KNOWLEDGE FROM THE BLACK SEA: A ROLE MODEL FOR ECOSYSTEM MANAGEMENT

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Abstract
There has been substantial accumulation, particularly during the last two decades, of accessible information about the Black Sea ecosystem. Major natural and anthropogenic factors (i.e. pollution, eutrophication, overfishing, invasive species, climatic changes) have all been shown to have impact on the overall ecosystem dynamics of the Black Sea, often collectively. Successful models encompassing all these factors simultaneously are needed as an indispensable tool in overall ecosystem based management in the Black Sea. The information gathered on the abrupt ecosystem changes seen in the Black Sea could be invaluable in solving the similar problems of other ecosystems.
Keywords : Black Sea, Global Change, Species Introduction, Fisheries, Models.

With its specific limited characteristics such as (a) biodiversity and relatively short food chains, (b) exchange of water with world oceans, and (c) benthic pelagic coupling, the Black Sea ecosystem could serve as a large laboratory, with strong reactions to tested parameters due to its high productivity. The major threats for pelagic marine ecosystems are (1) pollution and eutrophication, (2) overfishing, (3) human-accelerated climate change, and (4) invasive species. Almost all these threats have been shown to have had impacts on all main components of the Black Sea ecosystem. This is not surprising as can often these factors closely affect each other and any affected component would cause a domino effect through top-down or bottom-up control mechanisms. The role of these factors or components mainly affected may change spatially or temporally.

Trends in the catch of small pelagics reveal much about how these factors and mechanisms affect the Black Sea. The catch of small pelagics in the entire basin, and of anchovy from the southern Black Sea in particular, rose from the 1960s till 1988. The steady increase observed regarding the anchovy catch of the Turkish fishery (that is confined to the southern Black Sea) is not solely due to the use of modern fishing gear, but also to increased fertility (i.e. mesotrophic) of this region and a decrease in predation pressure [1]. Increases in small pelagics for most of the other regions of the Black Sea were only evident until the 1980s when the eutrophication and pollution levels along with accelerated habitat destruction were reported to be strongest for the shallow northwestern shelf regions. The impact from climate change in this period seems low when the system was warm (causing decreased fertility due to limited vertical transport of nutrients) and relatively stable. During the period between 1988 and 1992 the sudden collapse of small pelagics along with zooplankton for all regions of the Black Sea occurred, undoubtedly caused by the invasive ctenophore *Mnemiopsis leidyi*, a voracious mesozooplankton and ichthyoplankton predator. However, the sudden explosion of this ctenophore, which reproduces at higher temperatures, must be closely correlated with the temperature increase in the late 1980s, following one of the coldest periods in the early 1980s in the Black Sea. It should be noted that an overall high productivity level of the basin is the main prerequisite for the success of this ctenophore, which poses no threat to oligotrophic regions. The sharp decrease in temperature during the early 1990s was beneficial for the small pelagics, through (a) increasing the overall productivity due to vertical mixing and (b) decreasing levels of the competing *Mnemiopsis*. During the warming period of the mid 1990s, *Mnemiopsis* peaked again, causing sharp decreases in zooplankton and fish but high chlorophyll levels (due to decreased grazing). Field observations and modeling studies unquestionably underline the key importance of this ctenophore in the ecosystem dynamics [2,3,4]. The appearance of another invasive ctenophore *Beroe* which feeds exclusively on *Mnemiopsis* has resulted in a much lowered preassure on fisheries (and ecosystem) from the latter during the last decade, emphasising the importance of top-down control in the food web of the Black Sea [3]. Based on observations from the Black Sea, timely warnings and mitigations have already been put forward for similar ecosystems (i.e. Caspian Sea, Baltic Sea etc) which are also suffering from the invasion of *Mnemiopsis.*

Trophic models encompassing the major components of the Black Sea ecosystem have been refined during the last decade [4,5]. Future models would benefit from integrating the rates of changes in all major threats to the ecosystem, the main ecosystem components, along with detailed fisheries parameters. The accumulated knowledge gathered from the Black Sea may facilitate the application of such a holistic ecosystem approach towards better management of its resources.

References

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