A food web model of the Southern Bight of the North Sea: Historical dynamics (1991–2022) to support ecosystem-based management

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The Southern Bight of the North Sea (SBNS) supports a diverse range of commercial activities and a rapidly growing blue economy. This multi-use exerts multiple pressures on the ecosystem's diversity and functioning. An ecosystem-based management approach, yet to be developed for our study area, can help understand and mitigate the environmental impacts of blue economy activities.

Effective ecosystem-based management requires robust, quantitative tools for assessing the environmental impacts of human activities. Food web models are an integrative tool as they can be used to assess and predict the effects of policy changes on ecosystem dynamics. By quantifying predator-prey interactions among functional groups, food web models estimate ecological indicators to assess ecosystem functioning. Through scenario simulations, the potential consequences of policy measures on these indicators can be quantified, supporting the design of sustainable strategies. As a first step towards ecosystem-based management of the Belgian part of the North Sea, we recently developed a food web model to explore and quantify the effects of prospective policy changes on food web dynamics.

This food web model was constructed using Ecopath with 1991 as a baseline year. The model describes the relationships between 42 functional groups across all trophic levels, ranging from phytoplankton to harbour porpoise, as well as their interactions with commercial and recreational fishing fleets. An initial analysis of the 1991 baseline model, based on the estimation of thirteen ecological indicators and two fisheries indicators, revealed that the SBNS had not fully recovered from historical overfishing at this time.

Based on these results, we now incorporated temporal dynamics (1991 – 2022) to describe how food web dynamics have changed over time. First findings indicate that the mean trophic level of the SBNS community increased (2%), alongside a decrease in both total food web biomass (4%) and total fisheries catch (74%). These changes in ecological and fisheries indicators suggest a small improvement of ecosystem functioning during this period. In addition, calibrating the model to past trends improves predictions towards the future. This is essential for ecosystem-based management, as it will allow scenario testing in the scope of climate change and various policy measures for the multiple stressors acting on the SBNS ecosystem.

We expect this work to be an important step toward the creation of a digital twin for the SBNS and the development of an objective decision-making tool to support the management of blue economy activities in the region.

Keywords
Ecological Modelling; Ecopath with Ecosim; Southern Bight Of The North Sea; Blue Economy; Trophic Interactions