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Revenga S., Badalamenti F.

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Management of Marine Protected Areas for fisheries in the Mediterranean

S. Revenga* and F. Badalamenti**
*Ministerio de Agricultura, Pesca y Alimentación (MAPA), Secretaría General de Pesca Marítima (SGPM), D.G. Recursos Pesqueros, c/ Jose Ortega y Gasset, 57, 28006 Madrid, Spain
**CNR-IAMC, Laboratorio Di Ecologia Marina, Via G. Da Verrazzano, 17
91014 Castellammare Del Golfo (Tp), Italy

SUMMARY – Marine Protected Areas (MPAs) have been established for several decades in the Mediterranean. Most of them focus on nature conservation and incomes derive mainly from tourism. However, there is growing interest in the use of MPAs as fishery management tools. With this in mind more empirical data, gathered with appropriate sampling design, are needed to test the effectiveness of MPAs for fishery purposes. Spain is a pioneer country in establishing MPAs in the Mediterranean and a number of protected areas have been specifically established for fisheries. A synthesis of the main results achieved for these Spanish MPAs is provided.

Keywords: Marine Protected Areas, fishery, Mediterranean Sea, sampling design.

RESUME *– "Gestion d'aires marines protégées pour la pêche en Méditerranée". Des aires marines protégées (AMP) ont été implantées depuis déjà plusieurs décennies en Méditerranée. La plupart d'entre elles sont axées sur la conservation de la nature, et le tourisme constitue une part principale de leurs recettes. Toutefois, il existe un intérêt croissant quant à l'utilisation des AMP en tant qu'outils de gestion des pêches. Dans ce but, il sera nécessaire d'obtenir davantage de données empiriques, collectées selon un dispositif d'échantillonnage approprié, afin de tester l'efficacité des AMP à des fins halieutiques. L'Espagne est un pays pionnier en matière d'implantation d'AMP en Méditerranée, ayant déjà établi un certain nombre de zones protégées spécifiquement à des fins halieutiques. Cet article présente une synthèse des principaux résultats obtenus par ces AMP espagnoles.*

Mots-clés : *Aires marines protégées, pêche, mer Méditerranée, dispositif d'échantillonnage.*

Introduction

The number of Marine Protected Areas (MPAs) established and/or planned worldwide has grown dramatically in recent years (Guidetti, 2006). The Mediterranean Sea has followed this pattern, from about 40 MPAs at the end of the nineties (Badalamenti *et al*., 2000) to roughly 100 at present (Badalamenti unpublished data). The dual role played by MPAs in conservation and fishery management may explain this success. Protection of marine areas, in the Mediterranean and elsewhere, is no longer seen only as an instrument of nature conservation but as a useful tool against declining coastal fish resources as well as attracting tourists (Badalamenti *et al.,* 2000; Claudet *et al*., 2006). As a consequence, the number of studies dealing with the use and functioning of MPAs as fisheries management tools has increased (Harmelin, 2000; Pipitone *et al*., 2000; Badalamenti *et al*., 2002; Shipp, 2003; Pelletier and Mahevas, 2005) but remain few. Most published on the functioning of MPAs deal with theoretical models and very few report empirical data demonstrating the effects of the MPAs and/or corroborating the models (Willis *et al*., 2003).

While it is easy to acknowledge the role of MPAs for nature conservation (Agardy, 1994, Leslie, 2005) their function as a tool for fishery management remains controversial (Gårdmark *et al*., 2006). For example, MPAs have a biased effect on different species in a community (Botsford *et al*., 2001, Botsford *et al*., 2003) because they better protect species with shorter dispersal distances, which are more likely to stay within the reserve boundaries (Polunin, 2002). They may increase the practice of "fishing the line" (i.e. the concentration of fishing effort at the boundary of a marine reserve upon the principle of spillover, the net export of stock from the marine reserve to the surrounding unprotected waters) (Kellner *et al*., 2007) and they may increase poaching (Polunin, 2002). Despite these potential

negative or no effects, MPAs are largely acknowledged to be useful for the following: managing fisheries and in particular rebuilding over-fished or collapsed demersal stocks, preventing the effects of recruitment overfishing, exporting biomass (spillover) of adult and larvae to adjacent areas, protecting nursery and spawning areas (Bohnsack, 1998; Lauck *et al*., 1998; Gell and Roberts, 2003). Undoubtedly, once an MPA is established it contributes to the increase in overall biomass and to that of large-sized individuals inside the protected areas (Johnson *et al*., 1999; Pipitone *et al*., 2000; Halpern, 2003; Alcala *et al*., 2005; Smith *et al*., 2006). What is less clear is whether, how and to what extent such an increase benefits the surrounding areas and, ultimately, fisheries (Kellner *et al*., 2007; Stelzenmüller *et al*., 2007). Although the theoretical bases have been discussed in several papers (Chapman and Kramer, 1999; Sánchez Lizaso *et al*., 2000), an export of biomass and or an increase in total catch following reserve establishment has been documented only rarely. This is the case for a lobster population at the Columbretes Islands Marine Reserve (Goñi *et al*., 2006), the scallop fishery at Georges Bank (Murawski *et al*., 2000) and in a contested report (Hilborn, 2002) by Roberts *et al*. (2001) on a Caribbean reef fishery.

The state of the art in Europe

The case for European Mediterranean MPAs is particular. Despite the declared interest for fisheries the MPAs are all small (usually <10 km^2), mostly located around or adjacent to islands or promontories on shallow rocky habitat and are generally managed with a small no-take zone surrounded by a partial-take zone (Badalamenti *et al*., 2000). MPA incomes are often linked to tourism/diving activities rather than fisheries and are managed more for nature conservation purposes than for fisheries (Badalamenti *et al*., 2000). Indeed, commercial fishing is restricted to some types of fishing gear and fishing boats that are typical of artisanal fisheries: trammel nets, gillnets or longlines (Colloca *et al*., 2004). A good example comes from Spain, where 7 MPAs have been specifically established for fisheries together with a vast fishing box around the Island of Alboran in the last 20 years. Other European non Mediterranean MPAs (e.g. those in the North Sea) are well distinguishable from those of the Mediterranean in being larger, generally on soft bottom habitats and with management that is fishery-orientated with semi industrial or industrial commercial fleets.

In this respect, the no-trawl zones established in Italy and Greece in the nineties represent an exception in the Mediterranean panorama. These are large areas characterized by soft bottom habitats generally encompassing the whole continental shelf where trawling is banned all year round. Unfortunately, very few data are available for these MPAs, namely those from the 200 km^2 ban on commercial trawlers in the Gulf of Castellammare (Northen Sicily, Italy), where an 8-fold increase in fish biomass (from spring surveys) was reported (Pipitone *et al*., 2000) as a consequence of the ban. In this gulf fishing is permitted for the c.a. 100 boats employing mainly selective gears such as trammel nets and set gillnets and for recreational vessels. Both fishing activities extend over the whole continental shelf of the Gulf and the artisanal fisheries have largely benefited from the new biomass inside the Gulf (Whitmarsh *et al*., 2002; 2003). No data are available on biomass export.

Marine protected areas for fisheries in Spain

Spain is a practical case with a 20 year history and 7 marine reserves for fisheries already established in the Mediterranean, with protected areas covering 31,600 ha, besides the fishing box around the Island of Alboran that covers a surface area of 425,645 ha.

The 7 Spanish Protected Areas for Fisheries in the Mediterranean are a clear sign of support for the protection of marine areas in Spain and for the protection and management of areas of interest for small-scale or artisanal fishing fleets through strict surveillance measures and dialogue with stakeholders, mainly professional fishermen and recreational divers.

This experience, that can be considered a pioneer experience in the Mediterranean, is marked by the following characteristics:

(i) These marine protected areas for fisheries were requested by the artisanal fishing sector.

(ii) They are aimed at the regeneration of fishery resources with the purpose of conserving sustainable artisanal fisheries.

(iii) Three are exclusively coastal (Masía Blanca, Cabo de Gata-Níjar and Cala Ratjada), 3 surround islands or archipelagos (Columbretes Islands, Island of Alborán and Island of Tabarca) and 1 is of a mixed type, as it includes both coastline and islets (Cabo de Palos-Islas Hormigas).

(iv) For the regeneration of coastal fishery resources the following species have proven to be useful measures: grouper, red mullet, brown meagre, cuttlefish, lobster, Mediterranean locust lobster, among others.

(v) The reserve effect leads to increases observed in stocks, in sizes and in catches in the surrounding areas.

(vi) Within the protected areas and outside the no-take zones artisanal fishing is practised by the habitual fishermen using traditional fishing gear, and should be included in the specific fishery census that is conducted for each protected area for which *numerus clausus* have been established.

(vii) Angling is prohibited in most of the protected areas, and of course submarine fishing is never authorised.

(viii) In the protected marine areas, the sea bottom is characterised by a good state of conservation with an abundance of marine phanerogams, laminaria, macroalgae meadows, pre-coral and coral bottoms, gorgonia fields, rocky bottoms and walls.

(ix) Monitoring work shows the conservation of, and even a clear increase in the biodiversity values: the number of unique species of environmental quality such as *Pinna nobilis*, macrocrustaceans such as the lobster and the Mediterranean locust lobster as well as top predators like the grouper.

(x) The marine protected areas have also shown to be permanent laboratories for operational oceanography: they provide continuous data on the fauna, flora and the environment: temperatures, sea level, nutrients, etc.

(xi) These results are based on considerable economic effort, reaching an annual mean expenditure of 300,000 euros per protected area spent on: surveillance, monitoring, and education and awareness-building.

Furthermore, the marine protected areas for fishing also provide an example of "governance" since they have arisen from obliged cooperation between administrations (State, Autonomous Communities, City Councils) and sectors (professional fishing world, recreational and scientific diving, and civil society).

At present, and after more than 20 years of experience in Spain, the "Guidelines for the establishment of the Natura 2000 network in the marine environment. Application of the habitats and birds guidelines", drawn up by the Commission in May 2007, are particularly pertinent: the fishery protection actions taken, such as marine protected areas and artificial reefs, are clear examples of very effective instruments in protecting marine areas.

Likewise, although focused on coastal areas or surrounding islands, they may serve as background and guide so that in the very near future work can be done towards the protection of areas further away from the coast, to preserve unique marine ecosystems in territorial waters or, as in our case, the Mediterranean basin.

Finally, it is no coincidence that the marine protected areas for fisheries have led to the conservation of the ecosystems that they host and continue to do so. Therefore, of the 7 Marine Reserves of the Mediterranean, 6 are to be found in areas designated SCI (Sites of Community Importance) but by all means can be considered already as SAC (Special Areas of Conservation), as all of them have management plans that implement surveillance, monitoring, etc., and 4 are included in SPAMI (Specially Protected Areas of Mediterranean Importance).

Conclusions

While there are some differences in the management objectives of MPAs in Europe, they are

commonly seen as an instrument for improving both fishery management and marine environmental protection. However, in most cases the real effectiveness of MPAs seems to be limited to nature conservation and the increase in biomass and individual fish size inside protected areas. It is not always easy to distinguish what is due to natural variation and what to protection; there is a lack of empirical studies, which have largely been outnumbered by theoretical studies and reviews (Willis *et al*., 2003). Proper experimental designs encompassing, for example, "before" and "after" data and paired or multiple MPAs and controls are a prerequisite to obtain unconfounded results and empirically test the various theories about MPA functioning. Moreover, there are several scientific gaps in our knowledge of the ecology of MPAs. Sale *et al*. (2005) identified five crucial gaps in the ecological science of no-take reserves:

(i) The distance and direction to which marine larvae disperse from the protected areas.

(ii) The pattern of movement during juvenile and adult phases of fish.

(iii) Knowledge of the behaviour of water masses in the vicinity of complex coastlines.

(iv) Knowledge of ecosystem impacts of fishing.

(v) Design of MPAs in such a way that allows rigorous demonstration of sustaining or enhancing fishery yield in surrounding regions.

These gaps impede the development of an explicit science for MPA design, one that can generate quantitative criteria for use in planning of MPA networks (see Sale *et al*. 2005 for a review). What is needed is large-scale investment in research to evaluate the effects of protection, and to monitor and model them. The perspective is one of adaptive management –an experimental approach that is itself gradually perfected as results are obtained (Hilborn *et al*., 2004). It is to be hoped that this research can be carried out in the near future.

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