Project *brief*

Thünen Institute of Sea Fisheries 2024/27a

Sustainable Use of Marine Ecosystems and Preservation of Biodiversity in Times of Climate Change

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- **Price developments and management strategies have a greater impact on the profitability of demersal fishing fleets than the spatial development of marine protected areas.**
- **Nature-based solutions provide a cost-effective way to enhance the resilience of ecosystems and preserve biodiversity.**
- **Despite stringent protection measures, demersal fisheries in the North Sea can still operate profitably under climate change conditions.**

Background and objectives

Climate change is globally altering marine ecosystems through rising temperatures, ocean acidification, and changes in currents, which shift habitats and threaten fish stocks. Socioeconomic factors such as rising fuel prices exacerbate the situation. The *FutureMARES* project explored nature-based solutions (NBS) that leverage natural processes to mitigate the impacts of climate change while ensuring marine biodiversity and the economic viability of fisheries. The goal was to develop ecologically, socially, and economically sustainable NBS that strengthen coastal communities and fishing fleets and provide policymakers with scientific recommendations for the sustainable use of marine resources.

Methodology

A comprehensive range of methods was used to investigate the effects of climate change on demersal fisheries and the effectiveness of NBS. Three key climate scenarios were developed:

Global Sustainability (GS): Strict environmental regulations and sustainable development. Emission reductions and biodiversity protection are key priorities, supported by strong international co-operation.

National Enterprise (NE): Focus on national interests, with economic development and industry at the forefront. Environmental protection is only moderately implemented, and regulation is weaker than in other scenarios.

World Markets (WM): A global, market-oriented approach focused on economic growth. Environmental measures are deprioritized in favor of free trade and global competition.

These scenarios consider different political, social, and economic developments in the future and allow the simulation of potential adaptation strategies and management options.

A central method was the use of the bioeconomic model *FishRent*, which combines data on fish stocks, fleet structures, and socioeconomic factors to assess the profitability of fishing fleets under the various scenarios. The model integrates cost data such as fuel prices and the availability of fishing areas, as well as external factors such as offshore wind projects and marine protected areas. The mode helped to identify potential conflicts between economic profitability and ecological conservation goals.

Additionally, cost-benefit and cost-effectiveness analyses were conducted to assess the economic efficiency of various nature-based solutions. These analyses focused on measures to promote biodiversity, the protection provided by marine protected areas, and the restoration of habitats, such as oyster reefs and kelp forests. Data on the future development of climate change and marine use were collected and refined through close collaboration with over 30 partner institutions and expert workshops.

Another key step was the integration of small-scale temperature projections to simulate shifts in species distribution areas and better assess the impacts on fisheries. These projections were linked with regional and international data sources to provide a realistic picture of future conditions.

This multidisciplinary approach enabled the development of scientifically grounded solutions for adapting fisheries to climate change and optimizing NBS.

Results

Simulations for UK, German, and Norwegian fishing fleets were conducted as part of the *FutureMARES* project, with projections extending to 2060. The focus was on key roundfish species such as cod (*Gadus morhua*), pollack (*Pollachius virens*), and haddock (*Melanogrammus aeglefinus*), which are caught using bottom trawl nets.

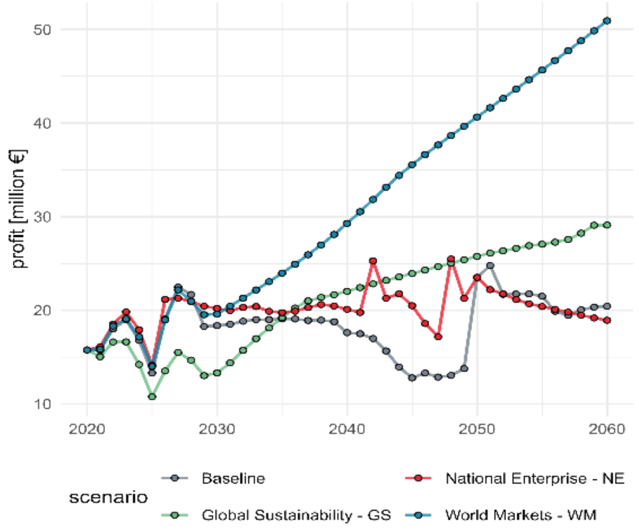

Figure 1: Profitability of all modelled fleets under three climate change scenarios and a baseline scenario. (Source: Thünen Institute / Erik Sulanke, 2024).

The modeling was done under the three aforementioned climate scenarios and a baseline scenario, which represented the status-quo. The results show that price developments and management strategies were decisive factors for fleet profitability. In the WM and GS scenarios, cumulative profits for the fisheries steadily increased, while in the NE scenario, they stagnated and even declined towards the end of the projections (see Fig. 1).
This is mainly due to two reasons: First, rising fuel costs and a lack of investments in energy efficiency significantly reduced the profitability of UK fleets. Second, excessive catch quotas in the NE scenario led to the permanent overfishing of cod stocks, which were on the verge of collapse by the end of the simulation.
Marine Spatial Planning (MSP), including the expansion of marine protected areas and offshore wind farm development, was also considered in the scenarios.

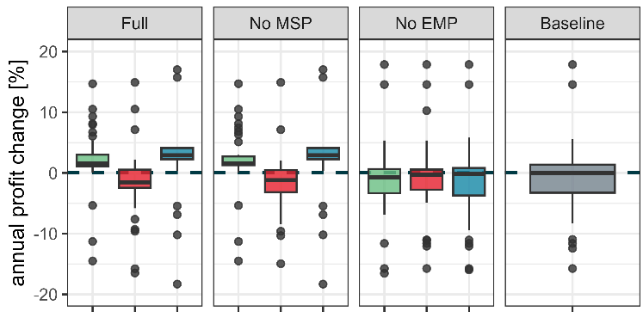

Figure 2: Annual percentage change in profitability of all fleets in 1) full scenarios, 2) without Marine Spatial Planning (No MSP), 3) without price and management projections (No EMP), and 4) in the baseline scenario. (Source: Thünen Institute / Erik Sulanke, 2024).

By the end of the century, a quarter of the North Sea could be covered by wind farms, while EU member states plan to designate 30% of their marine areas as protected zones by 2030. Interestingly, this ambitious spatial development had only minor effects on the profitability of fishing fleets, even in the strictest scenarios like Global Sustainability (see Fig. 2). Even under stringent protection measures, the fleets remained profitable, indicating that fisheries can still operate economically despite increased spatial restrictions from protected areas and offshore energy projects. However, regional differences were apparent, particularly in relation to the location of fishing grounds and fleet cost structures. Shifting fishing efforts helped offset losses in fishing areas. The cost-benefit analyses showed that NBS such as habitat restoration (e.g., oyster reefs) and the establishment of Marine Protected Areas offer economically viable approaches to enhancing the resilience of marine ecosystems. These measures contributed to the preservation and promotion of biodiversity while also supporting the sustainable use of marine resources. Particularly in the GS scenario, these measures brought long-term ecological and economic benefits, while in the WM scenario, the prioritization of short-term profits diminished the ecological gains.

Further Information

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Publications

Sulanke and Simons (2024). The path of the righteous: Economic and spacial response of North Sea demersal fisheries to climate change. Poster. Bremerhaven

Sulanke et al. (2024) Sales, space, sustainability: Predictions of a bio-economic model on climate-induced changes in fisheries profitability and the potential of nature-inclusive harvesting strategies. In prep. Bremerhaven.

Di Cintio et al. (2024) Investigating artisanal fishers' support for MPAs: Evidence from the Tuscan Archipelago (Mediterranean Sea). Mar Policy 167:106260, DOI:10.1016/j.marpol.2024.106260

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