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European Marine Protected Areas as tools for Fisheries management and conservation

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Guidelines for the Assessment of Marine Protected Areas as Tools for Fisheries Management and Conservation

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EMPAFISH Deliverable No. 31

Management Manual

Guidelines for the Assessment of Marine Protected Areas as Tools for Fisheries Management and Conservation

Stephen Mangi

Melanie Austen

Plymouth Marine Laboratory, Prospect Place, The Hoe, Plymouth PL1 3DH, United Kingdom

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For further information contact Dr Stephen Mangi at stcma@pml.ac.uk

1. Why areas of the sea need protection

There is increasing concern worldwide for the future of the oceans' biodiversity and their capacity to support productive fisheries, recreation and other services. Many marine areas host key habitats vital for the functioning of marine populations that in turn provide us with direct and indirect services. However, marine resources in many parts of the world are intensively exploited and their habitats are degraded by human activities. Populations of large predatory fish have been depleted owing to intensive fishing (Koslow et al. 1988, Russ and Alcala 1996), and destructive fishing practices have caused severe damage to habitats (Gomez et al. 1987, Alcala and Gomez 1987, McManus 1997, Guard and Masaiganah 1997, Edinger et al. 1998). In spite of the progress made in the ecological understanding of these communities (Sale 1991), many aspects of the dynamics of their exploitation still remain obscure (Russ 1991, Botsford et al. 1997, Cochrane 2000), and successful management methods suited to these complex ecosystems are still being designed (Polunin and Roberts 1996, NRC 2000, Martin-Smith et al. 2004). Management of these marine ecosystems is often inadequate or absent, due in part to insufficient data.

The Mediterranean Sea has a long history of resource extraction and multi-jurisdictional governance (Goñi et al. 2000, Caddy 2004, Abdulla et al. 2007). In recent years, most coastal resources have been reported to be overexploited raising concerns about the long-term sustainability of certain fisheries (Castilla 2000, Pauly et al. 2002). Of the 70 marine areas currently under some form of protection, all but one is coastal. The majority, 80% are located along the northern shore, 14% in the east and 6% in the south (Abdulla et al. 2007). The under-represented southern and eastern Mediterranean coasts have unique oceanographic and biogeographic conditions and low levels of human development. However, human impacts on the relatively underdeveloped areas of southern and eastern Mediterranean are expected to rise in the next decade. Unless measures are put in place, species of current commercial interest will have disappeared by 2050 (Worm et al. 2006). Given the high endemism of the Mediterranean Sea there is a need to develop a comprehensive plan for conservation of its biodiversity. The solutions provided by those responsible for management of the sea are multiple, and rely on 1) reducing fishing capacity through traditional fisheries measures such as catch quotas and controlling fishing effort, and 2) establishing marine protected areas (MPAs).

Multiple use marine protected areas (MPAs) are widely recognized as one method for managing large and diverse marine ecosystems. The term marine protected area refers to areas of the sea where fishing and other practical uses such as diving are restricted or prohibited. Such protected areas have been proposed throughout the world to protect marine ecosystems and rebuild depleted fish stocks (Rowley 1994, Carr 2000, Roberts et al. 2003). Wherever MPAs have been properly established, and have existed for a number of years with full protection, they have generally been successful (Roberts and Hawkins 2000). Most have not only achieved conservation goals such as maintaining marine biodiversity and protecting

marine habitats, they have also brought social and economic benefits (Salm and Tessema 1998).

Properly implemented MPAs that include no-take zones may improve fishery yield outside the protected area. The accumulation and maintenance of mature fish stocks to carrying capacity levels within the no-take areas may enable them to serve as sources for adjacent fishing areas. This takes place through the dispersal of adults and larvae across the no-take zone boundaries and is commonly referred to as spillover (Rowley 1994, McClanahan and Mangi 2000, Roberts et al. 2001). As populations of exploited species increase in the no-take areas, conditions become sufficiently crowded and resources scarce such that some fish move to areas where population densities are lower. Such areas lie outside the no-take zones. Protection therefore leads to net emigration of fish from no-take zones to fishing grounds. Some of the factors that influence such movements include:

1. Level of protection – fully protected areas enable a rapid build up of populations to reach higher levels than where protection is partial or incomplete.
2. Time since MPA was established – the longer the MPA has been established, the closer populations will approach carrying capacity of that area. Note that natural disturbances may limit populations from reaching carrying capacity.
3. Fishing intensity outside no-take areas – high fishing intensity outside no-take areas result in low population densities of fish in those areas. This could encourage a rapid spillover as the difference in density is high. However, high fishing intensity could act as a constraint to movements if the fish avoid disturbed areas or the habitats they depend on have been destroyed (Roberts and Hawkins 2000).

Purpose of the manual

The purpose of this manual is to provide a summary of the approach and explanation of the methods and data that are utilised in the various EMPAFISH work package booklets appearing on the EMPAFISH website at: http://www.um.es/empafish

This manual provides guidelines that can be integrated into the decision-making regarding marine protected areas as tools for fisheries management and conservation. It is hoped that our recommendations will constitute an improved basis for the design, the selection and the management of protected areas in southern Europe. This manual also ensures that results from EMPAFISH are readily available, and should assist the formation of future fisheries regulation, and provide guidelines for applying the methodologies to other marine areas.

Who it is intended for

Potential users include all groups and individuals with an interest in marine protected areas. This manual should be potentially useful to MPA managers, fisheries managers, fishing industry representatives, environmental groups and academic researchers.

2. What is involved in assessing MPAs

Marine protected areas have three main functions: ecological (conservation), fisheries management and enhancement of socio-economic benefits. Thus an important first step in the assessment of MPAs is the collection of relevant ecological, fisheries and socio-economic information. These data could be collected at different time periods to look for changes over time, for example, before and after the MPA is established, or at set intervals subsequent to MPA establishment. They could also be collected at sites both inside and outside the MPA, in attempt to tease out the effect of protection (Figure 1).

Ecological data

A major goal of MPAs has been the protection of species and ecosystems from human activities. Ecological data therefore provides information on the ecological processes involved in the functioning of a MPA and helps to understand how ecological networks and relationships between species within an ecosystem reorganize after protection from fishing. Fish biomass and density are commonly used measures.

Fisheries data

In terms of fisheries management, the primary function of MPAs is to provide refuge for exploited species, with the aim of improving stocks outside of MPAs. It is therefore important to know how protecting an area from fishing leads to enhancement of fishery yields and sustainability of fisheries. Fisheries data, mainly catch per unit effort (CPUE), are essential for understanding how beneficial MPAs are to adjacent fished areas. It is widely accepted that MPAs offer two potential advantages to fisheries: net migration of adults and juveniles to adjacent areas, commonly referred to as “spillover”, and export of eggs and larvae or “recruitment subsidy”.

Socio-economic data

Different forms of resource use may take place inside protected areas. Such uses could be consumptive e.g. harvesting of particular species, or non-consumptive such as diving and snorkelling. To assess the practical use of MPAs as an ecosystem-based marine resource management tool, the economic effects of MPA implementation therefore need to be examined. Such an analysis would include quantifying both the consumptive and non-consumptive benefits of the MPA and assessing if such uses conflict with other the objectives of protection.

Stakeholder consultation

Information is also required to evaluate how stakeholders perceive marine protection thereby addressing stakeholder concerns raised by the establishment of MPAs. The process of stakeholder involvement makes explicit the diverse perceptions they have and can hence create opportunities for decision-making and management based on consensus rather than conflict. By informing all stakeholders about the implications of resource use and the

acceptability of changing practises, stakeholders can resolve their own conflicts and build trust between each other.

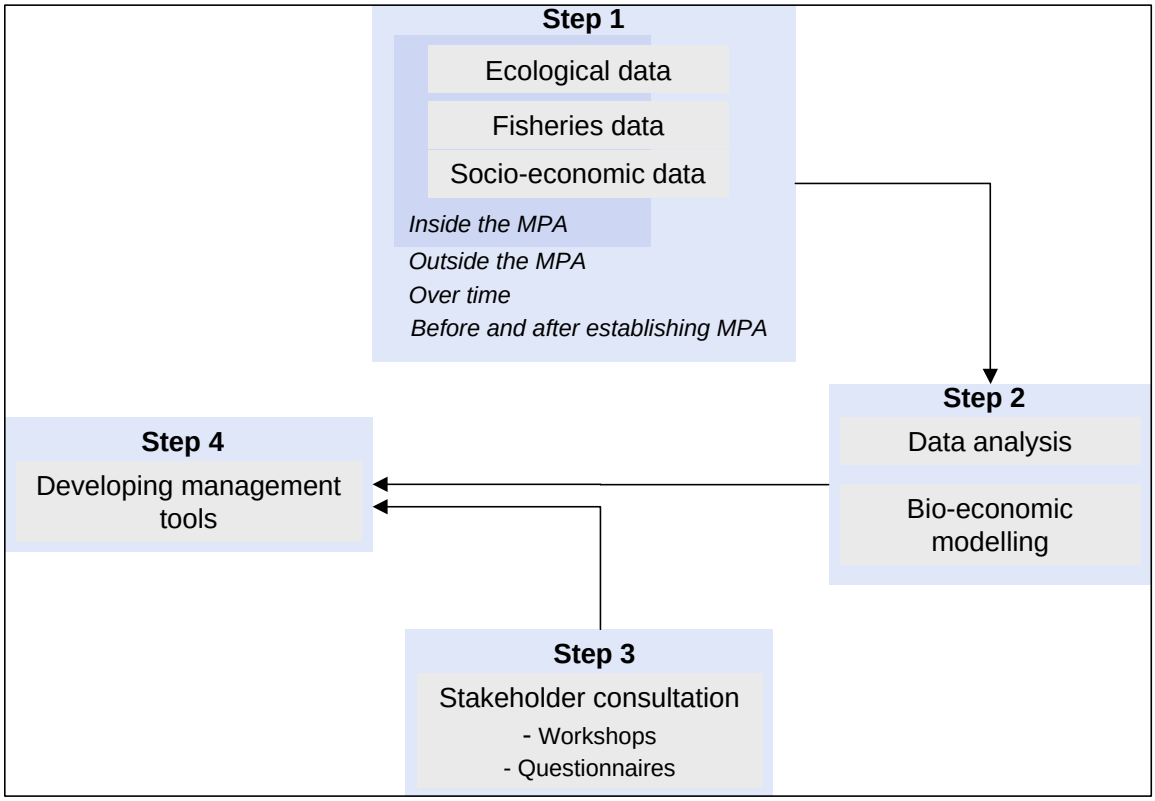

Figure 1: Summary of the process involved in assessing MPAs showing the steps to take from data collection to the development of decision support tools.

3. What data to collect

The variables to consider include fish species composition and abundance, types of habitat and complexity, catch and effort in adjacent fishing grounds, recreational uses and attitudes of stakeholders. If possible all these variables should be assessed, otherwise data collection could prioritise variables based on the goals of the assessment and specific conditions of the site.

Fish biomass and density

Fish density usually refers to the number of fish in an area while fish biomass is the wet weight of fish in that area. Estimates of fish density and biomass can be derived through underwater visual surveys, experimental fishing and baited video sampling techniques. Fish density and / or biomass data is required to quantify fish abundance before and after establishing the MPA, or for areas under different management regimes such as closed versus fished areas, or at different time periods. Literature shows that accurate estimates of fish

density and biomass are difficult due to natural variations in fish behaviour and variability in the data due to observer bias, time of day, tides, and other sampling factors.

Catch per unit effort

This involves recording the amount of fish landed by fishermen using the adjacent area to the MPA or the amount of fish landed from experimental fishing. Effort can be expressed in a variety of ways including the time that an individual fishing trip takes, the number of fishers involved, and the number of gears deployed. Data used to calculate catch per unit effort could come from primary data collection or secondary sources including documents at landing sites, statistical reports and reports of previous assessment and surveys.

Use and non-use values

This includes quantifying both extractive exploitation, if it is allowed in the MPA, such as recreational fishing, and non-use values such as in research, education, diving and snorkelling. These data can be collected using questionnaires and secondary sources including local reports.

Stakeholder perceptions

Stakeholder consultation is important as it can act as a social tool enabling stakeholders to come together and identify common ground. Stakeholders could be consulted through structured and informal interviews, workshops and focus group discussions. Stakeholder consultations can generally involve anybody who is affected or influenced by the MPA, but in most cases it is key informants from each stakeholder group that take part. Key informants are individuals whose experience and / or knowledge, because of their position, can provide insight and information on behalf of the larger population.

4. Case study: The EMPAFISH Project

This section of the manual explains the approach used by the EMPAFISH project to study the potential of different regimes of MPAs in Europe. The MPAs were established as measures to protect sensitive and endangered species, habitats and ecosystems from the effects of fishing.

Objectives of Empafish

EMPAFISH (European Marine Protected Areas as tools for Fisheries Management and Conservation) is a project funded by the European Commission to:

1. Investigate the potential of different regimes of MPAs in Europe as measures to protect sensitive and endangered species, habitats and ecosystems from the effects of fishing;
2. Develop quantitative methods to assess the effects of marine protected areas, and
3. Provide the EU with a set of integrated measures and policy proposals for the implementation of MPAs as fisheries and ecosystem management tools.

What we did

A key challenge in assessing the role of MPAs in the context of fisheries management lies in the multiplicity of forms that MPAs take. MPAs are a flexible tool encompassing a range of management options from small, strictly protected no-take reserves to large zoned multiple-use areas with zones where different activities are managed (Martin et al 2007). We therefore compiled an extensive dataset of 58 case studies from 19 MPAs distributed over 3000 kilometres from the central Mediterranean to the North East Atlantic Ocean. We used a three-point criteria to select the dataset for use in our final analyses:

1) The data should have been collected at a protected location that is a true no-take zone;
2) The data for the control location was from an unprotected area; and
3) The dataset reported the same fish species sampled in the no-take zone and unprotected area.

Meta-analyses of fish density data for commercially important species was then undertaken to determine the effects of MPAs across the study sites (Read more from EMPAFISH Project Booklet No. 1: Ecological Effects of Atlanto-Mediterranean Marine Protected Areas in the European Union - www.um.es/empafish)

We further gathered together commercial fisheries data from 16 established MPAs representing a broad spectrum of habitats, fisheries and fishery management regimes. Diverse fishery regimes were characterised and classified according to fishing and management attributes (Read more from EMPAFISH Booklet No. 2: Fishery Regimes in Atlanto-Mediterranean European Marine Protected Areas – www.um.es/empafish) For each location, an appraisal of the trend in catch per unit effort (CPUE) of aggregated catch was undertaken for fishers operating in partially protected areas of MPAs and outside of the MPA. Project partners indicated the top three most important fish species from their MPA region, and also the most important fishing gear. Meta-analysis was used to determine the patterns in CPUE across study sites

We performed socio-economic analyses with data from 14 MPAs including value of landings by professional fishers, expenditure of recreational fishers, income from diving operators and budget for divers. Comparative analyses were performed on 14 coordinated socioeconomic field surveys of extractive and non-extractive uses of MPAs in southern Europe. These surveys were conducted through questionnaires in 2005 and 2006 and covered commercial and sport fishing, diving and snorkelling. A total of 4 083 questionnaires were completed, providing information on the behaviour and attitudes of users as well as the economic impact of their activity ((Read more from Alban et al. (2007) Marine Protected Areas Socio-Economic Data: A review of EMPAFISH field survey – www.um.es/empafish).

Perceptions of stakeholders on the importance of MPAs as tools for fisheries management and conservation were sought through a questionnaire. The questionnaire was translated into local

languages to make it easier for stakeholders to provide their views. Three sets of questions were applied:

1) Questions focusing on objectives of marine protection including whether MPAs are sites to protect representative sections of marine environment, protect marine biodiversity from damaging activities, prevent overexploitation of species, improve or sustain yields in adjacent areas, provide undisturbed localities for research or promote the development of tourism. Each respondent was asked to rank the objectives in order of importance.
2) Another set of questions focused on the best zonation of MPAs in southern Europe. These include Zone A (no use zone) where all forms of use are prohibited except for research and education; Zone B (Regulated no extraction zone) which is the area of the MPA where uses such as for diving and research are allowed but no resource extraction activities are permitted; and Zone C (Regulated extraction zone) where resource extraction is permitted under certain conditions e.g. for specified fishing gear types and / or seasons. Respondents were asked to rank how the different zonation of a MPA contributes to each of the objectives of marine protection.
3) The third set of questions focused on specific issues dividing stakeholder opinion. For instance, should recreational fishers be allowed to fish in no-take areas for sport purposes when professional fishers are not allowed? To ascertain the stakeholders' views on these issues, each respondent was asked to choose whether they agree or disagree with statements such as 'Certain areas of the MPA should be permanently designated where any form of fishing including recreational fishing is not allowed'. All stakeholders were asked the same questions and the results were compared (Read more from Deliverable 29).

Results of the meta-analyses showed that the size of no-take zone and partially protected zone interacted with time since the MPA was established to influence fish density and catch per unit effort (CPUE). We therefore used these to tease out a wide range of sizes of no-take and partial protected zones for their levels of fish densities and CPUE based on different lengths of time. We termed MPAs as small if they were less than 150 ha, medium if they were between 151 to 600ha and large if they were over 601 ha. The sizes of partial protection zones (buffer zones) used included having a partial protection zone that was half the size of the no-take zone, or having a partial protection zone that was the same size as the no-take zone, or a partial protection zone that was twice the size of the no-take zone. Using the windows-based software DEFINITE (decisions on a finite set of alternatives) we:

1) Standardized the data to make the measured units comparable across the scenarios; and
2) Weighted each criteria based on ranks of objectives provided by local MPA stakeholders

This procedure led us to compute a value for each scenario that was a number between zero and one with one indicating maximum benefit and zero indicating no benefit (See EMPAFISH Deliverable no. 28).

Summary of main findings

Briefly, the main findings of this work are

1. Abundance and size structure of populations of commercial fish species increase with time since an MPA was established.
2. There were gradients of fish abundance and biomass across MPA boundaries implying that spillover takes place since the first years although it appears to occur at fine spatial scales.
3. Fisheries benefits from MPAs are maximised by having fully protected zones (no-take areas) that are larger than the surrounding buffer zones. Such areas would allow recruitment of fish to reach larger sizes before they are caught. The migrations and movement of adult fish out of these no-take areas should enhance catches in the adjacent fishing grounds.
4. Catch per unit effort for fishers using fishing grounds adjacent to MPAs increased with the age of the MPA. Fishing grounds adjacent to older MPAs showed higher CPUE compared to fishing grounds adjacent recently established MPAs.
5. Intensive exploitation of areas adjacent to MPAs result in spillover effects taking more than 30 years after protection to detect.
6. Stakeholders would like to see a hierarchical limitation on the use of marine resources and the separation of conflicting activities. Local stakeholders would like to see MPAs comprised of a central (no use) zone that is bordered by a regulated (no extraction) zone with an outer regulated (extraction) zone. Stakeholders view such an MPA to meet all the objectives of marine protection highly.
7. Perceptions of fishers whose fishing grounds are adjacent to older MPAs are that the potential of MPAs to deliver fisheries objectives declines the longer the MPA has been designated. This finding stems from the fact that scores provided by fishers on MPAs as areas to manage fisheries decreased with the length of time of protected area management.
8. Benefits of MPAs were maximised by having a large MPA in which the size of the partially protected zone was half that of the no-take zone.

Recommendations for management

The main recommendations that are derived from this work include:

1. Marine protected areas in southern Europe should have a no-take area so as to meet the objectives of marine protection. Having such a zone will improve the conservation and fisheries goals of marine protection.
2. There is a need for more socio-economic studies to quantify the costs and benefits to fishers of establishing MPAs in southern Europe.
3. There is a need for increased dialogue between scientists, managers and fishers to reduce the disparity in understanding the fisheries benefits of marine protection between these groups.

5. Conclusions

There are a number of reasons why areas of the sea need to be properly protected: to stop widespread depletion of species and alteration and destruction of habitats, to ensure there are refuges for exploited species, and to maintain ecosystem processes and integrity. Coastal fisheries are an important component of the fishery sector and economy of many countries in southern Europe, generating food and income to millions of people. The coastal population is rising and population driven demand for food and employment will therefore keep exerting pressures on the sea, with serious consequences on the income of fishers and economies in the countries of the Mediterranean and North West Atlantic region.

Coastal fisheries are also under increasing pressure from destructive fishing methods that have led to reductions in productivity and degraded coastal habitats. This is particularly so in the Mediterranean region where multi-jurisdictional governance of the sea imposes socio-economic and political constraints to improved management. There is a need for fisheries management to recognize the problems of degradation of coastal fisheries, and the resultant adverse impact on fishing communities, and improve efforts to manage the resources. Such efforts could start with a better implementation of marine protected areas. In support of efforts to improve the management of marine protected areas, EMPAFISH has taken a holistic approach to assess MPAs where the ecological, fisheries, social, and economic aspects are examined. Our overall goal was to improve the scientific basis for design and selection of marine protected areas by providing efficient, quantitative framework to assess MPAs as tools for fisheries management and conservation.

In the EMPAFISH project we carried out a comprehensive review of MPAs in southern Europe as tools for fisheries management and conservation. We have analysed the ecological effects of MPAs, fisheries effects, socioeconomic impacts and conducted a stakeholder consultation to build consensus and feed stakeholder perceptions to decision makers. The approach used (multi-criteria analysis of ecological data, fisheries data, socio-economic data and stakeholder perceptions, Deliverable 28) can also be used in a variety of assessments including integrated coastal zone management and coastal defence strategies. The main advantages of using frameworks like the one developed here are to ensure ‘best science’ is used to support decisions, to encourage acceptance of management strategies and to ensure equity through stakeholder involvement.

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