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TITLE: An integrated approach for assessing the relative significance of human pressures and environmental forcing on the status of Large Marine Ecosystems

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ABSTRACT:

An ecosystem approach to the management of the marine environment has received considerable attention over recent years. However, there are few examples which demonstrate its practical implementation. Much of this relates to the history of existing marine monitoring and assessment programmes which (for many countries) are sectoral, making it difficult to integrate monitoring data and knowledge across programmes at the operational level. To address this, a scientific expert group, under the auspices of the International Council for the Exploration of the Sea (ICES), prepared a plan for how ICES could contribute to the development of an Integrated Ecosystem Assessment (IEA) for the North Sea by undertaking a pilot study utilising marine monitoring data. This paper presents the main findings arising from the expert group and in particular it sets out one possible integrated approach for assessing the relative significance of environmental forcing and fishing pressure on the ecological status of the North Sea, it then compares the findings with assessments made of other Large Marine Ecosystems (LMEs). We define the North Sea ecosystem on the basis of 114 state and pressure variables resolved as annual averages between 1983 and 2003 and at the spatial scale of ICES rectangles. The paper presents results of integrated time-series and spatial analysis which identifies and explains significant spatial and temporal gradients in the data. For example, a significant shift in the status of the North Sea ecosystem (based upon 114 state-pressure variables) is identified to have occurred around 1993. This corresponds to previously documented shifts in the environmental conditions (particularly sea surface temperature) and changes in the distribution of key species of plankton (*Calanus* sp.), both reported to have occurred in 1989. The difference in specific timing between reported regime shifts for the North Sea may be explained, in part, by time-lag dependencies in the trophic structure of the ecosystem with shifts in higher trophic levels occurring later than 1989. By examining the connection (or relatedness) between ecosystem components (e.g. environment, plankton, fish, fishery and seabirds) for the identified regime states (1983?1993; 1993?2003) we conclude that both the North Sea pelagic and benthic parts of the ecosystem were predominantly top-down (fishery) controlled between 1983 and 1993, whereas between 1993 and 2003 the pelagic stocks shifted to a state responding mainly to bottom-up (environment) influences. However, for the demersal fish stocks between 1993 and 2003 top-down (fishery) pressure dominated even though over this period significant reductions in fishing pressure occurred. The present analysis, therefore, provides further evidence in support of the need for precautionary management measures taken in relation to setting fishery quotas.

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