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# Reflections on the Large Marine Ecosystems movement

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ABSTRACT

In this commentary I reflect on the origin and unique approach for blending good natural and social sciences into a unified strategy for assessing and managing Large Marine Ecosystems around the globe.



## 1. Introduction

For me it is great pleasure and honour to provide some reflections on the Large Marine Ecosystem approach to marine resources science and management. There is ample material to discuss. I will, however, take the prosaic style of an old professor and start with a brief historical introduction, and then talk about the invention of the LME as an assessment and management unit. From there I go to the five modules of indicators of the state of the LME and their implementation in LME projects. The importance of the LME approach for management and development is dealt with by very competent authors of the papers in this theme volume of *Environmental Development*, "Ecosystem Based Management of Large Marine Ecosystems." I will just mention the potential role of the LME approach for marine science and for professional capacity building. In closing I will praise the LME movement, taking the Benguela LME as a wonderful example.

## 2. Historical introduction

### 2.1. The FAO assessment

How much fish can we get out of the sea? In certain regions and globally? In 1966 the FAO started an assessment of the fisheries resources of the World Ocean largely in search for new resources for the expanding industrial fisheries. The geographical breakdown into 14 large areas of ocean margins plus one unit each for the Open Ocean and the Antarctic waters followed the geographical structure of FAO fishery statistics without oceanographic or ecological considerations. The assessments were based on existing information of the resources themselves and on the geographic features of the different regions, their primary and secondary production as well as abundance of plankton and benthos. The 1972 FAO assessment, published by Gulland led to two very optimistic conclusions:

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(1) the present catches could be about doubled from the familiar types of demersal and pelagic fish;
(2) very much greater catches could be taken by harvesting the smaller and less familiar animals such as lantern fish and krill (Gulland, 1972).

### 2.2. Georges Bank and North Sea regional assessments

In parallel to FAO's global assessment, some in-depth studies of well defined upwelling and shelf regions provided insights into the complexity of marine ecosystems and their variability in fish production. Two outstanding series of studies referred to the U.S. Northeast coast shelves and the North Sea.

Already in the 1970s, monitoring of the Georges Bank and other parts of the U.S. NE shelf demonstrated complex shifts in composition and abundance of the fish populations and in zooplankton, presumably due to fisheries and to variations in the oceanographic regime.

Since the creation of ICES in 1901 the individual fish stocks of the North Sea were intensively studied in relation to overfishing and to environmental conditions, but rather little attention was given to species interaction.

In the 1960s something surprising happened – in spite of continued heavy fishing the stocks of North Sea gadoid fishes increased greatly. Was this due to major environmental changes or to indirect effects of fisheries heavily depleting herring and mackerel as key predators of larval and juvenile gadoids. The 1975 Symposium of ICES "North Sea Fish stocks – Recent changes and their causes" was one of the first describing and interpreting the changes in the demersal and pelagic fish populations of a Large Marine Ecosystem. The term ecosystem overfishing was born, stating that fishing on one stock indirectly influences the stocks of other species by changing their biotic environment through reduction of predators and competitors, or food supply at the various stages of their life history (Hempel, 1978). The concept was supported by the multi-species model of Andersen and Ursin (1977). Fisheries were taken as the main driving force for changes in fish stocks and in the ecosystem as a whole.

Since those days we have witnessed a considerable paradigm change in fisheries science from a predominantly single-species approach modelled on temperate industrial fisheries towards ecosystem-based approaches to fisheries which additionally are seeking to integrate progressively the social and economic dimensions to fulfil sustainability requirements (Nauen and Hempel, 2011).

### 2.3. The invention of the Large Marine Ecosystem (LME)

Based on his work in Georges Bank fisheries and plankton and on the general discussions in ICES, Kenneth Sherman developed the concept of Large Marine Ecosystems (LMEs) for resource management in multispecies fisheries. AAAS adopted the baby and ran three special symposia on it in 1980s (1984, 1987, 1988), and a fourth in 1990.

The 1984 definition of LME reads: the LMEs are defined as regions with unique hydrographic regimes, submarine topography, and trophically linked populations. They were described as natural units of ocean space (200.000 square-kilometres or larger) encompassing areas from river basins and estuaries seaward to the margins of the continental shelves and coastal current systems. They are characterized by distinct bathymetry, hydrography, productivity, and trophically dependent populations (Sherman, 1986). Most of them border more than one national state and are stressed by human action like fisheries, pollution, eutrophication and habitat destruction. In the course of the years the coasts of the World Ocean were divided into 66 LMEs.

Early it had been realized, that management of fisheries resources is not a matter for fisheries biologists and marine ecologists alone but has to take into account economics, social factors, public awareness, and politics, including users other than fisheries. Integrated coastal zone management (ICZM) was in the minds of the promoters of the LME concept well before it became an international buzz word. UNCED in Rio de Janeiro, 1992 provided the global forum for the recognition of the marine environment and its production capacity as life support. There had been close links and feed backs between the further development of the LME concept and the draughting of Agenda 21. The dialogue among natural scientists, economists and politicians in the development of integrated management schemes goes far beyond the regulation of individual fisheries.

### 2.4. The five modules of indicators

Much information is needed to assess and to manage the exploitation of the living resources of a given LME and to restore and safeguard its ecosystem.

The LME approach comprises five modules of indicators on changes in (i) productivity, (ii) fish and fisheries, (iii) pollution and ecosystem health, (iv) socioeconomics, and (v) governance to support management practices. No need for me to deal with them, but just to refer to a 2014 review by Sherman in *Environmental Development* (Sherman, 2014).

### 2.5. The LME projects implementing the five modules

Originally the LME concept was conceived as a tool for improved management of the coastal waters along the U.S. east coast. During the 1988 AAAS meeting we felt that it was time to export the LME approach to other parts of the globe. Since