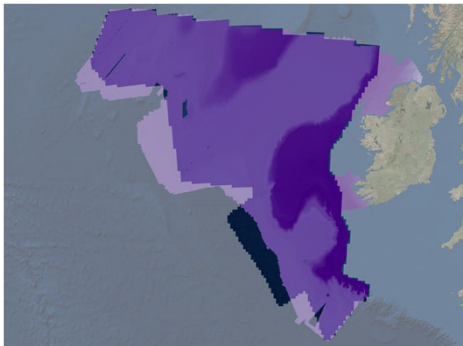


Anthony Grehan & Oisín Callery

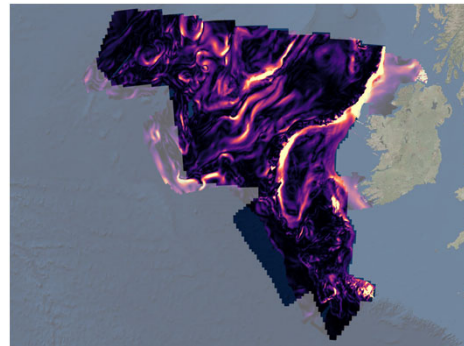


# atlas CS5 Data sources & Methods

Environmental layers used in final models



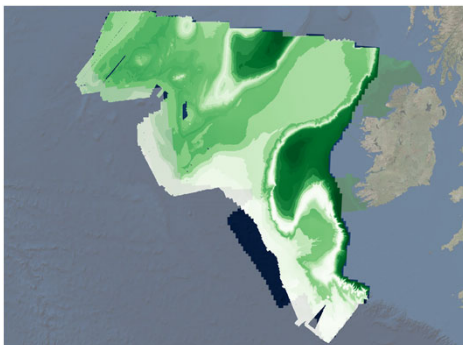
Omega Aragonite



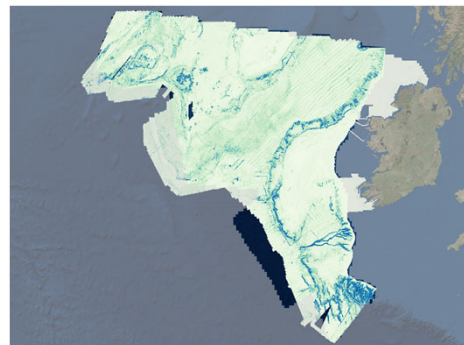
Bottom Stress



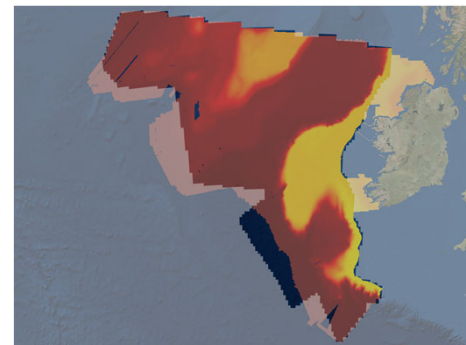
BPI



Oxygen Saturation



Std. Dev. Slope



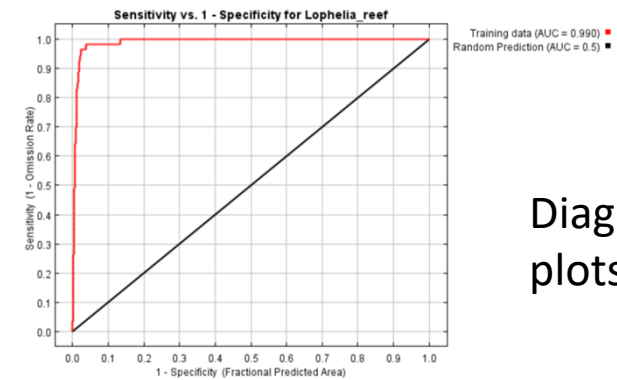
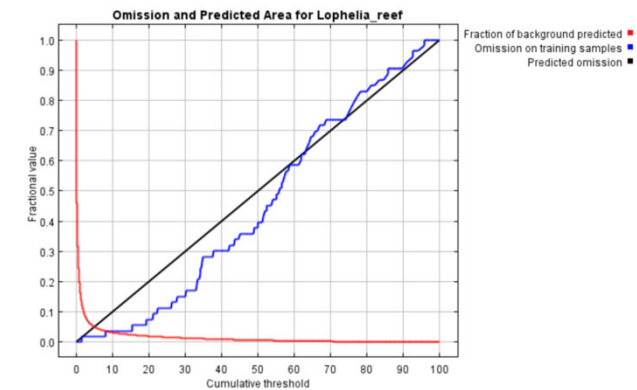
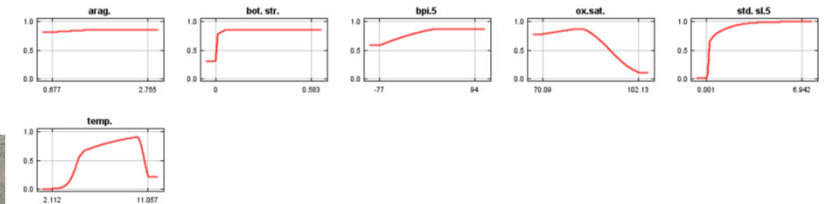
Temperature

Modelled *Lophelia pertusa* PO records using MaxEnt



# atlas CS5 Maps & Results

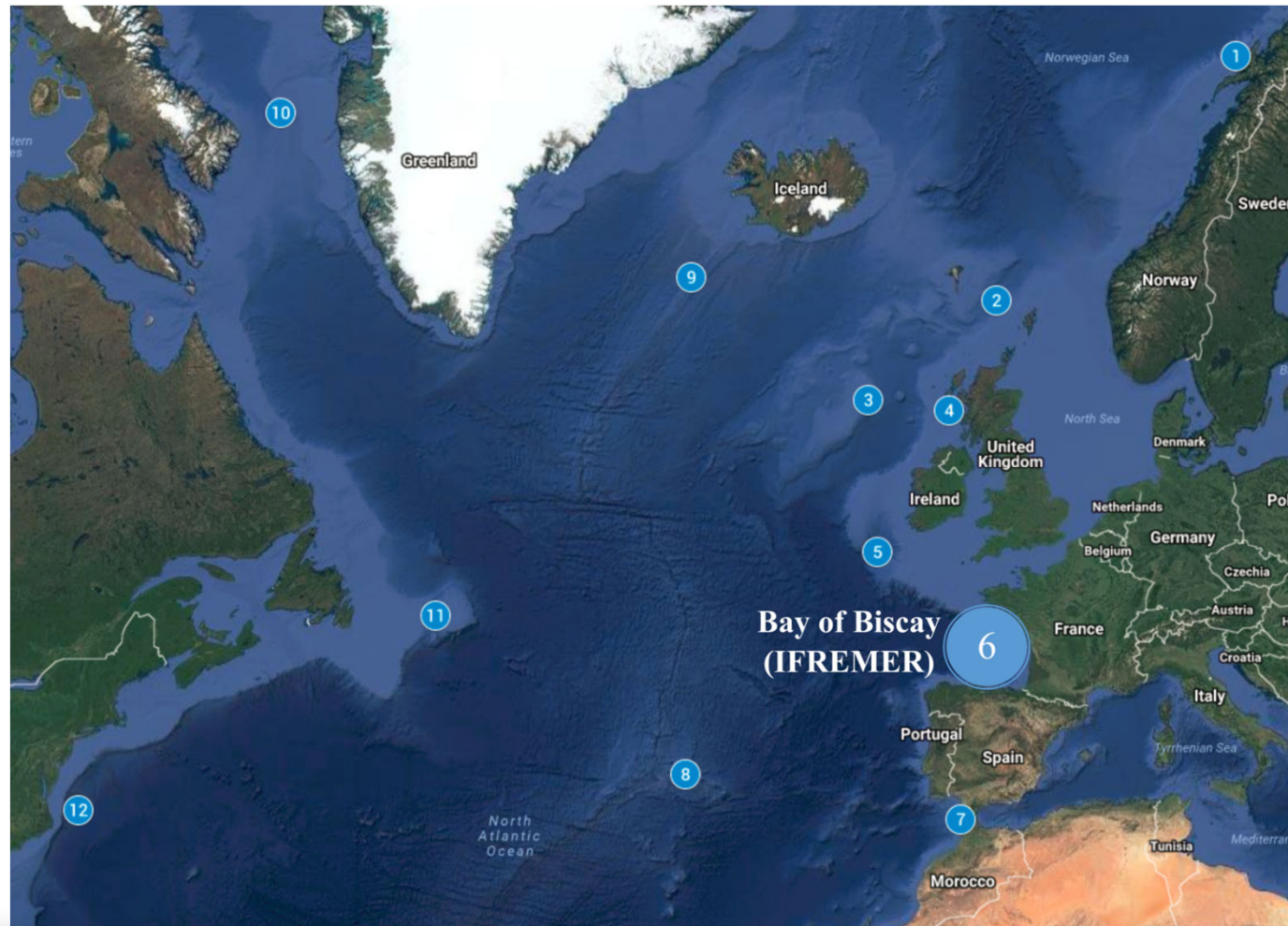
Relative probability of presence



Diagnostic  
plots



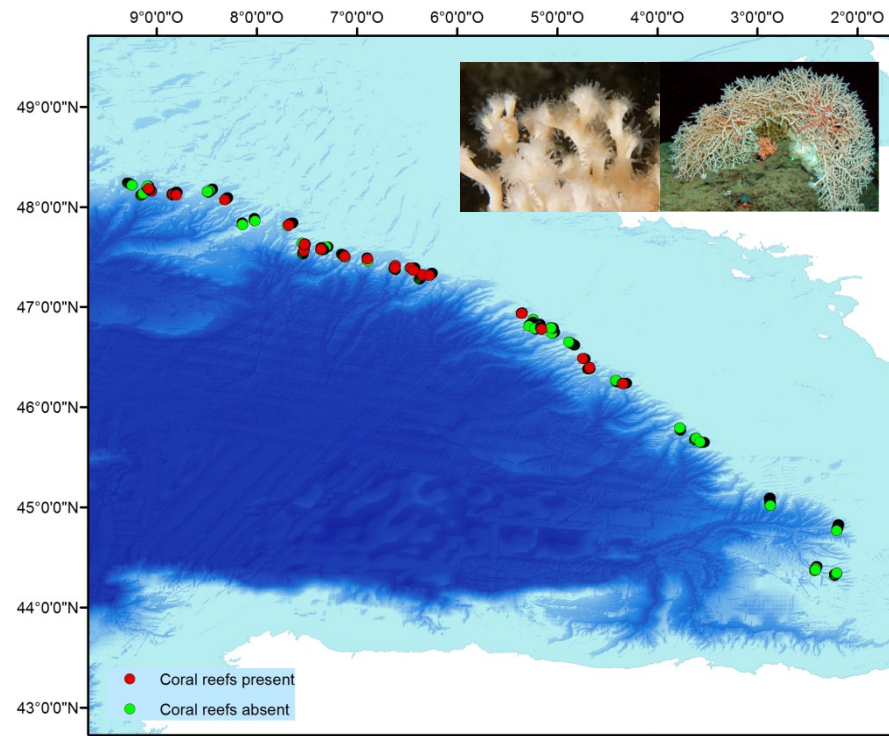
# atlas CS6 Bay of Biscay (IFREMER)



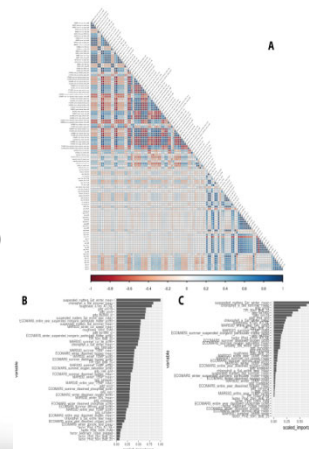
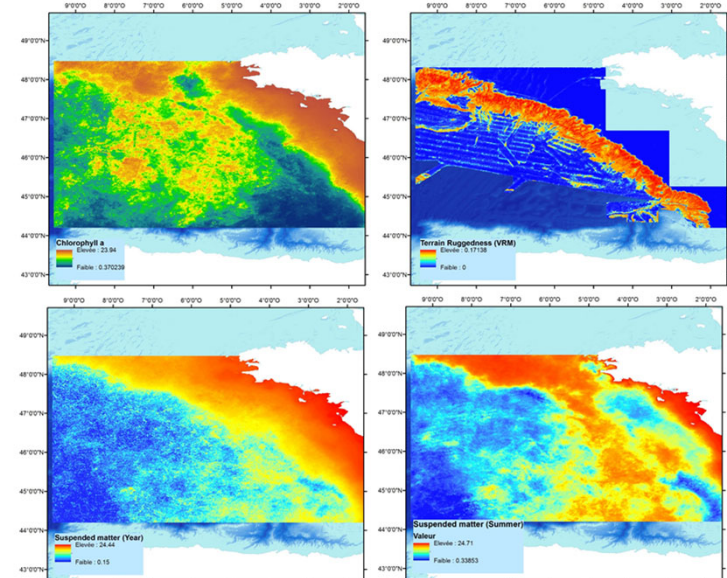
Sandrine Vaz, Pascal Laffargue, Sébastien Rochette, Lenaick Menot



# atlas CS6 Data sources & Methods



Presence/Absence of *L. pertusa* and *M. oculata* larger than 25 m<sup>2</sup>, from images of 50 video/photo transects in 24 canyons

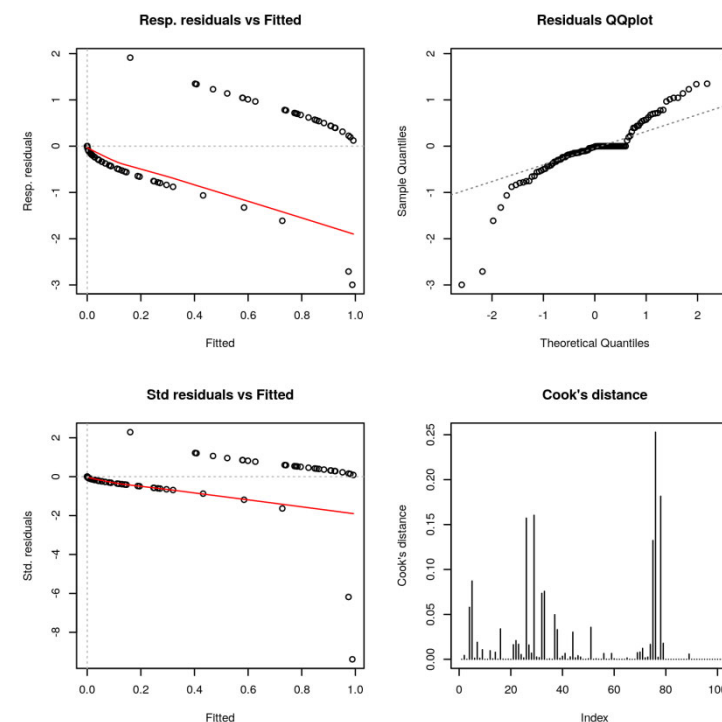
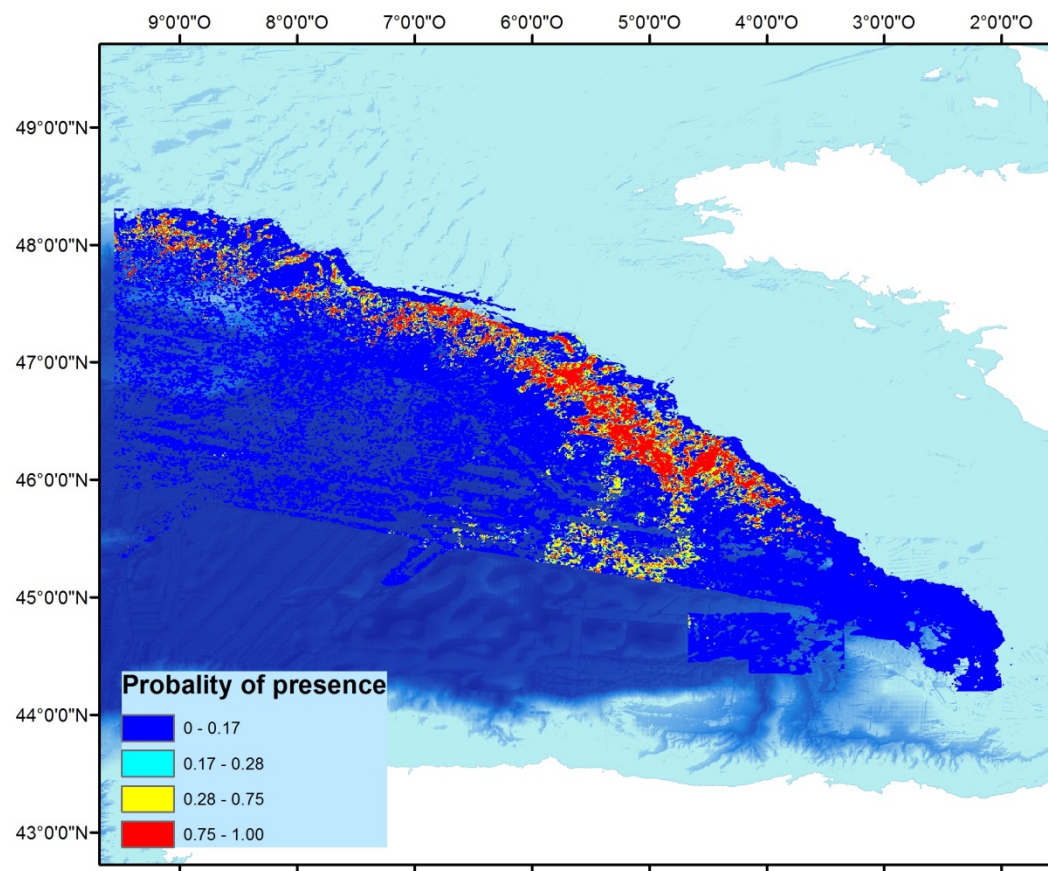


A two-step modelling approach:

- 1) Variable selection using both RF & BRT
- 2) GAM/GLM models



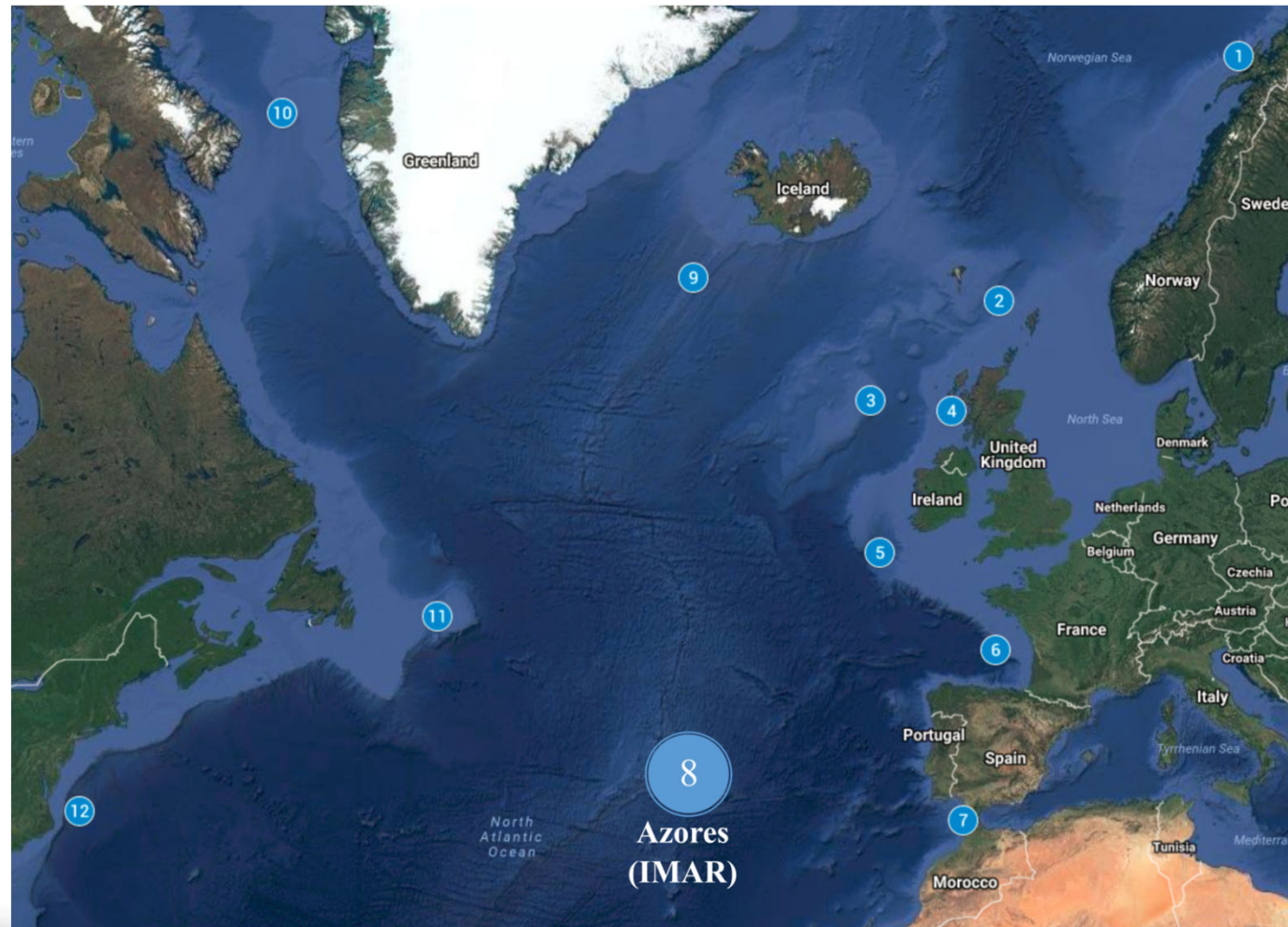
# atlas CS6 Maps & Results



Diagnostic plots



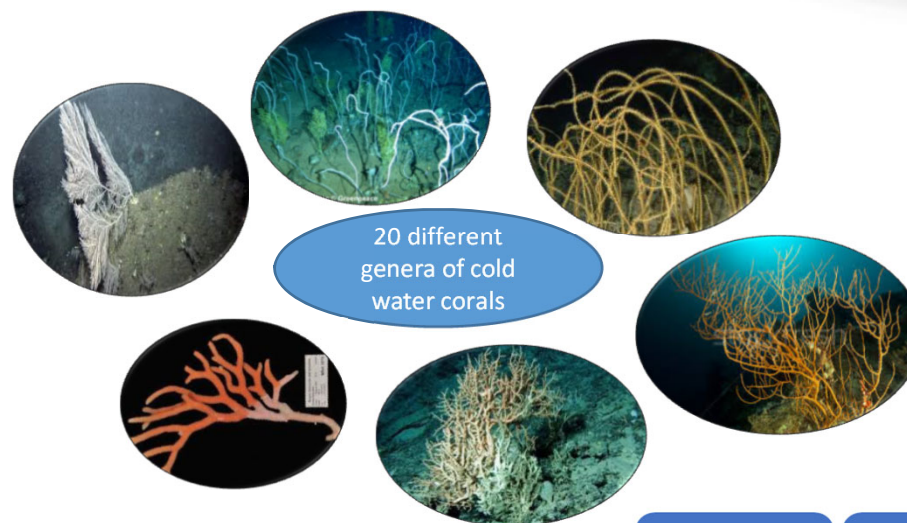
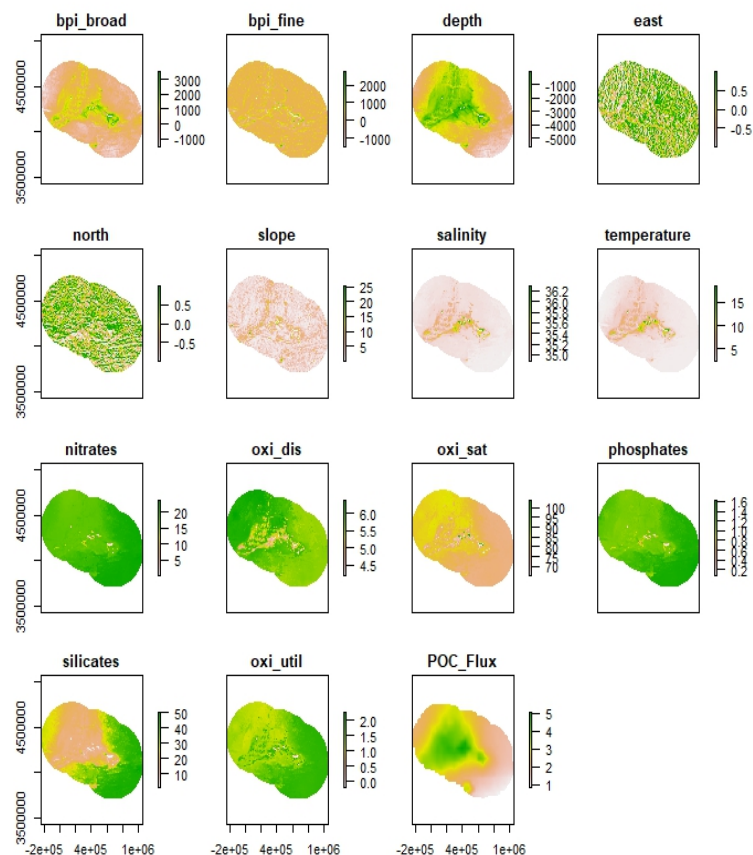
# atlas CS8 Azores (IMAR)



Telmo Morato, José Gonzalez-Irusta, Gerald Taranto, et al.



# atlas CS8 Data sources & Methods



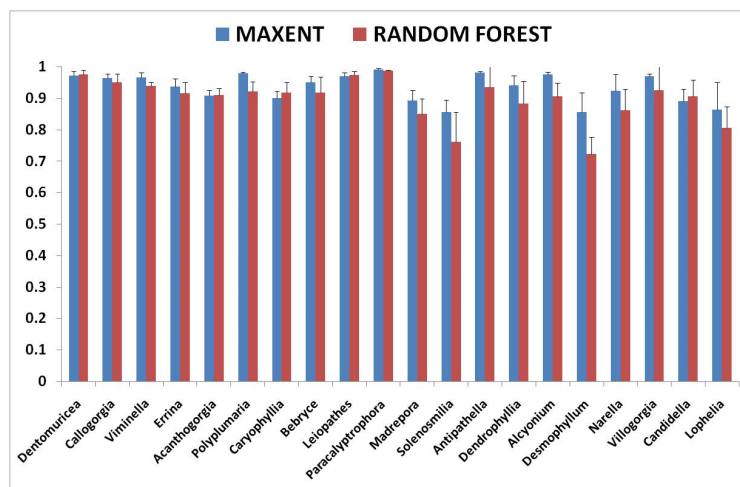
## 2 DIFFERENT APPROACHES

- Random forest using pseudo-absences (10,000 points in rasters with around 14,000 cells avoiding the presence points)
- MaxEnt (using background points)



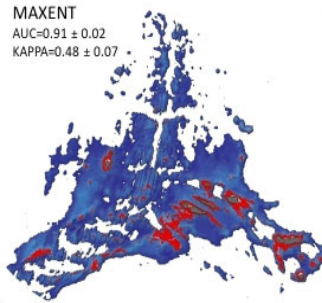


# atlas CS8 Maps & Results

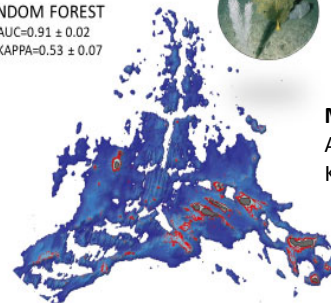


## Acanthogorgia

MAXENT  
AUC=0.91 ± 0.02  
KAPPA=0.48 ± 0.07

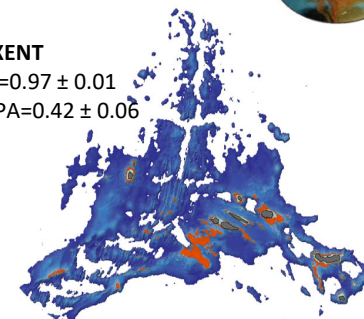


RANDOM FOREST  
AUC=0.91 ± 0.02  
KAPPA=0.53 ± 0.07



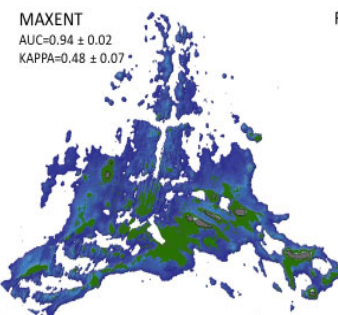
## Leopathes

MAXENT  
AUC=0.97 ± 0.01  
KAPPA=0.42 ± 0.06

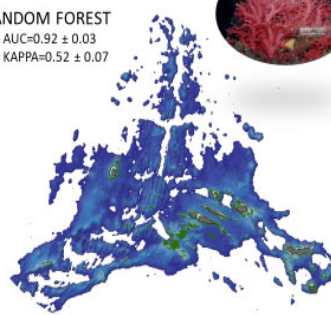


## Errina

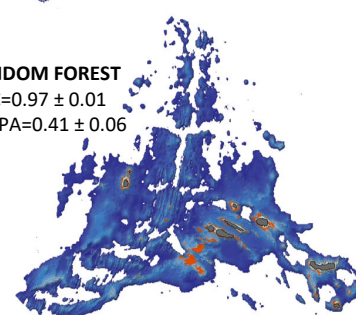
MAXENT  
AUC=0.94 ± 0.02  
KAPPA=0.48 ± 0.07



RANDOM FOREST  
AUC=0.92 ± 0.03  
KAPPA=0.52 ± 0.07

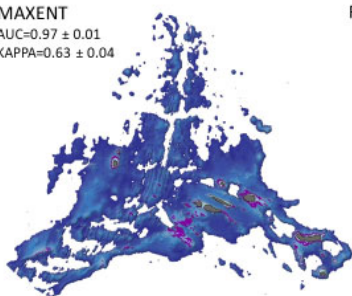


RANDOM FOREST  
AUC=0.97 ± 0.01  
KAPPA=0.41 ± 0.06

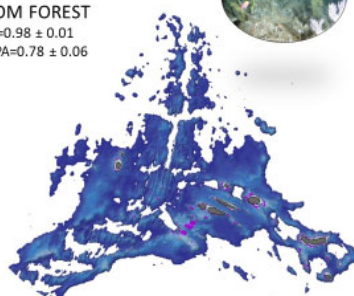


## Dentomuricea

MAXENT  
AUC=0.97 ± 0.01  
KAPPA=0.63 ± 0.04



RANDOM FOREST  
AUC=0.98 ± 0.01  
KAPPA=0.78 ± 0.06

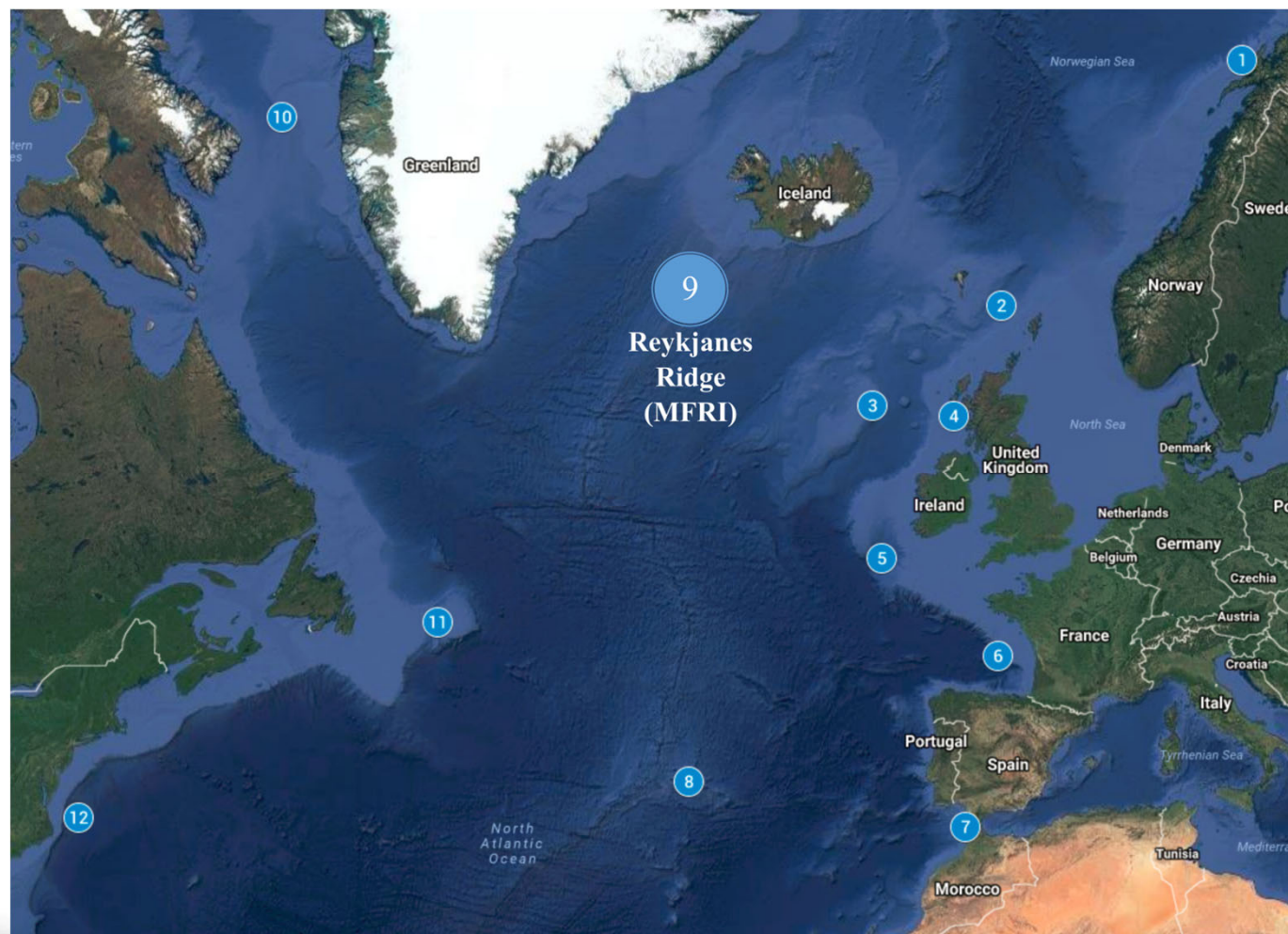


Most of the models showed values of AUC and kappa higher than the threshold for a good performance (0.7 and 0.4 respectively)

Depth was the most important variable for most of the models, followed by oxygen saturation and Particle Organic Carbon (POC) flux



# atlas CS9 Reykjanes Ridge (MFRI)



Hrönn Egilsdottir, José Gonzalez-Irusta, Telmo Morato, Stefan Aki Ragnarsson



# atlas CS9 Data sources & Methods

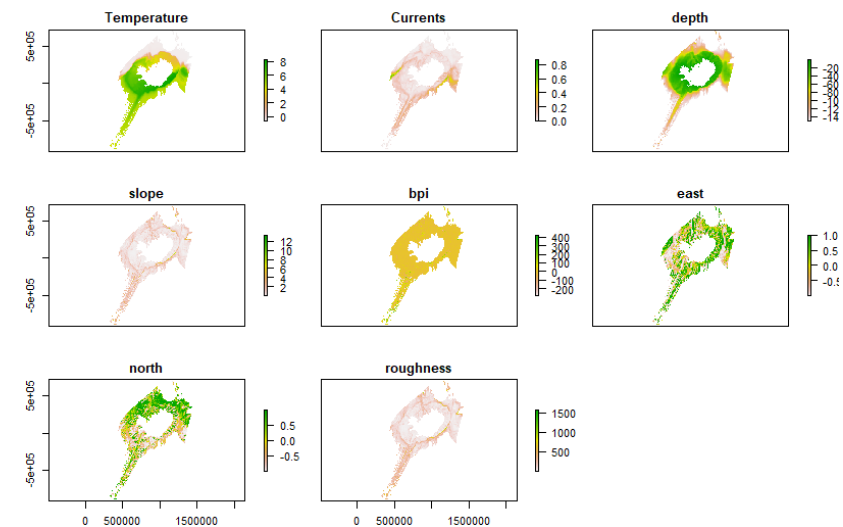
## *Helicolenus dactylopterus*



Trawl survey data (1989 – 2009)



## Environmental variables

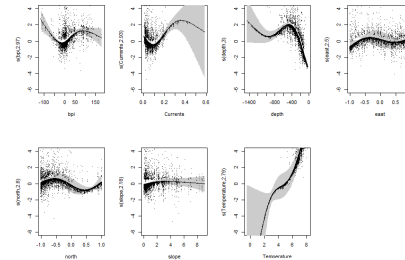


- Depth & derivatives
- Temperature and Current velocities (avg)
- Predictions made for 2 time periods:
  - 1989 – 1998
  - 1999 - 2009
- Used MaxEnt & GAMs



# atlas CS9 Maps & Results

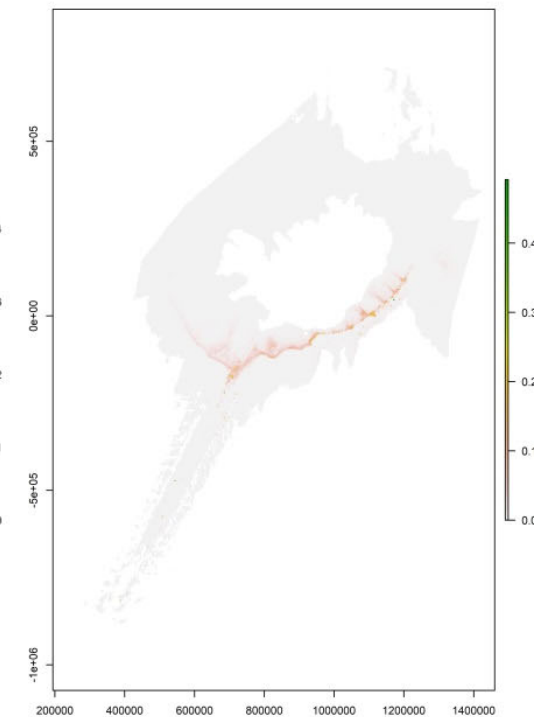
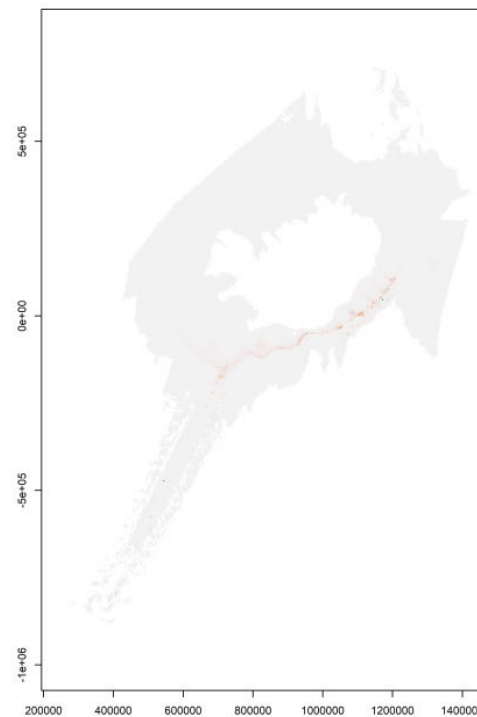
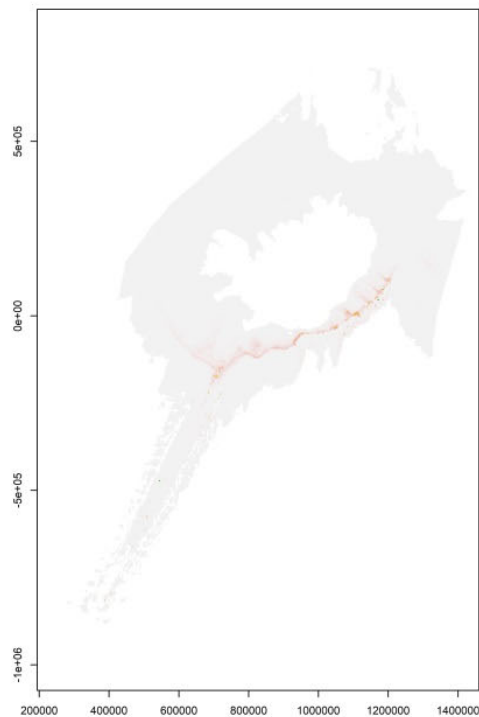
GAM results: the increase in abundance during second period likely related to increase in temperature



1989 - 2009

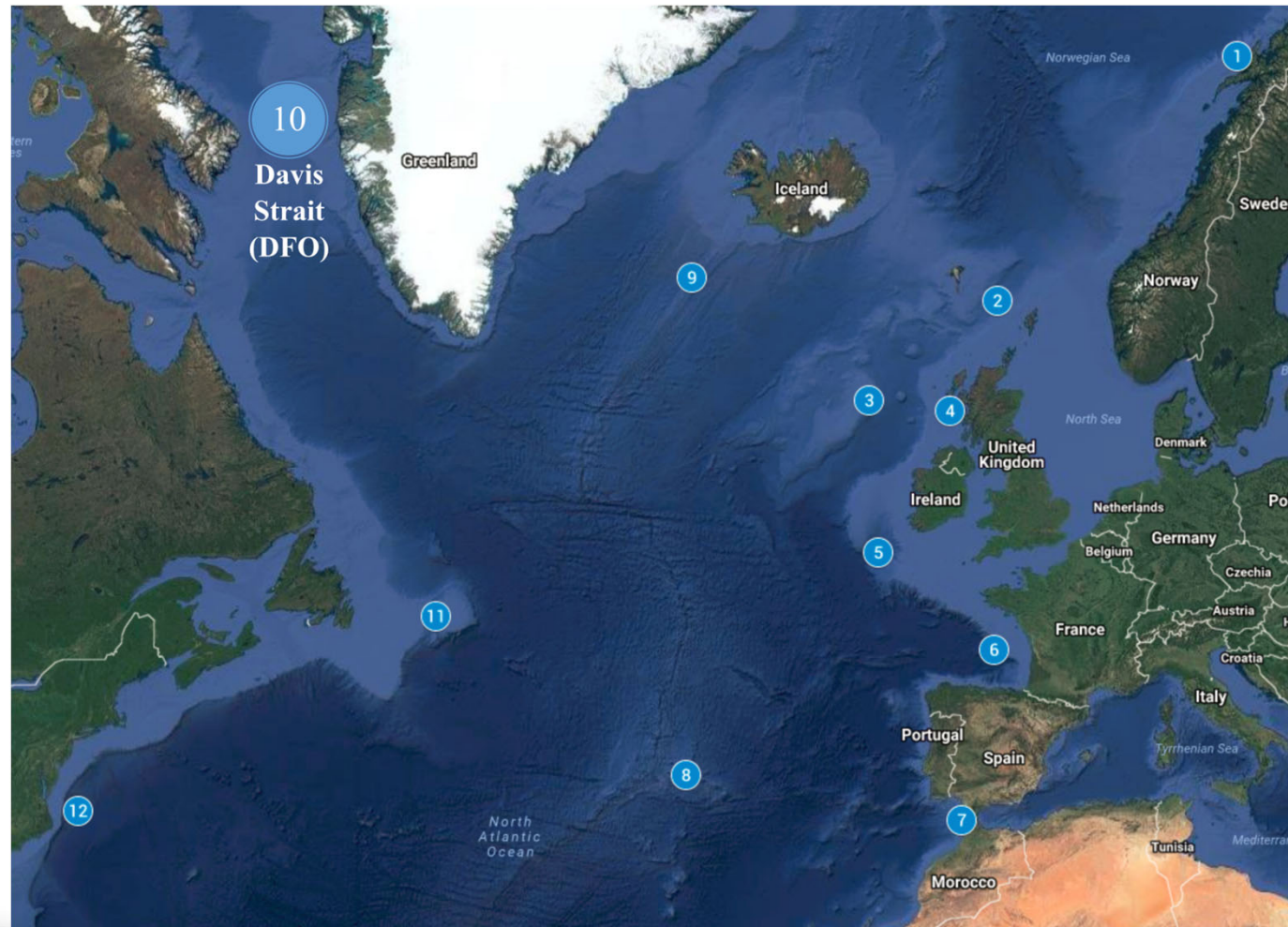
1989 - 1998

1999 - 2009





# atlas CS10 Davis Strait (DFO)

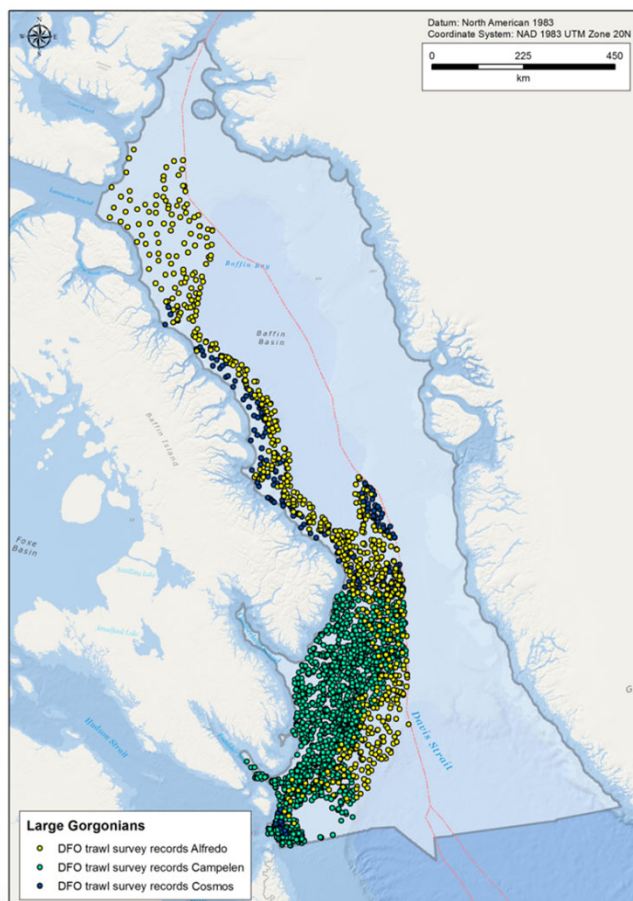


Ellen Kenchington, Lindsay Beazley, Javier Murillo



# atlas

## CS10 Data sources & Methods



**Environmental layers**  
used as predictor  
variables (n = 58)

**Occurrence data**  
from DFO trawl  
surveys (PA)

**Species groups:**

- Sea pens
- Small gorgonians
- Large Gorgonians

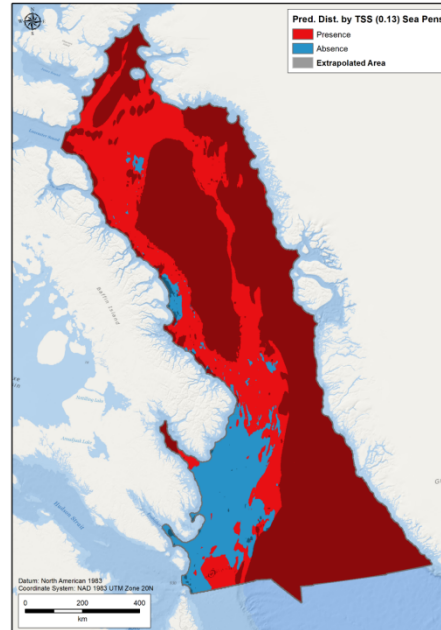
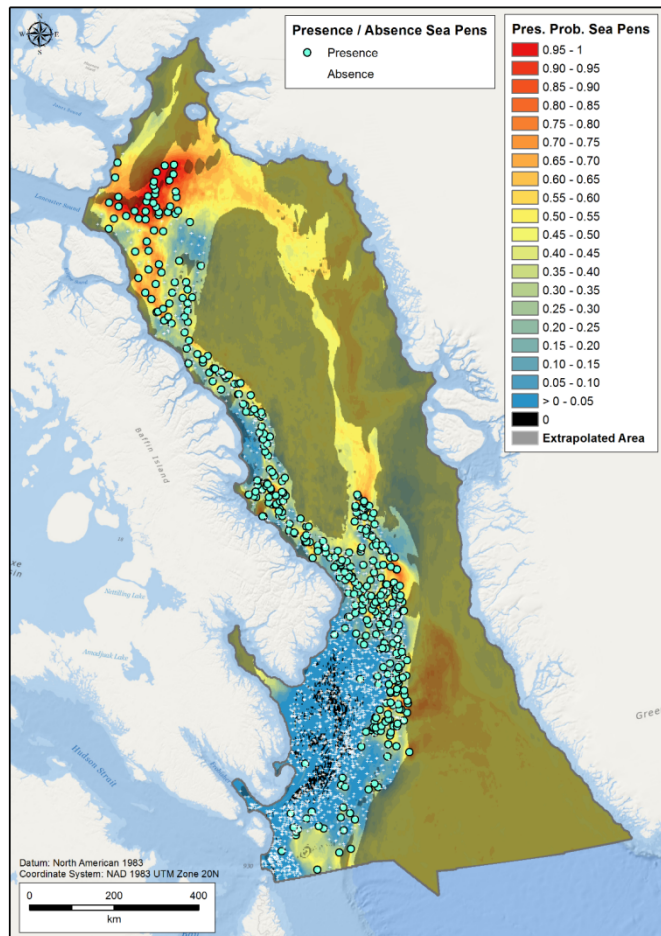
**Modelling methods:**

- Random Forest  
(classification)

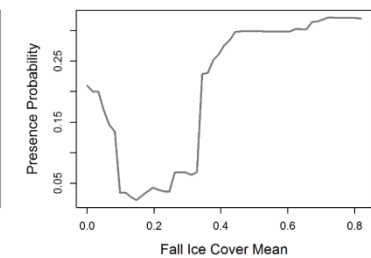
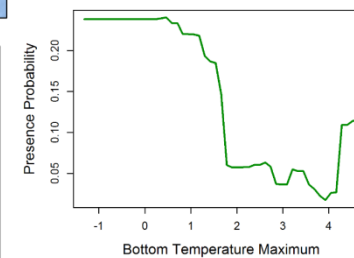
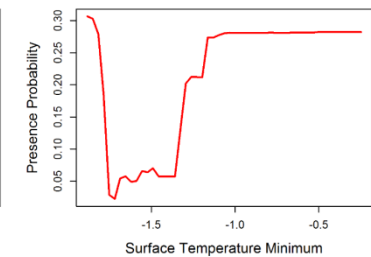
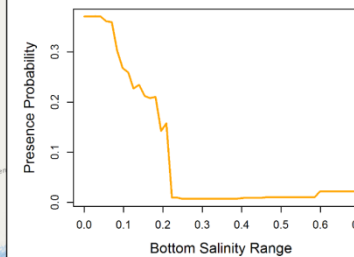
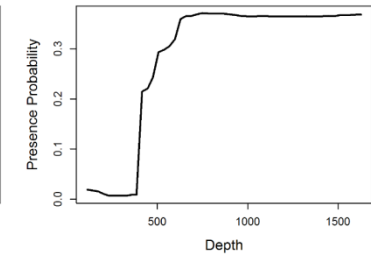
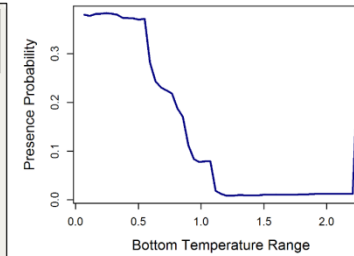
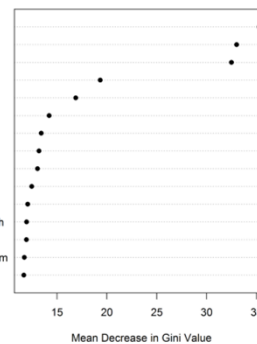
Variable	Data Source	Temporal Range	Unit	Native Resolution
Depth	GEBCO	N/A	metres	30 arc-sec.
Slope	GEBCO	N/A	degrees	30 arc-sec.
Bottom Salinity Mean	GLORYS2V1	1993 - 2011	N/A	‰
Bottom Salinity Minimum	GLORYS2V1	1993 - 2011	N/A	‰
Bottom Salinity Maximum	GLORYS2V1	1993 - 2011	N/A	‰
Bottom Salinity Range	GLORYS2V1	1993 - 2011	N/A	‰
Bottom Temperature Mean	GLORYS2V1	1993 - 2011	°C	‰
Bottom Temperature Minimum	GLORYS2V1	1993 - 2011	°C	‰
Bottom Temperature Maximum	GLORYS2V1	1993 - 2011	°C	‰
Bottom Temperature Range	GLORYS2V1	1993 - 2011	°C	‰
Bottom Current Speed Mean	GLORYS2V1	1993 - 2011	m s <sup>-1</sup>	‰
Bottom Current Speed Minimum	GLORYS2V1	1993 - 2011	m s <sup>-1</sup>	‰
Bottom Current Speed Maximum	GLORYS2V1	1993 - 2011	m s <sup>-1</sup>	‰
Bottom Current Speed Range	GLORYS2V1	1993 - 2011	m s <sup>-1</sup>	‰
Bottom Shear Mean	GLORYS2V1	1993 - 2011	Pa	‰
Bottom Shear Minimum	GLORYS2V1	1993 - 2011	Pa	‰
Bottom Shear Maximum	GLORYS2V1	1993 - 2011	Pa	‰
Bottom Shear Range	GLORYS2V1	1993 - 2011	Pa	‰
Surface Salinity Mean	GLORYS2V1	1993 - 2011	N/A	‰
Surface Salinity Minimum	GLORYS2V1	1993 - 2011	N/A	‰
Surface Salinity Maximum	GLORYS2V1	1993 - 2011	N/A	‰
Surface Salinity Range	GLORYS2V1	1993 - 2011	N/A	‰
Surface Temperature Mean	GLORYS2V1	1993 - 2011	°C	‰
Surface Temperature Minimum	GLORYS2V1	1993 - 2011	°C	‰
Surface Temperature Maximum	GLORYS2V1	1993 - 2011	°C	‰
Surface Temperature Range	GLORYS2V1	1993 - 2011	°C	‰
Surface Current Speed Mean	GLORYS2V1	1993 - 2011	m s <sup>-1</sup>	‰
Surface Current Speed Minimum	GLORYS2V1	1993 - 2011	m s <sup>-1</sup>	‰
Surface Current Speed Maximum	GLORYS2V1	1993 - 2011	m s <sup>-1</sup>	‰
Surface Current Speed Range	GLORYS2V1	1993 - 2011	m s <sup>-1</sup>	‰
Maximum Fall Mixed Layer Depth	GLORYS2V1	1993 - 2011	metres	‰
Maximum Winter Mixed Layer Depth	GLORYS2V1	1993 - 2011	metres	‰
Maximum Spring Mixed Layer Depth	GLORYS2V1	1993 - 2011	metres	‰
Maximum Summer Mixed Layer Depth	GLORYS2V1	1993 - 2011	metres	‰
Summer Chlorophyll a Mean	SeaWiFS Level-3, NASA's OceanColor	2001 - 2010	mg m <sup>-3</sup>	9 km
Summer Chlorophyll a Minimum	SeaWiFS Level-3, NASA's OceanColor	2001 - 2010	mg m <sup>-3</sup>	9 km
Annual Chlorophyll a Mean	SeaWiFS Level-3, NASA's OceanColor	2001 - 2010	mg m <sup>-3</sup>	9 km
Annual Chlorophyll a Minimum	SeaWiFS Level-3, NASA's OceanColor	2001 - 2010	mg m <sup>-3</sup>	9 km
Summer Primary Production Mean	SeaWiFS Level-3 with other input parameters	2006 - 2010	mg C m <sup>-3</sup> day <sup>-1</sup>	9 km
Summer Primary Production Minimum	SeaWiFS Level-3 with other input parameters	2006 - 2010	mg C m <sup>-3</sup> day <sup>-1</sup>	9 km
Summer Primary Production Maximum	SeaWiFS Level-3 with other input parameters	2006 - 2010	mg C m <sup>-3</sup> day <sup>-1</sup>	9 km
Summer Primary Production Range	SeaWiFS Level-3 with other input parameters	2006 - 2010	mg C m <sup>-3</sup> day <sup>-1</sup>	9 km
Annual Primary Production Mean	SeaWiFS Level-3 with other input parameters	2006 - 2010	mg C m <sup>-3</sup> day <sup>-1</sup>	9 km
Annual Primary Production Minimum	SeaWiFS Level-3 with other input parameters	2006 - 2010	mg C m <sup>-3</sup> day <sup>-1</sup>	9 km
Annual Primary Production Maximum	SeaWiFS Level-3 with other input parameters	2006 - 2010	mg C m <sup>-3</sup> day <sup>-1</sup>	9 km
Annual Primary Production Range	SeaWiFS Level-3 with other input parameters	2006 - 2010	mg C m <sup>-3</sup> day <sup>-1</sup>	9 km
Spring Ice Cover Mean	HadISST	1993-2010	Percent (%)	1°
Spring Ice Cover Minimum	HadISST	1993-2010	Percent (%)	1°
Spring Ice Cover Maximum	HadISST	1993-2010	Percent (%)	1°
Spring Ice Cover Range	HadISST	1993-2010	Percent (%)	1°
Fall Ice Cover Mean	HadISST	1993-2010	Percent (%)	1°
Fall Ice Cover Minimum	HadISST	1993-2010	Percent (%)	1°
Fall Ice Cover Maximum	HadISST	1993-2010	Percent (%)	1°
Fall Ice Cover Range	HadISST	1993-2010	Percent (%)	1°
Winter Ice Cover Mean	HadISST	1993-2010	Percent (%)	1°
Winter Ice Cover Minimum	HadISST	1993-2010	Percent (%)	1°
Winter Ice Cover Maximum	HadISST	1993-2010	Percent (%)	1°
Winter Ice Cover Range	HadISST	1993-2010	Percent (%)	1°



# atlas CS10 Davis Strait (DFO)



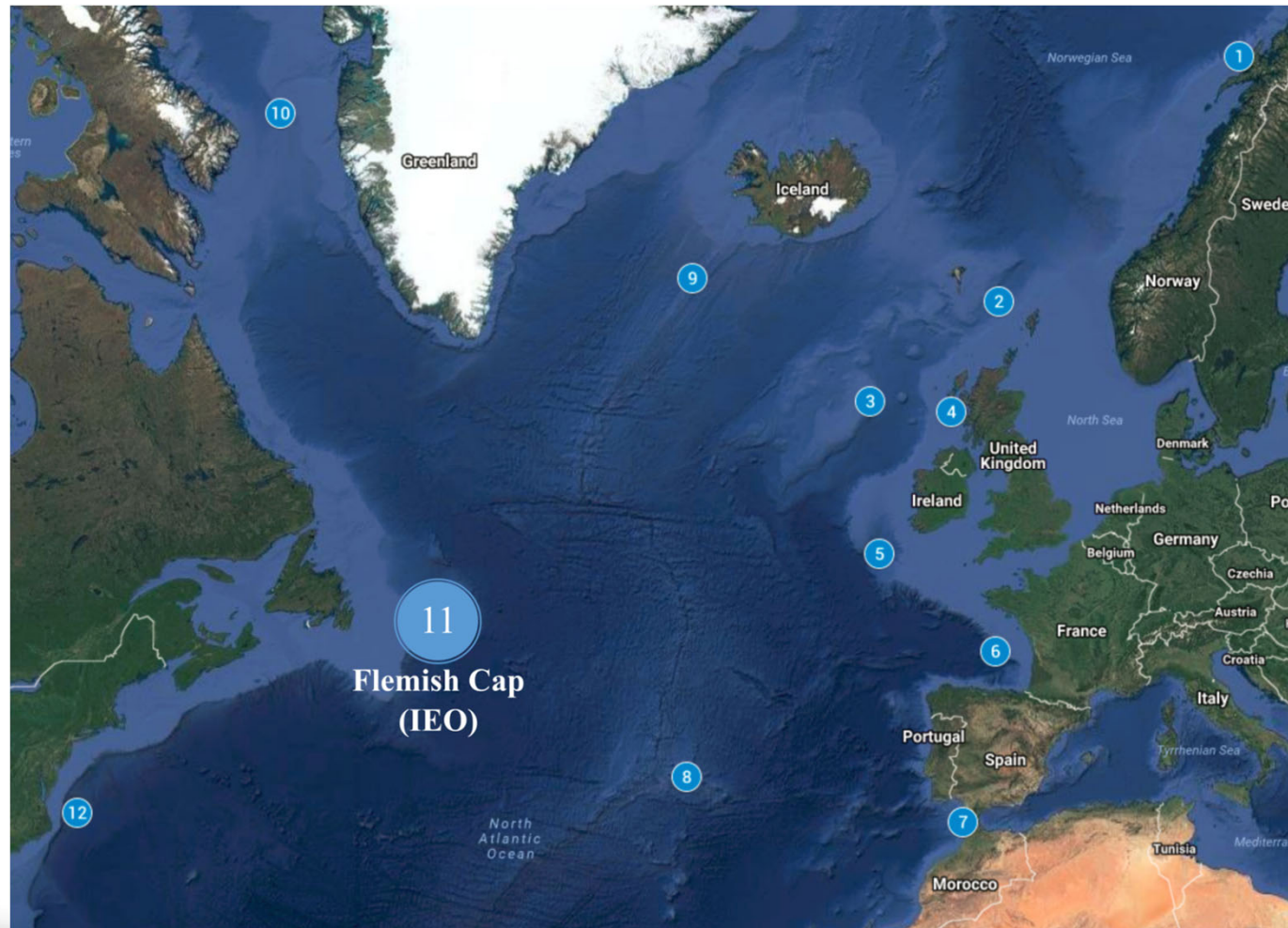
Bottom Temperature Range  
Depth  
Bottom Salinity Range  
Surface Temperature Minimum  
Bottom Temperature Maximum  
Fall Ice Cover Mean  
Bottom Temperature Mean  
Winter Ice Cover Mean  
Bottom Salinity Minimum  
Winter Ice Cover Range  
Bottom Temperature Minimum  
Maximum Winter Mixed Layer Depth  
Fall Ice Cover Maximum  
Annual Primary Production Maximum  
Annual Chlorophyll a Mean



e.g. Sea pens



# atlas CS11 Flemish Cap (IEO)

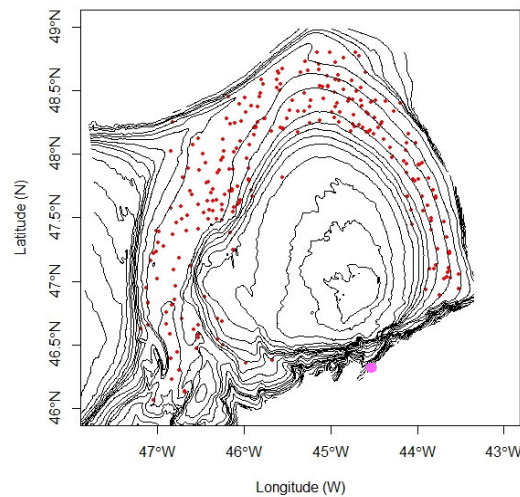


Mar Sacau, Ana García-Alegre, M. G. Pennino, Pablo Durán Muñoz



# atlas CS11 Data sources & Methods

*Funiculina quadrangularis*



**Species (sea pens)**  
*Anthoptilum grandiflorum*,  
*Pennatula aculeata*,  
*Acanella arbuscula* &  
*Funiculina quadrangularis*

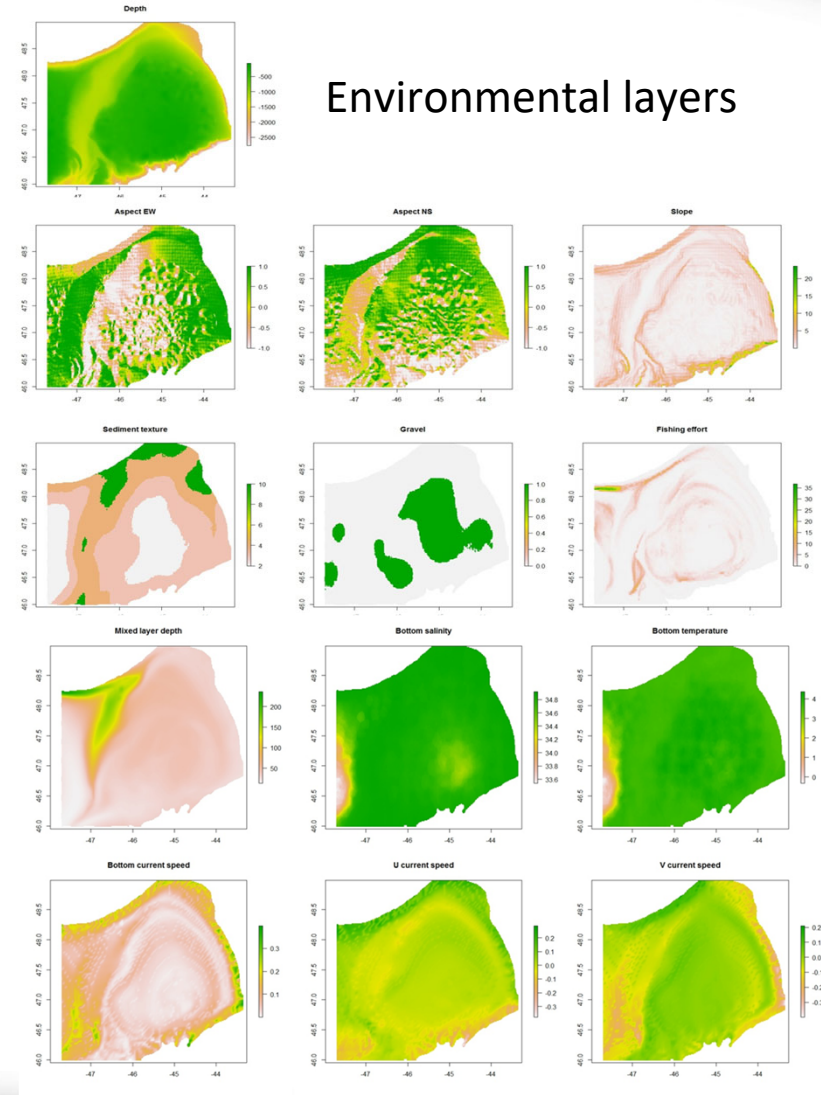
Modelling methods:

- GAM
- RF
- MaxEnt
- Ensemble

Sea pen  
 occurrence (PA)  
 data (2007-2017)  
 from R/V Vizconde  
 de EZA Groundfish  
 Surveys



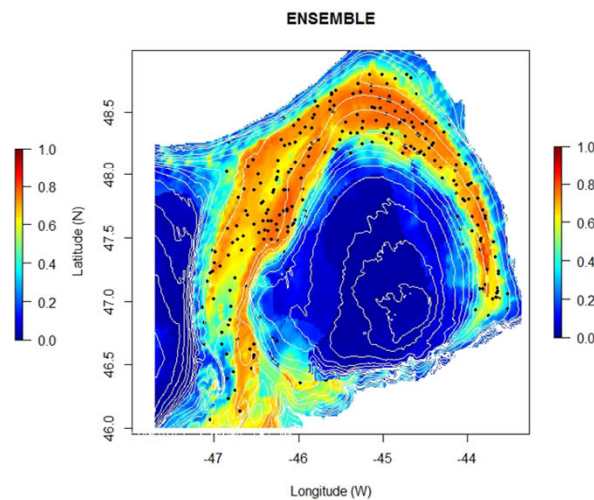
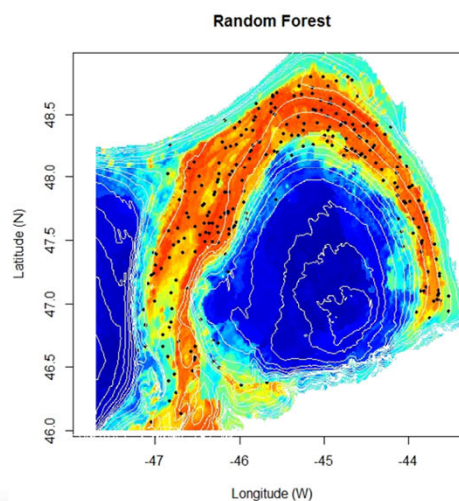
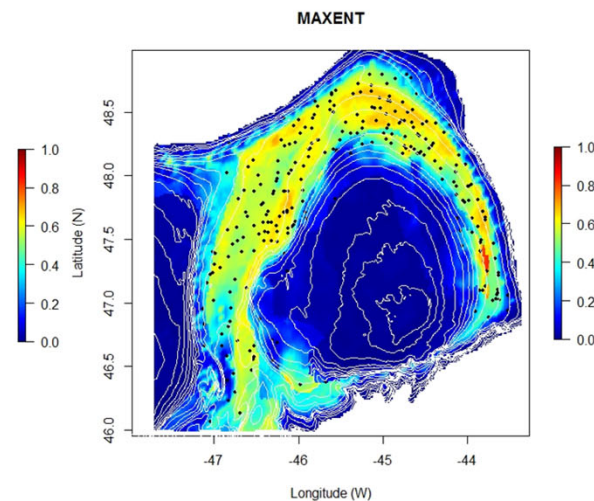
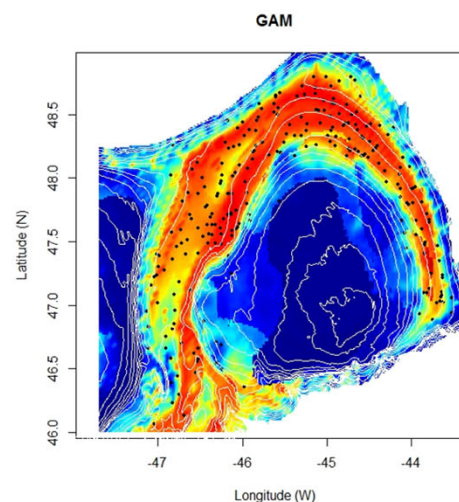
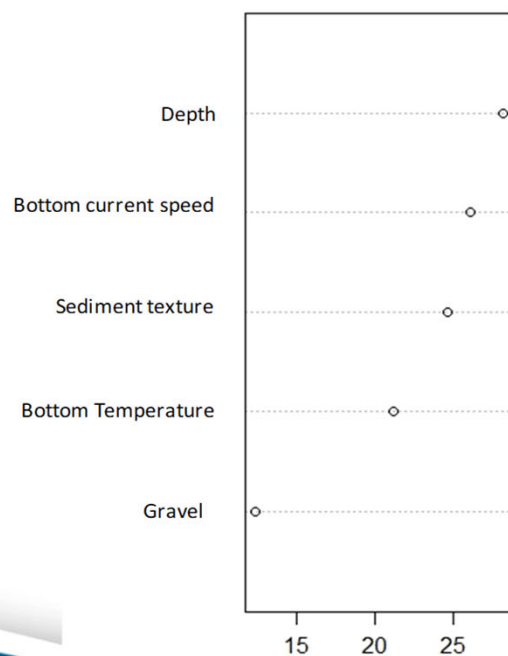
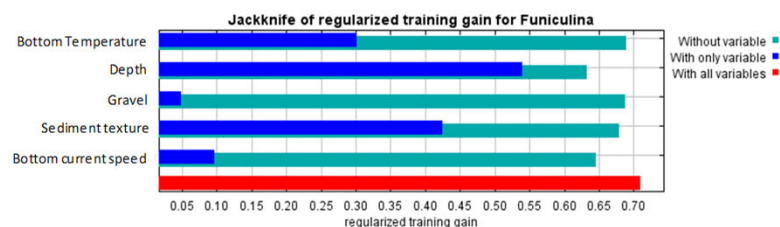
Environmental layers





# atlas CS11 Maps & Results

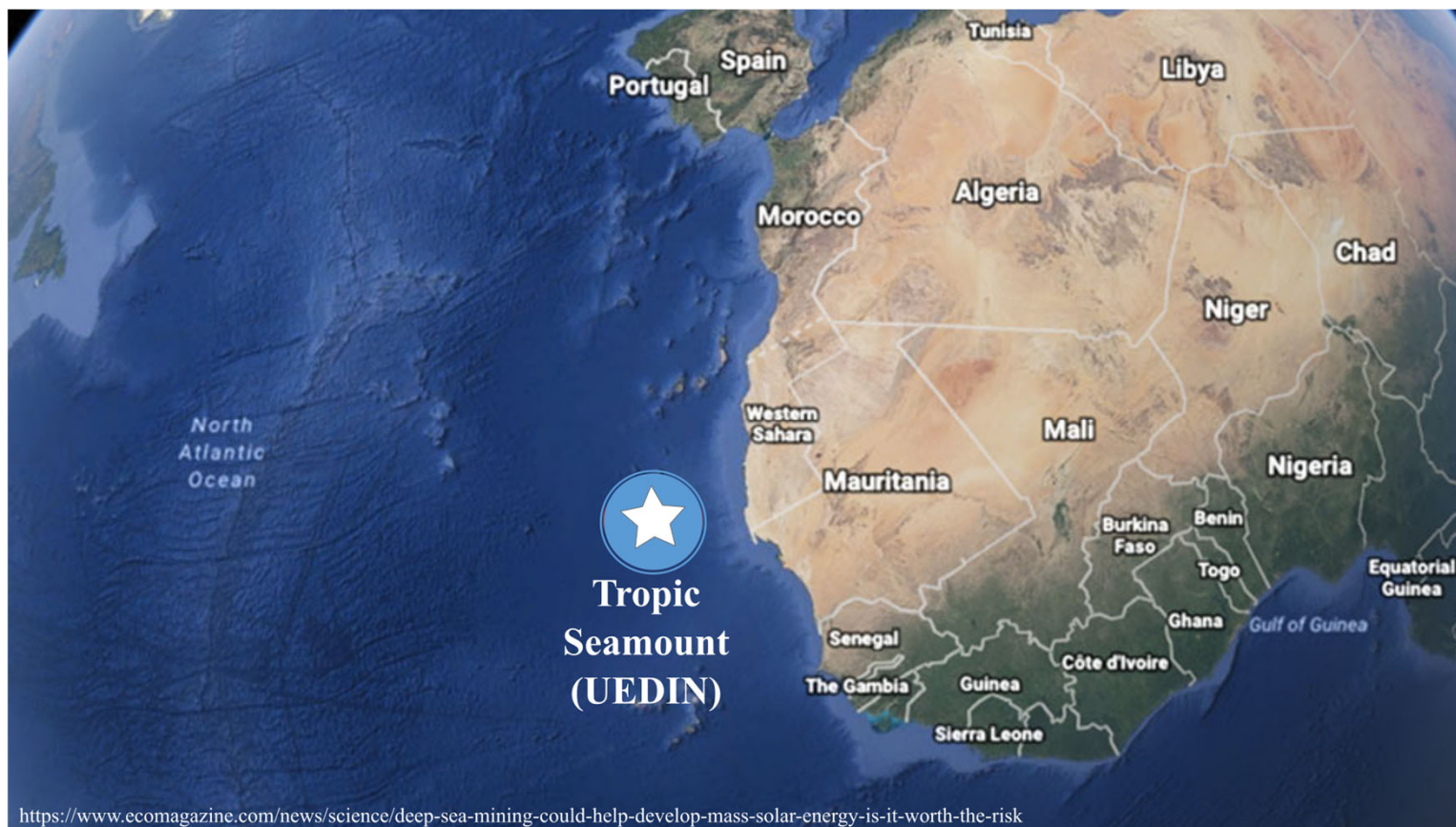
*E.g. Funiculina quadrangularis*





**atlas**

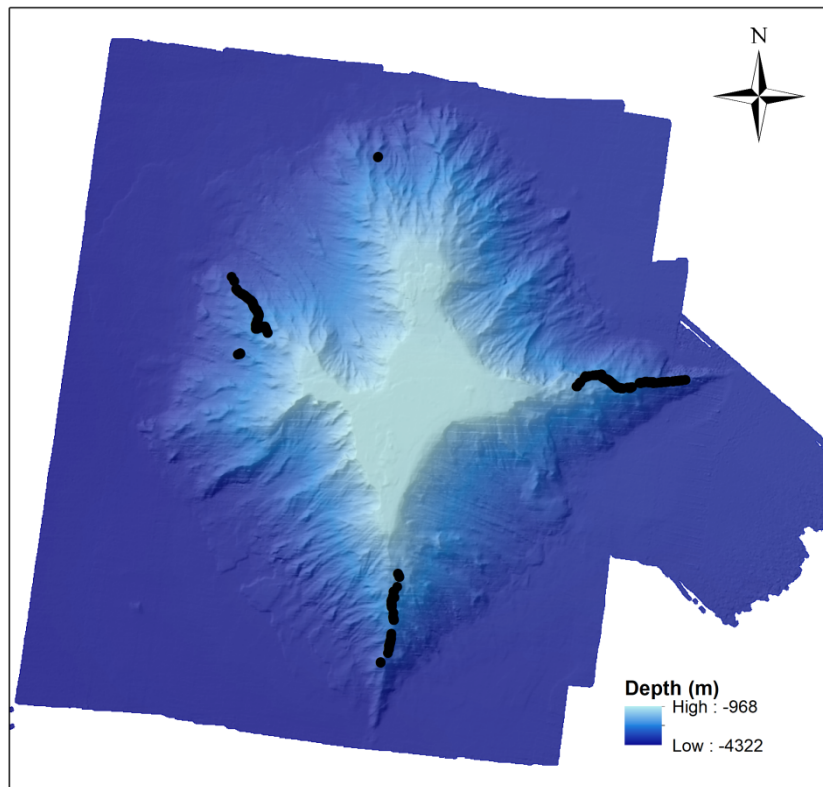
## Bonus CS: Trophic Seamount (UEDIN)



Berta Ramiro-Sanchez, Lea-Anne Henry



# atlas TSM: Data sources & Methods



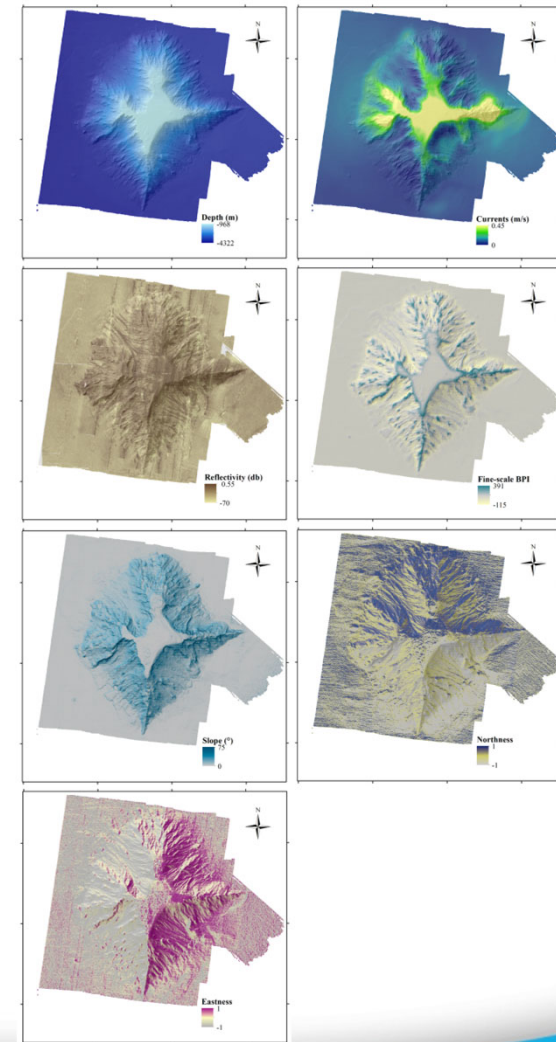
**Occurrence:** hexactinellid sponge  
*Poliopogon amadou* (PO)

## Environmental layers:

- Depth & derivatives
- Current velocities

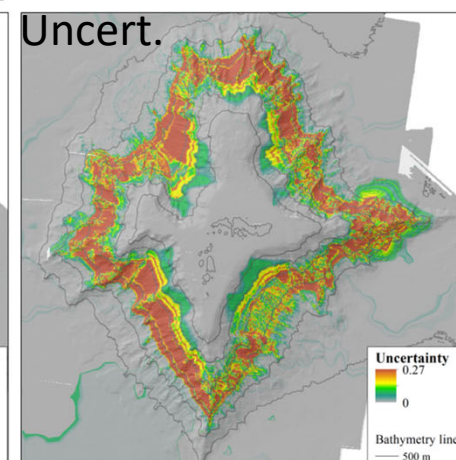
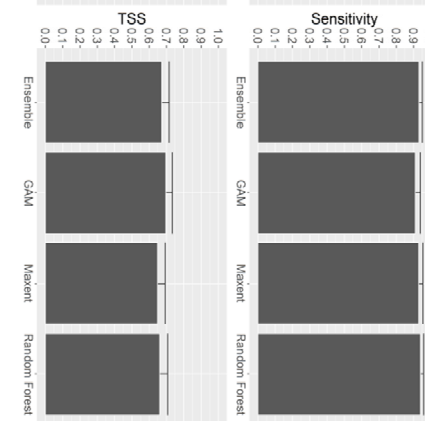
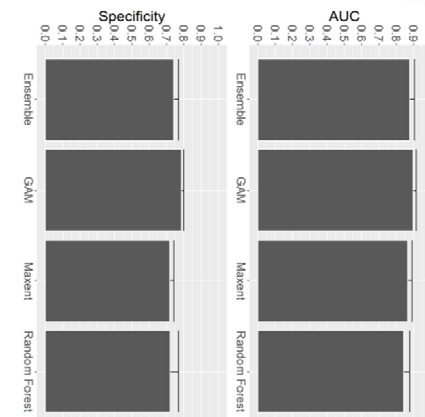
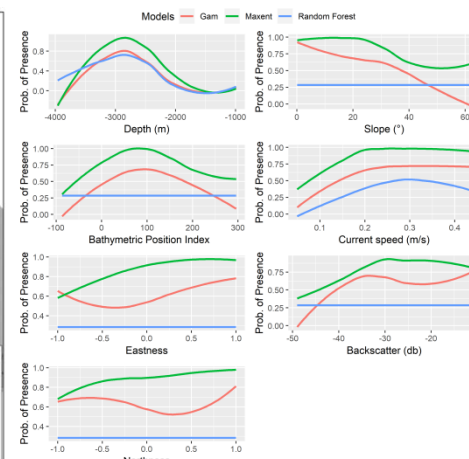
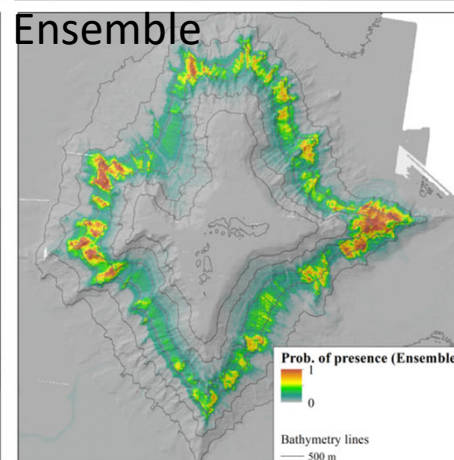
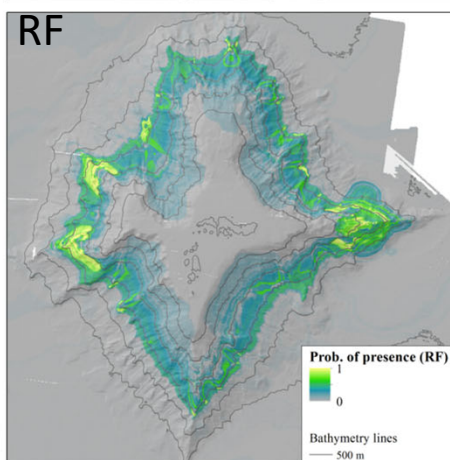
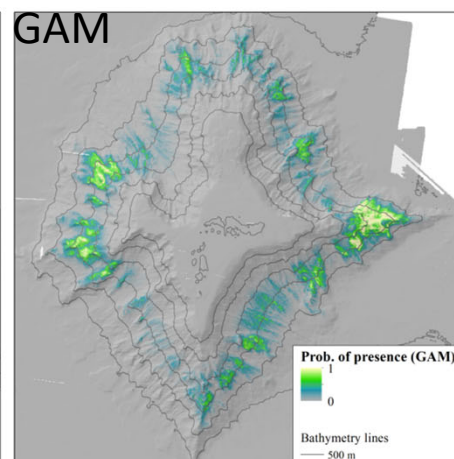
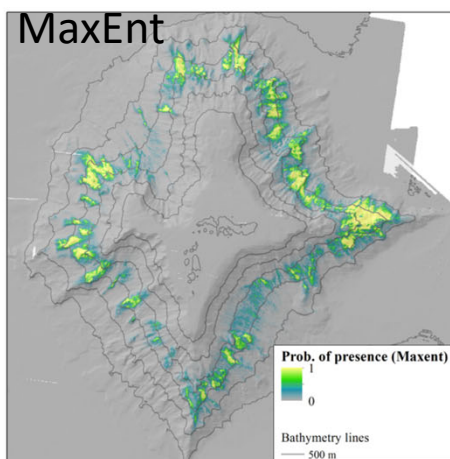
## Modelling methods:

- GAM
- MaxEnt
- RF (regression)
- Ensemble





## Bonus: Trophic Seamount (UEDIN)



# Thank You!



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Image credit: BGS