Integration of predator habitat preference to support mariculture planning

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A key challenge in developing sustainable mariculture is optimizing geographic placement as well as harvesting times. For mussel aquaculture, the importance of environmental conditions for farm site selection is widely recognized. As such, multiple models have been developed to determine the most suitable habitat for mussels. However, often this approach does not allow predictions concerning mussel biomass yields. In addition, there is a focus on the impact of environmental factors on habitat suitability, overlooking biotic effects on aquaculture yield such as losses due to predation. This is a particular concern in the Belgian Part of the North Sea (BPNS), where one of the main predators targeting blue mussels (*Mytilus edulis*) in aquaculture is the abundant common starfish (*Asterias rubens*).

In this study, we aim to predict mussel biomass yields under varying environmental conditions whilst taking the effect of predation by starfish into account. Our approach will combine classical habitat suitability models for mussels and starfish with food web modelling, a methodology to investigate trophic interactions that can be used to make species biomass predictions. As a first step, this requires habitat suitability models describing the spatial preferences of blue mussels and common starfish within the BPNS. For blue mussels, a previously developed model by Pint *et al.* (2024a) will be used. However, for starfish, no recent model exists for the BPNS.

Hence, the first stage of this study is developing a habitat suitability model for common starfish in the BPNS. To predict suitable habitat throughout the year for both current and future environmental conditions, two complementary data-driven methodologies will be applied: a Generalized Additive Model (GAM) and a MaxEnt model. A statistical regression approach such as GAM is well-suited for making inferences, and it provides clear insight into the ecological processes driving species distribution. Maxent is better for predictions but less suitable to provide ecological insight due to the "black box" nature of such machine learning methods. By combining both, we will investigate the drivers of starfish distribution, as well as accurately predict how this might change under future climate change scenarios.

These models will estimate the suitable habitat in the BPNS by linking 29.453 starfish observations in the greater North Sea from the year 2000-2019 to their corresponding environmental conditions. Environmental factors to consider (i.e. bathymetry, seabed habitat, current velocity, temperature, salinity, chlorophyll, pH and oxygen concentration) were selected based on a literature review. Species occurrence data was obtained from the EurOBIS database, whereas environmental variables were sourced from the European Marine Observation and Data Network (EMODnet) and the Copernicus Marine Environment Monitoring Service (CMEMS). For each of the environmental variables, predictions for future climate change scenarios are available in the BioOracle database.

To verify whether the selected environmental factors influence starfish presence in the BPNS, the relationship between each considered variable and starfish presence was visualized. This data exploration confirmed findings from literature, showing clear relationships between all selected variables and starfish presence. In addition, our findings suggest a seasonal pattern to starfish abundance in the BPNS, with the highest occurrences recorded in fall.

When our newfound knowledge concerning starfish habitat suitability will be combined with environmental information concerning suitable habitat for mussel aquaculture (Pint at al., 2024a) into a food web model (Pint *et al.*, 2024b), it will allow mussel aquaculture & reef restoration planning in BPNS to minimize yield losses due to starfish predation. As such, providing a blueprint for the consideration of species interactions in models to optimize the location and timing for aquaculture cultivation.

References

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