

Manuscript Number: JEMA-D-18-00610R2

Title: Applying organization science to assess the management performance of Marine Protected Areas: an exploratory study

Article Type: Research Article

Keywords: Mediterranean MPA, organizational features, performance assessment, performance index

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Abstract: Marine Protected Areas (MPAs) are important tools to achieve marine conservation and resources management goals. The management effectiveness of MPAs (the degree to which MPAs achieve their goals) is highly variable and can be affected by many MPA attributes, for example their design, enforcement and age. Another key factor possibly affecting MPA management effectiveness is the management performance, here conceived according to Horigue et al. definition (2014) as the "level of effort exerted to enhance and sustain management of MPAs". Organization Science (OS), the discipline that studies organizations, can offer a useful framework to assess and interpret MPA management performance. Using an exploratory multiple case study approach, we applied OS principles to 11 Mediterranean MPAs in order to: i) characterize several MPA organizational features; ii) assess MPA management performance (evaluated as the effort deployed in, for example, planning the future, formalizing measurable goals and implementing specific strategies). Results show that a number of organizational features and networking attributes are highly variable among the MPAs we have studied. For instance, goals are seldom measurable and the strategy to achieve goals is not systematically pursued. Two relevant outcomes emerge from this exploratory study: i) the management performance of the MPAs considered needs considerable improvements; ii) the methods and the approach proposed could help MPAs' managers and policy makers to understand how to improve their management performance and, consequently, their effectiveness.

Applying organization science to assess the management performance of Marine Protected Areas: an exploratory study

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1 **Abstract**

2 Marine Protected Areas (MPAs) are important tools to achieve marine conservation and
3 resources management goals. The management effectiveness of MPAs (the degree to which
4 MPAs achieve their goals) is highly variable and can be affected by many MPA attributes, for
5 example their design, enforcement and age. Another key factor possibly affecting MPA
6 management effectiveness is the management performance, here conceived according to Horigue
7 et al. definition (2014) as the “level of effort exerted to enhance and sustain management of
8 MPAs”. Organization Science (OS), the discipline that studies organizations, can offer a useful
9 framework to assess and interpret MPA management performance. Using an exploratory
10 multiple case study approach, we applied OS principles to 11 Mediterranean MPAs in order to: i)
11 characterize several MPA organizational features; ii) assess MPA management performance
12 (evaluated as the effort deployed in, for example, planning the future, formalizing measurable
13 goals and implementing specific strategies). Results show that a number of organizational
14 features and networking attributes are highly variable among the MPAs we have studied. For
15 instance, goals are seldom measurable and the strategy to achieve goals is not systematically
16 pursued. Two relevant outcomes emerge from this exploratory study: i) the management
17 performance of the MPAs considered needs considerable improvements; ii) the methods and the
18 approach proposed could help MPAs’ managers and policy makers to understand how to
19 improve their management performance and, consequently, their effectiveness.

22 **Key words**

23 Mediterranean MPA, organizational features, performance assessment, performance index

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4 26 “Success is dependent on effort”, *Electra*, Sophocles (c. 497–405 BC)
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9 **28 1. Introduction**

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11 29 Protected areas (PAs) are usually defined as “clearly defined geographical spaces,
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13 30 recognized, dedicated and managed, through legal or other effective means, to achieve the long-
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15 31 term conservation of nature with associated ecosystem services and cultural values” (Dudley,
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17 32 2008). Marine protected areas (MPAs) share the same characteristics with PAs (which they are
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19 33 part of) but are specifically dedicated to marine ecosystems. Following the IUCN classification,
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21 34 MPAs fall into different PA categories on the basis of the objectives they have been created for
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23 35 (Day et al., 2012). MPAs are generally considered as important tools to achieve marine
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25 36 conservation and/or resources management goals (Gaines et al., 2010; Parravicini et al., 2013).

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27 37 Management effectiveness is the success or the degree to which MPAs achieve their
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29 38 goals (Hockings et al., 2006) and it has been proved to be highly variable (Lester et al., 2009).
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31 39 Management effectiveness can be affected by many MPA attributes (e.g. design, age) along with
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33 40 a number of ecological features, social behaviour and land-based pressures (e.g., species
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35 41 characteristics, habitat continuity, compliance, outfalls) (Claudet et al., 2008; Edgar et al., 2014;
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37 42 Guidetti et al., 2014; Lester et al., 2009; McClanahan et al., 2006).

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39 43 MPA management effectiveness can be also affected by the ‘management performance’,
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41 44 defined by Horigue et al. (2014) as “the level of effort exerted to enhance and sustain
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43 45 management of MPAs”. In other words, management performance is what managers and
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45 46 decision makers do in order to improve the degree of achievement of MPA goals. Such a
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47 47 definition of management performance formally distinguishes between the concepts of
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49 48 “effectiveness” and “performance”, which have been considered as synonymous in the past
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51 49 (Ervin, 2003; Jones, 2014; Pomeroy et al., 2004; Tempesta & Otero, 2013) and still are in some
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53 50 studies (Ban et al., 2017; Emslie et al., 2015; Gill et al., 2017). Only few studies have dealt so far
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55 51 with management performance according to the previous definition and employing specific
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57 52 approaches and tools to investigate it (Horigue et al., 2014; Rodríguez-Rodríguez et al., 2016).

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59 53 Several tools for the assessment of MPA management processes have been already
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61 54 developed (Leverington et al., 2010), such as the Management Effectiveness Tracking Tool
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63 55 (METT) (Stolton et al., 2007), World Bank MPA Score Card (Staub & Hatzios, 2004), and
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56 Rapid Assessment and Prioritization of Protected Area Management Methodology (RAPPAM)
57 (Ervin, 2003). These tools mainly involve data collection through expert opinions and the Likert
58 scale. The aim of this study is to develop a novel and science-based approach to help policy
59 makers and managers take into consideration organizational features to assess and compare
60 MPA's performance, without however creating an organic and holistic Management
61 Performance System (Anthony & Govindarajan, 1998). Consistently with the performance
62 definition of Horigue et al. (2014), assessing MPA performance is here considered as a
63 fundamental step towards gauging MPA effectiveness.

64 MPA's are organizations (Scianna et al., 2015) and consequently their management
65 features and performance can be analyzed by applying the Organization Science (OS) approach.
66 OS is a discipline that studies the structures, processes and practices of organizations, and offers
67 useful tools to identify the interventions needed to benefit the organization themselves (Daft,
68 2010). In OS, organizations are defined as "cooperative systems of consciously coordinated
69 activities of two or more persons, with a common purpose" (Barnard, 1938). MPAs are entities
70 where people, at different hierarchical levels, cooperate to carry out activities, such as
71 enforcement, environmental education and monitoring of socio-ecological variables, in order to
72 pursue one or more well-defined common objectives (e.g. conservation of specific species,
73 restoration of fish stocks).

74 OS principles and methods have been conceived to study the traits of different public and
75 non-profit organizations, such as schools, federal or governmental agencies and NGOs (Bryson,
76 1988; Daft, 2010; Ingersoll, 2001; Rainey & Steinbauer, 1999). The lessons learnt from OS
77 research may therefore have broad relevance for the analysis of MPAs and their management
78 performance.

79 Each organization is characterized by its dimensions, specific design traits that allow for
80 comparisons (Daft, 2010). The organizational dimensions delineate the organization's structure
81 (Pugh et al., 1968), such as the workforce on which the MPA can rely, defined as the
82 'organizational size'. It is important to clarify that herein MPA size does not refer to the surface
83 area of the MPA as is often the case in MPA-relevant literature (e.g. Claudet et al., 2008; Lester
84 et al., 2009; Sala et al., 2012), but to the workforce in an MPA. The organizational dimensions
85 describe also the context of an organization and define why it exists (mission), where it wants to
86 go (vision), what it wants to achieve (goals) and how (strategy). Within this framework, vision

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4 87 and mission are part of the culture (the shared fundamental values) of the organization, and,
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6 88 together with the analysis of the strategy and the related activities, they can be taken into account
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8 89 in the assessment of MPA management performance (Fig. 1, see section 2 for more details).
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10 90 Management monitoring can provide hints to readjust the entire management process. The
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12 91 assessment of the management performance could allow rearrangement of the strategy, which, in
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14 92 turn, may improve the management performance itself. Management effectiveness should then
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16 93 be assessed as the degree of achievement of the goals. The assessment of the management
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18 94 effectiveness could provide a basis for identification of the steps of the management process that
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20 95 do not enable the achievement of their goals (if this is the case), and consequently their revision
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22 96 and restatement.

23 97 The present work is an exploratory study aiming at: i) applying for the first time, to our
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25 98 knowledge, the OS approach to the MPA context, introducing new concepts together with their
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27 99 definitions, ii) developing new and standardized methods based on factual data (and not on
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29 100 expert opinion), collected through a questionnaire and summed up through new indices, iii)
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31 101 evaluating a number of Mediterranean MPAs from an organizational point of view,
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33 102 characterizing their legal status and authority, several organizational features and their
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35 103 management performance.
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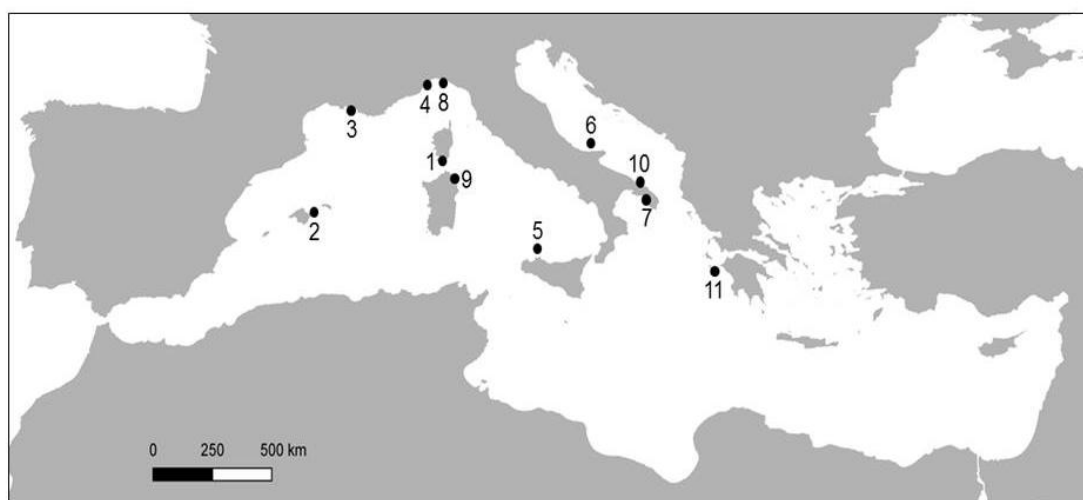
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57 106 **Fig. 1.** Conceptual flow diagram of the management monitoring. Links between some organizational dimensions
58 107 and (the assessment of) management performance and effectiveness. Management effectiveness and related arrows
59 108 are in light grey because they are beyond the scope of the present study.

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109 2. Methods

110 2.1 Study areas

111 We firstly contacted via e-mail 15 MPA management bodies selected in the
112 Mediterranean Sea among those that actively manage MPAs through legal means (following the
113 IUCN PA definition) (Dudley, 2008). We sent three follow-up emails before considering an
114 MPA as not responsive. The management bodies related to eleven MPAs responded to our
115 invitation to take part in this study, representing a response rate of ~73%. These MPAs are
116 located in 4 Mediterranean countries, i.e. France, Greece, Italy and Spain (Table 1, Fig. 2). These
117 countries host about 75% (in terms of surface, i.e. 14059 km² out of 18967.55 km²) of all MPAs
118 established in the Mediterranean Sea (Gabrié et al., 2012), representing the states that deploy
119 more effort in using the MPAs as tools to actively conserve their marine ecosystems. The
120 possibility of getting organizational data strictly depends, for each MPA, on the existence of a
121 management body and the willingness of the manager to share the data. In this kind of study,
122 therefore, it is not possible to run a purely random selection of MPAs, which could be the best
123 option in terms of representation, in our case, of the Mediterranean context. The 11 MPAs we
124 have included in our study, therefore, have to be conceived as 11 MPAs representing case studies
125 or examples in the Mediterranean Sea where the approach proposed in this study has been
126 applied.



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129 **Fig. 2.** Geographical location of the 11 MPAs investigated. 1) Bouches de Bonifacio Natural Reserve, 2) Cala
130 Ratjada-Peninsula de Llevant Marine Reserve, 3) Côte Bleue Marine Park, 4) Isola di

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4 131 Ustica MPA, 6) Isole Tremiti MPA, 7) Porto Cesareo MPA, 8) Portofino MPA, 9) Tavolara-Punta Coda Cavallo
5 132 MPA, 10) Torre Guaceto MPA, 11) Zakynthos National Marine Park.
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9 134 **Table 1.** Description of the 11 MPAs investigated

MPA	Country	Surface area (ha)	Surface area score ^a	Year of establishment	Management authority
Bouches de Bonifacio Natural Reserve	France	79,640	5	1999	Corsican Office of the Environment
Cala Ratjada-Peninsula de Llevante Marine Reserve	Spain	11,286	4	2007	Spanish Ministry of the Environment and Environment Department of the Balearic Islands
Côte Bleue Marine Park	France	9,873	4	1983	Consortium constituted by five municipalities (Carry-le-Rouet, Ensues-la-Redonne, Le Rove, Martigues, Sausset les Pins), the Bouches du-Rhône local authority (<i>Département</i>) and the Provence-Alpes-Côte d'Azur region
Isola di Bergeggi MPA	Italy	215	1	2007	Municipality of Bergeggi
Isola di Ustica MPA	Italy	15,951	4	1986	Municipality of Ustica
Isole Tremiti MPA	Italy	1,466	2	1989	National Park of Gargano
Porto Cesareo MPA	Italy	16,654	4	1997	Consortium constituted by two municipalities (Porto Cesareo and Nardò), and the district of Lecce
Portofino MPA	Italy	346	1	1999	Consortium constituted by municipalities of Camogli, Portofino and Santa Margherita, the district of Genoa, and the University of Genoa
Tavolara-Punta Coda Cavallo MPA	Italy	15,000	4	1997	Consortium constituted by the municipalities of Loiri-Porto San Paolo, Olbia and San Teodoro
Torre Guaceto MPA	Italy	2,200	2	1991	Consortium constituted by the WWF Italy and the municipalities of Brindisi and Carovigno
Zakynthos National Marine Park	Greece	8,331	3	1999	Management Agency of National Marine Park of Zakynthos.

135 ^a: 1 = 1 to 1,000 ha, 2 = 1,001 to 3,000 ha, 3 = 3,001 to 9,000, 4 = 9,001 to 27,000 ha, 5 = 27,001 to 81,000 ha.

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137 **2.2 Data collection**

138 Questionnaires (Appendix A, Text A.1) were drawn up, tested and then always
139 administrated by the same person to MPA managers and staff members via structured face-to-
140 face interviews (n= 9 MPAs) or Skype calls (n= 2 MPAs). The amount and the quality of the
141 data we gathered were not biased by the method employed (Sturges & Hanrahan, 2004),
142 especially considering that questions referred to factual data and not to opinions - a procedure
143 that eliminated the possibility of bias and misleading answers. In addition to the interviews, we
144 completed the collection of data for each MPA by consulting management plans and internal
145 reports. A total of 104 variables (e.g., see subsections 2.3.1-2.3.4) have been taken into account.
146 We investigated every MPA conceiving it as an organization and mainly focusing on internal
147 organizational variables. Due to the intrinsic complexity of the proposed framework, we decided
148 to set aside some variables, e.g. those related to the MPA relationships between managers and
149 employees. Due to the complexity of their monitoring process, we also decided to set aside other
150 external relevant variables, such as the relationships between the MPA and its partners or
151 stakeholders, except for the core activity of surveillance.

152 153 **2.3 Data treatment**

154 Several organizational dimensions have been characterized through the analysis of single
155 variables. A hierarchy of indices has been developed to summarize the management performance
156 assessment (Fig. 3). To build the indices, the relevant information has been collected through
157 different components (items and targets), each evaluated with specific metrics depending on its
158 specific nature (e.g., categories or numerical variables). Each component has also been ranked
159 and scored in order to obtain five isometric 1st order indices. The 1st order indices were further
160 combined into two aggregated indices (Fig. 3). The indices taken into account are presented in
161 the following paragraphs.

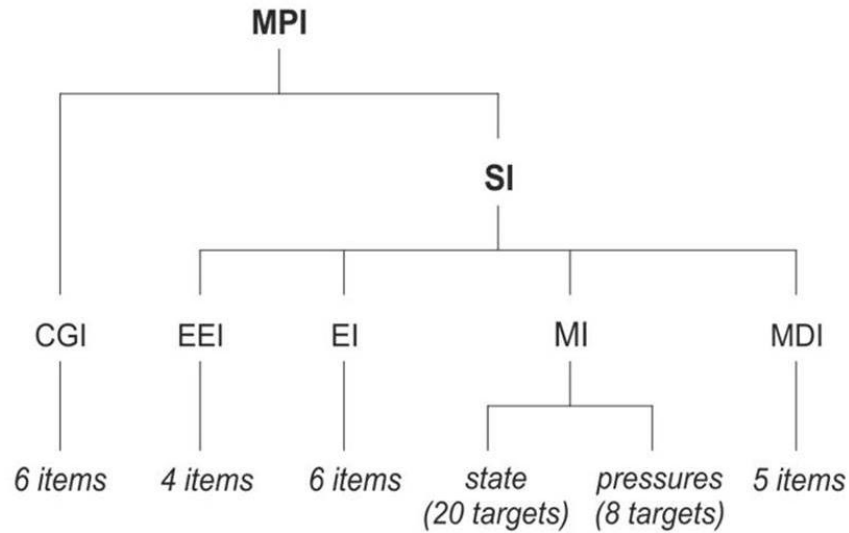


Fig. 3. The hierarchy of the indices implemented in this study. Components are in italics, 1st order indices in roman, aggregated indices in bold. Top to bottom: MPI = management performance index; SI = strategy index; CGI = culture and goal index; EEI = environmental education index; EI = enforcement index; MI = monitoring index; MDI = management data index.

2.3.1 Legal status and authority characterization

We investigated the legal status of the management body of the 11 MPAs by considering six variables:

- i) pre-existence of the management body before creation of the MPA (yes/no);
- ii) nature of the management body (public/private/mixed);
- iii) management body constituted by institution/s having the legal power to issue penalties to offenders (yes/no);
- iv) management body with the legal authority to directly employ the manager and the staff (only the manager/both the manager and the staff/neither of the two);
- v) management body directly allocating its own police officers for surveillance (when it is the case) (yes/no);
- vi) MPA staff members with the legal power to issue penalties to offenders (yes/no).

2.3.2 Characterization of the organizational structure and size

The organizational structure has been assessed on the basis of eight variables:

- i) centralization, i.e. where the decisional power is held (national level/regional level/local level);
- ii) hierarchy, defined as the number of different levels of authority within the management body;

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186 iii) organizational size: the workforce on which the MPA can rely, expressed here as the ratio
187 between the number of full-time equivalents (FTE, the equivalent number of employees working
188 full-time in an organization) and the total surface area of the MPA in km² (FTE/km²). It is
189 important to underline again that herein MPA size does not refer to the surface area of the MPA,
190 but to the workforce in an MPA;

191 iv) operative personnel ratio, defined as the ratio between the number of full-time operative (Op)
192 workers (e.g. doing surveillance in the field) and the total number of FTE (Op/FTE);

193 v) personnel stability, i.e. the ratio between the number of full-time permanent employees (PE)
194 and the total number of FTE (PE/FTE);

195 vi) manager stability, in terms of:

196 a) manager position (non-permanent position/permanent position);

197 b) ratio between the age (A, in years) of the MPA since its implementation and the number
198 of managers appointed (M) (M/A);

199 vii) manager professionalism, defined as the manager's educational level, training and work
200 experience, assessed on the basis of seven features:

201 a) educational level (Bachelor/Master degree/PhD);

202 b) degree consistent with natural resource management issues (yes/no);

203 c) specific training in marine topics after graduation (yes/no);

204 d) previous employment in an environmental or marine sector (yes/no);

205 e) previous employment in MPAs (yes/no);

206 f) specific training in management (yes/no);

207 g) previous management experience, e.g. in companies (yes/no).

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209 ***2.3.3 Characterization of networking for surveillance***

210 We also focused on the effort made by the management body to collaborate with the
211 police body (if present) legally responsible for enforcing the MPA (e.g. the coastguard).
212 'Network' in OS is defined as the number and kind of collaborative relationships that the
213 organizations may activate with their 'environment', i.e. everything outside the organization's
214 boundaries (Powell, 1990; Uzzi, 1996). We considered three variables:

215 i) presence of a police body responsible for enforcing the MPA (yes/no/the 'police' function is
216 provided by MPA staff);

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4 217 ii) active collaboration (e.g. working together in the field, sharing funds) between the MPA
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6 218 management body and the police body (yes/no);
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8 219 iii) surveillance data available, in terms of ‘hours’ carried out by the police body (yes/no).
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10 220 11 221 **2.3.4 Management performance assessment**

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13 222 MPA management performance was assessed by combining two indices, the Culture &
14 223 Goal Index (CGI) and the Strategy Index (SI), into a final aggregated index.

15 224 The Culture & Goals Index (CGI) assesses the effort deployed in planning the long term
16 225 future, through the formalization of the mission and vision, and the short term future, through
17 226 setting the goals. We characterized the “type of mission” that each MPA formalized, i.e. the
18 227 main purpose the MPA was created for, considering 5 categories: conservation, education,
19 228 monitoring and research, recreation, resources management (Bianchi et al., 2012). Mission and
20 229 vision are part of the culture (a body of shared values and governing ideas), which is crucial for
21 230 planning the future of any organization (Etzioni, 1964; Nanus, 1992). It also measures the effort
22 231 deployed by each MPA management body in formalizing, periodically updating and quantifying
23 232 its goals. The goals are necessary tools to assess the progress of MPA effectiveness (Ervin, 2003;
24 233 Kay & Alder, 1999), but progress is measureable only if the goals are themselves measureable
25 234 (Grafton & Kompas, 2005). The CGI is a 1st order index constituted by 6 items, and ranges from
26 235 0 to 8 (Appendix A, Table A.1).
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30 236 The Strategy Index (SI) is an aggregated index. It is constituted by four 1st order indices,
31 237 each evaluating the planning and the realization of the four main activities implemented within a
32 238 MPA: Environmental Education Index (EEI), Enforcement Index (EI), Monitoring Index (MI),
33 239 and Management Data Index (MDI) (see Appendix A, Table A.2 to A5 for more details). The
34 240 scores of each of the 4 activity indices have been ranked to range between 0 and 8. Averaging
35 241 the ranks for each activity gives the score of the SI, according to the formula: $SI =$
36 242 $(EEI + EI + MI + MDI) / 4$. The maximum score for the SI is therefore 8.
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39 243 The Management Performance Index (MPI) was devised to integrate the Culture & Goals
40 244 Index (CGI), seen as a measure of what should be done, and the Strategy Index (SI), seen as
41 245 a synoptic expression of what is actually done to achieve MPA goals. The basic concept beyond
42 246 the MPI is that neither good ideas and targets (GI) nor impressive activities (SI) alone are
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4 247 enough: a satisfactory management system requires both. The MPI is computed through the
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6 248 formula: $MPI = \sqrt{((CGI^2 + SI^2)/2)}$, so that its maximum score is again 8.
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11 251 **3. Results**

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14 252 Below, we report the results obtained for each of the categories of variables and/or indices
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16 253 identified in the previous section.
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19 255 *3.1 Characterization of legal status and authority*

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21 256 Four MPAs out of eleven are managed by a pre-existing body. The remaining MPAs are
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23 257 managed by bodies specifically and exclusively created to manage the MPA (along with a
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25 258 terrestrial National Park in the case of Tremiti MPA). Nine management bodies are public
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27 259 organizations or consortia of public bodies. Torre Guaceto and Zakynthos are managed by hybrid
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29 260 public and non-profit organization.

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31 261 Staff members of the management body have the legal power to inflict penalties in the
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33 262 Bonifacio MPA only. All the other MPAs here considered have a management body that
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35 263 includes at least one institution having the power to inflict penalties (e.g. fines, confiscations) on
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37 264 offenders. Public institutions that are part of the management bodies at Bergeggi and Portofino
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39 265 MPAs (municipality and district, respectively) allocate police officers to help the management
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41 266 body to enforce the MPA.

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43 267 All the eleven MPAs have the legal power to directly employ the managers. The
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45 268 management bodies of Bonifacio, Cala Ratjada, Côte Bleue and Zakynthos also have the legal
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47 269 power to employ staff members. The seven Italian MPA management bodies do not have any
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49 270 legal power to hire any staff.
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51 272 *3.2 Characterization of the organizational structure and size*

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53 273 Nine MPAs are managed at local level, Bonifacio is managed at regional level, and Cala
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55 274 Ratjada is managed simultaneously at national and regional level (via the collaboration between
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57 275 the National Ministry of Environment and Rural and Marine Affairs, and the Regional
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59 276 government of the Balearic Islands). Ten MPAs have four hierarchical levels (president, one or
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two management boards, manager, and staff). Cala Ratjada has 6 hierarchical levels (minister, general secretariat, general director, subdirector, two managers, and staff).

The MPA organizational size is measured as the ratio between Full Time Equivalent positions and surface area (FTE/km²). It varies from 0.01 (Ustica) to 2.31 (Portofino) (mean = 0.52 ± 0.79 SD), meaning that there is one FTE per 2 km² of surface area on average (Table 2). The operative personnel ratio (Op/FTE) ranges from 0.11 (Tremiti) to 0.89 (Bonifacio) (mean=0.56 ± 0.23 SD) (Table 2). The personnel stability ratio (PE/FTE) varies from 0 (Porto Cesareo) to 0.89 (Tremiti) (mean=0.34 ± 0.27 SD), meaning that one third of the staff members are permanent employees on average (Table 2). Thus, these three organizational dimensions show high variability in the sample of MPAs considered (Fig. 4a and 4b).

Table 2. Scores of the organizational dimensions and of the indices of management performance for each MPA studied here.

Organizational dimensions	Bergeggi	Bonifacio	Cala Ratjada	Côte Bleue	Portofino	Porto Cesareo	Tavolara	Torre Guaceto	Tremiti	Ustica	Zakynthos
Size	1.76	0.04	0.07	0.08	2.31	0.03	0.05	0.77	0.12	0.01	0.47
Operative personnel ratio	0.34	0.89	0.65	0.71	0.5	0.47	0.5	0.79	0.11	0.36	0.81
Personnel stability	0.37	0.71	0.49	0.41	0.25	0	0.13	0.06	0.89	0.29	0.1
Manager stability	3.5	7.5	7	32	4.33	9	11	14	6.33	3.83	7
Culture and goals index	4	3	2	4.5	6.5	5.5	4.5	6.5	4	4	2
Environmental education index	4	6	2	6	2	3	4	6	3	4	6
Enforcement index	5	5	4	4	4	3	3	5	2	2	7
Monitoring index	2	3	1	5	2	2	3	4	1	2	3
Management data index	4	6	6	6	0	1	5	6	5	2	6
Strategy index	3.75	5	3.25	5.25	2	2.25	3.75	5.25	2.75	2.50	5.50
Management performance index	3.88	4.12	2.70	4.89	4.81	4.20	4.14	5.91	3.43	3.34	4.14

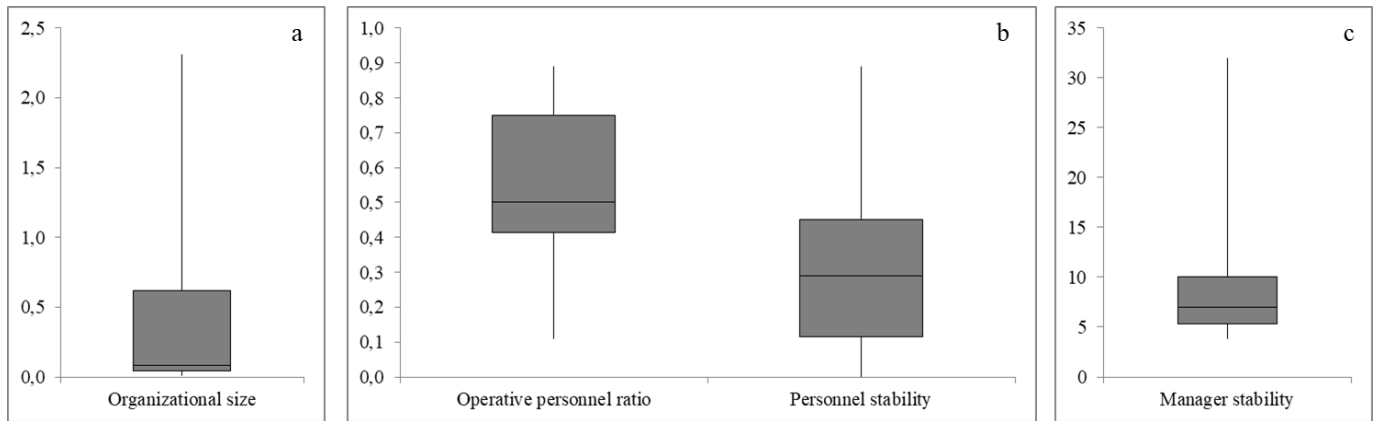


Fig. 4. Box plots showing the median (horizontal line), first and third quartiles (limits of the box), and minimum and maximum values (whiskers) of the organizational size (panel a), the operative personnel ratio and personnel stability (panel b) and the manager stability (panel c) for the 11 MPAs investigated.

The managers of Bergeggi, Portofino, Porto Cesareo, Tavolara and Ustica hold non-permanent positions, while the managers of the other MPAs have permanent positions. The ratio between the age of the MPAs and the number of managers appointed (M/A, manager stability) varies from 3.5 (Bergeggi) to 32 (Côte Bleue) (mean=9.59± 8.06 SD). Côte Bleue had just one manager since its implementation, while Bergeggi had two managers but, as it is a young MPA (7 years old), the value of this ratio is inevitably low. Ustica is the MPA that had the highest number of managers (6 successive managers in 23 years). Also this feature shows a high variability among the MPAs considered (Fig. 4c).

Concerning the professionalism of the MPA managers, the picture is again extremely variable among the eleven MPAs considered. Three MPA managers out of eleven have a PhD, while the others have a Bachelor or Master degree. Nine out of eleven managers received an academic education in environmental and resource management. Nine and seven out of eleven managers attended training courses on marine/environmental issues or management issues, respectively, after their degree. Apart from the academic background, ten out of eleven managers had previous employment in the marine/environmental sector, four out of eleven in the business management sector, and four out of eleven were already employed previously in the MPA sector. In some MPAs (e.g. Cala Ratjada and Tavolara), the education of the manager was diversified, varying from a PhD or Bachelor/Master degree in environmental (often marine) subjects to training and previous employment in the business management sector or local public

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administration (e.g. Municipality). In the case of other MPAs, the educational background and work-political experience of the managers was more limited.

3.3 Characterization of networking for surveillance

The inter-organization cooperation developed in order to carry out surveillance is very heterogeneous. As previously evidenced, in all the MPAs considered, there are one or more police bodies responsible for enforcement. Only at Bonifacio do some staff members have the same legal power as the police officers, so there is no strict need in this case for the MPA to formalize collaboration with the police authorities, this core function being incorporated within the MPA management body itself.

At Zakynthos, many hours of surveillance in the MPA are performed by the staff jointly with police officers. The police body also makes available the data on the hours of surveillance carried out independently. At Côte Bleue too, the staff carry out surveillance jointly with police officers, even if only for a few hours per year. At Bergeggi, Porto Cesareo and Tremiti, MPA management bodies share funds with the police bodies to finance surveillance activities. Bergeggi, Porto Cesareo, Portofino, Tavolara, Torre Guaceto, Tremiti and Zakynthos share the surveillance data with the police body.

3.4 Management performance assessment

Portofino and Torre Guaceto achieved the highest values for the Culture & Goals Index (CGI, Table 2). These MPAs made an attempt to formalize their vision, even though their vision statements are rather inaccurate/imprecise. These two MPAs adopted a high percentage of measurable goals (69%, and 55%, respectively). All the eleven MPAs have formalized their mission: “conservation” is the stated mission for ten MPAs; at Cala Ratjada, the declared mission is “resources management”. Cala Ratjada and Zakynthos do not have formal goals, so their CGI obtained the lowest scores among the MPAs considered (Table 2). As for the Strategy Index (SI), Zakynthos, Côte Bleue, Torre Guaceto and Bonifacio MPAs achieved the highest values, followed by Bergeggi and Tavolara, and then the remaining MPAs (Table 2).

Looking in greater depth into the specific 1st order indices of the SI for each MPA, the highest score for EEI (Environmental Education Index) is achieved by Zakynthos (Fig. 5), which gets the highest value for three out of the four items composing the EEI (see Appendix A, Table

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A.2 for more details). None of the MPAs considered assessed the efficacy of environmental education projects. The lowest EEI scores are obtained by Portofino and Cala Ratjada, where the environmental education projects were only carried out occasionally. Zakynthos again gets the highest score for the EI (Enforcement Index) (Fig. 5), because of the significant number of hours of surveillance that the MPA staff performs both independently and jointly with the police body. The lowest score is recorded by Ustica, due to the low number of hours of surveillance performed by the MPA staff and the police body. The only MPA where the staff members carry out the legal enforcement is Bonifacio, but its EI is lower than that of Zakynthos due to the very extensive surface area of Bonifacio. The MI (Monitoring Index) displays in general fairly low values (Fig. 5), due to the low number of targets (e.g. species) that are usually monitored (mean number of targets = 12 ± 4.8) or the short-term nature of monitoring activities. With regard to the MDI (Management Data Index), Bonifacio, Cala Ratjada, Côte Bleue, Torre Guaceto and Zakynthos record quite high scores (Fig. 5), achieving the maximum value for 3 out of the 5 items of the index (see Appendix A, Table A.5 for more details). At Portofino, the MDI equals 0 because the staff does not perform any surveillance, and education projects are not monitored for their effects. MDI scores obtained by many MPAs are generally low, mainly because the MPAs do not assess the environmental education effectiveness (Fig. 5).

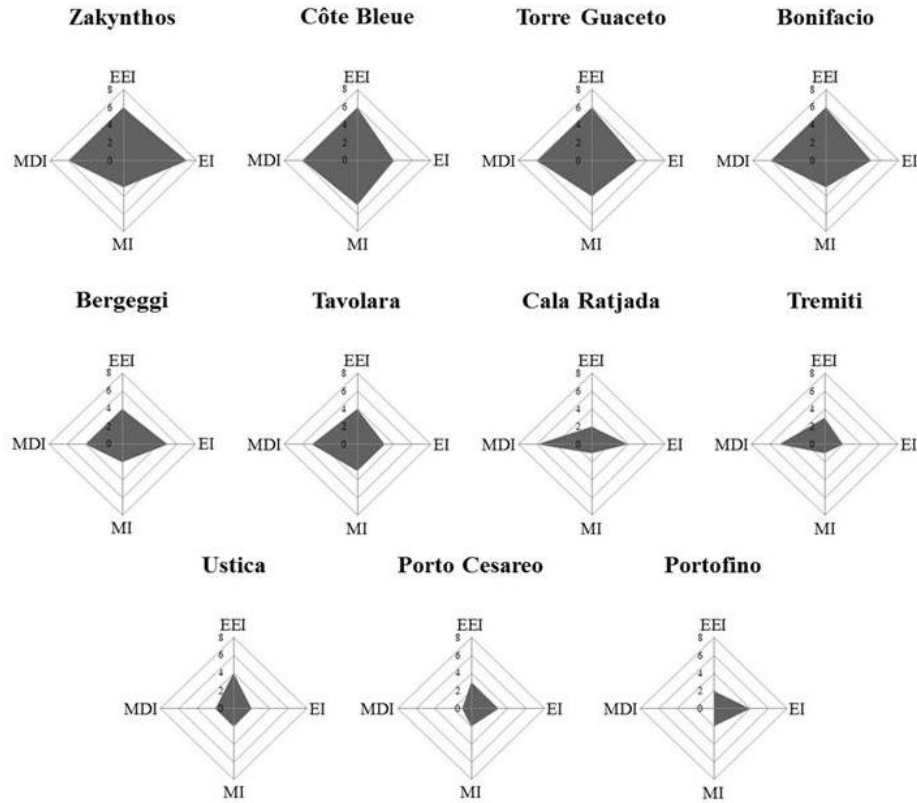


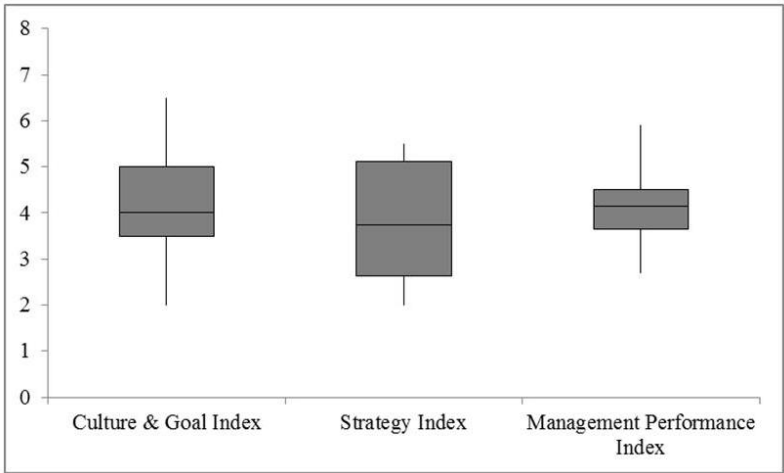
Fig. 5. Scores of the Environmental Education Index (EEI), the Enforcement Index (EI), the Monitoring Index (MI) and the Management Data Index (MDI) for the 11 MPAs considered. Note that no MPA achieves the theoretical maximum for all indices.

So although the EEI, EI, MI and MDI provided fairly different contributions to the overall Strategy Index (SI), which results from their average, SI represents a synoptic assessment of the activities performed at the MPAs studied here. Zakynthos is the most active (Table 2), but the low value for MI (Fig. 5) suggests that there is still room for improvement. In addition, Bonifacio, Côte Bleue and Torre Guaceto exhibit high scores for the SI (Table 2), but monitoring and enforcement (measured by MI and EI) are not optimal yet (Fig. 5). Ustica, Porto Cesareo and Portofino are the MPAs with the lowest SI scores (Table 2), which suggests the need for improvement in three or four management components.

Both CGI and SI show a high variability, with a wide range of scores, in the MPAs considered. None of the MPAs reaches the maximum score for either index (Fig. 6). Coupling CGI and SI into the Management Performance Index (MPI; Table 2) highlights that Torre Guaceto is distinctly the top-performer, followed by Côte Bleue and Portofino, whereas Tremiti, Ustica and Cala Ratjada come last. In addition, for this index a high variability is evident (Fig.

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382 6). However, four different situations can be distinguished (Fig. 7): i) Torre Guaceto and Côte
383 Bleue obtain a high MPI because of their significant effort in carrying out fundamental activities
384 linked to well-defined projects (both CGI and SI are high); ii) Zakynthos and Bonifacio are quite
385 active but pay little attention to the formalization of vision, mission and goals (SI is high but CGI
386 is low); iii) Tavolara, Porto Cesareo and Portofino conducted appropriate projects but invested
387 less in assessing, planning and accomplishing their activities (e.g. monitoring the effect of
388 educational activities); iv) the remaining MPAs are insufficient and/or incomplete in both their
389 planning and implementation of activities.



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392 **Fig. 6.** Box plots showing the median (horizontal line), first and third quartiles (limits of the box), and minimum and
393 maximum values (whiskers), of the Culture & Goals (CGI), Strategy (SI) and Management Performance (MPI)
394 Indexes for the 11 MPAs investigated.

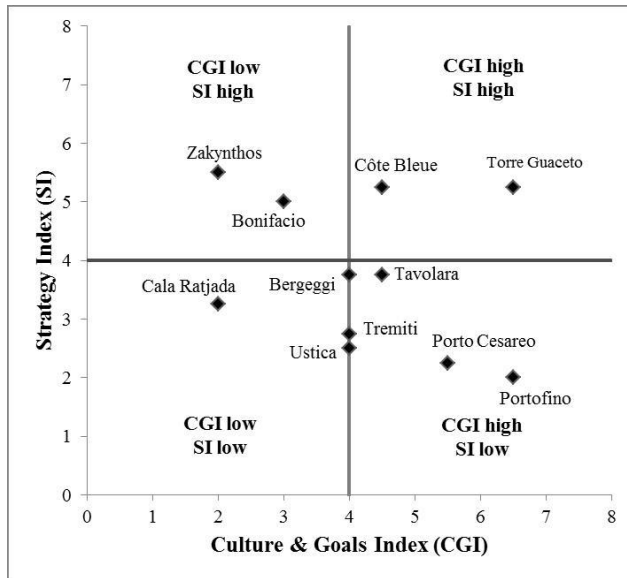


Fig. 75. Scores of the Strategy Index (SI) and the Culture and Goals index (CGI) for the 11 MPAs studied. Crossing the two indices, four different scenarios emerge (see subsections 3.4).

4. Discussion

The present study underlines the importance of management features in MPA science (Gill et al., 2017; Hargreaves-Allen et al., 2017; Worm, 2017) and offers a novel perspective and framework to evaluate and interpret MPA performance. It supplies new tools, such as a standardized questionnaire, created to collect factual data (and not opinions of the interviewees), and simple indices. The collection of factual data through an objective approach is the most important characteristic of our methodology, allowing applicability to different geographical contexts and scales, and making it different from the other tools so far employed (e.g., METT, World Bank MPA Score Card and RAPPAM) (Ervin, 2003; Stolton et al., 2007; Staub & Hatzios, 2004). The framework provided also differs from the tools previously employed because it takes advantage of the experience gathered through research in another science (OS). This can be useful in helping MPA managers and policy makers to solve problems and assess several crucial management aspects (e.g. centralization, professionalism, enforcement) (Claudet et al., 2008; Guidetti et al., 2008; Montefalcone et al., 2009), which are often neglected in conservation science. We tried to make our assessment objective as far as possible and to avoid social biases. For example, in the assessment of the enforcement, we did not consider the number of penalties inflicted on the offenders because punitive actions are not always the best deterrent,

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4 419 and other strategies or investments can be more effective to enforce an MPA (e.g. cooperation,
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6 420 trust, leadership) (Micheli & Niccolini, 2013; Pieraccini et al., 2016).

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8 421 The present study provides a tool for the assessment of MPA management performance
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10 422 that allows comparison between the MPAs. In particular, policy makers responsible for the
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12 423 management of national MPAs (and the systems they form) can use it to integrate and assess
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14 424 organizational factors to compare management performance among MPAs. It was not our
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16 425 purpose to create a completely new Management Performance System, and furthermore we did
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18 426 not focus on the entire process within an organization that may influence employees' behaviour
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20 427 and implement specific strategies (Anthony & Govindarajan, 1998). However, such an approach
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22 428 could be taken into account in further studies.

23 429 One of the most significant difficulties we faced in this study was the limited availability
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25 430 of data (Fox et al., 2014; Worm, 2017). MPAs are often small and sometimes young
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27 431 organizations that normally do not have enough resources for exhaustive monitoring. Ecological
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29 432 and management data, when they are collected, are often not collected within the same time
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31 433 frame, and not stocked or reported in a standardized way (Claudet & Guidetti, 2010; Gill et al.,
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33 434 2017). Such shortcomings make it difficult to couple ecological and management data and
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35 435 extract generalizations, something which needs an appropriate sample size. This is the case also
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37 436 for Gill et al. (2017), who assessed MPA management effectiveness at global scale, finally
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39 437 taking into account 64 MPAs due to the limited data availability. So our sample size (11 MPAs
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41 438 at Mediterranean scale) should be considered in the light of the limited availability of
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43 439 management and bio-ecological data from MPAs (Gill et al., 2017).

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45 440 The first clear evidence emerging from this study is the heterogeneity displayed by the
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47 441 eleven MPAs investigated. The heterogeneity concerns the legal status, the pre-existence and the
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49 442 authority to inflict penalties and employ managers and staff of the management body. This
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51 443 suggests that the process of creation and subsequent management of a MPA is extremely
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53 444 variable, with possible repercussions on the MPA performance and effectiveness (Francour et al.,
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55 445 2001). Further studies should be done to urgently investigate the effects of these features on
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57 446 MPA management effectiveness.

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59 447 The MPAs taken into account are more homogeneous when the centralization is taken
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61 448 into account. However, the existence of MPAs managed at different levels of centralization
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63 449 (local, regional and national) suggests the need to carry out studies to investigate how
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centralization could affect MPAs' management effectiveness. We can observe that the management at national level may help in developing a unitary organizational system of guidance, service and support for the individual MPAs (such as systematic training opportunities for managers or employees, volunteer programs). This is the case, for instance, for the National Marine Sanctuaries Office of the National Oceanic Atmospheric Administration (NOAA) in the USA (Morandi et al., 2012). On the other hand, decentralized management levels can enhance the customer orientation in public organizations (Andrews et al., 2006; Osborne & Gaebler, 1992), which, in the MPA context, could imply a closer connection with the local communities. An interesting option could be a mixed system: i) the national (or supranational, such as the EU) management level (e.g., through an inter- or governmental agency) harmonizes and standardizes some aspects of the MPAs' functioning, structure and management, such as legal status, authority, internal hierarchy, stability and functions of the staff and support services (e.g. a national MPAs website or a national volunteer program); ii) the local level helps in adapting the MPA management to the local context (e.g. adopting the right contingent solutions for specific threats or pressures, integrating within the co-management specific categories of stakeholders, adapting management measures to local cultures) (White et al., 2002). However, when several bodies are involved in making decisions at different levels regarding the management of a single MPA, it requires a major effort to coordinate decisions and activities in order to be effective (Rife et al., 2013).

Furthermore, the hierarchy of the eleven MPAs considered gives quite homogeneous results. A proper number of hierarchical levels to increment MPA management effectiveness is probably not the same in each MPA context, but it is known that an excessive number of hierarchical levels may interfere with effective communication up and down the organization structure (Pugh, 1973). Further studies should focus on possible alternatives to hierarchical structures for the MPAs that lead to the enhancement of the management effectiveness.

The eleven MPAs considered were extremely variable also in terms of organizational size and structure (operative personnel ratio, personnel and manager stability, manager professionalism). So far, no studies have investigated the effects of such features on MPAs management effectiveness. However, studies focusing on organizations other than MPAs have shown that a small organizational size could negatively affect the productivity and services provided by public and private organizations (Gooding & Wagner, 1985). A poorly balanced

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481 staff structure, specifically the presence of too many administrative workers (which sometimes it
482 is needed to deal with an excessive and complex bureaucracy of the system), could significantly
483 decrease the effectiveness of the organization (Bidwell & Kasarda, 1975). High personnel
484 stability reduces the costs of employment transactions, promotes the creation of effective
485 working relationships, improves motivation and enables management continuity (Coase, 1937;
486 Leana & Van Buren, 1999; Pfeffer, 1998). In the MPA context, the relative stability of managers
487 and employees is particularly important, as the most significant strategic MPA targets,
488 particularly ecological and socio-economic responses (e.g. increase of fish biomass and size, and
489 related enhanced fishing catches), require long periods of time (decades) to be achieved (García-
490 Rubies et al., 2013). A high degree of professionalism could positively affect the effectiveness of
491 the manager, and probably of the employees in general, which may impact in turn the
492 organizational effectiveness and the achievement of the goals (Daft, 1978; Damanpour et al.,
493 1989; Vigoda-Gadot, 2007).

494 The characterization of the networking related to the surveillance of the MPAs showed
495 that the collaboration among MPA management bodies and police bodies is often limited. The
496 joint activity of MPA staff and police officers could enable the pooling of competences (e.g.
497 knowledge of the legal framework, knowledge of the territory, correct classification of protected
498 species included in international protocols such as the Habitat Directive of the EU) so as to
499 improve the effectiveness of surveillance activities. This is consistent with the generally accepted
500 principle that cooperative attitudes can favour the sharing of different skills and consequently
501 improve the effectiveness of organizations' strategies (Alter & Hage, 1993; Greenhalgh, 2001;
502 Hamel, 1991). Even though it may appear surprising for organizations such as Marine *Protected*
503 *Areas*, the availability of data regarding the surveillance activities carried out by MPA staff
504 and/or police bodies is very limited, and often the available data are raw, inaccurate and
505 sometimes entirely unreliable. The absence of accurate and reliable data on MPA surveillance
506 makes it difficult to set up a proper adaptive management system to optimize costs and make
507 MPAs increasingly effective (Holling, 1978; Parma AM & NCEAS Working Group on
508 Population Management, 1998; Walters & Hilborn, 1978). In the Mediterranean MPA context,
509 the existing cooperation is more the result of personal initiatives of managers who have decided
510 to invest in networking, than the outcome of structural measures aimed at making MPAs
511 effective.

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4 512 The eleven MPAs are highly variable also in terms of the indices considered. The scores
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6 513 for Culture and Goals Index (CGI) revealed that, unexpectedly, the importance of formalizing
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8 514 the vision, mission and measurable goals is not generally understood yet in the context of
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10 515 Mediterranean MPAs. In OS, it has been demonstrated that the formalization of the vision,
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12 516 mission and measurable goals enables organizations to achieve higher effectiveness (Baetz &
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14 517 Bart, 1996; Lipton, 1996; Kantabutra, 2008; O'Brien & Meadows, 2000). In addition, a clearer
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16 518 perspective on the future, in both the long term (vision) and the short term (goals), and similarly
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18 519 a clear mission statement, might improve the consistency and effectiveness of the strategy of any
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20 520 organization, and provide a basis for developing coherent effectiveness assessment systems
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22 521 (Sawhill & Williamson, 2001). The heterogeneity in the results of the Strategy Index (SI) is due
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24 522 to the investment in one or more activities (e.g., enforcement, education, monitoring, data
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26 523 collection), which is the result of the personal initiative or choice of each single MPA manager.
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28 524 This is also surprisingly true for the monitoring, the activity that provides the information on the
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30 525 effectiveness of the management process and enables decisions to be made concerning what the
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32 526 management body needs to change in the management strategy, or where and when additional
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34 527 effort is needed. Such heterogeneity in the strategy and the related activities is also determined
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36 528 by the difficulties faced during the management process: paucity of staff and funding (e.g. for
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38 529 enforcement, monitoring, education), lack of political will (especially for the enforcement),
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40 530 underestimation of the importance of the availability of crucial data (e.g. monitoring and
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42 531 management data) for the setting up of the adaptive management of MPAs and the assessment of
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44 532 the effectiveness of management actions (Balmford & Whitten, 2003; Day et al., 2012; Thur,
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46 533 2010; Walters & Hilborn, 1978). Accounting for the effort devoted to the monitoring enables
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48 534 evaluation of the ability/possibility of the organizations to assess the achievement of their goals.
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50 535 The Management Performance Index (integrating the effort made to plan the future and
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52 536 accomplish the related activities in the MPAs) underlined a surprising overall heterogeneity in
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54 537 terms of the attention and importance paid to the different aspects of the management process by
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56 538 the MPAs.
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5. Conclusions

This exploratory study applied OS principles and framework to develop a novel method to characterize crucial MPA features, such as authority, structure, organizational size and networking, and to assess and explain MPA performance (Horigue et al., 2014). A number of indices were also developed that offer a basis for summarizing and better understanding the weaknesses of each MPA. Such indices clearly indicate the management aspects that need to be improved to enhance MPA performance, which in turn can improve MPA effectiveness.

Our exploratory research, although focused on a limited number of case studies, provides a partial picture of the reality investigated. The confirmation of the the validity of the specific results produced by this exploratory study can be obtained only by broadening the sample of the MPAs investigated, and repeating the the survey in other ecoregions.

Being conscious of those intrinsic limitations, we can say that our exploratory research showed that some answers to MPA performance issues could be found by looking more in depth into their organizational setting. Without any pretension of creating a complete and new Management Performance System (MPS) (Anthony and Dearden, 1980), the framework proposed here can offer useful information and indications in particular to MPA policy makers (at regional and national level) as a basis for interpreting the organizational reasons why MPAs achieve different level of performance, and consequently improving the implementation of strategy for an entire MPA system. At the same time, some of the organizational dimensions assessed here can be useful sources of information for single MPA managers for “improving the likelihood of their organization to implement their [MPA] strategy” (Anthony & Govindarajan, 1998). In this perspective, our exploratory study can provide useful indications, tools and methodological clues, especially for policy makers responsible for the management of national MPA systems to include organizational factors within their national Management Control System (MCS) and also for single MPA managers to include some organizational factors within their single MPA’s MCS.

Should our results be confirmed by more exhaustive sampling, we can imagine that a more standardized framework related to MPA management at EU and Mediterranean scales (e.g. planning and performing strategic activities, prioritizing monitoring targets, standardizing enforcement methods, collecting data on management and education programs) could increase the success of the existing MPAs and produce a catalyzing effect for future developments. An

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574 improvement of the legal framework also seems to be needed, particularly in order to implement
575 the enforcement of MPAs and the stability of managers and employees.

576 We strongly believe that the present exploratory research represents a useful step forward
577 in MPA science, providing a new insight towards the understanding of the features that can
578 affect management effectiveness. Improving and enriching on the basis of the OS perspective the
579 methodological approaches to assess MPAs' performance and effectiveness, finally, is pivotal
580 step towards assessing the achievement of international targets to which countries are officially
581 committed, such as the Aichi target 11 of the CBD (2011) or the SDG target 14 (UNEP, 2015).

582 **Acknowledgements**

583 We would like to thank, first of all, the MPA managers we have interviewed, who provided us
584 with crucial information (in alphabetic order): Frédéric Bachet, Simone Bava, Maddaleine
585 Cancemi, Alessandro Ciccolella, Paolo D'Ambrosio, Giuseppe Di Carlo, Drosos Koutsoubas,
586 Giorgio Fanciulli, Juan Carlos Jorquera Gámez, Silvia Revenga Martínez de Pazos, Augusto
587 Navone, Pasquale Santoro and Laurent Sourbes. We also wish to thank some staff members who
588 kindly provided supplementary data and explanations: Pasquale Baiata, Valentina Cappanera,
589 Eric Charbonnel, Jean-Michel Culioli, Francesco De Franco, Sergio Fai, Tiziana Ferrando, Javier
590 Llorente Palao, Luciana Muscogiuri, Pier Panzalis and Dimitriadis Xaralambos. We want to
591 thank Michael Paul for his invaluable help in reviewing the earlier version of this manuscript.

592 **Funding**

593 The present study has been supported by the Prince Albert II of Monaco Foundation (Monaco),
594 the Total Corporate Foundation (France), MedPAN (France), the *Agence des Aires Marines*
595 *Protégées* (now the *Agence Française pour la Biodiversité*) and the WWF-MedPO (Italy).

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4 **Appendix A**
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9 **Text A.1 Questionnaire administered to the 11 MPAs studied here**
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14 MPA Name: _____ Country: _____ Date: _____
15

16
17 **General Information**

18 year of creation: _____

19 year of implementation: _____

20 number of highest protected zone: _____

21 total highest protected zone size (ha): _____

22 size of each highest protected zone (ha): 1. _____; 2. _____; 3. _____; 4. _____

23 total zones number: _____
24
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27
28 **Legal status and authority of the management body**

29 pre-existence of the management body before the creation of the MPA: yes, no

30 nature of the management body: public, private, mixed

31 the management body was constituted by institution/s having the legal power to issue penalties to
32 offenders: yes, no

33 the management body has the legal authority to directly employ the manager and the staff:
34 only the manager, both the manager and the staff, neither of the two

35 the management body directly allocates its own police officers for surveillance (when it is the
36 case): yes, no

37 MPA staff members have the legal power to issue penalties to offenders: yes, no
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43 **Structure**

44 level of centralization: national, regional, local

45 which are the hierarchical levels in the management of the MPA? _____

46 total Employee Number: _____

47 permanent Employee Number: _____

48 non-Permanent Employee Number: _____

49 full-Time Employee Number: _____

50 part-Time Employee Number: _____

51 all Year Employee Number: _____

52 seasonal Employee Number: _____

53 (months of employment of the seasonal employees: _____)

54 managers Number: _____

55 operative Employee number: _____
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4 817 administrative Employee number: _____
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6 818 number of managers appointed since the implementation of the MPA: _____
7 819 type of contract of the manager: permanent position, no-permanent position
8
9 820 duration of the employment of the current manager number of months: _____
10 821 educational level of the manager: PhD; MD, BD, High School, Inferior level,
11 822 degree focus consistent with natural resource management issues: yes, no
12
13 823 specific training in marine subjects after the graduation: yes, no
14 824 previous employment on environmental or marine sector: yes, no
15
16 825 previous employment in other MPAs: yes, no
17 826 specific training in management: yes, no
18 827 previous management experience, e.g. in companies: yes, no
19
20 828
21 829 **Networking**
22 830 presence of a police body responsible for enforcing the MPA: yes, no, the 'police' function
23 831 is provided by MPA staff
24 832 active collaboration (e.g. working together in the field, sharing funds) between MPA
25 833 management body and police body: yes, no
26
27 834 surveillance data available, in terms of 'hours' carried out by the police body: yes, no
28
29 835
30
31 836 **Management performance**
32 837 Type of mission
33 838 conservation, education, monitoring and research, recreation, resources management,
34 839 other: _____
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36 840
37
38 841 *Culture and Goals*
39 842 presence of a stated mission in one or more official documents: formalized, not formalized
40 843 presence of a stated vision in one or more official documents: formalized, not formalized
41 844 technically correct statement of the vision: inaccurate, accurate
42 845 presence of a stated goals in one or more official documents: formalized, not formalized
43 846 goals formalized in documents currently in effect: not updated, updated
44 847 percentage of measurable goals: 0, 1-25%, 26-50%, 51-75%, 76-100%
45
46 848
47
48 849 *Environmental education*
49 850 duration (number of years) of environmental education projects: none, occasionally, 2-5
50 851 years consecutively, 6-9 years consecutively, more than 9 years consecutively
51 852 classes of stakeholders involved in environmental education projects: students, local
52 853 community, tourists, local authorities, others: _____
53 854 number of people involved in environmental education projects in 2014: _____
54 855 effectiveness of environmental education projects: no or data non available, 1-25%, 26-
55 856 50%, 51-75%, 76-100%
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858 *Enforcement*

859 kind of enforcement adopted by the MPA staff: none, interpretative enforcement, legal
860 enforcement

861 networking (cooperation) with police bodies: yes, no

862 methods employed by the MPA for the surveillance: at sea, from land, daytime, night

863 time, video cameras, radar, vessel monitoring system, night vision binocular, camera

864 with georeferenced position, laser

865 hours spent by the MPA staff for the surveillance per year: _____

866 hours spent by the police bodies for the surveillance per year : _____

867 amount of hours the MPA staff spend for the surveillance each month during the winter (October

868 to May): _____

869 amount of hours the MPA staff spend for the surveillance each month during the winter (June to

870 September): _____

871

872 *Monitoring*

873 monitoring targets _____ Years: ____

874 Report: not reported

875 internal reports

876 communications and outreach

877 scientific papers without impact factors and scientific report

878 scientific papers with impact factor

879

880 monitoring targets _____ Years: ____

881 Report: not reported

882 internal reports

883 communications and outreach

884 scientific papers without impact factors and scientific report

885 scientific papers with impact factor

886

887 monitoring targets _____ Years: ____

888 Report: not reported

889 internal reports

890 communications and outreach

891 scientific papers without impact factors and scientific report

892 scientific papers with impact factor

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894 monitoring targets _____ Years: ____

895 Report: not reported

896 internal reports

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- 897 communications and outreach
- 898 scientific papers without impact factors and scientific report
- 899 scientific papers with impact factor

900
901 monitoring targets _____ Years:____

- Report:
- 902 not reported
 - 903 internal reports
 - 904 communications and outreach
 - 905 scientific papers without impact factors and scientific report
 - 906 scientific papers with impact factor

908
909 *Management data*

- 910 presence of records of the surveillance activities by the MPA staff: yes, no
- 911 data availability about the hours spent for the surveillance by the MPA staff: data not available, data approximated, data available
- 912 data availability about the number of people involved in environmental education projects: data not available, data approximated, data available
- 913 existence of an evaluation process of the effectiveness of the environmental education projects: yes, no
- 914 availability of the data about the effectiveness of the environmental education project: data not available, data approximated, data available
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920 Text A.2 List of the monitoring targets considered in the monitoring index

921 State

- 922 Benthic assemblage
- 923 Carlit
- 924 Coralligenous
- 925 *Corallum rubrum*
- 926 Entozoan
- 927 *Epinephelus marginatus*
- 928 Fish assemblage
- 929 Gorgonians
- 930 Maps habitat
- 931 Mammals and turtles
- 932 *Octopus vulgaris*
- 933 *Palinurus elephas*
- 934 *Patella ferruginea*
- 935 *Pinna nobilis*
- 936 *Posidonia oceanica*
- 937 *Scyllarides latus*
- 938 Sea birds
- 939 Sea urchins
- 940 Water (abiotic factors)
- 941 Zooplankton

944 Threats/Pressure

- 945 Artisanal fisheries
- 946 Artisanal fisheries through logbook
- 947 Boating
- 948 Diving
- 949 Invasive species
- 950 Recreational fisheries
- 951 Recreational fisheries through logbook
- 952 Touristic activities (other than the previous)

955 **Table A.1 Structure of the Culture and Goals Index (CGI)**

Items	Weight	Categories and values	Scores=Ranks
presence of a stated mission in one or more official documents	A weight of 2 has been assigned to this item in order to highlight the importance of having a formalized mission as a guide for goals statement and strategy planning	not formalized = 0	1-8
		formalized = 1	
presence of a stated vision in one or more official documents		not formalized = 0	
		formalized = 1	
technically correct statement of the vision		inaccurate = 0	
		accurate = 1	
presence of stated goals in one or more official documents		not formalized = 0	
		formalized = 1	
goals formalized in documents currently in effect		not updated = 0	
		updated = 1	
percentage of measurable goals, calculated as the number of measurable goals respect to the total number of goals formalized		0% = 0	
		1-25% = 0.5	
		26-50% = 1	
		51-75% = 1.5	
		75-100% = 2	

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958 **Table A.2 Structure of the Environmental Education Index (EEI)**

959 EEI is constituted by four items

Items	Categories and values	Scores	Ranks
duration (number of years) of environmental education projects	none = 0	1-16	1-2 = 1
	occasional = 1		
	2-5 years consecutively = 2		
	6-9 years consecutively = 3		
	more than 9 years consecutively = 4		
classes of targets involved in environmental education projects (categories created following the Guttman scale method)	none = 0		3-4 = 2
	students = 1		5-6 = 3
	students and local community = 2		7-8 = 4
	students, local community and tourists = 3		
	students, local community, tourists and local authorities = 4		
number of people involved in environmental education projects in 2014 (year of our assessment)	0 or data not available = 0		9-10 = 5
	<500 people = 1		11-12 = 6
	500-1000 people = 2		
	1001-1500 people = 3		13-14 = 7
	>1500 people = 4		
effectiveness of environmental education projects, in terms of increment in percentage of knowledge acquired, understanding and commitment about MPAs issues after the project (see Dimopoulos et al., 2008)	no effect or data not available = 0		15-16 = 8
	1-25% = 1		
	26-50% = 2		
	51-75% = 3		
	76-100% = 4		

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963 **Table A.3 Structure of the Enforcement Index (EI)**

964 EI is constituted by six items, with two of them taking into account the MPA surface area. In order to assess these
 965 two items that are dependent on the MPA surface area, we attributed a score to each MPA on the basis of their total
 966 surface area (Table 1 in the manuscript).

Items	Weight	Categories and values	Scores	Ranks
kind of enforcement adopted by the MPA staff		none = 0		
		interpretative enforcement = 1		
		legal enforcement = 2		
networking (cooperation) with police bodies		no = 0		
		yes = 1		
methods employed by the MPA for the surveillance		a score of 0.1 for each method employed: at sea/from land/daytime/ at night/video camera/radar/vessel monitoring system/night vision binocular/camera with georeferenced position/laser		
		zero hours = 0		
hours spent by the MPA staff for the surveillance per year divided by the surface MPA score (the nine categories have been created <i>a posteriori</i> in order to assign to the ratio a value)	a weight of 1.5 has been assigned to the hours of surveillance carried out by MPAs staff that has the authority to inflict penalties or when staff members work jointly with a police body that has the authority to do it	1-100 hours = 1	1-24	1-3 = 1
		101-200 hours = 2		4-6 = 2
		201-300 hours = 3		7-9 = 3
		301-400 hours = 4		
		401-500 hours = 5		
		501-600 hours = 6		
		601-700 hours = 7		
		701-800 hours = 8		
		>800 hours = 8		
hours spent by the police bodies for the surveillance per year divided by the surface MPA score (the nine categories have been created <i>a posteriori</i> in order to assign to the ratio a value)	A weight of 1.2 has been assigned to the hours of surveillance performed by police bodies, which have the duty to insure safety rules at sea beside the MPA surveillance. This weight is intermediate between the one assigned to the hours of surveillance performed by MPA staff members (when do not have any legal authority) and the one assigned to the hours of surveillance performed by staff members having the legal power and that have the only surveillance task inside the MPA	zero hours = 0	1-24	10-12 = 4
		1-35 hours = 1		13-15 = 5
		36-70 hours = 2		16-18 = 6
		71-105 hours = 3		19-21 = 7
		106-140 hours = 4		22-24 = 8
		141-175 hours = 5		
		176-210 hours = 6		
		211-245 hours = 7		
		>245 hours = 8		
amount of hours the MPA staff spend for the surveillance each month during the winter (October to May) divided by the surface MPA score		zero hours = 0		
		1-40 hours = 1		
		41-80 hours = 2		
percent increase of the hours of surveillance from winter to summer		81-160 hours = 3		
		no increment = 0		
		1-100% increment = 0.2		
		100-200% = 0.4		
		200-300% = 0.6		
300-400% = 0.8				
		>400 increment = 1		

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4 **968 Table A.4 Structure of the Monitoring Index (MI)**

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6 **969** MI was designated in order to assess the effort deployed in the monitoring of the state of the system (in our case the
7 **970** MPA) and the pressures, or threats (Borja et al., 2012), acting upon it. For both state and pressures, we considered
8 several monitoring targets, selected on the basis of the monitoring targets actually surveyed by the MPAs considered
9 **971** here. In total, 20 monitoring targets have been taken into account for the assessment of the state (e.g. fish
10 **972** assemblages, sea urchins, *Posidonia oceanica* meadows, *Patella ferruginea*, *Pinna nobilis* and other protected
11 **973** habitats and species of the Mediterranean Sea) (Bianchi, 2002; Bianchi & Morri, 2003; Boudouresque & Bianchi,
12 **974** 2013; Rovere et al., 2011), and 8 for the assessment of the pressures (e.g. effort of artisanal fishery, invasive species,
13 **975** recreational activities), for a grand total of 28 monitoring targets.
14 **976**

Items	Categories and values	Scores	Ranks
duration (number of years) of monitoring	none = 0	1-224	1-28 = 1
	occasional = 1		29-56 = 2
	sampling activities carried out for 2-4 years consecutively or samplings carried out every 3-5 years for max 3 times = 2		57-84 = 3
	sampling carried out for 5-7 years consecutively or every 3-5 years for 3-5 times = 3		85-112 = 4
methods to report monitoring data	sampling carried out for more than 7 years consecutively or every 3-5 years more than 6 times = 4	1-224	113-140 = 5
	not reported = 0		141-168 = 6
	internal reports = 1		169-196 = 7
	communications and outreach = 2		197-224 = 8
	scientific papers without impact factors and scientific reports = 3		
	scientific papers with impact factors = 4		

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32 **978 Table A.5 Structure of the Management Data Index (MDI)**

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34 **979** MDI assesses the effort deployed in the collection of management data useful for improvement of the strategy and
35 **980** the activities. It is constituted by 5 items.
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Items	Weight	Categories and values	Scores=Ranks
records of the surveillance activities by the MPA staff	a weight of 2 has been assigned to this item to highlight the importance of keeping records of the surveillance activities	no = 0 yes = 1	
data availability about the hours spent for the surveillance by the MPA staff		data not available = 0 approximate data = 1 precise data = 2	
data availability about the number of people involved in environmental education projects		data not available = 0 approximate data = 1 precise data = 2	1-8
evaluation process of the effectiveness of the environmental education projects		no = 0 yes = 1	
availability of the data about the effectiveness of environmental education projects		no = 0 yes = 1	

51 **981**

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53 **982 Text A.3 References in the appendix**

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