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Climate change impact on seaweed meadow distribution in the North Atlantic

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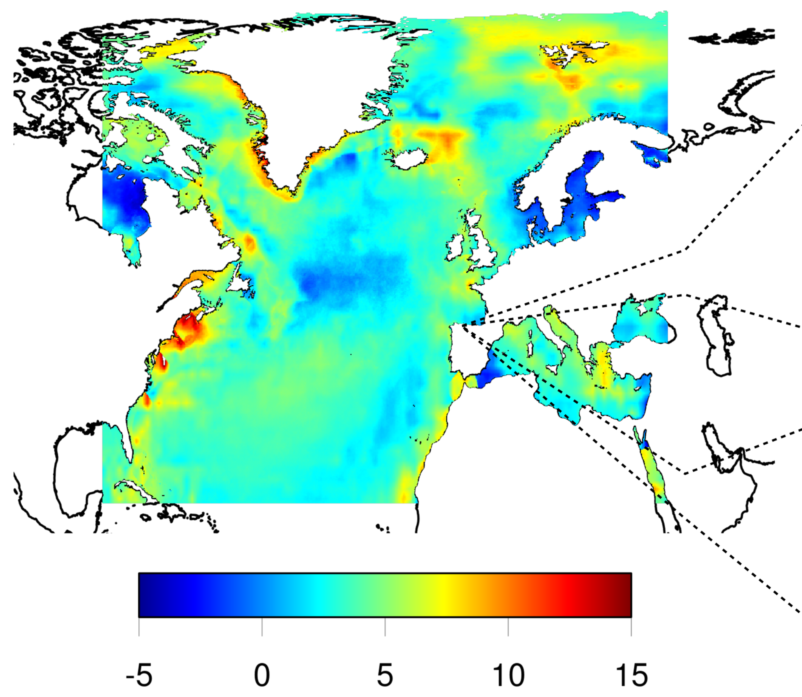
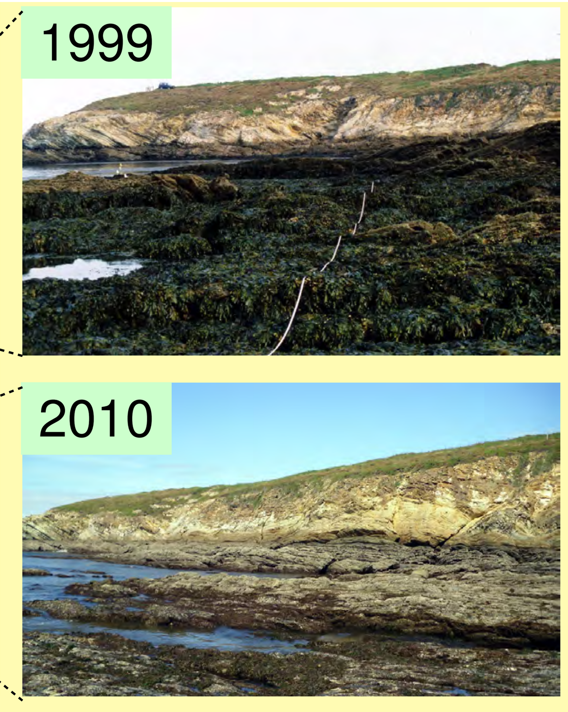
Background Climate change affects seaweed meadows on temperate rocky shores

Seaweeds mediate the climate warming impact on North Atlantic rocky shores

Under predicted climate change, the future state of the rocky shore community depends on how marine **intertidal key species** respond. **Seaweeds** are key elements of temperate rocky intertidal communities and provide an excellent system in which to investigate the **impact of climate change** since their **distributional boundaries** are commonly correlated with SST isotherms.



Sea surface temperature change (°C) until 2200



90% abundance decline in *Fucus serratus*

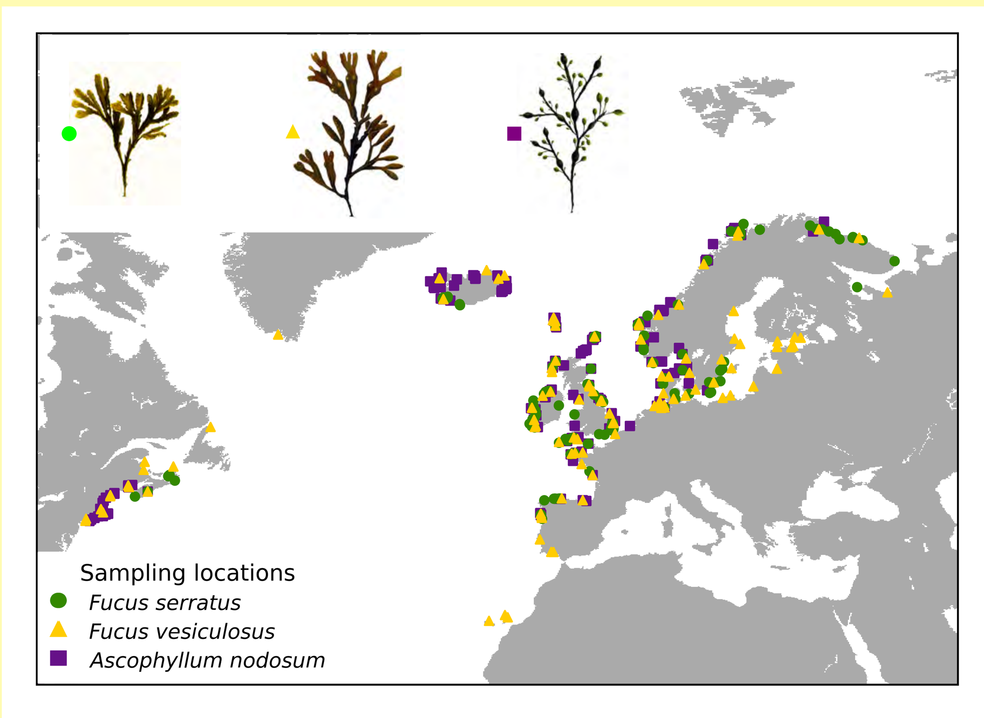
Ongoing poleward shift

Evidence arose over the last decade that climate change causes a **global poleward shift** of temperate seaweed species.

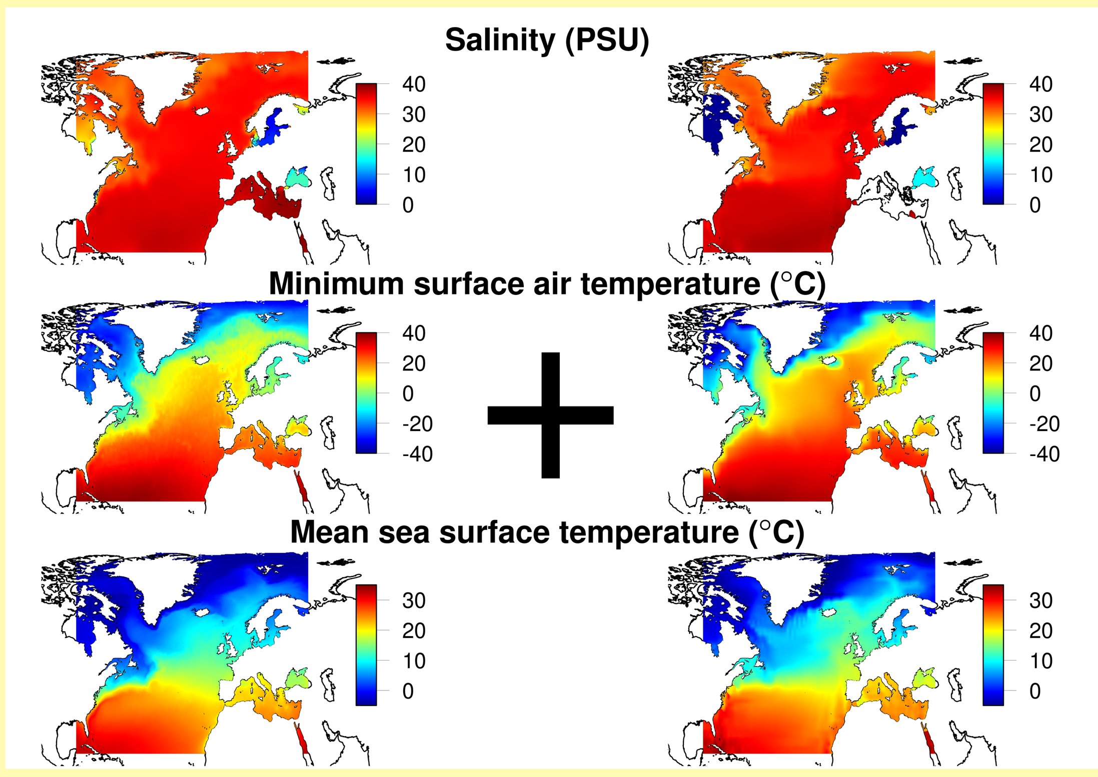
Research questions

1. Areas of **biggest change**?
2. **Coherent** shift of entire temperate flora?
3. Can seaweeds **trace** the predicted shift?

Methods Ecological niche modeling



Occurrence records



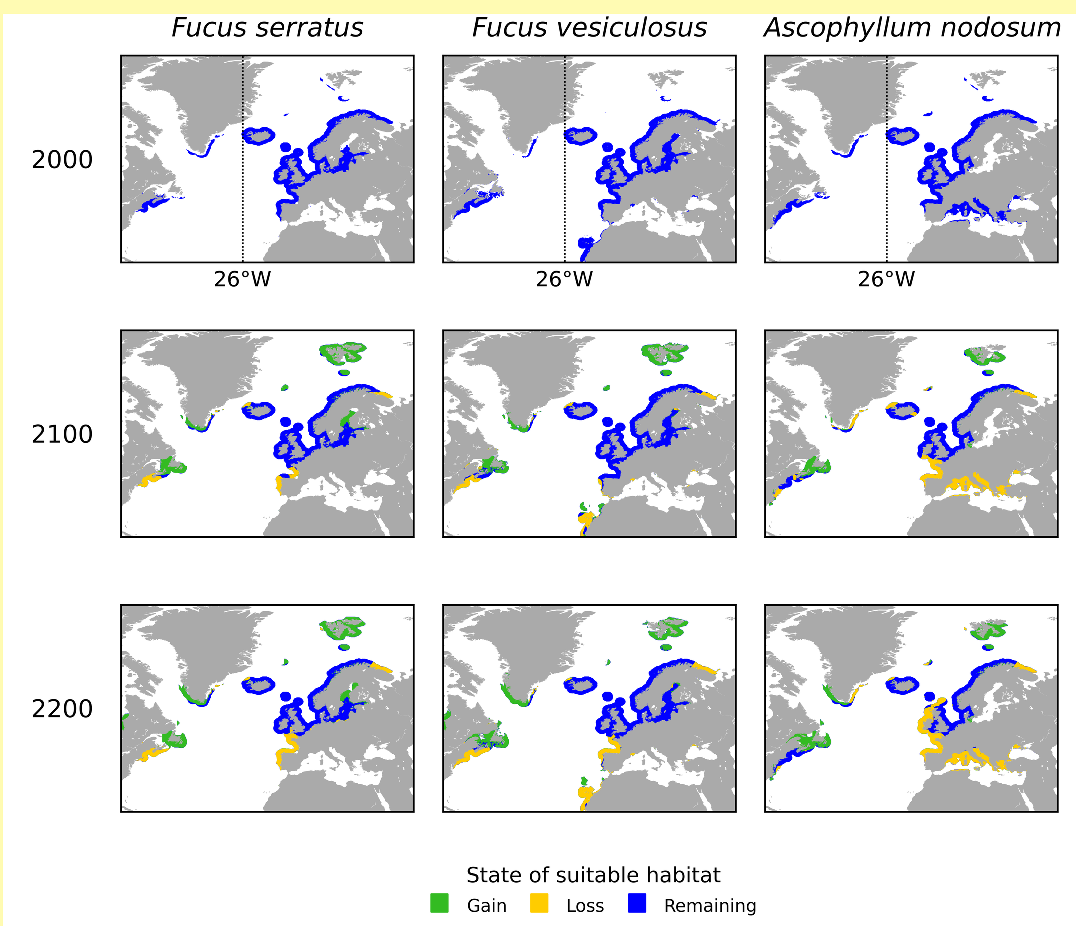
Environmental layers 2000

Climate predictions until 2200

Predicting future seaweed distribution

Three of the **most abundant and characteristic macroalgae** of North Atlantic shores are *Fucus serratus*, *Fucus vesiculosus* and *Ascophyllum nodosum*. We estimated their **ecological niches** based on their geographical occurrence and the environmental conditions at these locations (from the Bio-ORACLE database [4]) using the program MAXENT [3]. Projections of the future state of these conditions were then compiled with the R package 'raster' [2] from three IPCC climate change projections (B1, A1B and A2) and the UKMO-HadCM3 model [1] to **predict suitable seaweed habitats** in 2100 and 2200.

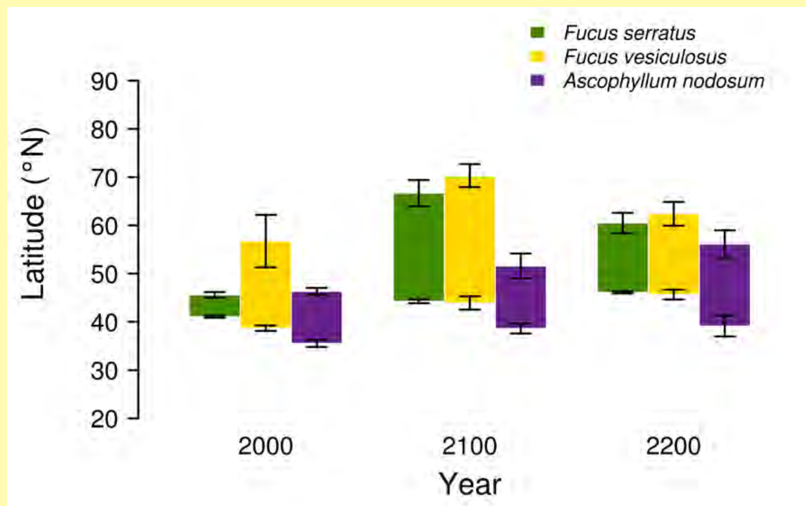
Results Arctic gain and southern retreat



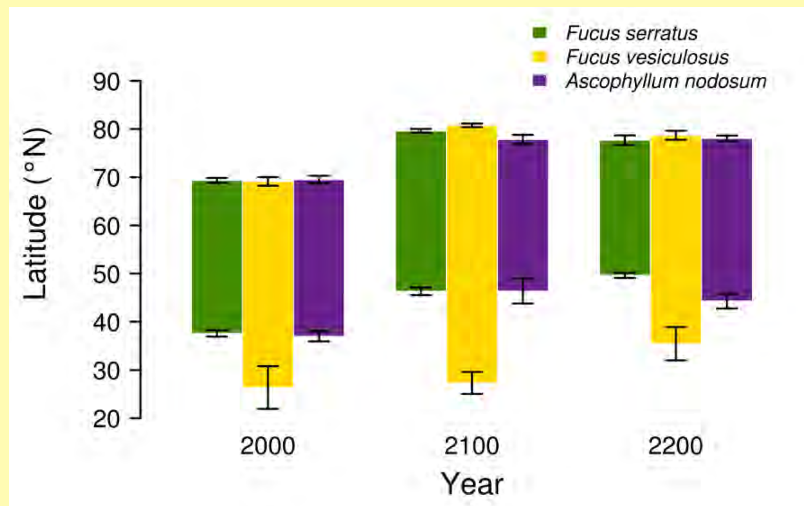
Habitat suitability changes under the intermediate climate change scenario A1B

Northward shift

Already in 2100, **arctic shores** in Canada, Greenland and Spitsbergen are predicted to become **suitable** for the temperate seaweeds, but shores **south** of Britain and Newfoundland are indicated to **lose** at least two of the three focal species until 2200.



West Atlantic



East Atlantic

Predicted **change of latitudinal distribution boundaries** for the three algal species over the next two centuries. Bars of one standard error indicate the variation that is due to the different IPCC scenarios and different threshold rules that discriminate suitable from non-suitable habitat. *F. serratus*, *F. vesiculosus* and *A. nodosum* were predicted to **lose** 5.0°, 7.0° and 3.6° latitude in the NW- and 12.0°, 9.1° and 7.3° latitude in the NE-Atlantic and to **gain** 14.9°, 5.7° and 9.8° latitude in the NW- and 8.3° , 9.6° and 8.5° latitude in the NE-Atlantic, respectively.

Conclusions

1. **Biggest changes** are expected in **phytogeographic transition zones** like the southern arctic and temperate provinces.
2. The temperate marine flora is likely to **restructure into a nonanalogous hybrid community** since its component species shift incoherently.
3. Human shipping could induce a **rapid invasion** of temperate seaweeds in the **Arctic** despite their low intrinsic dispersal potential.

References

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