Aquamaps/AquaX project

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AquaMaps

AquaX

Modeling Marine Life

UBC

MIAMI

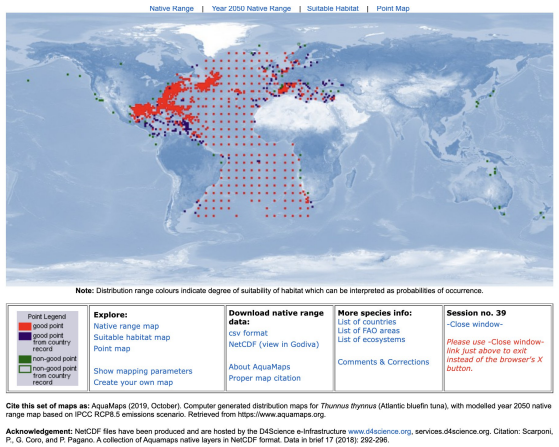
CHANGING OCEAN
THE UNIVERSITY OF BRITISH COLUMBIA

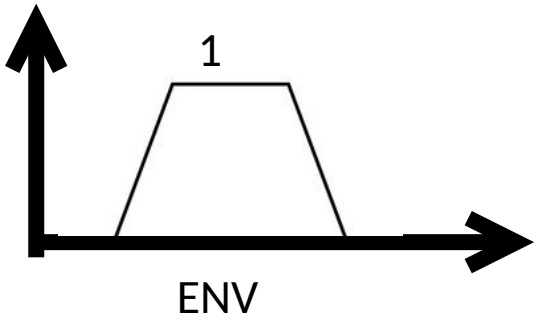
SeaLifeBase

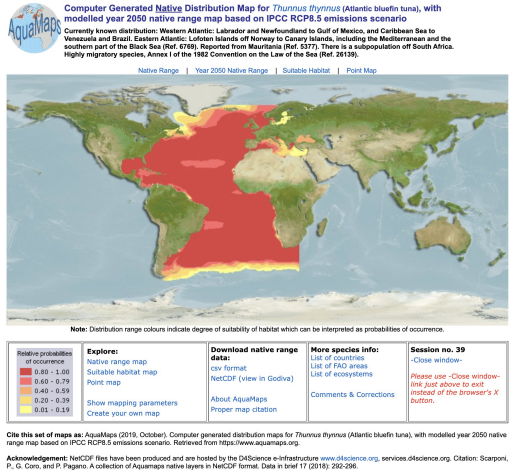
FishBase

History & Goals

The environmental envelope model was initially developed in 2005 based on the RES model (Kaschner et al, 2005) aka the **trapezoidal model**

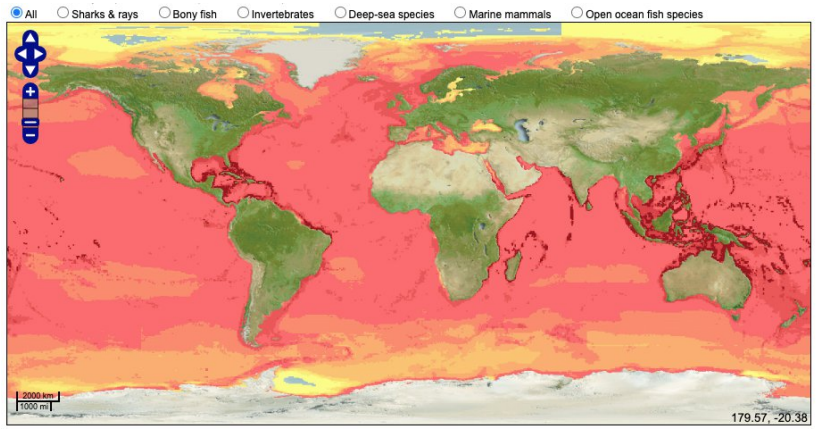






Research application fields:

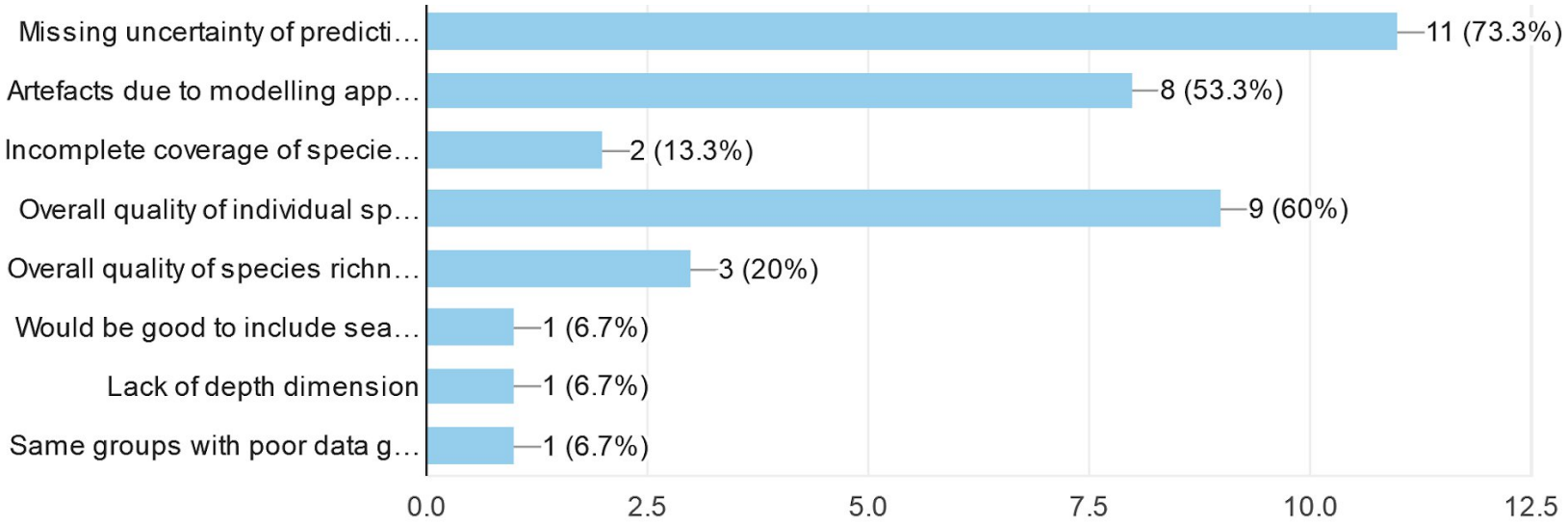
- Biodiversity
- Climate change research
- Spatial planning (and marine policy)



Where are we now

- 33,518 species mapped (23,699 using rule of at least >=10 good cells to generate envelope)
- A verified occurrence and metadata based
- 375 reviewed maps
- ~ 12,800 visits by 8,500 visitors/month
- 35 publications since 2014 involving core team
- Currently 800-1000 related citations / year

Changes Needed



A **clear need** for methodological changes with emphasis on :

+ Uncertainties (spatial, modelling procedure)
+ Biases on distribution (occurrence and models)
+ Quality of the model
+ Scientific development: Depth , seasonality, connectivity
+ A better Database / Approach to guide MPA managers

A new modelling approach

Philosophy “building on top of the monument built by the Aquamaps team”

Step 1: “ a more interconnected Database”

- taxonomy rests now on the **Aphia ID**
- Direct and interconnected link with OBIS, GBIF, WORMS, and soon Fishbase and Sealifebase
- 1 ID for 1 species including synonyms

WoRMS
World Register of Marine Species

A new modelling approach

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Step 2: “ Verification of occurrence and metadata”

- All occurrences are now verified either manually (Aquamaps Db) or numerically (OBIS, AquaX) based on **literature** and **geographical** test

- Expert range maps from IUCN were all integrated in the AquaX workflow:
  verification of the occurrence / definition of native range

- All the metadata (habitat and biogeographical information) are reverified by the Aquamaps **team based on the literature and taxonomist expert**

A new modelling approach

Philosophy “building on top of the monument built by the Aquamaps team”

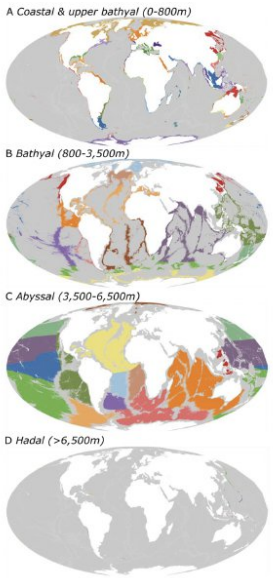
Step 3: “ a new definition for native range and climate range ”

- If no expert range map are available
- FAO area were dropped from the AquaX workflow to respect the ecological distribution of species

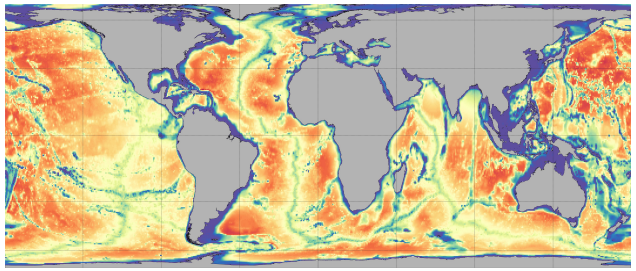
Habitat of the species

Seafloor associated

Pelagic associated



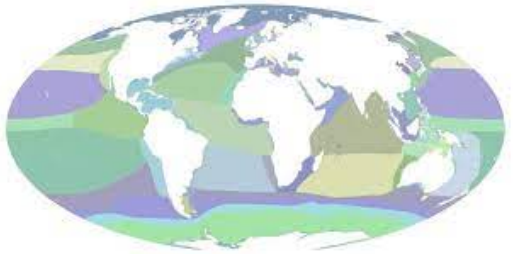
Depth range filtration



Habitat filtration

Coral reef
Kelp forest
Seamount …

Pelagic Province of the world



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A new modelling approach

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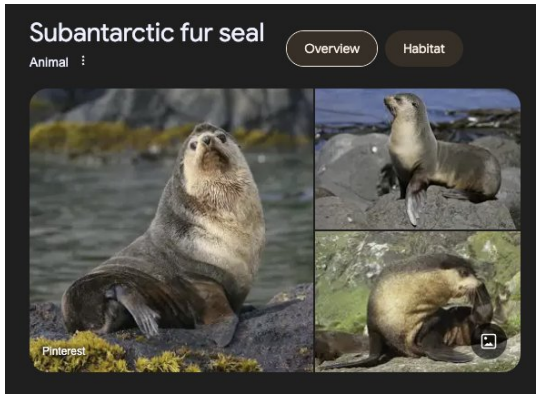
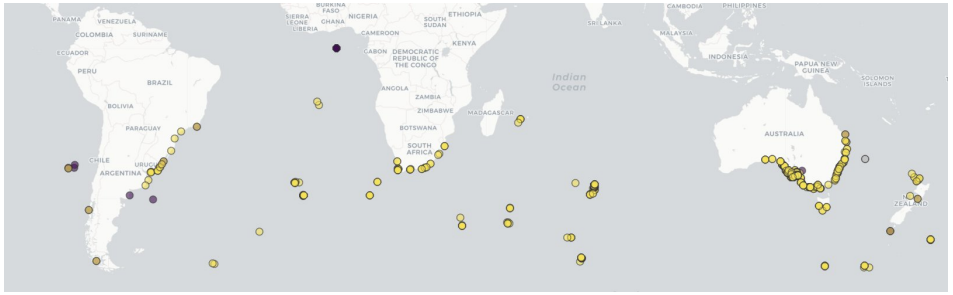
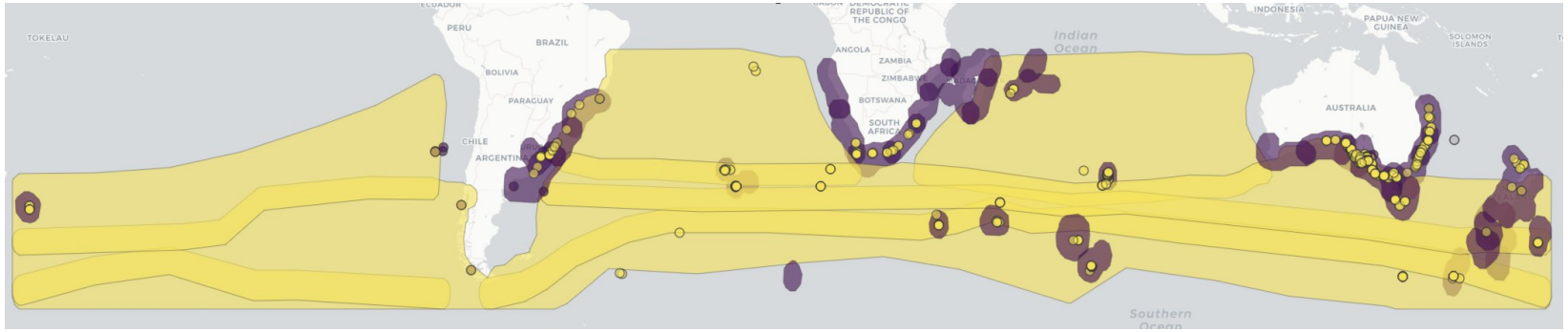
Step 3: “ a new definition for native range and climate range ”



occurrence



Native range

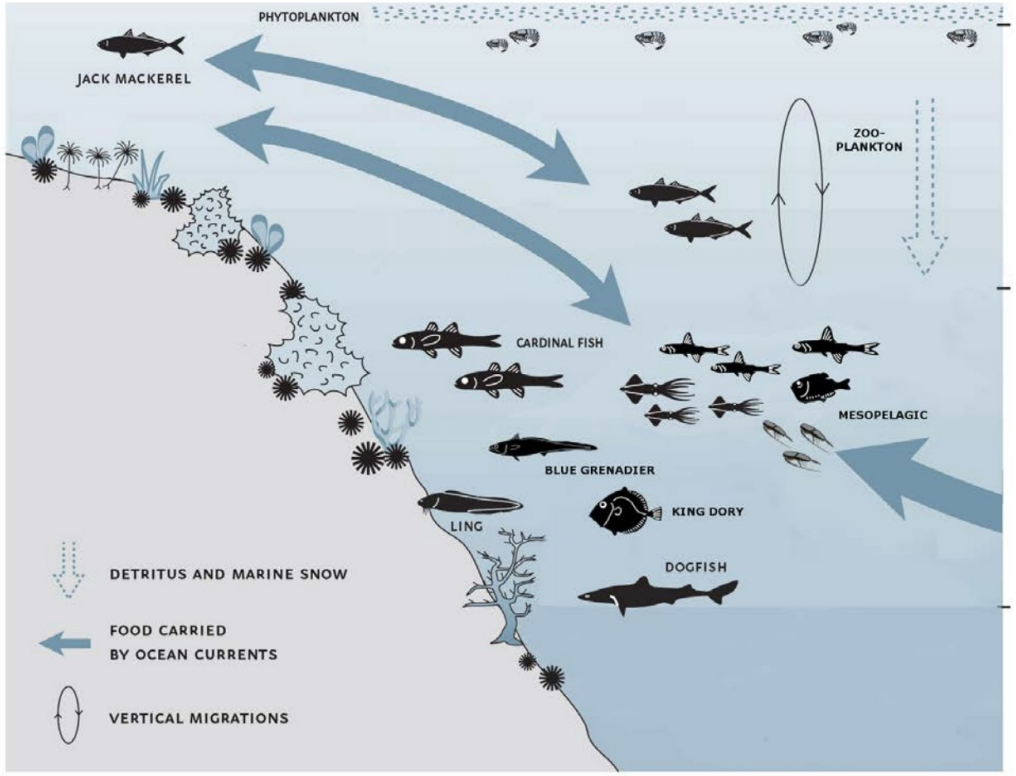


Climate range is defined as all the neighbouring province where the species
Could access within the next 80 years based on climate velocity

A new modelling approach

Philosophy “building on top of the monument built by the Aquamaps team”

Step 4: “Environmental data fitted for climate change study and conservation ”



+ Selection of the variable based on the ecology of the species (Seafloor, surface)

+ Selection of set of variable based on the ecology and taxa of the species (based on expert knowledge and literatureà

+ Selection of Pseudo absences based on ecology and Native range (ERM, AquaX-RM)

A new modelling approach

Philosophy “building on top of the monument built by the Aquamaps team”

Step 4: “Environmental data fitted for climate change study and conservation ”

Depth of layers

- (●) Surface layers [conditions at the top layer of the ocean]
- ( ) Benthic layers [conditions along the sea bottom]

List of layers

Variable	Unit	Max	Mean	Min	Lt. Max	Lt. Min	Range
Ocean temperature	oC	☐	☐	☐	☐	☐	☐
Salinity	-	☐	☐	☐	☐	☐	☐
Sea water velocity	m.s-1	☐	☐	☐	☐	☐	☐
Sea water direction	degree	☐	☐	☐	☐	☐	☐
Nitrate	mmol . m-3	☐	☐	☐	☐	☐	☐
Phosphate	mmol . m-3	☐	☐	☐	☐	☐	☐
Silicate	mmol . m-3	☐	☐	☐	☐	☐	☐
Dissolved molecular oxygen	mmol . m-3	☐	☐	☐	☐	☐	☐
Iron	mmol . m-3	☐	☐	☐	☐	☐	☐
Primary productivity	mmol . m-3	☐	☐	☐	☐	☐	☐
pH	-	☐	☐	☐	☐	☐	☐
Chlorophyll	mmol . m-3	☐	☐	☐	☐	☐	☐
Sea ice thickness	m	☐	☐	☐	☐	☐	☐
Sea ice cover	Fraction	☐	☐	☐	☐	☐	☐
Cloud cover	%	☐	☐	☐	☐	☐	☐
Mixed layer depth	m	☐	☐	☐	☐	☐	☐
Air temperature	oC	☐	☐	☐	☐	☐	☐
Photosynt. Avail. Radiation	E.m-2.day-1	☐	☐	☐	☐	☐	☐
Diffuse attenuation	m-1	☐	☐	☐	☐	☐	☐
Bathymetry	m	☐	☐	☐			
Topographic slope	-		☐				
Topographic aspect	-		☐				
Topographic position index	-		☐				
Terrain ruggedness index	-		☐				

V3.0 (Assis et al. 2024)

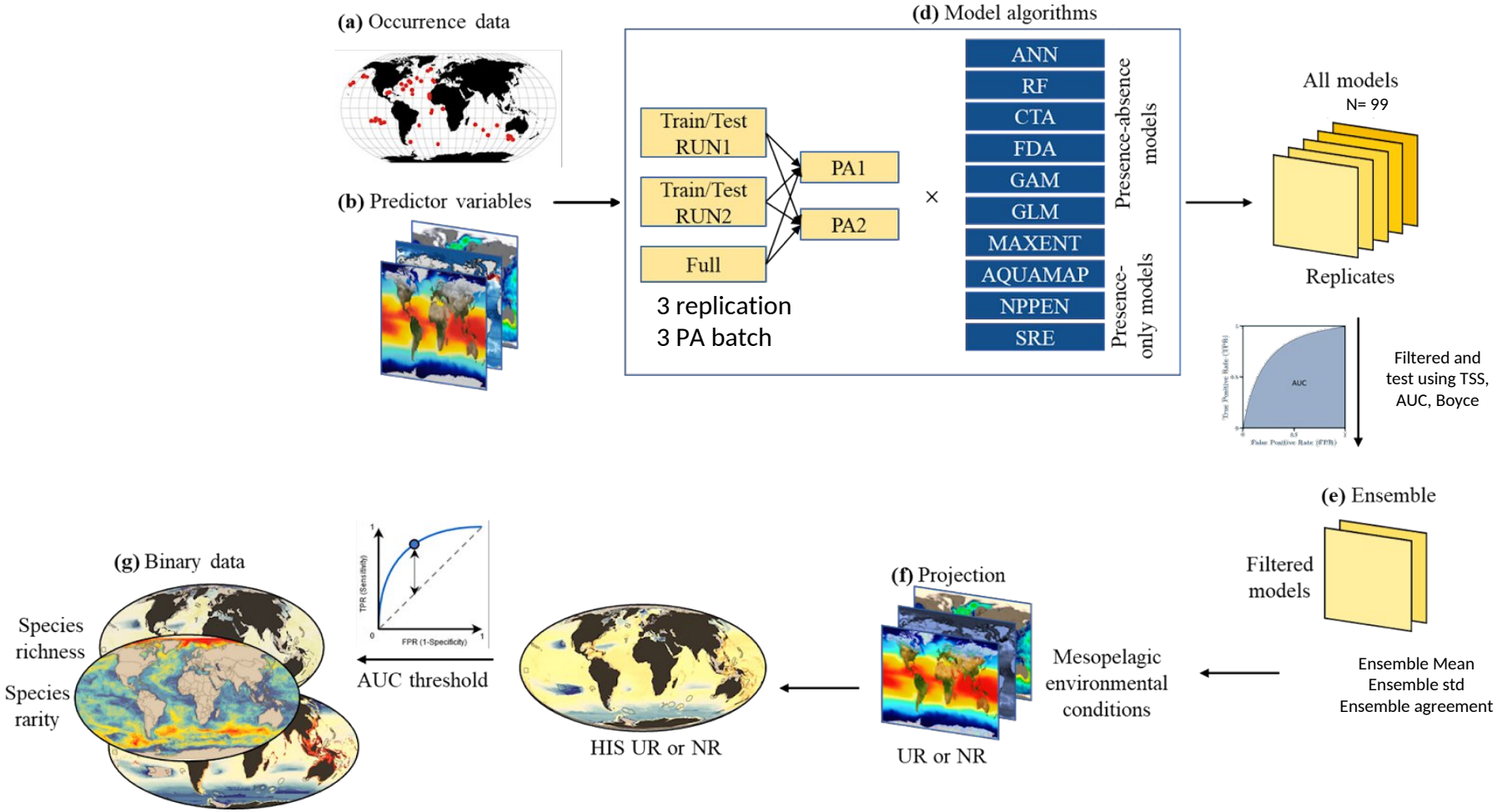
All variables available on R and originating from CMIP6

Resolution : 10km

Time period : 2000-2010, 2040-2060, 2080-2100

SSP- RCP : SSP1-RCP26, SSP3-RCP45, SSP5 RCP85

New Algorithms



AquaX

Modeling Marine Life

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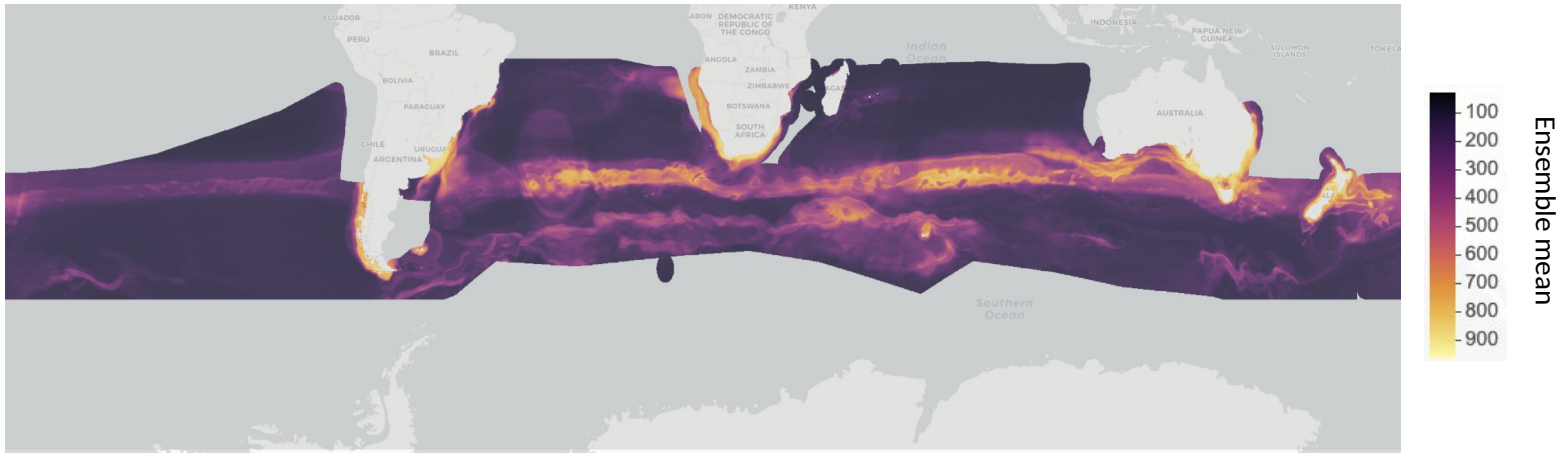
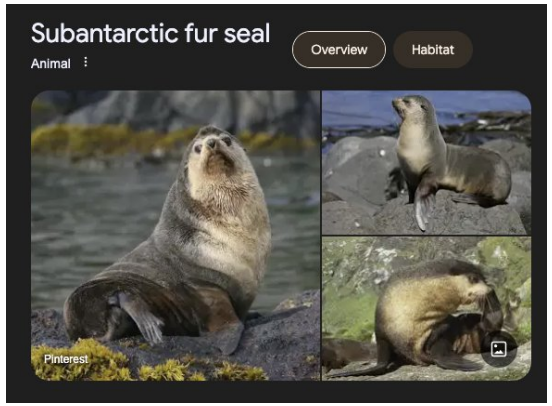
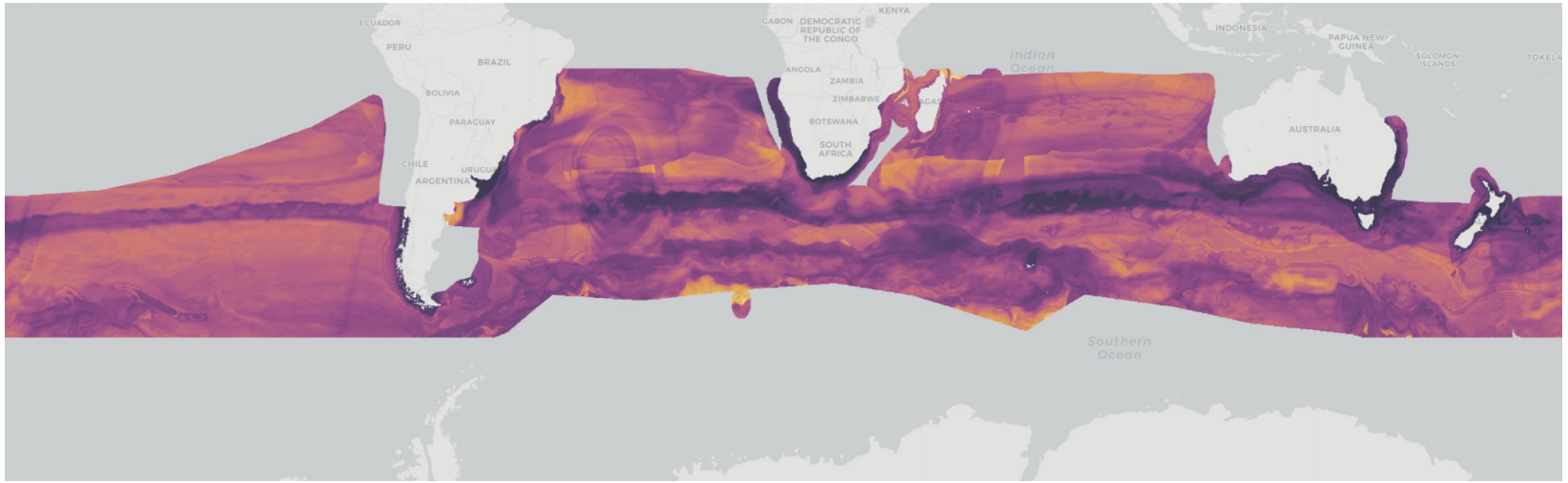
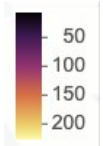
New Algorithms



Ensemble mean







Standard deviation

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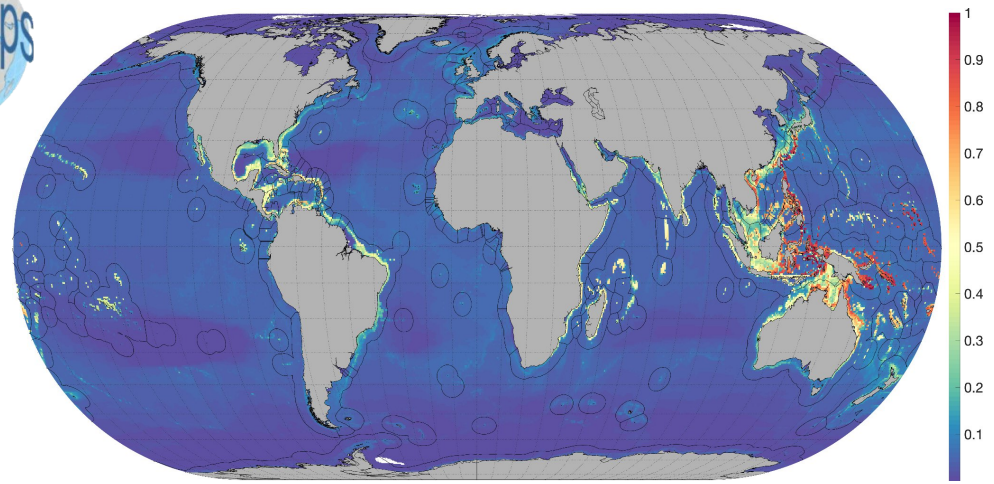
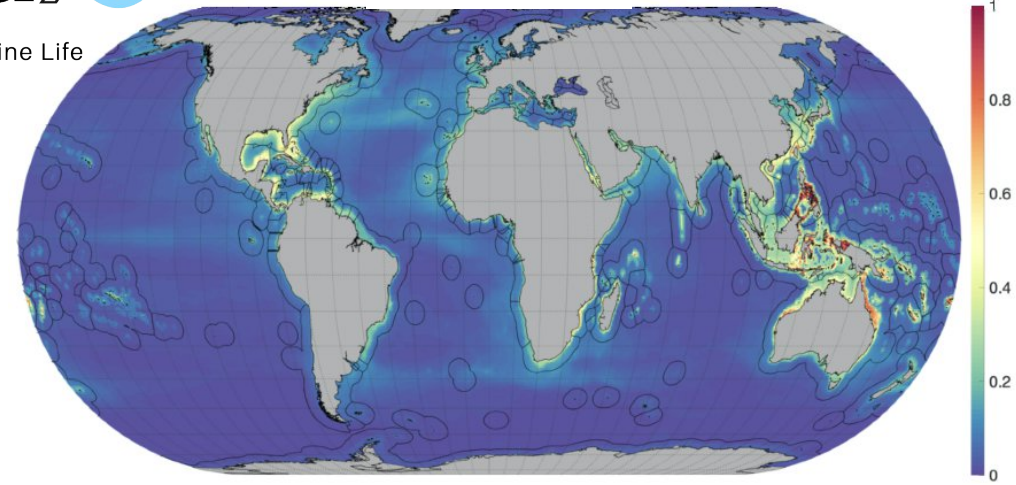
Introducing Aqua-X Platform: Multi-Species Modelling

Improved and new analytical tools & indices:



Aqua X

Modeling Marine Life



- **Species Richness recomputed using the 10 models agreement**

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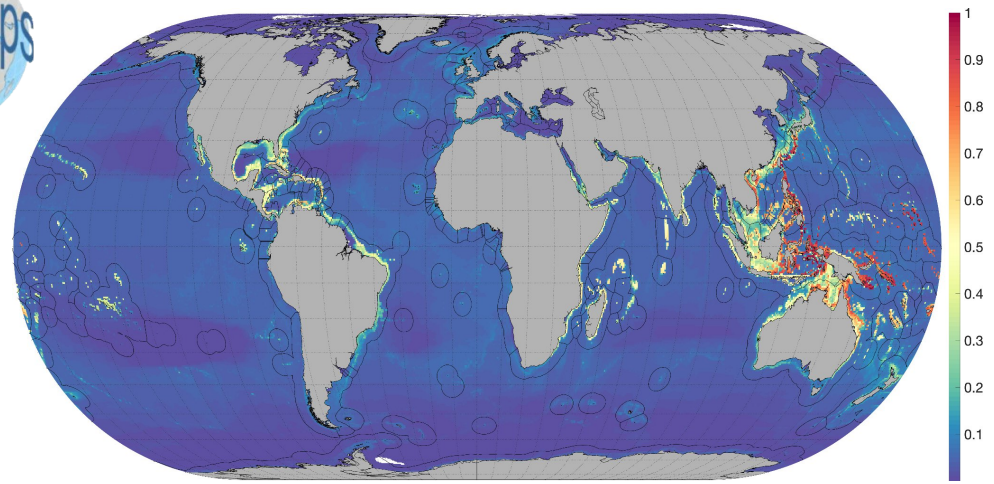

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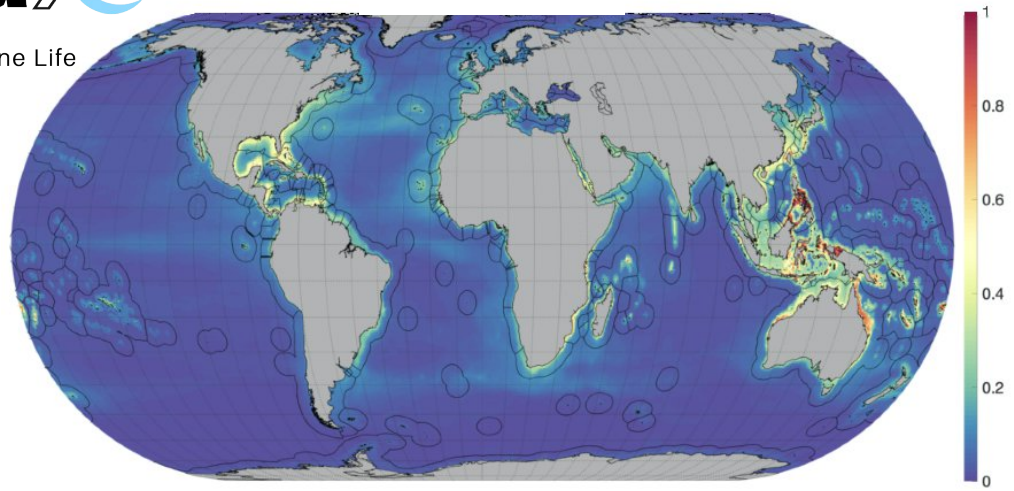
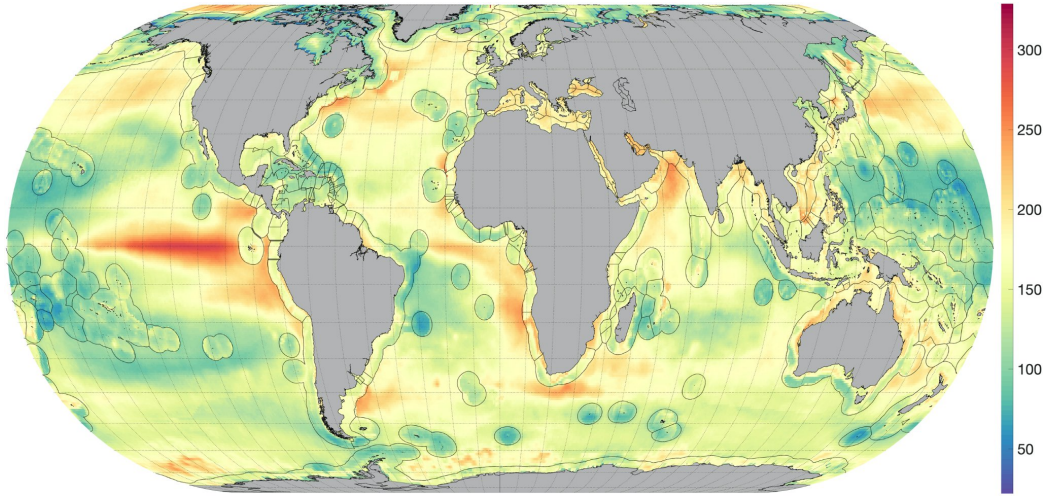


- **Species Richness recomputed using the 10 models agreement**
- **Development of Confidence interval**



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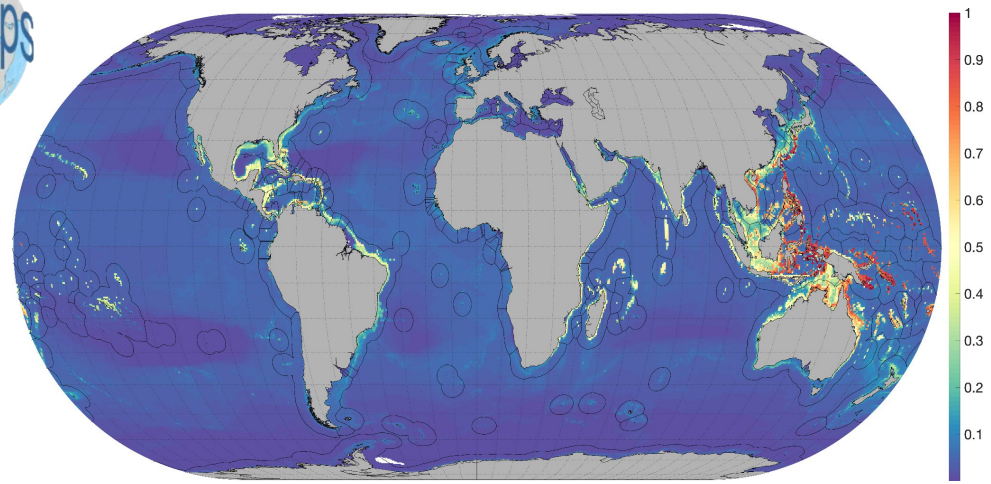
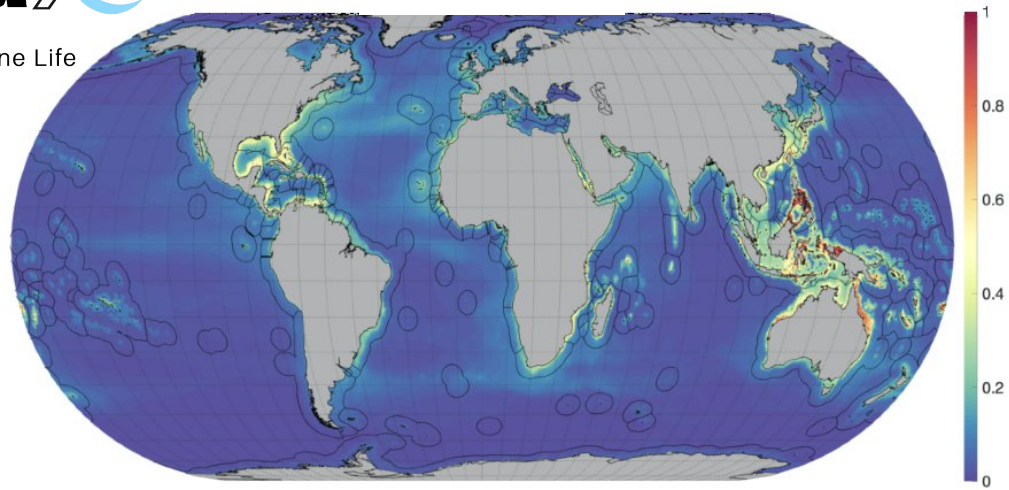
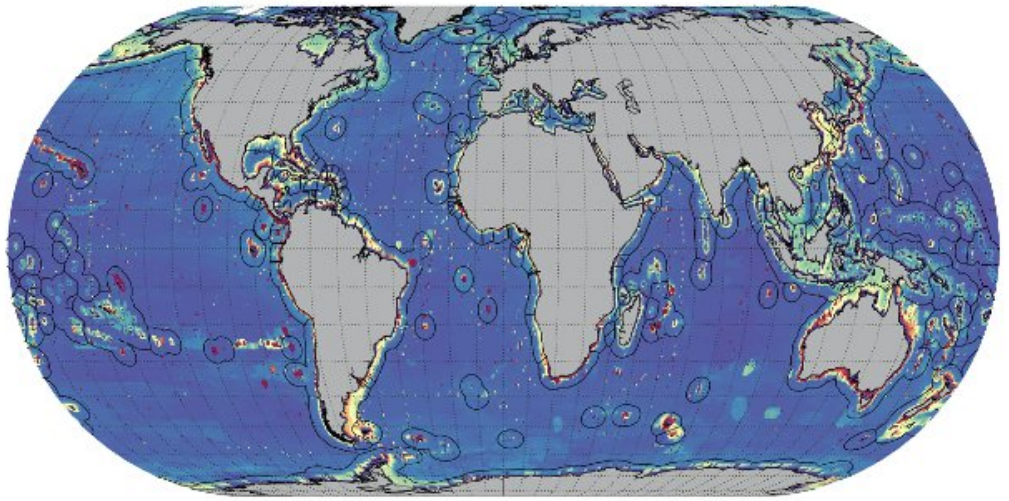


Aqua X
Modeling Marine Life

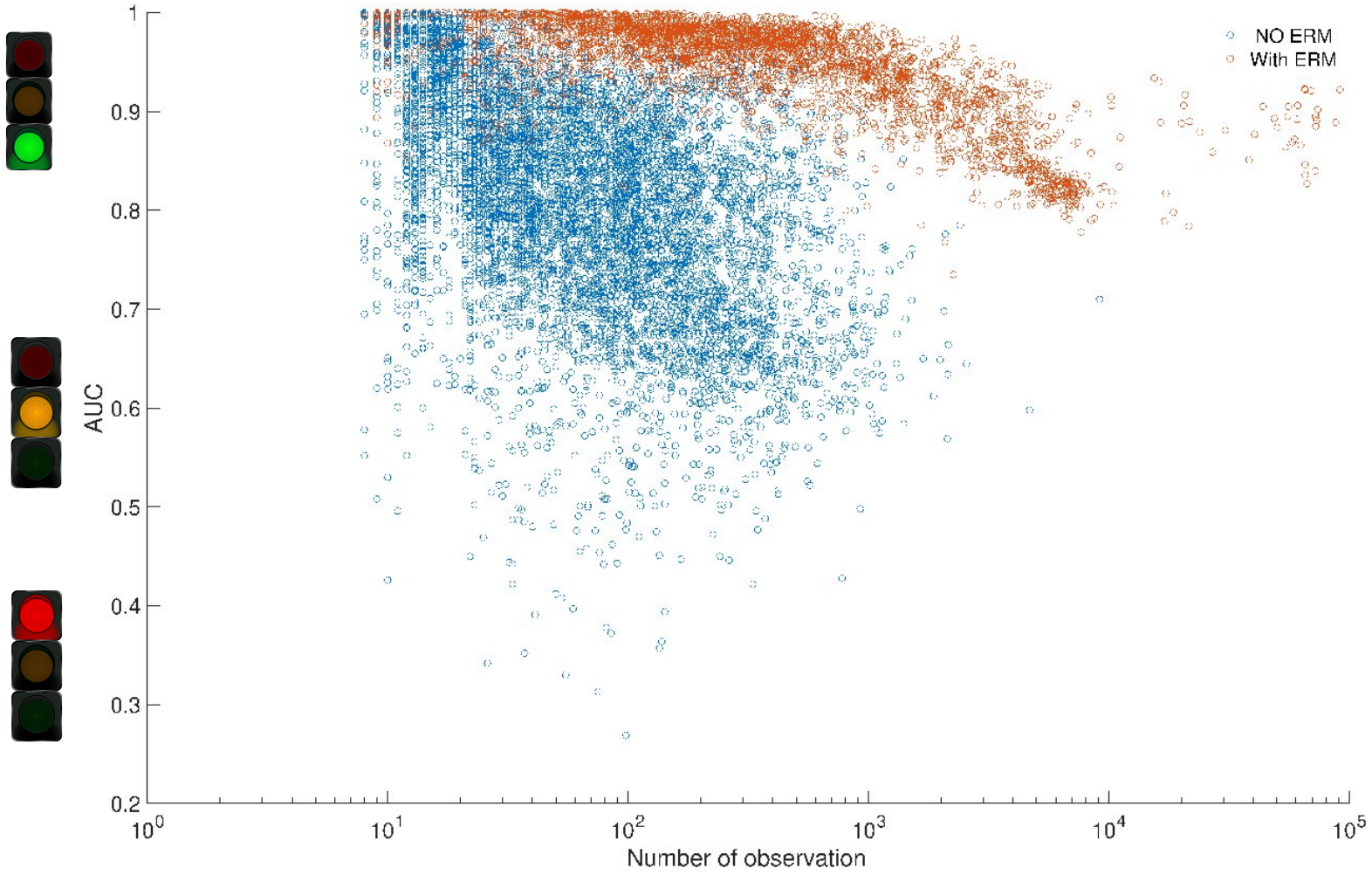


- **Species Richness recomputed using the 10 models agreement**
- **Development of Confidence interval**
- **New indices to guide conservation and effect of climate change :**
  Range Rarity, Invasion, Extirpation, turn Over



Model quality for each species

- Model development : improved distribution using expert knowledge

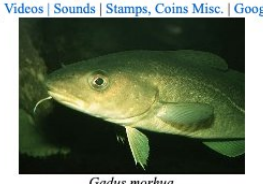


Looking ahead - our vision

Aqua-X - 2024: A new website

Gadus morhua Linnaeus, 1758
Atlantic cod

Upload your photos and videos
Pictures | Videos | Sounds | Stamps, Coins Misc. | Google image



Environment: milieu / climate zone / depth range / distribution range Ecology

Marine; brackish; benthopelagic; oceanodromous (Ref. 51243); depth range 0 - 600 m (Ref. 1371), usually 150 - 200 m (Ref. 54441). Temperate; 0°C - 15°C; 83°N - 35°N, 76°W - 86°E (Ref. 1371)

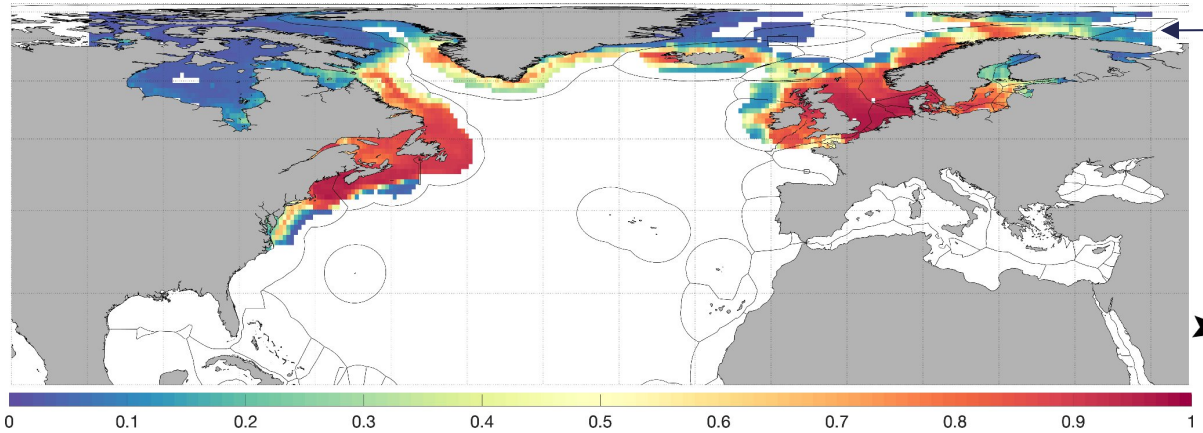
Distribution Countries | FAO areas | Ecosystems | Occurrences | Point map | Introductions | Faunafri

North Atlantic and Arctic: Ungava Bay in Canada along the North American coast to Cape Hatteras; North Carolina in the western Atlantic. East and west coast of Greenland; around Iceland; from Barents Sea including the region around Bear Island along the European coast to Bay of Biscay (Ref. 88171).

META information And link

Time period
Historical
2050's
2090's

CO2 scenario
2.6
4.5
8.5



New Mapper

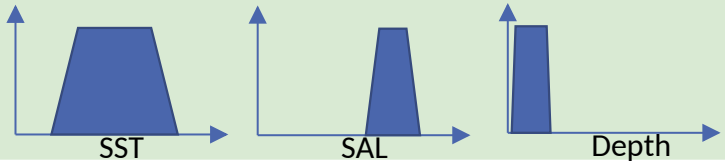
Quality of the model

Expert checked Or not

AquaMap Maxent NPPEN GLM GAM ....

Model selection

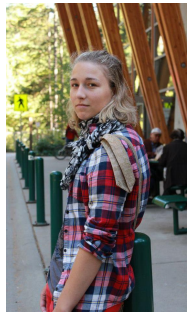
Environmental niche



Comment Section for user

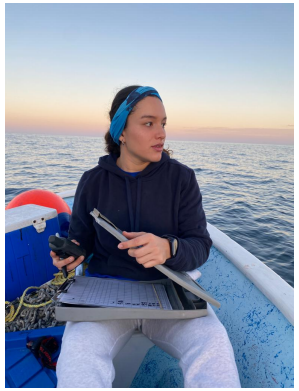
Looking ahead - our vision

4 projects launching 2025



Yulia Egorova

Biodiversity of plankton



Elka Garcia Rada

Seasonality of biodiversity

Juliette casemajor

Advection/diffusion in SDM

Evgenii Pakhomov

3Dimesional SDMs

Looking ahead - our vision

Implementation of an **SDMip** for marine life : A platform for SDM intercomparison

Agreement to collaborate with :

GBIF Global Biodiversity Information Facility

OBIS OCEAN BIOGEOGRAPHIC INFORMATION SYSTEM

FishBase

WoRMS World Register of Marine Species

Protocol following the white paper of Tittensor 2020

SDMip intended to be under the umbrella of FISH-MIP biodiversity (coordinator : Kelsey Roberts)

MBON MARINE BIODIVERSITY MONITORING FOR EUROPE

FishMIP Fisheries & Marine Ecosystem Model Intercomparison Project