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Improving marine protected area governance through collaboration and co-production

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1 Abstract

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

26

27 Keywords

28 Marine protected areas; good governance; perceived socio-ecological benefits; collaboration; co-
29 production; action research

30

31 1. Introduction

32

33 Marine protected areas (MPAs) are the most widely promoted spatially explicit conservation tool
34 and policy solution to address many of the well-documented problems of marine habitat
35 degradation and overfishing (Caveen et al., 2013). However, marine environments are highly
36 complex and MPAs are found to vary significantly in their effectiveness. Many studies indicate that,
37 when properly designed, funded, enforced, organised and managed, MPAs are able to provide a
38 series of ecological benefits within their borders (namely the 'reserve effect') (Di Franco et al., 2018;
39 Edgar et al., 2014; Giakoumi et al., 2017; Gill et al., 2017; Scianna et al., 2019), which can potentially
40 lead to positive socio-economic effects in nearby areas (Di Franco et al., 2016; Hattam et al., 2014;
41 Kerwath et al., 2013; Sala et al., 2013). However, there remains some debate as research has also
42 shown that MPAs can be both an ecological success and a social failure (Chaigneau and Brown, 2016;
43 Christie, 2004; Hogg et al., 2019). There remains considerable controversy over what makes MPAs
44 successful and how they should be governed (Bown et al., 2013; Chuenpagdee et al., 2013; Jentoft et
45 al., 2007; Jones et al., 2011).

46

47 MPAs can be viewed as complex social-ecological systems where humans and nature overlap and
48 interact. When MPAs are created human activities and behaviours are directly curtailed or
49 regulated, which can affect nearby communities and lead to local opposition. MPA conservation
50 problems need to be examined hand-in-hand with social factors, including local livelihoods, values,
51 interests and perceptions (Voyer et al., 2012). Yet, research on the human dimension and the social
52 impacts of MPAs have been limited (Bennett, 2016; Bennett et al., 2017; Christie et al., 2017).
53 Mounting evidence suggests that organisational and social factors determine the overall success or
54 failure of a MPA, indicating the inherent need for increased consideration of the human dimension
55 (Bennett et al., 2019; Bennett et al., 2020; Blount and Pitchon, 2007; Chaigneau and Brown, 2016;
56 Hogg et al., 2017b; Jentoft et al., 2012; Lubchenco and Grorud-Colvert, 2015; Mascia et al., 2010;
57 Pollnac et al., 2010).

58

59 In addition to the failure to understand and incorporate the human dimension, MPA success has
60 been found to be significantly hampered by governance shortcomings (e.g., lack of participation,
61 inadequate communication and transparency) and capacity shortfalls (e.g., inadequate management
62 processes, staff and budget capacity, and lack of enforcement) (Di Franco et al., 2016; Gill et al.,
63 2017; Guidetti et al., 2008; Scianna et al., 2015). One response to addressing such shortfalls and the
64 complexities associated with dynamic socio-ecological systems has been to increase stakeholder

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

72

73 Stakeholder participation and management insights can be facilitated through action research or
74 knowledge co-production processes (Beier et al., 2017; Djenontin and Meadow, 2018; Norström et
75 al., 2020; Rodela and Swartling, 2019). Conservation initiatives that encourage action research
76 (research carried out by a team encompassing scientists and local actors, e.g. resource users,
77 inhabitants of a defined area, etc., seeking to improve their situation, Cassell and Johnson, 2016;
78 Greenwood and Levin, 2007) and knowledge co-production (Beier et al., 2017; Djenontin and
79 Meadow, 2018; Norström et al., 2020; Rodela and Swartling, 2019) which directly involve scientists,
80 local actors (e.g. resource users) and public managers and policy makers are increasingly being
81 funded, developing participatory and capacity building initiatives that can better address some of
82 the issues undermining biodiversity conservation and fisheries management (Chuenpagdee et al.,
83 2010; Garcia and Charles, 2007; Leleu et al., 2012; Mackinson et al., 2011; Norström et al., 2020). In
84 order to design effective strategies aimed at reconciling biodiversity conservation and management
85 of sustainable human uses, it is important to assess how local communities respond to such
86 knowledge co-production initiatives and identify circumstances that can make these initiatives
87 successful.

88

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

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

109

110 2. Methods

111 2.1 Geographical context

112

113 The Mediterranean Sea is a highly valued and diverse inland sea, yet among the most heavily
114 degraded, with presence of invasive species and human pressures such as pollution, resource
115 exploitation, tourism and extraction continually increasing (Coll et al., 2011; Micheli et al., 2013).
116 Estimates from 2017 suggest that 78% of fish stocks are harvested at biologically unsustainable
117 levels (FAO, 2018). An estimated 86,500 fishing vessels operate in the Mediterranean and Black Sea,
118 directly employing about 240,000 people on board vessels and contributing \$2.8 billion in landed
119 value (FAO, 2018). Small-scale fisheries represent 84% (70,000 vessels) of the fleet in the
120 Mediterranean and Black Sea, employing 60% (150,000) of all fishers in the region, and producing
121 26% of total fishery revenue (FAO, 2018).

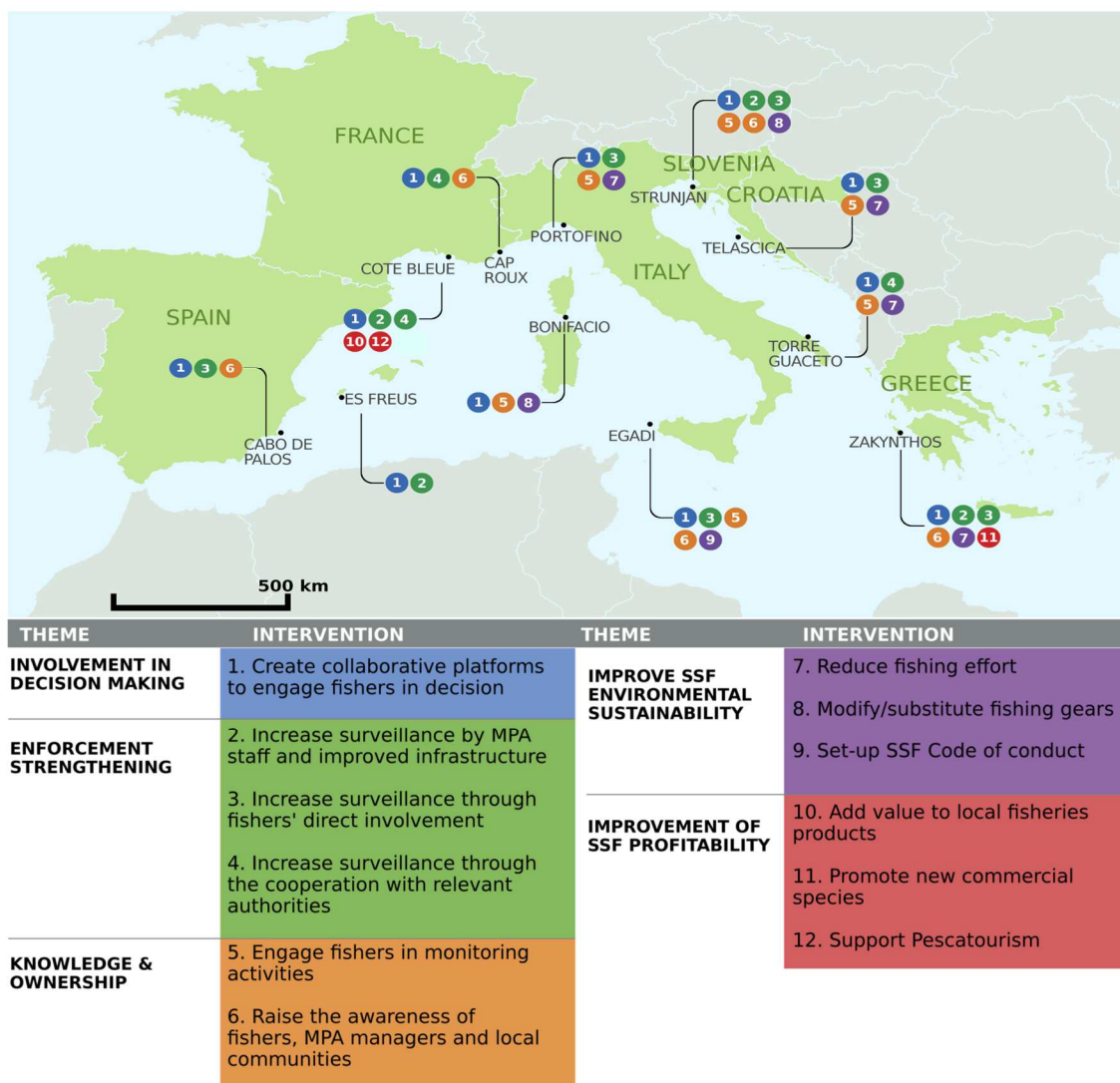
122

123 In 2016, there were a total of 1,215 MPAs covering 6.81% of the Mediterranean Sea (MedPANSPA-
124 RAC, 2019), by 2019, 9.68% of the Mediterranean Sea had been designated as MPAs (Gomei et al.,
125 2019). Most of the surface covered is located in the Western Mediterranean, with the majority of
126 these in EU waters. Yet only 2.48% of MPAs have a management plan, 1.27% are effectively
127 implementing these plans and only 0.03% of the Mediterranean is covered by fully-protected areas
128 (Gomei et al., 2019). MPAs in the Mediterranean generally follow a centralised form of governance
129 (yet there is some movement towards co-management) (Hogg et al., 2013), often enforcement is
130 weak and they are characterised by a lack of financial and staff capacity (Scianna et al., 2018). In
131 general, studies into the human dimension of MPAs in the Mediterranean are missing, and the social

132 dimension is not regularly monitored by MPA managers as part of their plan or strategy (Hogg et al.,
 133 2017a; 2017c; Scianna et al., 2018).

134

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



142

143

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

148

149 2.2 Governance-intervention approach

150

151 Twelve interventions believed to benefit SSF management within and around MPAs, broadly divided
152 into 5 governance categories (involvement in decision making; enforcement strengthening;
153 knowledge and ownership; improvement of SSF environmental sustainability; and improvement of
154 SSF profitability, see Figure 1) were identified through a preliminary study in 2015-2016 (Bennett et
155 al., 2019; Di Franco et al., 2016). Here we focused on small-scale fishers as key users of MPAs, and
156 SSF as an activity potentially promoting sustainable local economies that benefit from MPAs
157 (Claudet and Guidetti, 2010; Di Franco et al., 2016; Guidetti and Claudet, 2010). The present study
158 (2016-2019) tested these interventions in 11 MPAs, to quantify and assess the effectiveness in
159 achieving socio-ecological benefits. The governance intervention approach adopted followed the
160 same systematic sequence in each MPA (see Figure 2) which created: MPA profiles allowing needs to
161 be identified (collected through questionnaires administered to MPA managers in March 2017 and
162 complemented with a literature review) (Step 1); a stakeholder engagement process through the
163 establishment of a Local Governance Group (LGG) in each MPA, involving fishers in the decision-
164 making process, ensuring local MPA needs were better understood through sharing of more diverse
165 points of view (Note: in some MPAs fishers were already part of the MPA management committee)
166 (Step 2); prioritisation of MPA needs, selection of governance interventions through participatory
167 processes seeking consensus in each LGG and implementation of selected interventions (Step 3); and
168 closure of the project and assessment of the successes and challenges of the interventions tested
169 (Step 4) (access [10.6084/m9.figshare.12144789](https://doi.org/10.6084/m9.figshare.12144789) for: project deliverables including the document
170 created at the beginning of the project containing all the MPA profiles; and the reports describing
171 the specific process followed in each LGG). After the period of implementation of the interventions,
172 managers were asked to rate, on a 3-point scale (from 1=low to 3=high), the performance of
173 interventions tested using three different indicators: economic feasibility, time efficiency and
174 stakeholder participation required. Closure meeting minutes and notes were analysed and feedback
175 on the interventions extracted to provide a tentative guide on the overall effectiveness of each
176 implemented tool (on a 3-point scale low-high). This information was used to generate a set of web

177 plots, that provide a simple visualization of strengths and weaknesses of the governance categories
178 and each individual intervention.
179



180

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

182

183 2.3 Assessment of perceived socio-ecological effectiveness of interventions

184

185 To assess the perceived socio-ecological impacts of the governance interventions implemented, a
186 questionnaire was administered to small-scale fishers a year after the start of their implementation.
187 Fieldwork was carried out in each MPA between June - July 2018, with interviews conducted with
188 120 SSFs (54.3% of all fishers operating within the selected MPAs) in 10 of the 11 MPAs (for details
189 about numbers of fishers interviewed per MPA see Supplementary Materials, Table SM1).

190 Respondents were mostly targeted through purposive, opportunistic and snowball sampling
191 (Bryman, 2012) ensuring a representative proportion of each community (i.e. the fishers operating
192 within and/or around each MPA) was interviewed ($\geq \sim 27\%$ of all fishers in each MPA). Three of the
193 120 fishers did not wish to respond to the questions about the perceived socio-ecological impacts of
194 the governance interventions. These interviews were maintained in the sample but due to the lack
195 of some data could not be included in all the analyses that follow. During this fieldwork period
196 fishers from Bonifacio declared to MPA staff that they were involved in too many projects and
197 suffering interviewer fatigue, a common concern for projects and social researchers (Bryman, 2012).
198 They elected not to respond to the final questionnaire, however participated fully in all previous
199 activities related to the project, i.e. implementing and testing the governance interventions.

200

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

220

221 2.4 Data analysis

222

223 Descriptive tables were used to examine demographics and characteristics of small-scale fishers.
224 Small-scale fishers' perceptions about the effect of the interventions on the 9 socio-ecological
225 variables (Supplementary Materials, Table SM2) from the 10 MPAs were analysed at the level of
226 single MPAs to explore potential variability among-MPAs and represented through intervention-
227 specific pie-chart maps. The data was then plotted on a Likert plot (ranging from least-most
228 potential benefit) to highlight regional patterns. The results for the nine different variables were
229 summed to create a single composite perception score capturing the overall effectiveness of the
230 governance interventions. The sum was normalized and rounded on a scale from 1 to 10. Before
231 summing the single items, internal coherence of the items in each scale was made using Chronbach's
232 alpha co-efficient. No issue with internal coherence was highlighted for any of the 9 items (always
233 >0.7). To identify potential predictors of perceived socio-ecological effectiveness of the
234 implemented interventions, perceptions about effects of the governance interventions and the
235 composite perception score were tested against a set of variables including: a) demographic
236 characteristics at the scale of fisher (age, education level and proportion of household incomes
237 deriving from SSF); b) individual perceptions of MPA governance (extent to which decision-makers
238 consider fishers' point of view and needs); and c) characteristics at the location level (MPA age,
239 presence of single/multiple villages in each fishers community and overall size of fishers
240 community). Drivers of perceptions were investigated through a model-selection approach (see
241 Supplementary Materials, Text SM1 for modelling details). Given that single response items were
242 recorded as ordered categorical variables (on a scale from 1 to 5), analysis was carried out using
243 proportional odds models, implementing in R the function 'clm' of the 'ordinal' package
244 (Christensen, 2018). A single model was run for 7 of the 9 perception items (perceptions on 'habitat'
245 and 'catch' were not considered for collinearity issues, see Supplementary Materials Figure SM1)
246 and for the composite score. Following analysis of collinearity, the predictor 'Extent to which
247 decision-makers consider your (fisher) needs' was dropped for redundancy (Supplementary
248 Materials Figure SM 2). Model outputs were presented as odds ratio (OR) and relative confidence
249 intervals (CI). All analyses were conducted in R environment (R Core Team, 2018).

250

251 3. Results

252 3.1 MPA management and governance features

253

254 The survey conducted with MPA managers (step 1) highlighted that the set of 11 MPAs selected
255 included a wide range of management contexts. MPAs differed in terms of: surface area, zoning

256 schemes, enforcement strategies, governance type, interaction with stakeholders (especially
 257 fishers), management needs and activities; and several organizational characteristics such as the
 258 structure of the management authority, and the presence of, style and detail in management plans
 259 (Table 1). On engagement with fishers all MPA managers reported some degree of interaction:
 260 54.5% (6) reported a bidirectional interaction (i.e. where fishers and the MPA management body are
 261 able to express their own views and ideas); in one case the MPA management body reported a
 262 proactive interaction where fishers/their representatives have a proactive interaction (i.e. fishers
 263 actively propose and organise meetings); in the remaining MPAs (36.6%: 4) informal or
 264 unidirectional interactions were reported, with fishers simply being informed once management
 265 decisions were taken. On the number of meetings and fishers' attendance, 63.6% (7) reported 1-2
 266 meetings a year are held, and fishers' attendance varied relatively evenly across all categories. The
 267 majority of managers (72%: 8) reported an overall staff shortfall to manage the MPA. All MPAs
 268 declared that the annual MPA budget was insufficient for all management needs. On enforcement
 269 operated by MPA personnel, one management body (9%) does not perform surveillance activities
 270 (Cap Roux), 4 (36%) perform interpretative/educational enforcement, and 6 (54%) performed both
 271 interpretative/educational and legal enforcement. Managers declared that the biggest shortfalls
 272 were enforcement, outreach programs (found to be very limited or absent in most of the cases, 9:
 273 81.8%), and stakeholder engagement. See Supplementary Materials Text SM2 for an extended
 274 description of the results.

275

276 **Table 1.** Summary information of MPA characteristics (see Supplementary Materials Text SM2 for
 277 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'Evisssa 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

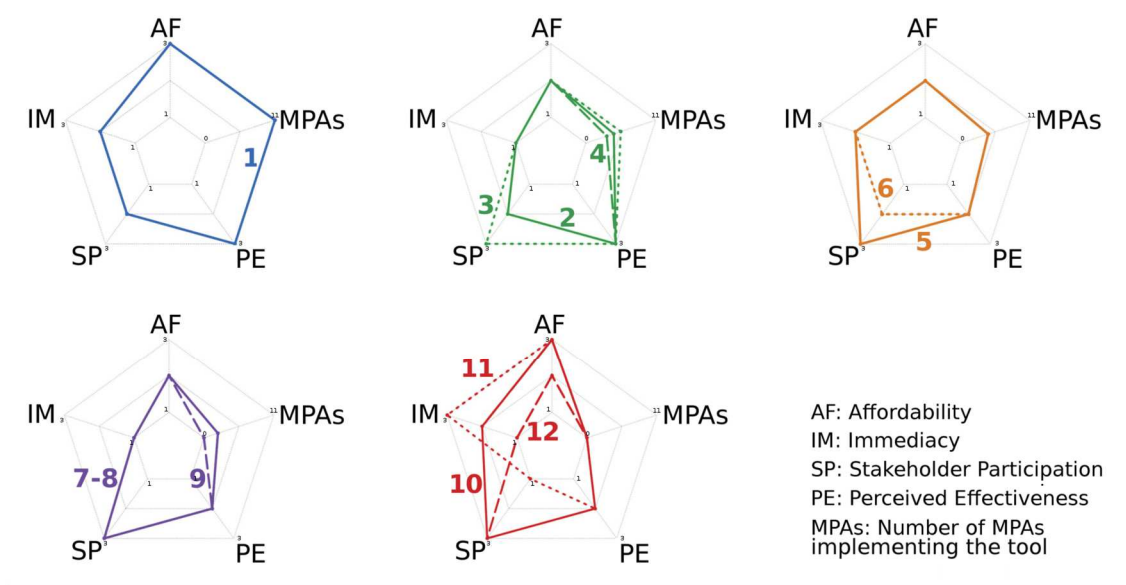
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279 3.2 Selected governance interventions and feasibility

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 and strengthening fishers' organisations through Fishers
285 Local Action Groups (FLAGs). In one pilot site (Egadi Islands) fishers created and signed a voluntary
286 code of conduct for SSF within the MPA. Overlapping with fishers' engagement in decision-making
287 were actions to improve enforcement through fishers' direct involvement, and to improve
288 knowledge and awareness by involving fishers directly in MPA monitoring. Several MPAs committed
289 to address capacity shortfalls in enforcement, by using the project funds available to improve the
290 infrastructure and train staff to better enforce fisheries regulations. Capacity building focused on
291 ensuring MPA staff had legal authority to issue sanctions to transgressors. One LGG selected to
292 install a state-of-the-art video surveillance system that would provide wide coverage of the MPA day
293 and night. All actors were committed to this plan, however unforeseen bureaucratic and legislative
294 challenges significantly delayed the process. In terms of cost, feasibility, level of stakeholder
295 engagement required, and overall perceived effectiveness, the closing meetings and interviews with
296 MPA managers revealed that engaging fishers in decision-making required low financial investment,
297 a medium investment of time yet the impact was perceived to be very high (Figure 3). Similarly,
298 interventions tested to increase enforcement capacity were rated as having medium cost, longer

299 time requirements and depending on which intervention, medium to high involvement from
 300 stakeholders, with a high impact expected/perceived. No interventions were expected or perceived
 301 to have low impact (Figure 3).



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
ENFORCEMENT STRENGTHENING	2. Increase surveillance by MPA staff and improved infrastructure	IMPROVEMENT OF SSF PROFITABILITY	9. Set-up SSF Code of conduct
	3. Increase surveillance through fishers' direct involvement		10. Add value to local fisheries products
	4. Increase surveillance through the cooperation with relevant authorities		11. Promote new commercial species
KNOWLEDGE & OWNERSHIP	5. Engage fishers in monitoring activities		12. Support Pescaturism
	6. Raise the awareness of fishers, MPA managers and local communities		

302
 303 **Figure 3.** Web-plots showing, on a 1 (low) to 3 (high) scale, the economic affordability (AF),
 304 immediacy of implementation (IM), level of stakeholder participation (SP) as rated by MPA
 305 managers, perceived effectiveness (PE) as rated by small-scale fishers, and the number of MPAs
 306 (from 0 to 11) implementing each intervention (counter-clockwise from the top vertex of the
 307 pentagon respectively). Colours represent governance categories. Different line types (whole,
 308 dashed, dotted) are used to distinguish the different interventions along with the numbers which
 309 represent the specific interventions reported in the table.

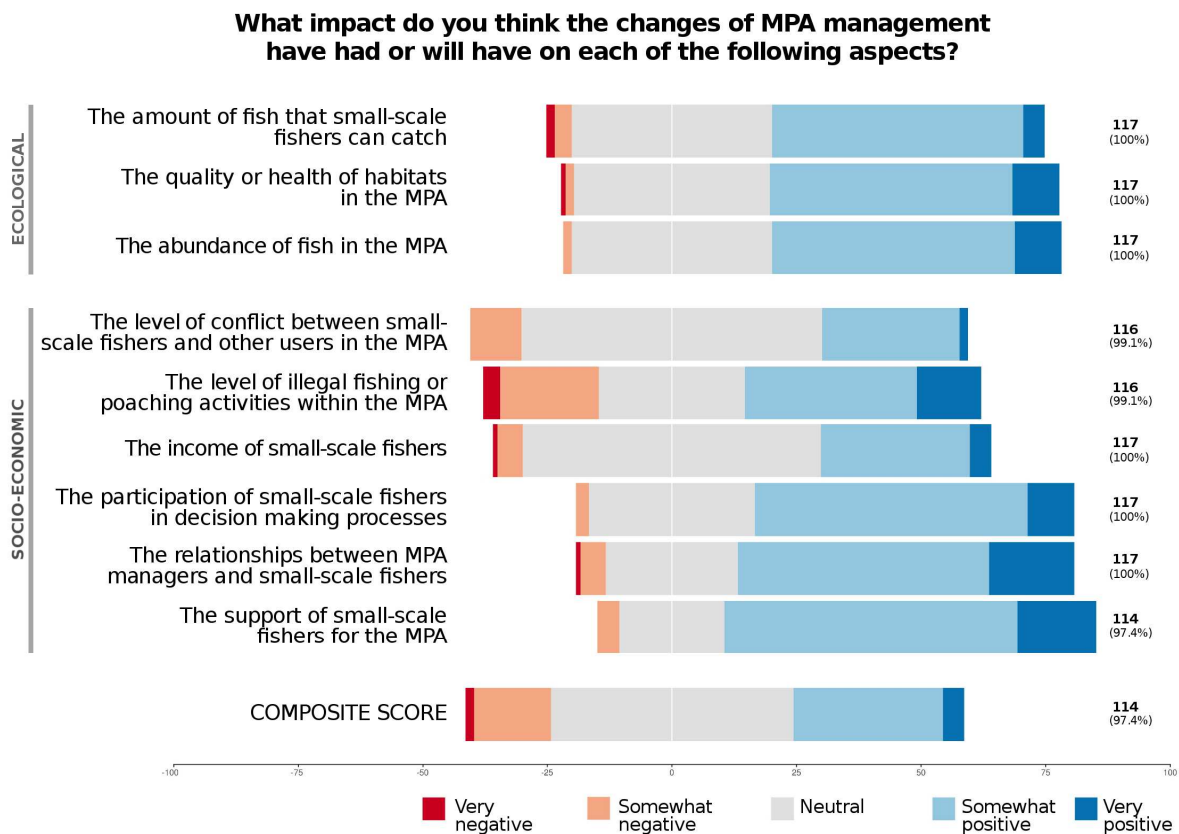
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311 3.3 Small-scale fishers survey sample and perceived socio-ecological outcomes

312

313 All 120 survey respondents were male small-scale fishers, mainly coming from the local
 314 villages/towns or the nearby area of each MPA. More than half of fishers were older than 50 years
 315 (Supplementary Materials, Table SM3). The majority of respondents had a middle school (39%) or
 316 elementary school degree (35%). Households were often composed by two (28%), three (24%), or
 317 four (28%) people, with 1 or 2 of them employed and contributing to the total household income.
 318 Only 32% of the respondent's family incomes were derived solely from small-scale fishing.
 319 On awareness of the management interventions, survey results revealed that 85.5% of fishers knew
 320 about the interventions being tested. On the potential effects of governance interventions
 321 implemented, considering all the responses pooled together, 54.2% of fishers perceived positive
 322 effects, while very few fishers perceived that the implemented interventions were having or will
 323 have negative effects (6.8%) on the socio-ecological variables considered (Figure 4, Supplementary
 324 Materials Table SM4 and SM5).

325



326

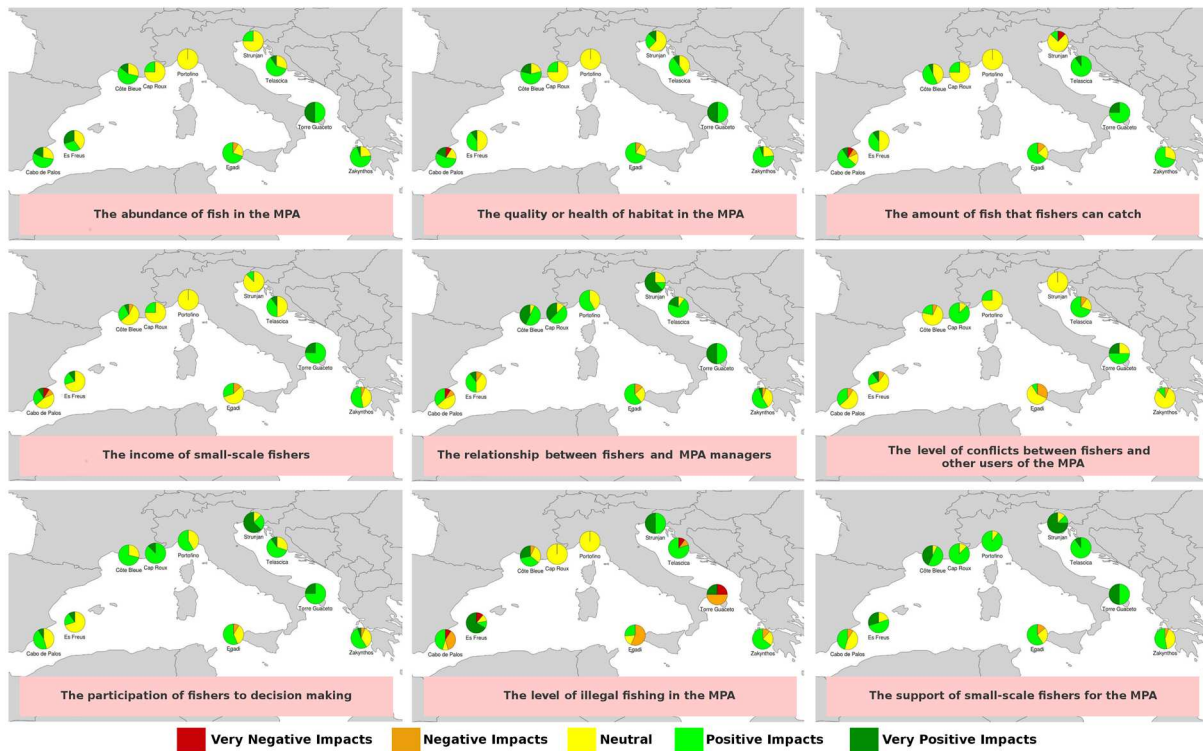
327 **Figure 4.** Likert stacked bar-chart of fishers' perceptions regarding the potential impact the
 328 interventions had or will have on different aspects reported on the left. Within the two categories of
 329 perceptions (ecological and socio-economic), items are ordered from the most negative to the most
 330 positive. Composite score rescaled from 1-5 scale for visualization purposes. Absolute number of

331 respondents for each statement and %'s of the total interviewed population are reported on the
332 right.

333

334 Concerning the amount of fish that small-scale fishers can catch, 57% stated that the interventions
335 tested in the toolkit can produce positive or very positive benefits. Concerning both the abundance
336 of fishes and the health of habitat in their MPA, 58.1% of fishers stated the new interventions
337 adopted were producing or will produce positive or very positive effects. Concerning the level of
338 conflicts between fishers and others MPA users, 60% of fishers stated that the governance
339 interventions implemented in their MPAs were not (or will not) providing any benefits on reducing
340 conflict with other users. On the potential effects of illegal fishing or poaching activities within the
341 MPA the results were more heterogeneous with 23% perceiving negative effects, 30% neutral and
342 47% perceiving a positive or very positive effects. Thirty-five percent of fishers perceived a positive
343 or very positive impact on their income, while 40% of fishers perceived no impacts (neither positive
344 nor negative). The two questions concerning the potential benefits of the governance interventions
345 on fishers' participation in decision-making and the relationship with MPA managers revealed that
346 the majority of fishers (64.1% and 67%, respectively) agreed that the new governance interventions
347 were or can provide positive benefits on these two aspects. Besides these general patterns it is
348 interesting to highlight that responses were heterogeneous among MPAs, with some cases where
349 responses were generally all skewed toward positive perceptions (e.g. Torre Guaceto), while others
350 showing greater variability within the community (e.g. Cabo de Palos) (Figure 5, and please see
351 Supplementary Materials, Text SM3 for more detail on individual MPAs).

352



353

354 **Figure 5.** Detailed perceptions for each MPA about the effects of the governance tools on each one
 355 of the aspects considered. Each aspect is represented by a map. Please see Supplementary
 356 Materials, Text SM3 for more detail on individual MPAs.

357

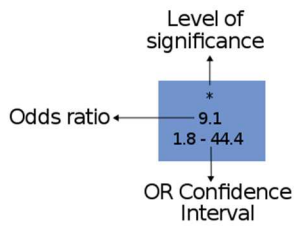
358 Finally, 74.6% believed the governance interventions are improving support for the MPA. Concerning
 359 the composite score, although variable among MPAs, an overall slight positive trend was highlighted
 360 (mean=5.9±0.13, Figure 4). It is noteworthy that there was also a significant proportion of
 361 respondents in the neutral range, perhaps due to the short-time frame since the interventions were
 362 implemented.

363

364 Proportional odds models highlighted that perceptions on the effect of the interventions on “the
 365 abundance of fish” were significantly affected by the ‘proportion of household income derived from
 366 SSF’ with positive perceptions more likely with higher proportion of income from SSF (Figure 6
 367 details odd ratio and confidence intervals for each significant predictor). The same predictor was
 368 found to positively and significantly affect perceptions on the effect of interventions on fishers’
 369 incomes. Concerning the perceptions on the effect of the interventions on the relationship between
 370 fishers and MPA managers, perceptions were found to be significantly and more positively
 371 correlated with increasing age of the MPA, increasing consideration of fishers’ point of view in
 372 decision-making and for MPAs that span multiple villages. These perceptions were found to be
 373 negatively affected by increasing overall size of the fisher community. The size of the community

374 was also the only significant factor to affect the perceptions on the effects of the interventions on
375 the level of conflict between small-scale fishers and other users in the MPA, i.e. the larger the
376 community of fishers, the more likely are negative perceptions about the effect of interventions on
377 the level of conflicts. No factors significantly relate with the effect of the governance interventions
378 on the participation of small-scale fishers in decision-making. Perceptions on intervention effects on
379 the level of illegal fishing or poaching activities within the MPA were positively related to MPA age,
380 while negatively by the overall size of the SSF community. The same pattern was observed for the
381 perception of intervention effects on the support of small-scale fishers for the MPA, found to be
382 more positive with increasing MPA age and negative with increasing SSF community size. The level
383 of consideration of small-scale fishers' point of view by decision makers also positively related to the
384 perceived support for the MPA. Finally, the composite score was significantly positively related with
385 the age of the MPA and the proportion of income deriving from SSF while was negatively related to
386 the size of the community (see Supplementary Table SM6 for the full summary of the models).
387

	PREDICTORS				
	Proportion of household incomes from SSF	Decision-makers consider your point of view	MPA age	Multiple villages	Size of SSF community
The abundance of fish in the MPA	* 9.07 1.85 - 44.35				
The income of small-scale fishers	** 22.17 3.82 - 128.36				
The relationships between MPA managers and small-scale fishers	* 2.20 0.50 - 9.68	*** 1.22 1.11 - 1.35	** 10.10 2.15 - 48.24	** 0.90 0.84 - 0.96	
The level of conflict between small-scale fishers and other users in the MPA				** 0.90 0.84 - 0.96	
The participation of small-scale fishers in decision making processes					
The level of illegal fishing or poaching activities within the MPA		*** 1.18 1.08 - 1.29		** 0.91 0.85 - 0.96	
The support of small-scale fishers for the MPA	* 1.10 0.21 - 5.80	*** 1.23 1.10 - 1.37		*** 0.86 0.80 - 0.93	
Composite Score	* 11.96 2.60 - 55.01	*** 1.15 1.06 - 1.25		* 0.93 0.88 - 0.98	



388

389 **Figure 6.** Significant predictors, derived from proportional odds models, for the perceptions about

390 the effects of the interventions implemented on the 9 variables considered. Perceptions on ‘habitat’

391 and ‘catch’ were not considered (and are not reported here) for collinearity issues (see Methods).

392 Composite perception score capturing the overall effectiveness of the governance interventions

393 implementation is the sum of the nine different items. Blue colour indicates positive relation with

394 predictors, red colour indicates negative relation with predictors. For each significant predictor, odds

395 ratio (OR) and the relative confidence interval (CI) are reported, together with the level of

396 significance (see legend on top-left, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$). See Supplementary Table

397 SM6 for the full summary of the models.

398

399 4. Discussion

400 This research provides a multi-site study of a governance-intervention approach, quantifying the
401 perceived socio-ecological impacts of conservation interventions by small-scale fishers. Our study
402 builds on previous literature examining perceptions of conservation, that have mostly used
403 qualitative methods based on individual case studies (Bennett, 2016; Bennett et al., 2019). It extends
404 previous conservation work and research employing a participative governance-intervention
405 approach, to examine how participation in decision-making can affect perceptions and MPA support.
406 Overall, results show that small-scale fishers are interested in increasing their level of engagement in
407 decision-making and in other activities related to compliance and management (such as surveillance
408 and monitoring) in MPAs. Previous evidence highlighted that perceptions of ecological effectiveness,
409 social impacts, and good governance are drivers of local support toward MPAs (Bennett et al., 2019).
410 Our findings suggest that perceptions of these elements can be enhanced through a participative
411 governance-intervention approach. This change is a process as situations and perceptions
412 continually evolve; however, it is a positive sign that within a relatively short time period (~1year)
413 we can see progress has been made. While small-scale fishers perceived positive effects for all the
414 socio-ecological variables considered, it was those mostly associated with relationships with
415 management, participation in decision-making and overall MPA support that revealed the most
416 positive perceptions for potential/real impact. The perceived potential or real benefits associated
417 with ecological and economic factors (e.g. abundance of fishes, habitat health, availability of fish to
418 catch and fishers' income) were more varied, given that biological results from protection take a
419 significant amount of time (5 years plus) (Claudet et al., 2008; Edgar et al., 2014). The timespan of
420 the initiative is insufficient to expect significant changes in these factors. The social and governance
421 factors that can be accrued are however much more immediate (Blount and Pitchon, 2007; Christie,
422 2004; Kelleher and Recchia, 1998; Mascia, 2004).

423

424 Our results highlighted that the perceived effects of tested interventions varied between MPAs and
425 also when considering the different socio-ecological variables. This could be due to, among other
426 things, the different contexts of each MPA (socioecological and in terms of MPA management and
427 governance, Bennett et al. 2020) highlighted by the significant effect of some of the predictors we
428 considered in our analyses. The fishers who reported no perceived benefits, could have done so due
429 to the short time frame the governance interventions were implemented which was perhaps
430 insufficient to modify their perceptions. Alternatively, these fishers could have already taken part in
431 previous participatory processes that were unsuccessful, or have in some way been deceived by

432 false promises regarding the MPAs management and potential results and are therefore more
433 resigned to being more cautious (Chaigneau and Brown, 2016; Hogg et al., 2019).

434 It is important to point out that perceived benefits related to ecological and economic factors do not
435 necessarily mirror factual improvements in these variables. Yet, perceptions represent crucial
436 information and despite often being dismissed as anecdotal, can be effectively used to improve
437 management (Bennett, 2016). Different methods (e.g. ecological assessment using underwater
438 visual census or similar techniques to investigate potential change in fish abundance) can provide
439 complementary insights and enable accurate impact assessments of biological and economic change
440 over a longer period.

441

442 Our results concur with previous research that reveal employment of good governance processes
443 (e.g. involving stakeholders in decision-making) and management of social aspects are key for
444 ensuring local support for conservation (Bennett et al., 2019). The demand of each MPA to create
445 the LGG represented a first step towards improved engagement and is representative of the much-
446 needed shift towards co-management (Hogg et al., 2013). Management arrangements developed by
447 LGGs or similar platforms, in line with what has been observed in community-based management in
448 other geographical contexts, can better align with local social and ecological conditions, conferring
449 social benefits, such as: increased collaboration and learning among partners; integration of
450 scientific and local knowledge systems; community empowerment; improved social capital, in terms
451 of social cohesion between stakeholders, a key element to increase a community's adaptive capacity
452 and to reduce vulnerability to local threats and global pressures that may threaten local small-scale
453 fisher communities livelihoods and wellbeing; and higher levels of compliance (Kittinger et al., 2013;
454 Norström et al., 2020; Silva et al., 2019; Thiault et al., 2019).

455

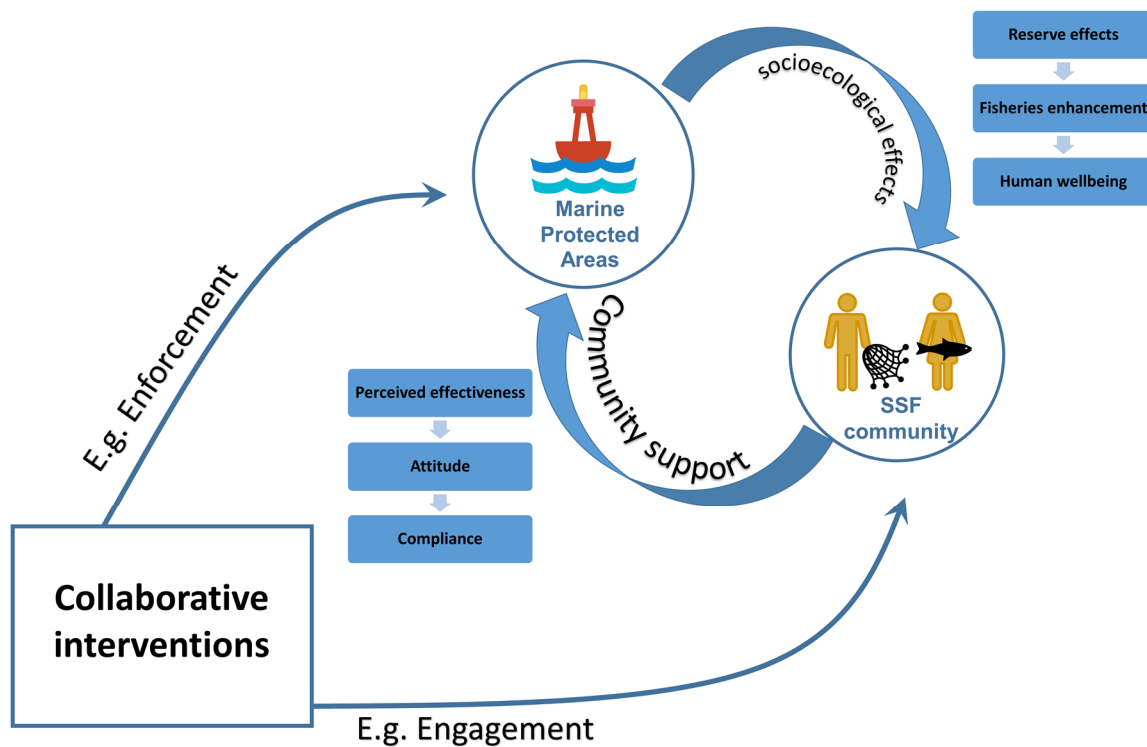
456 The findings of this study are extremely relevant considering the shortfall in MPA capacities, both in
457 terms of staff and funds, as declared by MPA managers in the 11 case study sites, and as reported
458 previously in other cases (Gill et al., 2017; Scianna et al., 2018). These features are key drivers of
459 MPA ecological effectiveness (Gill et al., 2017; Scianna et al., 2019) and therefore represent vital
460 aspects for MPA governance and management. Particularly relevant is the fact that enforcement
461 and stakeholder engagement, two elements largely acknowledged as key to enhance MPA
462 effectiveness (Di Franco et al., 2016; Edgar et al., 2014; Gill et al., 2017), represent major capacity
463 shortfalls for the investigated MPAs. From this standpoint, we have presented a number of
464 interventions that have been perceived positively by both MPA managers and small-scale fishers to
465 overcome these shortfalls which sound promising to improve current MPA status. Specifically,

466 increased enforcement can help reduce poaching, which is now acknowledged as widespread in
467 MPAs globally (Bergseth et al., 2018; 2017) and represents a major threat to small-scale fisher
468 communities (Thiault et al., 2019).

469

470 We highlight that collaborative interventions like the ones tested in this study can rapidly enhance
471 stakeholder perceptions of MPA socio-ecological effectiveness and increase support toward MPAs.
472 This could potentially lead to enhanced stakeholders' compliance with rules, both for members of
473 local communities and also for external members through increased patrolling and voluntary
474 surveillance (Bergseth et al., 2018; Thiault et al., 2019). Increased compliance could in turn
475 contribute towards ecological benefits, that need more time to arise, and potentially impact
476 stakeholders' livelihoods and wellbeing (through increased catches), finally creating a positive
477 feedback loop for stakeholder perceptions and support toward conservation initiatives i.e. a virtuous
478 cycle (Figure 7).

479



480

481

482 **Figure 7.** Conceptual scheme of the cycle linking Marine Protected Areas (MPA) socio-ecological
483 effectiveness and community support. Blue filled boxes with arrows indicate the potential chain of
484 elements for each item represented in the two thick curved arrows (socioecological effects,
485 community support). Collaborative interventions can affect both the MPA and its socioecological

486 effectiveness (e.g. through enforcement and surveillance) and SSF community and its support
487 toward the MPA (e.g. through engagement and participatory decision-making).

488

489 However this cycle can be stopped, and the associated benefits quickly eroded if good governance
490 stops, shattering stakeholder trust, expectations and potentially inducing a decrease in MPA support
491 and compliance with rules (Chaigneau and Brown, 2016). This could prompt a decrease in MPA
492 socio-ecological effectiveness and induce a vicious cycle, potentially pushing the system into a socio-
493 ecological trap, defined as a situation when feedback between social and ecological systems lead
494 toward an undesirable state that may be difficult or impossible to reverse (Cinner, 2011; Kittinger et
495 al., 2013). The potential shift between the virtuous and vicious cycle, with all the related societal
496 implications, stresses further the importance of giving sufficient attention to the human dimension
497 in MPAs and making use of information on both the factual and perceived socio-ecological
498 effectiveness of the MPA. From this point of view, we also highlighted that the perceived
499 effectiveness of conservation interventions can be affected by a set of elements at individual (e.g.
500 demographic), community (e.g. size) and MPA (age, size) levels, that represent potential leverage
501 points upon which to act in order to maximize perceived effectiveness and enhance support toward
502 MPAs. Specifically, perceptions of socio-ecological effectiveness are positively associated with small
503 communities, old MPAs and fishers with high proportions of household income derived from small-
504 scale fisheries. It is interesting to note that our results suggest that the overall size of the fisher
505 community is relevant in shaping perceived effectiveness of the interventions. This may suggest that
506 MPA management and governance efforts, in terms of capacities and resources allocated, should be
507 planned based on the size of the community, adding to recent findings suggesting that these
508 elements should be set based on MPA surface area (Scianna et al., 2019). These two variables (size
509 of the community and MPA surface area) are not necessarily related, and further investigations
510 should be carried out to understand how and if they interact. It is also possible that in large
511 communities economic activities are more complex and diversified, meaning they could be less
512 dependent on the MPA conservation status.

513

514 To create the virtuous cycle and/or prevent it from stopping it is crucial for an MPA to: 1) set the
515 right conditions to determine the onset of the reserve effect, in terms for instance of increased fish
516 biomass, that will then potentially translate into socio-economic benefits for local communities; and
517 2) support participation and create allies of local communities in decision-making and management
518 processes to help generate long-term support for conservation initiatives.

519

520 We acknowledge that the establishment of a LGG or similar collaborative platform alone is
521 insufficient to ensure long-term change. In addition, we recommend, that future studies sample a
522 broader group of stakeholders, and extend participation in decision-making beyond small-scale
523 fishers to include a wider array of actors, especially as MPAs are often multi-use or affect a wider
524 range of actors, thus ensuring a more complete representation of community' needs.

525

526 This study has a number of relevant implications for other conservation initiatives, policy makers and
527 practitioners. First and foremost, it reveals that conservation practitioners and managers need to be
528 attentive to the quality of governance and the social impacts of conservation (Bennett and
529 Satterfield, 2018; Borrini-Feyerabend and Hill, 2015; Lockwood, 2010). It confirms the merit of
530 engaging stakeholders in long-term and well managed decision-making processes that ultimately
531 affect their livelihoods (Jentoft, 2005; Wilson, 2003). In addition, this study highlights that the
532 positive perceptions yielded were accrued by giving increased attention, effectiveness and
533 continuity to governance and management processes (Bennett et al., 2019) and not reliant on
534 improved ecological or fisheries outcomes (as there was not enough time to see these results).
535 Second, it highlights the benefits of considering the human dimension and people's perceptions
536 (Bennett, 2016; Voyer et al., 2012). Monitoring people's perceptions can help confirm whether
537 and/or which management interventions can increase support for MPAs or other conservation
538 initiatives (Bennett, 2016; Hogg et al., 2019; 2017b; Voyer et al., 2012). Finally, the testing of
539 multiple interventions across different MPA contexts has provided actionable insight into the overall
540 feasibility and effectiveness of each. Given the variability of MPAs included in our relatively large and
541 heterogeneous sample, which represent a wide range of socio-ecological and governance contexts,
542 the governance approach and governance interventions tested are transferable and can likely be
543 adapted to many MPA settings globally.

544

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

553 strongly recommend that participatory decision-making processes employ neutral parties trained in
554 facilitation, mediation and conflict resolution.

555

556 5. Conclusion

557 Engagement of local people and perceived MPA socio-ecological benefits are crucial elements for
558 garnering support for and long-term success of conservation initiatives. Here we have reported an
559 approach tested in 11 MPAs that provides clear and actionable elements that can help to support
560 this process. This study demonstrated that small-scale fishers' perceptions of MPA ecological
561 effectiveness, social impacts and good governance can be quickly enhanced through collaborative
562 conservation interventions co-produced with local communities. Although perceptions towards
563 ecological and economic outcomes were positive it was perceptions of governance and other social
564 factors that were found to have the greatest prospect of being improved in the short-term by the
565 management interventions tested and approach applied. If MPAs and stakeholders continue to
566 apply these interventions, it is likely that there will also be positive impacts on ecological and
567 economic factors. The results of this study strongly suggest that conservation practitioners need to
568 be attentive to all three dimensions – ecological effectiveness, social impacts and good governance -
569 during the implementation and ongoing management of conservation initiatives, yet small changes
570 in the governance structure and increased engagement of fishers and other actors can easily and
571 quickly improve overall support for conservation. It is essential to ensure good governance is
572 sustained over time and adequately resourced (financially and by full-time trained personnel who
573 can carry out participative decision-making processes).

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