Habitat suitability modelling of macroalgae with a mechanistic approach

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Intertidal, macroalgal species in the North-Atlantic are vulnerable to climate change and species that lack an adaptive capacity to the rising temperatures will either go extinct of migrate north to a more suitable habitat. Many intertidal macroalgae function as ecosystem engineer, a range shift therefore has the potential to disturb the intertidal community and to initiate changes that resonate throughout the entire marine ecosystem. To assess a potential range shift of macroalgae, their habitat suitability in the European marine environment was predicted, as well as the evolution of this habitat suitability by 2100. To predict the habitat suitability, we used a mechanistic model comprising physiological optima and –thresholds, reported in literature, and applied this model to environmental data. Variables included in the mechanistic model are sea surface temperature, surface salinity, photosynthetically active radiation, nitrate concentration, turbidity and surface temperature of the warmest month. Using a mechanistic model enables to do predictions outside the environmental range where the species is presently distributed. This is highly relevant for climate change scenarios. The model was validated by comparing the predicted habitat suitability with distribution records from the Global Biodiversity Information Facility. For example, for the red algae *Chondrus crispus*, no presences were recorded on locations with a low habitat suitability (< 0.4). Most presences (> 85%) corresponded with a high predicted habitat suitability (> 0.6). Climate change was modelled by using the Representative Concentration Pathways (RCP), adopted by the Intergovernmental Panel on Climate Change. For *Chondrus crispus* the most optimal habitat is predicted to migrate 160 km north by 2100 under the most optimistic climate change scenario, RCP 2.6. This migration is 375 kilometers by 2100 under the more pessimistic climate change scenario, RCP 6.0.

The results of this research may aid in the decision making process on the location for the aquaculture of certain seaweed species. To make the habitat suitability map relevant for aquacultural purposes, spatial planning of the marine environment was added to the model and the depth of the water column was taken into account. Eight macroalgae were modelled so far but this selection is likely to expand in the near future.

Keywords: mechanistic modelling; physiological thresholds; species distribution models; climate change; marine macroalgae; *Chondrus crispus*