Are pelagic fisheries the future of European seas?

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Understanding the habitats of commercially important pelagic fish is essential for their sustainable management. The impact of Brexit on European fisheries particularly the reduced access to UK waters, has prompted European fleets including Belgian fleets to explore alternative fishing grounds including pelagic fisheries, which are less utilised by some. Climate change is reshaping marine environments by altering ocean temperatures and salinity, which affects the distribution and behaviour of pelagic fish. These fish are not only economically important due to high demand and lower fishing costs but also play crucial ecological roles in maintaining marine ecosystems.

In light of the challenges posed by a changing environment, this research seeks to understand how climate change, according to Shared Socioeconomic Pathways (SSPs) scenarios, affects the spawning versus non-spawning habitats of three commercially significant pelagic species in European waters: Atlantic herring (*Clupea harengus*), Atlantic mackerel (*Scomber scombrus*), and European seabass (*Dicentrarchus labrax*). We developed mechanistic niche models using temperature and salinity data sourced from BioOracle and validated these models using 655,389 species occurrence records from EMODnet.

Model validation, performed using Root Mean Square Error (RMSE) and visual inspection of predicted versus observed distributions, showed good alignment between observed presence and predicted suitable habitats, supporting the reliability of our models despite some regional mismatches and challenges due to uneven data distribution. Our analysis estimated Habitat Suitability Index (HSI) values and observed distribution patterns, focusing on how optimal suitability shifted over time, independent of longitudinal variations. The HSI was classified on a scale where values were considered optimal ($HSI \geq 0.75$), suboptimal ($0.5 < HSI < 0.75$), and poor ($HSI \leq 0.5$). We examined the impact of climate change on habitat suitability under six SSP scenarios (SSP1-1.9, SSP1-2.6, SSP2-4.5, SSP3-7.0, SSP4-6.0, SSP5-8.5), representing a range of future socioeconomic and greenhouse gas emission trajectories. By exploring these dynamics, this research sheds light on critical aspects of the responses of three pelagic fish species to a changing environment, providing insights crucial for the development of sustainable management strategies for marine ecosystems in the face of climate challenges.

In our study, baseline habitat suitability for Atlantic herring, Atlantic mackerel, and European seabass was significantly influenced by temperature and salinity changes. European seabass exhibited the highest temperature-driven habitat suitability, particularly in the North Atlantic Ocean (HSI=0.90) and the Inner Seas off the West Coast of Scotland (HSI=1), while the Eastern Mediterranean region showed lower suitability (HSI=0.33). In contrast, salinity-driven habitat suitability revealed distinct patterns: Atlantic herring and mackerel thrived in northern seas (HSI>0.50) but had poor suitability in the Mediterranean (HSI=0). Under the SSP5-8.5 scenario, all three species are projected to shift northward, with notable habitat losses in southern areas and gains in northern regions due to salinity changes. Atlantic herring is expected to shift its range northward by 638 km by 2100, while Atlantic mackerel will lose significant habitat ($-2.1 km^2$) by 2100 under SSP5-8.5 due to temperature influences. The study results align with previous research showing latitudinal shifts in marine species due to warming temperatures, with significant implications for ecosystems and fisheries, particularly in the northern and southern regions of Europe. Increases in habitat suitability in northern regions, such as for Atlantic mackerel, contrast with the decline in the Mediterranean and Black Seas.

These findings show the necessity of adapting fisheries management to account for climate-induced shifts in pelagic fish distributions. As European fleets face new challenges such as Brexit and changing environmental conditions, this research provides crucial insights into future habitat suitability trends, helping to ensure the sustainable exploitation and conservation of these vital marine resources. Ultimately, this study highlights the crucial role of understanding shifts in fish habitat suitability to determine whether pelagic fisheries represent the future of European seas.

Keywords
Climate Change, Mechanistic Niche Modelling, Pelagic Fish, Habitat Suitability, Species-specific Response Curves