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### **Ecosystem variability: preparing an integrated assessment of the North Sea.**

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An understanding of the causes of variability (or state change) in marine ecosystems is fundamental for developing effective management approaches. It is central to the implementation of the ecosystem approach and in meeting numerous policy objectives (e.g. the European Commission's Marine Strategy Framework Directive, MSFD, to deliver Good Environmental Status) What is less well defined is how much understanding is enough to ensure the development of effective environmental policies and management practices? This is largely a question related to knowledge transfer, maximising the value of what we know and what we hold in the form of empirical data, and presenting the results in a manner that is helpful for those making management decisions.

In the late 1990's ICES recognised these challenges and initiated a process which is still active today in developing regional integrated ecosystem assessment approaches as part of its Regional Seas Programme. The activities are presently divided between two different approaches, namely: i. data driven, and ii. management driven. The difference essentially being, data driven approaches focus on assessing patterns of ecosystem variability which are then used to identify the key causes of change at a range of spatial and temporal scales; whereas management driven approaches, through existing knowledge of human activities and their impacts on the marine ecosystem, focus on identifying the key causes of change from the outset. In an ideal world, where there is effective transfer of knowledge from the empirical data to the identification of the key causes of ecosystem change, the outcome of the two approaches should be the same.

What we have learnt from a data driven approach is that change in the North Sea (as it is for all ecosystems) is the norm. The North Sea exhibits cyclical trends in state across all trophic levels, but at any given time not all components vary with the same rate, magnitude or direction of change. Describing and understanding such differences, in particular their dependencies, has resulted in a much greater appreciation of the importance in understanding and in defining a hierarchy of ecosystem variability at a range of space- and time-scales. In essence, what is emerging is an ordered picture of component trends within trends making up the whole ecosystem, some of which we are able to control directly (e.g. fishing effort), but others we are not (e.g. primary and secondary production). This ordered picture of variation should help to prioritise the identification of the causes of change as part of the management driven approach and to ensure the most appropriate management actions are therefore taken.

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