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Changes in the ecosystem structure of the Black Sea under predicted climatological and anthropogenic variations

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A dynamic Ecopath with Ecosim higher-trophic-level (HTL) model representation of the Black Sea ecosystem was coupled to the physical (BIMS-CIR) and biogeochemical (BIMS-ECO) models of the Black Sea in order to investigate historical anthropogenic and climatological interactions and feedbacks in the ecosystem. Further, the coupled models were used to assess the likely consequences of these interactions on the ecosystem's structure and functioning under predicted future climate (IPCC A1B) and fishing variability. Therefore, two model scenarios were used; i) a hindcast scenario (1980-1999) to evaluate and understand the impacts of the short-term climate and physical variability and the introduction of invasive species on the Black Sea ecosystem, and ii) a forecast scenario (2080-2099) to investigate the potential implications of climate change and anthropogenic exploitation on living resources of the Black Sea ecosystem by the end of the 21st century.

According to the outcomes of the hindcast simulation, fisheries were found to be the main driver in determining the structure and functioning of the Black Sea ecosystem under changing environmental conditions. The coupled physical-biogeochemical forecast simulations predicted a slight but statistically significant basin-wide increase in the Black Sea's primary productivity by the end of the century due to increased stratification induced by basin-wide temperature increase and reduced Cold Intermediate Layer (CIL) formation which increased the residence time of riverine nutrients within the euphotic zone. Despite this increased primary productivity, the HTL model forecast simulation predicted a significant decrease in the commercial fish stocks primarily due to fisheries exploitation if current catch rates are maintained into the future. Results further suggested that some economically important small pelagic fish species are likely to disappear from the ecosystem making the recovery of the already-collapsed piscivorous fish stocks increasingly unlikely. In addition, a further reduction in the proportion of piscivorous fish in the fish community was found to be consequent.

From a management perspective, the results of the study suggested that along with managing fishing exploitation levels of the target stocks, monitoring and management of other species in the ecosystem that are tightly coupled with the fish species in terms of food web interactions were found to be the most effective way of applying an ecosystem-based management strategy in the Black Sea. Such an approach will ensure the sustainable utilisation of the fish stocks of the Black Sea by maintaining the ecological integrity of the Black Sea marine food web.