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## COMMENT

# The Mediterranean: marine protected areas and the recovery of a large marine ecosystem

In the Mediterranean, fishing is an ancient tradition and signs of its presence can be found everywhere along its coasts. In early times, most fishing was carried out from land with small nets and traps and only a portion of the fishing operations was carried out from boats away from the coast. Over time, growth of human populations along the Mediterranean coasts led to the expansion of sea fishing and gradual depletion of many near-shore stocks. Until recently, fishing in the Mediterranean retained its artisanal character. The type of small vessels, the fishing gears and labour-intensive character of the operations had changed little from generation to generation. However, some fishing practices benefited greatly from the advent of new technologies, such as those that replaced sails by powered engines, or the incorporation of fish-finding devices and efficient gear-handling techniques. These developments added to a growing market demand from the booming Mediterranean population, and led to overfishing of the most vulnerable target populations.

Marine research *sensu stricto* and management of Mediterranean fisheries are of recent origin. There were some early descriptions of ecological phenomena, many of which were related to fisheries (e.g. Aristotle 384–322 BC, pp. 1848–74; Farrugio *et al.* 1993), but only with the establishment of numerous research stations along the Mediterranean coasts from the late nineteenth century onwards did Mediterranean oceanographic and coastal research commence. Studies related to fisheries and detailed descriptions of the morphologies and life cycles of many Mediterranean species followed (Margalef 1985).

In those years, there was little concern about possible detrimental effects of fishing on the diverse fauna and flora of the Mediterranean or depletion of the traditional fishing grounds. However, as in many other fisheries of the world, during the twentieth century, catch per unit effort tended gradually to decline, while total effective effort grew apace (Grainger & García 1996). Yet the pattern of exploitation and its effects have not been uniform across all stocks. Pressure has certainly increased on many demersal stocks, for example where juveniles occur in the inshore waters on which most fishing is focused. In contrast, some fisheries have shown a surprising resilience to exploitation that is believed to be associated with a 'refuge effect' operating on segments of the parental stocks which inhabit areas beyond the traditional fishing grounds (Farrugio *et al.* 1993; Caddy 1999). The Mediterranean production of a number of species groups has in fact continued to increase, and this has probably been abetted by higher inputs of nutrients from the river runoff of continental Europe (e.g. FAO 1997). The species affected are mostly planktivores and detritus feeders, while the effects of overfishing have been felt most clearly on populations of benthic, high-value or slow-growing species, such as lobsters (*Palinurus elephas*) and red coral (*Corallium rubrum*) (FAO 1997). Yet professional fishing is not the sole agent of over-exploitation of Mediterranean species; sport fishing, mainly with spears and rods, has a substantial impact especially on the largest and less abundant species such as groupers and croakers. The concentration of multiple fishing activities in the narrow Mediterranean continental shelves has also contributed to the degradation of productive and sensitive habitats such as seagrass meadows that are thought to play important physical and biological roles. Managers in the countries of the Mediterranean basin have reacted to these threats by implementing a suite of control measures including the total ban of some fishing gears such as drift-nets, the exclusion from sensitive areas of certain fishing methods (e.g. trawling within the 50 m isobath), and the deployment of anti-trawling artificial reefs or creation of marine protected areas (MPAs). By 1999, some 68 MPAs had been created in the Mediterranean, of which 47 were in Spain, France and Italy (Boudouresque 2000).

While the idea of conserving or replenishing exploited species probably underlies the creation of many of the Mediterranean MPAs, a number of other objectives exist, ranging from the protection of sensitive habitats of endangered species (e.g. the Sporades National Park of the eastern Mediterranean, for the monk seal [*Monachus monachus*]), to the protection of singular assemblages

(e.g. the coralligenous community of the Columbretes Islands Marine Reserve, western Mediterranean), and to conserve or restore relatively pristine habitats. In general, spear fishing and many forms of professional fishing are banned in these MPAs, while artisanal activities and some forms of sport fishing may be allowed in others.

In the western Mediterranean, scientific interest in how populations respond to the cessation of fishing in MPAs got under way in the 1980s, primarily in response to the opportunities created by the establishment of the first MPAs, in France in the mid-1970s, and in Spain and Italy in the early 1980s. Research in MPAs has focused on rocky-littoral fish communities, although some studies have centred on seagrass fish communities and on some invertebrate populations. The results of these studies have concurred with those obtained in other marine regions in that the abundance of previously-exploited, large sedentary species increases rapidly when fishing ceases. For mobile species, many of which are important in fisheries, the results are bound not to be as clear-cut, but from work in Cyprus, there is strong evidence that large-scale reduction in fishing effort (in this case through seasonal closure to trawling) can reverse a downward trend in yield (García & Demetropoulos 1986). In spite of the promise of MPAs for recovery of fishery-target species, many important questions remain. Are the small existing MPAs contributing to increased recruitment of the species that are locally protected within them? Are these MPAs replenishing populations beyond their boundaries? As abundances change, are density-dependent processes reducing or enhancing these replenishment opportunities? What are the indirect effects of protecting certain species on non-target organisms or on the overall structure of the littoral communities, and what are the consequences of any such changes? How does structural heterogeneity of the habitat influence the abundance and distribution of littoral fish populations and our ability to evaluate changes in them?

From the human point of view, the establishment of MPAs can be expected to have both positive and negative effects. Those who are evicted from the natural areas, which they have used in many cases for generations, stand to lose, while those who successfully exploit the non-extractive values of protected areas, mainly through tourism, will surely gain. What are the effects of MPAs on the socio-economic fabric of coastal communities? How much are the losers losing and the winners winning? Could the interests of these two groups be made to coincide? Where there is resistance to the concept of MPAs, can the acceptability of MPAs be enhanced amongst local communities and, if so, how?

Many of these questions have scarcely been addressed in relation to MPAs anywhere, let alone in the Mediterranean. Five papers in this issue of *Environmental Conservation* (Badalamenti *et al.* 2000; García Charton *et al.* 2000; Pinnegar *et al.* 2000; Planes *et al.* 2000; Sánchez Lizaso *et al.* 2000) represent a comprehensive effort as part of a project entitled ECOMARE which was funded by the European Union to review understanding of the full ecological impacts and social-economic implications of MPAs. An ultimate overall question is as to whether long-term declines can be reversed. At large scale and in general, the answer must surely be 'yes', but regrettably the large-scale options, such as protection of the whole Sea, or of entire component basins, will remain purely hypothetical. The question then is as to whether management measures at small scale can significantly serve the purpose of reversing Mediterranean degradation. The reviews published in this issue typically highlight the thin scientific basis for predicting the consequences of halting fishery exploitation; part of their purpose was to highlight researchable topics. However, the small MPAs that have thus far been effectively closed to fishing represent potential points of departure in the quest for the means of rehabilitation. They offer glimpses of how parts at least of this 'large marine ecosystem' might respond, and maybe given time recover, where they have been degraded. If, as Margalef (1985) supposed, the Mediterranean can usefully be viewed as a 'small scale model of a real ocean' in terms of its conservation as well as its oceanography, then such work may yet produce messages of importance to the wider world.

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