Socioeconomic impacts of marine protected areas in the Mediterranean and Black Seas

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Highlights:

- Socioeconomic impacts of MPA are understudied in the Mediterranean and Black Seas
- We surveyed stakeholders from 14 countries to evaluate perceptions on MPA impacts
- Our literature review suggests that MPAs positively impact artisanal fishing
- Perceptions on MPA impacts differ between Mediterranean and Black Sea stakeholders
- Ecosystem-based management of marine resources should embrace multiple viewpoints

Abstract: The socioeconomic implications of Marine Protected Areas (MPAs) and perceptions of stakeholders on MPA impacts are important to consider when designing, implementing, and managing MPAs. However, the currently available knowledge about these areas and especially of stakeholder perceptions is scarce and limited to restricted geographic areas. The present study aims to address this gap by examining these factors in the Mediterranean and Black Seas using an extensive literature review and an online survey approach. We collated and examined a total of 208 published studies on socioeconomic impacts of MPAs and marine uses. We found that for fishing, the socioeconomic impacts of MPAs were generally perceived as negative for industrial fishing and positive for artisanal fishing. In the online survey, we collected ca. 100 responses and found that stakeholder perceptions on the impacts of MPAs differ across sectors and regions. Industrial fishing was perceived as being negatively impacted in the Black Sea, while most respondents from the Mediterranean Sea were neutral in their responses relating industrial fishing and MPAs. The impact of MPAs on artisanal and recreational fishing was generally viewed as neutral by respondents from the Black Sea, whereas most Mediterranean respondents indicated a positive impact of MPAs. We also found that perceptions of the major threats to MPAs differed across the Mediterranean and the Black Sea. Responses from the Black Sea were systematically shifted towards a more negative perception of threats to MPAs compared to those from the Mediterranean Sea. Illegal fishing and other illegal activities were considered to be the most relevant threats to MPAs by stakeholders in both regions. The mismatch found between evidence of MPA effectiveness and impacts from the scientific literature and the results of our survey suggests that within the framework of maritime spatial planning and ecosystem-based management, effective MPA planning should be informed by multiple sources across regions.

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Keywords:

Impact assessment; Marine Protected Areas (MPAs); Mediterranean Sea; Black Sea; Social Perceptions.

1. Introduction

Marine Protected Areas (MPAs) are commonly used for coastal and marine management with the principal purpose of biodiversity conservation and conserving marine living resources (Fabinyi, 2008; NRC, 2001; Pita et al., 2011). MPAs vary widely in the type and level of protection applied, ranging from areas that allow multiple uses to areas that entirely exclude human access (Pita et al., 2011). As such, their implementation under a wide range of economic and social conditions (Angulo-Valdés and Hatcher, 2010) can have profound impacts on local livelihoods (Halpern et al., 2010). Therefore, the designation, implementation, and management of MPAs should consider conservation outcomes as well as socioeconomic impacts, and financial and institutional sustainability (Gurney et al., 2014; Niesten et al., 2010; Richardson et al., 2006). Such considerations can reinforce the likelihood of an MPA to achieve its goals in the long run (Christie et al., 2003; Cornu et al., 2014; Hattam et al., 2014; Mascia, 2004; Voyer et al., 2012).

Earlier research efforts have largely focused on pinpointing the positive ecological impacts of MPAs and advocating in favor of their broad set of benefits in the long-term (Lester et al., 2009). For example, Angulo-Valdés and Hatcher (2010) listed a total of 99 benefits deriving from MPAs, ranging from the protection of spawning stocks and/or critical habitats to the enhancement of aesthetic experiences and non-consumptive opportunities such as recreation. If well designed, and effectively managed, an MPA can generate benefits with a direct, immediate or delayed economic and social value in addition to those related to its conservation value. Several studies have reported that the establishment of MPAs and the consequent protection of naturally important areas (such as breeding, nursery, and recruitment habitats) have had a considerable positive impact on local and regional economies (Ami et al., 2005; Badalamenti et al., 2000; Boncoeur et al., 2002; Farrow, 1996; Harmelin et al., 1995; Higgins et

al., 2008; Hoskin et al., 2011; Lausche, 2011; Lloret et al., 2008; Russ and Alcala, 2004; Sanchirico et al., 2002). Positive impacts include provisioning of goods and services, support to economically valuable activities, creation of new jobs and diversification of livelihoods, increase in revenues due to tourist taxes and expenditures from non-consumptive recreation and tourism . This wider view of protected areas as an important tool to foster sustainability and their vital role in biodiversity conservation was acknowledged over ten years ago at the 5th IUCN World Parks Congress entitled 'Benefits beyond Boundaries' (IUCN, 2003).

In contrast, some authors have argued that the ecological benefits of MPAs are necessary, but are insufficient in order to ensure the MPAs' positive socioeconomic benefits (Christie, 2004, Grafton et al., 2005). MPA design is usually focused on getting scientific advice on the biological dimension, while less attention is placed on the socioeconomic consequences (Beare et al., 2013). The implementation of marine reserves (the strictest form of marine protection) often creates conflicts among stakeholders, as access to valued ecosystems, localities, and stocks is prohibited or heavily curtailed (Coleman et al., 2004; Cox et al., 2003; Granek et al., 2008; Salz and Loomis, 2005). These conflicts, in return, may affect the social, economic, and institutional dimensions, which are critical to the success of MPAs (Charles and Wilson, 2009; Jennings, 2009; Mascia and Claus, 2009).

Recently, an upsurge of interest in the socioeconomic impacts (both positive and negative) that are expected from MPAs has been observed (Rees et al., 2013; Weigel et al., 2015). Globally, studies assessing the impacts of MPAs on individual activities such as fishing (Scholz et al., 2011), tourism (Agardy, 1993; Davis and Tisdell, 1996; Hargreaves-Allen et al., 2011), and recreation (Lynch et al., 2004) are increasing. The same trend is seen in studies that incorporate socioeconomic variables into the designation of MPAs (e.g. Giakoumi et al., 2011; Klein et al., 2008; Scholz et al., 2011). However, most studies indicate that the assessment of social impacts is still uncommon (Voyer et al., 2012). More information is needed to address the

level of uncertainty regarding the magnitude of the social and economic impacts of MPAs. Most importantly, it is important to understand how these impacts vary over time, across spatial scales and levels of social organization, across social domains and within and among social groups (Fox et al., 2012; Pita et al., 2011; Richardson et al., 2006). Acknowledging the existence of diverging social perceptions and ideological clashes around MPA impacts and taking them appropriately into account is crucial to incorporate the social value of MPAs into decision making (Agardy et al., 2003; Ami et al., 2005; Gall and Rodwell, 2016; Leleu et al., 2012). Adequately accounting for the viewpoints of different stakeholders (Verweij and van Densen, 2010) is also key to the design of policies aiming to enhance social acceptance of MPAs, and to reduce enforcement costs by improving the social compliance to these policies (Hattam et al., 2014).

The Mediterranean and Black Seas are semi-enclosed systems surrounded by a large number of European (some of which belong to the European Union – EU), Asian and/or African countries, each with its diverse social, environmental, and economic characteristics. These environmental and geopolitical complexities usually drive differences in stakeholder's perceptions on the role and impacts of MPAs depending on the stakeholder's activity or location. Such factors should be accounted for when designing new MPAs or managing existing ones (Pipitone et al., 2014). However, the last comprehensive study on socioeconomic aspects of MPAs in the Mediterranean was carried out 15 years ago by Badalamenti et al. (2000), and it did not consider the social perceptions on the impacts of MPAs. In the last fifteen years, several studies have investigated stakeholders' perceptions in individual MPAs, such as in the National Marine Park of Alonissos (Oikonomou and Dikou, 2008). However, there has been no attempt to conduct a large-scale study to update Badalamenti et al.'s (2000) work. Furthermore, no study has, to date, explored the socioeconomic aspects of MPAs in the Black Sea.

107 The objectives of the present study are to: (i) review the socioeconomic impacts of MPAs in both
108 the Mediterranean and Black seas; (ii) examine the social perceptions of Mediterranean and
109 Black Sea MPA stakeholders on the socioeconomic impacts of MPAs; and (iii) suggest how this
110 information could be used to advance future MPA design and management.

111 ## 2. Methods

112 We created a list of current MPAs in the Mediterranean and Black Seas on the basis of
113 the MAPAMED database (www.mapamed.org) and the World Database on Protected Areas
114 (www.protectedplanet.net). Further information on Black Sea MPAs was gathered from
115 Milchakova (2011) and Begun et al. (2012). A total 232 MPAs were listed for the Mediterranean
116 and Black Seas (Table A1).

117 In order to analyze which uses could potentially be impacted by the establishment of
118 MPAs, a total of 22 marine uses were identified: 1) industrial fishing (including trawlers, seiners,
119 and purse seiners); 2) artisanal fishing (including hooks, lines, traps, fixed nets, trammel nets,
120 fish barriers, gill nets, and multi-purpose vessels); 3) recreational fishing (land- or boat-based
121 angling); 4) underwater recreational fishing (spearfishing); 5) aquaculture / mariculture (open
122 ocean); 6) shellfishing; 7) biological resources extraction (including species not considered in
123 fishing, aquaculture or mariculture activities, such as sea cucumbers, algae or corals); 8) tourism
124 (including sunbathing); 9) hiking, walking, access to beaches; 10) swimming, snorkeling,
125 canoeing, surfing, paddle surfing, wind surfing, etc.; 11) diving; 12) underwater archaeology; 13)
126 recreational boating (sailing and marine cruising); 14) scientific research; 15) educational
127 activities; 16) sand / gravel extraction; 17) oil / gas extraction; 18) offshore wind farming; 19)
128 wave farming; 20) industrial maritime transport; 21) building along the coastline; and 22)
129 military uses. The socioeconomic interactions between MPAs and the above-listed marine uses

were investigated combining two approaches: an extensive literature review (section 2.1) and an online survey (section 2.2).

2.1. Literature review on the socioeconomic impacts of MPAs

Peer-reviewed and grey literature, published up to January 2015, regarding positive and negative socioeconomic impacts of MPAs was compiled. The search of the literature was performed by browsing the Web of Science for 'Marine Protected Area*' and 'impact*' topic keywords and further refining by 'economic', 'social', 'positive', 'negative' and combinations of those topics (Table A2). The search was not constrained to the Mediterranean and Black Seas in order to gather as much worldwide evidences as available. However, only studies that explicitly stated clear evidence of impact were selected, excluding studies that just mentioned impacts without reporting any evidence. Additional studies known by the authors were also added. As impacts of MPAs can be positive or negative, we classified the evidence found into the 22 marine uses listed in the previous section as positive or negative according to what was stated in the original study (Table A3).

2.2. Survey of stakeholder perceptions on MPAs objectives, impacts, and risks

An online questionnaire (Appendix B) was prepared to gather information on stakeholders' perceptions about the main objectives of Mediterranean and Black Sea MPAs, the socioeconomic impacts they have on existing marine uses (called "effects" in the survey), and the natural and anthropogenic stressors they are exposed to. The questionnaire was divided into 5 sections: 1) an introduction explaining the purpose of the survey; 2) questions about the respondent and his/her role in the MPA under scrutiny; 3) questions about the MPA, including its extent, zonation, estimated number of annual visitors, and main pursued objectives for its establishment; 4) questions about the importance of the impacts that the establishment of the

MPA has caused on human activities in the area; and 5) questions about the extent to which different natural and anthropogenic stressors affect the MPA.

The questionnaire primarily included multiple-choice questions, with some open-ended questions. Specifically, to identify the main objectives of the MPA respondents were asked to choose up to five options from a list of ten predefined answers (with the possibility to add a user-specified one). Regarding the socioeconomic impacts of MPAs on different marine uses, respondents were asked to express their perception over a 5-point scale ranging from 'clearly negative' to 'clearly positive', with the further possibility to select 'no answer' or 'not applicable'. Questions regarding natural and anthropogenic stressors were answered using a 4-point scale, ranging from 'high' to 'none', with the possibility to choose 'no answer'. The questionnaire was delivered by email in autumn 2013 to nearly 400 stakeholders. Candidate respondents were selected among MPA professionals and stakeholders whose professional activity is directly affected by the presence of MPAs. They included MPA managers, members of MPA staff, scientists, local authorities, NGO members, fishers, tourism and business professionals (such as workers of aquaculture facilities, workers of the tourism industry or workers of recreational facilities) from the Mediterranean and Black Sea. The questionnaire drafted originally in English was translated into different languages (French, Italian, Spanish, Russian and Ukrainian) and the recipients were requested to forward it to other stakeholders involved in marine uses.

The effect of explanatory variables (e.g. geographic region, respondent role) on the answers to the different sections of the questionnaire was assessed using chi-square (χ^2) tests on contingency tables. The statistical association across answers regarding the main impacts of MPAs on marine uses and across those regarding the main stressors to MPAs was assessed (both in an aggregate form and separately for the Mediterranean and Black Sea) using the Mann-Kendall's tau-b test (Agresti, 2012; Burkey, 2006).

177 # 3. Results

178 *3.1. Literature-based scientifically documented socioeconomic impacts of MPAs*

179 A total of 208 studies were found documenting socioeconomic impacts of MPAs on the
180 marine uses identified in Section 2 (Table A3). Evidence of impacts in the Mediterranean Sea
181 were found for Albania, Algeria, France, Greece, Israel, Italy, Malta, Spain, Tunisia, and Turkey,
182 while few evidences from the Black Sea were limited to Ukraine. Of the 122 studies that we
183 found and collated documenting impacts of MPAs on industrial fishing worldwide, 54% referred
184 to negative impacts (Table 1). Negative impacts arise as a decrease in catch, landings, and
185 biomass; as problems related with the displacement of fishing (increase in fuel/time costs, risks,
186 competition with other uses etc.); or as a consequence of direct loss of access due to the closure
187 of areas to fishing. Positive impact evidences refer to increases in catches thanks to recruitment
188 subsidy and spillover outside MPAs, or to the increase in fish biomass due to reserve effect and
189 decrease in fishing within MPAs (Table A3). On the other hand, the search for specific evidences
190 of the impacts on industrial fishing in the Mediterranean Sea resulted in mainly positive impacts
191 (58%), especially in French and Spanish MPAs, while some negative impacts were found in
192 specific MPAs in France, Greece, Israel, Malta, Italy, and Spain (Table 1). In the Black Sea,
193 evidences of positive impacts on industrial fishing were found for Ukrainian MPAs.

194 Regarding artisanal and recreational fishing, evidences of impact were mainly positive
195 (69% and 90%, respectively), while negative impacts were reported for spearfishing (67%) at the
196 global scale and, specifically for the Mediterranean region, in French, Spanish, and Italian MPAs
197 (Table 1). Substantial negative impact evidence (71%) were found on aquaculture, mariculture
198 and/or shellfishing both worldwide and specifically in the Mediterranean Sea (Albania and
199 Spain), as well as on biological resources extraction, such as algae and species for aquarium
200 trade. The majority of evidence of impacts of MPAs on tourism were found to be positive (96%)

(Table 1). Positive impacts were also recorded for swimming, snorkeling, canoeing, surfing, diving, recreational boating, scientific research, and educational activities. However, negative impacts of MPAs on SCUBA diving (41% for the Mediterranean and 40% for the Black Sea) and recreational boating (53% for the Mediterranean and 50% for the Black Seas) were also found.

Only four cases of negative impacts of MPAs on sand and gravel extraction and two cases of positive impacts of MPAs on offshore wind farming were reported. Interestingly, none of the scrutinized studies explicitly reported either positive or negative impacts on hiking, walking and access to beaches, underwater archaeology, oil and gas extraction, wave farming, industrial maritime transport, building along the coastline, and military uses.

Table 1

Summary of MPA impact evidence on marine uses reported in the literature review. (MED: Mediterranean Sea; BS: Black Sea; OUT: outside Mediterranean and Black Seas; NR: No evidence reported)

Marine uses	Impact	Number of studies			Countries (MED / BS)
		MED	BS	OUT	
1) Industrial fishing	+	31	2	56	France (11); Italy (4); Spain (16) / Ukraine (2)
	–	22	NR	66	France (5); Greece (2); Israel (1); Italy (3); Malta (2); Spain (9)
2) Artisanal fishing	+	56	NR	33	Algeria (1); France (16); Greece (1); Italy (10); Malta (2); Tunisia (1); Turkey (1); Spain (24)
	–	18	NR	15	France (2); Greece (1); Italy (7); Spain (8)
3) Recreational fishing	+	15	NR	9	Algeria (1); France (1); Greece (1); Italy (1); Malta (1); Tunisia (1); Turkey (1); Spain (8)
	–	6	NR	1	France (2); Italy (1); Spain (3)
4) Spearfishing	+	4	NR	2	Spain (4)
	–	13	NR	4	France (4); Italy (2); Spain (7)
5-6) Aquaculture / mariculture / shellfishing	+	2	NR	5	Spain (2)
	–	2	NR	12	Albania (1); Spain (1)
7) Biological resources extraction	+	NR	NR	1	NR
	–	1	NR	2	Spain (1)
8) Tourism	+	27	NR	26	Algeria (1); France (7); Greece (4); Italy (3); Tunisia (1); Turkey (1); Spain (10)
	–	5	NR	1	Greece (2); Spain (3)
9) Hiking, walking, access to beaches	NR				
10) Swimming, snorkeling, canoeing, surfing	+	3	NR	6	France (2); Spain (1)
	–	NR	NR	NR	NR
11) Diving	+	22	3	25	Algeria (1); France (7); Greece (2); Italy (3); Tunisia (1); Turkey (1); Spain (7) / Ukraine (3)
	–	15	2	1	France (3); Greece (1); Spain (11) / Ukraine (2)
12) Underwater archaeology	NR				
13) Recreational boating	+	7	3	5	France (2); Italy (1); Spain (4) / Ukraine (3)
	–	8	3	NR	France (4); Spain (4) / Ukraine (3)
14-15) Scientific research / educational activities	+	2	4	1	France (2) / Ukraine (4)
	–	NR	NR	NR	NR
16) Sand / gravel extraction	+	NR	NR	NR	NR
	–	NR	NR	4	NR
17) Oil / gas extraction	NR				
18) Offshore wind farming	+	NR	NR	2	NR
	–	NR	NR	NR	NR
19) Wave farming	NR				
20) Ind. maritime transport	NR				
21) Building along coastline	NR				
22) Military uses	NR				

3.2. Social perceptions on MPA objectives, impacts, and stressors

We gathered a total of 97 responses via the online questionnaire (45 from the Mediterranean Sea and 52 from the Black Sea), covering 34 different MPAs in the Mediterranean and 28 in the Black Sea (Fig. 1 & Table A4). Most respondents (44%) were scientific researchers, 14% MPA managers, 12% NGO members, 11% workers of the tourism industry, 7% MPA staff, 3% fishers, 1% local authorities, 1% recreational professionals, and 7% other stakeholders (including engineers, divers, tourists, volunteers, project managers). The average experience of respondents in their professional roles was about 10 years. Respondent composition differed significantly between the Mediterranean and Black Sea (chi-squared test, $\chi^2 = 35.21$, $P < 0.001$) and between EU and non-EU countries ($\chi^2 = 43.16$, $P < 0.001$).

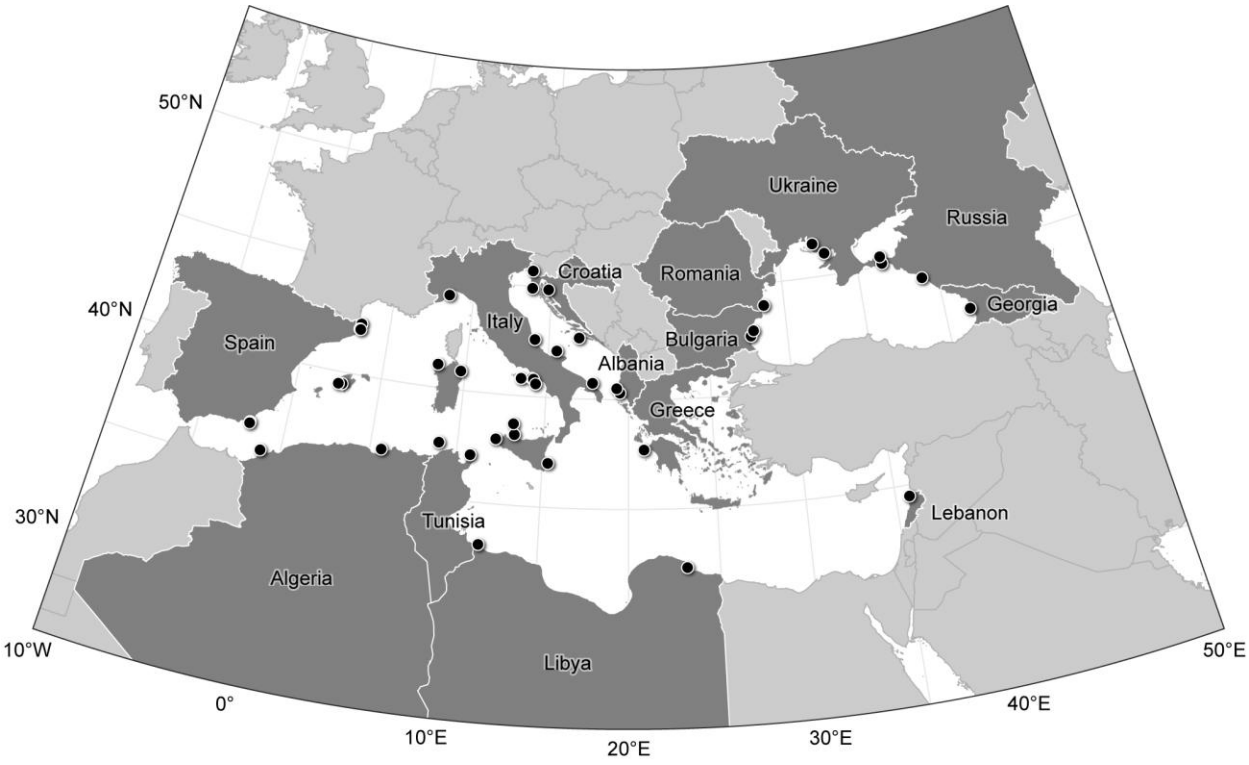

Fig. 1. Distribution of stakeholder's responses collected using our survey. Circles show the spatial location of the MPAs for which responses were obtained in the Mediterranean and Black Sea regions.

Most respondents indicated protection of biodiversity, scientific research and monitoring, as well as environmental education and awareness-raising as the primary objectives of an MPA, regardless of the stakeholder group they belonged to (Fig. 2). On the other hand, the relative importance of some objectives differed significantly between the two geographic regions. In particular, respondents from the Black Sea gave more importance to the protection of unique/unusual geological features than respondents from the Mediterranean Sea (51% vs. 18%). The remaining objectives were considered more important by respondents from the Mediterranean than the Black Sea: protection of biodiversity (93% vs. 89%), sustainable fisheries management (53% vs. 16%), enhancement of fisheries outside the MPA (24% vs. 7%), and promotion of recreational activities (29% vs. 7%).

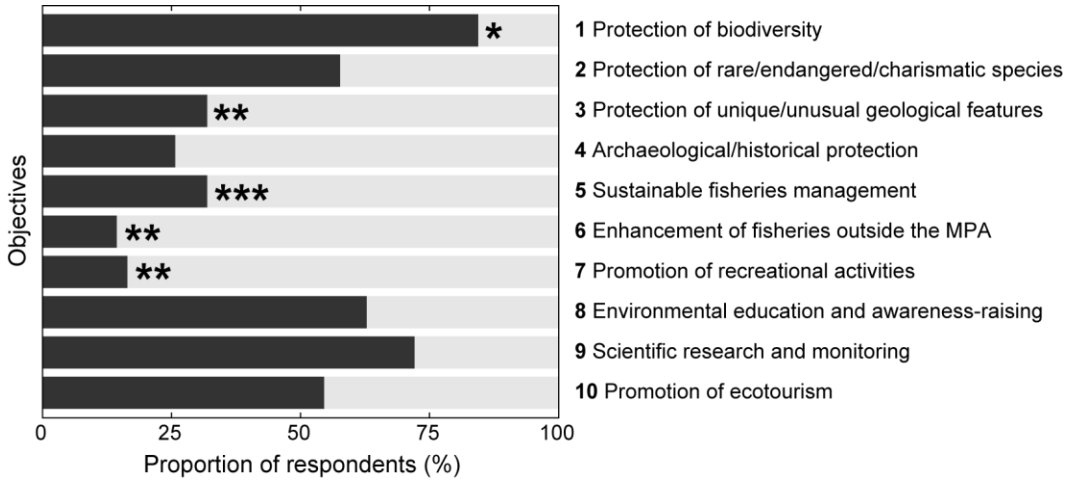

Fig. 2. The proportion of responses addressing the key MPA objectives. Asterisks indicate significant differences between Mediterranean and Black Seas (chi-squared test; ***: $P < 0.001$; **: $P < 0.01$; *: $P < 0.05$).

Statistical associations between responses to the key MPA objectives, assessed for the Mediterranean and Black Seas via chi-squared tests, were all positive, i.e. when an objective was selected, the second objective was more likely to be selected too. The most significant

associations linked protection of rare/endangered/charismatic species with environmental education and awareness-raising ($\chi^2 = 10.97$, $P < 0.001$), and sustainable fisheries management with enhancement of fisheries outside the MPA ($\chi^2 = 11.72$, $P < 0.001$). Associations across objectives were also assessed separately for the Mediterranean and Black Seas (Fig. A1): all significant associations were positive. The most significant associations in the Mediterranean Sea were between environmental education and awareness-raising and promotion of ecotourism ($\chi^2 = 13.79$, $P < 0.001$) and between the protection of unique/unusual geological features and archaeological and historical protection ($\chi^2 = 10.07$, $P < 0.01$). In the Black Sea, stakeholders linked the protection of rare/endangered/charismatic species with environmental education and awareness raising ($\chi^2 = 10.53$, $P < 0.01$), and protection of biodiversity with promotion of ecotourism ($\chi^2 = 7.34$, $P < 0.01$).

The role of the respondent was inconsequential in determining the perception of the main objectives of MPAs, except for conservation of biodiversity ($\chi^2 = 27.50$, $P < 0.001$) and scientific research ($\chi^2 = 26.84$, $P < 0.001$). The significant effect of respondent role in these cases can be ascribed to the responses of operators from the tourism/recreational sector, who indicated the conservation of biodiversity as a primary objective in 47% of the responses and scientific research in 27% only of the responses.

Perceptions about the impacts of MPAs on fishing activities were clearly different between the two regions: industrial fishing was judged to be negatively impacted in the Black Sea, while respondents from the Mediterranean mostly answered "not applicable", likely because in the Mediterranean there is no spatial overlap between MPAs (which are mainly located in coastal areas) and industrial fishing grounds. The impact of MPAs on artisanal and recreational fishing was generally stated as neutral by Black Sea respondents, while most respondents from the Mediterranean Sea indicated a positive impact. Impacts on spearfishing were mostly considered as negligible ("neutral" for Black Sea, "not applicable" for Mediterranean

respondents). When assessing impacts on the different activities, responses from the Black Sea were systematically shifted towards a more negative opinion compared to those from the Mediterranean (Fig. 3). However, most respondents from both regions indicated a clearly positive impact of MPAs on tourism, recreational, and cultural activities (excluding underwater archaeology). Aquaculture and biological resources extraction, as well as underwater archaeology, were generally considered to be unaffected by the presence of MPAs (with most respondents from the Mediterranean answering "not applicable" and most from the Black Sea being "neutral"), and so were non-biological resources extraction, energy production activities (offshore wind farms and wave farming infrastructures), transport, building, and military uses.

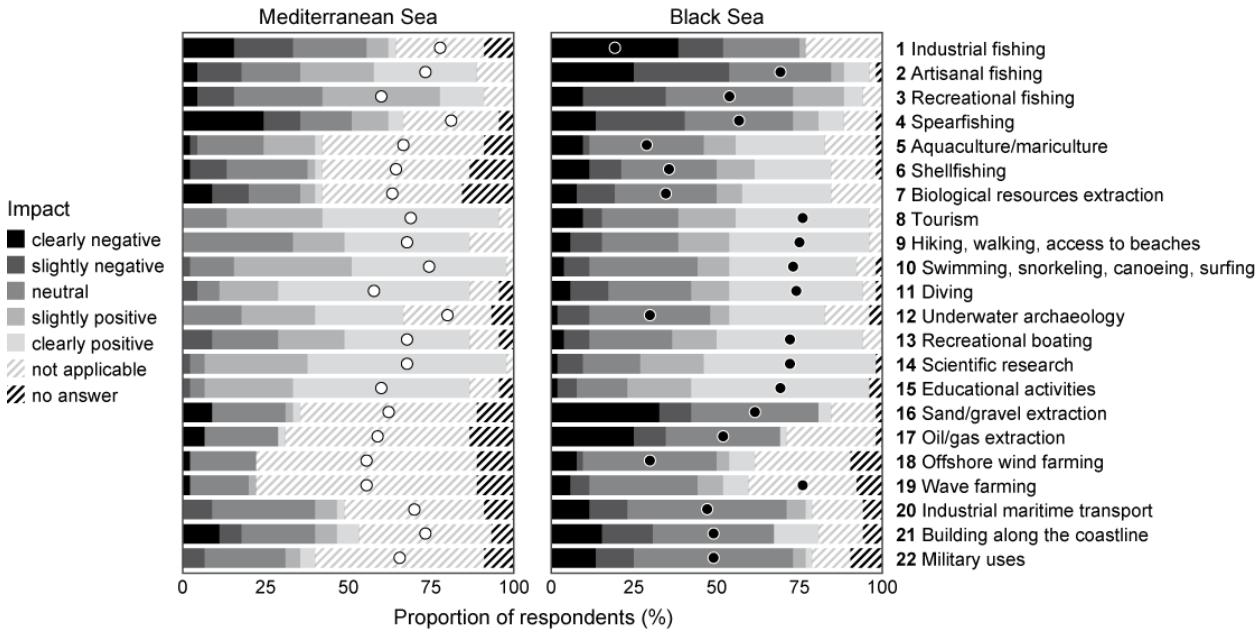

Fig. 3. Summary of the responses regarding MPA impacts on socioeconomic activities. Shades of gray indicate the perceived magnitude of each impact, from "clearly negative" to "clearly positive" plus "not applicable" and "no answer" (hatched bars). Circles indicate the modal response in the two regions (white: Mediterranean; black: Black Sea).

Associations were much stronger among responses from the Black Sea. However, the general patterns were quite similar between the Black and the Mediterranean Seas. Strong levels

of association among responses to questions were found in the same section of the survey (e.g. fishing, recreational and tourism activities, extractive uses). Significant associations (Fig. A2) were found among 1) fishing activities (industrial fishing, artisanal fishing, recreational fishing, spearfishing); 2) aquaculture and biological resources extraction (aquaculture/mariculture, shellfishing, biological resources extraction); 3) tourism, recreational and cultural activities (tourism, hiking/walking, swimming/snorkeling/canoeing/surfing, diving, underwater archaeology, recreational boating, scientific research, educational activities); 4) non-biological resources extraction (sand/gravel extraction, oil/gas extraction), energy production (offshore wind farming, wave farming), industrial maritime transport, building along the coastline, and military uses.

When respondents were asked to indicate the most important stressors affecting MPAs, illegal fishing and other illegal activities were considered to be the most relevant threats (high stress) in both regions (Fig. 4). Global change related threats, such as invasive species and climate change, were also considered to have negative consequences (medium stress) in both regions. Respondents from the Black Sea attributed high importance to local stressors, such as pollution (urban, agricultural and industrial), oil/gas extraction at sea, and port activities. In contrast, respondents from the Mediterranean attributed low (or even none) to medium levels of stress to these activities. Likewise, shipping activities were indicated to cause a "low stress" by most Black Sea respondents and a "medium stress" by Mediterranean respondents. On the other hand, stress associated with aquaculture was generally perceived as low (Black Sea) or negligible (Mediterranean), while that associated to tourism and recreation was evaluated as low by the majority of respondents from both regions. Stress from fishing activities was considered higher for industrial fishing (medium to high, depending on the region) and lower for artisanal and recreational fishing (low to medium, depending on the region). With the exception of few

questions, Black Sea respondents seemed to perceive higher effect of natural and anthropogenic stressors on MPAs than Mediterranean respondents.

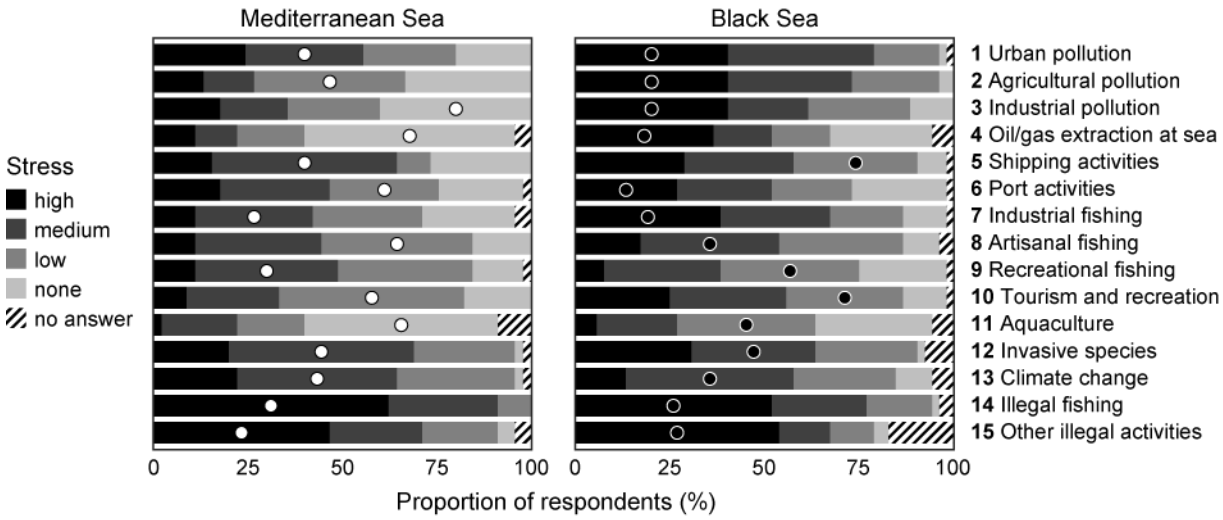

Fig. 4. Summary of the responses regarding natural and anthropogenic stressors to MPAs. Shades of gray indicate the perceived importance of each stressor, from "none" to "high" plus "no answer" (hatched bars). Circles indicate the modal response in the two regions (white: Mediterranean; black: Black Sea).

Highly significant statistical relationships (Fig. A3) were found among answers regarding the following human activities: 1) urban, agricultural and industrial pollution, oil/gas extraction at sea, shipping and port activities, industrial fishing; 2) artisanal fishing, recreational fishing and tourism/recreation activities; 3) aquaculture, invasive species, climate change, illegal fishing and other illegal activities. Association patterns were quite similar across regions for activities such as pollution, fossil fuel extraction and shipping activities, while they were slightly different for other (e.g., in the Mediterranean, aquaculture was mostly associated with agricultural and industrial pollution, while in the Black Sea it was mostly associated with port activities).

4. Discussion

4.1. MPA impacts on marine uses – evidence from the literature

Despite the broad recognition of the importance of assessing MPA impacts on multiple marine uses (Badalamenti et al., 2000; Pita et al., 2011), present work reveals gaps for many of the marine uses. Many uses lack evidence of impacts associated to the establishment of MPAs. Moreover, information available for MPAs in the Black Sea was scarce (1.9% of the 208 studies analyzed).

Most impact assessments have explored how fishing, tourism, and recreational activities have been either positively or negatively impacted by the establishment of MPAs (Table 1), whereas assessments for the remaining uses are scarce or absent. Evidence from the literature suggests that artisanal, land and boat-based recreational fishing, tourism and beach access, scuba diving, and other recreational activities can be generally benefited by the establishment of MPAs. Conversely, industrial fishing, spearfishing, aquaculture and mariculture, as well as sand and gravel extraction, seem to be negatively impacted by MPAs. In general, evidence from outside our study region and those from the Mediterranean Sea showed similar effects. However, the majority of the studies have been conducted in the central and western part of the northern Mediterranean (Spain, France, and Italy), leaving most coastal areas under-reported.

In the scientific literature review we found a large variation in type and representativeness of evidence from MPAs. Consequently, evidence may not be directly comparable among studies, especially since MPA characteristics vary significantly from site to site, such as the existence or not of zoning and regulatory legislation (e.g., adjacent MPAs may have different management plans). Variation in stakeholders' perceptions is another aspect that makes it difficult to derive clear conclusions about the socioeconomic impacts of MPAs on marine uses. As perceptions are affected by the socioeconomic conditions of each user (e.g., the

dependence on resources for subsistence), they do drastically differ among user groups and even within the same group. Another critical point is that evidence analyses are rarely replicated either in time or in space. In fact, very few studies accounted for spatiotemporal variability in populations, which could be linked to environmental and biological factors other than MPA status (e.g. Charton and Ruzafa, 1999). Increasing and replicating over time the number of quantitative assessments of MPA impacts, based both on empirical data and on surveys to marine stakeholders, is therefore crucial. Furthermore, we found that studies are usually more likely to report beneficial impacts of MPAs rather than detrimental ones, regardless of the geographic region where they were conducted. However, scientific publications might be biased towards "positive results" (i.e. results that support the tested hypothesis). The increased pressure to publish in academia may be a driver for this bias, as papers are less likely to be published and to be cited if they report “negative” results (Fanelli, 2010). Independent of this, as the scientific literature mainly reflects the viewpoint of scientists, assessing the perceptions of a variety of stakeholders is crucial to derive a comprehensive assessment of the success or failure of MPAs in achieving their multiple objectives and on their impacts on society. Ideally, such assessments should be harmonized on the basis of commonly accepted protocols, which, under the guidelines of intergovernmental bodies, such as the European Union, would allow for comparisons among various site-based assessments.

4.2. MPA impacts on marine uses – stakeholders' perceptions emerging from surveys

In the absence of more substantial field-based and evidence-based perceptions data, information gathered through surveys can provide important insights on the impacts of MPAs on marine stakeholders. Most importantly, such studies reveal the perceptions of different stakeholder groups, which might, in principle, differ significantly from what is reported in the literature. While MPAs are often presented as win-win solutions in the scientific literature, this is

not always necessarily the case if the viewpoints of other stakeholder groups, such as extractive marine users (Gall and Rodwell, 2016), are explicitly included in the analysis.

Ex-ante evaluations of MPA impacts (Batista et al., 2011; Horta e Costa et al., 2013; Hussain et al., 2010; Pinheiro et al., 2009; Stoffle and Minnis, 2007), aimed at gathering stakeholders' perceptions prior to MPA designation, can be very useful to assess expected changes in the biological and ecological significance of a site. To date, however, very few studies have gathered stakeholders' perceptions prior to MPA designation, hindering *ex-ante* assessment of future MPA benefits (Hussain et al., 2010).

A variety of different perceptions emerges from the different groups and communities surveyed in the present study. While scientists, NGO members, conservationists, and recreational users tended to consider MPA impacts on other marine uses as positive, the perceptions of the remaining marine stakeholders were not in unison. For example, some stakeholders in the Black Sea perceived MPA impacts as very negative to industrial fishing. Responses from fishers clearly pointed out their worry on the 'real' impacts, and subsequent costs, of MPAs on their activity, which may be spatially excluded or re-allocated.

Nevertheless, negative perceptions on MPAs cannot be explained by perceptions of the impacts alone (Voyer et al., 2014), as opinions or motivations about management and governance (human dimensions) might also play an important role in determining the social acceptability of MPAs (Bennett and Dearden, 2014; Charles and Wilson, 2009; De Santo et al., 2013; Dunne et al., 2014). Differences in socio-cultural contexts (e.g. history, income, dependency, equity issues) might lead to actively campaign against MPAs, not providing them with a social license (Marshall et al., 2010; Voyer et al., 2015). This opposition might be overcome through successful stakeholder engagement since the beginning of the MPA designation process, thanks to a stakeholder-driven design process (Klein et al., 2008). This allows stakeholders to develop a sense of environmental stewardship, ownership, responsibility,

and sense of place meaning (Granek et al., 2008; Fraser et al., 2014; Hoehn and Thapa, 2009; Lédée et al., 2012; Perez de Oliveira, 2013; Rosendo et al., 2011; von Heland et al., 2014; Wynveen and Kyle, 2015). Incorporating local knowledge and traditions, using leadership and regional networks for bottom-up co-management schemes, as well as creating collaborations among various stakeholder groups, will maximize the probability of stakeholder involvement and process success (Granek et al., 2008; López-Angarita et al., 2014; Voyer et al., 2015).

Although our survey covered a wide range of stakeholders from more than half of the countries bordering the Mediterranean and Black Seas, our results should be taken with caution, due to the relatively small number of respondents compared to the vast geographical area under scrutiny and the complexity of the socioeconomic interactions that take place in the region. In particular, the heterogeneity in the composition of respondents across the study area did not allow us to disentangle the effects of geographic region, country, and/or respondent role on the results. To derive more robust conclusions, future studies should aim to increase the sample size of each stakeholder group across the study area. Yet, this venture requires a lot of resources that are currently limited in these regions. Until adequate resources are dedicated to the investigation of this important topic, the results of our analysis provide a first contribution to fill the wide knowledge gap about stakeholders' perceptions on MPA impacts in the Mediterranean and Black Seas.

4.3. Anthropogenic stressors affecting MPAs – stakeholders' perceptions from the survey

Feedback between conservation initiatives and social-ecological systems are still poorly understood (Miller et al., 2012). In particular, environmental conservation may result in social changes causing secondary effects on protected ecosystems and making it difficult to predict their consequences on the achievement of conservation targets. In order to close these feedback loops and address both the social dynamics resulting from the impacts of MPAs and the

subsequent positive or negative environmental effects (under the assumption that undesirable or negative social outcomes could yield undesirable environmental effects and desirable or positive social outcomes could yield desirable environmental effects), stakeholders were also asked about their perceptions on stressors posed to MPAs by human activities.

Interestingly, pollution (agricultural and industrial), oil/gas extraction at sea, and port activities were perceived as high-risk factors by Black Sea stakeholders and as low-risk factors by Mediterranean ones. This difference in responses reflects the different perceptions of stressors affecting the environment within each region. Most Mediterranean stakeholders participating in the survey were from EU states that have adopted European directives regarding pollution control (e.g. Directive 2008/1/EC of the European Parliament and of the Council concerning integrated pollution prevention and control). Thus, pollution issues were considered as a minor risk factor for MPAs in the Mediterranean Sea. Although not addressed here, stakeholders' perception on MPA stressors is thought to be dependent on the pre-existing level of disturbance (e.g., fishing pressure). Therefore, it is essential to define the role of pre-existing disturbances in the MPAs as a way to understand and rate the perceptions of marine stakeholders on certain marine uses (Savina et al., 2013).

4.4. Management considerations

The ultimate success or failure of an MPA can at least partly depend on the public acceptance, which is sometimes constrained by the different uses that occur in the marine environments. Maritime spatial planning aims at creating a more rational organization of how the marine space can be used by multiple stakeholders and how different uses interact with each other, to balance demands for development with the need to protect the environment, and to achieve social and economic objectives in an open and planned way (Douvere, 2008). MPA designation is an integral part of maritime spatial planning and the achievement of ecosystem-

454 based management (Crowder and Norse, 2008). Therefore, when establishing MPAs, it is
455 important to know how the spatial regulation of human activities within MPAs will affect marine
456 stakeholders (Cárcamo et al., 2014). In MPAs, marine uses may be constrained, subject to
457 stringent conditions, or even totally excluded depending on the location and type of MPA
458 established. The specific location of the MPA would hence determine how marine uses might be
459 positively or negatively impacted.

460 In maritime spatial planning, it is equally important to consider how MPAs are affected
461 by human activities taking place in adjacent areas. For instance, some extractive uses, if located
462 in close proximity to MPAs, can reduce or even nullify the beneficial effects MPAs have on
463 species and ecosystems. Numerous legal issues relate to whether certain activities, like oil and
464 gas, sand and gravel extraction, aquaculture and mariculture, or energy production, should be
465 strictly prohibited in MPAs or be allowed under specific conditions; or whether already existing
466 activities (such as maritime transport or military uses) should precede the designation of an MPA
467 and remain in place or be subject to re-location if necessary.

468 Evidence on impacts of human activities on MPAs and vice versa can also provide
469 insights to MPA planners and managers about the zonation within MPAs. In the Mediterranean
470 Sea, MPAs are most often multiple-use areas (Gabrié et al. 2012). Typically, there may be one or
471 more fully protected (no-take) core areas surrounded by one or more partially protected (buffer)
472 areas. Inside the fully protected area, no extractive activities are allowed but, in some occasions,
473 recreational activities such as swimming and diving may be permitted under specific regulations
474 (e.g. Medes Marine Reserve in Spain or Marine Nature Reserve in Crimea). Inside the buffer
475 zone, extractive activities, such as artisanal fishing, are generally allowed but they are regulated.
476 More comprehensive analyses of the relationships among human uses, stakeholders' perceptions,
477 and MPAs could lead to more sustainable zoning schemes.

Incorporating multiple stakeholder perceptions in MPA design and more broadly in maritime spatial planning can lead to more feasible and socially accepted conservation outcomes. Differences in the perception of stakeholders and users of MPAs were observed in the Mediterranean and Black Seas, indicating that perceptions of the levels of stress can vary both across stakeholders and across regions. Stakeholders' perception analyses thus should be context-specific and inform planning and management at local or regional scales.

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Figure Captions

Fig. 1. Distribution of stakeholder's responses collected using our survey. Circles show the spatial location of the MPAs for which responses were obtained in the Mediterranean and Black Sea regions.

Fig. 2. The proportion of responses addressing the key MPA objectives. Asterisks indicate significant differences between Mediterranean and Black Seas (chi-squared test; ***: $P < 0.001$; **: $P < 0.01$; *: $P < 0.05$).

Fig. 3. Summary of the responses regarding MPA impacts on socioeconomic activities. Shades of gray indicate the perceived magnitude of each impact, from "clearly negative" to "clearly positive" plus "not applicable" and "no answer" (hatched bars). Circles indicate the modal response in the two regions (white: Mediterranean; black: Black Sea).

Fig. 4. Summary of the responses regarding natural and anthropogenic stressors to MPAs. Shades of gray indicate the perceived importance of each stressor, from "none" to "high" plus "no answer" (hatched bars). Circles indicate the modal response in the two regions (white: Mediterranean; black: Black Sea).