MARINE PROTECTED AREAS EUROPE

PI: Prof. Mark J. Costello, Nord University (NORD, Norway)

Mapping optimal locations for Marine Protected Areas (MPAs) in European seas

Anna M. Addamo, Nord University (NORD, Norway)

N2K Biogeographical Seminar for
the Mediterranean and Black Sea regions
12-14 March 2024, Marseille (FR)

NORD University

The MPA Europe project is co-funded by the European Union under the Horizon Europe program (grant agreement no. 101059988)

Co-funded by the European Union

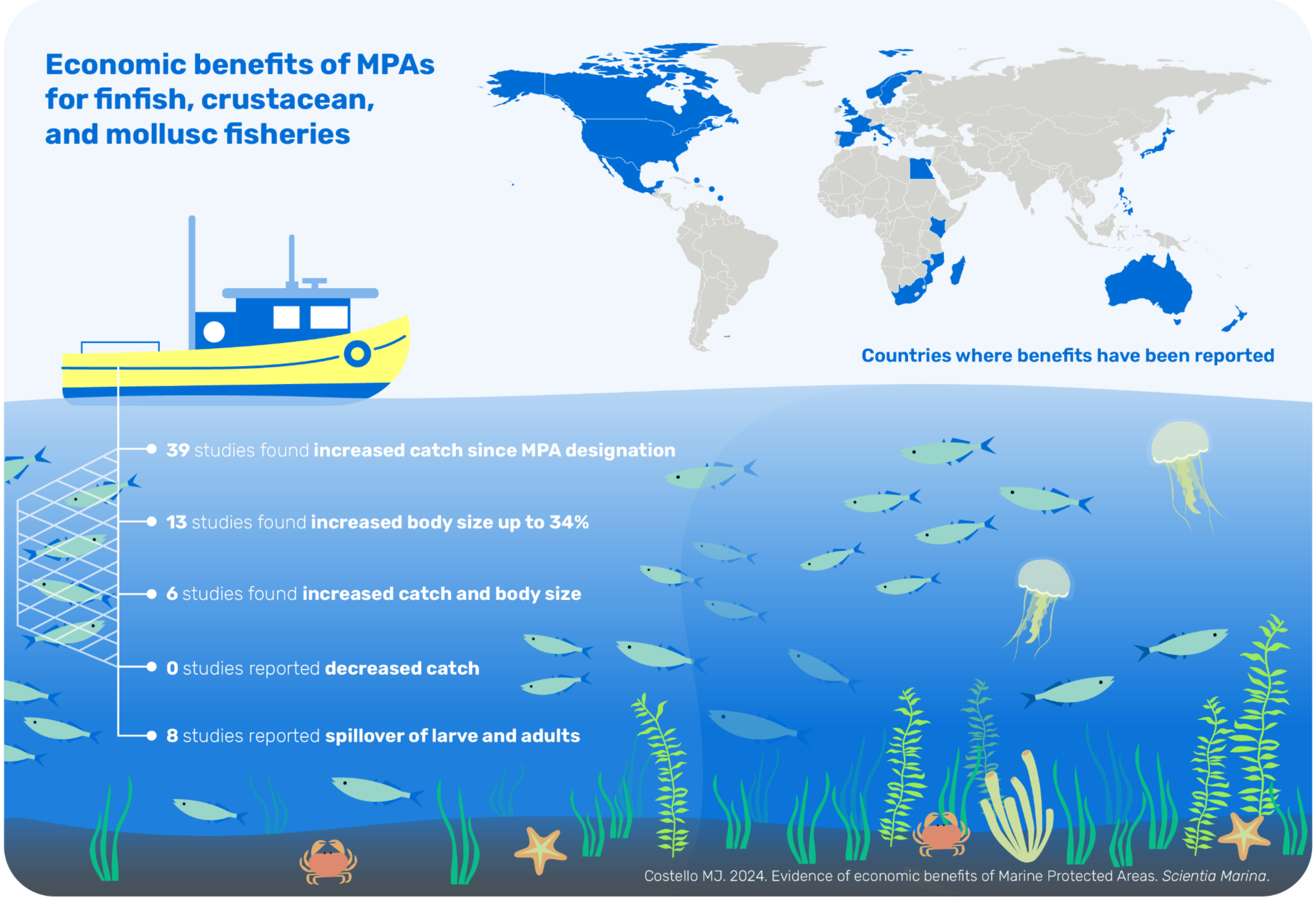
UK Research and Innovation

PROJECT BACKGROUND

WHY MPA EUROPE?

New review of MPA effects on fisheries and tourism.

No evidence of MPA causing a loss to any fishery anywhere, but 46 examples of benefits.



Costello MJ. 2024. Economic benefits of MPA to fisheries and tourism. *Scientia Marina* 88 (1).

Co-funded by the European Union

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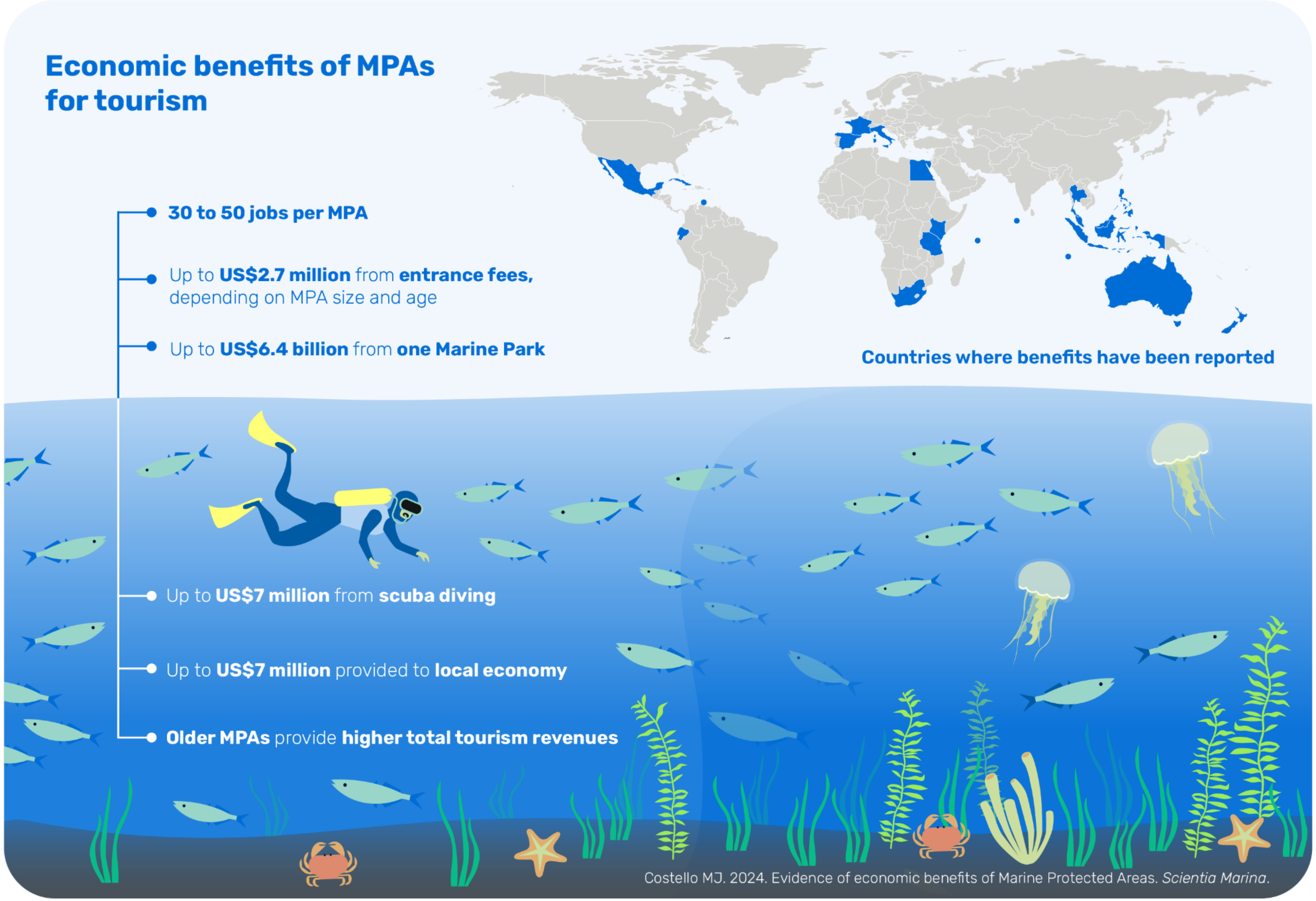
PROJECT BACKGROUND

MARINE RESERVES: WIN-WIN FOR BIODIVERSITY & BLUE ECONOMY



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MPA MARINE PROTECTED AREAS EUROPE

PROJECT STUDY AREA & MAIN GOAL

MPA EUROPE IS MAPPING THE OPTIMAL LOCATIONS FOR MARINE PROTECTED AREAS IN EUROPEAN SEAS TO SUPPORT SCIENCE-BASED MARINE SPATIAL PLANNING

NORD University · SAMS Scottish Association for Marine Science · CCMAR Centro de Ciências do Mar · SCIENCE CRUNCHERS The Scientific Creative Agency · AARHUS UNIVERSITY · unesco Intergovernmental Oceanographic Commission · CLIMAZUL · 中国海洋大学 OCEAN UNIVERSITY OF CHINA · 琉球大学 University of the Ryukyus · JNCC Joint Nature Conservation Committee

PROJECT TARGETS

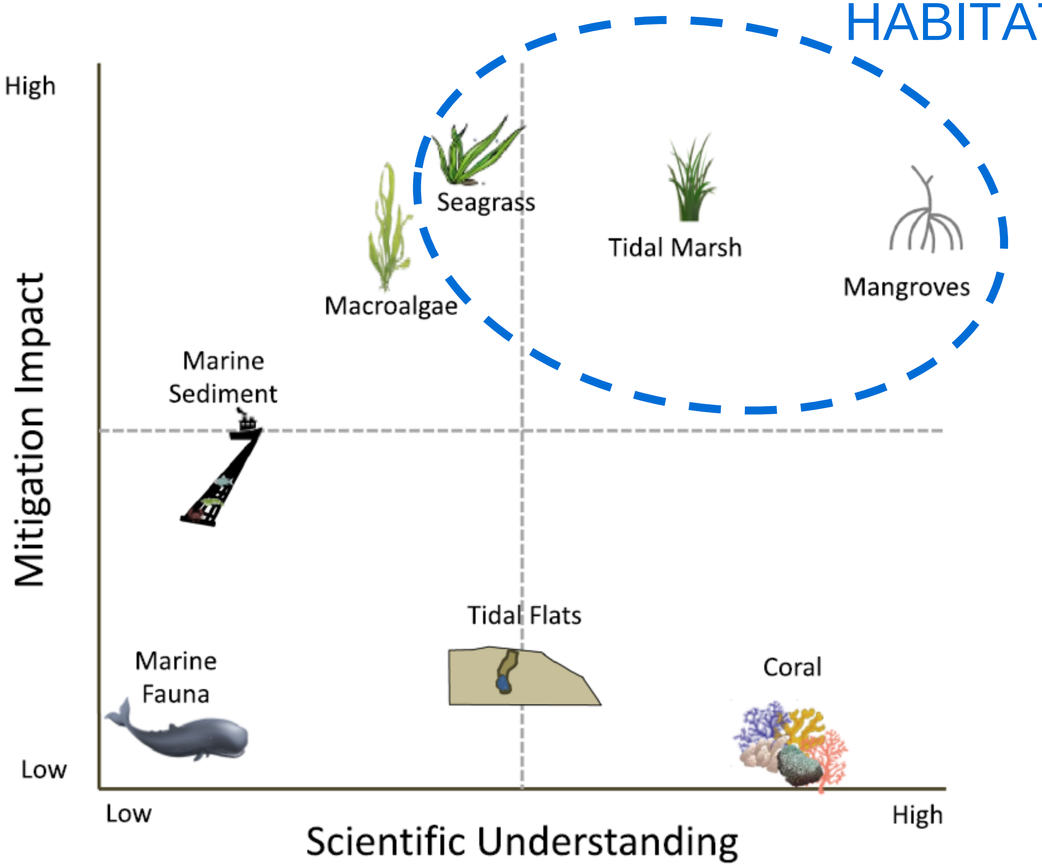
BIODIVERSITY

BLUE CARBON

IPCC definition: “**all biologically-driven carbon fluxes and storage in marine systems** that are amenable to management”.

Management of Blue Carbon (BC): Protection and restoration of BC habitats and associated C-sinks require information on BC location, size and associated drivers.

«CLASSICAL» BLUE CARBON HABITATS



Howard et al. 2023

IPCC = Intergovernmental Panel on Climate Change

PROJECT COMPONENTS

Carbon sequestration, storage and deposition based on the environmental conditions, habitats, and species present

Develop **blue carbon scoring system** supporting management of blue carbon

Connectivity modelling (present)

Climate velocity (recent and future)

Design **MPA networks covering 10% and 30% of European seas** that maximise coverage of biodiversity and blue carbon

30 000 SPECIES

Environmental niche modelling

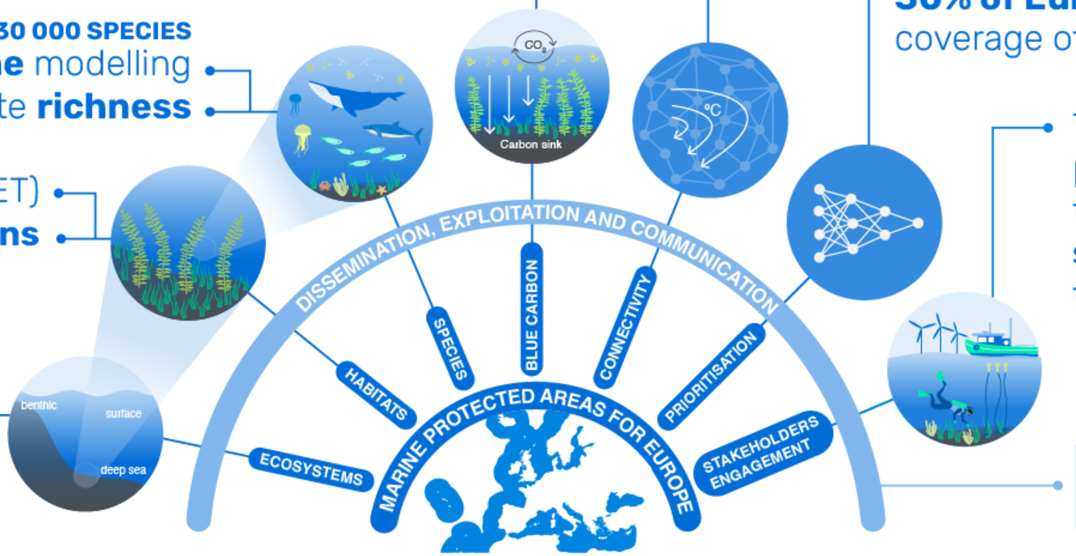
Estimate **richness**

Benthic habitats (EMODNET)

Modelled **habitat distributions**

Environmental data (Copernicus)

Two way process with marine spatial planners and other interested parties to formulate **regional or national case studies**, ensuring project traceability, transparency and reproducibility



Project website, peer-reviewed scientific papers, workshops, conference, fact sheets, policy brief for stakeholders

PROJECT PRIORIZATION

Standardised and complete data layers

Environmental data (Copernicus)

Benthic habitats (EMODNET)
Modelled **habitat distributions**

Environmental niche modelling
Estimate **richness**

Carbon sequestration, storage and deposition based on the environmental conditions, habitats, and species present

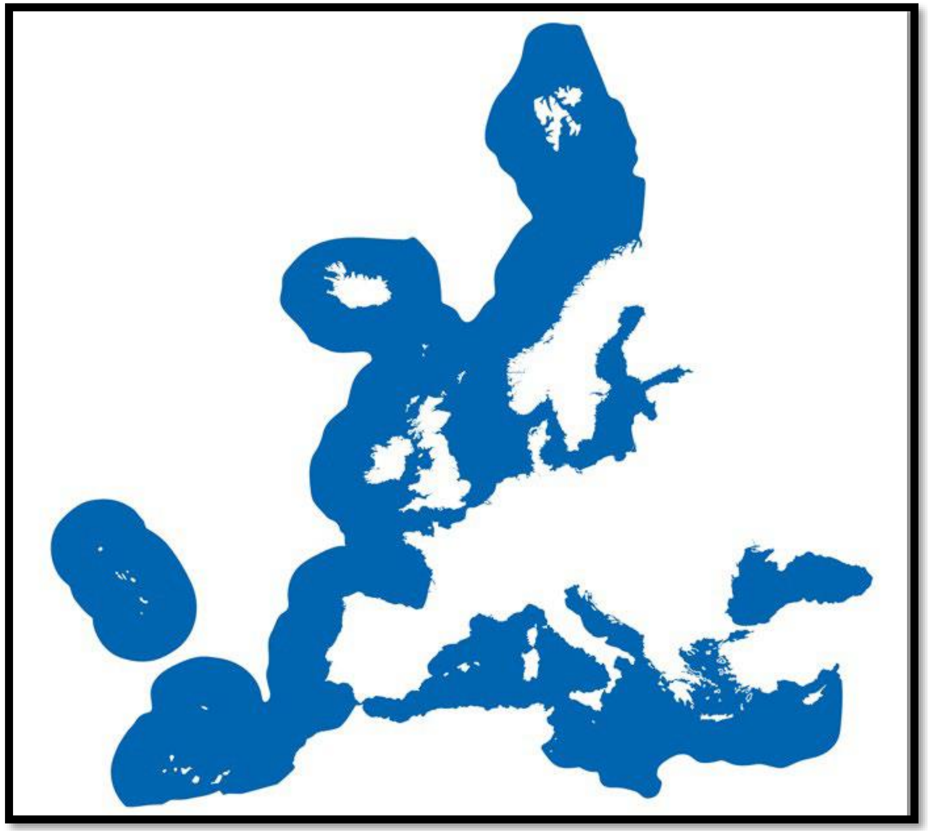
Develop **blue carbon scoring system** supporting management of blue carbon

SCP approach

MPA EUROPE PROPOSE PRIORITY AREAS TO PROTECT
(A) BIODIVERSITY AND
(B) BLUE CARBON

PROJECT PRIORIZATION

Standardised and complete data layers



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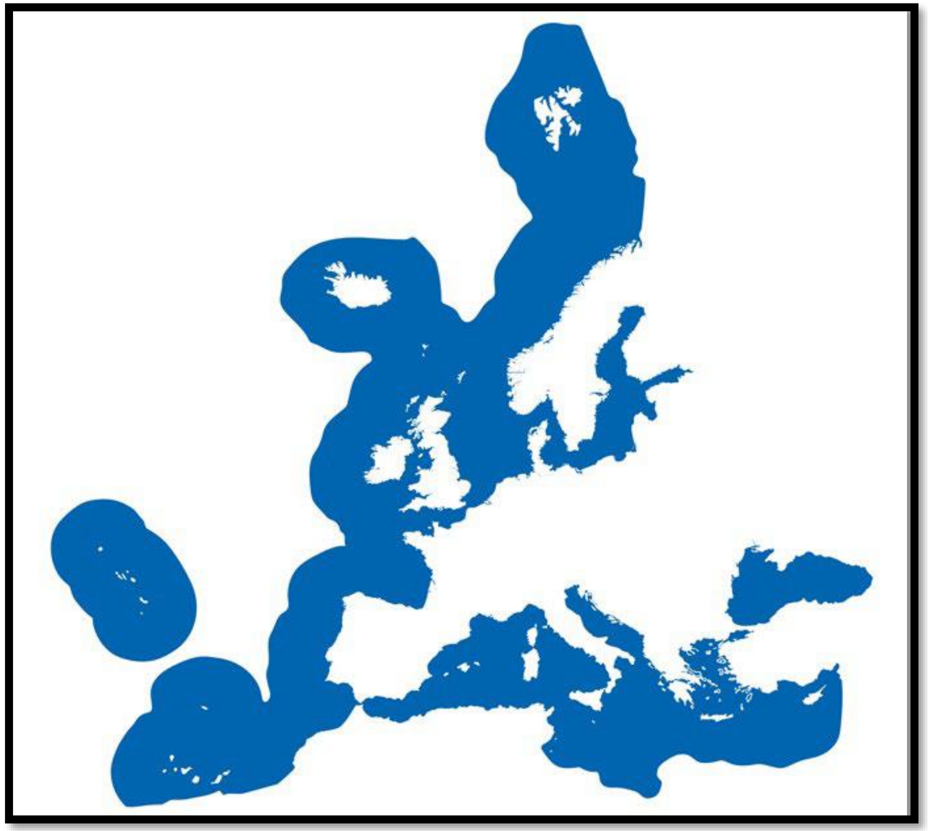
SCP approach

MPA EUROPE PROPOSE PRIORITY AREAS TO PROTECT
(A) BIODIVERSITY AND
(B) BLUE CARBON

PROJECT PRIORIZATION

Standardised and complete data layers



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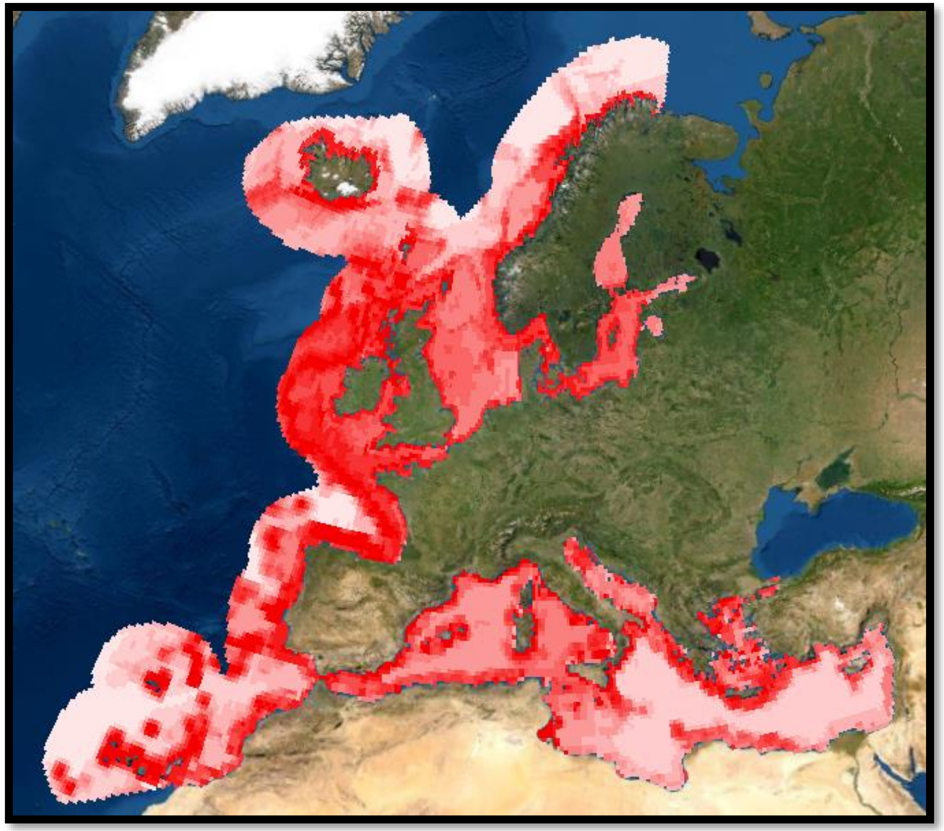
SCP approach

Hypothetical example of prioritised areas (**darker** red = **higher** priority)



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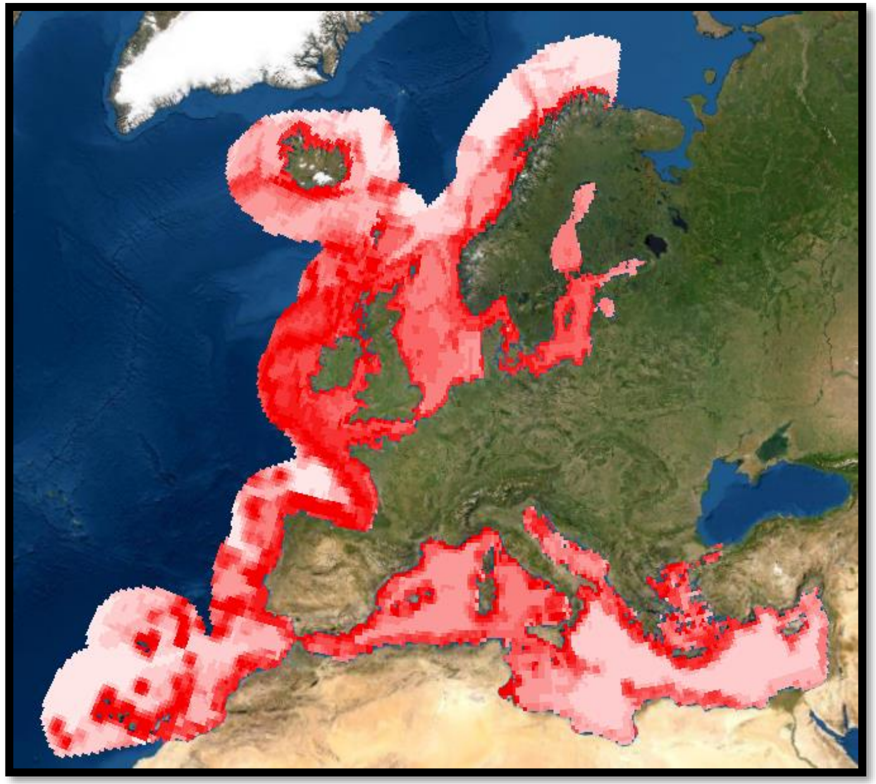
PROJECT PRIORIZATION



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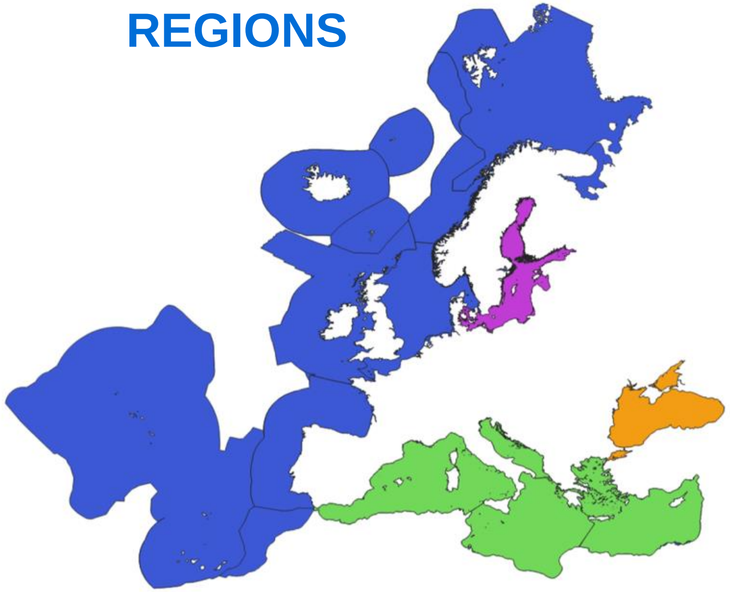
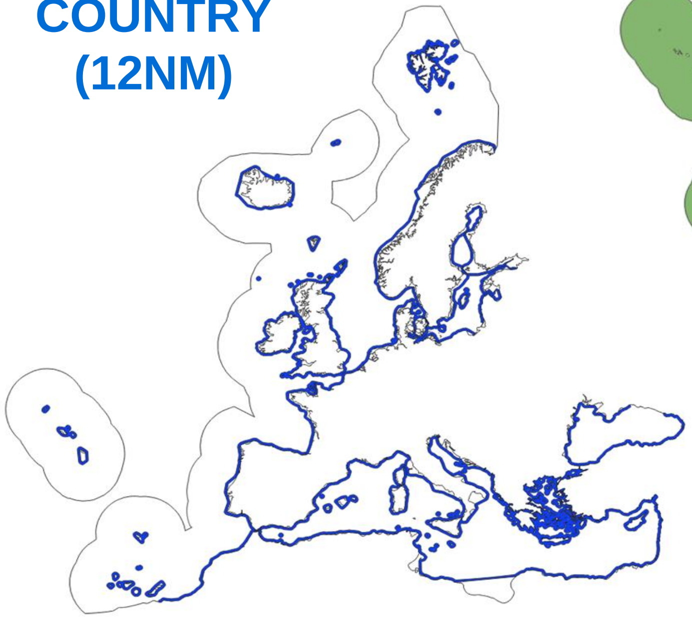
REGIONS

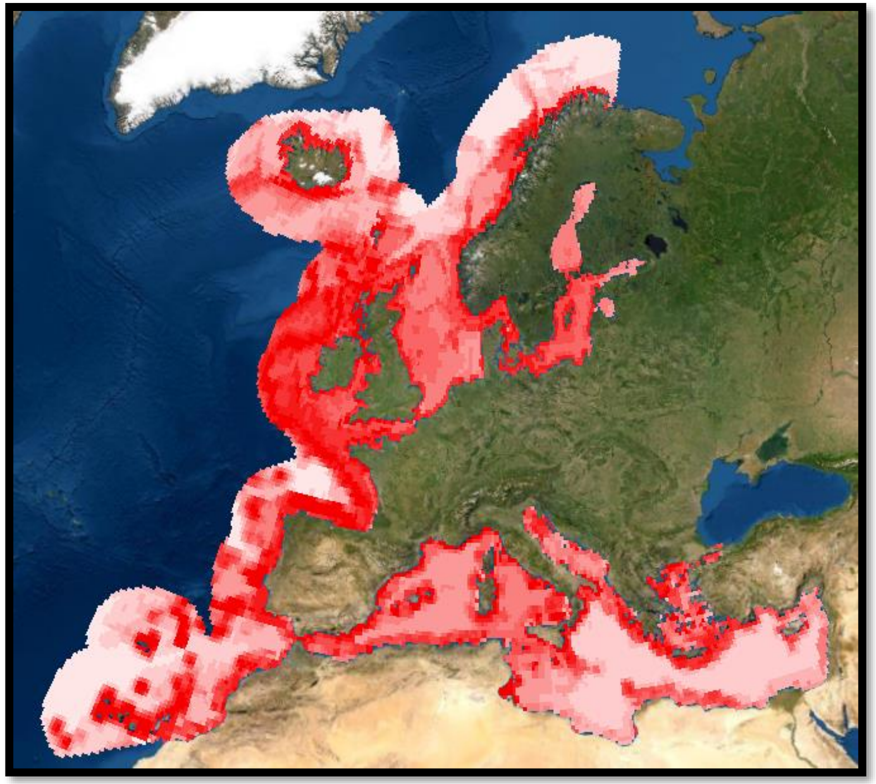


COUNTRY (EEZ)

COUNTRY (12NM)



PROJECT PRIORIZATION



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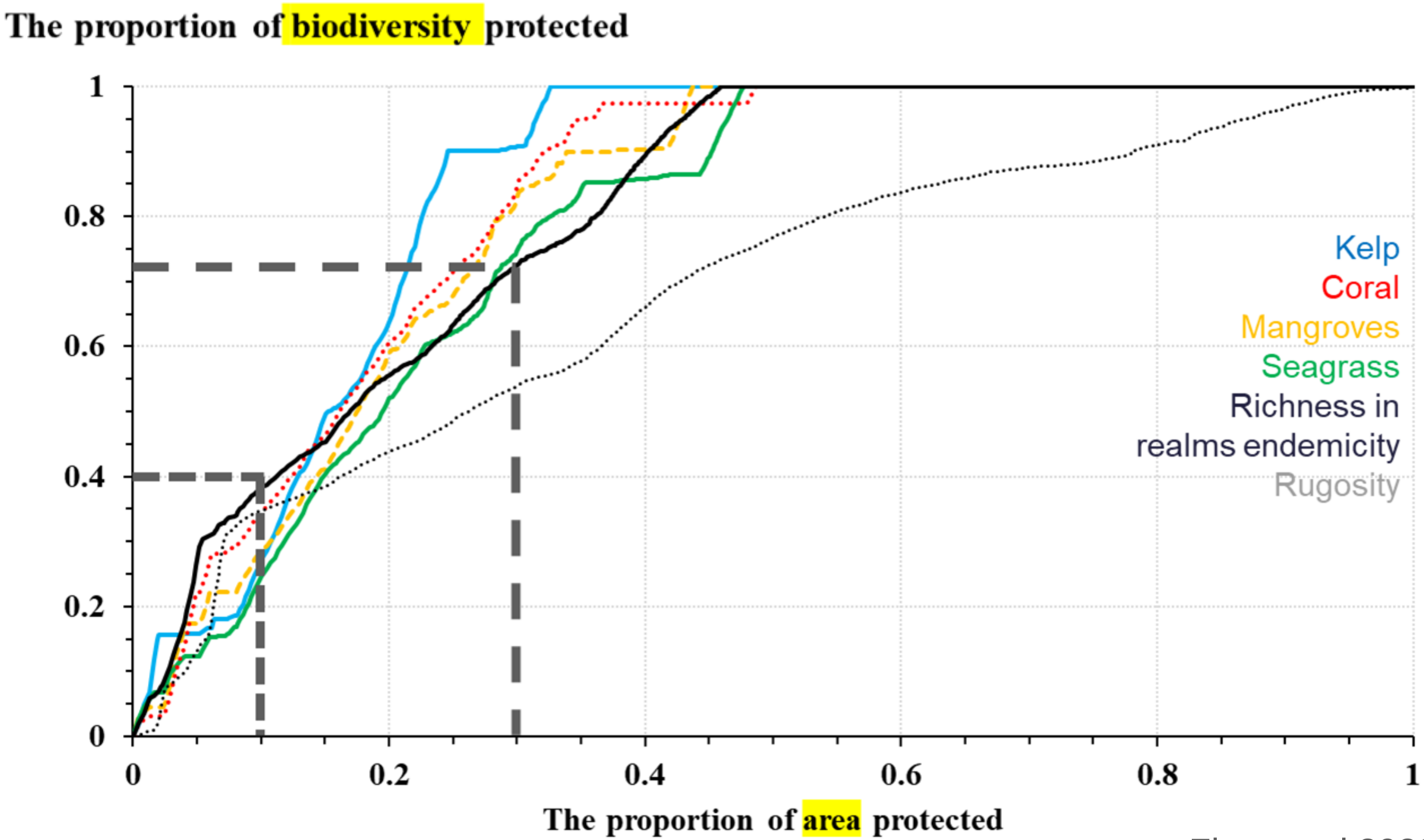
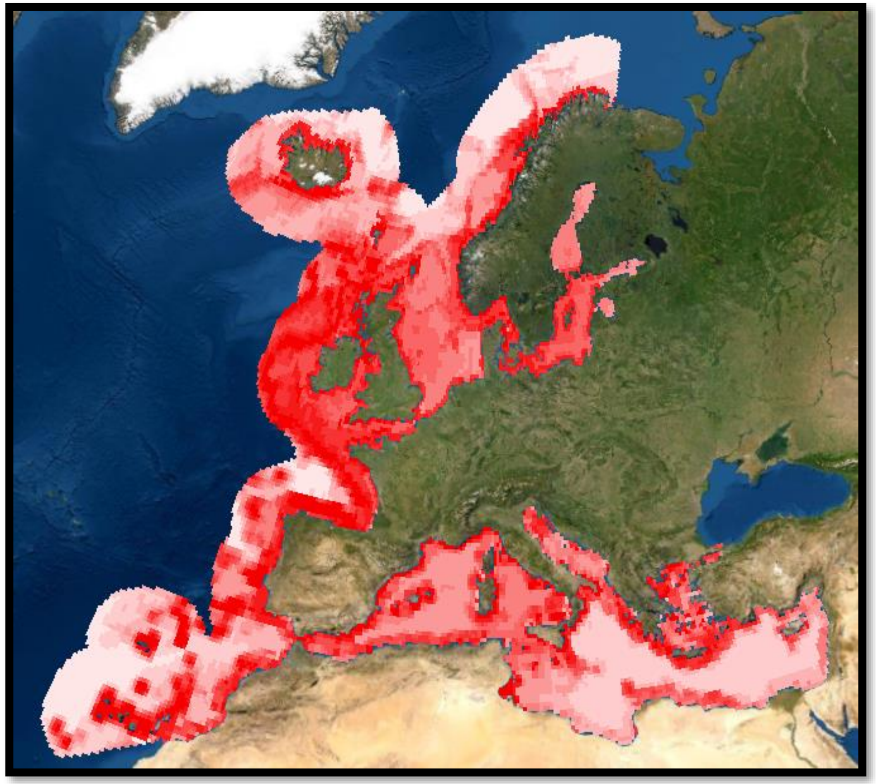
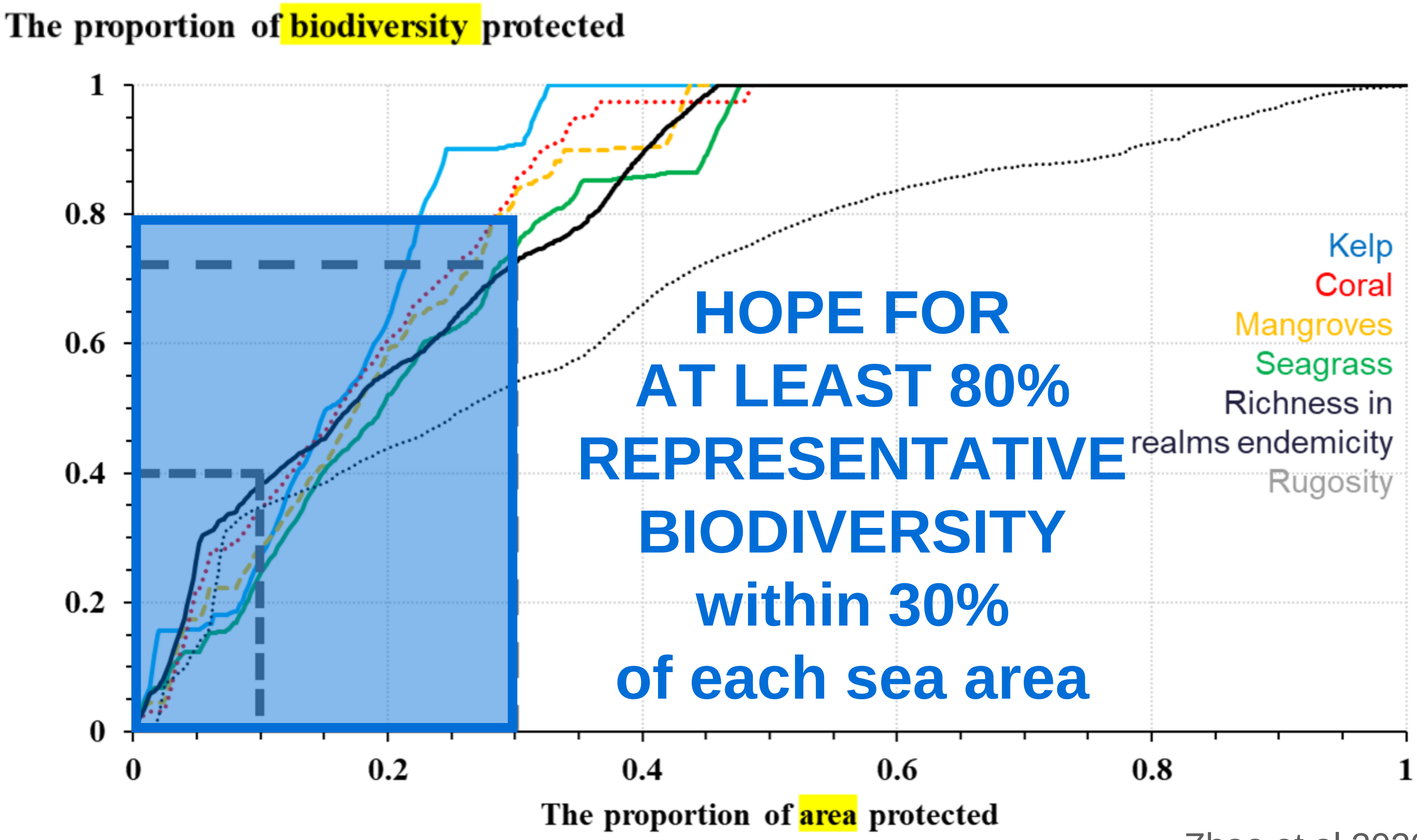


Zhao et al 2020

PROJECT PRIORIZATION





Zhao et al 2020

PROJECT MAIN OUTPUTS

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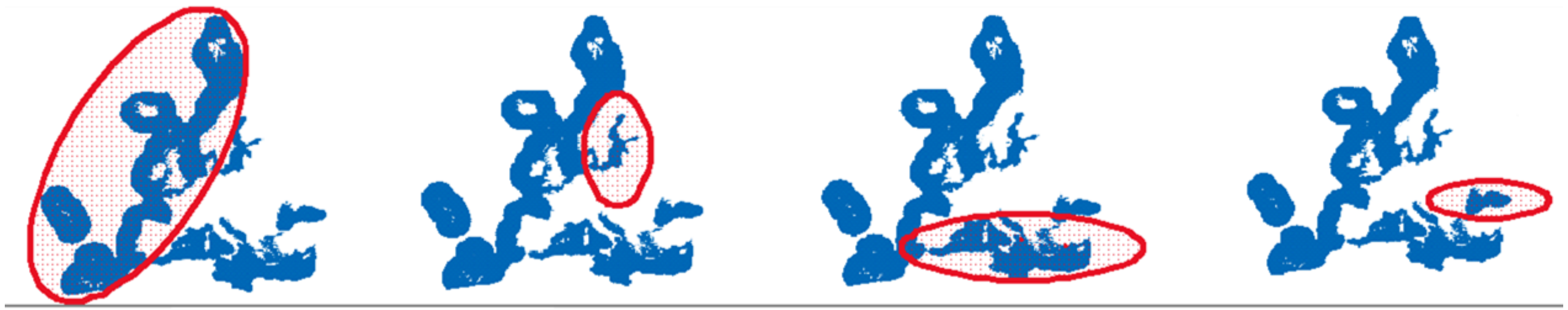
- The **first data-driven classification of ecosystems** in shallow and deep European seas based on a new comprehensive dataset of high-resolution environmental layers for bioclimatic modelling
- Maps of **species richness** in European seas **based on multiple indicators**, including actual observed data, statistical estimators, and modelled geographic range maps
- **Potential geographic distributions of important biogenic habitats** in European seas
- Maps of an optimal MPA network in European seas **prioritised for biodiversity protection** and **blue carbon benefits**
- An **online European marine biodiversity atlas** for use by researchers, students, teachers, and in Marine Spatial Planning by policy makers, industry and NGOs

PROJECT STAKEHOLDERS

MARINE PROTECTED AREAS EUROPE

STAKEHOLDERS – by sea basin



International science to policy

ICES CIEM

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

PROTECTING AT LEAST 30% OF THE OCEAN BY 2030 (MPA 2030)

Regional Seas Conventions and Strategies

OSPAR

HELCOM

UN environment programme | Mediterranean Action Plan Barcelona Convention

VASAB VISION & STRATEGIES AROUND THE BALTIC SEA

PAP/RAC

MSP and MPA national authorities

GOVERNO DOS AÇORES

FRCT FUNDO REGIONAL DA CIÊNCIA E TECNOLOGIA

REPUBLIC OF ESTONIA MINISTRY OF REGIONAL AFFAIRS AND AGRICULTURE

Ministerstwo Infrastruktury

MINISTRY OF ENVIRONMENT & ENERGY

GUVERNUL ROMÂNIEI Ministry of Development, Public Works and Administration

REPUBLIC OF SLOVENIA MINISTRY OF NATURAL RESOURCES AND SPATIAL PLANNING

Institutes, projects and NGOs

MSP4BIO

MarinePlan

PROTECT BALTIC Preserve Revive Thrive

BLUEMISSION AA

FAIR SEAS

INCDM

MedPAN

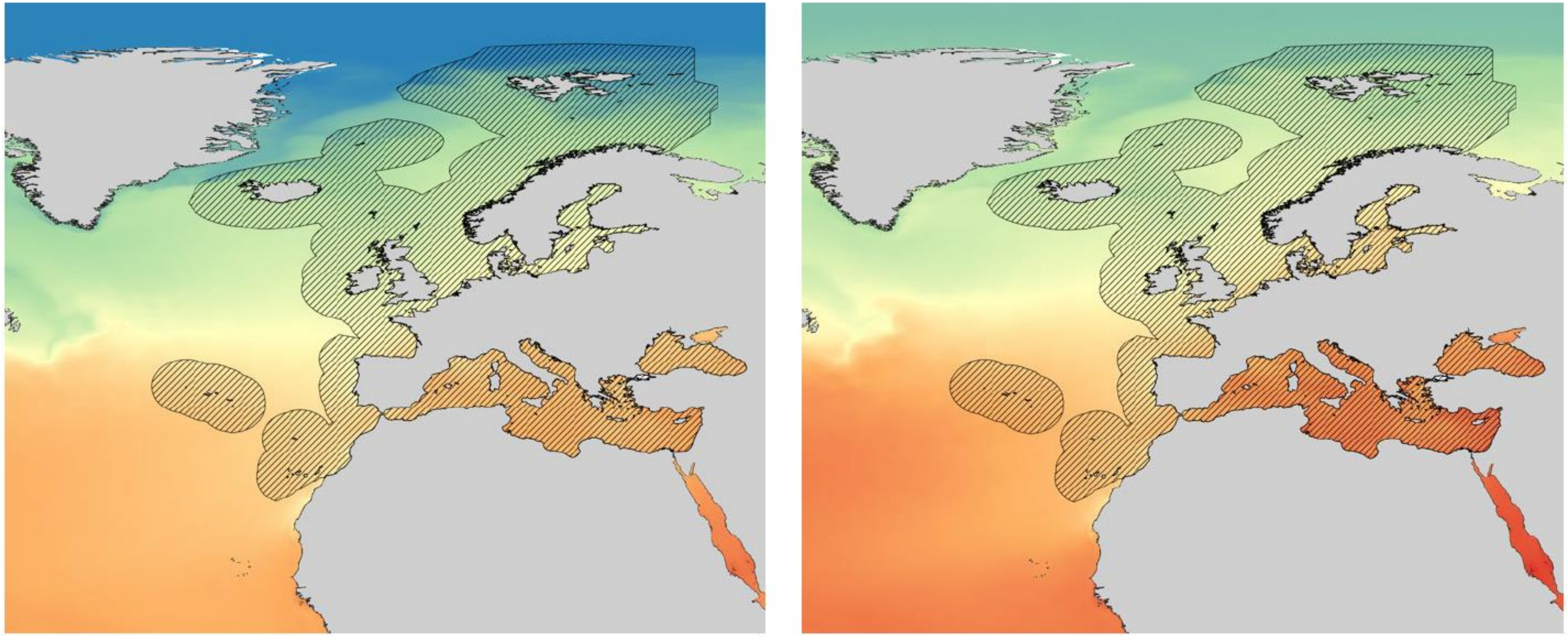
CCMS

WWF

...

ENVIRONMENTAL DATA

Variable
Temperature
Salinity
Sea Ice Cover
Sea Ice Thickness
Sea Water Velocity
Mixed Layer Depth
Diffuse Attenuation Coefficient
PAR
PAR at bottom
Oxygen
pH
Iron
Phosphate
Nitrate
Silicate
Total phytoplankton
Chlorophyll
Topographic (slope)
Topographic (roughness)
EMODnet Bathymetry
Sedimentation Rates
Seabed Substrates
Distance to coast
Distance to closest port



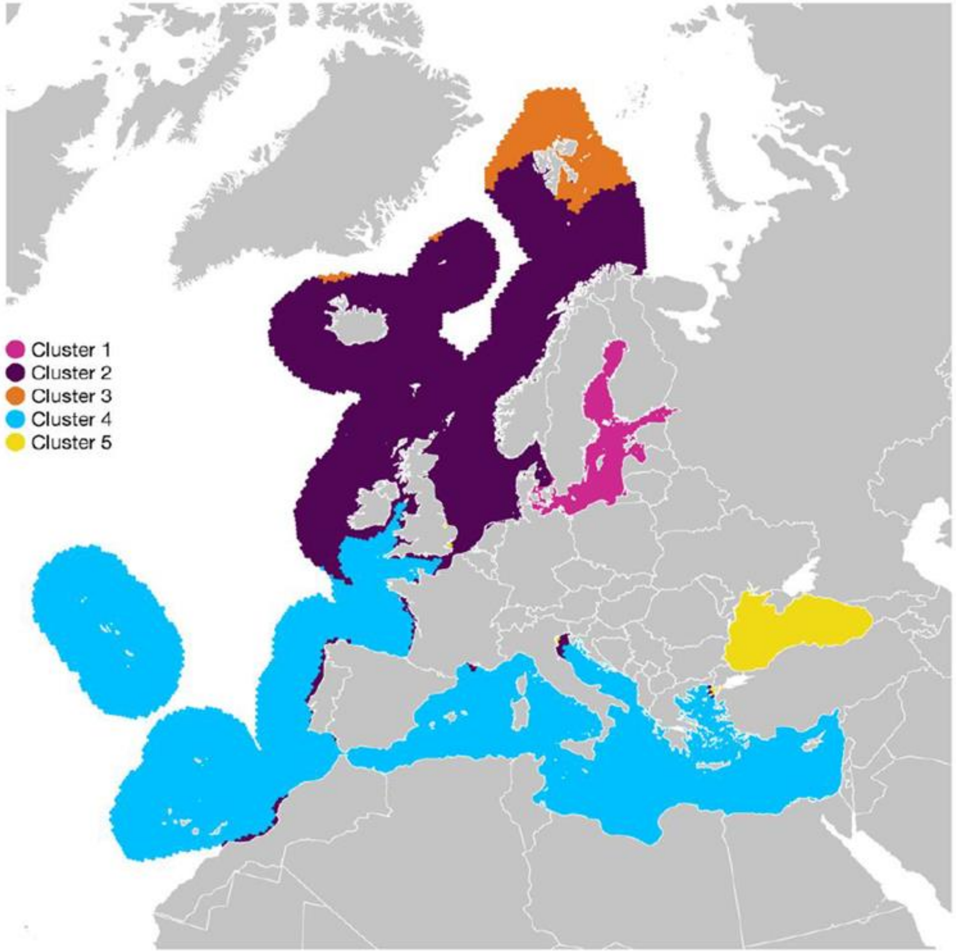
Present-day sea surface temperature

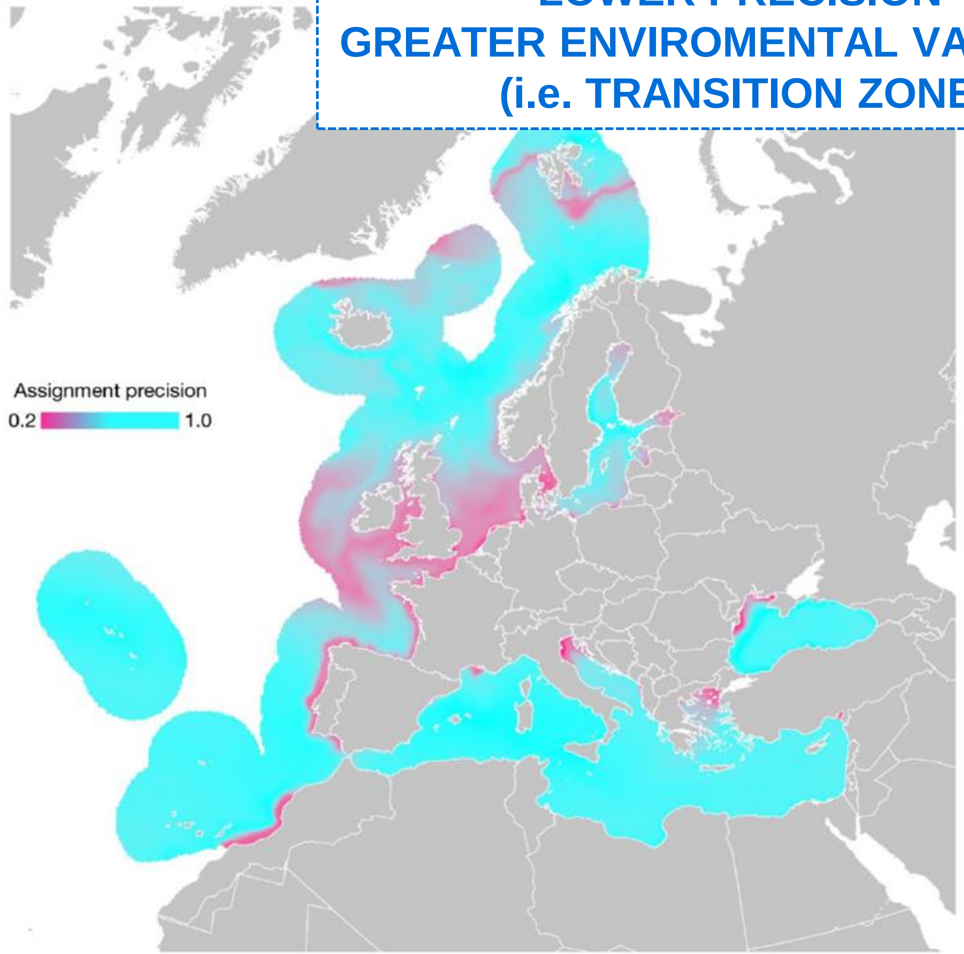
Future (decade 2090) sea surface temperature

Example of data layer produced for the European Seas from **BioOracle v3**.
Colour gradients reflect spatial differences in °C from today (left) to 2090 (right)

ECOSYSTEM CLASSIFICATION – SEA SURFACE

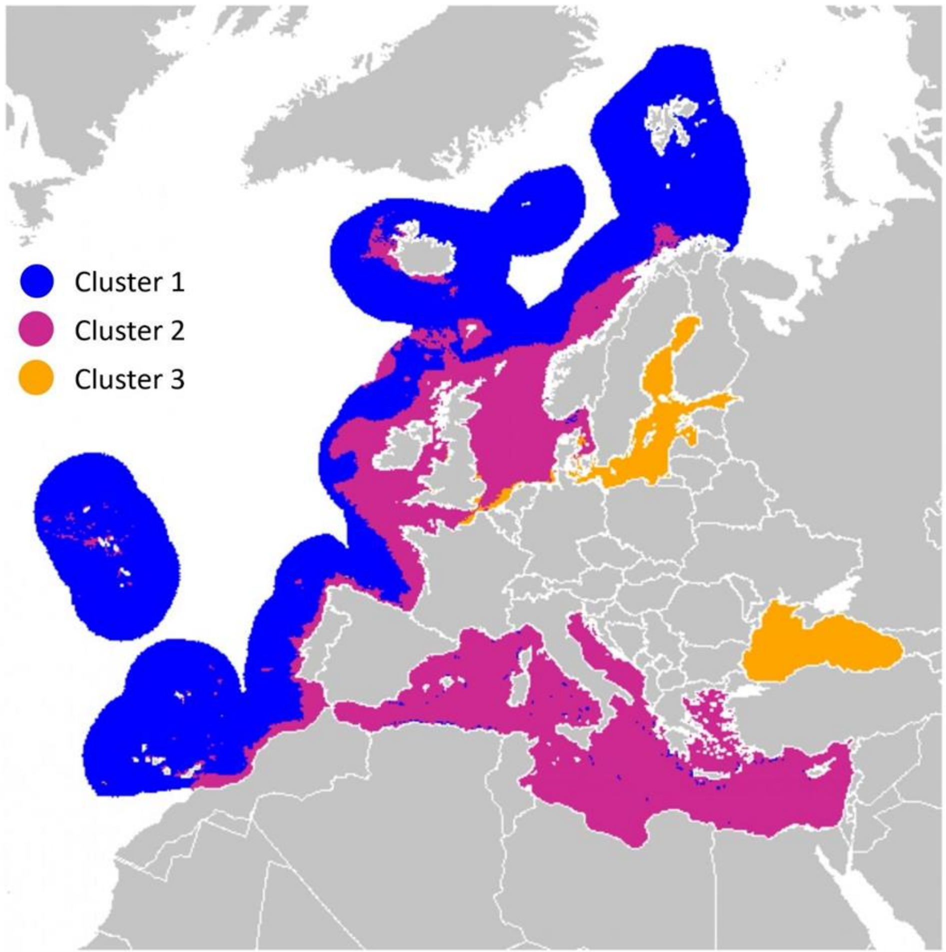
LOWER PRECISION =
GREATER ENVIROMENTAL VARIABILITY
(i.e. TRANSITION ZONES)

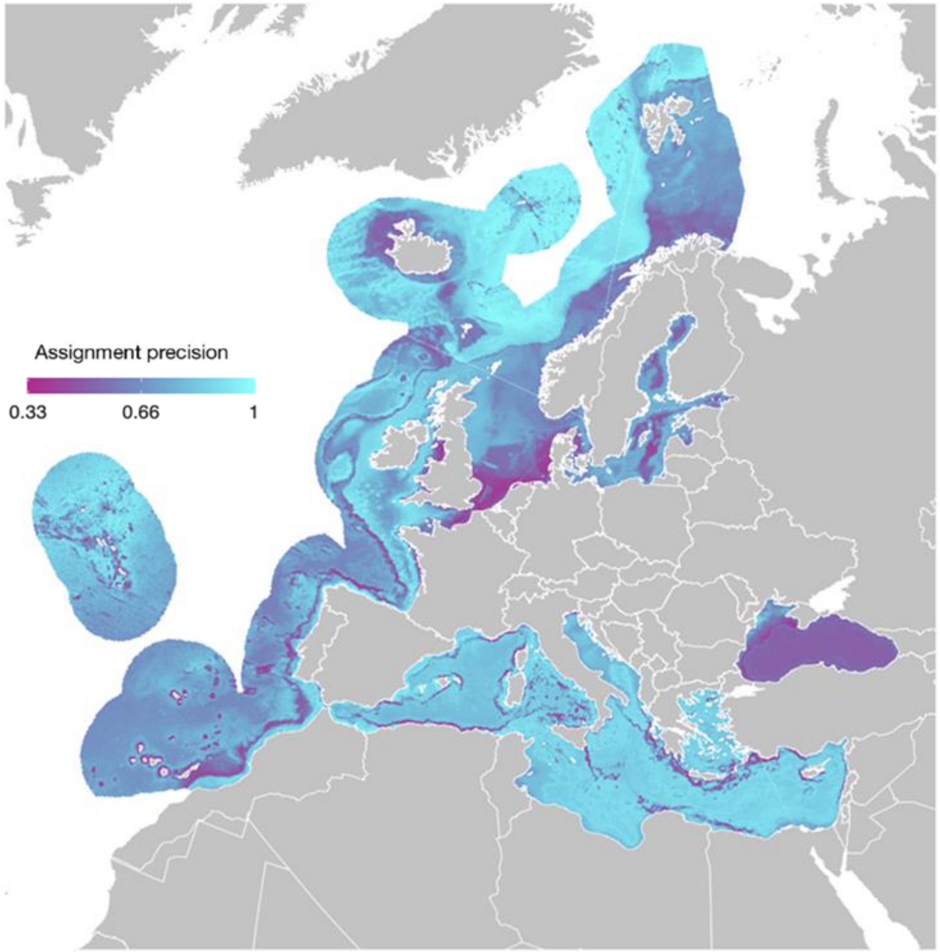




European marine ecosystems of **surface waters** estimated by k-means clustering analysis of environmental data (left) AND clustering assignment precision based on fuzzy logic (right)

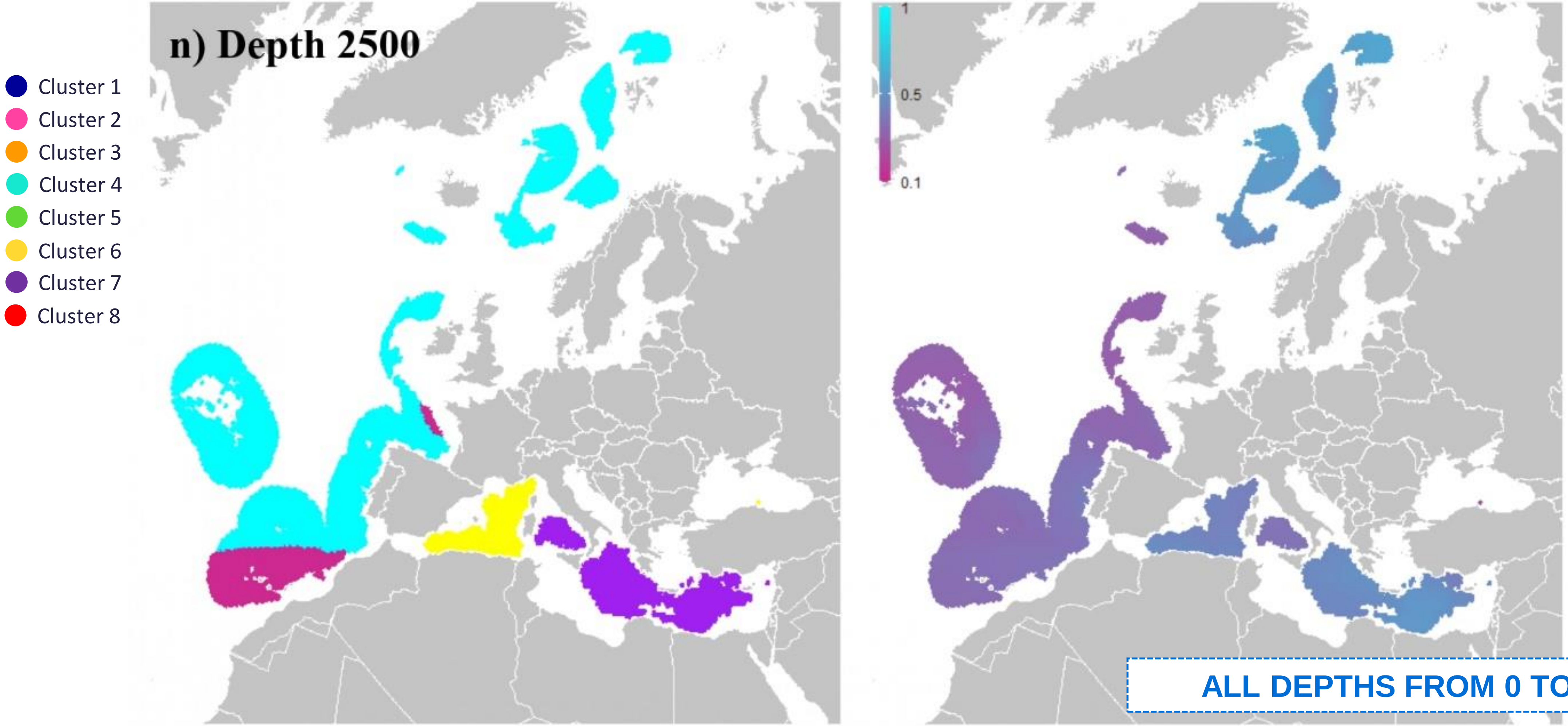
ECOSYSTEM CLASSIFICATION – NEAR SEABED





European marine ecosystems of **near seabed** estimated by k-means clustering analysis of environmental data (left) AND clustering assignment precision based on fuzzy logic (right)

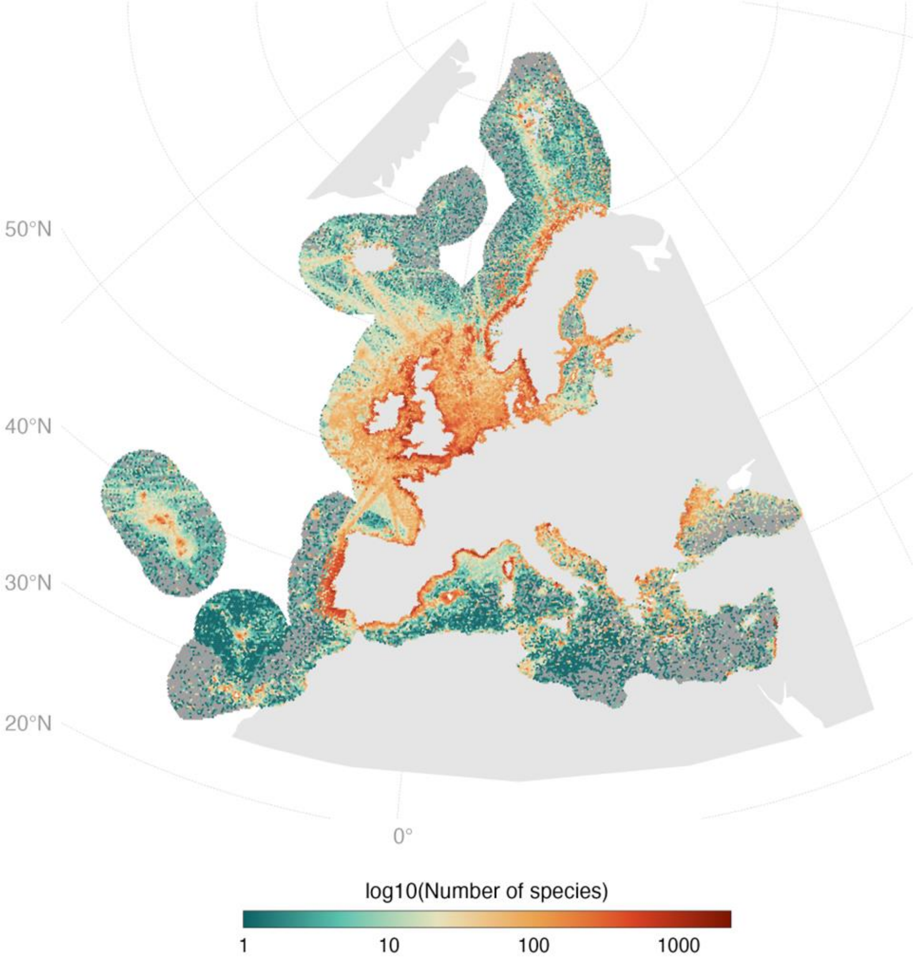
ECOSYSTEM CLASSIFICATION – 3D

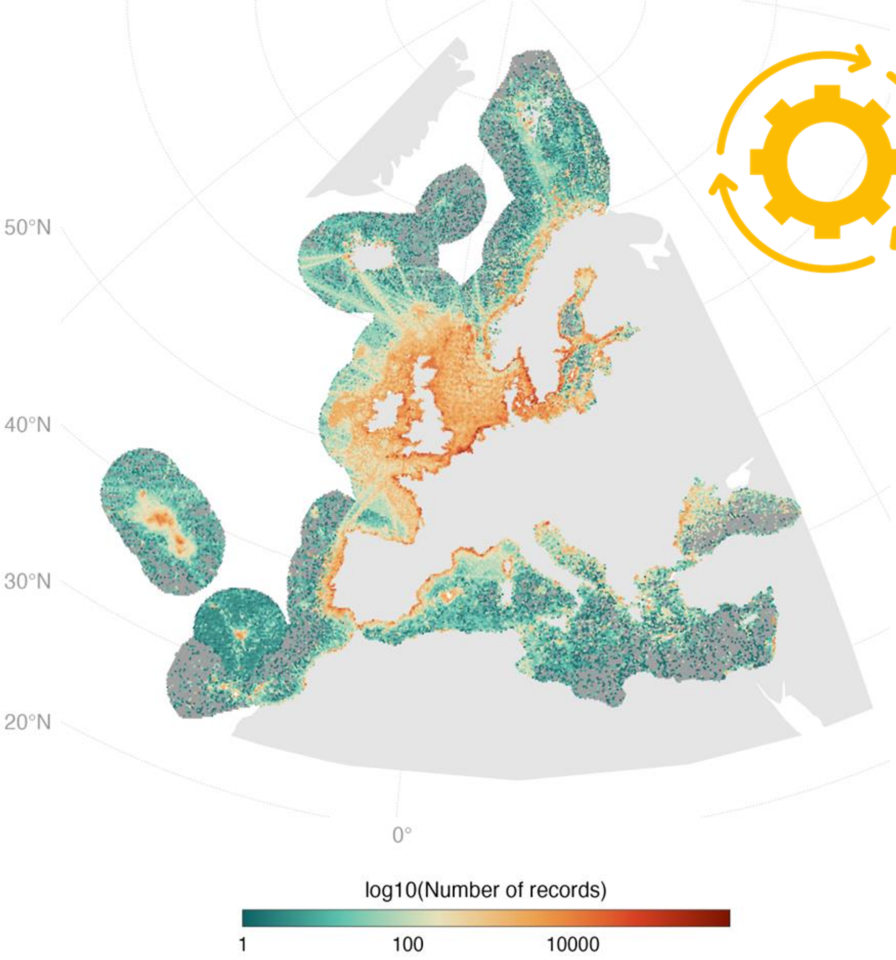


ALL DEPTHS FROM 0 TO 2,500 m

European **depth-integrated** marine ecosystems classification estimated by k-means clustering analysis of environmental data (left) AND their assignment precision based on fuzzy logic (right)

SPECIES DISTRIBUTION DATA





© OBIS

SOURCE OF ADDITIONAL SPECIES DATASETS (into OBIS)

- Peer
- BioTIME
- GBIF
- Dryad
- Literature
- ...

GBIF Global Biodiversity Information Facility


PHILOSOPHICAL TRANSACTIONS B

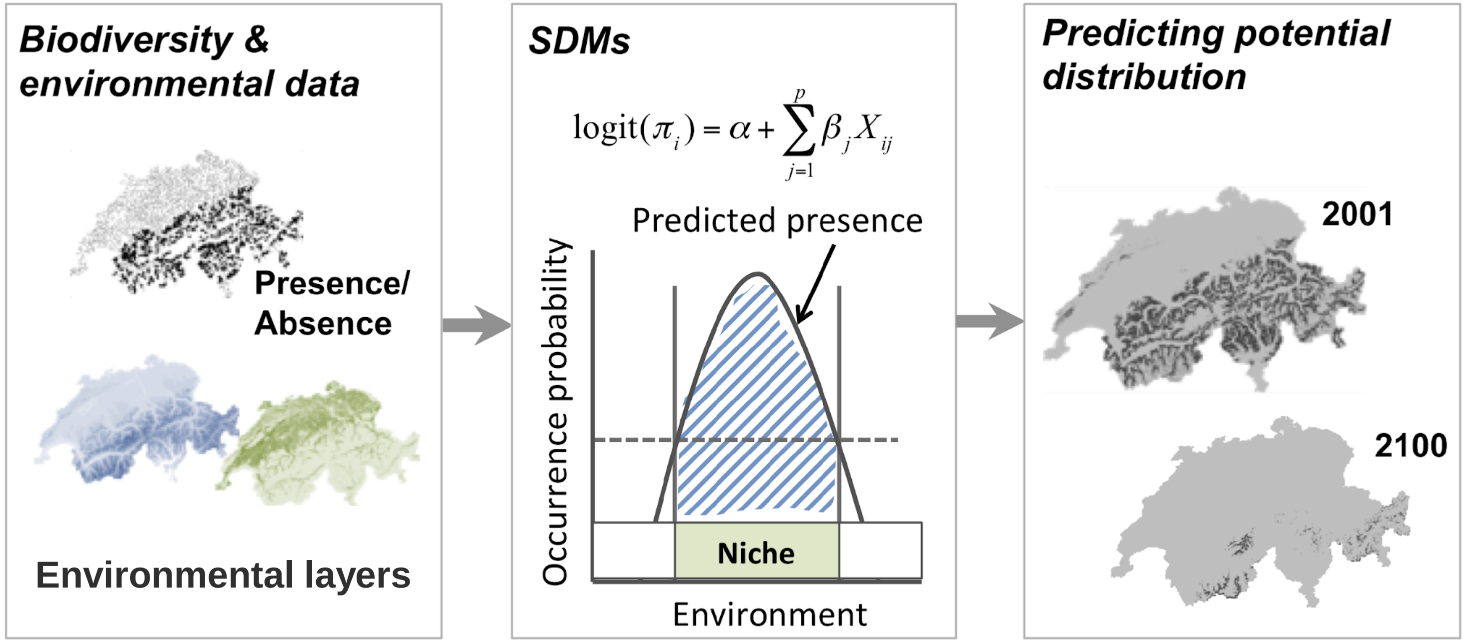
Cross-continental analysis of coastal biodiversity change

DRYAD

...

Marine species distribution data available in **OBIS**, including ~ 35,000 species (left) AND > 67,000,000 records (right)

SPECIES & HABITAT DISTRIBUTION MODELLING



Zurrel 2022

Distribution maps for ~15,000 marine species from Europe

Biogenic habitat maps, based on SDMs

Conservation status of species and habitats **(Red List)**

Species range shifts

Occurrence information from OBIS and GBIF (new pipelines for seamless data integration between both providers)

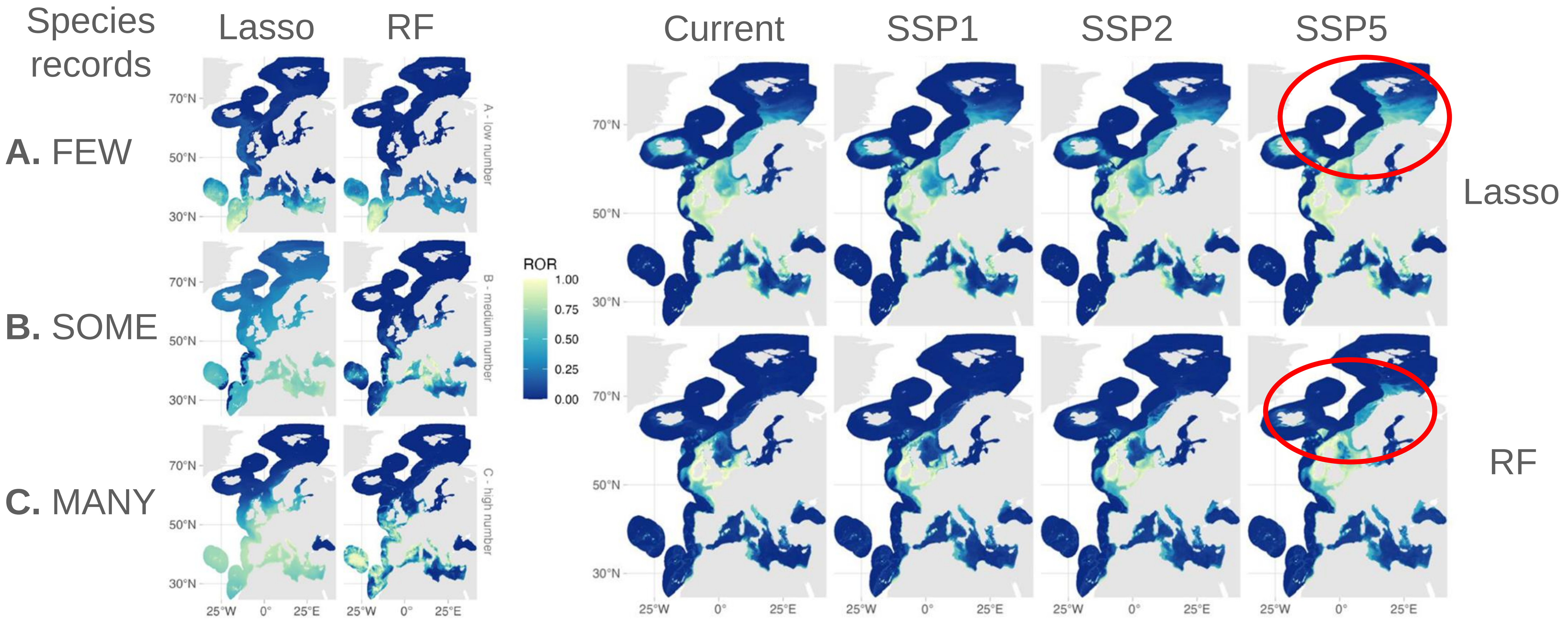
OCEAN BIODIVERSITY INFORMATION SYSTEM

Environmental data from Bio-ORACLE v3 (high-resolution ~5 km)

New CMIP6 scenarios SSP1, SSP2, SSP3, SSP4 and SSP5

Two periods: 2050 / 2100

SPECIES DISTRIBUTION PREDICTIONS

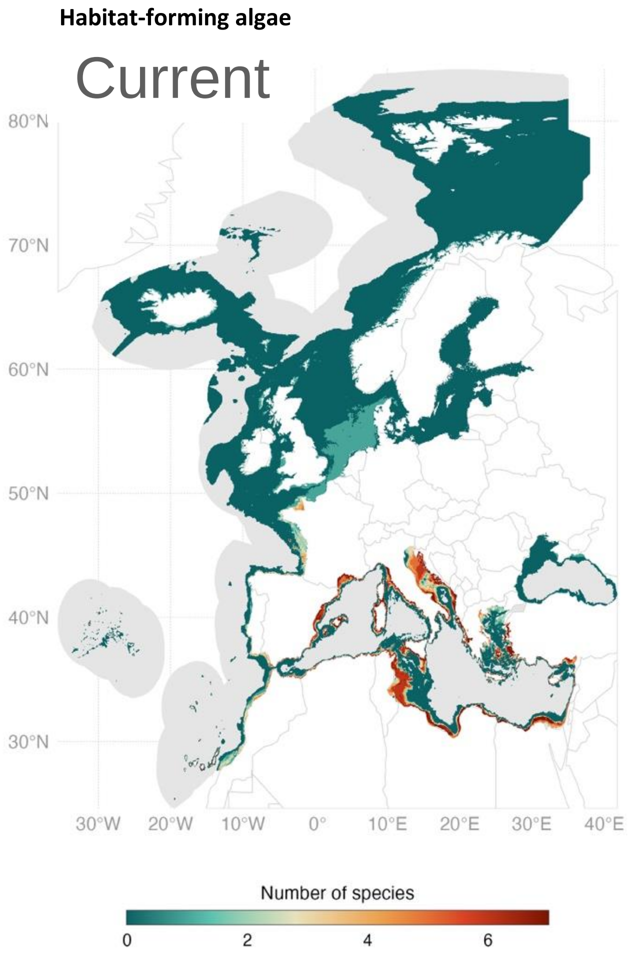


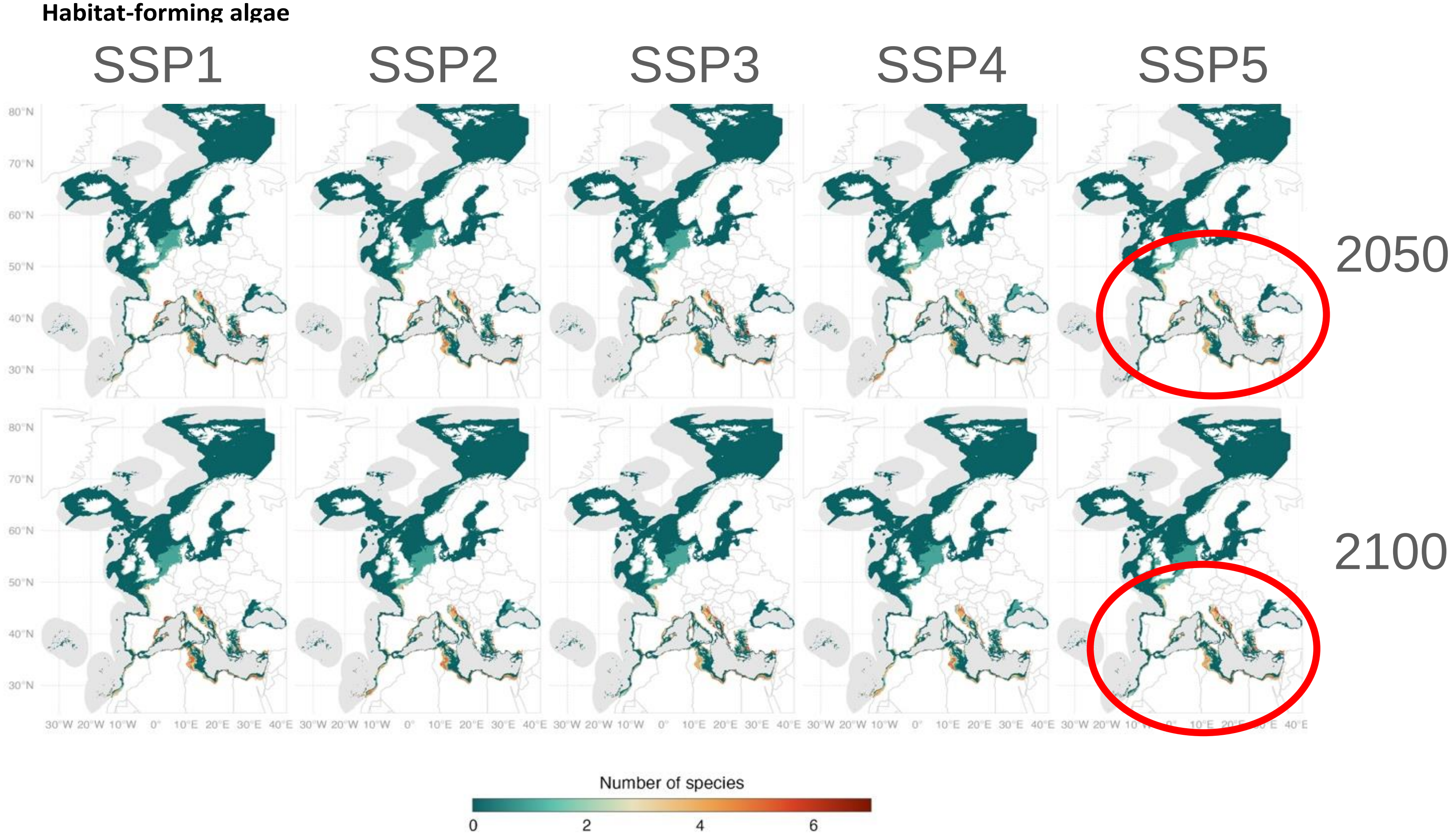
Species distribution predictions for three species with different number of records (A-C) according to two methods (left) AND species distribution predictions for the species *Raja brachyura* (right)

ROR = Relative Occurrence Rate, higher values = areas of higher suitability for the species

Red circle = area of change, in this case indicating expansion of *R. brachyura* range

BIOGENIC HABITAT DISTRIBUTION PREDICTIONS

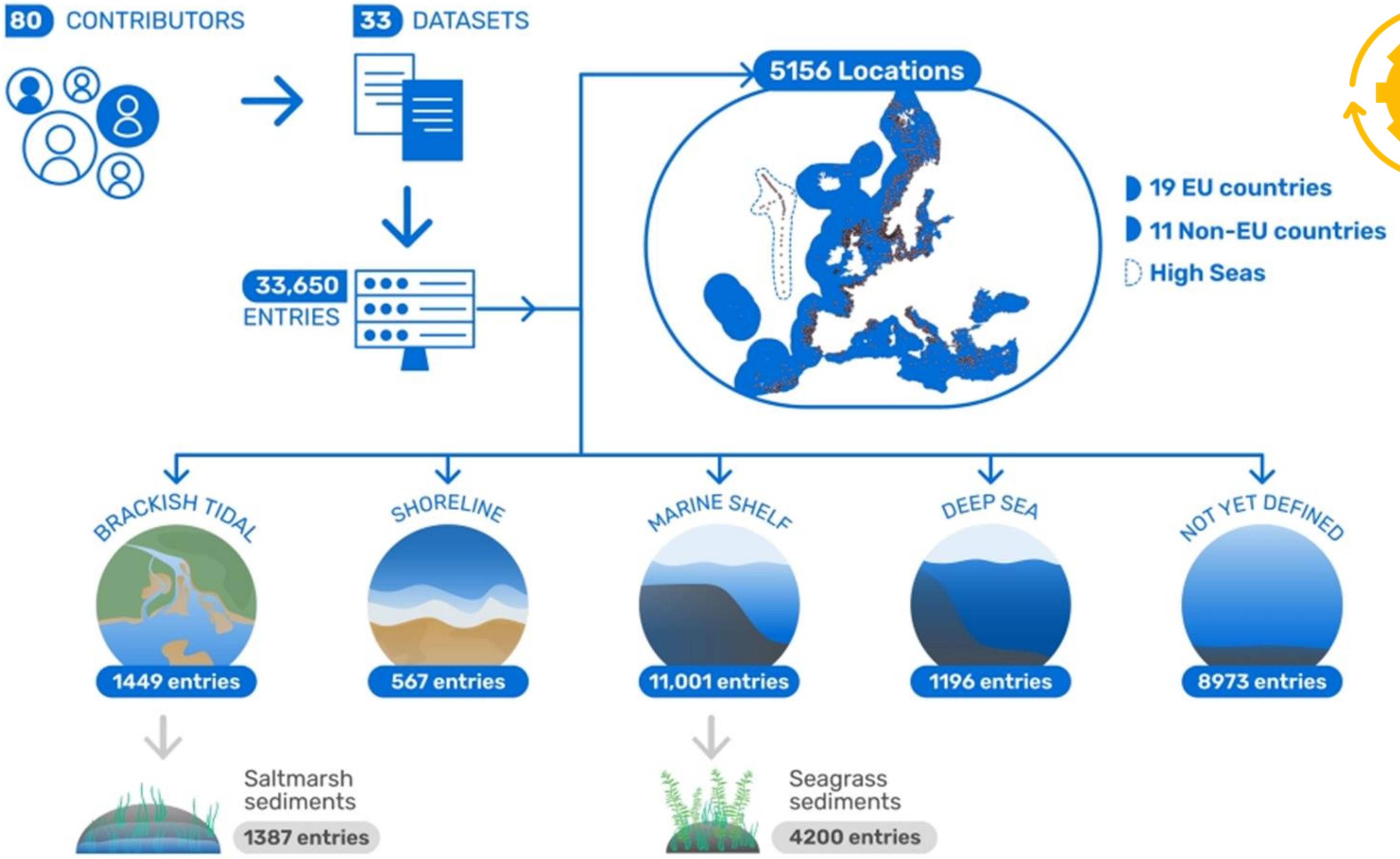




Predicted distribution of habitat-forming macroalgae in the **current** period (left) AND in the **future** period (right) according to species distribution models, considering **five climate scenarios** (SSP1, SSP2, SSP3, SSP4 and SSP5) and two time periods (2050 and 2100)

Red circle = area of change, in this case indicating contraction/expansion of habitat-forming algae

BLUE CARBON DATA



SOURCES OF ADDITIONAL BLUE CARBON DATASETS

PANGAEA.

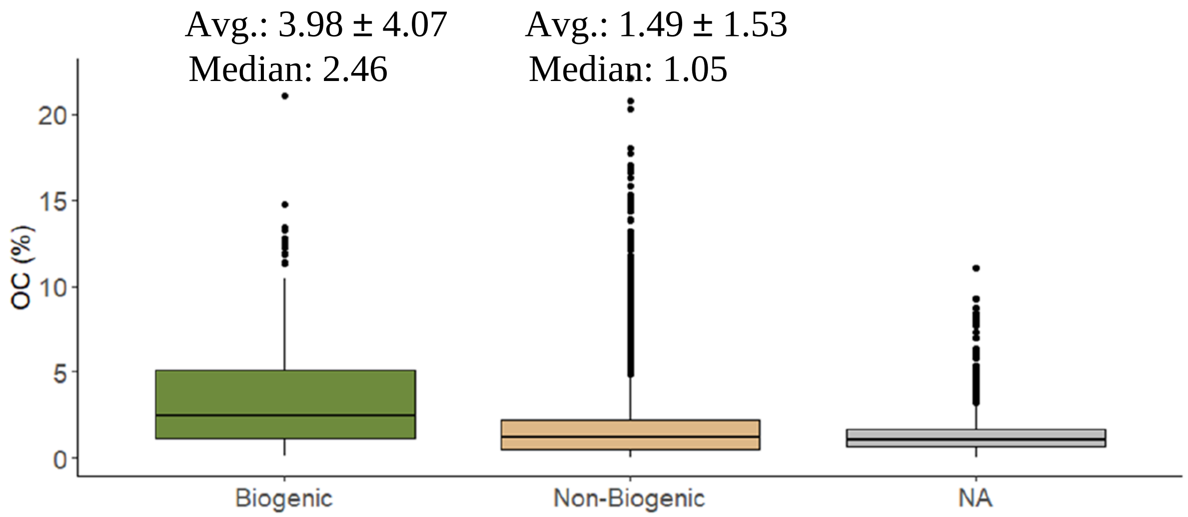
SeaDataNet

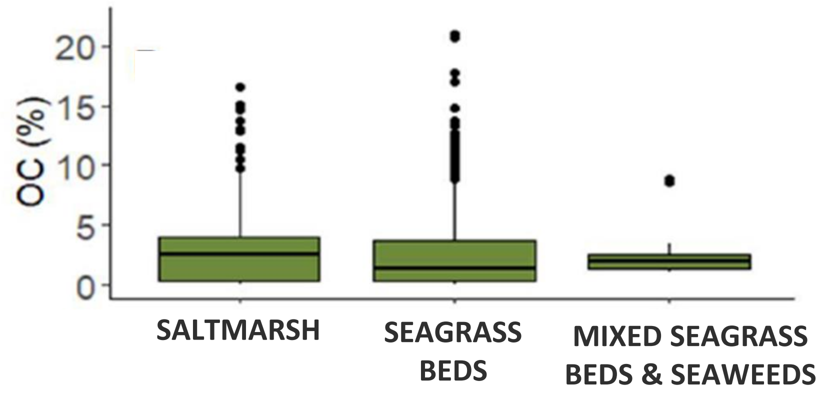
EMODnet
European Marine Observation and Data Network

Geo-Seas

...

ORGANIC CARBON CONTENT

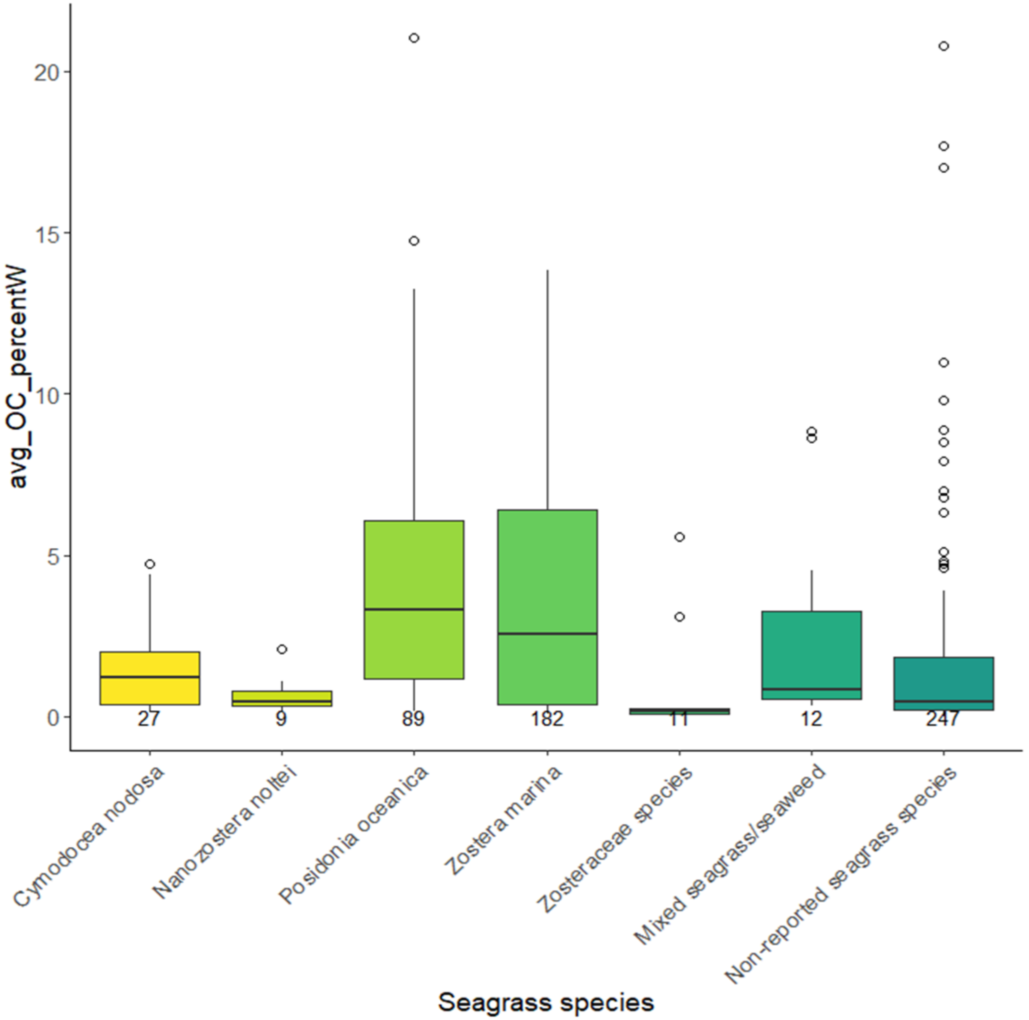


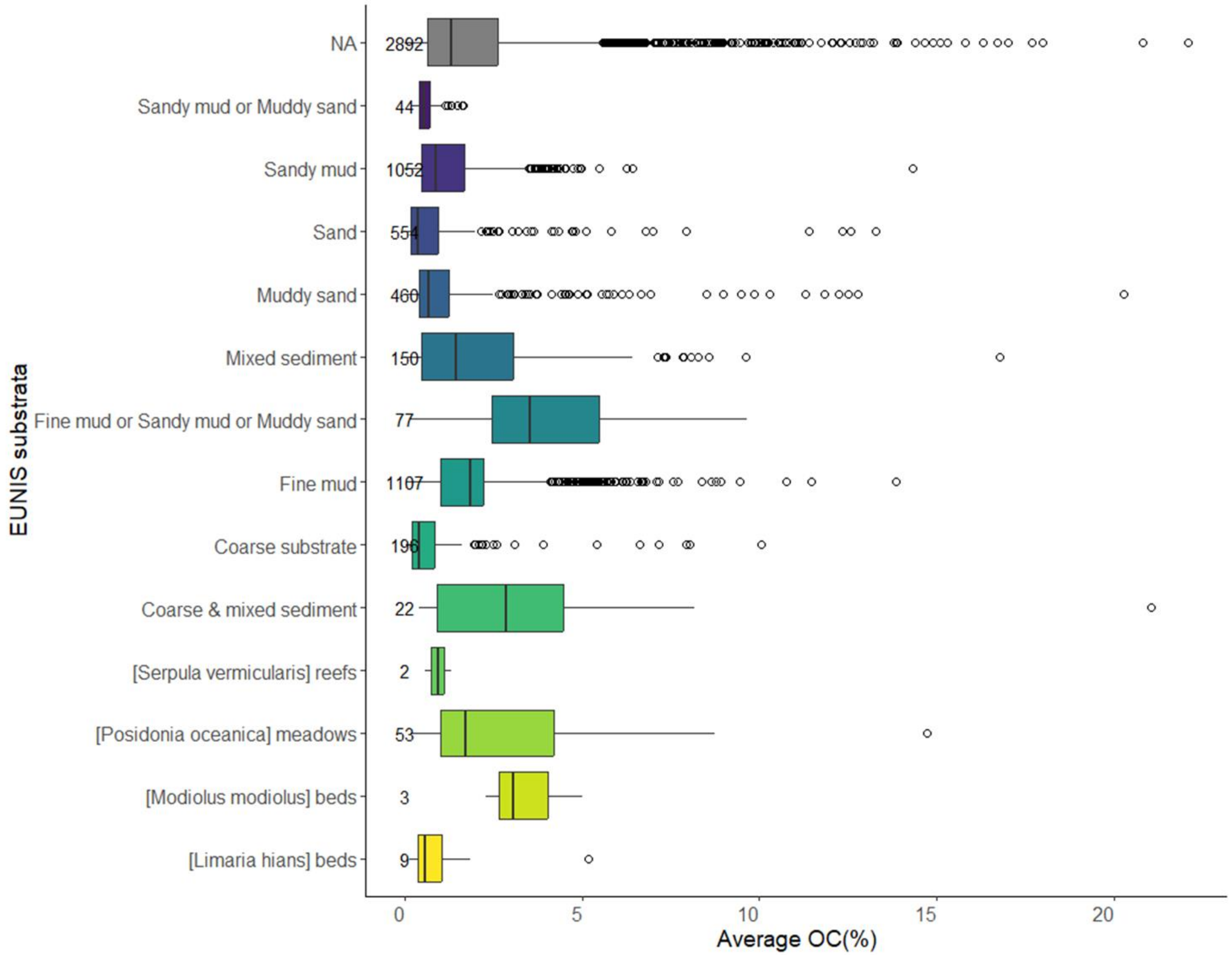


Spatial coverage of **organic carbon content (%OC)** in marine sediment (left) AND in the top 10cm of the sediment for **biogenic & non-biogenic habitats** (EUNIS definition) (top right)

© Graversen et al (2023) - MPA Europe

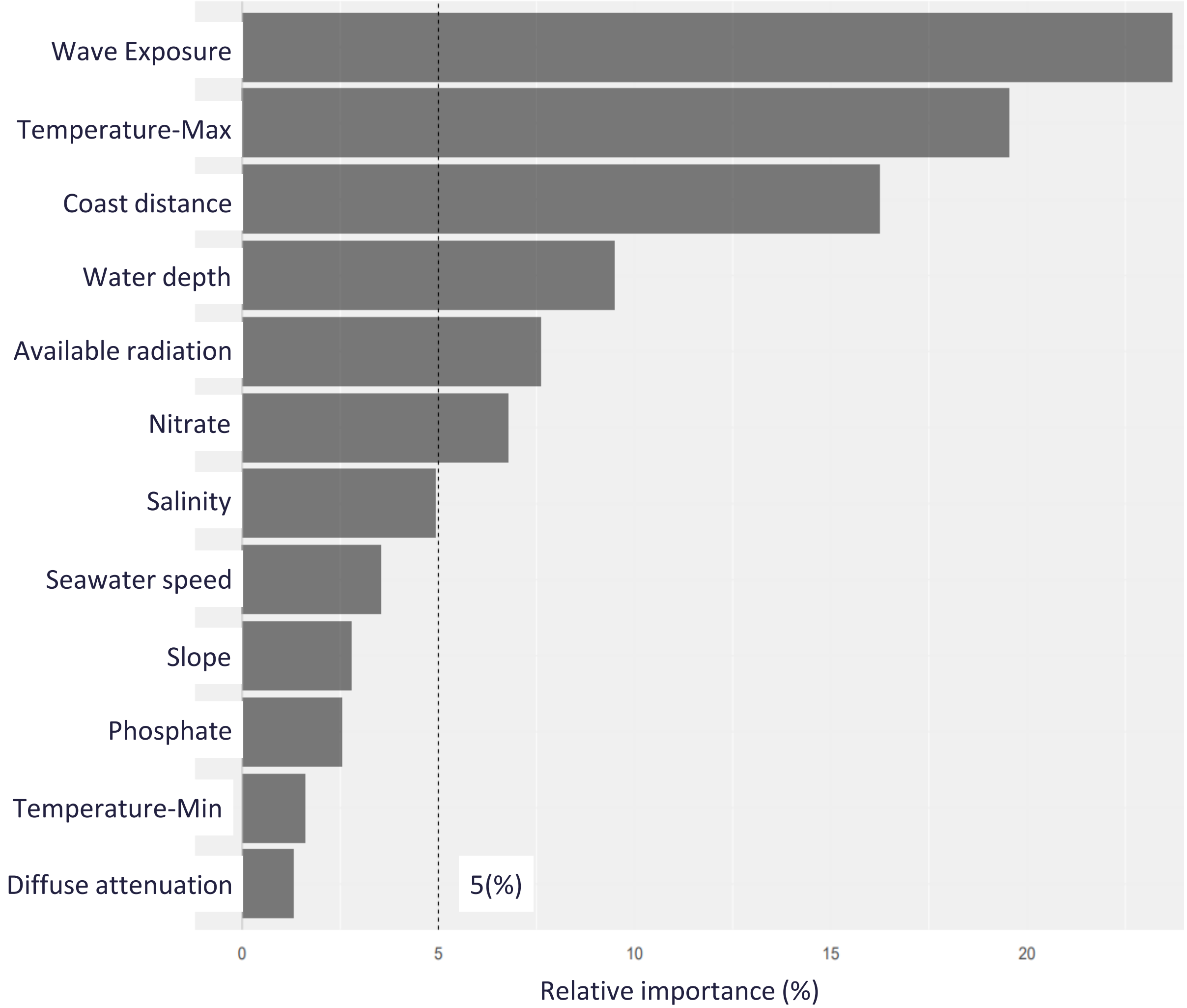
OC within & beyond BIOGENIC habitats

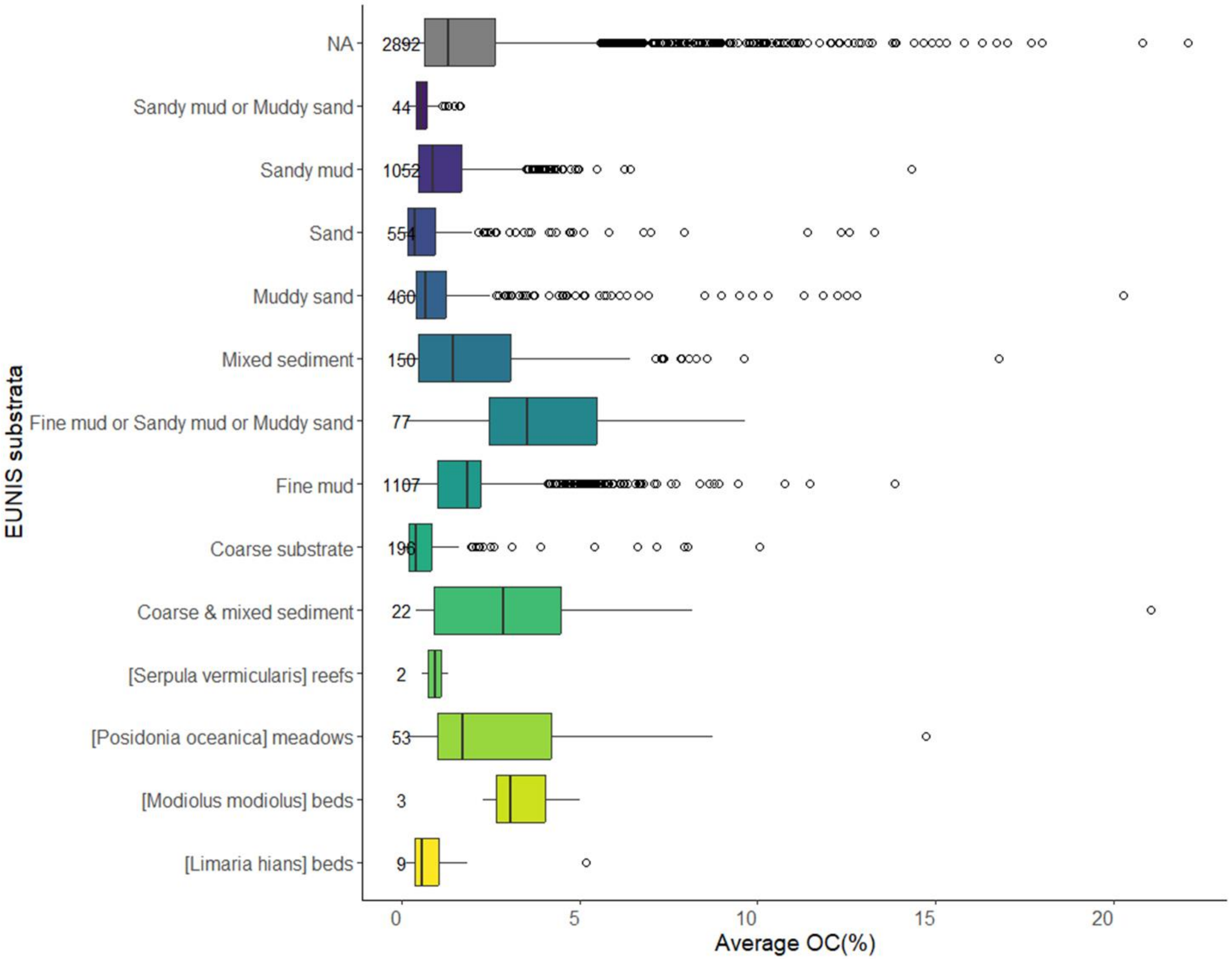




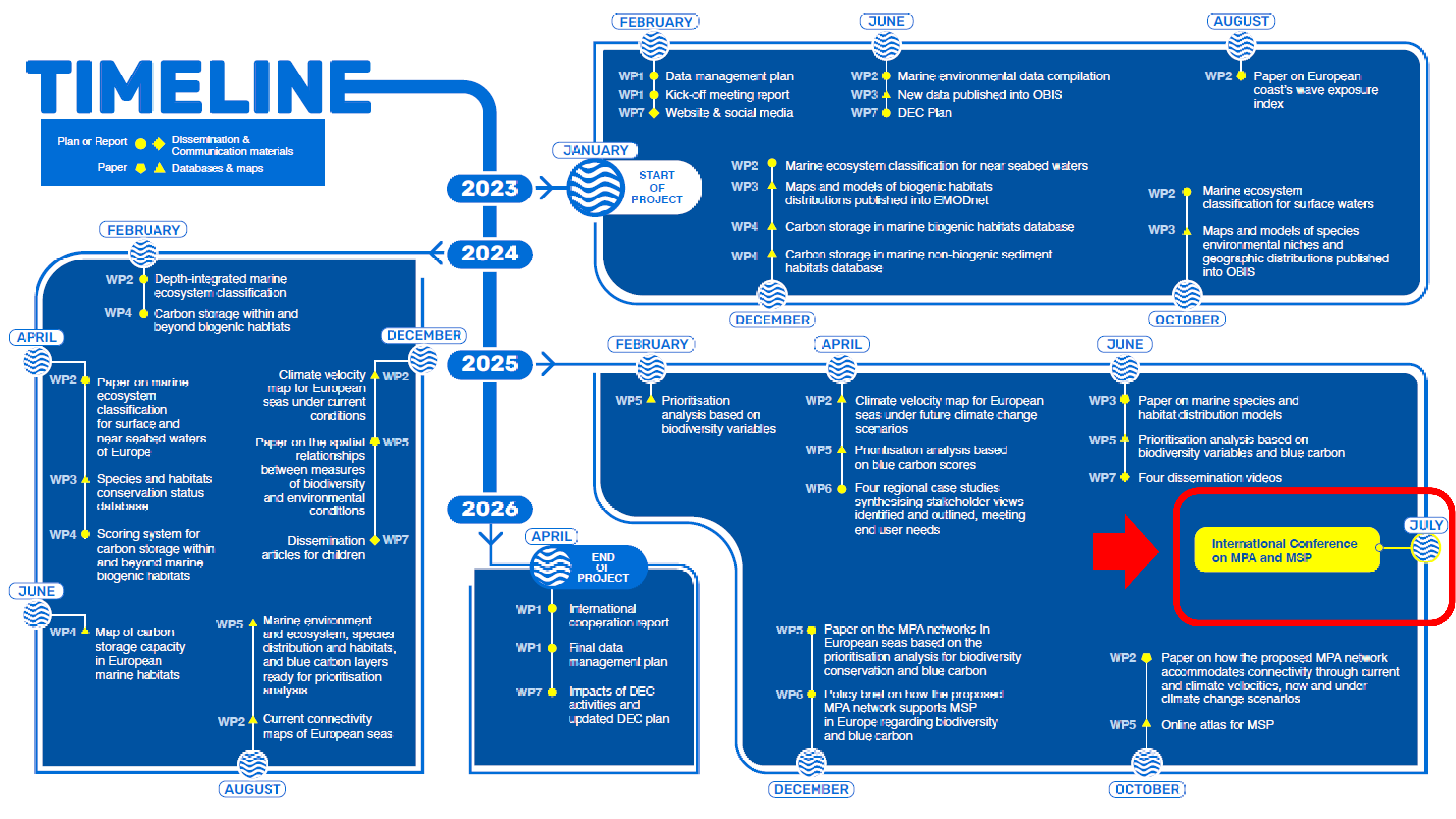
Organic carbon content (%OC) in marine sedimenta (EUNIS definition) (right), with seagrass species (left), AND the importance of environmental predictor in describing the OC (right)

OC within & beyond BIOGENIC habitats





Organic carbon content (%OC) in marine sedimenta (EUNIS definition) (right), with seagrass species (left), AND the importance of environmental predictor in describing the OC (right)


TIMELINE
Plan or Report
Dissemination & Communication materials
Paper
Databases & maps
2023
JANUARY
START OF PROJECT
FEBRUARY
WP1 Data management plan
WP1 Kick-off meeting report
WP7 Website & social media
JUNE
WP2 Marine environmental data compilation
WP3 New data published into OBIS
WP7 DEC Plan
AUGUST
WP2 Paper on European coast's wave exposure index
OCTOBER
WP2 Marine ecosystem classification for surface waters
WP3 Maps and models of species environmental niches and geographic distributions published into OBIS
DECEMBER
WP2 Marine ecosystem classification for near seabed waters
WP3 Maps and models of biogenic habitats distributions published into EMODnet
WP4 Carbon storage in marine biogenic habitats database
WP4 Carbon storage in marine non-biogenic sediment habitats database
2024
FEBRUARY
WP2 Depth-integrated marine ecosystem classification
WP4 Carbon storage within and beyond biogenic habitats
APRIL
WP2 Paper on marine ecosystem classification for surface and near seabed waters of Europe
WP3 Species and habitats conservation status database
WP4 Scoring system for carbon storage within and beyond marine biogenic habitats
JUNE
WP4 Map of carbon storage capacity in European marine habitats
AUGUST
WP5 Marine environment and ecosystem, species distribution and habitats, and blue carbon layers ready for prioritisation analysis
WP2 Current connectivity maps of European seas
DECEMBER
WP2 Climate velocity map for European seas under current conditions
WP5 Paper on the spatial relationships between measures of biodiversity and environmental conditions
WP7 Dissemination articles for children
2025
FEBRUARY
WP5 Prioritisation analysis based on biodiversity variables
APRIL
WP2 Climate velocity map for European seas under future climate change scenarios
WP5 Prioritisation analysis based on blue carbon scores
WP6 Four regional case studies synthesising stakeholder views identified and outlined, meeting end user needs
JUNE
WP3 Paper on marine species and habitat distribution models
WP5 Prioritisation analysis based on biodiversity variables and blue carbon
WP7 Four dissemination videos
JULY
International Conference on MPA and MSP
OCTOBER
WP2 Paper on how the proposed MPA network accommodates connectivity through current and climate velocities, now and under climate change scenarios
WP5 Online atlas for MSP
DECEMBER
WP5 Paper on the MPA networks in European seas based on the prioritisation analysis for biodiversity conservation and blue carbon
WP6 Policy brief on how the proposed MPA network supports MSP in Europe regarding biodiversity and blue carbon
2026
APRIL
END OF PROJECT
WP1 International cooperation report
WP1 Final data management plan
WP7 Impacts of DEC activities and updated DEC plan

TIMELINE

MPA

HOMEPAGE | THE PROJECT | TEAM | STAKEHOLDER NETWORK | RESOURCES | FAQs | NEWS | CONTACT US | MPA CONFERENCE

INTERNATIONAL CONFERENCE ON MARINE PROTECTED AREAS IN MARINE SPATIAL PLANNING

THANK YOU

ANNA M ADDAMO – anna.m.addamo@nord.no

NORD universitet

BELINDA BRAMLEY – belindabramley@gmail.com

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