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TITLE: Quantifying heterogeneous responses of fish community size structure using novel combined statistical techniques

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ABSTRACT:

Abstract To understand changes in ecosystems, the appropriate scale at which to study them must be determined. Large marine ecosystems (LME s) cover thousands of square kilometres and are a useful classification scheme for ecosystem monitoring and assessment. However, averaging across LME s may obscure intricate dynamics within. The purpose of this study is to mathematically determine local and regional patterns of ecological change within an LME using empirical orthogonal functions (EOF s). After using EOF s to define regions with distinct patterns of change, a statistical model originating from control theory is applied (Nonlinear AutoRegressive Moving Average with eX ogenous input ? NARMAX) to assess potential drivers of change within these regions. We have selected spatial data sets (0.5° latitude × 1°longitude) of fish abundance from North Sea fisheries research surveys (spanning 1980?2008) as well as of temperature, oxygen, net primary production and a fishing pressure proxy, to which we apply the EOF and NARMAX methods. Two regions showed significant changes since 1980: the central North Sea displayed a decrease in community size structure which the NARMAX model suggested was linked to changes in fishing; and the Norwegian trench region displayed an increase in community size structure which, as indicated by NARMAX results, was primarily linked to changes in sea?bottom temperature. These regions were compared to an area of no change along the eastern Scottish coast where the model determined the community size structure was most strongly associated to net primary production. This study highlights the multifaceted effects of environmental change and fishing pressures in different regions of the North Sea. Furthermore, by highlighting this spatial heterogeneity in community size structure change, important local spatial dynamics are often overlooked when the North Sea is considered as a broad?scale, homogeneous ecosystem (as normally is the case within the political Marine Strategy Framework Directive).

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