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Recent changes in the marine ecosystems of the northern Adriatic Sea

Michele Giani [a,*], Tamara Djakovac [b], Danilo Degobbis [b], Stefano Cozzi [c], Cosimo Solidoro [a], Serena Fonda Umani [d]

[a] Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, via A. Piccard 54, 34014 Trieste, Italy
[b] Center for Marine Research, Rudjer Boskovic Institute (CMR), Rovinj, Croatia
[c] Istituto di Scienze Marine, CNR, Trieste, Italy
[d] Dipartimento di Scienze della Vita, Università di Trieste, Trieste, Italy

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ABSTRACT

This review of studies on long term series on river discharges, oceanographic features, plankton, fish and benthic compartments, collected since the 1970s revealed significant changes of mechanisms and trophic structures in the northern Adriatic ecosystems. A gradual increase of eutrophication pressure occurred during the 1970s until the mid 1980s, followed by a reversal of the trend, particularly marked in the 2000s. This trend was ascribed to the combination of a reduction of the anthropogenic impact, mainly due to a substantial decrease of the phosphorus loads, and of climatic modifications, resulting in a decline of atmospheric precipitations and, consequently, of the runoff in the northern Adriatic Sea. Significant decreases of the phytoplankton abundances were observed after the mid 1980s, concurrently with changes in the species composition of the communities, with an evident shift toward smaller cells or organism sizes. Moreover, changes in the zooplankton community were also observed. A decrease of demersal fishes, top predators and small pelagic fishes was ascribed to both overfishing and a demise of eutrophication.

Macrozoobenthic communities slowly recovered in the last two decades after the anoxia events of the 1970s and 1980s.

An increasing number of non-autochthonous species has been recorded in the last decades moreover the increasing seawater temperature facilitated the spreading of thermophilic species.

1. Introduction

The northern Adriatic Sea (NAd) is the shallowest (<60 m), land locked, northernmost region of the Mediterranean (Fig. 1).

The general circulation of NAd is driven by the combination of wind stress, river runoff and surface buoyancy fluxes, exchange at the southern boundary, and physiographic constraints. The Po and other river discharges originate a southward, intense, coastal current along the western coast (Western Adriatic Current, WAC), which fuels and sustains a cyclonic circulation, while on the eastern side of the basin, the weak, warm and salty Eastern Adriatic Current (EAC) flows along the eastern coast. At depth, a colder and denser water mass moves southwards. A bathymetric controlled transverse current along the 50 m isobath, re-circulate the EAC into the WAC (Poulain et al., 2001).

In this region, water column stratification, caused by freshwater buoyancy and heating of the sea surface, occurs from spring to mid autumn, whereas in winter cooling and cold north-easterly wind cause intense mixing and the formation of dense waters. The impact of nutrient loads from Italian rivers is more marked along the western and northern coastal areas, extending in period of water column stratification over larger areas (e.g. Degobbis et al., 2000; Cozzi and Giani, 2011). These processes together with remineralization sustain a high primary production. In contrast, in the eastern more oligotrophic NAd, less influenced by river discharges, remineralization processes are more relevant than external nutrient inputs.

Combined effects of the anthropogenic impact and regional climate changes are causing modifications of the physical and chemical oceanographic characteristics of the NAd, influencing its biota. These modifications are documented by a growing amount of data, so that their re-analysis is important to better clarify the current state of this marine ecosystem and to address future research.

In this paper the main changes observed during the last four decades in the NAd ecosystem are summarized, based on results of this Special Issue on “Fluctuations and trends in the northern

* Corresponding author.
E-mail address: mgiani@inogs.it (M. Giani).

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