Marine habitat modelling: a state-of-the-art model to identify favorable growth sites for mariculture

Gert Everaert; George Westmeijer; Hans Pirlet; Michiel B.Vandegehuchte; Olivier De Clerck

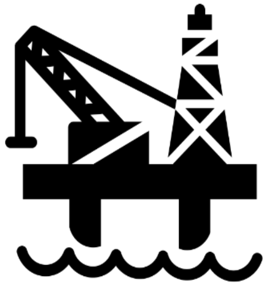
Increased interest in seaweed culture in Europe

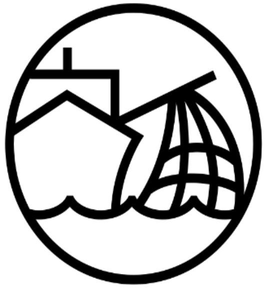
Annual worldwide yield approx. 28 million tonnes

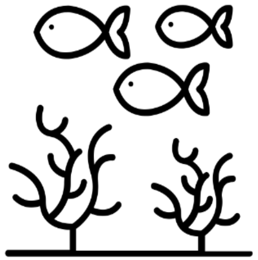
Europe 1%

Expected to increase, stimulated by EU Blue Growth and bioeconomy strategies

Challenge for marine spatial planning







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Aim of the study

Aim?

Identify sites within European marine waters for optimal growth conditions of macroalgal species

Selected based on:

- Representing brown and red seaweeds
- Demonstrated economic importance
- Availability of physiological data
- Known distribution along European shores

How?

Mechanistic model predicting habitat suitability for nine macroalgae species

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Mechanistic model explained

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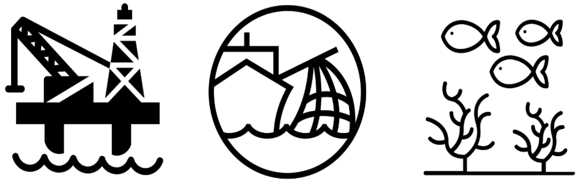
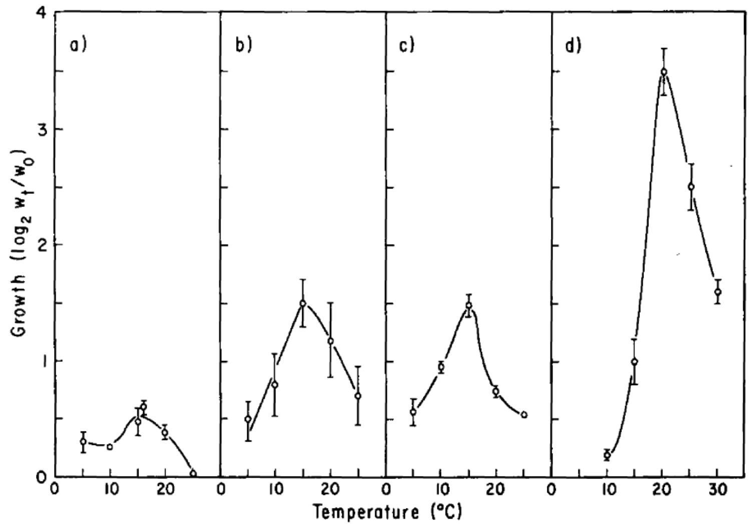
Mechanistic model explained

Input 3: Marine spatial planning & technical requirements





Input 1: Species-specific growth optima

Input 2: Environmental layers (Bio-ORACLE, MARSPEC)

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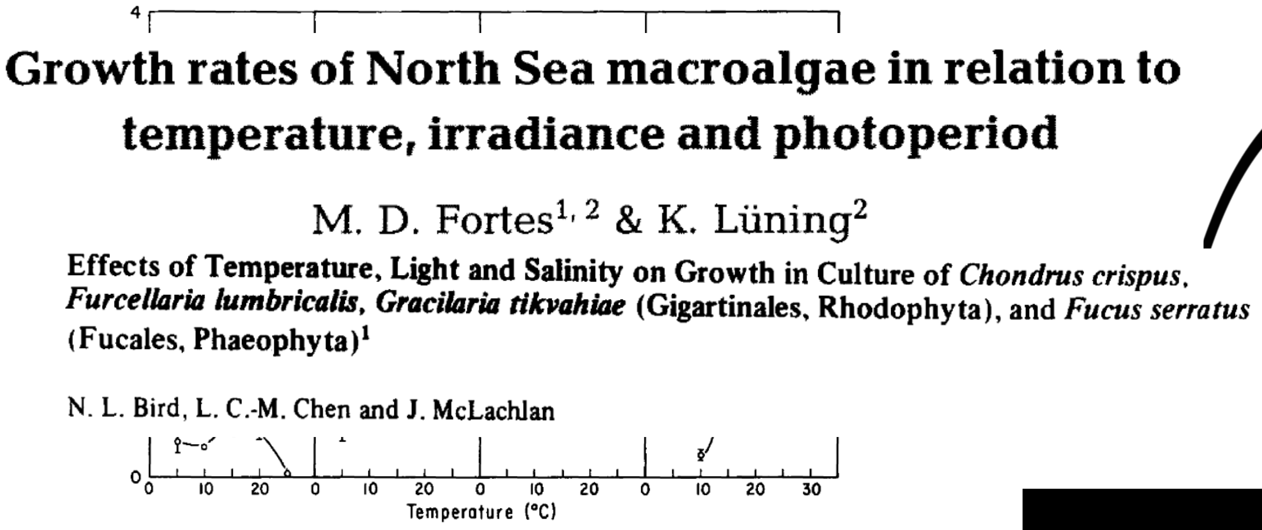
Mechanistic model explained

Input 3: Marine spatial planning & technical requirements

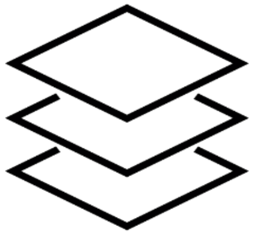

Growth rates of North Sea macroalgae in relation to temperature, irradiance and photoperiod

M. D. Fortes[1, 2] & K. Lüning[2]

Effects of Temperature, Light and Salinity on Growth in Culture of *Chondrus crispus*, *Furcellaria lumbricalis*, *Gracilaria tikvahiae* (Gigartinales, Rhodophyta), and *Fucus serratus* (Fucales, Phaeophyta)[1]

N. L. Bird, L. C.-M. Chen and J. McLachlan

Input 1: Species-specific growth optima



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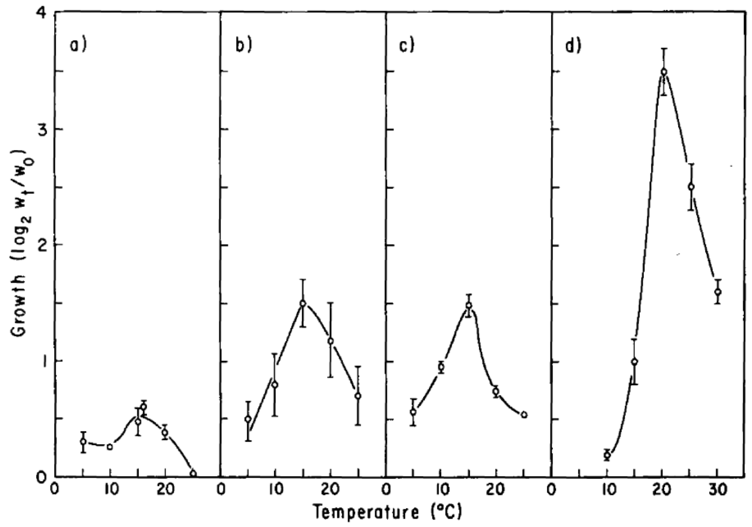
Mechanistic model explained

Input 3: Marine spatial planning & technical requirements



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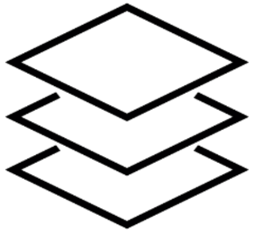


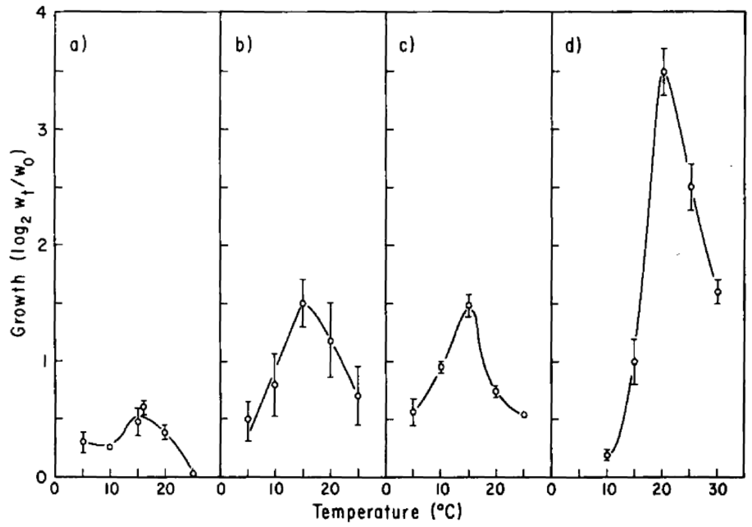
e.g. sea surface temperature & salinity
photosynthetically active radiation
nutrients

Input 2: Environmental layers (Bio-ORACLE, MARSPEC)

Present and future climate change scenarios: RCP 2.6, 4.5, 6.0 and 8.5

Mechanistic model explained

Input 3: Marine spatial planning & technical requirements



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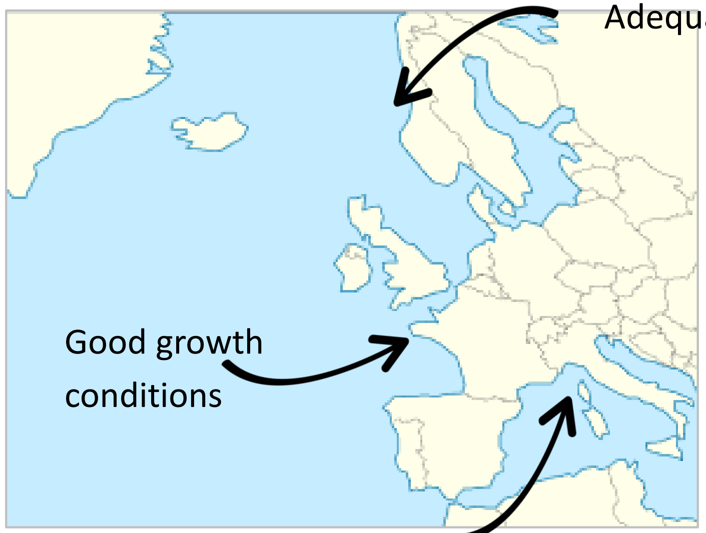
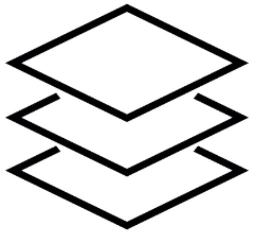


Adequate

Good growth conditions

Poor



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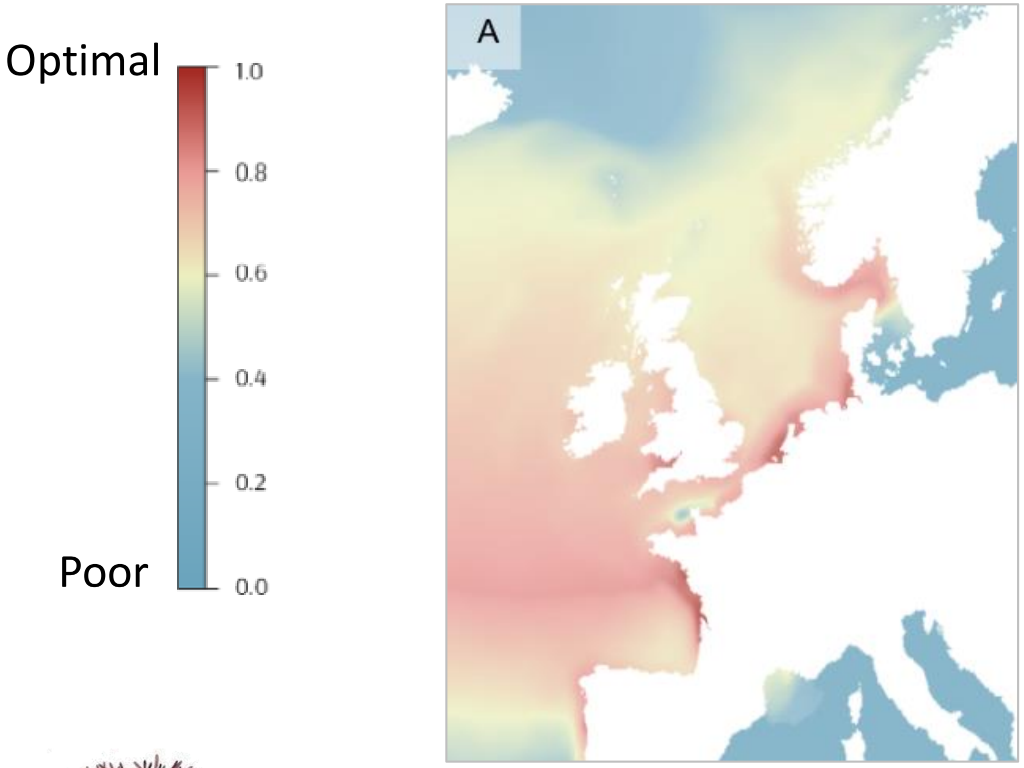
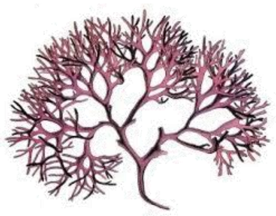
Species specific habitat suitability model



Habitat suitability based on abiotic restrictions



Chondrus crispus

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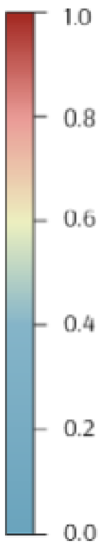
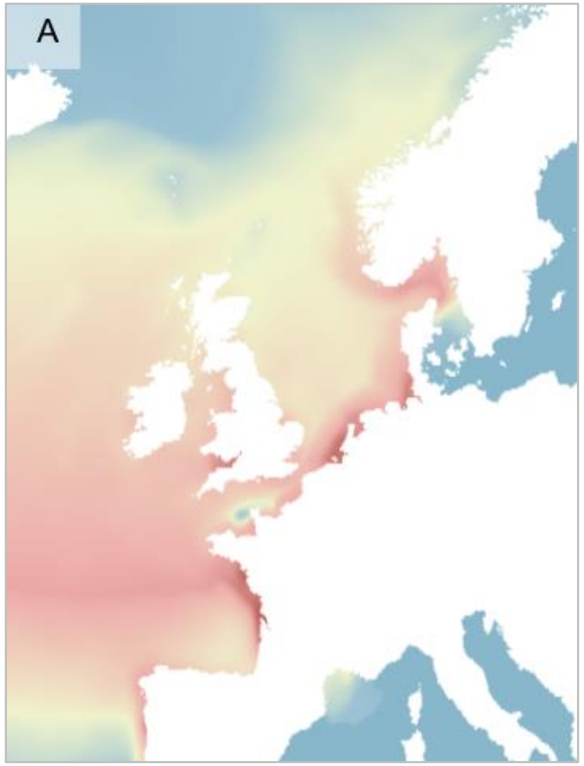
Species specific habitat suitability model

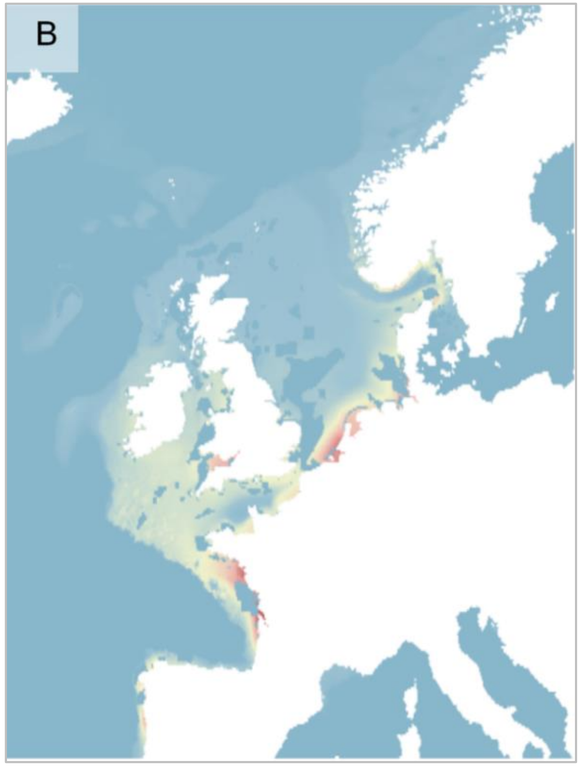
Optimal



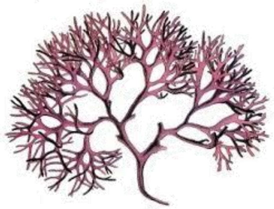
Poor



Habitat suitability based on abiotic restrictions



Habitat suitability based on abiotic restrictions; marine spatial planning; technical requirements



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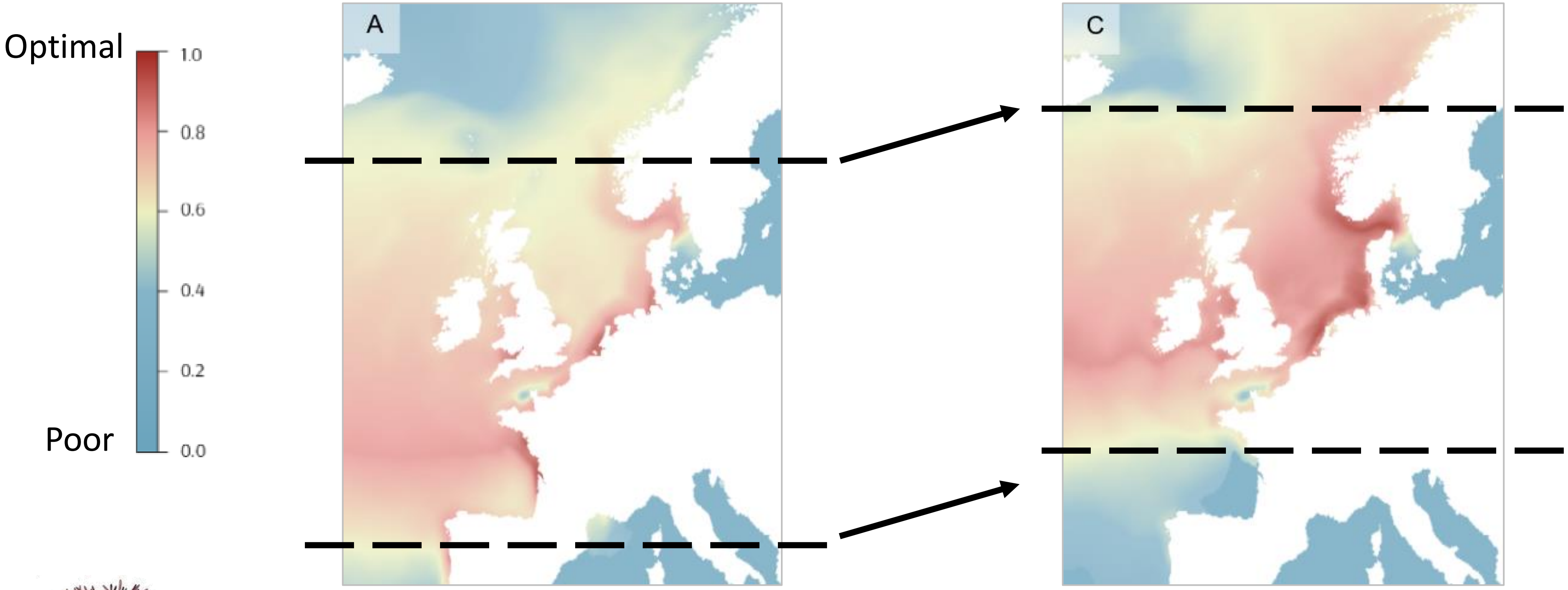
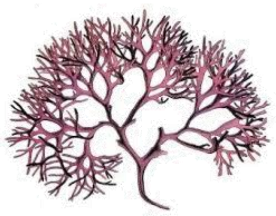
Species specific habitat suitability model



Habitat suitability based on abiotic restrictions

Habitat suitability based on abiotic restrictions Under RCP 8.5



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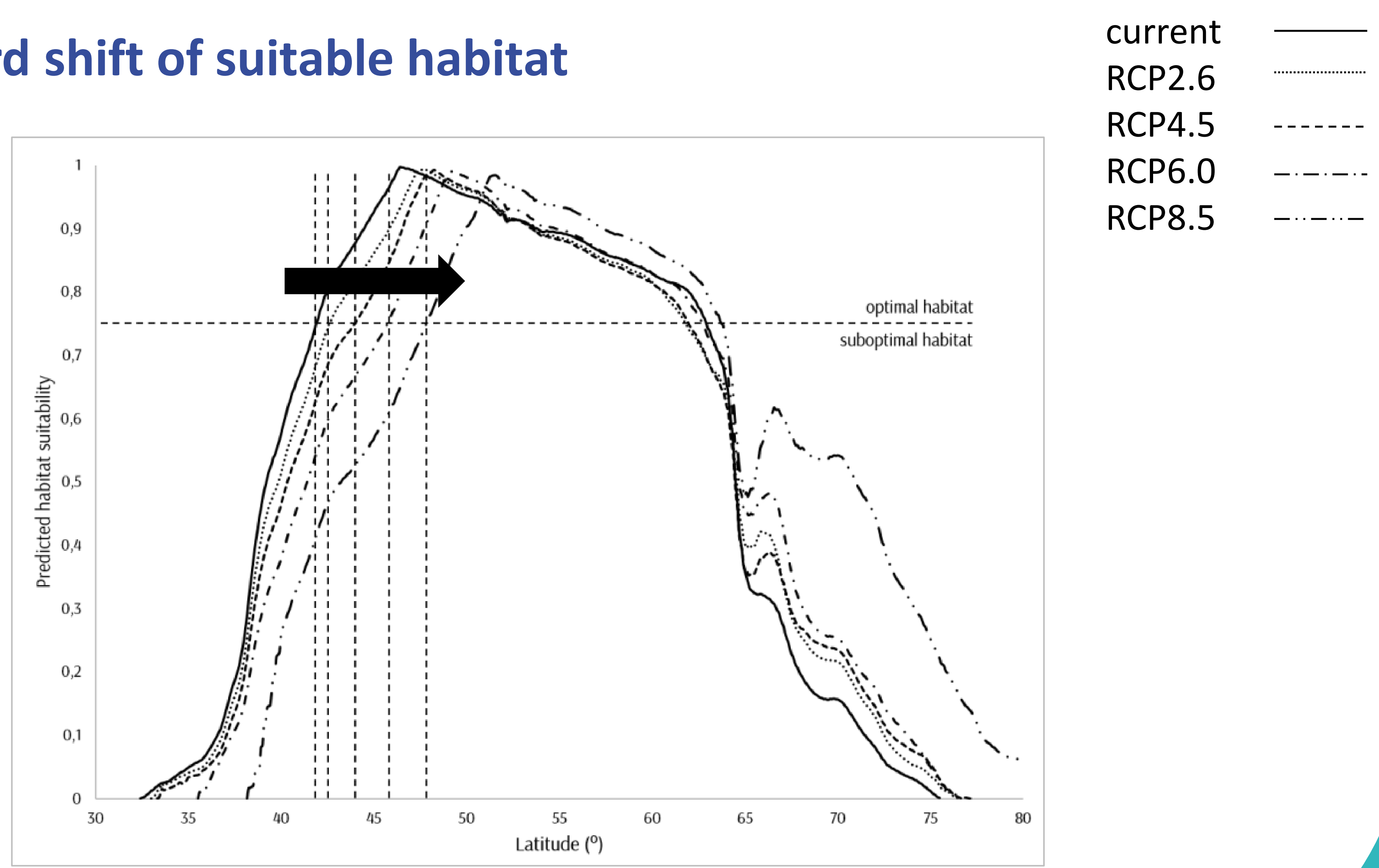
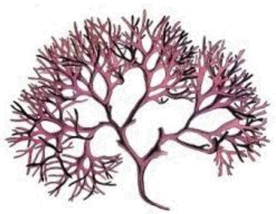
Northward shift of suitable habitat



Northward shift of optimal habitat 137 to 635 km under different climate change scenarios



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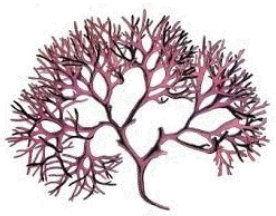
Model validation

Overlap of habitat suitability estimates with independent distribution data

GBIF Global Biodiversity Information Facility

OBIS OCEAN BIOGEOGRAPHIC INFORMATION SYSTEM

Distribution data → Quality checks



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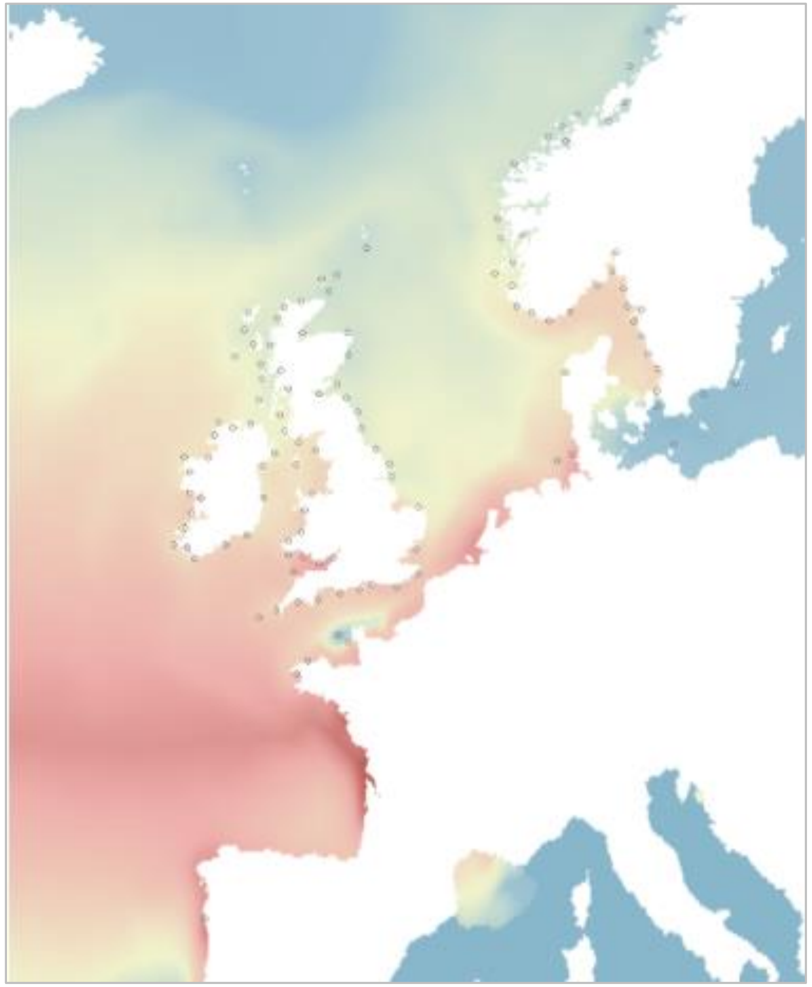
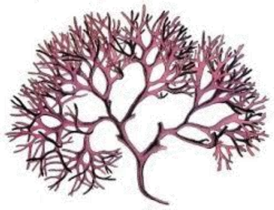


Accurate prediction of occurrence

- 90% of presences in predicted optimal and suboptimal habitat
- Area Under Curve (AUC) of Receiver Operating Characteristic (ROC): 0.82



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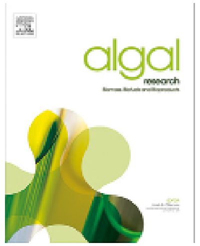

Mechanistic niche modelling to identify favorable growth sites of temperate macroalgae

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A R T I C L E I N F O

Keywords:
Habitat suitability
Mechanistic niche modelling
Northward range shift
Physiological thresholds
Seaweed aquaculture

A B S T R A C T

The European seaweed cultivation sector is in a transition phase with the rise of seaweed aquaculture due to an increased interest in seaweed resources. Identifying regions with optimal growth conditions for the cultivation of specific seaweed species contributes to the cultivation process. An understanding how these regions evolve under climate change is required to ensure favorable growth conditions on the long-term. In the present research, regions with favorable growth conditions for specific seaweed species were identified by combining physiological and environmental data in a mechanistic niche model. The outcome of the mechanistic model is a species-

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Conclusions

- Habitat suitability of nine temperate seaweeds by means of mechanistic niche modelling;
- A species-specific response as a function of the temperature, salinity, light and nutrient requirements;
- Coast of Portugal to the south coast of Brittany is currently a suitable habitat for most of the studied species;
- Depending on the climate scenario, the northward shift ranged from 110 km to 635 km;
- Results can contribute to the decision-making process in marine spatial planning of aquaculture activities.

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