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Abstract: Marine protected areas (MPAs) socio-ecological effectiveness depends on a number of management and governance elements, among which stakeholder engagement and community support play key roles. Collaborative conservation initiatives that engage stakeholders in action research and knowledge co-production processes can enhance management and governance of MPAs. To design effective strategies aimed at reconciling biodiversity conservation and management of sustainable human uses, it is key to assess how local communities respond to such initiatives and identify the set of contextual factors, institutional, local and individual, potentially affecting these responses. This paper presents the approach and results of one such initiative, spanning 6 EU countries and 11 MPAs in the Mediterranean Sea, focusing on small-scale fishers as key MPA users. Through a collaborative project, managers and fishers agreed upon specific governance interventions (e.g. increasing stakeholder engagement, engaging fishers in monitoring activities, reducing fishing efforts) to be implemented in each MPA for one year. We then employed structured surveys to query: MPA managers on the MPA context, governance structure, feasibility and effectiveness of the tested interventions; and small-scale fishers on their perceptions of the impact of the tested interventions on a set of 9 socio-ecological variables (e.g. amount of fish caught, level of participation in decision-making, support for the MPA). Results revealed that the interventions tested were relatively feasible, effective and cost-effective. Fishers reported positive perceptions of the interventions for the 9 variables considered, but especially for level of support for the MPA and for those associated with aspects of governance. A Model-selection approach using proportional odds ordinal logistic regressions highlighted that perceived effects are maximized under certain institutional, local and individual circumstances (e.g. old MPAs, small fisher communities, and fishers with a high proportion of income from fisheries). Findings highlight that employing good governance processes that involve stakeholders may rapidly generate improved local support for

conservation and provide insights for potential leverage points upon which to act to maximize perceived effectiveness and enhance support toward MPAs.

Title page

Improving marine protected area governance through collaboration and co-production

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Palermo, 6th February 2020

To: R. Dewil, J.M. Evans and B. Tansel,
Co-Editor-in-Chief of the Journal of Environmental Management

Dear Dr. Dewil, Dr. Evans and Dr. Tansel,

We present: **"Improving marine protected area governance through collaboration and co-production"**, by Di Franco, Hogg, Calò et al.

I would be grateful if the Journal of Environmental Management would consider this paper for publication as a Research Article in a future issue. It is a research-based study on the salient issue of improving Marine Protected Areas (MPAs) governance through a collaborative conservation initiative. Spanning 6 EU countries and 11 MPAs in the Mediterranean the paper adds to our understanding of how such approaches can be applied and most importantly perceived in differing contexts. It makes an original contribution by providing new evidence about the effects of collaborative conservation interventions in a socio-ecological context and highlights actionable elements for decision makers and MPA managers. In this respect we believe that this paper will be intriguing to academics and policy makers alike and fits well within the scope of Journal of Environmental Management.

If useful we suggest the following potential referees:

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The paper and data are both original and have not been published or submitted for consideration elsewhere. The paper has the full approval of all co- authors to be submitted and the co-authors have adhered to all the legal requirements.

We hope you find this manuscript suitable for publication in Journal of Environmental Management. Thank you in advance for your time and interest.

Kind regards,

Antonio Di Franco (on behalf of all authors)

***Highlights (for review)**

Click here to view linked References

- We present a collaborative conservation initiative spanning 11 MPAs in 6 countries
- We administered structured surveys to MPA managers and small-scale fishers
- Interventions tested were relatively feasible, effective and cost-effective
- Small scale fishers reported positive perceptions of the interventions
- Perceived effects maximized under certain institutional, local, individual conditions

Abstract

Marine protected areas (MPAs) socio-ecological effectiveness depends on a number of management and governance elements, among which stakeholder engagement and community support play key roles. Collaborative conservation initiatives that engage stakeholders in action research and knowledge co-production processes can enhance management and governance of MPAs. To design effective strategies aimed at reconciling biodiversity conservation and management of sustainable human uses, it is key to assess how local communities respond to such initiatives and identify the set of contextual factors, institutional, local and individual, potentially affecting these responses. This paper presents the approach and results of one such initiative, spanning 6 EU countries and 11 MPAs in the Mediterranean Sea, focusing on small-scale fishers as key MPA users. Through a collaborative project, managers and fishers agreed upon specific governance interventions (e.g. increasing stakeholder engagement, engaging fishers in monitoring activities, reducing fishing efforts) to be implemented in each MPA for one year. We then employed structured surveys to query: MPA managers on the MPA context, governance structure, feasibility and effectiveness of the tested interventions; and small-scale fishers on their perceptions of the impact of the tested interventions on a set of 9 socio-ecological variables (e.g. amount of fish caught, level of participation in decision-making, support for the MPA). Results revealed that the interventions tested were relatively feasible, effective and cost-effective. Fishers reported positive perceptions of the interventions for the 9 variables considered, but especially for level of support for the MPA and for those associated with aspects of governance. A Model-selection approach using proportional odds ordinal logistic regressions highlighted that perceived effects are maximized under certain institutional, local and individual circumstances (e.g. old MPAs, small fisher communities, and fishers with a high proportion of income from fisheries). Findings highlight that employing good governance processes that involve stakeholders may rapidly generate improved local support for conservation and provide insights for potential leverage points upon which to act to maximize perceived effectiveness and enhance support toward MPAs.

Keywords

Marine protected areas; good governance; perceived benefits; collaboration; co-production; action research

1. Introduction

Marine protected areas (MPAs) are today the most widely promoted spatially explicit conservation tool and policy solution to address the well-documented problems of marine habitat degradation and overfishing (Caveen et al., 2013). However, marine environments are highly complex and MPAs are found to vary significantly in their effectiveness. Many studies indicate that, when properly funded, enforced, organised and managed, MPAs are able to provide a series of ecological benefits within their borders (namely the 'reserve effect') (Edgar et al., 2014; Giakoumi et al., 2017; Gill et al., 2017; Scianna et al., 2019), which can potentially lead to positive socio-economic effects in nearby areas (Di Franco et al., 2016; Hattam et al., 2014; Kerwath et al., 2013; Sala et al., 2013). However, there remains some debate as research has also shown that MPAs can be both an ecological success and a social failure (Chaigneau and Brown, 2016; Christie, 2004; Hogg et al., 2019). There is also still considerable controversy over what makes MPAs successful and how they should be governed (Bown et al., 2013; Chuenpagdee et al., 2013; Jentoft et al., 2007; Jones et al., 2011).

MPAs can be viewed as complex social-ecological systems where humans and nature overlap and interact. When MPAs are created human activities and behaviours are directly curtailed or regulated, which can affect nearby communities and lead to local opposition. Thus, MPA conservation problems need to be examined hand-in-hand with social considerations, including local livelihoods, values, interests and perceptions (Voyer et al., 2012). In practice, research on the human dimension and the social impacts of MPAs have been limited (Bennett, 2016; Bennett et al., 2017; Christie et al., 2017). Yet mounting evidence suggests that organisational and social factors determine the overall success or failure of a MPA, indicating the inherent need for increased consideration of the human dimension (Bennett et al., 2019; Blount and Pitchon, 2007; Chaigneau and Brown, 2016; Hogg et al., 2017b; Jentoft et al., 2012; Lubchenco and Grorud-Colvert, 2015; Mascia et al., 2010; Pollnac et al., 2010).

In addition to the failure to understand and incorporate the human dimension, MPA success has been found to be significantly hampered by governance shortcomings (e.g., lack of participation, inadequate communication and transparency) and capacity shortfalls (e.g., inadequate management processes, staff and budget capacity, and lack of enforcement) (Di Franco et al., 2016; Gill et al., 2017; Guidetti et al., 2008; Scianna et al., 2015). One response to addressing such shortfalls and the complexities associated with dynamic socio-ecological systems has been to increase stakeholder engagement, which aligns with a shift in marine conservation and governance towards more

inclusive and participatory strategies (Freeman et al., 2018). Supporters of stakeholder participation in marine and coastal management claim that it facilitates representation of diverse views and values; provides local knowledge and solutions tailored to specific contexts and local needs; prepares the ground for more effective implementation of long-term management policies; legitimizes marine resource governance; and effectively develops individual learning capacities through action (Armitage et al., 2008; Berghöfer et al., 2008; Carlsson and Berkes, 2005; Hogg et al., 2017b; Nenadovic and Epstein, 2016).

Stakeholder participation and management insights can also be facilitated through action research or knowledge co-production processes (Beier et al., 2017; Djenontin and Meadow, 2018; Norström et al., 2020; Rodela and Swartling, 2019). Conservation initiatives that encourage action research (research carried out by a team encompassing scientists and local actors (e.g. resource users, inhabitants of a defined area, etc.) seeking to improve their situation (Cassell and Johnson, 2016; Greenwood and Levin, 2007)) and knowledge co-production (Beier et al., 2017; Djenontin and Meadow, 2018; Norström et al., 2020; Rodela and Swartling, 2019) which directly involve scientists, local actors (e.g. resource users) and public managers and policy makers are increasingly being funded, developing participatory and capacity building initiatives that can better address some of the issues undermining biodiversity conservation and fisheries management (Chuenpagdee et al., 2010; Garcia and Charles, 2007; Leleu et al., 2012; Mackinson et al., 2011; Norström et al., 2020). In order to design effective strategies aimed at reconciling biodiversity conservation and management of sustainable human uses, it is important to assess how local communities respond to such knowledge co-production initiatives and identify the set of circumstances that can make these initiatives successful.

Here we present the approach and results of one such initiative that was carried out between 2016-2019, spanning 6 EU countries and 11 MPAs in the Mediterranean region, encompassing a wide spectrum of governance systems, legislation schemes, MPA and small scale fisheries (SSF) community characteristics. The aim of the initiative was to enhance MPA capacity; reconciling biodiversity conservation and SSF management, testing a series of interventions developed through a participatory approach with local actors. The initiative entailed a systematic approach (applied to 11 case study MPAs) which went a step beyond the business as usual approach to conservation. The process was designed to ensure that: local actors were involved, interventions met local needs; and the process and outcomes of the initiative were evaluated (i.e. the success or failure of interventions was tested in each MPA, and level of perceived support for the interventions was examined). Testing

these interventions in a wide variety of contexts provided an excellent opportunity to assess the role of these elements across a wide array of MPA settings.

The current study aims to contribute to the growing literature on participatory initiatives and the important role of perceptions in understanding local actors support for conservation by 1) providing a descriptive analysis of the governance-intervention approach implemented, 2) examining how the interventions tested may have improved perceived MPA socio-ecological effectiveness and specifically affected local actor support toward MPAs, 3) assessing which elements (institutional and individual) can affect stakeholder perceptions of effectiveness of implemented interventions. We hypothesise that the governance intervention process applied can improve perceptions of ecological and social factors even in such a short timeframe (~1 year) and, through the participative process, generate increased support for the MPA and its governance.

2. Methods

2.1 Geographical context

The Mediterranean Sea is a highly valued and diverse inland sea, yet among the most heavily degraded, with presence of invasive species and human pressures such as pollution, resource exploitation, tourism and extraction continually increasing (Coll et al., 2011; Micheli et al., 2013). Estimates from 2017 suggest that 78% of fish stocks are harvested at biologically unsustainable levels (FAO, 2018). An estimated 86,500 fishing vessels operate in the Mediterranean and Black Sea, directly employing about 240,000 people on board vessels and contributing $2.8 billion in landed value (FAO, 2018). Small-scale fisheries represent 84% (70,000 vessels) of the fleet in the Mediterranean and Black Sea, employing 60% (150,000) of all fishers in the region, and producing 26% of total fishery revenue (FAO, 2018).

In 2016, there were a total of 1,215 MPAs covering 6.81% of the Mediterranean Sea (MedPANSPA-RAC, 2019), by 2019, 9.68% of the Mediterranean Sea had been designated as MPAs (Gomei et al., 2019). Most of the surface covered was located in the Western Mediterranean, with the majority of these in EU waters. Yet only 2.48% of MPAs have a management plan, 1.27% are effectively implementing these plans and only 0.03% of the Mediterranean is covered by fully-protected areas (Gomei et al., 2019). MPAs in the Mediterranean generally follow a centralised form of governance (yet there is some movement towards co-management) (Hogg et al., 2013), often enforcement is

weak and they are characterised by a lack of financial and staff capacity (Scianna et al., 2018). In general, studies into the human dimension of MPAs in the Mediterranean are missing, and the social dimension is not something that is regularly monitored by MPA managers as part of their plan or strategy (Hogg et al., 2017a; 2017c; Scianna et al., 2018).

In this study small-scale fishing communities were investigated, operating inside or close to 11 EU MPAs in 6 countries: Telašćica Nature Park (Croatia), Nature Reserve of Bouches de Bonifacio, Cap Roux Fishing Reserve and Côte Bleue Marine Park (France), Zakynthos National Marine Park (Greece), Egadi Islands MPA, Portofino MPA and Torre Guaceto MPA (Italy), Strunjan Landscape Park (Slovenia), Cabo de Palos-Islas Hormigas Marine Reserve of Fisheries Interest and Es Freus D'Evissa I Formentera Marine Reserve of Fisheries Interest (Spain) (Figure 1) (from here on in MPAs referred to by underlined part of name).

THEME	INTERVENTION	THEME	INTERVENTION
INVOLVEMENT IN DECISION MAKING	1. Create collaborative platforms to engage fishers in decision	IMPROVE SSF ENVIRONMENTAL SUSTAINABILITY	7. Reduce fishing effort 8. Modify/substitute fishing gears 9. Set-up SSF Code of conduct
ENFORCEMENT STRENGTHENING	2. Increase surveillance by MPA staff and improved infrastructure 3. Increase surveillance through fishers' direct involvement 4. Increase surveillance through the cooperation with relevant authorities	IMPROVEMENT OF SSF PROFITABILITY	10. Add value to local fisheries products 11. Promote new commercial species 12. Support Pescatourism
KNOWLEDGE & OWNERSHIP	5. Engage fishers in monitoring activities 6. Raise the awareness of fishers, MPA managers and local communities		

Figure 1. Map of MPA case studies. For each MPA circles represent the governance interventions selected by the relative Local Governance Group (LGG): colours indicate the governance categories in which interventions have been clustered, numbers represent the specific intervention implemented. Legend at the bottom details the interventions.

2.2 Governance-intervention approach

Twelve interventions believed to benefit SSF management within and around MPAs, broadly divided into 5 governance categories (involvement in decision making; enforcement strengthening; knowledge and ownership; improvement of SSF environmental sustainability; and improvement of SSF profitability, see Figure 1) were identified through a preliminary study in 2015-2016 (Bennett et al., 2019; Di Franco et al., 2016). Here we focused on small-scale fishers as key users of MPAs, and small-scale fisheries as an activity potentially promoting sustainable local socio-economies and that can benefit from MPAs (Claudet and Guidetti, 2010; Di Franco et al., 2016; Guidetti and Claudet, 2010). The present study (2016-2019) was set up to test these interventions in 11 MPAs, to quantify and assess the effectiveness in achieving socio-ecological benefits. The governance intervention approach adopted in this project followed the same systematic sequence in each MPA (see Figure 2) which created: MPA profiles allowing needs to be identified (collected through questionnaires administered to MPA managers in March 2017 and complemented with a literature review) (Step 1); a stakeholder engagement process through the establishment of a Local Governance Group (LGG) in each MPA, involving fishers in the decision-making process, ensuring local MPA needs were better understood through sharing of more diverse points of view (Note: in some MPAs fishers were already part of the MPA management committee) (Step 2); prioritisation of MPA needs, selection of governance interventions and implementation of selected interventions (Step 3); and closure of the project and assessment of the successes and challenges of the interventions tested (Step 4). After the period of implementation of the interventions, managers were asked to rate, on a 3-point scale, the performance of interventions tested using three different indicators: economic feasibility, time efficiency and stakeholder participation required. Closure meeting minutes and notes were analysed and feedback on the interventions extracted to provide a tentative guide on the overall effectiveness of each implemented tool (on a 3-point scale). This information was used to generate a set of web plots, to highlight strengths and weaknesses of the governance categories and each individual intervention.

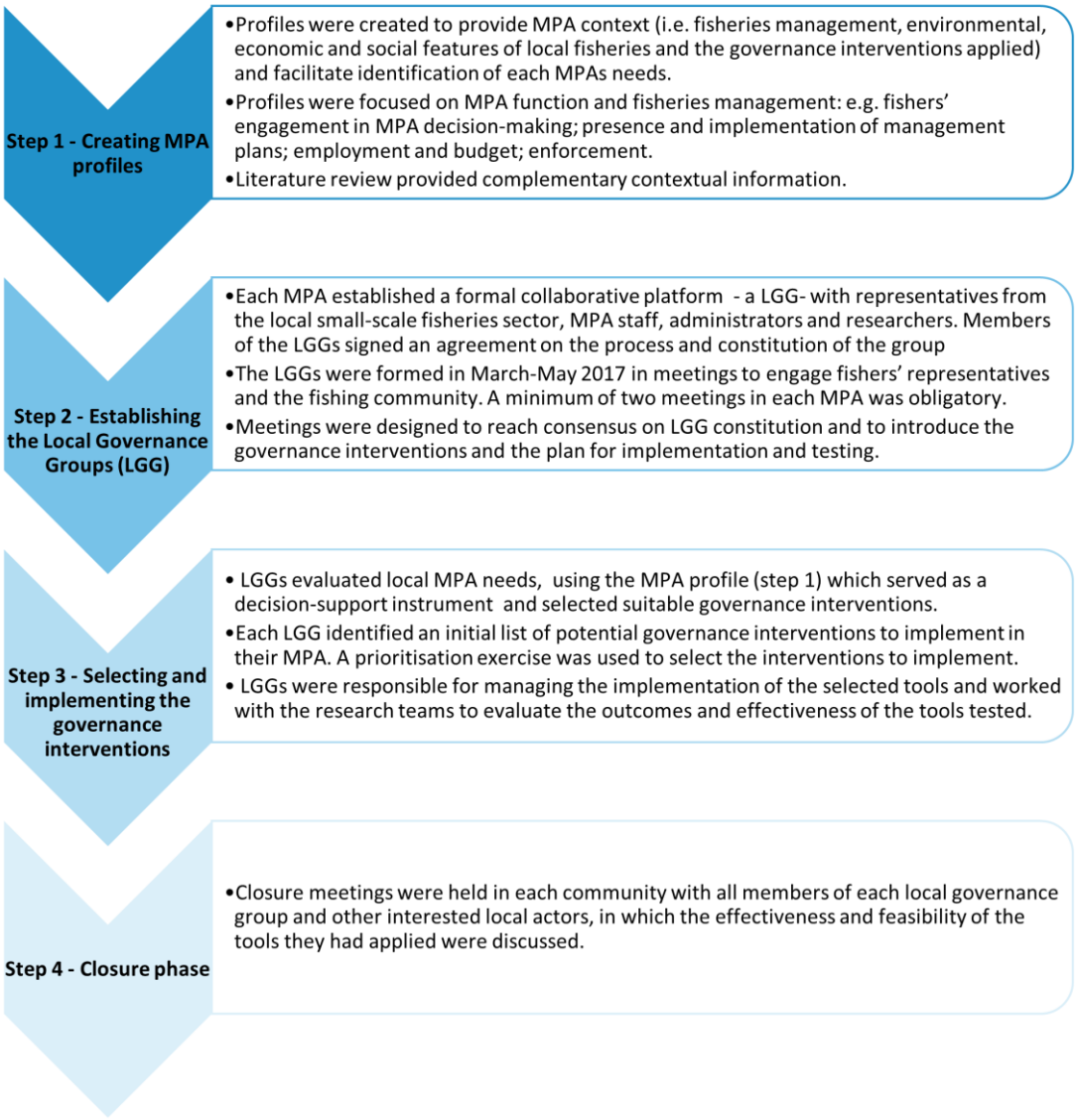


Figure 2. Collaborative governance-intervention approach followed by the 11 pilot MPAs.

2.3 Assessment of perceived socio-ecological effectiveness of interventions

To assess the perceived socio-ecological impacts of the governance interventions implemented a questionnaire was administered to small-scale fishers a year after their implementation. Fieldwork was carried out in each MPA between June - July 2018, with interviews conducted with 120 SSFs (54.3% of all fishers operating within the selected MPAs) in 10 of the 11 MPAs (for details about numbers of fishers interviewed per MPA see Supplementary Materials, Table SM1). Respondents were mostly targeted through purposive, opportunistic and snowball sampling (Bryman, 2012) ensuring a representative proportion of each small-scale fishers community (i.e. the fishers

operating within and/or around each MPA) was interviewed (≥ ~27% of all fishers in each MPA). Three of the 120 fishers did not wish to respond to all questions. During this fieldwork period fishers from Bonifacio declared to MPA staff that they were involved in too many projects and suffering from interviewer fatigue, a common concern for projects and social researchers (Bryman, 2012). As a result, they elected not to respond to the final questionnaire, however they had participated fully in all previous interviews and activities related to the project, i.e. implementing and testing the governance interventions.

Fishers were asked if they had awareness of the initiative and governance interventions tested. This allowed assessment of whether fishers beyond those directly involved in the LGG were well informed. Following this, they were asked to rate their opinion, on a 5-point scale from very negative to very positive impact, on 9 statements related to the impact/potential impact of each intervention on a set of variables describing MPA socio-ecological effectiveness: 1) the abundance of fish in the MPA,;2) the quality or health of habitats in the MPA; 3) the amount of fish that small-scale fishers can catch,;4) the income of small-scale fishers; 5) the relationships between MPA managers and small-scale fishers; 6) the level of conflict between small-scale fishers and other users in the MPA; 7) the participation of small-scale fishers in decision making processes; 8) the level of illegal fishing or poaching activities within the MPA; and 9) the support of small-scale fishers for the MPA (Supplementary Materials, Table SM2). All surveys were designed by the project team, shared with project partners for feedback, translated into local languages, pilot tested for layout and question comprehension, and amended. Prior to being asked for verbal consent and proceeding with the survey, small-scale fishers and MPA managers were informed about the purpose of the survey and the intended use of the data, how data would be stored and treated anonymously and confidentially. To account for the 6 languages each MPA community had a dedicated individual to conduct interviews. Survey administrators received training and continuous assistance from the initiative team and followed a protocol on how to administer the survey, aiding consistency in all the MPAs.

2.4 Data analysis

Descriptive tables were used to examine demographics and characteristics of small-scale fishermen. Small-scale fishers' perceptions about the effect of the interventions on the 9 socio-ecological variables (Supplementary Materials, Table SM2) from the 10 MPAs were plotted on a Likert plot (ranging from least-most potential benefit) to highlight regional patterns. Data was also analysed at

the level of single MPAs to explore potential variability among-MPAs. The results for the nine different variables were then summed to create a single composite perception score capturing the overall effectiveness of the governance interventions implementation. The sum was normalized and rounded on a scale from 1 to 10. Before summing the single items, internal coherence of the items in each scale was made using Chronbach's alpha co-efficient. No issue with internal coherence was highlighted for any of the 9 items (always >0.7). In order to identify potential predictors of perceived socio-ecological effectiveness of the implemented interventions, perceptions about effects of the governance interventions and the composite perception score were tested against a set of variables including: a) demographic characteristics at the scale of fisher (age, education level and proportion of household incomes deriving from SSF); b) individual perceptions of MPA governance (extent to which decision-makers consider fishers' point of view and needs); and c) characteristics at the location level (MPA age, presence of single/multiple villages in each fishers community and overall size of fishers community). Drivers of perceptions were investigated through a model-selection approach (see Supplementary Materials, Text SM1 for modelling details). Given that single response items were recorded as ordered categorical variables (on a scale from 1 to 5), analysis was carried out using proportional odds ordinal logistic regressions (POLR), implementing in R the function 'clm' of the 'ordinal' package (Christensen, 2018) for cumulative link models. A single model was run for 7 of the 9 perception items (perceptions on 'habitat' and 'catch' were not considered for collinearity issues, Supplementary Materials Figure SM1) and for the composite score. After analysis of collinearity, the predictor 'Extent to which decision-makers consider your (fisher) needs' was dropped for redundancy (Supplementary Materials Figure SM 2). Model outputs were presented as odds ratio and relative confidence intervals (OR and CI). All analyses were conducted in R environment (R Core Team, 2018).

3. Results

3.1 MPA management and governance features

The survey conducted with MPA managers (step 1) highlighted that the set of 11 MPAs selected included a wide range of management contexts. MPAs differed in terms of surface area, zoning schemes, enforcement strategies, governance type, interaction with stakeholders (especially fishers), management needs and activities and several organizational characteristics such as the structure of the management authority, the presence of, style and detail in management plans (Table 1). On engagement with fishers all MPAs reported some degree of interaction: 54.5% (6)

reported a bidirectional interaction (i.e. where fishermen and the MPA management body are able to express their own views and ideas); in one case the MPA management body reported a proactive interaction where fishers/their representatives have a proactive interaction (i.e. fishers actively propose and organise meetings); in the remaining MPAs (36.6%:4) informal or unidirectional interactions were reported, with fishers simply being informed once management decisions were taken. On the number of meetings and fishers' attendance, 63.6% (7) reported that 1-2 meetings a year are held, and attendance by fishers varied relatively evenly across all categories. The majority of MPAs (72%: 8) reported an overall staff shortfall to manage the MPA.

No MPA declared that the annual MPA budget was sufficient for all management needs. On enforcement operated by MPA personnel, one MPA (9%) does not perform surveillance activities (Cap Roux), 4 (36%) perform interpretative/educational enforcement, and 6 (54%) performed both interpretative/educational and legal enforcement. Managers declared that the biggest shortfalls were enforcement, outreach programs (found to be very limited or absent in most of the cases (9: 81.8%), and stakeholder engagement. See Supplementary Materials Text SM2 for an extended description of the results.

Table 1. Summary information of MPA characteristics (see Supplementary Materials Text SM2 for additional details).

MPA	Country	Area (km^2)	Established	Zoning (NT=no-take, PP=partially protected)	Management authority	Number of meetings with fishers per year	Fishers attendance to meetings %	Management Plan
Egadi Islands MPA	Italy	540	1991	NT and PP	Local	1 to 2	0-25	Implemented
Portofino MPA	Italy	3.46	1999	NT and PP	Local	3 to 5	25-50	Implemented
Torre Guaceto MPA	Italy	22	1991	NT and PP	Local	>5	50-100	Implemented. Includes a section for SSF management
Cabo de Palos-Islas Hormigas Marine Reserve of Fisheries Interest	Spain	19.3	1995	NT and PP	National + Regional	1 to 2	25-50	Implemented
Es Freus D'Evissa I Formentera Marine Reserve of Fisheries Interest	Spain	150	1999	NT and PP	Regional	1	0-25	Implemented
Cap Roux Fishing Reserve	France	4.45	2003	NT	Local	3 to 5	50-100	Implemented
Cote Bleue Marine Park	France	100	1982	NT	Local	1 to 2	50-100	Implemented. Includes a section for

								SSF management
Nature Reserve of Bouches de Bonifacio	France	800	1999	NT and PP	Local	1 to 2	0-25	Implemented. Includes a section for SSF management
Strunjan Landscape Park	Slovenia	1.14	1990	NT and PP	Local	0	0	Prepared but not implemented yet
Telašćica Nature Park	Croatia	70	1988	NT and PP	Local	1 to 2	50-100	Implemented
Zakynthos National Marine Park	Greece	83.3	1999	NT (only for 6 months) and PP	Local	1 to 2	50-100	Prepared but not implemented yet

278

279 3.2 Selected governance interventions and feasibility

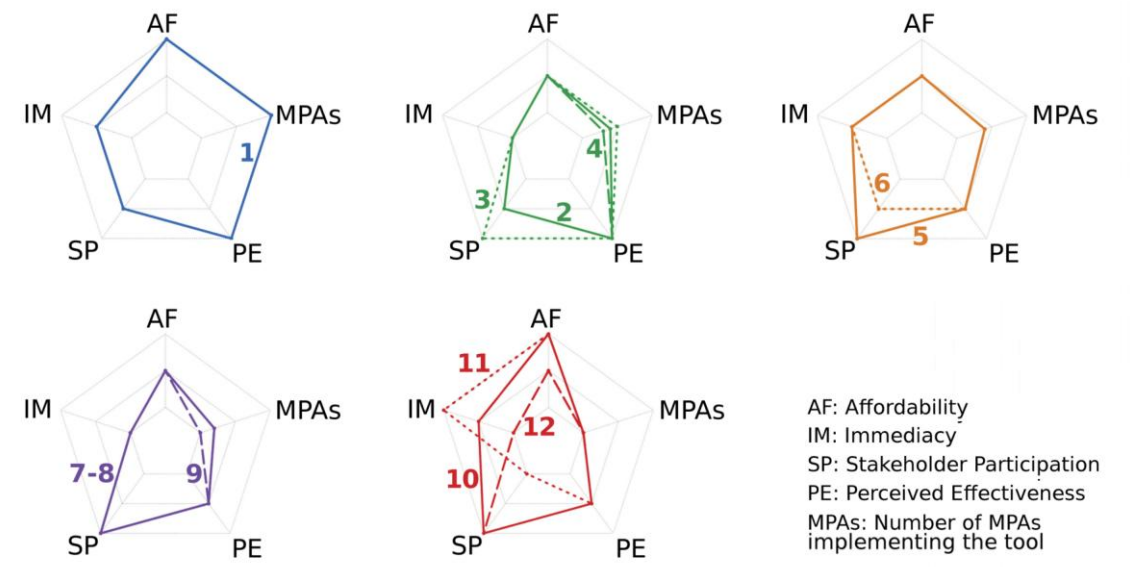
280

281 On which management interventions to implement, all LGGs selected engagement of fishers in
282 decision-making, and 10 selected interventions to improve enforcement (Figure 1 and Figure 3 for
283 details on the interventions). Improving fishers' engagement in decision-making included actions to
284 increase the number of MPA meetings held, strengthening fishers' organisations through Fishers
285 Local Action Groups (FLAGs). In one pilot site (Egadi Islands) fishers united to create and sign a
286 voluntary code of conduct for SSF within the MPA. Overlapping with fishers' engagement in
287 decision-making were actions to improve enforcement through fishers' direct involvement, and to
288 improve knowledge and awareness by involving fishers directly in MPA monitoring. Several MPAs
289 committed to address capacity shortfalls in enforcement, by using the project funds available to
290 improve the infrastructure and train staff to better enforce fisheries regulations. In addition,
291 capacity building was focused on ensuring MPA staff had legal authority to issue sanctions to
292 transgressors. One LGG selected to install a state-of-the-art video surveillance system that would
293 provide wide coverage of the MPA day and night. All actors were committed to this plan, however
294 unforeseen bureaucratic and legislative challenges significantly delayed the process.

295

296 In terms of cost, feasibility, level of stakeholder engagement required, and overall perceived
297 effectiveness, the closing meetings and interviews with MPA managers revealed that engaging
298 fishers in decision-making required low financial investment, a medium investment of time yet the
299 impact was perceived to be very high (Figure 3). Similarly, the interventions tested to increase
300 enforcement capacity were rated as having medium cost, longer time requirements and depending
301 on which intervention, medium to high involvement from stakeholders, with a high impact
302 expected/perceived. No interventions were expected or perceived to have low impact (Figure 3).

Interventions to improve the profitability of SSFs were the least selected for testing, despite the low perceived cost, short time and low involvement of stakeholders required for one tool e.g. promoting consumption of new/invasive species, that was expected/perceived to have medium impact.



THEME	INTERVENTION	THEME	INTERVENTION
INVOLVEMENT IN DECISION MAKING	1. Create collaborative platforms to engage fishers in decision	IMPROVE SSF ENVIRONMENTAL SUSTAINABILITY	7. Reduce fishing effort
ENFORCEMENT STRENGTHENING	2. Increase surveillance by MPA staff and improved infrastructure		8. Modify/substitute fishing gears
	3. Increase surveillance through fishers' direct involvement		9. Set-up SSF Code of conduct
	4. Increase surveillance through the cooperation with relevant authorities	IMPROVEMENT OF SSF PROFITABILITY	10. Add value to local fisheries products
KNOWLEDGE & OWNERSHIP	5. Engage fishers in monitoring activities		11. Promote new commercial species
	6. Raise the awareness of fishers, MPA managers and local communities		12. Support Pescatourism

Figure 3. Web-plots showing economic affordability (AF), immediacy of implementation (IM), level of stakeholder participation (SP) as rated by MPA managers, perceived effectiveness (PE) as rated by small-scale fishers, and the number of MPAs implementing each intervention (MPAs), counter-clockwise from top vertex of the pentagon. Colours represent governance categories, numbers represent interventions.

3.3 Small scale fishers survey sample and perceived socio-ecological outcomes

All 120 survey respondents were male small-scale fishers, mainly coming from the local villages/towns or the nearby area of each MPA. More than half of fishers were older than 50 years (Supplementary Materials, Table SM3). The majority of respondents had a middle school (39%) or

318 elementary school degree (35%). Households were often composed by two (28%), three (24%), or
319 four (28%) people, with 1 or 2 of them employed and contributing to the total household incomes.
320 Only 32% of the respondent's family incomes were derived solely from small-scale fishing.
321
322 On awareness of the management interventions, survey results revealed that 85.5% of fishers knew
323 about the interventions being tested. On the potential effects of governance interventions
324 implemented, considering all the responses pooled together, fishers mostly perceived positive
325 effects, while very few fishers perceived that the implemented interventions were having or will
326 have negative effects on the set of aspects they were questioned about (Figure 4, Supplementary
327 Materials Table SM4 and SM5). Concerning the amount of fish that small-scale fishers can catch,
328 57% stated that the interventions tested in the toolkit can produce positive or very positive benefits
329 (see Supplementary Materials Figure SM3 for details about each MPA). Concerning both the
330 abundance of fishes and the health of habitat in their MPA, 58.1% of fishers stated that the new
331 interventions adopted were producing or will produce positive or very positive effects in the near
332 future. Concerning social aspects, on the relationship with MPA managers and the level of conflicts
333 between fishers and others MPA users, the results revealed that 60% of fishers stated that the
334 governance interventions implemented in their MPAs were not (or will not) providing any benefits
335 on reducing conflict with other users. On the potential effects of the interventions on the level of
336 illegal fishing or poaching activities within the MPA the results were more heterogeneous with 23%
337 perceiving negative effects, 30% neutral and 47% perceiving a positive or very positive effect of the
338 implemented interventions on the reduction of illegal fishing. Thirty-five% of fishers perceived a
339 positive or very positive impact on their income, while 40% of fishers perceived no impacts (neither
340 positive nor negative). The two questions concerning the potential benefits of the governance
341 interventions on fishers' participation in decision-making and the relationship with MPA managers
342 revealed that the majority of fishers (64.1% and 67%, respectively) agreed that the new governance
343 interventions were or can provide positive benefits on these two aspects. Finally, on their overall
344 support for the MPA results revealed 74.6% believed the governance interventions are improving
345 support. Concerning the composite score, although variable among MPAs, an overall slight positive
346 tendency was highlighted (mean=5.9±0.13, Figure 4). It is noteworthy that there was also a
347 significant proportion of respondents in the neutral range, perhaps due to the short-time frame
348 since the interventions were implemented. For more detail on individual MPAs please see
349 Supplementary Materials, Text SM3.
350

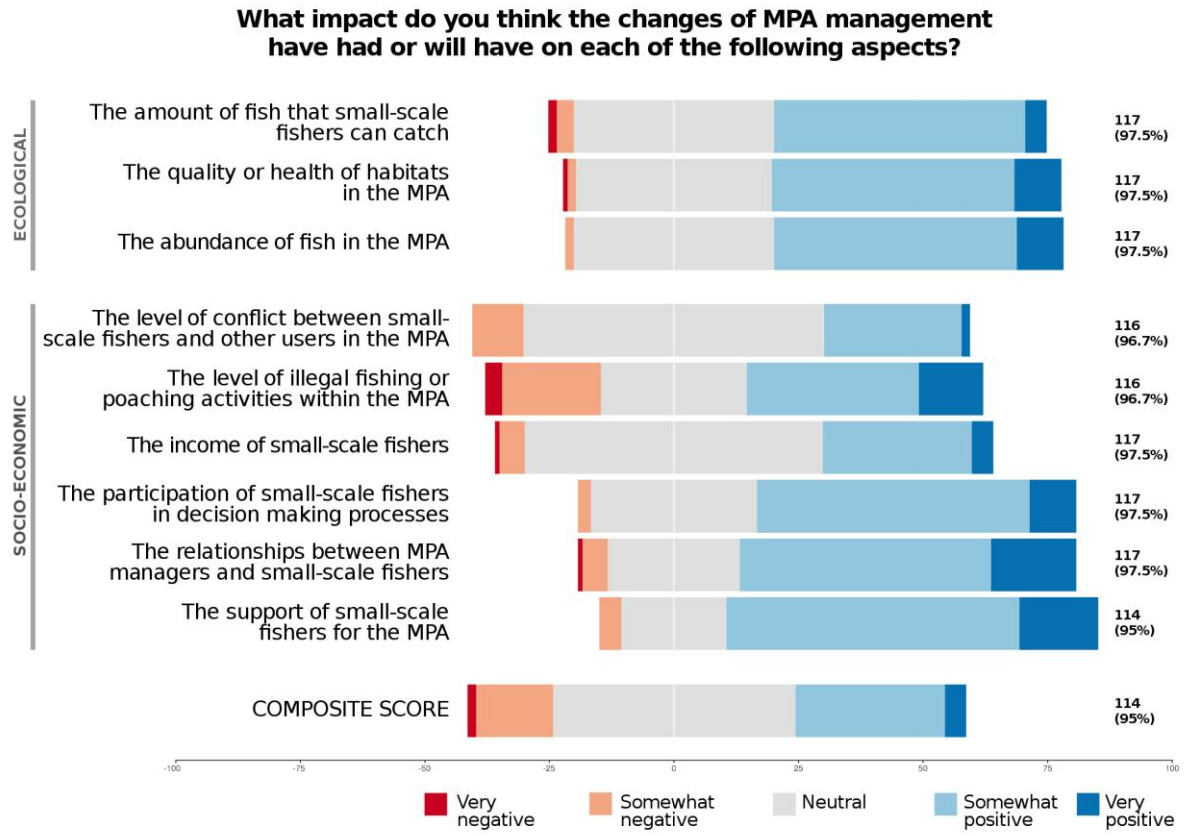


Figure 4. Likert stacked bar-chart of fishers' perceptions regarding the potential impact the interventions had or will have on different aspects reported on the left. Composite score rescaled on 1-5 scale for visualization purposes. Absolute number of respondents for each statement (and % of the total interviewed population n =120) is reported on the right.

Cumulative link models were used to identify potential drivers of perceptions about the effect of the interventions implemented. The full summary of the models analysed is presented in Supplementary Table SM6. Perceptions on the effect of the interventions on fishes were found to be significantly affected by the 'proportion of household income derived from SSF' with positive perceptions more likely with higher proportion of income from SSF (Figure 5) (OR: 9.07, CI: 1.85-44.35). The same predictor was found to positively and significantly affect perceptions on the effect of interventions on fishers' incomes (Figure 5) (OR: 22.166, CI: 3.82 -128.36). Concerning the perceptions on the effect of the interventions on the relationship between fishers and MPA managers, perceptions were found to be significantly and more positive with increasing age of the MPA (OR: 1.22, CI: 1.11-1.35), increasing consideration of fishers' point of view in decision-making (OR: 2.20, CI: 0.50-9.68) and for MPAs that span multiple villages (OR: 10.20, CI: 2.15-48.24). These perceptions were found to be negatively affected by increasing overall size of the fisher community (OR: 0.90, CI: 0.84-0.96). The size of the community was also the only significant factor to affect the perceptions on the

effects of the interventions on the level of conflict between small-scale fishers and other users in the MPA (OR: 0.90, CI: 0.84-0.96), i.e. the larger the community of fishers, the more likely are negative perceptions about the effect of interventions on the level of conflicts. No factors significantly relate with the effect of the governance interventions on the participation of SSFs to decision-making. Perceptions on intervention effects on the level of illegal fishing or poaching activities within the MPA were positively related to MPA age (OR:1.18, CI: 1.08-1.29), while negatively by the overall size of the SSF community (OR: 0.91, CI: 0.85-0.96). The same pattern was observed for the perception of intervention effects on the support of small-scale fishers for the MPA, found to be more positive with increasing MPA age (OR: 1.23, CI: 1.10-1.37) and negative with increasing SSF community size (OR: 0.86, CI: 0.80-0.93). The level of consideration of SSFs point of view by decision makers also positively related to the perceived support for the MPA (OR: 1.10, CI: 0.21-5.80). Finally, the composite score, was significantly positively related with the age of the MPA (OR: 1.15, CI: 1.06-1.25) and the proportion of income deriving from SSF (OR: 11.96, CI: 2.60-55.01) while was negatively related to the size of the community (OR: 0.93, CI:0.88-0.98).

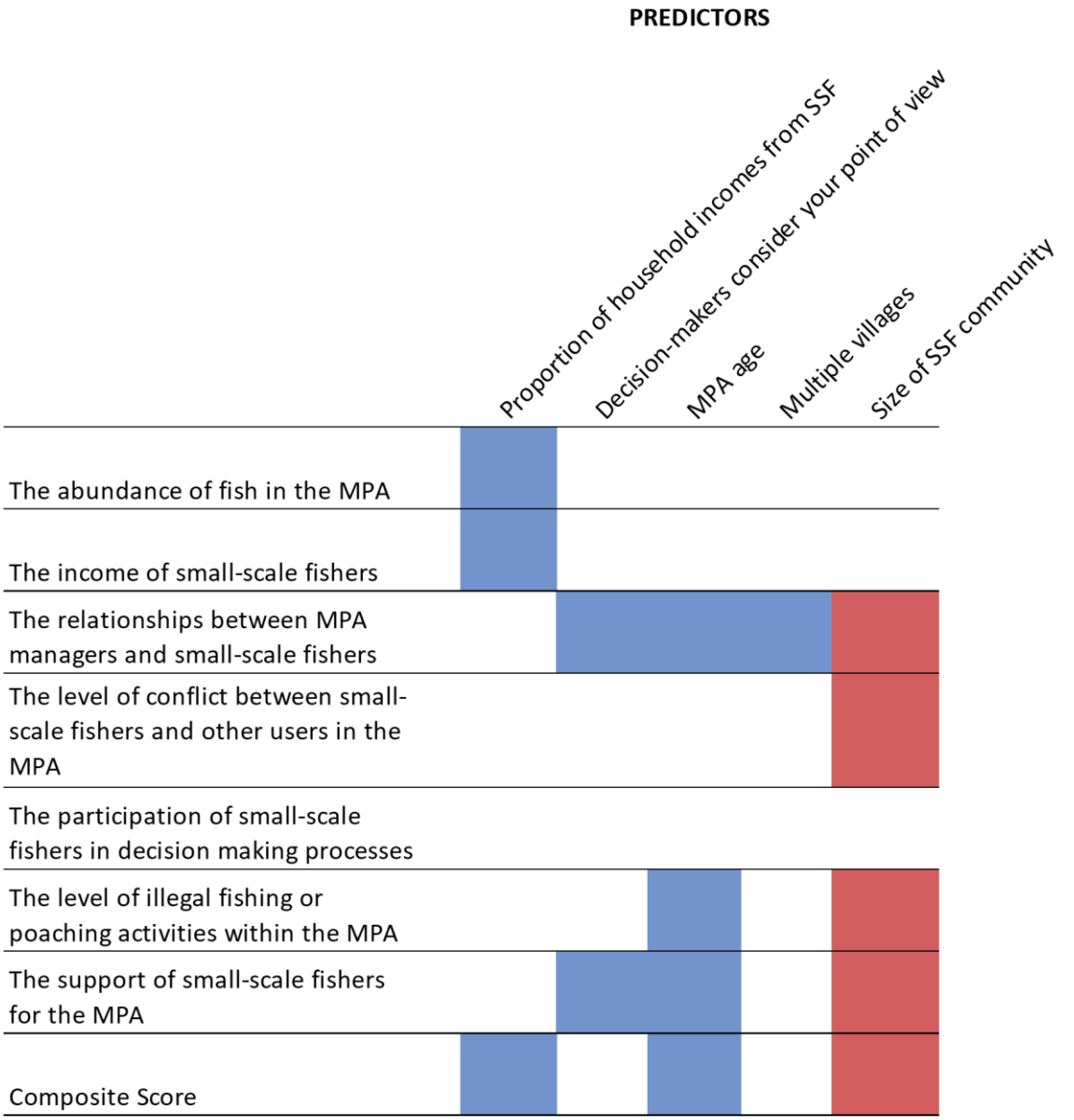


Figure 5. Significant predictors, derived from cumulative link models, for the perceptions about the effects of the interventions implemented on the 9 variables considered. Perceptions on 'habitat' and 'catch' were not considered (and are not reported here) for collinearity issues (see Methods). Composite perception score capturing the overall effectiveness of the governance interventions implementation is the sum of the nine different items. Blue colour indicates positive relation with predictors, red colour indicates negative relation with predictors.

4. Discussion

This research provides a multi-site study of a governance-intervention approach, quantifying the perceived socio-ecological impacts of conservation interventions by small-scale fishers. Our study

builds on previous literature examining perceptions of conservation, that have mostly used qualitative methods and is based on individual case studies (Bennett 2016, Bennett et al. 2019), and extends previous conservation work and research employing a participative governance-intervention approach, to examine how participation in decision-making can affect perceptions and MPA support. Overall, results show that small-scale fishers are interested in increasing their level of engagement in decision-making and in other activities related to MPA compliance and management (such as surveillance and monitoring) in MPAs. Previous evidence highlighted that perceptions of ecological effectiveness, social impacts, and good governance are drivers of local support toward MPAs (Bennett et al., 2019). Our findings suggest that perceptions of these elements can be enhanced through a participative governance-intervention approach. This change is a process as the situation and perceptions continually evolve, however it is a positive sign that within a relatively short time period (~1year) we can see progress has been made. While small-scale fishers perceived positive effects for all the socio-ecological variables considered, it was those mostly associated with relationships with management, participation in decision-making and overall MPA support that revealed the most positive perceptions for potential/real impact. The perceived potential or real benefits associated with ecological and economic factors (e.g. abundance of fishes, habitat health, availability of fish to catch and fishers' income) were more varied, given that biological results from protection take a significant amount of time (5 years plus) (Claudet et al., 2008; Edgar et al., 2014). The timespan of the initiative is insufficient to expect significant changes in these factors. The social and governance factors that can be accrued are however much more immediate (Blount and Pitchon, 2007; Christie, 2004; Kelleher and Recchia, 1998; Mascia, 2004).

These results concur with previous research that it is the employment of good governance processes (e.g. involving stakeholders in decision-making) and management of social aspects that are key for ensuring local support for conservation (Bennett et al., 2019). The demand of each MPA to create the LGG represented a first step towards improved engagement and is representative of the much-needed shift towards co-management (Hogg et al., 2013). Management arrangements developed by LGGs or similar platforms, in line with what has been observed in community-based management in other geographical contexts, can better align with local social and ecological conditions, conferring social benefits, such as: increased collaboration and learning among partners; integration of scientific and local knowledge systems; community empowerment; improved social capital, in terms of social cohesion between stakeholders, a key element to increase a community's adaptive capacity and to reduce vulnerability to local threats and global pressures that may threaten local small-scale

fisher communities livelihoods and wellbeing; and higher levels of compliance (Kittinger et al., 2013; Norström et al., 2020; Silva et al., 2019; Thiault et al., 2019).

The findings of this study are extremely relevant considering the shortfall in MPA capacities, both in terms of staff and funds, as declared by MPA managers in the 11 case study sites, and as reported previously in other cases (Gill et al., 2017; Scianna et al., 2018). These features have been identified as key drivers of MPA ecological effectiveness (Gill et al., 2017; Scianna et al., 2019) and therefore represent key aspects for MPA governance and management. Particularly relevant is the fact that enforcement and stakeholder engagement, two elements largely acknowledged as key to enhance MPA effectiveness (Di Franco et al., 2016; Edgar et al., 2014; Gill et al., 2017) represent major capacity shortfalls for the investigated MPAs. From this standpoint, we have presented a number of interventions that have been perceived positively by both MPA managers and small-scale fishers to overcome these shortfalls which sound promising to improve current MPA status. Specifically, increased enforcement can help reduce the poaching, which is now acknowledged as widespread in MPAs globally (Bergseth et al., 2018; 2017) representing a major threat to small-scale fisher communities (Thiault et al., 2019).

We highlight that collaborative interventions like the ones tested in this study can rapidly enhance stakeholder perceptions of MPA socio-ecological effectiveness and increase support toward MPAs. This could potentially lead to enhanced stakeholders' compliance with rules, both for members of the local communities and also for external members through increased patrolling and voluntary surveillance (Bergseth et al., 2018; Thiault et al., 2019). Increased compliance could in turn contribute towards ecological benefits, that need more time to arise, and potentially impact stakeholders' livelihood and wellbeing (through increased catches), finally creating a positive feedback loop for stakeholder perceptions and support toward conservation initiatives i.e. a virtuous cycle (Figure 6).

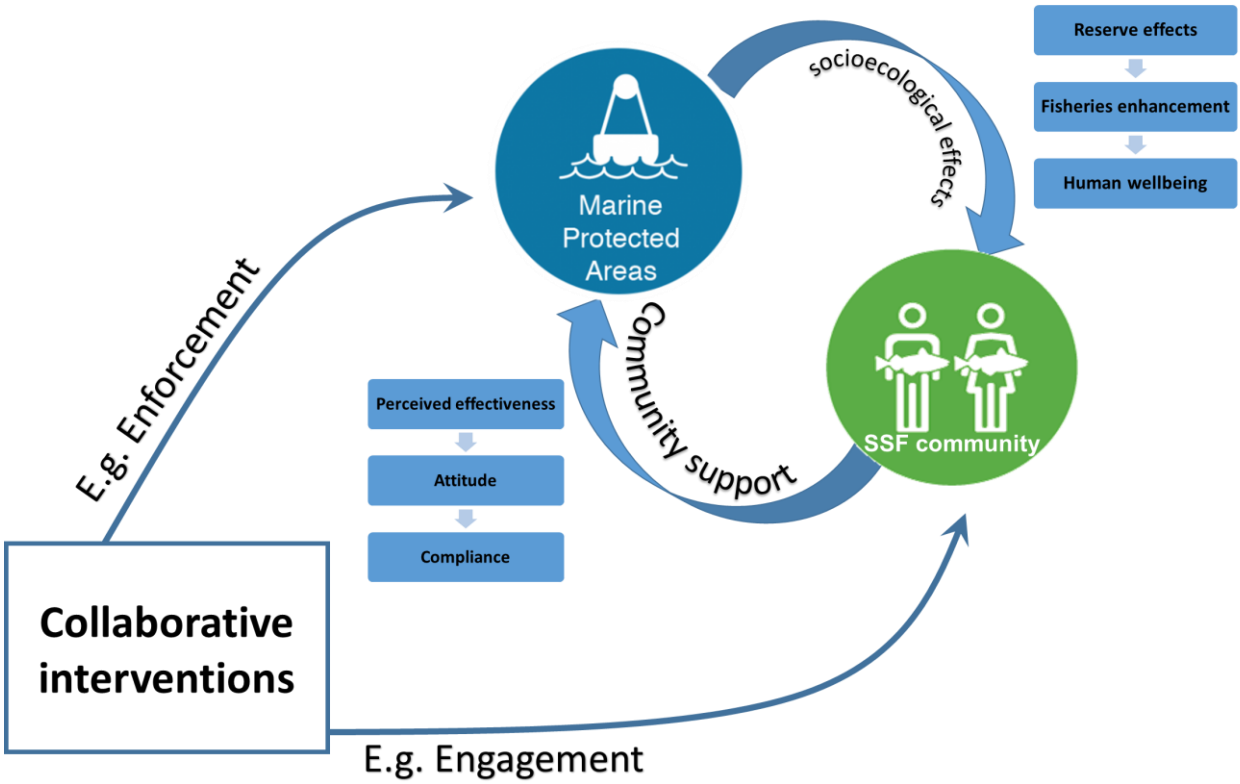


Figure 6. Conceptual scheme of the cycle linking Marine Protected Areas (MPA) socio-ecological effectiveness and community support. Blue filled boxes with arrows indicate the potential chain of elements for each item represented in the 2 thick curved arrows (socioecological effects, community support). Collaborative interventions can affect both the MPA and its socioecological effectiveness (e.g. through enforcement and surveillance) and SSF community and its support toward the MPA (e.g. through engagement and participatory decision-making).

It is however crucial to point out that this cycle can be stopped, and the associated benefits quickly eroded if good governance stops, shattering stakeholder trust, expectations and potentially inducing a decrease in support toward MPA and compliance with rules (Chaigneau and Brown, 2016). This could prompt a decrease in MPA socio-ecological effectiveness and induce a vicious cycle, potentially pushing the system into a socio-ecological trap, defined as a situation when feedbacks between social and ecological systems lead toward an undesirable state that may be difficult or impossible to reverse (Cinner, 2011; Kittinger et al., 2013). The potential shift between the virtuous and vicious cycle, with all the related societal implications, stresses further the importance of giving sufficient attention to the human dimension in MPAs and making use of information on both the factual and perceived socio-ecological effectiveness of the MPA. From this point of view, we also highlighted that the perceived effectiveness of conservation interventions can be affected by a set of elements at individual (e.g. demographic), community (e.g. size) and MPA (age, size) levels, that

represent potential leverage points upon which to act in order to maximize perceived effectiveness and enhance support toward MPAs. Specifically, perceptions of socio-ecological effectiveness are positively associated with small communities, old MPAs and fishers with high proportions of household income derived from small-scale fisheries. It is interesting to note that our results suggest that the overall size of the fisher community is relevant in shaping perceived effectiveness of the interventions. This may suggest that MPA management and governance efforts, in terms of capacities and resources allocated, should be planned based on the size of the community, adding to recent findings suggesting that these elements should be set based on MPA surface (Scianna et al. 2019). We also acknowledge that the establishment of a LGG or similar collaborative platform alone is insufficient to ensure long-term change. In addition, it is necessary to extend the participation beyond small-scale fishers to include a wider array of actors in decision-making, especially as MPAs are often multi-use or affect a wider range of actors.

This study therefore has a number of relevant implications for other conservation initiatives, policy makers and practitioners. First and foremost, it reveals that conservation practitioners and managers need to be attentive to the quality of governance and the social impacts of conservation (Bennett and Satterfield, 2018; Borrini-Feyerabend and Hill, 2015; Lockwood, 2010). It confirms the merit of engaging stakeholders in long-term and well managed decision-making processes that ultimately affect their livelihoods (Jentoft, 2005; Wilson, 2003). In addition, this study highlights that the positive perceptions yielded were accrued by giving increased attention, effectiveness and continuity to governance and management processes (Bennett et al., 2019) and not reliant on improved ecological or fisheries outcomes (as there was not enough time to see these results). Second, it highlights the benefits of considering the human dimension and people's perceptions (Bennett, 2016; Voyer et al., 2012). Monitoring people's perceptions can help confirm whether and/or which management interventions can increase support for MPAs or other conservation initiatives (Bennett, 2016; Hogg et al., 2019; 2017b; Voyer et al., 2012). Finally, the testing of multiple interventions across different MPA contexts has provided actionable insight into the overall feasibility and effectiveness of each, which can be adopted and applied to other MPAs.

We recognize some limitations of this work. The results of the MPA self-assessment by MPA staff could be affected by subjectivity. However, self-assessment is a common methodology utilised regularly for such evaluations (e.g. see Hockings et al., 2006; Jones, 2014; World Bank, 2004). To address this the research team requested documents from the MPAs to help verify and cross check data, however these were not always provided or available. We also caution that this study may

have limited generalizability to other settings as it focuses on one context (the EU Mediterranean MPAs), stakeholder group (small-scale fishers), and timeframe. We recommend that future studies sample a broader group of stakeholders, and to include them in the collaborative platforms such as the LGG established here.

Our recommendation for other MPAs aiming to increase the level of support is to permanently involve stakeholders in the process. Following the simple governance intervention approach outlined in this paper can have positive impacts on perceptions and level of support for MPAs, with relatively low demands in terms of time, money and resources from the MPA and stakeholders. For each of the 11 MPAs involved in this project our recommendation for the next step is to establish what kind of engagement the fishers want, and perhaps employ a system of trial and error experimenting with different engagement strategies until one that is suitable for all stakeholders is found while still ensuring effective and efficient decision-making (Hogg et al., 2017b). In addition, we strongly recommend that participatory decision-making processes employ neutral parties trained in mediation and conflict resolution.

5. Conclusion

Engagement of local people and perceived MPA socio-ecological benefits are crucial elements for garnering support for and long-term success of conservation initiatives. This study demonstrated that small-scale fishermen's perceptions of MPA ecological effectiveness, social impacts and good governance can be quickly enhanced through collaborative conservation interventions co-produced with local communities. Although perceptions towards ecological and economic outcomes were positive it was perceptions of governance and other social factors that were found to have the greatest prospect of being improved in the short-term by the management interventions tested and approach applied. If MPAs and stakeholders continue to apply these interventions, it is likely that there will also be positive impacts on ecological and economic factors. The results of this study strongly suggest that conservation practitioners need to be attentive to all three dimensions – ecological effectiveness, social impacts and good governance-during the implementation and ongoing management of conservation initiatives, yet small changes in the governance structure and increased engagement of fishers and other actors can easily and quickly improve overall support for conservation. It is essential to ensure good governance is sustained over time and adequately resourced (financially and by full-time trained personnel who can carry out participative decision-making processes).

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Supplementary materials

Improving marine protected area governance through collaboration and co-production

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799 **Table SM1**. Numbers of fishers interviewed per MPA

MPA Name	Number of fishers identified in community	Number interviewed	Percentage of total fishers (%)
Egadi	40	24	60.0
Torre Guaceto	5	4	80.0
Portofino	22	13	59.1
Zakynthos	35	17	48.6
Es Freus	18	11	61.1
Cabo de Palos	19	11	57.9
Cap Roux	30	8	26.7
Cote Bleue	27	14	51.9
Strunjan	10	8	80.0
Telascica	15	10	66.7

800

801

802 Table SM2. Statements rated to determine the impact the management measures have had or will
803 have on a series of variables. For all items scale was as following: very negative, somewhat negative,
804 neutral, somewhat positive, very positive.

Statements:
1.The abundance of fish in the MPA
2.The quality or health of habitats in the MPA
3.The amount of fish that small-scale fishers can catch
4.The income of small-scale fishers
5.The relationships between MPA managers and small-scale fishers
scale fishers and other users in the MPA
6.The level of conflict between small-scale fishers and other users in the MPA
7.The participation of small-scale fishers in decision making processes
8.The level of illegal fishing or poaching activities within the MPA
9.The support of small-scale fishers for the MPA

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806

Text SM1. Modelling details

Prior to the analyses, dependent variables (i.e. the perceptions on different aspects of the potential effects of the governance measures) were tested for potential multi-collinearity in order to confirm the logic of distinct analysis and avoid redundancy in outcomes. A certain collinearity was found between the perceptions of the effect of the governance measures on fishes, habitat, fishers' catch and incomes. For this reason, the dependent variables 'habitat' and 'catch' were not considered in POLR analyses. In all other cases, correlations never exceeded 0.55, a value considered below the threshold of concern for multi-collinearity (Fig. S1).

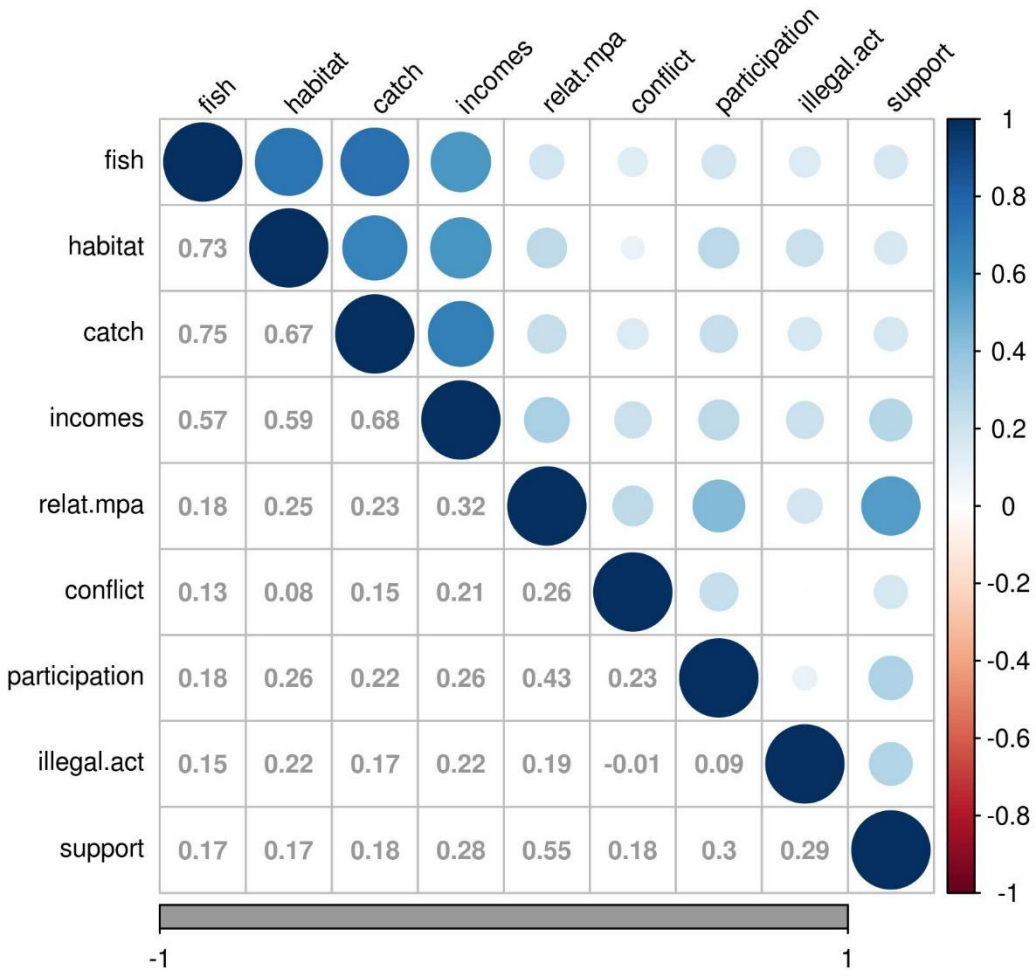

Figure SM1. Spearman's correlation between pairs of dependent variables (i.e. perceptions on different aspects of effects of governance measures)

A full model containing both fixed terms and the random term 'MPA' was constructed. Significance of random components were assessed through likelihood ratio test. Significance level on the final model containing only fixed terms was calculated using analysis of deviance based on Wald Chi-Square test.

Before performing model selection, we also tested for potential multi-collinearity between predictors analysing pairwise correlation between the explanatory variables using Spearman's correlation. Pairwise correlation was calculated through Spearman's correlation and visualized by a correlation plot (package 'corrplot' in R, Wei and Simko 2017). The binary predictor 'Presence of single/multiple village' was not included in this analysis. A relatively high level of correlation (0.75) was found between the variables 'Decision-makers consider your (fisher) point of view' and 'Decision-makers look after your (fisher) needs' (Fig. S2). For this reason, the second one was excluded from the potential predictors for redundancy.

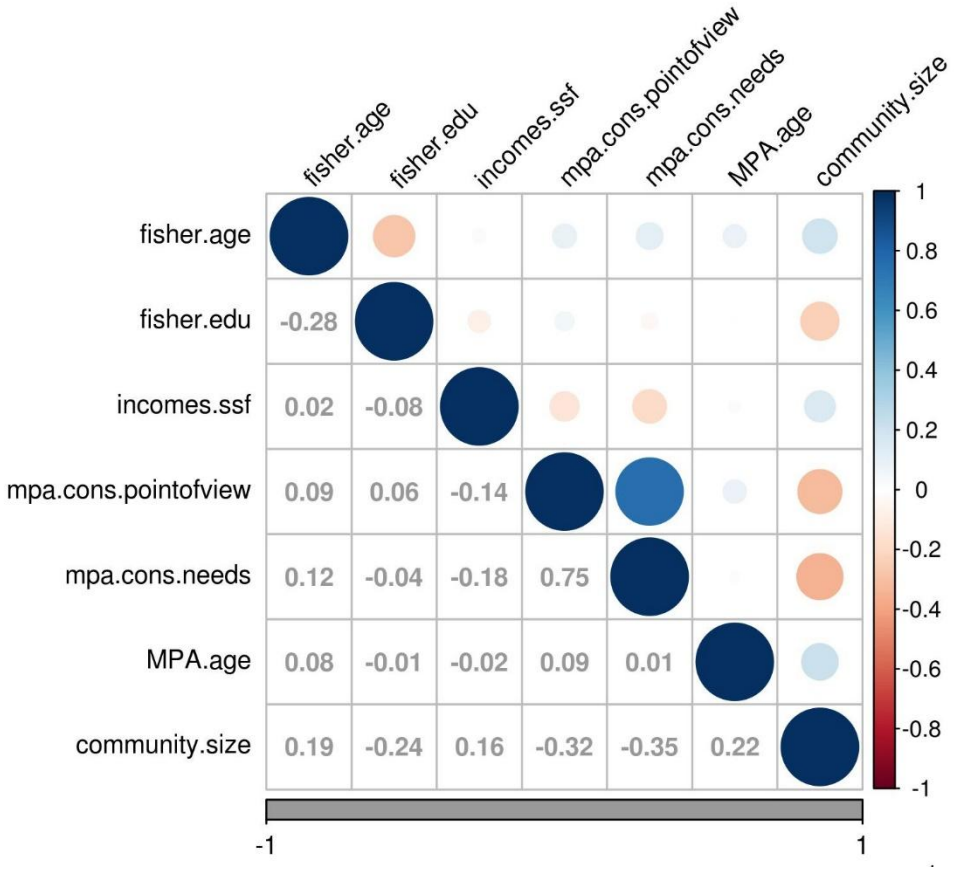

Figure SM2. Spearman's correlation between pairs of dependent variables (i.e. perceptions on different aspects of effects of governance measures)

836

837 Reference

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840

Text SM2. Supplementary results for Section 3.1 MPA management and governance features

On the presence of a dedicated MPA management plan 72% (8) reported a management plan to be in place. The drafting of 75% (6 of the 8) of the management plans involved multiple actors in the decision-making process. The remaining 3 were preparing management plans. Only 27% (3) had a specific plan dedicated to SSF, and 54% (6) had management plans that included regulation and management of SSF, 18% (2) had no mention of SSF. In cases where SSF plans were present it was reported that fishers had been involved in the decision-making process. On engagement with fishers all MPAs reported some degree of interaction: 54.5% (6) reported a bidirectional interaction (i.e. where fishermen and the MPA management body are able to express their own views and ideas); in one case the MPA management body reported a proactive interaction where fishers/their representatives have a proactive interaction (i.e. fishers actively propose and organise meetings); in the remaining MPAs (36.6%:4) informal or unidirectional interactions were reported, with fishers simply being informed once management decisions were taken. On the number of meetings and fishers' attendance, 63.6% (7) reported that 1-2 meetings a year are held, and attendance by fishers varied relatively evenly across all categories. In all MPAs where fishers' representatives are present, they always attended meetings. On MPA staff capacity results varied from 0 (Cap Roux, a community based MPA where no staff is appointed) to 49 (Egadi Islands, including full-time, part-time and seasonal staff). Full-time employees represented on average 56.6±10.3% (mean±s.e.) of the total staff, with 10.1±3.9% full-time employees per MPA. Part-time and seasonal staff represented respectively 27.9±7.9% and 15.5±7.5% of the total staff. The majority of respondents (72%: 8) reported a staff shortfall. In terms of capacity respondents reported staff to be competent in ecological monitoring yet required capacity building for social aspects. On MPA budget, reports ranged from 0 and 1.14 million euros, with funds reported to be primarily from public subsidies (72%: 8), with several (also) relying on other financing sources such as sponsors, donations, self-funding (90.9%: 10). One MPA (9%) reported having no secure annual budget, relying on spot-funds, one MPA (9%) declared that the budget was inadequate for basic management needs, and 9 (82%) declared that the budget was acceptable but should be improved to fully achieve effective management. No MPA declared that the budget was sufficient for all management needs. On enforcement, one MPA (9%) does not perform surveillance activities (Cap Roux), 4 (36%) perform interpretative/educational enforcement, and 6 (54%) performed both interpretative/educational and legal enforcement. Managers declared that the biggest shortfalls were enforcement, outreach programs (found to be very limited or absent in most of the cases (9: 81.8%), and stakeholder engagement.

Text SM3. Supplementary results for Section 3.3 Small scale fishers survey sample and perceived socio-ecological outcomes

On awareness of the management interventions in one case (Egadi Islands), 43% (10 of 23 fishers interviewed) were not aware, neither were 4 out of the 13 fishers interviewed in Zakynthos. In all other MPAs fishers were all aware except for 1 or 2 individuals. Concerning the amount of fish that small-scale fishers can catch a small number of fishers (5.13%) from Cabo de Palos-Islas Hormigas, Egadi Islands and Strunjan stated that the new interventions could generate a decrease in their catches, while, in Portofino, all fishers (100%) agree that no positive or negative effects are going to be produced by the governance interventions tested (Figure S3). On the potential effects of the interventions on the amount of illegal fishing or poaching activities within the MPA – in some MPAs, fishers agreed that the specific interventions implemented in their MPAs could produce a decrease in the amount of illegal activities (i.e. Strunjan, Es Freus, Telašćica and to a minor extent Cote Bleue and Zakynthos where the interventions tested were focused on strengthening enforcement capacity). In the case of Portofino and Cap Roux, all respondents interviewed stated that no negative nor positive impacts on poaching would result from the interventions tested. In the remaining MPAs (i.e. Torre Guaceto, Egadi and Cabo de Palos) a large proportion of fishers (75%, 56.65% and 45%, respectively) stated that the new interventions could produce an increase in illegal activities in their MPAs (Figure S3). On the potential impact on fishers' income all fishers in Torre Guaceto (100%) interviewed agreed the new interventions will produce benefits for their income.

899 **Table SM3**. Summary table of demographic characteristics of the survey sample. Number of fishers
900 n=120.

DEMOGRAPHIC CHARACTERISTICS					
Age	20-29	30-39	40-49	50-59	>60
%	5	14	26	32	23
Education (highest education level obtained)	None	Elementary	Middle	High	University
%	1	35	39	20	5
Origin	The local town/village	The nearby area	The same country	Another country	
%	81	12	5	3	
Number of people in the household	1	2	3	4	5 or more
%	9	28	24	28	11
Number of household people employed	1	2	3	4	5
%	2	42	46	9	1
Proportion of household incomes from SSF	none	less than half	about half	more than half	all
%	4	27	13	24	32

901

902

903 **Table SM4**. Fishers perceptions (absolute and percentages) regarding the potential impact the
904 management measures had or will have on the different aspects reported on the left. Number of
905 fishers n=120.

Aspect	Very negative	Somewhat negative	Neutral	Somewhat positive	Very positive	n	%
The number of fish in the MPA	0	2	47	57	11	117	97.5
	0	1.7	40.2	48.7	9.4		
The quality or health of habitats in the MPA	1	2	46	57	11	117	97.5
	0.9	1.7	39.3	48.7	9.4		
The amount of fish that small-scale fishers can catch	2	4	47	59	5	117	97.5
	1.7	3.4	40.2	50.4	4.3		
The income of small-scale fishers	1	6	70	35	5	117	97.5
	0.9	5.1	59.8	29.9	4.3		
The relationships between MPA managers and small-scale fishers	1	6	31	59	20	117	97.5
	0.9	5.1	26.5	50.4	17.1		
The amount of conflict between small-scale fishers and other users in the MPA	0	12	70	32	2	116	96.7
	0	10.3	60.3	27.6	1.7		
The participation of small-scale fishers in decision making processes	0	3	39	64	11	117	97.5
	0	2.6	33.3	54.7	9.4		
The amount of illegal fishing or poaching activities within the MPA	4	23	34	40	15	116	96.7
	3.4	19.8	29.3	34.5	12.9		
The support of small-scale fishers for the MPA	0	5	24	67	18	114	95.0
	0	4.4	21.1	58.8	15.8		

906

907

908 Table SM5. Summary statistics for the perceptions regarding the potential impact the management
909 measures had or will have on the different aspects reported on the left (scale 1-5) and the compound
910 score (scale 1-10).

Aspect	median	mean	st.error
The number of fish in the MPA	4	3.66	0.06
The quality or health of habitats in the MPA	4	3.64	0.07
The amount of fish that small-scale fishers can catch	4	3.52	0.07
The income of small-scale fishers	3	3.32	0.06
The relationships between MPA managers and small-scale fishers	4	3.78	0.07
The amount of conflict between small-scale fishers and other users in the MPA	3	3.21	0.06
The participation of small-scale fishers in decision making processes	4	3.71	0.06
The amount of illegal fishing or poaching activities within the MPA	3	3.33	0.1
The support of small-scale fishers for the MPA	4	3.84	0.07
COMPOUND SCORE	6	5.9	0.13

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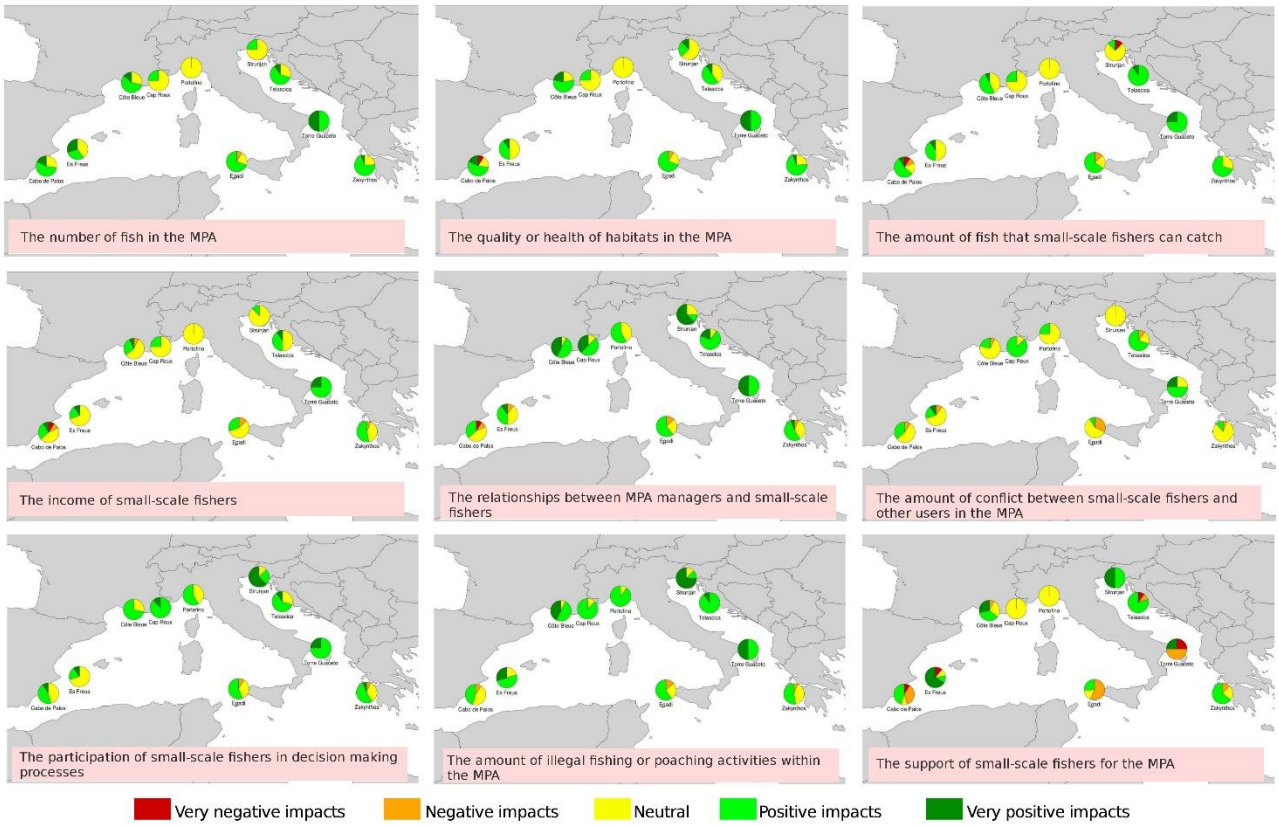

913 **Figure SM3**. Details for each MPA about perceptions on the effects of the governance tools on each
914 one of the aspect considered. Each aspect is represented by a map.

915

916 **Table SM6**. Output of Wald test on the cumulative link models run on the perceptions about the
917 effects of the governance tools on different aspects. Only significant predictors are reported.

Aspect	significant predictors	DF	Chi-square	p	
The number of fish in the MPA	Proportion of household incomes from SSF	4	10.379	0.034	*
The income of small-scale fishers	Proportion of household incomes from SSF	4	13.671	0.008	**
The relationships between MPA managers and small-scale fishers	Decision-makers consider your point of view	4	13.058	0.010	*
	MPA age	1	16.805	4.142e-05	***
	Multiple villages	1	8.588	0.003	**
	Size of SSF community	1	9.836	0.001	**
The amount of conflict between small-scale fishers and other users in the MPA	Size of SSF community	1	8.056	0.004	**
The participation of small-scale fishers in decision making processes	\				
The amount of illegal fishing or poaching activities within the MPA	MPA age	1	13.838	0.0001	***
	Size of SSF community	1	9.352	0.002	**
The support of small-scale fishers for the MPA	Decision-makers consider your point of view	4	12.874	0.011	*
	MPA age	1	13.286	0.0002	***
	Size of SSF community	1	14.866	0.0001	***
COMPOSITE SCORE	Proportion of household incomes from SSF	4	10.645	0.030	*
	MPA age	1	11.999	0.0005	***
	Size of SSF community	1	5.987	0.014	*

918

919

Figure 1

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THEME	INTERVENTION	THEME	INTERVENTION
INVOLVEMENT IN DECISION MAKING	1. Create collaborative platforms to engage fishers in decision	IMPROVE SSF ENVIRONMENTAL SUSTAINABILITY	7. Reduce fishing effort 8. Modify/substitute fishing gears 9. Set-up SSF Code of conduct
ENFORCEMENT STRENGTHENING	2. Increase surveillance by MPA staff and improved infrastructure 3. Increase surveillance through fishers' direct involvement 4. Increase surveillance through the cooperation with relevant authorities	IMPROVEMENT OF SSF PROFITABILITY	10. Add value to local fisheries products 11. Promote new commercial species 12. Support Pescatourism
KNOWLEDGE & OWNERSHIP	5. Engage fishers in monitoring activities 6. Raise the awareness of fishers, MPA managers and local communities		

Figure 2

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Figure 3

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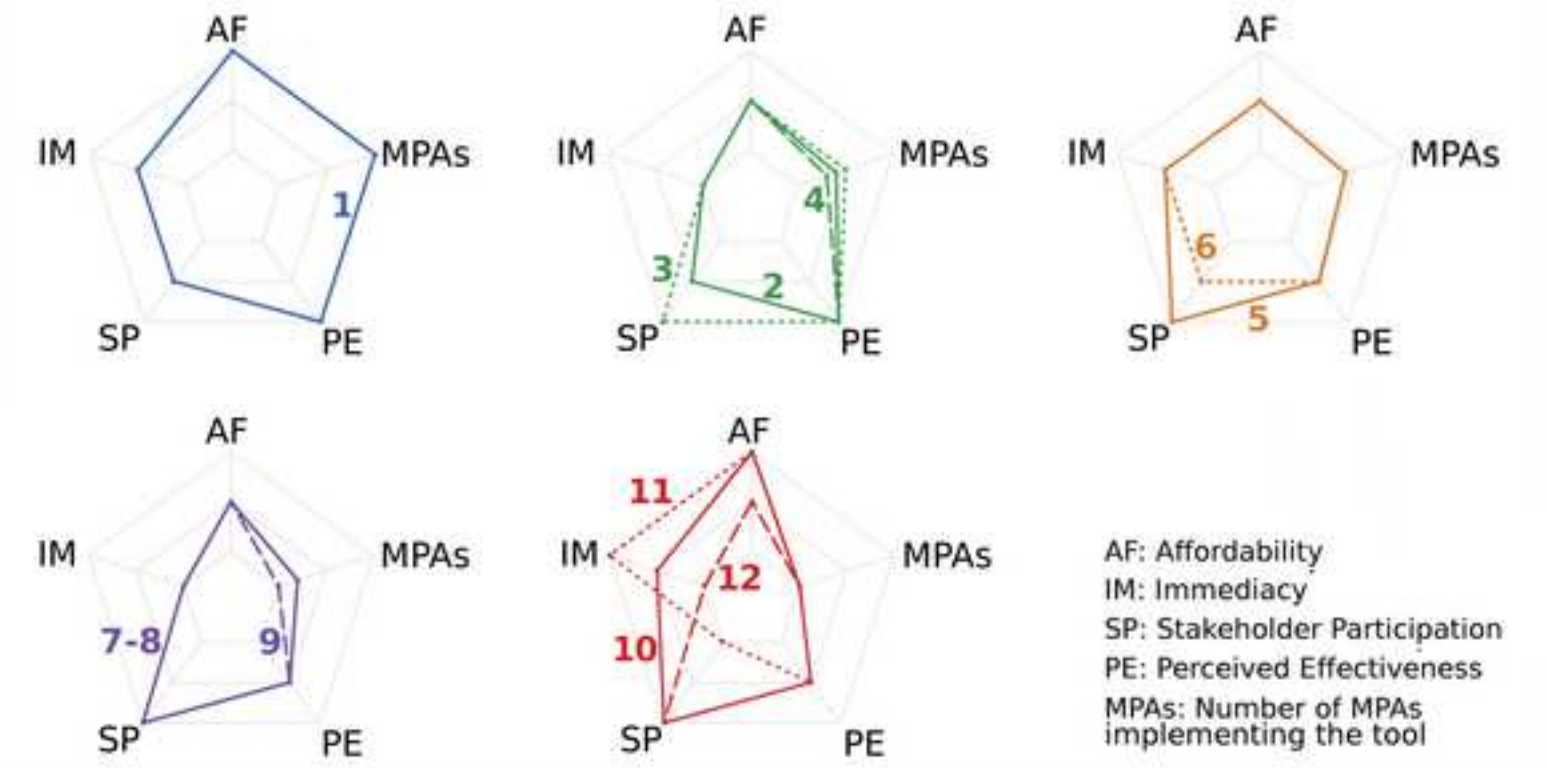

THEME	INTERVENTION
INVOLVEMENT IN DECISION MAKING	1. Create collaborative platforms to engage fishers in decision
ENFORCEMENT STRENGTHENING	2. Increase surveillance by MPA staff and improved infrastructure
	3. Increase surveillance through fishers' direct involvement
	4. Increase surveillance through the cooperation with relevant authorities
KNOWLEDGE & OWNERSHIP	5. Engage fishers in monitoring activities
	6. Raise the awareness of fishers, MPA managers and local communities
IMPROVE SSF ENVIRONMENTAL SUSTAINABILITY	7. Reduce fishing effort
	8. Modify/substitute fishing gears
	9. Set-up SSF Code of conduct
IMPROVEMENT OF SSF PROFITABILITY	10. Add value to local fisheries products
	11. Promote new commercial species
	12. Support Pescatourism

Figure 4

Click here to download high resolution image

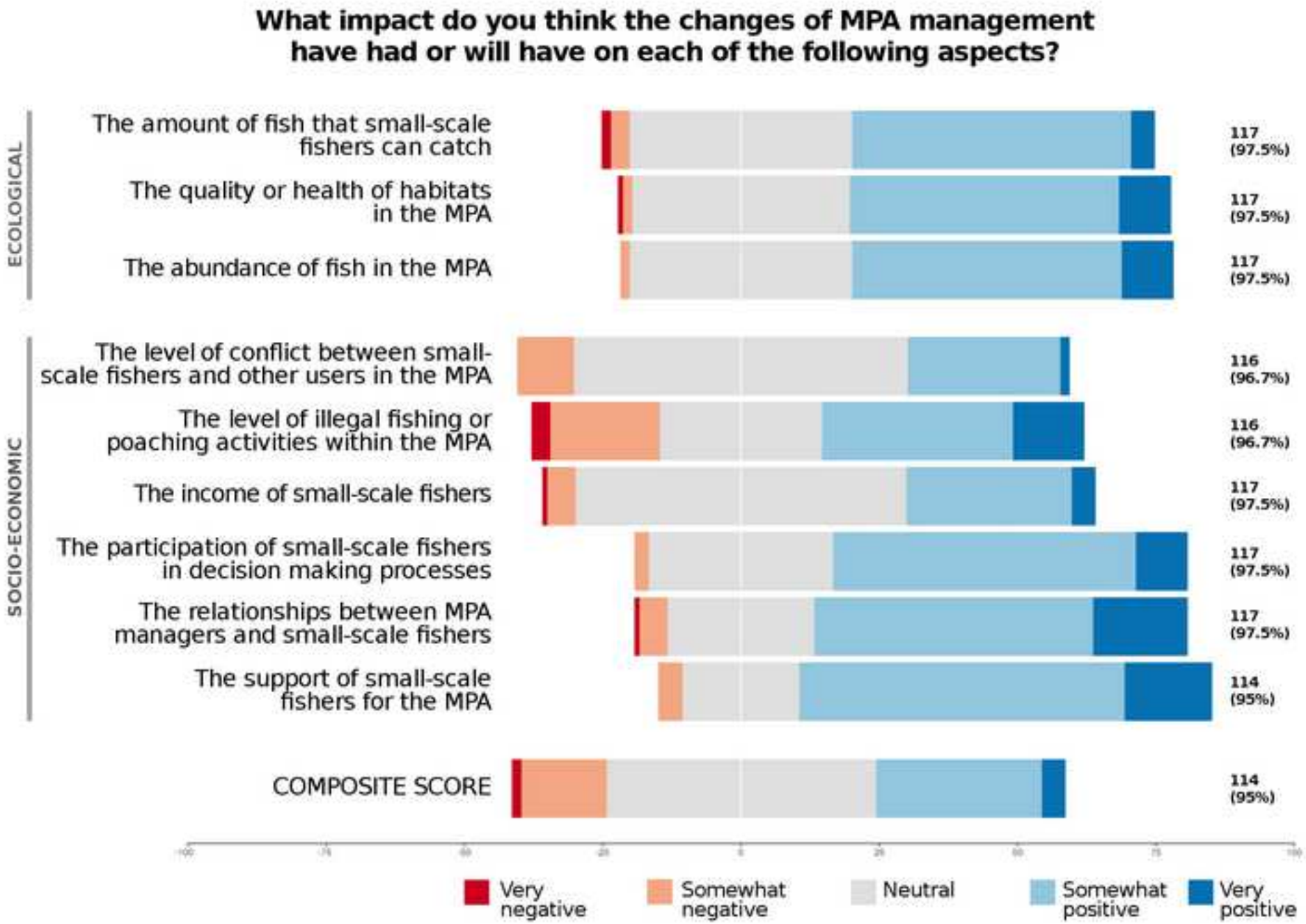

Figure 5

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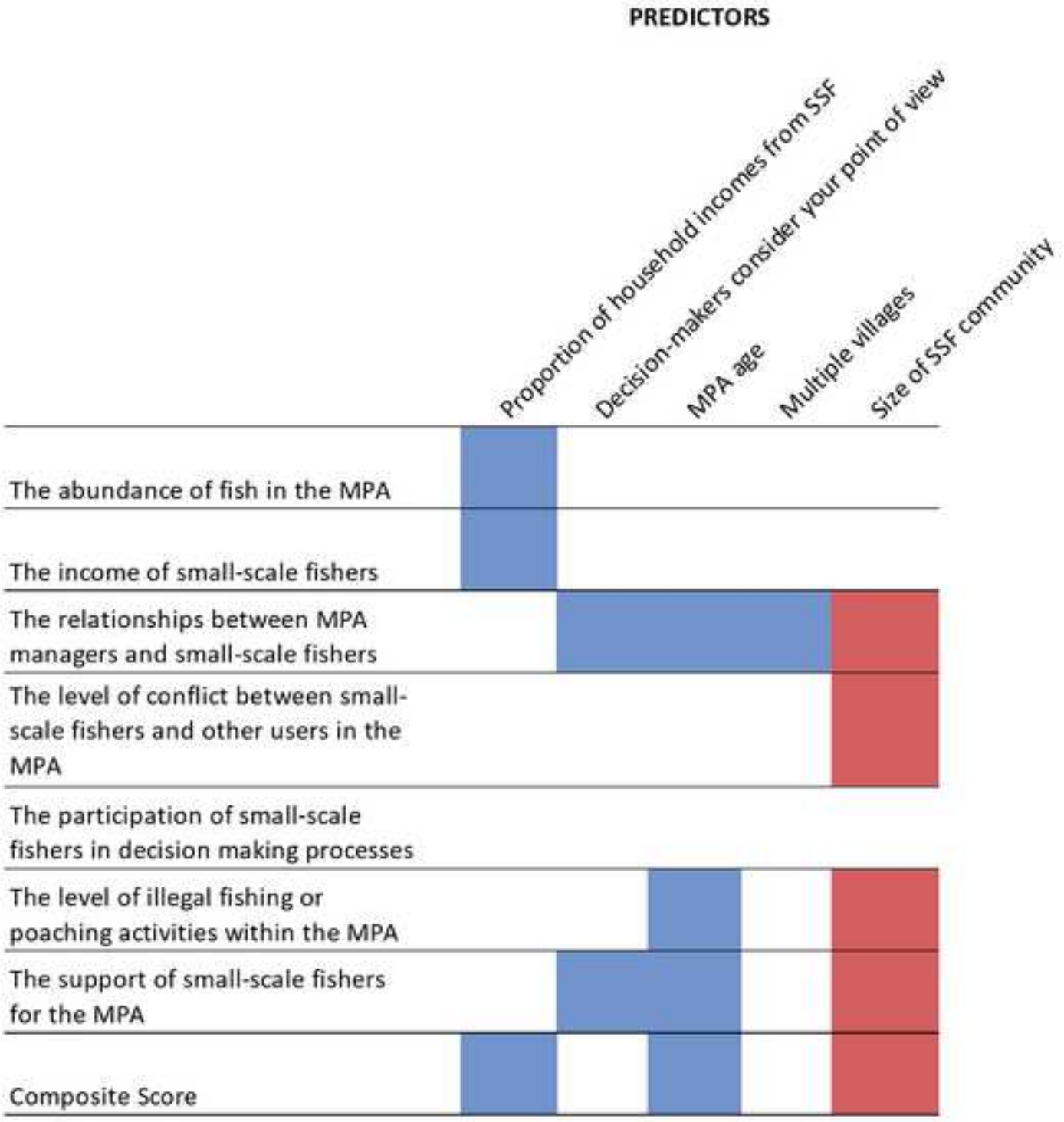

Figure 6

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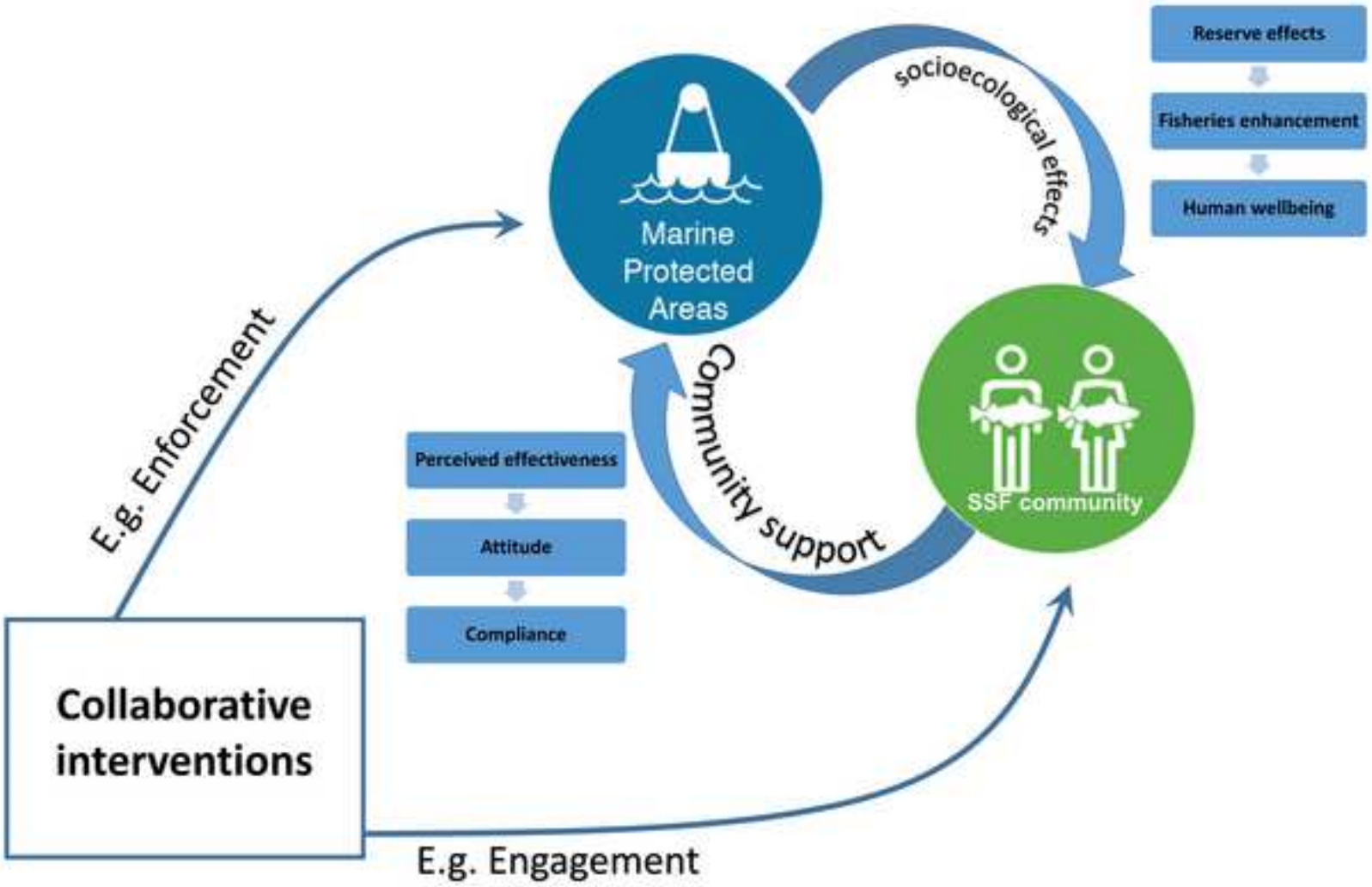

***Declaration of Interest Statement**

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☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: