



Marine Protected Areas for Europe: Systematic Planning and dispelling myths

Mark John Costello, Nord University, Norway

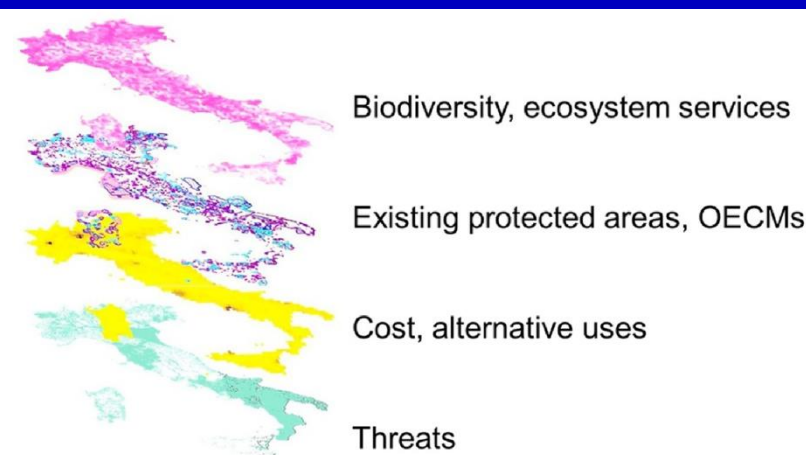
Systematic Conservation Planning

- Focusing conservation effort where it will **save species from extinction**
 - **Scientific evidence** to guide planning
 - **People negotiate** boundaries and activities allowed (or not), e.g., using SeaSketch
- Can use
 1. **Observed** locations of species and/or habitats
 2. **Expert drawn** range maps of where one or more species occurs (e.g., from IUCN Red List)
 3. **“species distribution model”** range maps based on predicting a species “environmental niche” from observations

Recently described in review paper

(A)

Set objectives, define targets, and scenarios
collect spatially explicit data



Spatial prioritization



REVIEW · Volume 40, Issue 4, P395-410, April 2025 · [Open Access](#) [Download Full Issue](#)

Advances in systematic conservation planning to meet global biodiversity goals

[Sylvaine Giakoumi](#)^{1,27} · [Anthony J. Richardson](#)^{2,3} · [Aggeliki Doxa](#)^{4,5} · ... · [Vanessa Stelzenmüller](#)²⁵ · [Hugh P. Possingham](#)² · [Stelios Katsanevakis](#)²⁶ ... [Show more](#)

Site								Richness
A	✓	✓	✓		✓	✓		5
B		✓	✓	✓	✓	✓		5
C		✓			✓	✓		3
D					✓	✓	✓	3
E	✓	✓	✓	✓				4

Marine global











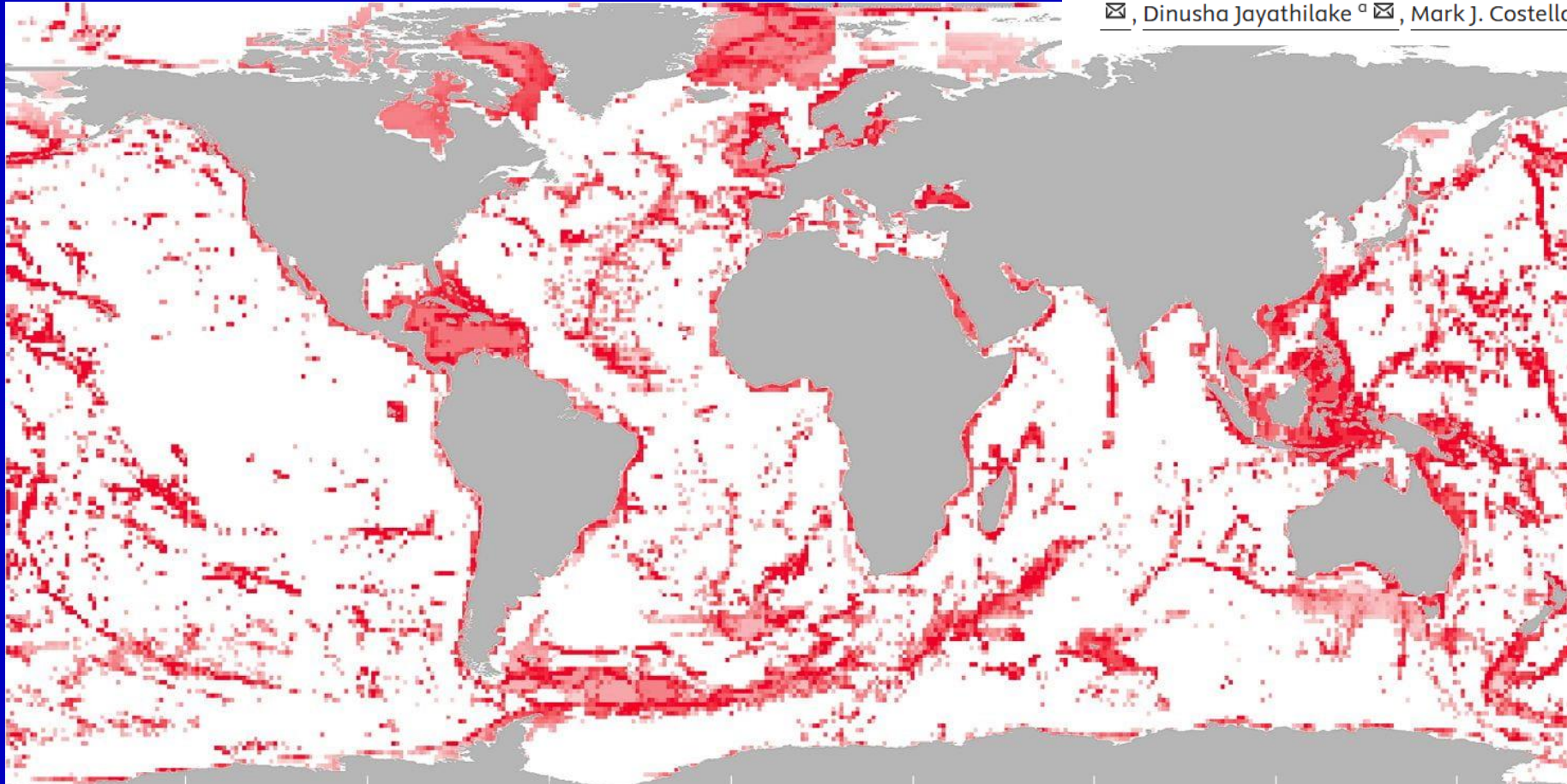
Biological Conservation

Volume 244, April 2020, 108536

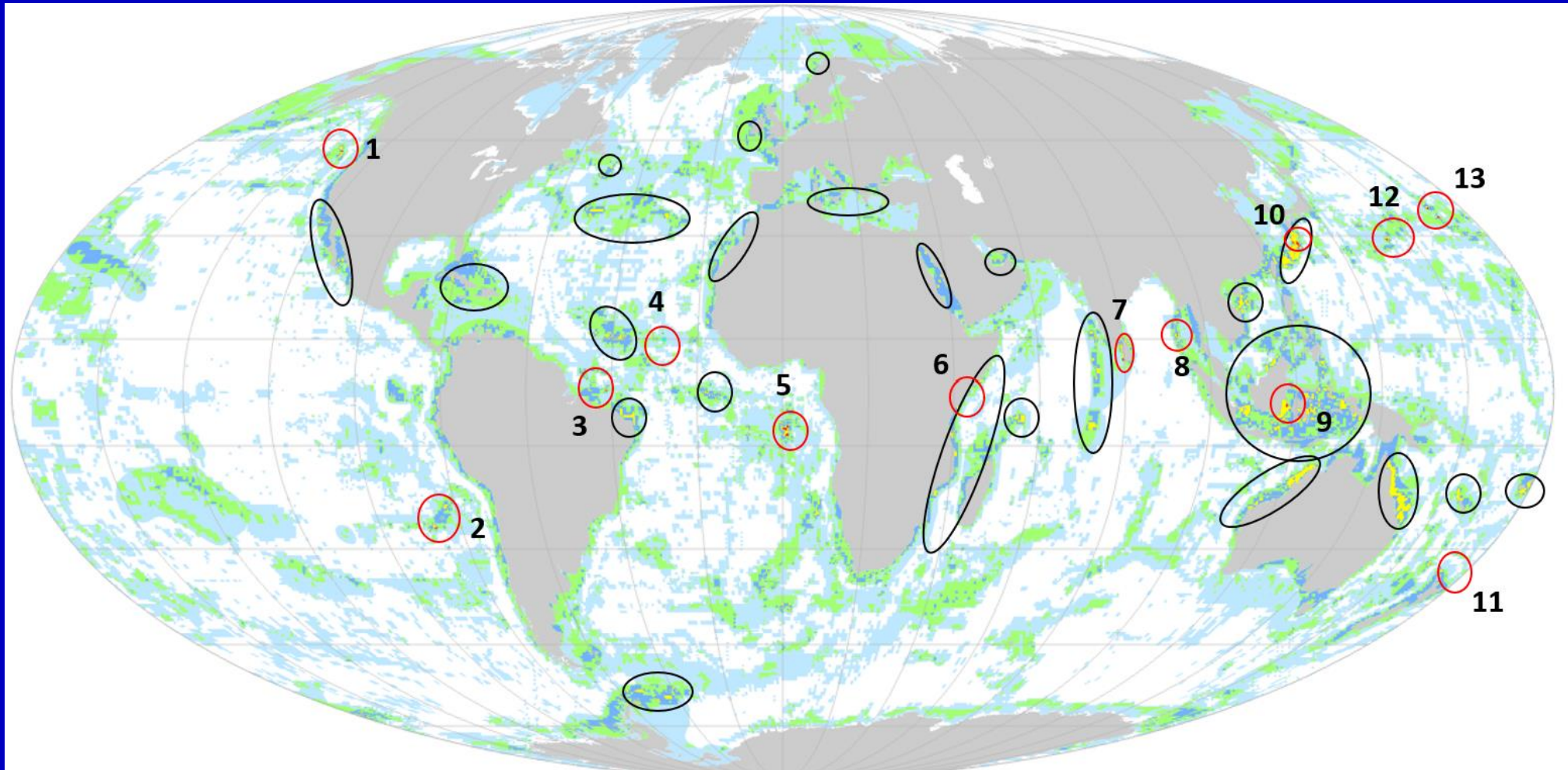


Where Marine Protected Areas would best represent 30% of ocean biodiversity

Qianshuo Zhao ^a  , Fabrice Stephenson ^{a,b} , Carolyn Lundquist ^{a,b} , Kristin Kaschner ^c 
, Dinusha Jayathilake ^a , Mark J. Costello ^{a,d,e} 



Overlap of 6 systematic prioritisation studies



None of these studies cited by Convention on Biological Diversity

nor used by countries

Data driven priority analysis: Jones et al., 2020; Sala et al., 2021; Selig et al., 2014; Visalli et al., 2020; Zhao et al., 2020; Brito-Morales et al. 2022; and expert opinion (Olson and Dinerstein 2002). [Zhao & Costello 2025, TREE review]



M **MARINE PROTECTED AREAS EUROPE** PA

Marine Protected Areas for Europe

January 2023 to April 2026
€3 million budget





Wonderful team



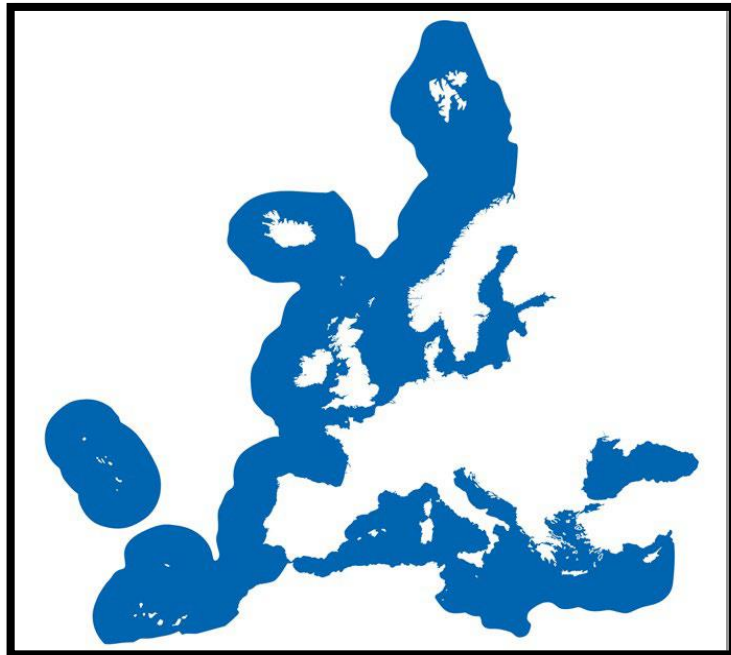
G
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MPA Europe mapped the **optimal locations** for Marine Protected Areas in European seas to support **science-based Marine Spatial Planning**

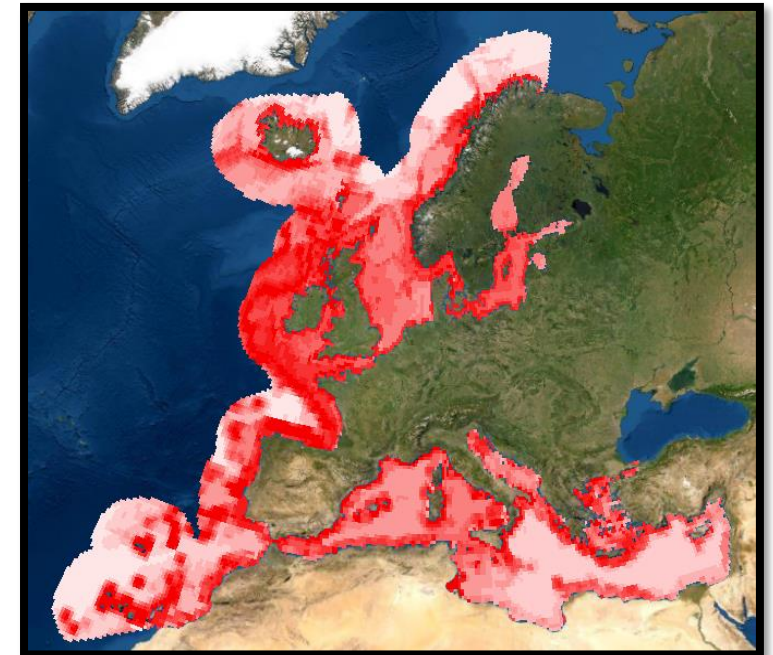
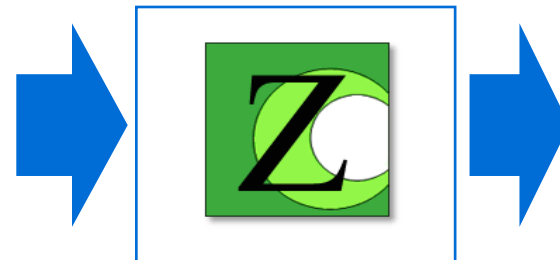
BIODIVERSITY

BLUE CARBON

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C
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SYSTEMATIC CONSERVATION PLANNING (SCP)



2023

2024

2025

2026

WORK PACKAGE N°	DELIVERABLE RELATED N°	DELIVERABLE NAME	DUE DATE	STATUS
WP1	D1.1	Data Management Plan	feb	Submitted
WP1	D1.2	Report from the kick-off meeting	feb	Submitted
WP7	D7.2	Project website and social media accounts	feb	Submitted
WP2	D2.1	Compilation of marine environmental data ready for ecosystem classification analysis and distribution modelling	jun	Submitted. View the submitted version here
WP3	D3.1	Compile additional data and publish it into OBIS	jun	Submitted. View the submitted version here
WP7	D7.1	Dissemination, Exploitation and Communication plan	jun	Submitted
WP2	D2.2	Paper on wave exposure index for all European coasts	aug	Submitted
WP2	D2.3	Marine ecosystem classification for surface waters of Europe	oct	Submitted. View the submitted version here

Deliverables reported on project website and can be downloaded from Zenodo



News on project website

NEWS

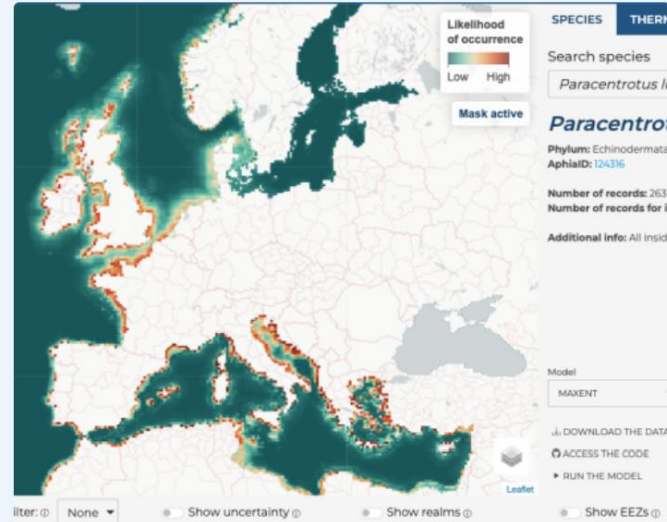


Mediterranean Sea Stakeholder Workshop Report is now available

April 4, 2025

MPA Europe's report on the Mediterranean Sea stakeholders workshop recently co-hosted by the project, is now available on the Resources page

[Read more >](#)



Calling All Marine Experts: Help Validate Species Distribution Models with MPA Europe

March 17, 2025

MPA Europe is inviting marine taxonomists and ecologists to contribute to an important collaborative effort—validating Species Distribution Models (SDMs). Experts who participate will gain

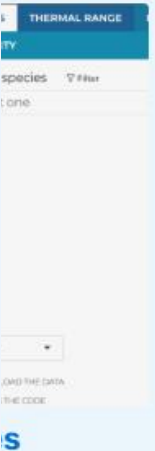


MPA Europe Annual Meeting 2025

February 28, 2025

On February 19 and 20, MPA Europe project team held its annual meeting in Copenhagen, Denmark.

[Read more >](#)



n hosted
nge maps
und in



MARITIME SPATIAL PLANNING IN THE EU



30 Events

~180 Stakeholders

4 Case studies

TWO-WAY PROCESS & WIN-WIN APPROACH

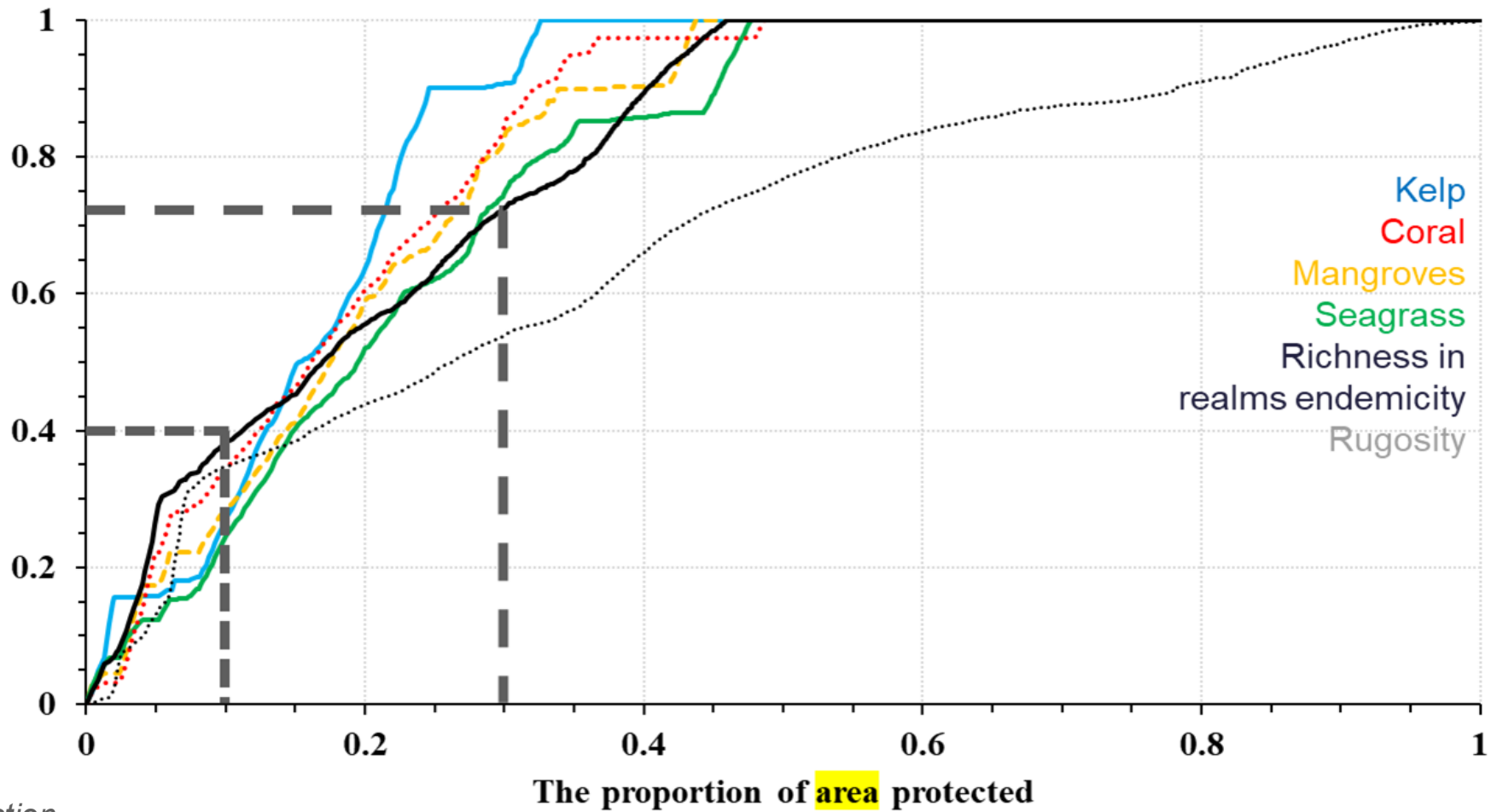
- since project's day-one ✓
- teamwork with sister projects ✓
- stakeholder diversity ✓
- regional meetings ✓
- co-design case-studies ✓
- regular interactions ✓
- open access data ✓
- analysis re-adaptation ✓

Systematic Conservation Planning designs a network of areas that best represent (include) measures of biodiversity

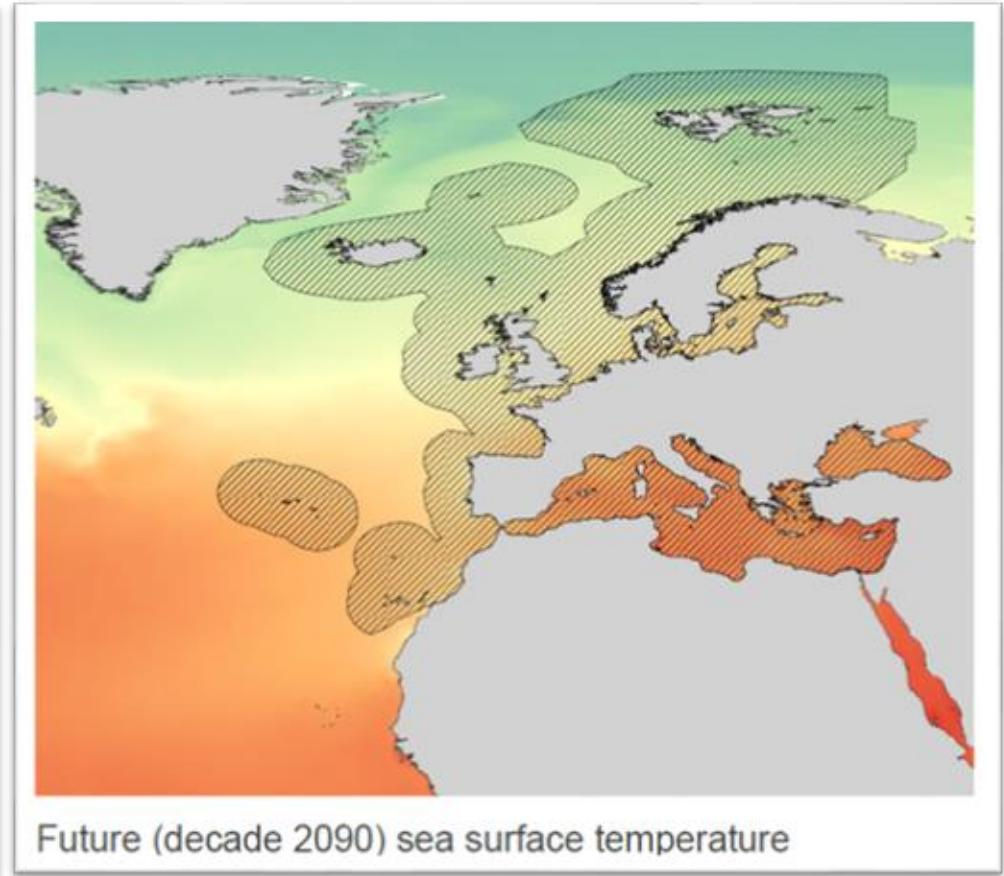
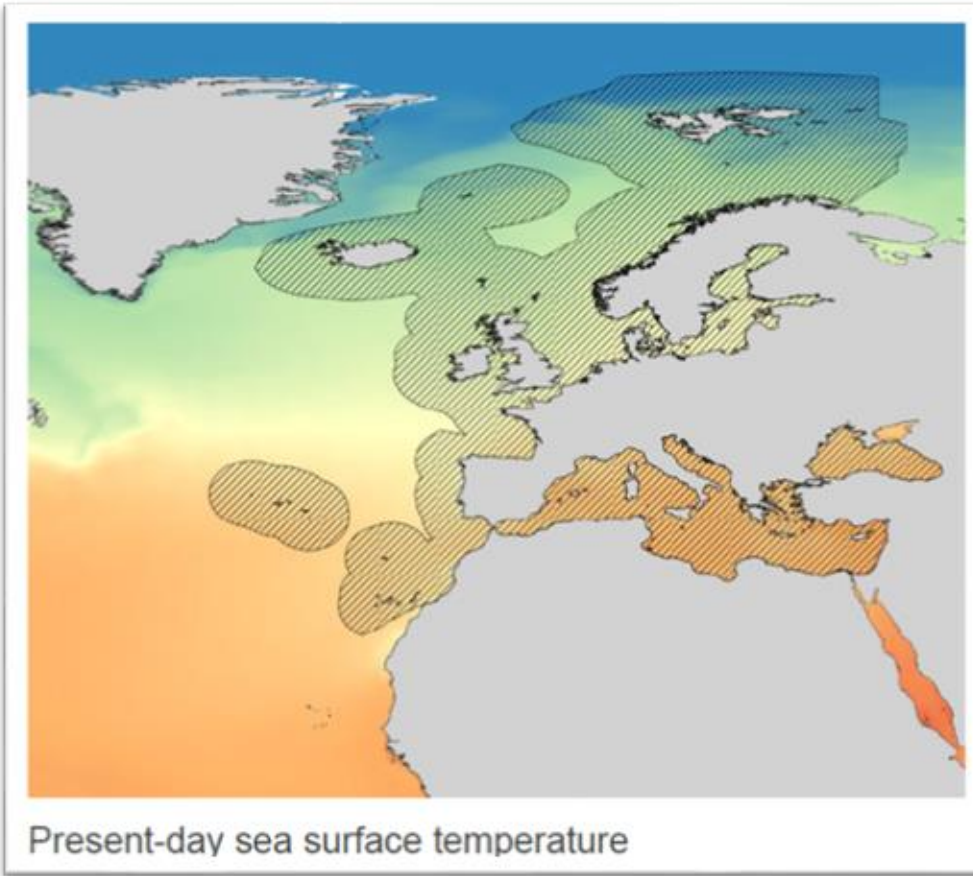
Aim for at least 80% representation of biodiversity within 30% of the sea area

Example is from a global prioritisation in 2020

The proportion of a measure of biodiversity per area



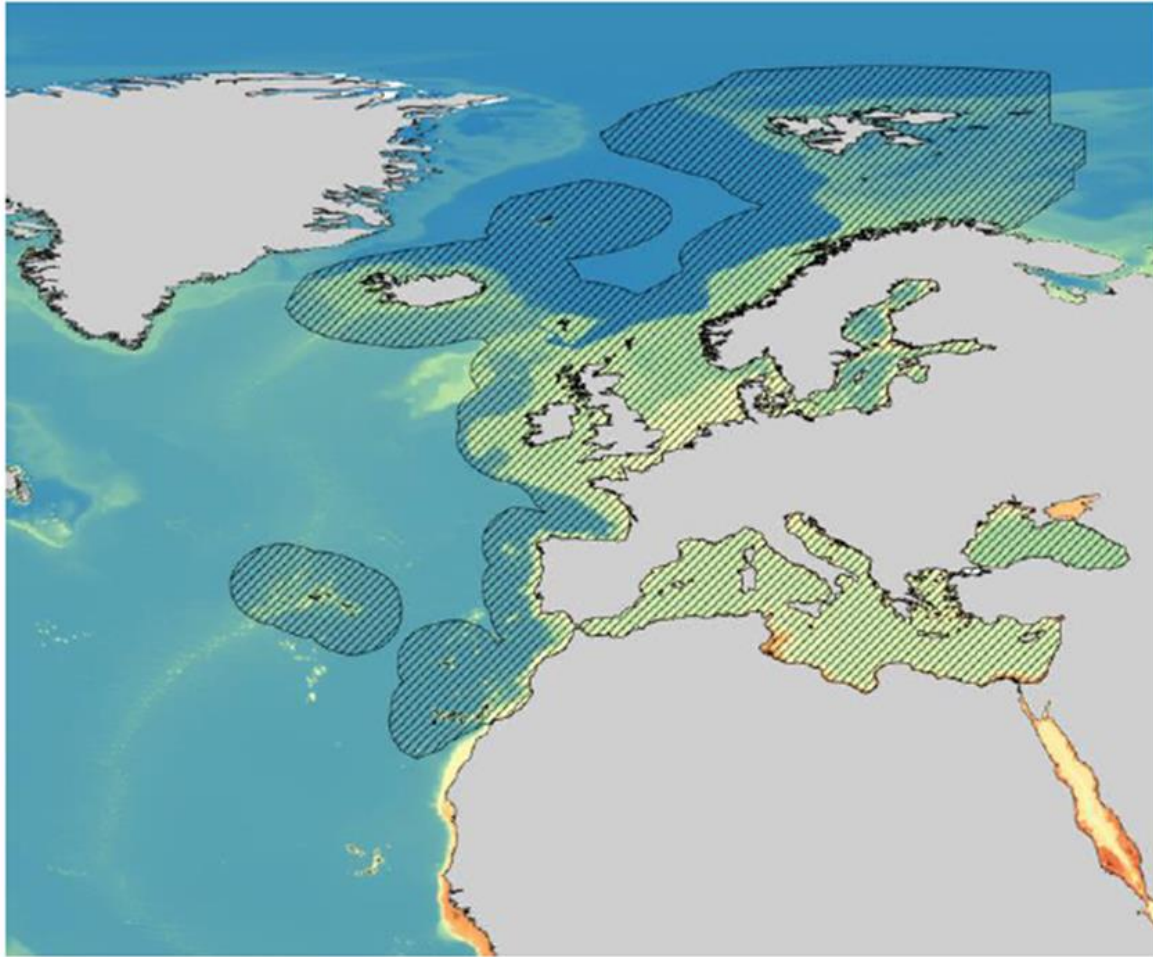
Variable
Temperature
Salinity
Sea Ice Cover
Sea Ice Thickness
Sea Water Velocity
Mixed Layer Depth
Diffuse Attenuation Coefficient
PAR
PAR at bottom
Oxygen
pH
Iron
Phosphate
Nitrate
Silicate
Total phytoplankton
Chlorophyll
Topographic (slope)
Topographic (roughness)
EMODnet Bathymetry
Sedimentation Rates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



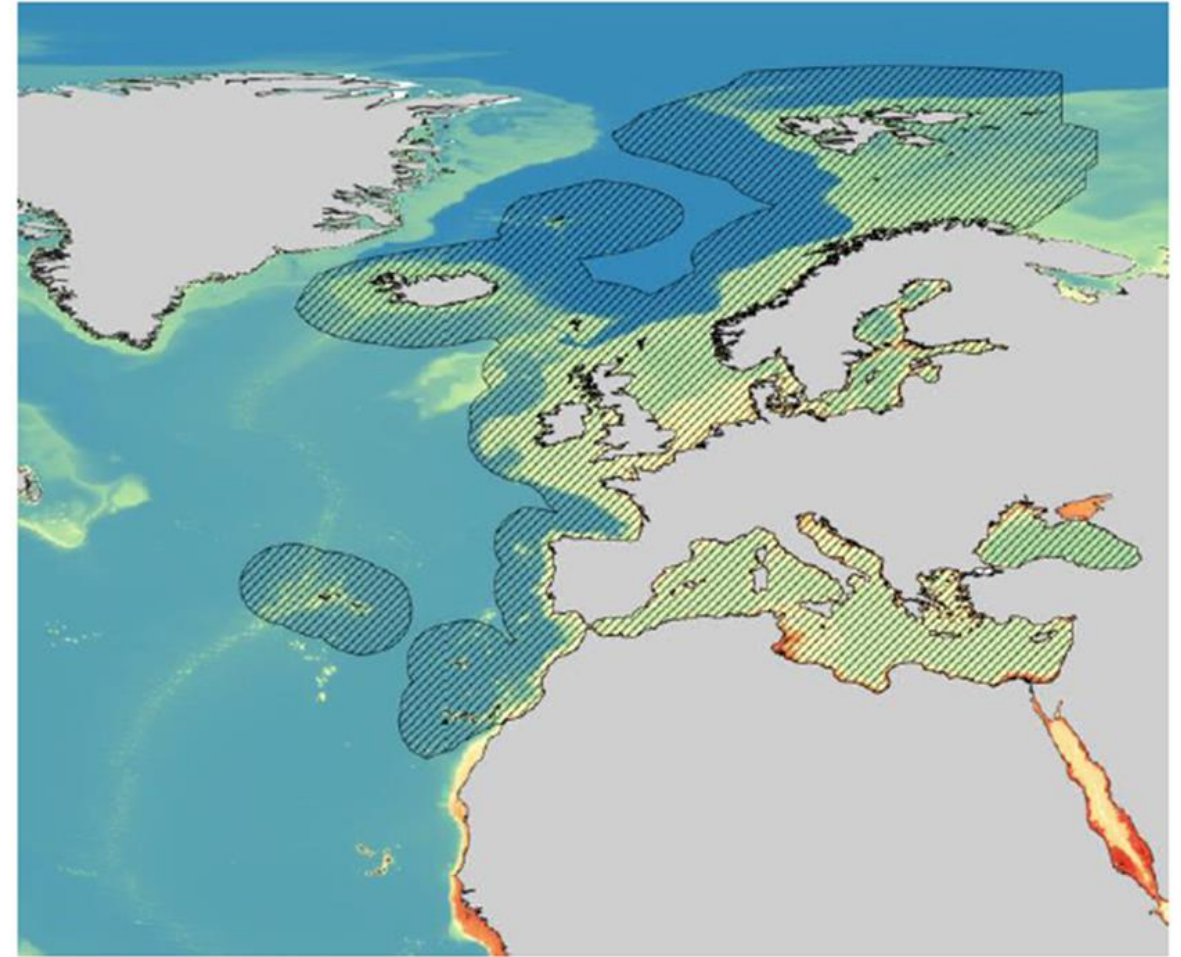
Example of data layer produced for the European Seas from **BioOracle**.
 Colour gradients reflect spatial differences in °C from today (left) to 2090 (right)

24 Environmental variables

Modelled in updated version of BioOracle (OA)

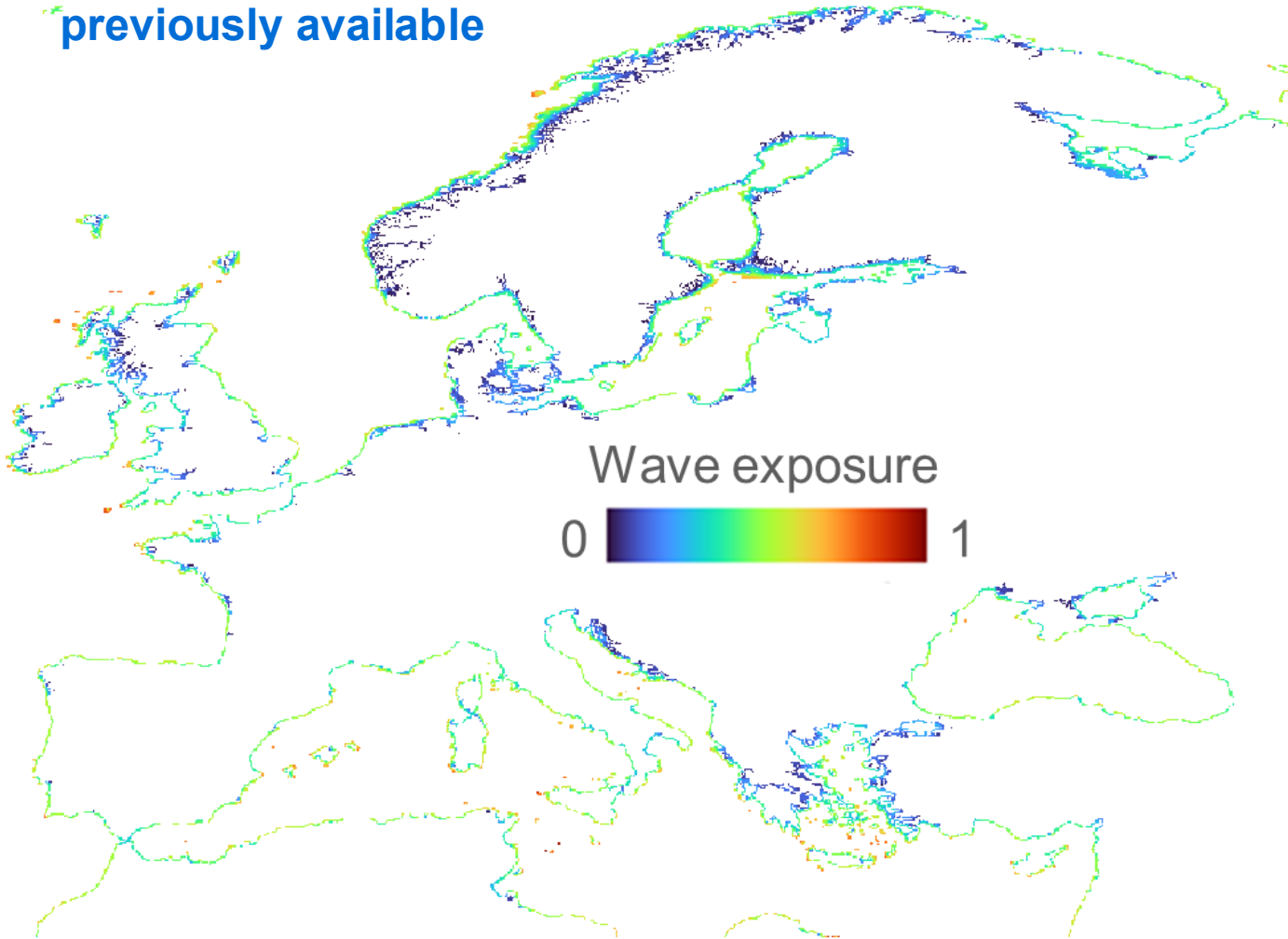


Present-day seafloor temperature

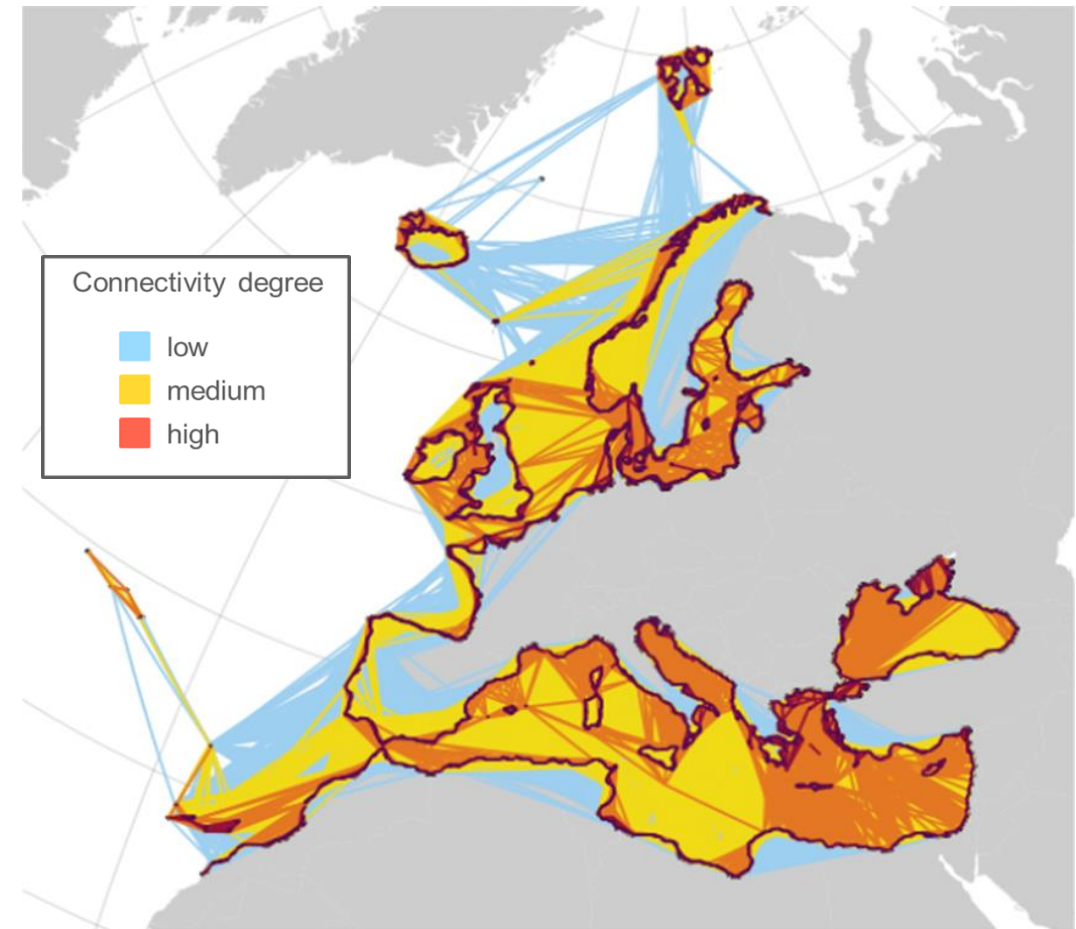


Future (decade 2090) seafloor temperature

WAVE EXPOSURE – significantly influences distribution of marine species (and organic carbon) but no European scale data on it previously available



OCEANOGRAPHIC CONNECTIVITY



Additional task on species biogeography

Aim

How do “ecosystems” classified based on environment variables align with biogeography (i.e., species composition)?

Use neural network analysis (InfoMap Bioregions) to define biogeographic regions for European seas using 5,000 species’

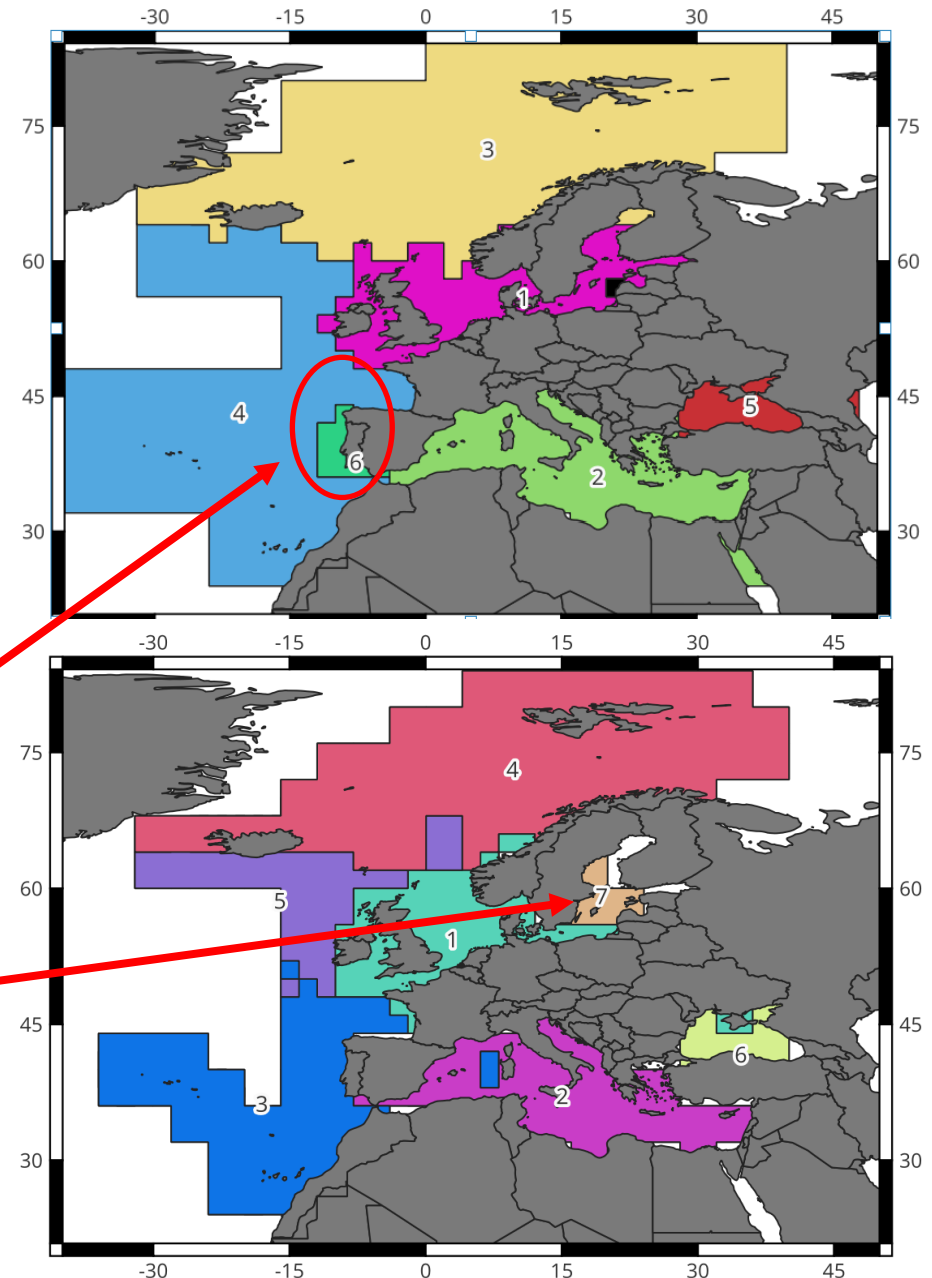
- distribution records in OBIS (subject to sampling bias, underestimate species distribution): n = **6 realms**
- range maps from AquaMaps (overestimate species occurrence):

7 realms

West Iberian realm artefact of data in OBIS

Note brackish realm 7 in AquaMaps

Comparison with ecosystem classification in progress



1st key message

The MPA network will need to include the 6 regions to be ecologically representative:

Baltic, Black and Mediterranean Seas

Arctic-Boreal

Mid-European Atlantic

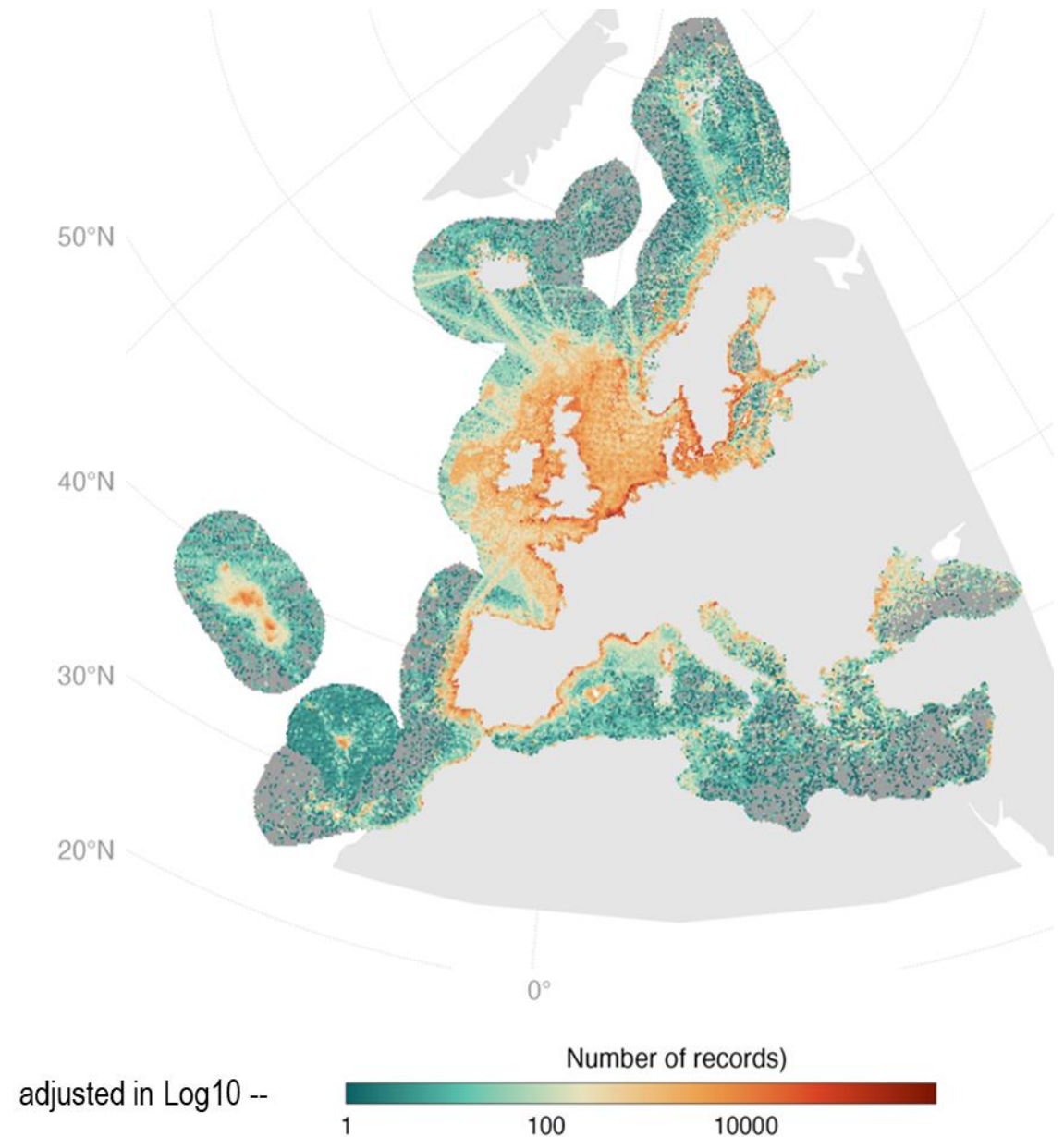
Offshore mid-southern European Atlantic and Macaronesia

We use OBIS

~ 35,000 species

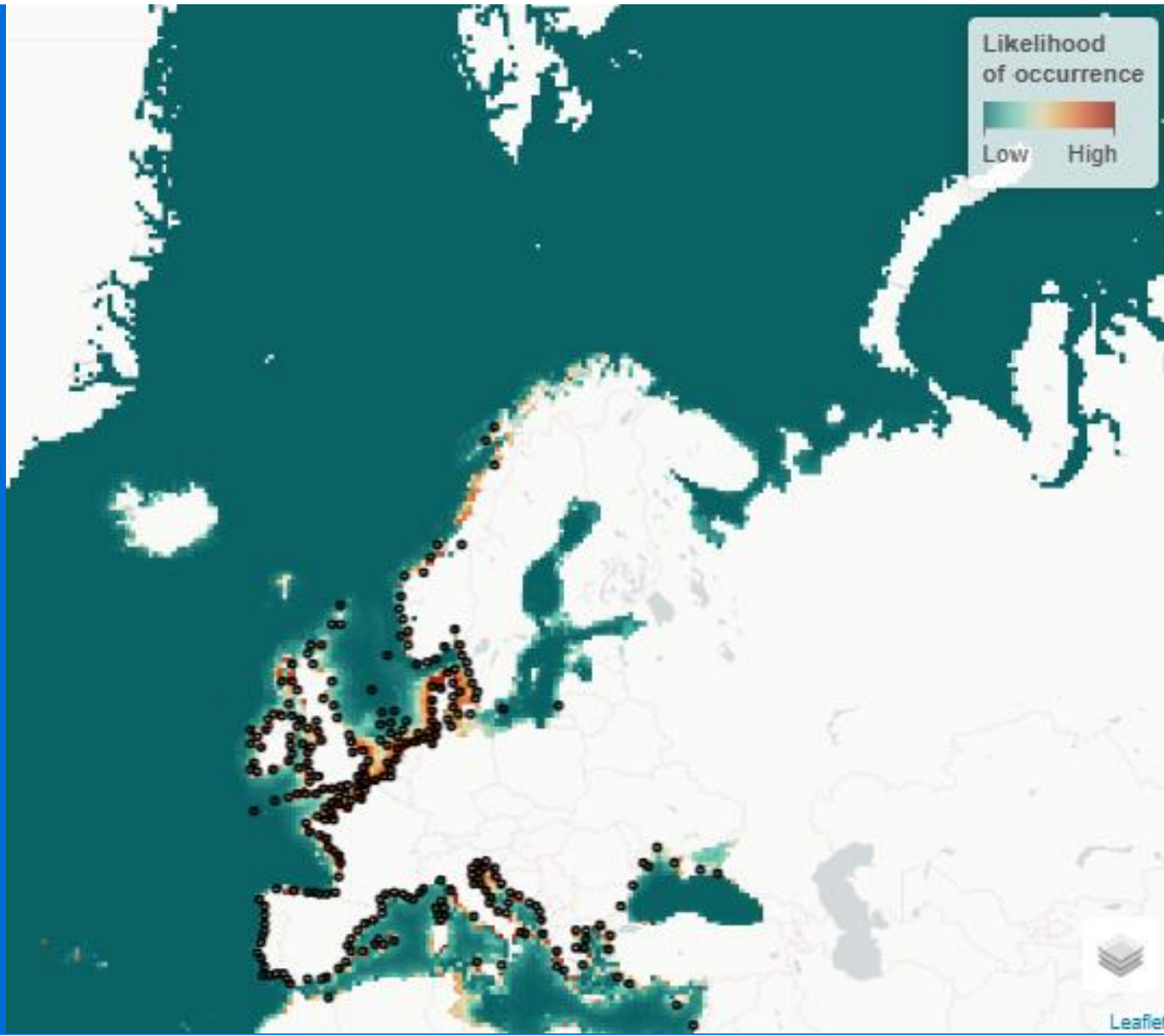
> 67,000,000 records

> 12,000 species ranges modelled



Example of species range map for the native oyster

Showing likelihood of occurrence and data points used in the model



SPECIES THERMAL RANGE HABITAT

Search species Filter

Ostrea edulis

Ostrea edulis

Phylum: Mollusca > Order: Ostreida > Family: Ostreidae
AphiaID: 140658

Number of records: 301

Number of records for independent evaluation: 11

Additional info: All inside thermal envelope? Yes (100%)

Model

MAXENT

Scenario

Current

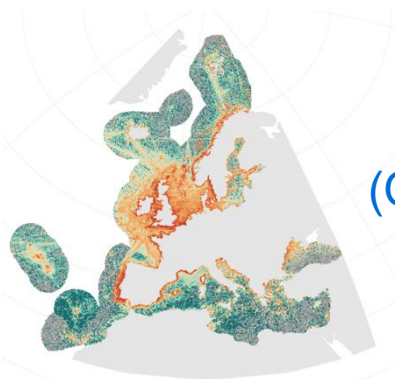
DOWNLOAD THE DATA

ACCESS THE CODE

RUN THE MODEL

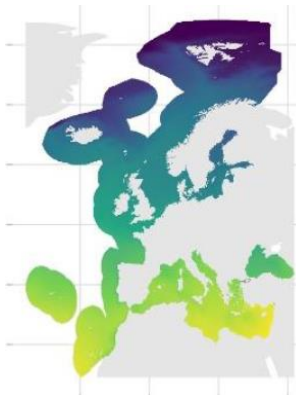
Biodiversity & Environmental data

Species occurrence
(OBIS + GBIF)



(BioOracle v3)

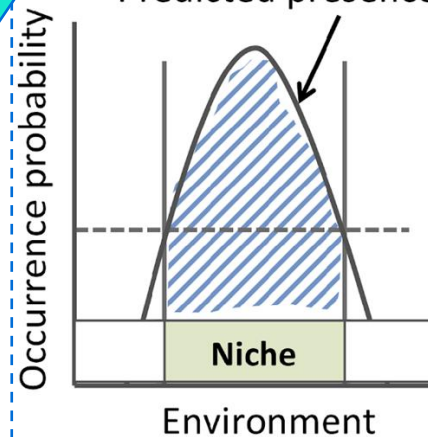
Sea Surface Temperature



SDM

$$\text{logit}(\pi_i) = \alpha + \sum_{j=1}^p \beta_j X_{ij}$$

Predicted presence



Predicting potential distribution



Five CMIP6 scenarios
(SSP1- SSP5)

Two periods
(2050 / 2100)



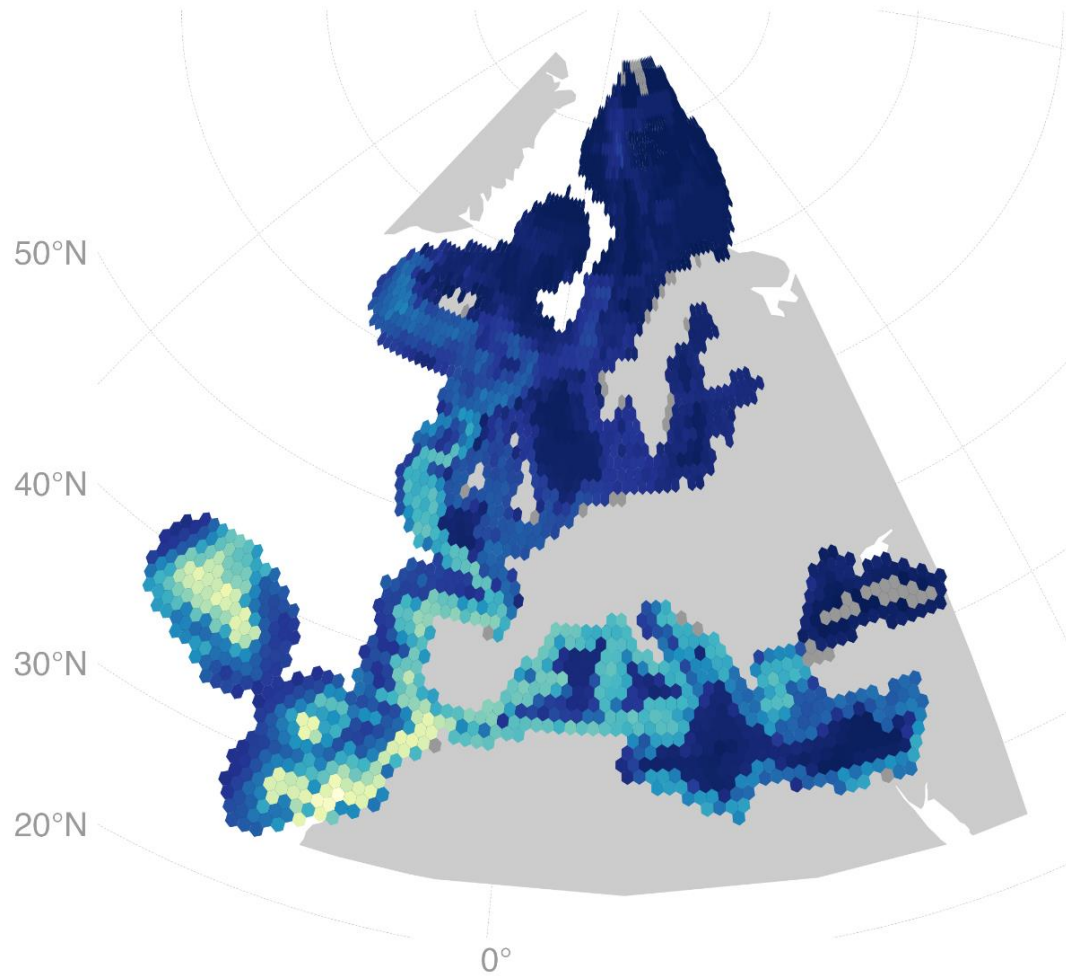
Distribution maps for
~12,000 marine species
from Europe

Biogenic habitat
maps, based on SDM

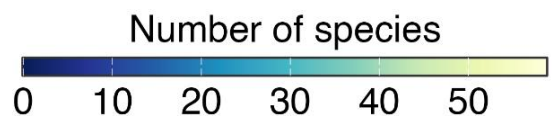
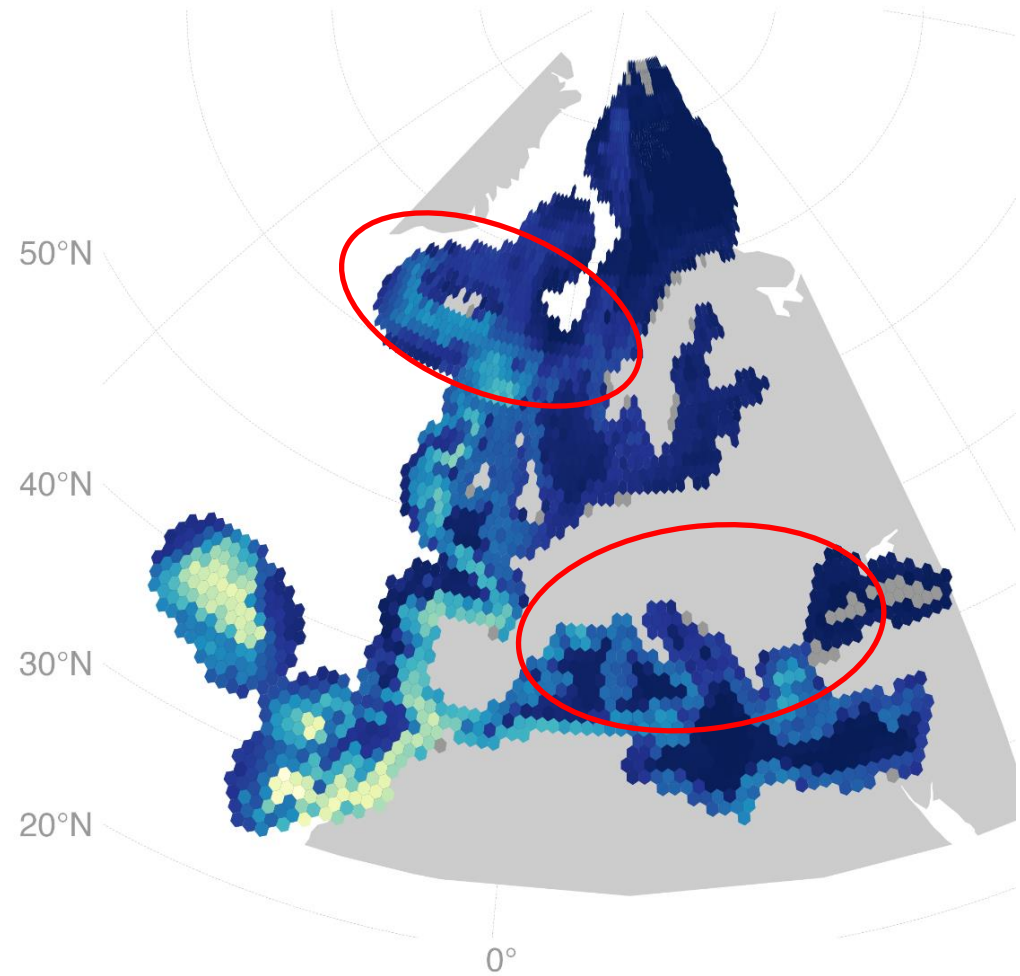
Conservation status
of species and habitats
(IUCN Red List)

Species range shifts
under climate change

Number of species - Fishes
Current period



Future (2100 - SSP5 - 8.5)



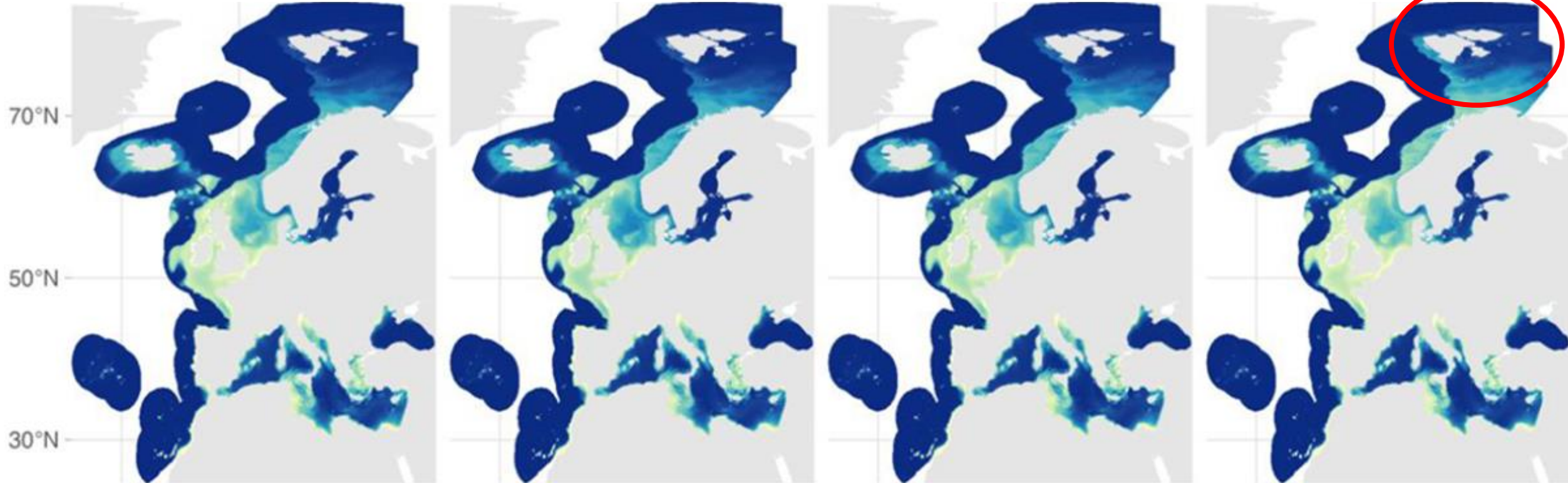
Species range maps, present and under 3 climate change scenarios

Current

SSP1

SSP2

SSP5



for the ray species *Raja brachyura*

2nd key message

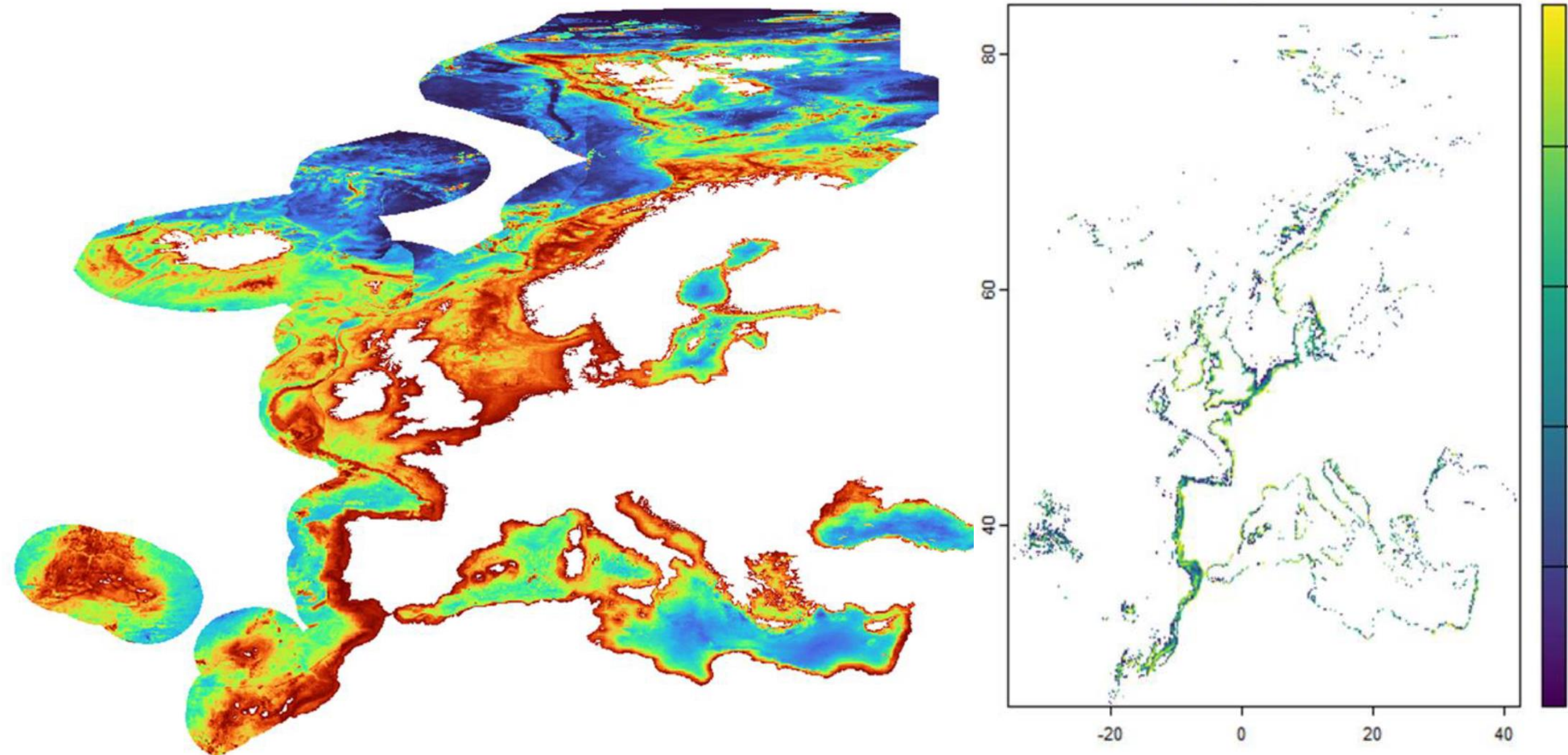
Even in worst case scenarios,

- Most species will remain in their current geographic range*
- With increased species richness in northernmost (Arctic)
- Possible extirpations of some species in the Mediterranean

*but their abundances will vary

Cells prioritised for an optimal contribution to an MPA network using *Zonation*

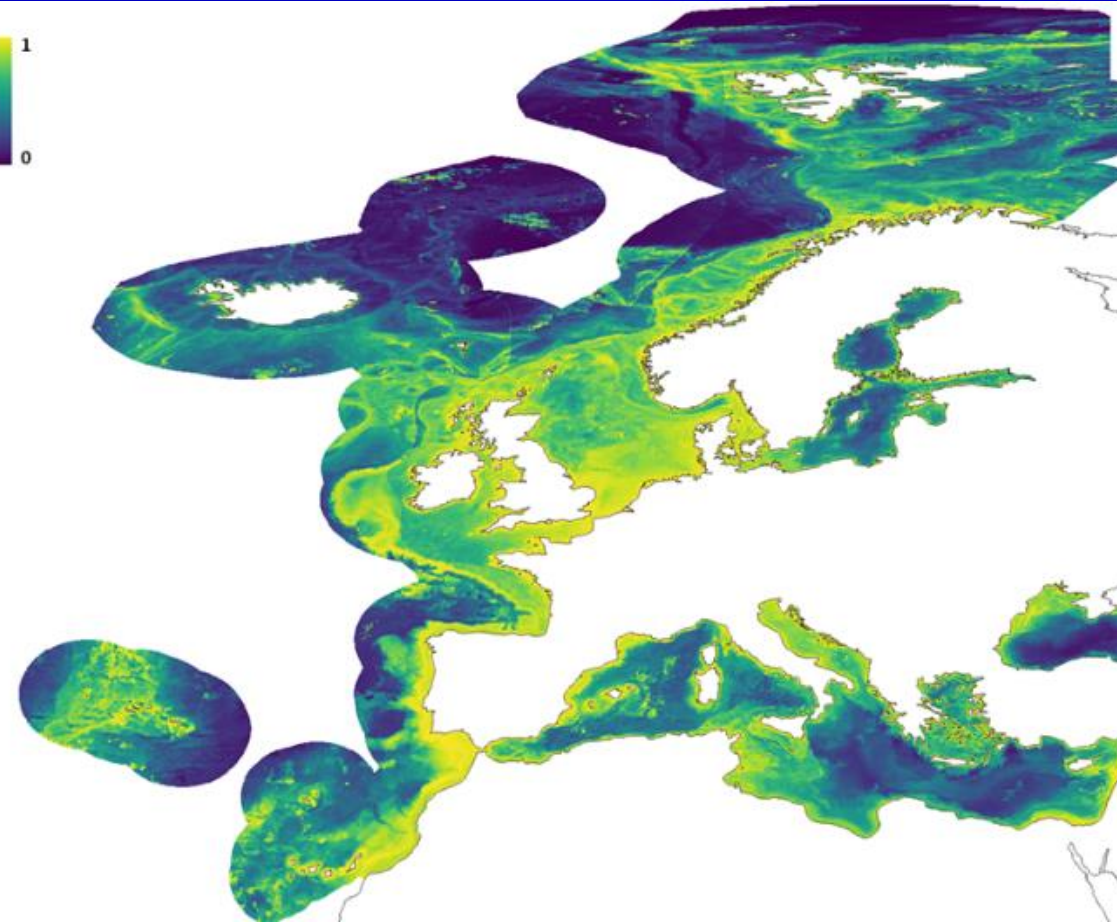
The top 10% of the area – coastal including islands



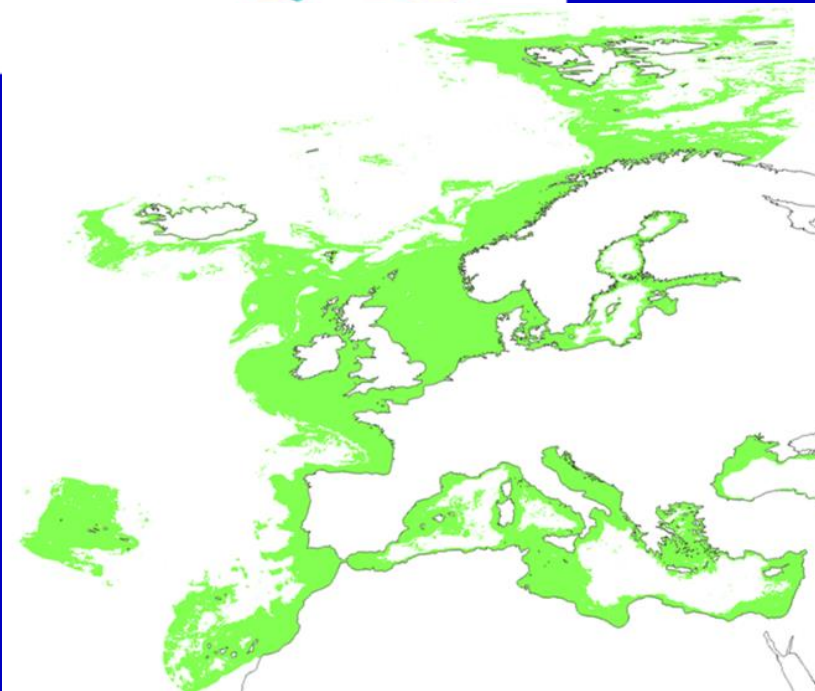
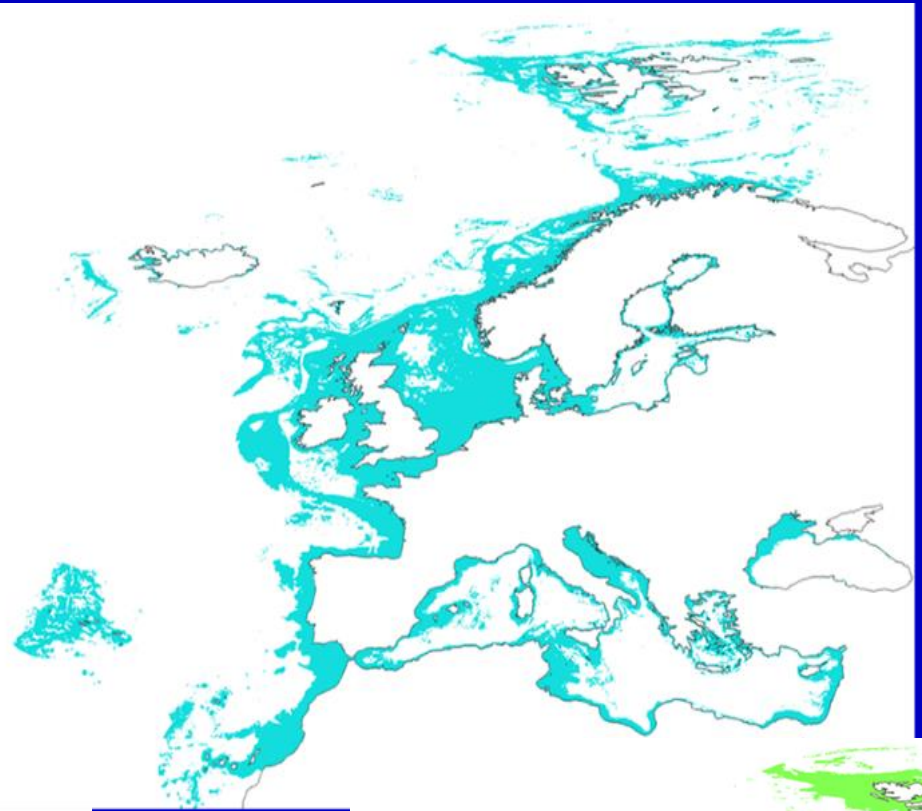
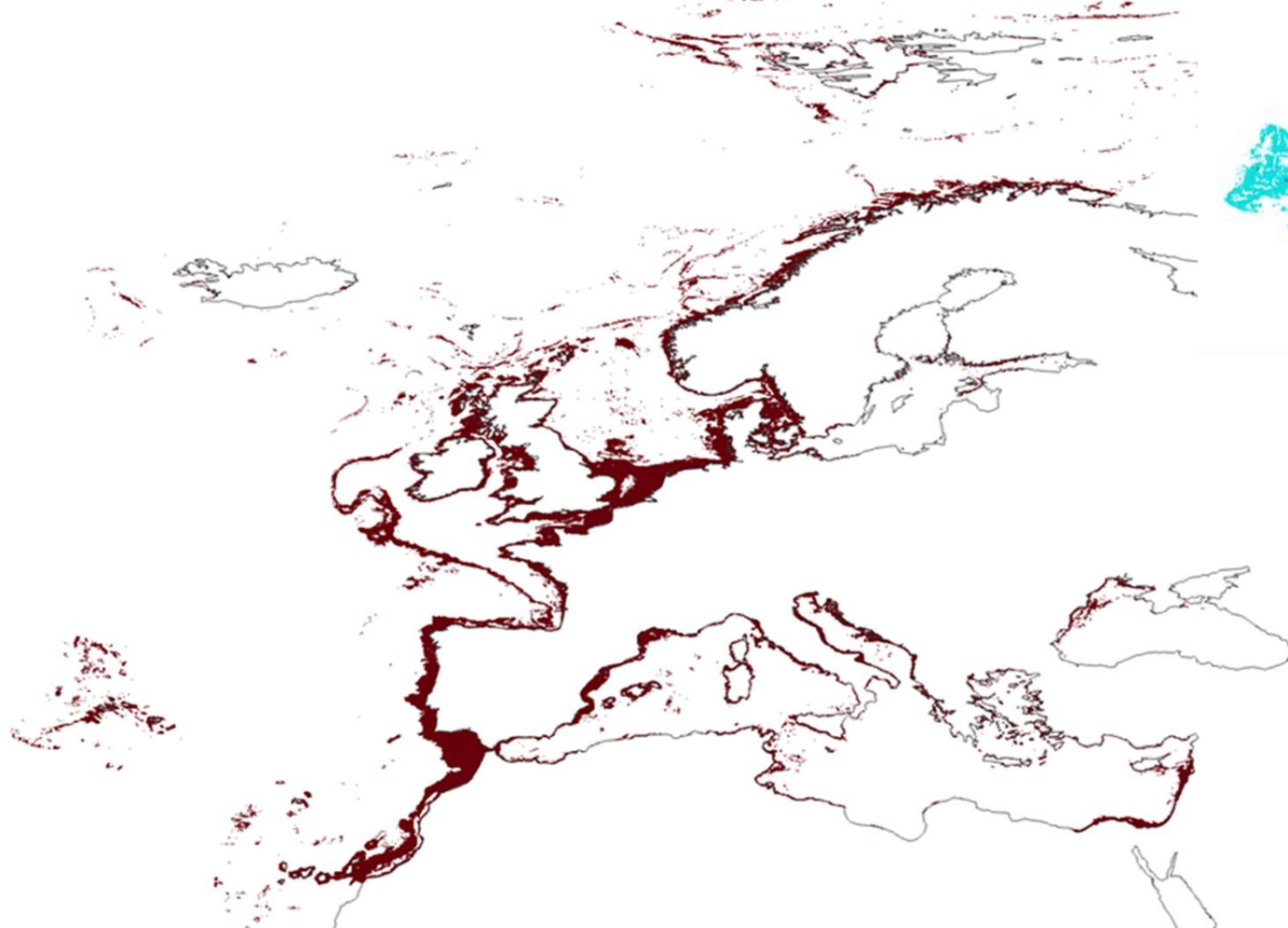
Distribution of records for species for which SDM were not available

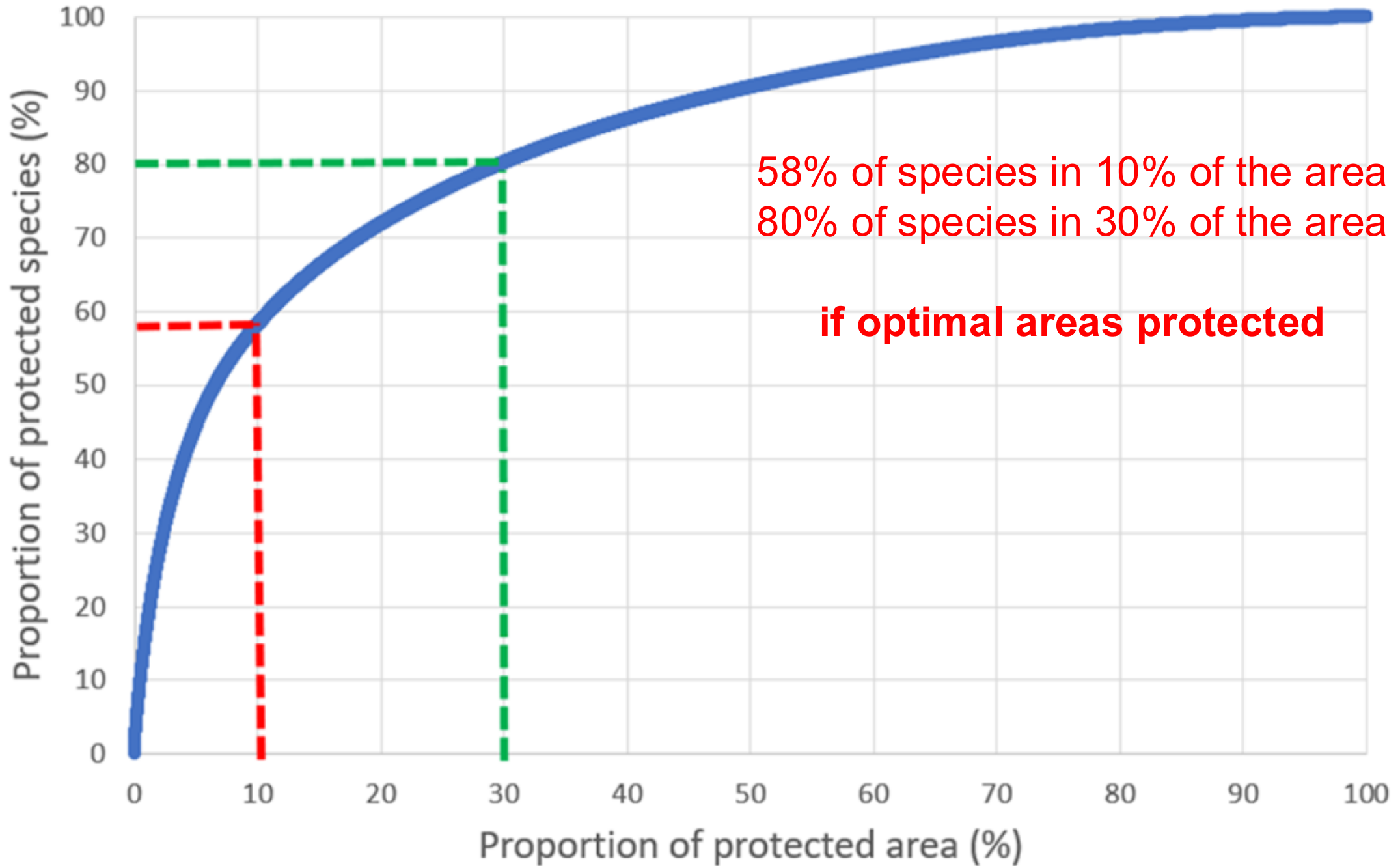


PRIORITY
1
0



The top 10 %, 30 % and 50 % of the Representative Biodiversity Areas





% species that can be included in % of the area

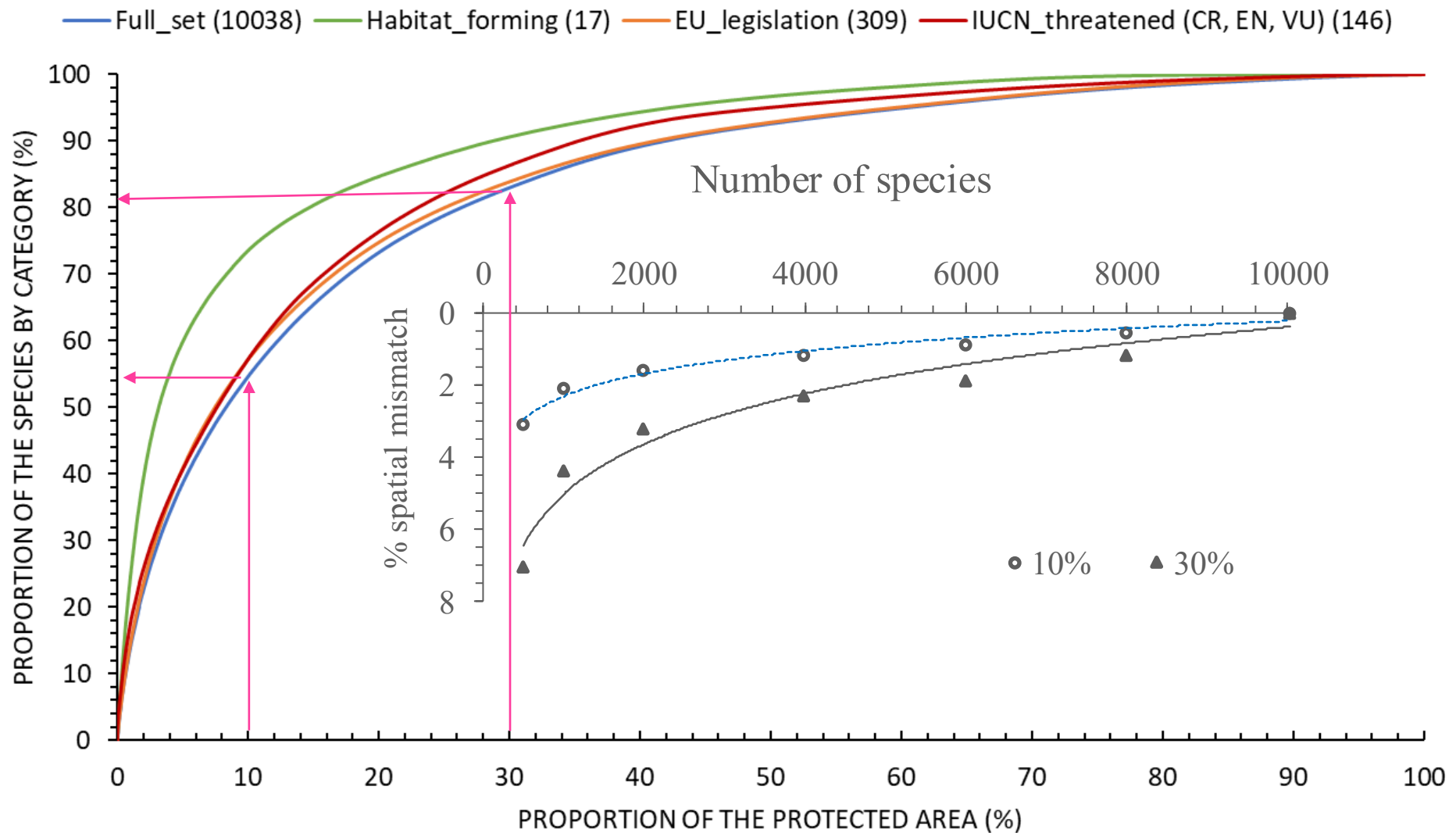
For all 10,000 species
(blue line)

Habitat forming species
(green line)

Species in EU legislation
(red line)

Species IUCN lists as
threatened with
extinction

Insert plot shows
differences when less
species used



The proportion of species that can be included within a country's Exclusive Economic Zone varies

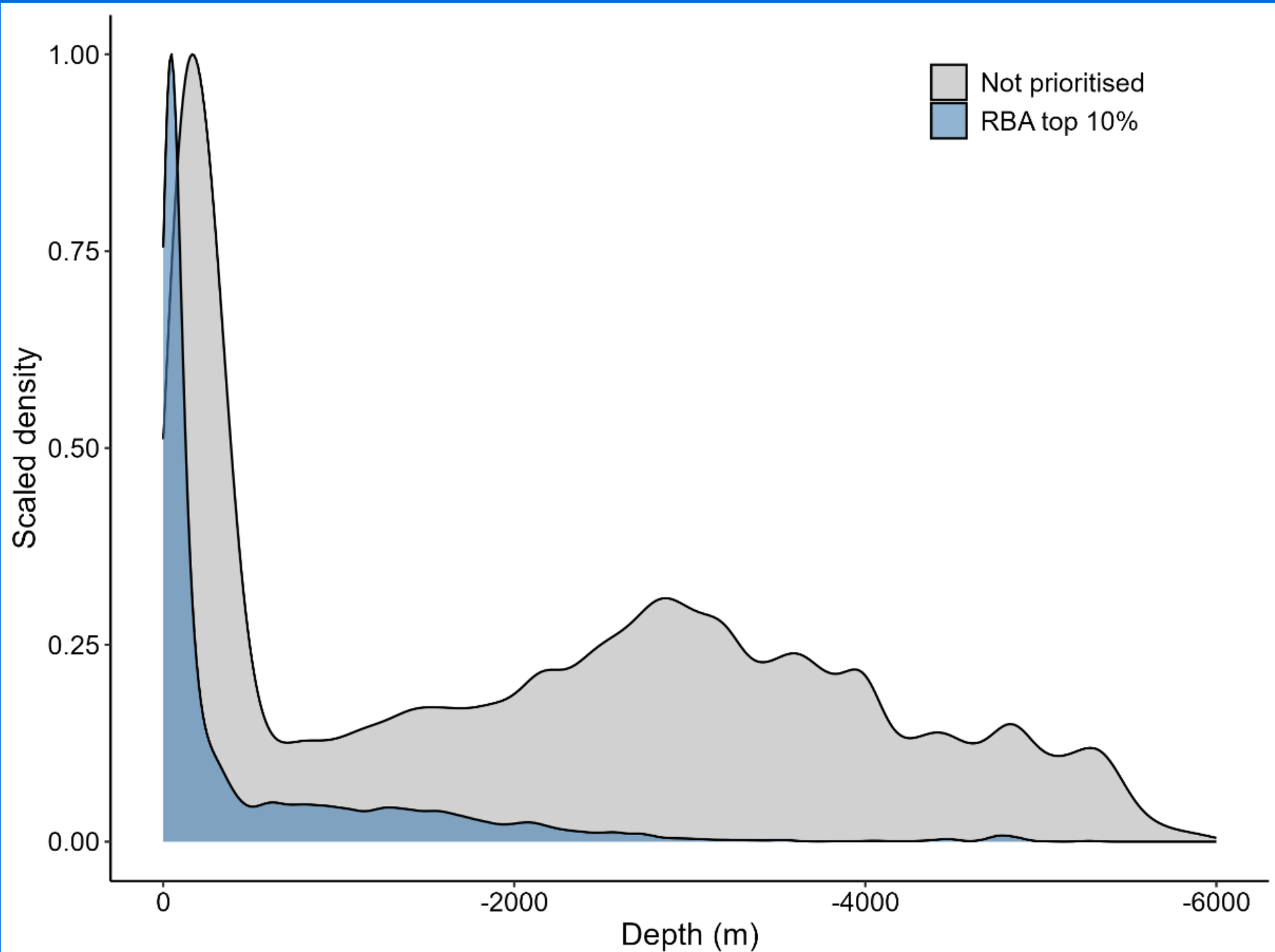
Sweden can include 76 % of its species in 10 % of its EEZ

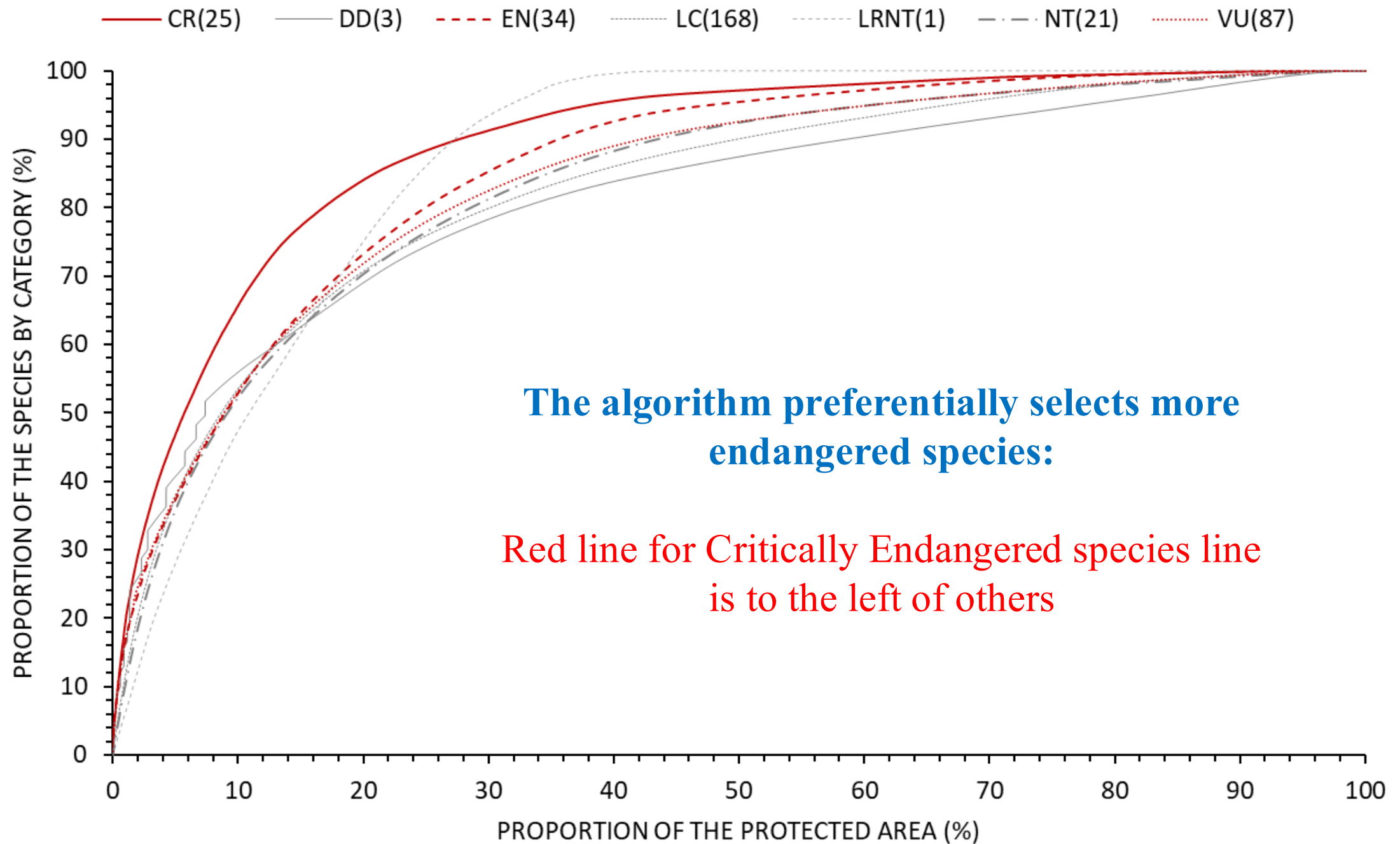
Slovenia can only 16 % in 10 % of the area

EEZ	10 %	30 %	50 %		10 %	30 %	50 %
Sweden	76	91	95	Lebanon	41	68	79
Canary	69	84	90	Monaco	41	59	71
Norway	66	84	93	Guernsey	39	62	75
Madeira	64	77	85	Faroe	38	63	81
Portugal	64	90	95	Romania	38	62	77
Azores	63	78	88	Iceland	37	60	77
Spain	62	86	93	Latvia	35	61	76
Algeria	59	79	86	Israel	34	62	77
Turkey	59	88	95	Libya	34	62	78
Greece	57	77	87	Montenegro	32	54	69
Italy	55	77	88	Lithuania	31	57	72
Poland	54	76	85	Egypt	30	63	80
Jan Mayen	53	71	83	Croatia	30	56	72
Ireland	52	71	84	Tunisia	29	51	68
Bulgaria	47	76	86	Netherlands	29	53	69
Cyprus	46	68	80	Finland	28	60	79
Georgia	46	66	79	Estonia	27	59	76
Russia	45	74	88	Albania	27	55	70
France	43	73	86	Syria	26	55	70
Morocco	43	71	87	Germany	24	50	69
Gibraltar	42	62	74	Denmark	23	49	68
Ukraine	42	72	88	Belgium	19	44	62
UK	42	66	79	Jersey	17	42	63
Malta	41	62	75	Slovenia	16	39	59

The Representative Biodiversity Areas include deep sea and coastal species

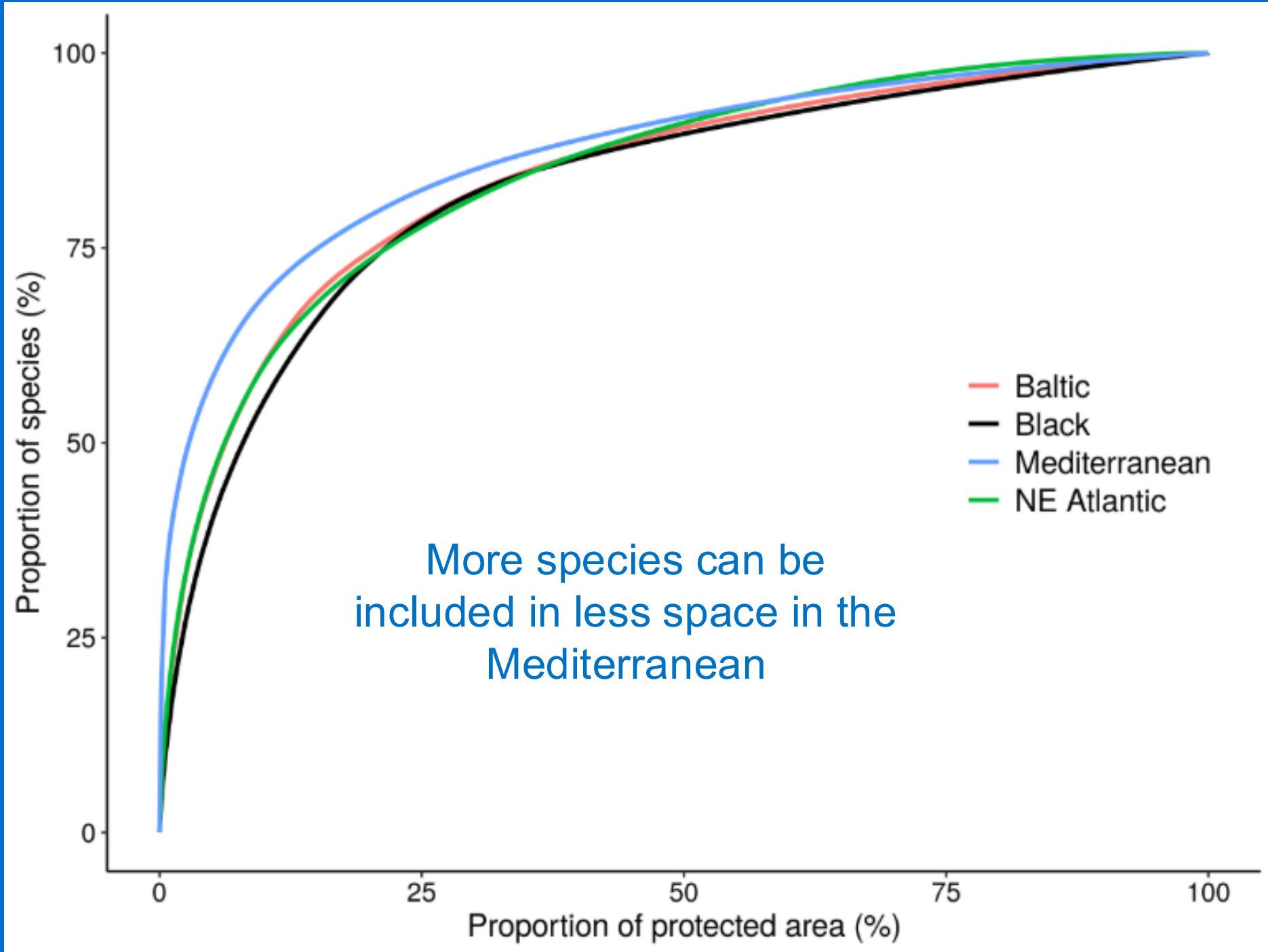
Some of 10 % areas extend to 5,600 m depth



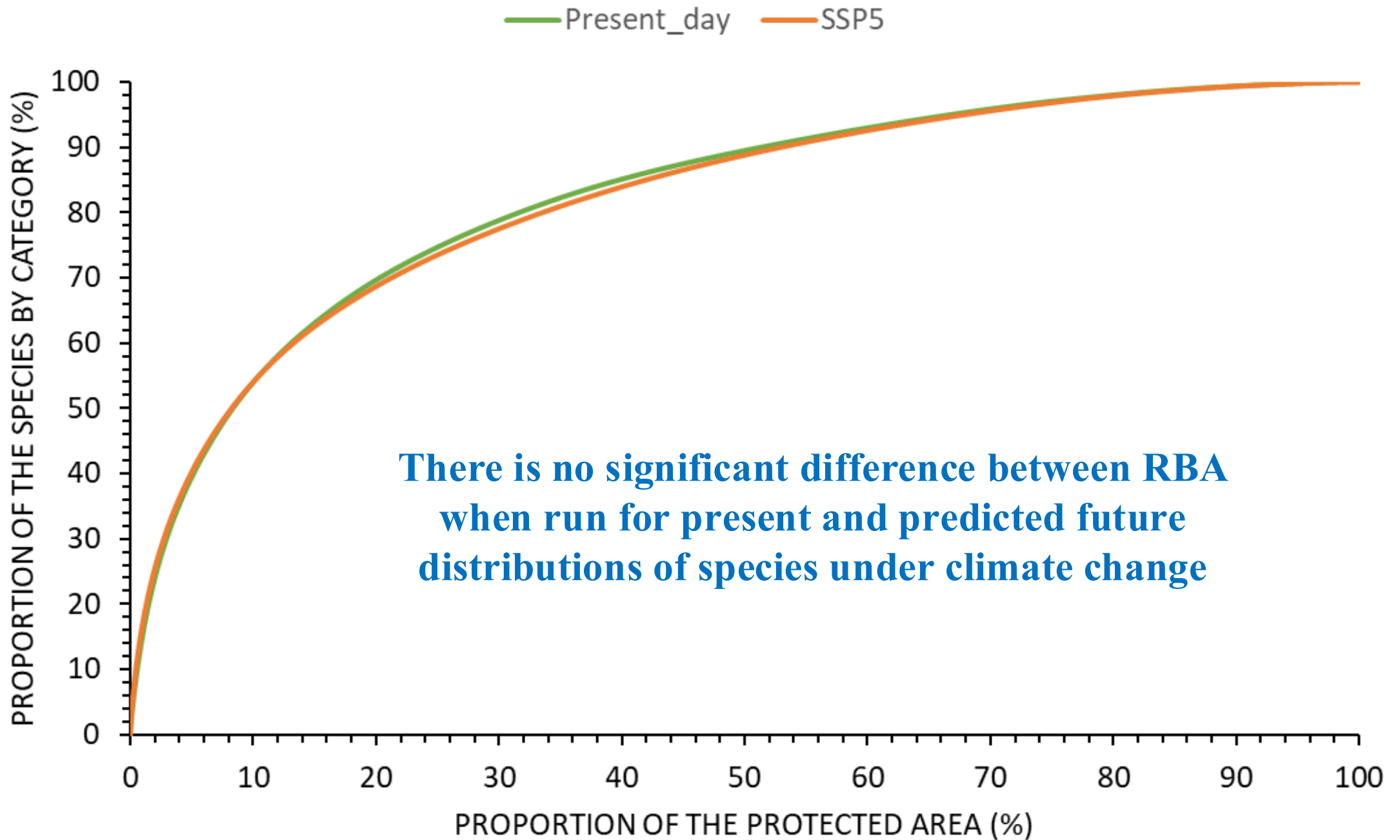


The algorithm preferentially selects more endangered species:

Red line for Critically Endangered species line is to the left of others



More species can be included in less space in the Mediterranean



**There is no significant difference between RBA
when run for present and predicted future
distributions of species under climate change**

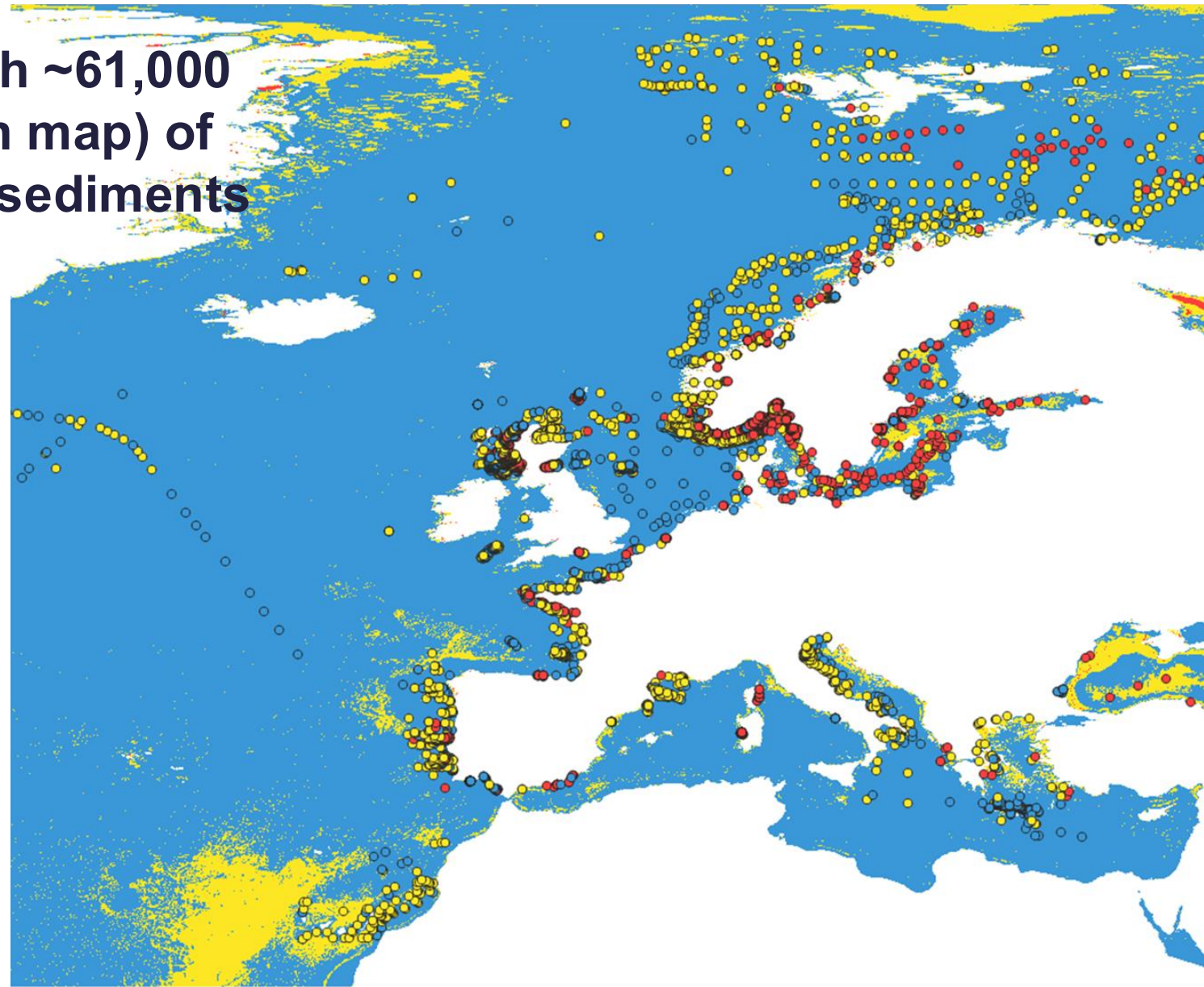
Conclusions so far

1. We have enough species in analysis to represent biodiversity
 2. The RBA is ecologically representative
 3. The RBA is climate resilient
 4. Protecting any coastal area could be a positive contribution
- BUT, our prioritisation does not consider variation in abundance or breeding locations of mammals, birds, fish, etc.. (so they need local species level attention)

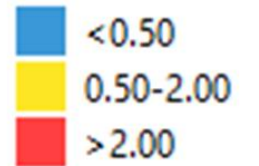
New database with ~61,000 samples (dots on map) of organic carbon in sediments

More organic carbon in coastal wave sheltered, cold sediments

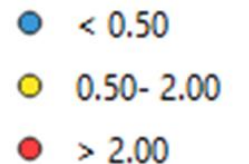
Map background is modelled distribution of organic carbon



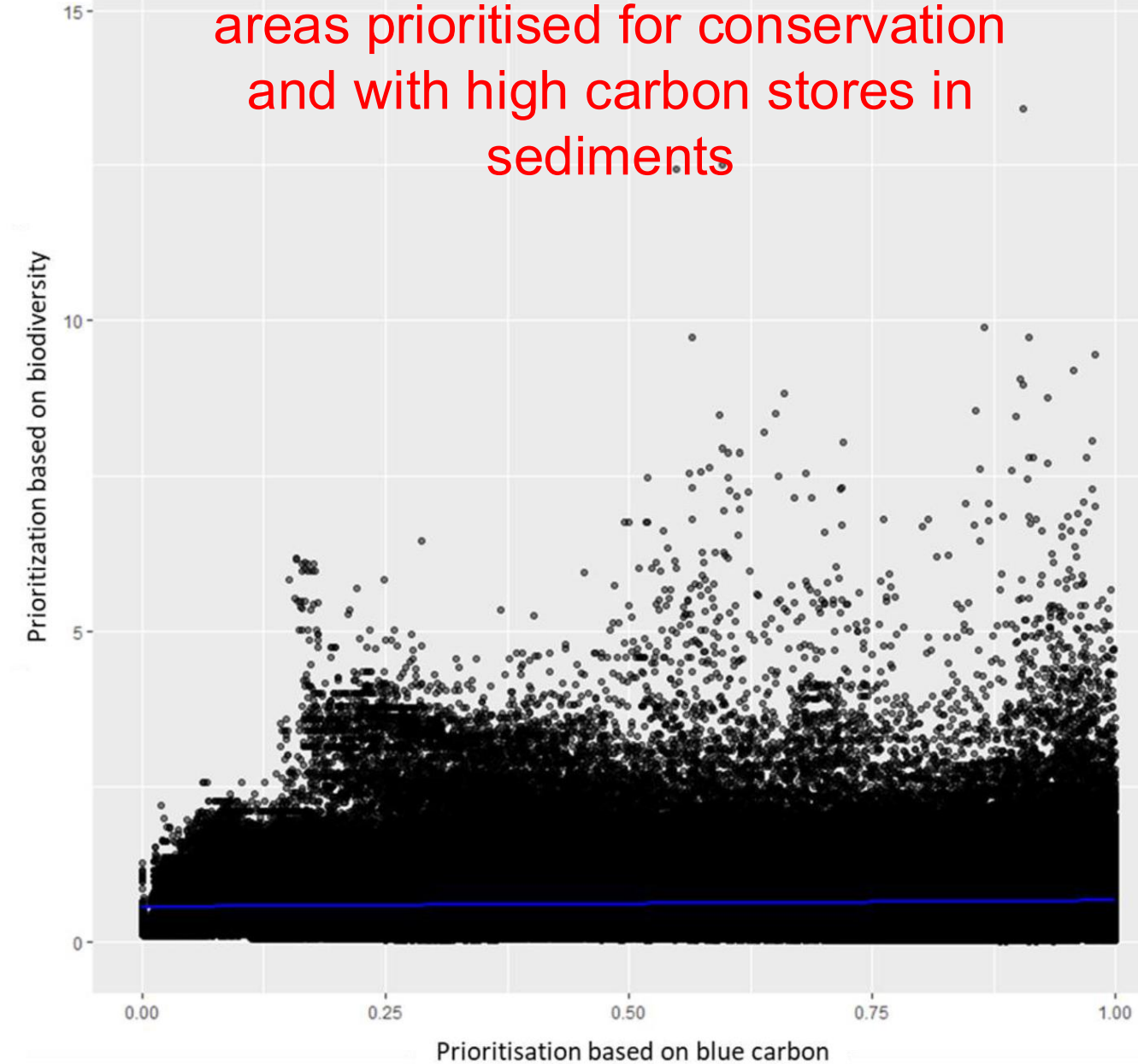
Modelled % Organic Carbon Index (OCI)



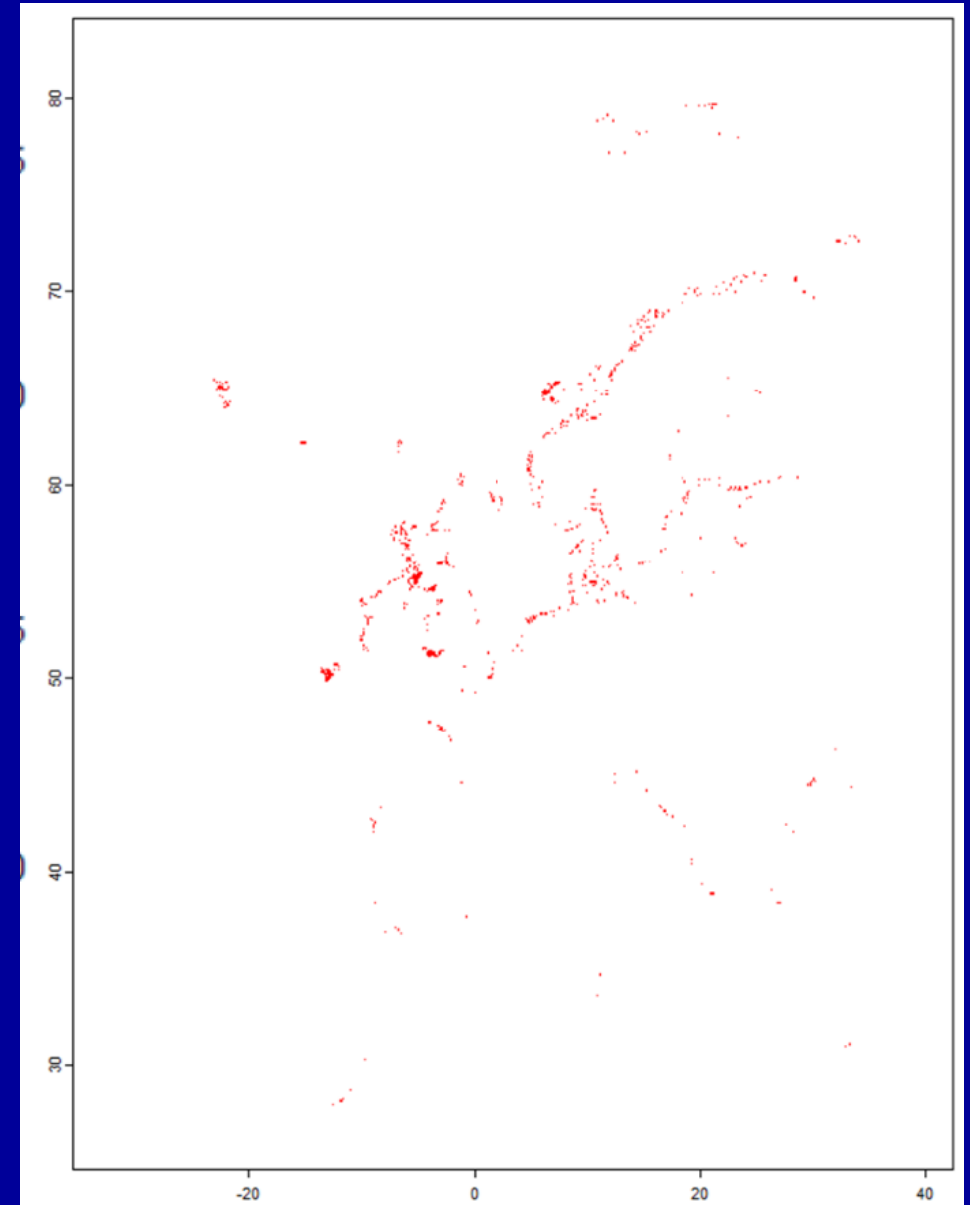
% Organic Carbon sampling points



Overall, no correlation between areas prioritised for conservation and with high carbon stores in sediments



Areas prioritised for biodiversity with high organic carbon in seabed



4th key message

1. Map of organic carbon concentrations available for European seabed.
2. Management could ban disturbance of sediments with high organic carbon to minimise release of greenhouse gases from sediments (CO₂, CH₄).
3. Spatial planning should consider protection of biodiversity and carbon stores separately, although disturbance of seabed by trawling and dredging will destroy biodiversity as well as release carbon from sediment stores

Responding to stakeholders

- Several misunderstandings amongst stakeholders
- Some criticisms of MPA without evidence and already known to be untrue = **zombie ideas**

10 myths and misunderstandings

1. Countries use best scientific practice to locate MPA
2. MPA aim to protect biodiversity as a whole
3. It is radical to limit public access in the ocean
4. Only commercial fishing impacts biodiversity
5. MPA only benefit seabed, not pelagic, life
6. MPA are expensive so only rich countries can afford MPA
7. MPA do not protect against pollution
8. MPA do not protect against climate change
9. MPA cause losses to or displace fisheries, > impacts outside MPA
10. Partially protected MPA, a compromise, are a solution



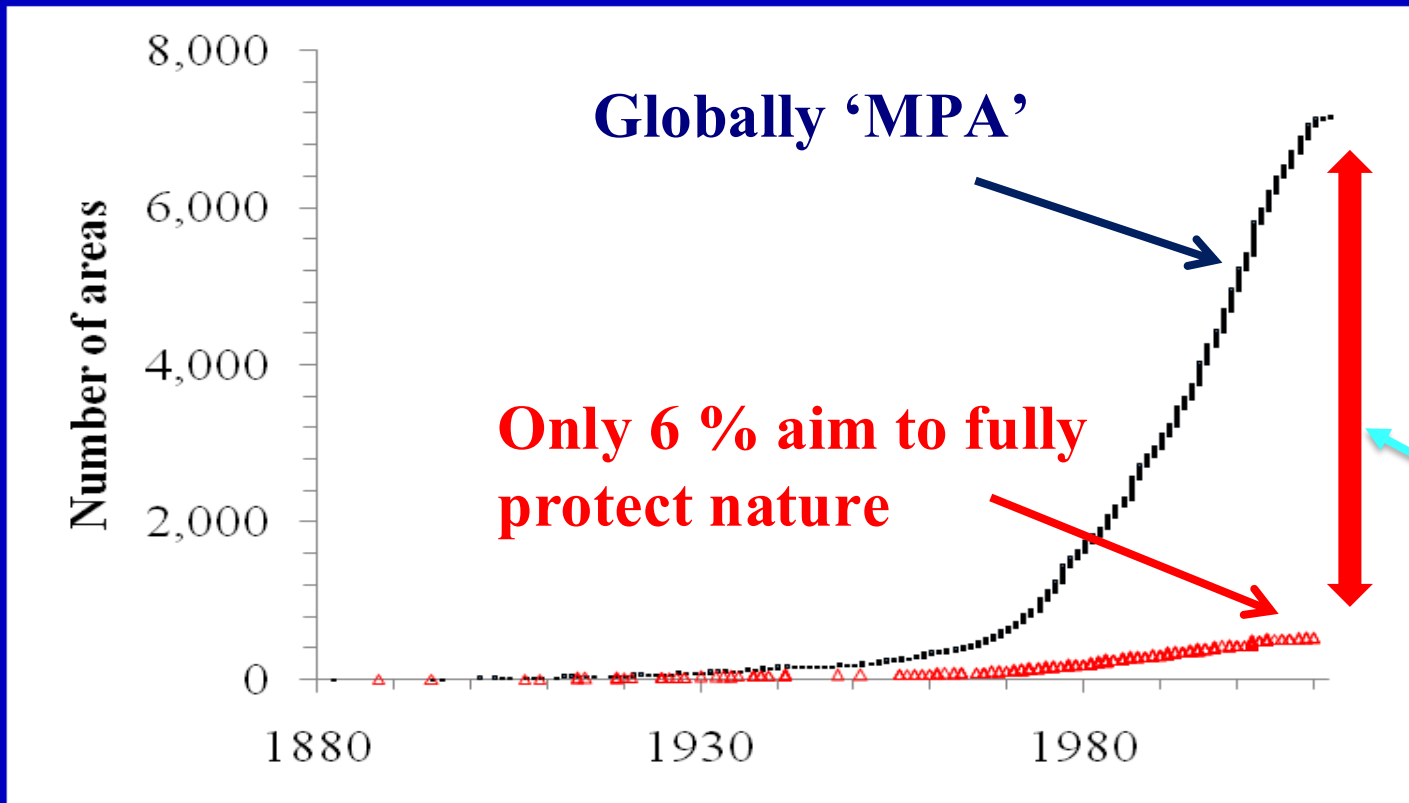
It is reasonable for public to think that

1. Wildlife in a “Protected Area” is not hunted and killed
2. Countries must use IUCN categories to define “Protected” status
3. Biodiversity in all areas listed as protected in the World Database on Protected Areas (WDPA) is protected

Today, only 2.9% of ocean area aims to be no-take (natural)

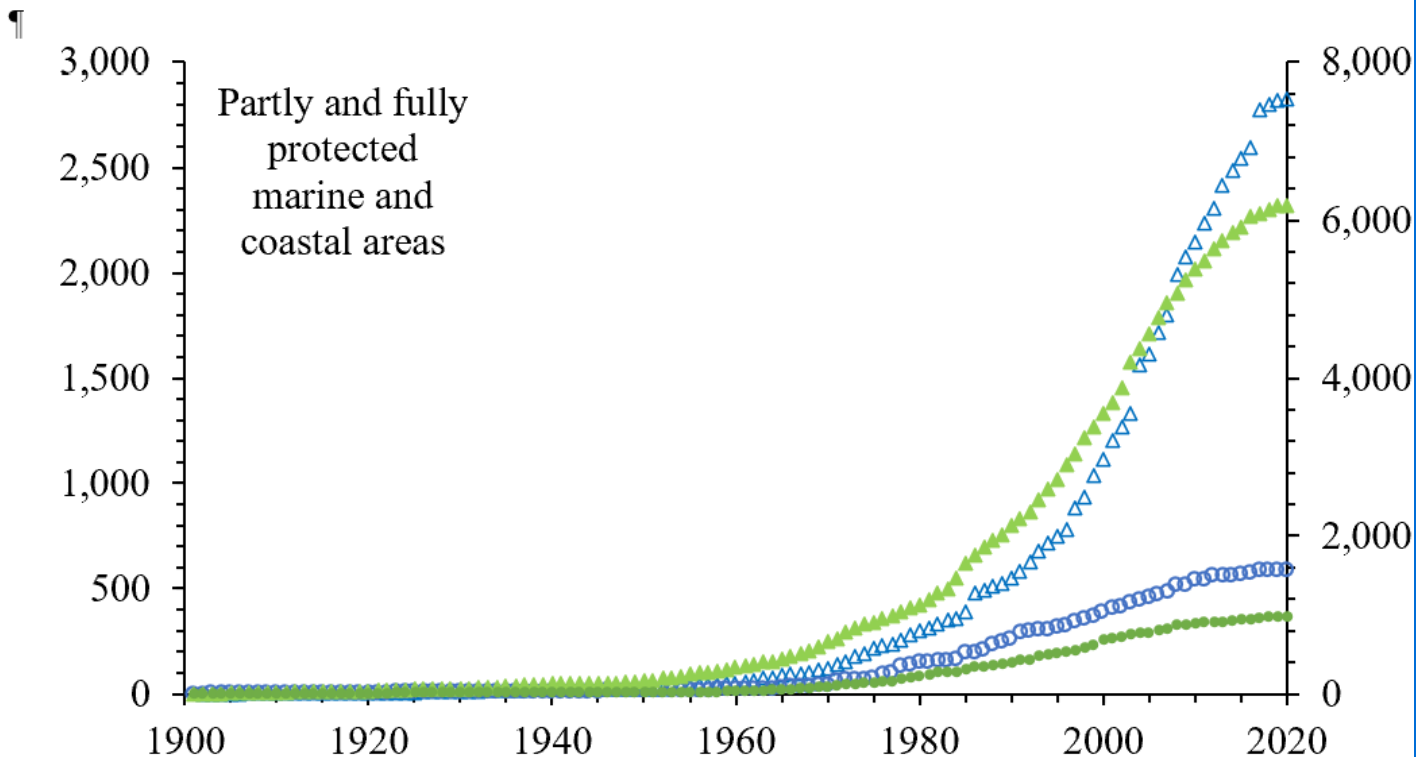
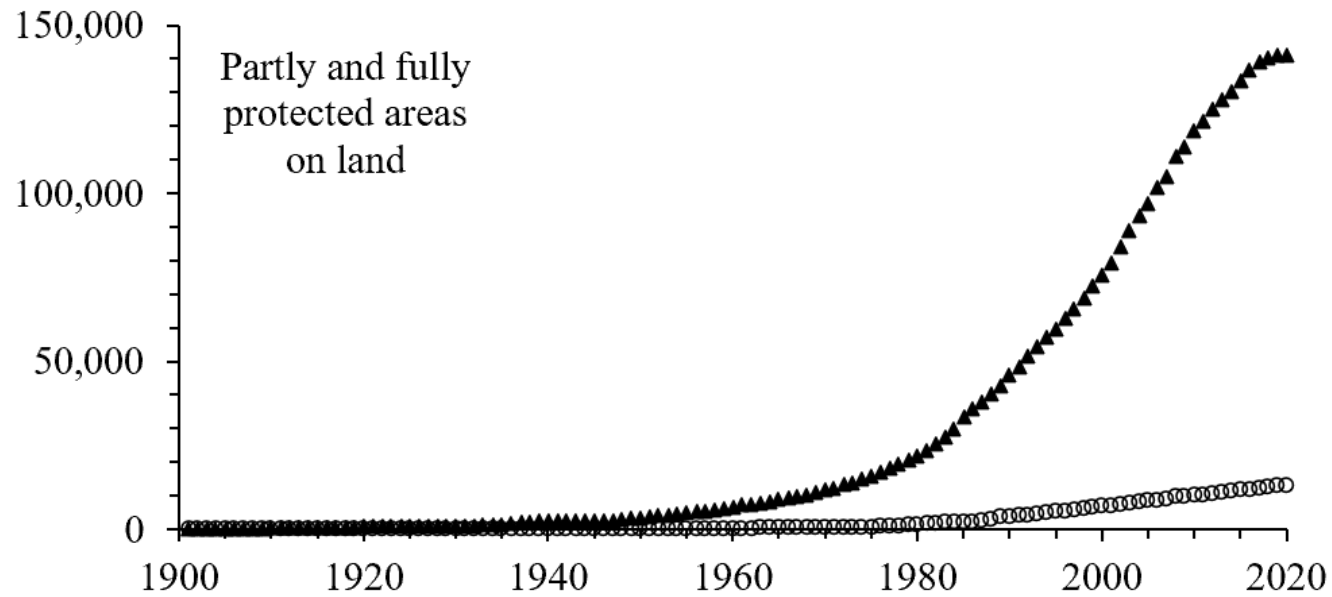
Countries promised 10% by 2020

Convention on Biological Diversity and UNCLOS draft High Seas Agreement call for 30% by 2030



3/4 coastal countries have no Marine Reserves (no-take MPA)

Gap between real and pretend protection widening



What does the widening gap between partly and fully protected areas, on land and sea, indicate?

Note these areas are not optimal (no systematic conservation planning).

Should conservation focus on 50% of species in 10% of area?

Data from WDPA (so not all protected for biodiversity)

The “Cons” in Conservation

- Protected does not mean protected, especially underwater
- 94% MPA do not aim to protect biodiversity
- Protection exaggeration is increasing
- Most (4 of 7) IUCN categories of Protected Area do not aim to protect all aspects of biodiversity in a natural condition
- IUCN has no authority, it is advisory
- Countries are free to call areas MPA as they wish; so they do (most European MPA allow seabed trawling, ~ 25% are trawled)

Experiencing Marine Reserves, > 70,000 people snorkelling since 2001

Marine Reserves
and other MPA help
people witness
marine wildlife
unafraid of people



MPA are not radical

It is common to set aside public land for public benefit – schools, hospitals, universities, museums, national parks, sports, art, transport

Why not in the ocean?

People and fishing are already excluded from many marine areas: harbours, pipeline and cable zones, military areas, fish farms; but far less than on land

MPA facilitate, not exclude, public access

Is limiting public access and use unusual?

No, it is common (*and normal on land*)

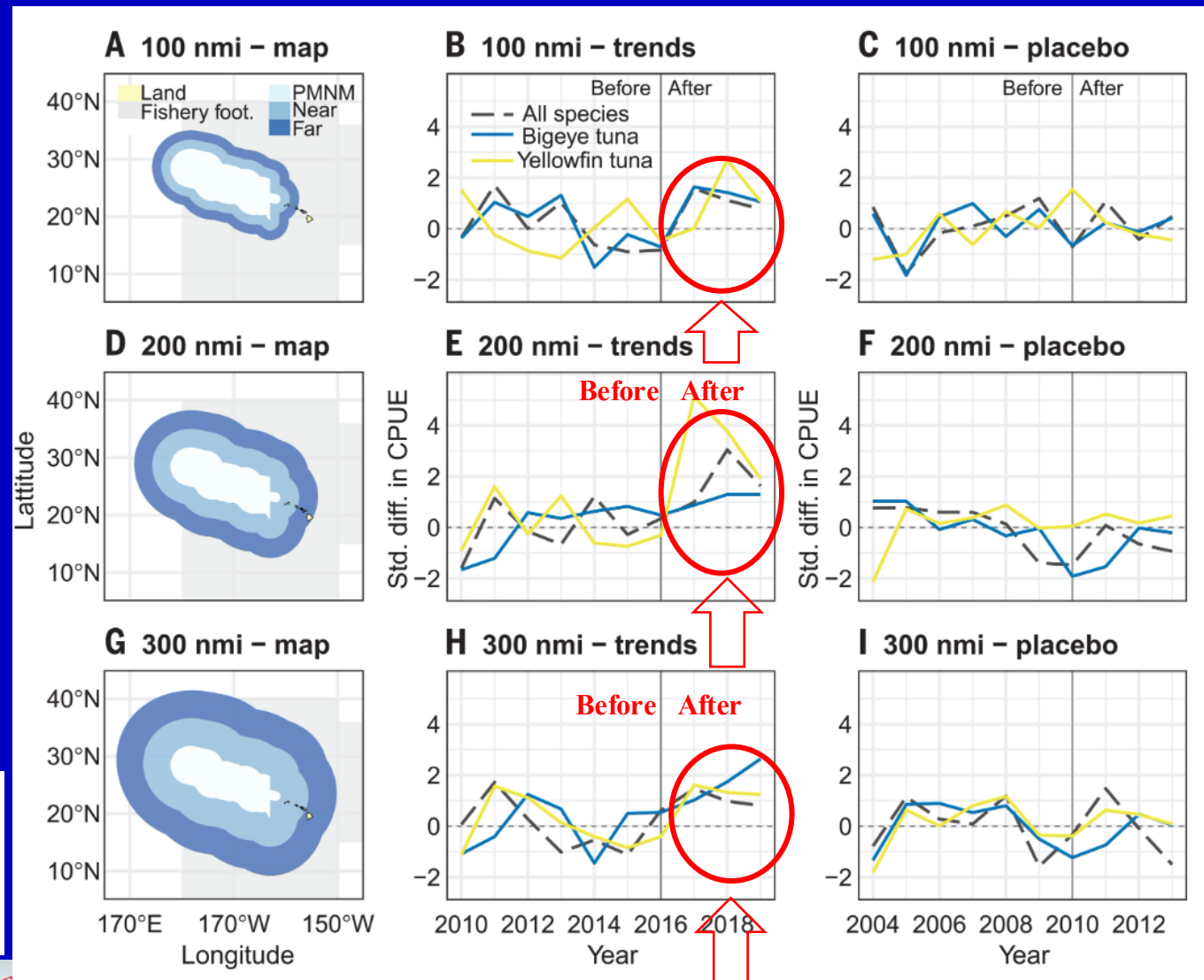
- Harbours
- Marinas
- Industrial areas
- Fish farms
- Pipelines
- Cable zones
- Military areas
- Mining

Is the public already excluded from more areas than currently MPA occupy?

And MPA do not exclude people – they welcome them for recreation!

Marine Reserves can benefit pelagic species

- Tuna and billfish from MPA boost adjacent fisheries
- Fishery catch per unit effort increased after and outside MPA



Spillover benefits from the world's largest fully protected MPA

SARAH MEDOFF¹, JOHN LYNHAM¹, AND JENNIFER RAYNOR¹ [Authors Info & Affiliations](#)

Science

Impact of two of the world's largest protected areas on longline fishery catch rates

John Lynham¹, Anton Nikolaev², Jennifer Raynor³, Thaís Vilela⁴ & Juan Carlos Villaseñor-Derbez⁵



MPA are not expensive – any country can afford to have Marine Reserves

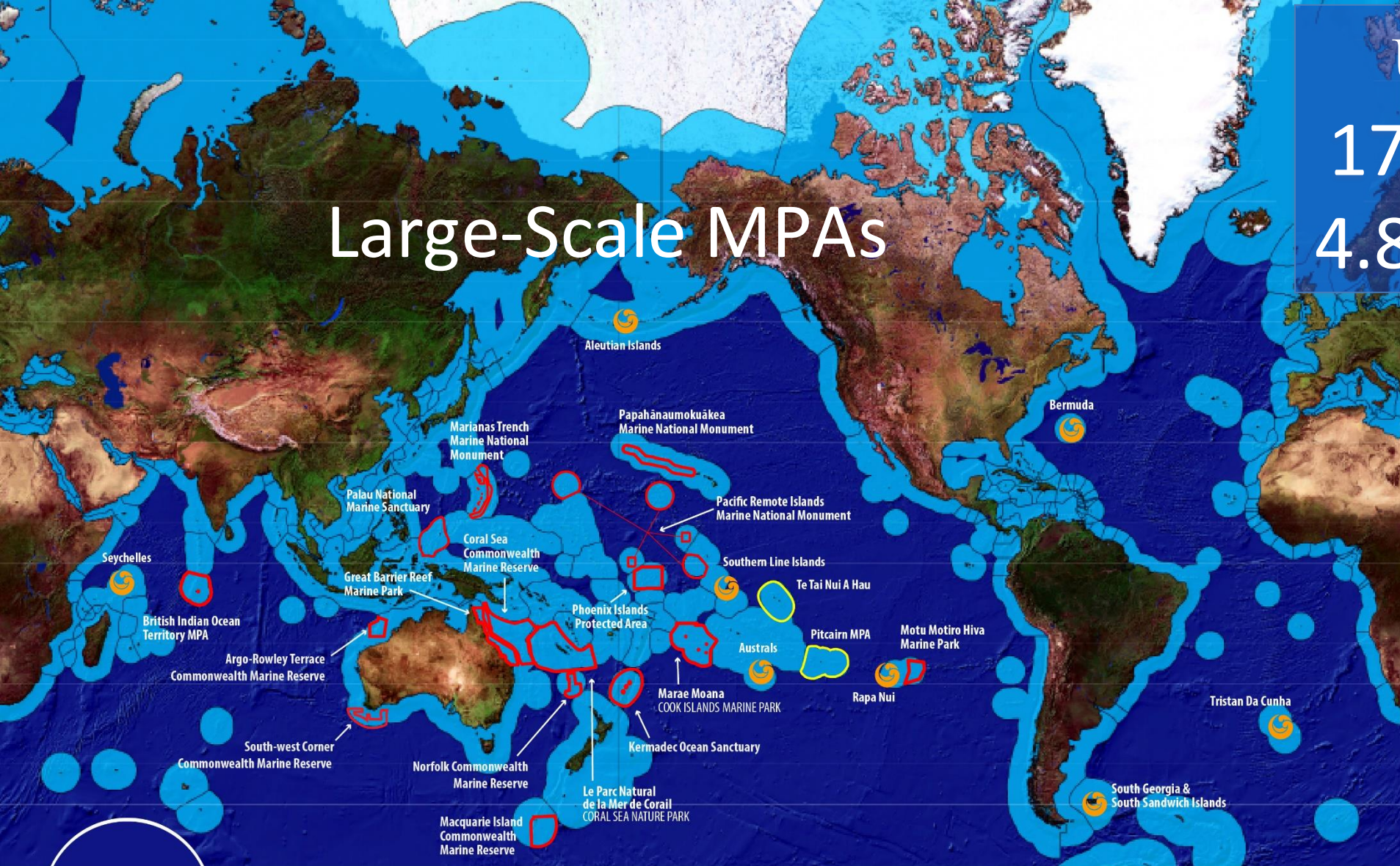
- People who rely on ocean for food recognise common sense to protect biodiversity
- Indigenous people's often have cultural 'no-take' areas, e.g. Indonesia, New Zealand, Solomon Islands, East Africa
- Flip management to *precautionary principle* to “all protected” unless permitted

Some largest Marine Reserves in world are in Developing Countries

- 408,250 km² Phoenix Islands (PIPA), Rep. Kiribati 2008
- 150-410,000 km² Motu Motiro Hiva (Easter Is.) Marine Park, Chile 2010
 - Chagos (Britain)

Large-Scale MPAs

Up to 28 sites
17.3~ million km²
4.8%~ of the ocean



1. MPA costs \approx fishery & environment management costs

2. ? cost doing nothing

3. Costs of fully-protected MPA management less



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Established Sites
Proposed by Governments
Proposed by NGOs

Are MPA expensive?

- False claims about MPA costs to fisheries, displacement, etc.
 - If an area is already managed, such as for fisheries, then MPA simplify management at no extra cost
1. **No evidence anywhere that MPA were a cost to any fisheries**
 2. **Fully-protected areas have lowest management costs (simpler rules)**
 3. **Good evidence of MPA benefits to fisheries (spillover)**

Pollution and MPA

- Pollution, like fishing, is **caused** by people
- Pollution, like fishing, can be managed **well** by people
- Authorities are likely to make a special effort to limit pollution into an MPA, from land and nearby sea areas
- Allowing pollution and fishing in an MPA is not the fault of the MPA, it is **bad management**

MPA and climate change

- MPA provide resilience against climate change by having larger, and more natural, populations
- MPA can be designed to accommodate future species range shifts due to climate change

nature communications 

Article <https://doi.org/10.1038/s41467-024-44976-y>

Marine protected areas promote stability of reef fish communities under climate warming

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Lisandro Benedetti-Cecchi¹✉, Amanda E. Bates², Giovanni Strona³, Fabio Bulleri¹, Barbara Horta e Costa⁴, Graham J. Edgar^{5,6}, Bernat Hereu⁷, Dan C. Reed⁸, Rick D. Stuart-Smith^{5,6}, Neville S. Barrett⁵, David J. Kushner⁹, Michael J. Emslie¹⁰, Jose Antonio Garcia-Charton¹¹, Emanuel J. Gonçalves¹² & Eneko Aspillaga¹³

Fisheries do NOT loose catch due to MPA

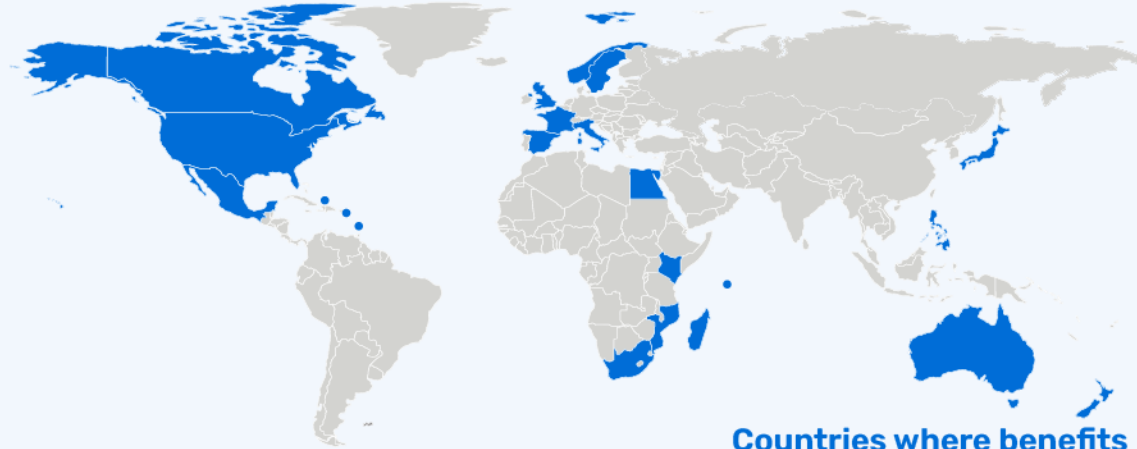
Total examples in literature	51	100%
Increased fishery catch only	33	
Increased body size of fishery species	5	
Both bigger catch and body size	6	
“Spillover” reported	8	
Sub-total benefits to fisheries	46	90 %
Uncertain effects on fishery	5	
Decreased fishery catch	0	0 %

Details in

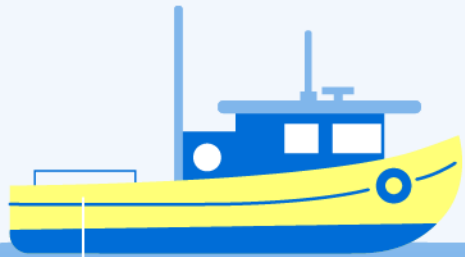
Costello MJ. 2024. Evidence of economic benefits from Marine Protected Areas.
Scientia Marina.



Economic benefits of MPAs for finfish, crustacean, and mollusc fisheries



Countries where benefits have been reported



- **39** studies found **increased catch since MPA designation**
- **13** studies found **increased body size up to 34%**
- **6** studies found **increased catch and body size**
- **0** studies reported **decreased catch**
- **8** studies reported **spillover of larvae and adults**

New review of science literature on MPA effects on fisheries found examples from 25 countries.

No indications of any fishery loss due to MPA anywhere.



Economic benefits of MPAs for tourism



Evidence of economic benefits from marine protected areas

Mark John Costello

SCIENTIA MARINA 88(1)
March 2024, e080, Barcelona (Spain)

- **30 to 50 jobs per MPA**
- Up to **US\$2.7 million** from **entrance fees**, depending on MPA size and age
- Up to **US\$6.4 billion** from **one Marine Park**

Countries where benefits have been reported

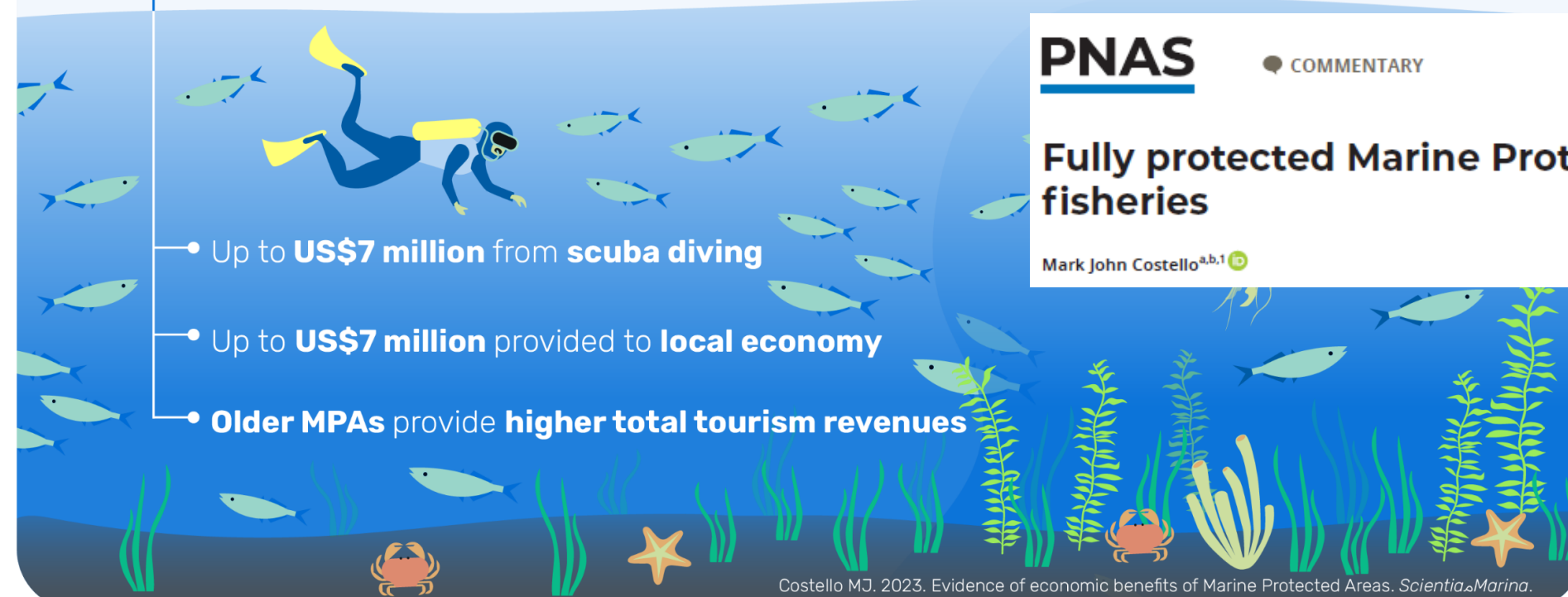
PNAS

COMMENTARY

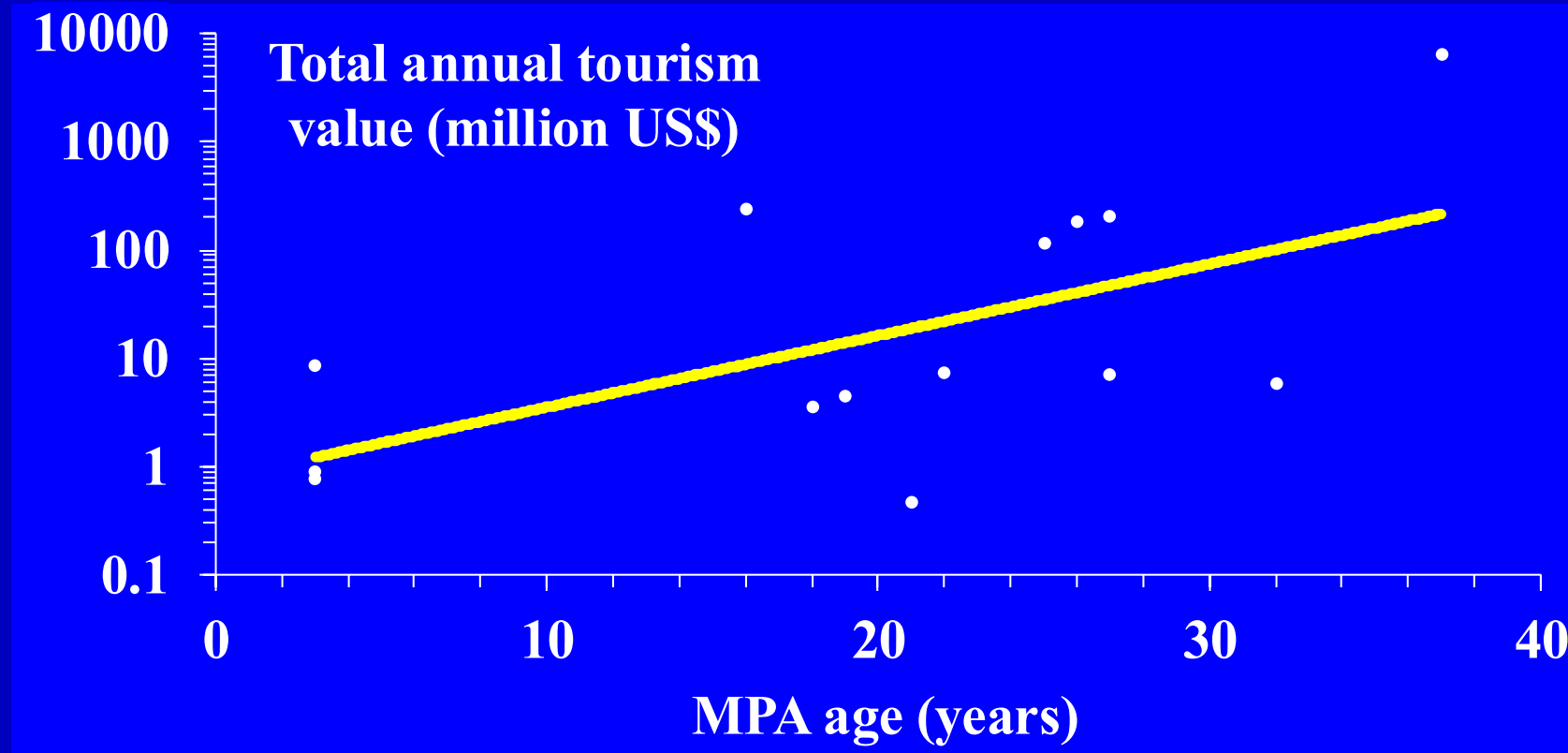
Fully protected Marine Protected Areas do not displace fisheries

Mark John Costello^{a,b,1}

- Up to **US\$7 million** from **scuba diving**
- Up to **US\$7 million** provided to **local economy**
- **Older MPAs** provide **higher total tourism revenues**



More tourism revenue from larger and older MPA



Details in

Costello MJ. 2024. Evidence of economic benefits from Marine Protected Areas. *Scientia Marina* in press.

Do MPA “displace fisheries” ?

or, is it an “*invented problem*” ? (Ballantine 2014)



ELSEVIER

Biological Conservation

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

Perspective

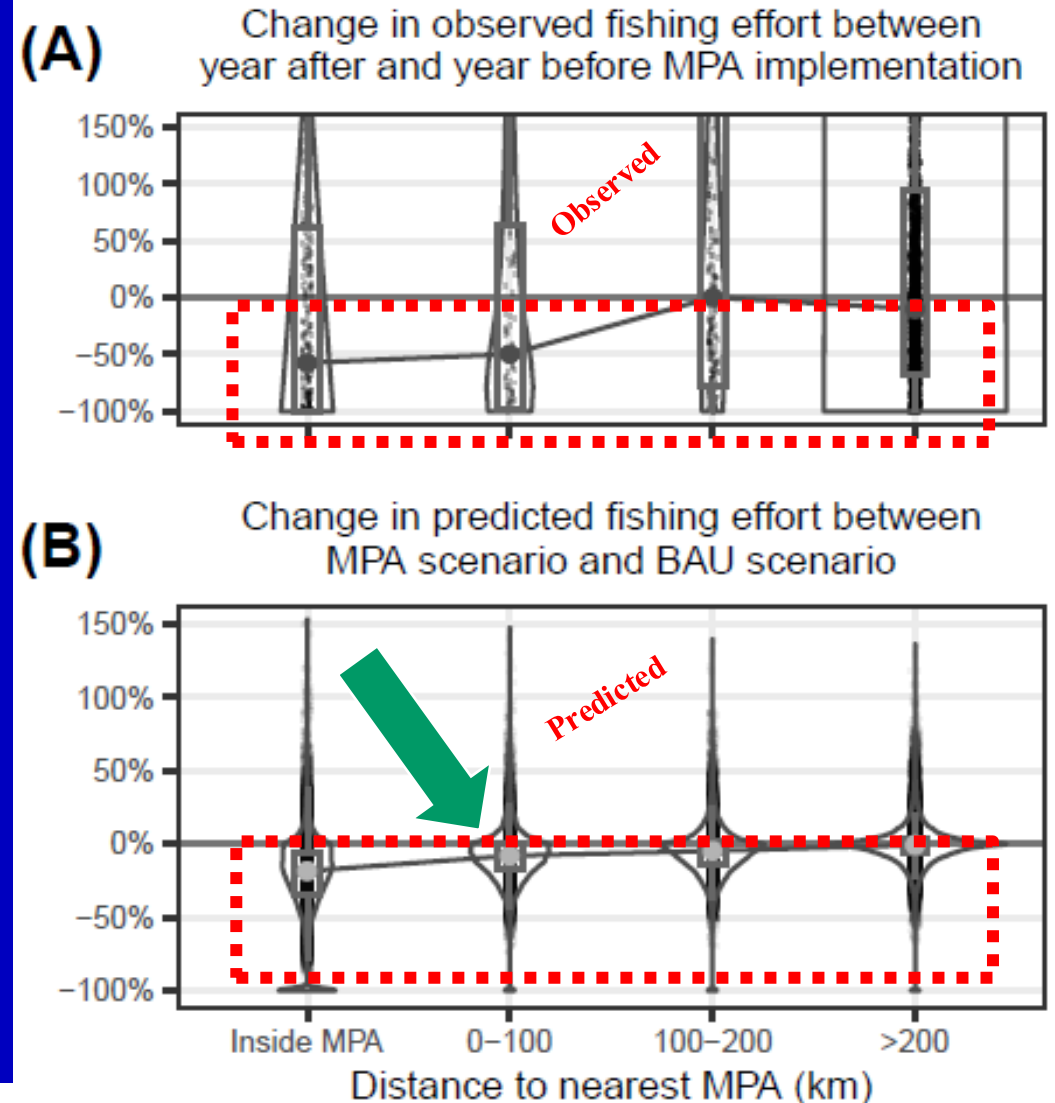
Fifty years on: Lessons from marine reserves in New Zealand and principles for a worldwide network

Bill Ballantine

University of Auckland, Institute of Marine Science, Leigh Marine Laboratory, PO Box 349, Warkworth, New Zealand

No!

1. Using global fishery data and past MPA expansion, find fishing effort decreased around MPA
2. Predict continued decreasing fishing effort under multiple MPA expansion scenarios
3. increased effort if business-as-usual



Global expansion of marine protected areas and the redistribution of fishing effort

PNAS

Coral Grouper fishery in the Great Barrier Reef, Australia

Marine reserves contribute half of the larval supply to a coral reef fishery

SCIENCE ADVANCES

5 Feb 2025

- 766 no-take Marine Reserves occupy 30% of the GBR area
- designed using systematic conservation planning
- fishery is well (sustainably) managed
- Yet 30% MPA contributes to whole GBR:
 - **55% of larval supply,**
 - **50% of larval settlement,**
 - **47% of commercial catch,**
 - **one of every two fish to the fishery.**




Partly-Protected MPA do not (aim to) work

1. 91% examples on fishery benefits from fully-protected MPA
2. Partly-protected MPA, allowing subsistence-recreational fishing, led to same trophic cascade as outside MPA.
3. European countries allow seabed trawling in MPA (25% trawled)
4. So they may have no ecological benefits
 - Effects relative to intensity of fishing outside
5. Do they have social or political benefits?

People do not see
benefit of partial
protection

Evaluating the social and ecological effectiveness of partially protected marine areas

Conservation Biology, Volume 35, No. 3, 921–932

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“We found no social or ecological benefits for partially protected areas”

partially protected areas act as red herrings in marine conservation because they create an illusion of protection and consume scarce conservation resources yet provide little or no social or ecological gain over open areas.

Fully protected areas, by contrast, have more fish species and biomass and are well understood, supported, and valued by the public. They are perceived to have better marine life and be improving over time in keeping with actual ecological results.”

Full protection is equitable for people and nature; why exclude commercial food-fishing over recreational fishing?

Part-protection does not work

- In medicine (half a dose may have no benefit)
- Public health
- In business (not getting paid what is needed)
- Or nature conservation
 - But may be better than nothing or a starting point

10 myths and misunderstandings

1. Countries use best scientific practice to locate MPA
2. MPA aim to protect biodiversity as a whole
3. It is radical to limit public access in the ocean
4. Only commercial fishing impacts biodiversity
5. MPA only benefit seabed, not pelagic, life
6. MPA are expensive so only rich countries can afford MPA
7. MPA do not protect against pollution
8. MPA do not protect against climate change
9. MPA cause losses to or displace fisheries, > impacts outside MPA
10. Partly protected MPA, a compromise, are a solution



5th key messages

1. MPA do not only benefit biodiversity, there are ~50 examples of benefits to fisheries through spillover effects.
2. There is no published evidence of any MPA reducing fishery catch anywhere.
3. There is no evidence of fishery displacements effects, but there is of improved fishery CPUE around MPA locally and globally.

Implications of key messages

- Because biodiversity includes all species and ecosystems, it cannot be protected piecemeal.
- Nature conservation should prioritise strictly protected areas where people are prohibited from killing any marine wildlife and damaging their habitats.
- An ecologically representative (coherent) network of MPA is appropriate now and under future climate change.

Beyond MPA Europe

- Limitations
 - Species are only present in locally suitable habitats within their range (they may have been extirpated by pollution or bottom trawling)
- Opportunities
 - Use the MPA Europe data layers to provide a geographic context for planning MPA in cooperation with local stakeholders, e.g., using the *SeaSketch* platform as used in the Azores.
 - How can MPA be designed to benefit fisheries? **New project MPA4Fish**

Thank you
Mark Costello

mark.j.costello @ nord.no

<https://www.facebook.com/marinereserves>
- a post a day about MPA



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