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Conservation "identity" and marine protected areas management: A Mediterranean case study

Michelle E. Portman[a,*], Daniel Nathan[b]

[a] Technion – Israel Institute of Technology, Israel
[b] Hebrew University of Jerusalem, Israel

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ABSTRACT

Protection of natural environments sought through management plans varies greatly between countries; characterizing these differences and what motivates them can inform future regional and international conservation efforts. This research builds on previous work addressing the spatial distribution of marine protected areas in the Mediterranean Sea. Particularly, it examines the relationship between a "protection level" (PL) score and a set of variables pertaining to each country's conservation efforts, economic conditions and human impact along the coast using regression analysis. Four sets of models demonstrated country characteristics that correlate with higher protection levels *within* marine protected areas (MPAs). Certain contextual factors – economic dependence on the marine environment, efforts at terrestrial conservation and greater human impact – were found to be significantly associated with higher PLs among the northern littoral countries of the Mediterranean. Such findings can inform policy makers about where efforts and investments should be directed for marine conservation.

Introduction

The Mediterranean Sea supports many endangered, endemic species, and it is an important hotspot for targeted conservation (Danovaro et al. 2010; Mouillot et al. 2011). It is an enclosed sea with a slow flush and exchange rate, both of which exacerbate its pollution problems. Further, environmental awareness among the sea's surrounding populations is low, leading to much unregulated development and overexploitation along its coasts (Laubier, 2005). As such, the management of activities within the sea is crucial, highlighting the need for an enhanced set of MPAs with high levels of protection, arranged as a network (Portman et al. 2013). Therefore analyzing the context within which marine protected areas (MPAs) are established and designed is important for understanding the potential for marine conservation in this area of the world (Coll et al. 2011; Levin et al. 2013).

Our research aims to identify conditions under which countries are amenable to conservation actions. Similar past efforts have examined spatial location in relation to management regimes of terrestrial protected areas (e.g., Eigenbrod et al. 2010; Seiferling et al. 2012) and others have examined geographic location and spatial attributes of MPAs (e.g., Guarderas et al. 2008; Weeks et al. 2010a). Most have looked at geographic location and spatial characteristics (such as size) in relation to the effectiveness of management regimes in terms of ecological conditions (e.g., Coll et al. 2011; Sala et al. 2012). Such studies shed light on the physical context within which conservation actions occur. Few studies have looked at characteristics of management regimes in relation to the socio-economic context within which they are developed, even though it is clear that such studies are needed (McDonald & Boucher, 2011; Sala et al. 2012)

To improve understanding of countries' decision making in regards to MPA management regimes, we reviewed information on MPAs of the Mediterranean Sea using several parameters such as their geographic distribution and physical characteristics together with parameters based on MPA management plans. Previous studies have surveyed MPAs using geographic distribution and physical characteristics (e.g., Coll et al. 2011; Guarderas et al. 2008; Sala et al. 2012) and some even consider socio-economic parameters (e.g., Abdulla et al. 2008, Weeks et al. 2010a). However, these past studies have not considered characteristics of management plans. For example, – Levin et al. (2013), examined the potential of countries to collaborate across national borders for improved marine conservation in the Mediterranean Sea. This study used size of MPAs as a proxy for marine conservation action without considering varied regulation within the MPAs.

* Corresponding author. Tel.: +972 48294067.
E-mail addresses: michellep@cc.technion.ac.il (M.E. Portman), danielnathan81@gmail.com (D. Nathan).

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Where and how to establish an MPA, i.e., according to what parameters, should be a question of local goals and objectives (Eigenbrod et al. 2010; Klein et al. 2008) but will also undoubtedly reflect country and regional contexts and priorities (Seiferling et al. 2012; Weeks et al. 2010b). Our research seeks to characterize MPAs in the Mediterranean by how countries interact with the marine environment. We hypothesize that those countries with greater protection levels within their MPAs will be those with a greater focus on the marine environment for conservation and those exhibiting greater dependence on the maritime economy. If similar to terrestrial PAs, *marine* PAs will likely be in areas relatively excluded from human activity (Seiferling et al. 2012). Although this study falls short of in-depth analysis of the specific management regimes within the protected areas, by using an ordinary least square (OLS) regression analysis we attempt to model levels of protection within MPAs. Levels of protection are modeled as a function of: (a) economic conditions, (b) distribution of human activities (human impacts) and (c) what we refer to as conservation "identity".

Defining MPAs and their management regimes

According to the Barcelona Convention,[1] MPAs in the Mediterranean Sea should safeguard natural ecosystems in danger of disappearing, including areas most vital to habitat and species survival. This can be accomplished in part, by ensuring that endangered species, endemic flora and fauna, and sites with high scientific and ecological value are undisturbed.

Past studies have found that MPAs increase the biomass, density and diversity of species within their borders and in their surrounding areas (Claudet et al. 2010; Francour 1994; Halpern 2003; Sala et al. 2012) even though some level of disturbance may still be allowed within the MPA itself. This begs the question: what constitutes an MPA? Is it an area of complete protection or reduced human disturbance? Is it completely a marine area or could it contain both marine and terrestrial (supra-littoral)[2] protected area?

Some so-called "marine" protected areas actually include within them mostly terrestrial (coastal) land area (see Portman et al. 2012). Well-known on-line databases that have been used in previous studies of MPAs, such as MedPan, Protected Planet and MPA Global (Guarderas et al. 2008; Wood 2007), list many protected areas as "marine" even though these areas are composed partly or even mostly of supra-littoral lands. In some cases these areas are on islands, in estuaries or wetlands; the terrestrial portion of the MPA may be greater than the marine area (see Portman et al. 2012). Countries themselves decide on what is an MPA and report via survey information picked up by these databases, resulting in much variation (Abdulla et al. 2008). Similarly, protection levels (PLs) within MPAs also vary on a continuum, from complete exclusion of human activities to conditional allowance of all human activities. Therefore the first step in a sea-wide study on the management regimes of MPAs should be directed towards defining what can be included as an observation (an MPA) *and* how protection levels can be characterized.

The MPAs we reviewed met the criteria used in our definition of an MPA as "a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (Dudley 2008). Less concerned with specific ecological traits and more interested in management regimes of reserves within the coastal zone, our study uses the same restrictive (exclusionary) approach to determine the list of MPAs analyzed as that employed in Portman et al. (2012). We updated the number of MPAs from 117 in Portman et al. (2012) to 142 based on new information initially obtained from Gabrié et al. (2012).

Once we defined what constitutes an MPA, past studies categorizing management regimes of protected areas, especially MPAs becomes apposite. Most studies on MPAs have used some version of the basic protection categories of no-take, limited-take and mixed-use or they use protection categories of the International Union of Conservation of Nature (IUCN) (Abdulla et al. 2008; Guarderas et al. 2008; Seiferling et al. 2012; Weeks et al. 2010a). The conceptual underpinnings of such simplistic regime categories warrant further explicit study.

So far, the body of knowledge researching the effectiveness of protection management regimes has focused on ecosystem health and services, such as ecological production (biomass) parameters or biodiversity. In Sala et al. (2012) PLs are categorized as high, medium and low. These categories translate respectively to: (1) well-enforced no-take areas where fishing is either allowed or occurs due to weak enforcement, or (2) areas where fishing regulations are poorly enforced; and/or (3) areas of open access. Study results determine, rather intuitively, that high PLs correlate with fish and algal biomass structure. For terrestrial areas, Eigenbrod et al. (2010) correlate the use of tiered-management conservation strategies with the levels of four ecosystem services (stored carbon, agricultural production, biodiversity and recreational value). "Tiering" refers to the spatial overlap of conservation strategies. The authors found that tiering – or the use of multiple conservation strategies (including protected areas and restrictive zoning) – coincides with the highest levels of various types of ecosystem services such as carbon storage, biodiversity or agricultural production found within the areas studied.

Given the importance of management regimes with respect to conservation effectiveness, we relate MPA management plans to the socio-economic and governance context of the country within which they have been established. To do so we consider activities allowed or prohibited within the various spatial domains (zones) of the MPAs according to their management plans. Such categorization of PLs provides insights about how seriously countries take the task of protecting the marine environment. This approximates the tiered conservation approach used by Eigenbrod et al. (2010) that looks at restrictive zoning (among other conservation strategies) and relates these to ecosystem services values. Our analysis, unlike that of Sala et al. (2012) which considered only fishing activity, attempts to categorize PLs based on a broader group of uses, either consumptive or non-consumptive, allowed in each spatial area (or zone).

The concept of "consumption-use" values has a long history in economic and philosophical thought, from Aristotle to political economists such as Adam Smith and Karl Marx. The links between different types of consumptive and non-consumptive use values, environmental impacts and ecology is intuitive, well-established (Burkett 1999; Duffus & Dearden, 1990), and is starting to be applied to marine conservation (McVittie & Moran, 2010). By making use of such links we can make judgments about PLs and go on to address why some countries seem to be taking MPAs more seriously than others. "Seriousness" can then be related to contextual factors such as economic dependence on the marine environment, areas of greater or lesser human impact and national efforts made for terrestrial conservation. For the latter measure, we assume that spatial characteristics (such as area) of MPAs can be compared to

[1] The Barcelona Convention in force since 1978 and amended several times, includes protocols addressing problems of pollution and biodiversity loss. This Convention remains the keystone of efforts to protect the Mediterranean Sea, including the designation and management of MPAs (Portman et al. 2013).

[2] Uplands are areas that are rarely if ever under water and the supra-littoral area is land above the high tide line that is regularly splashed, but not submerged by ocean water. Seawater penetrates these elevated areas only during storms with high tides.

those of terrestrial protected areas in the same country to indicate the relative importance of land versus sea conservation (see Lindholm & Barr 2001). In order to use this measure, our definition of MPAs must be clearly distinguished from terrestrial protected areas; therefore we apply an exclusionary definition of what is an MPA (i.e., an area of *mostly* submerged, sub-tidal area).

Measures of conservation, economic data and distribution of human impact levels make up what we call, for purposes of this study, conservation "identity". The results highlight Mediterranean MPAs' spatial and regulatory characteristics as a function of conservation identity. In the subsequent discussion, we address the implications of our findings for marine conservation in the Mediterranean.

Methods

Data on 142 MPAs in the Mediterranean Sea (see Table S2) was collected from international websites, particularly: Medpan, MPA Global, and Protected Planet – and from academic and professional literature and websites on specific MPAs. The list excludes islands unless they contain significant submerged areas around them. MPAs not yet fully established (i.e., proposed) at the time the data was collected were excluded, along with wetlands, inlets, coastal lagoons and enclosed bays. Although these areas may be important representatives of the marine–terrestrial interface, as mentioned above, we excluded them in an effort to distinguish marine conservation efforts from terrestrial initiatives. Areas managed strictly for commercial fishery goals were also not included in our list.

We then prepared a spatial (GIS shape) file with the configuration of each of the 142 MPAs. We examined their distribution and focused on comparing their characteristics at the country level. Since most MPAs are declared and managed at a nation-state level (Portman et al. 2012), like other studies (e.g., Guarderas et al. 2008; Levin et al. 2013), we used the *country* as the unit of analysis for this study.

We analyzed MPA management plans to determine a PL score for each MPA. Scores depend on: (1) identification of prohibited and allowed activities within a common set of zones (core, buffer and periphery) and (2) assignment of the highest scores to management regimes that limited the greatest number of consumptive uses in the least rigorously protected part (zone) of the MPA and vice versa. OLS regression analysis determined how PLs of the MPAs by country were associated with conservation "identity" data. The latter consists of spatial data of the area protected within the country (both marine and terrestrial), data indicating economic dependence on marine economy, and scores indicating human impact levels in the coastal zone.

Protection level scoring

The dependent variable we used is the cumulative PL score based on expected impact to the marine environment from regulated (allowed with conditions) or prohibited (not allowed) activities in each of the MPAs in our list and averaged by country. Scores vary according to whether uses are consumptive or non-consumptive activities (see Klein et al. 2008) and on the spatial zone within which the activities can (or cannot) take place (see Table 1).

The cumulative scale of PLs reflects the intent of a country to safeguard its MPAs. The scale was based on uses regulated or prohibited in management plans for MPAs using zones (most commonly: core, buffer and periphery) (Table 2) and therefore reflects planned intent (see limitations described in the Discussion section). These zones logically prohibit consumptive uses (e.g., "commercial" or "recreational" fishing and "spearfishing") in core zones while gradually decreasing such prohibitions in the outer zones. PL scoring gives expression to the most restrictive conditions in the least restrictive zone by allocating the highest scores to such conditions.

Table 1
Scoring system used for the protection levels. Score values reflect a range of values from the most restrictive conditions in the least restrictive zone (highest score) to the least restrictive conditions in the most restrictive zone (lowest score).

Core	Prohibited	Regulated
Each consumptive use[a]	Value = 10	Value = 4
Each non-consumptive use[b]	Value = 7	Value = 1
Buffer		
Each consumptive use	Value = 11	Value = 5
Each non-consumptive use	Value = 8	Value = 2
Periphery		
Each consumptive use	Value = 12	Value = 6
Each non-consumptive use	Value = 9	Value = 3

[a] Consumptive uses: recreational fishing; commercial fishing; spearfishing.
[b] Non-consumptive uses: diving; light recreational (hiking, swimming, walking); research and education; anchoring and mooring; boating (sailing, water sports, navigation).

For each MPA with available data, we assigned a value for each use (consumptive and non-consumptive) in its respective zone (core, periphery and buffer), depending on whether it is prohibited or regulated. "Prohibited" means that the use type is forbidden; "regulated" means the activity is allowed, but only under certain conditions. Consumptive uses prohibited in the periphery received a higher score (12) than prohibited uses in the buffer (11) or those within the core (10). Consumptive uses that were allowed but regulated followed this same principle, with regulated consumptive uses in the periphery receiving a 6, followed by a 5 in the buffer and a 4 in the core. Scoring for non-consumptive uses follows the approach, with prohibited values in the core, buffer and periphery receiving a 7, 8 and 9 (respectively) while regulated non-consumptive uses received a value of 1, 2 or 3 (respectively).

To ensure that PLs reflect the type of restrictions in each zone and not the number of zones or the amount of restrictions and prohibitions and to avoid double-counting, we divided the aggregate sum (or total score) by the total number of maximum uses in the respective MPA. For example, an MPA with two zones with diving and spearfishing listed in each would not equal four activities, but two. There are a total of eight possible activities, so no MPA's cumulative score was divided by anything greater than 8 (Table 1). We then combined these MPA "averages" for each country and divided by the number of MPAs with PLs in the country so as to provide a mean PL (see Fig. 1).

The independent variables we used in our statistical analysis are of three types. The first type pertains to the geographic characteristics of the Mediterranean countries: the country's size (terrestrial area, length of coast), coastal population, coastal population density and the number and area of its protected areas both marine and terrestrial (see Table 2). Along with the country's size, we give weight to the size of the country's potential exclusive economic zone area (EEZ)[3] based on the Flanders Marine Institute Maritime Boundaries Geodatabase (VLIZ 2012).[4] The various potential maritime zones and the weight these areas have in the whole basin will likely indicate importance of maritime activities to a country (de Vivero et al. 2009).

The second type of independent variable reflects the economic characteristics of the country through general economic indexes

[3] According to the UNCLOS, the EEZ can extend from the baseline to 200 nm seaward, if declared by the coastal state.
[4] The VLIZ (2012) data layer is used to determine what would be the potential EEZ area that a country could potentially claim. The VLIZ layers for the Mediterranean are in fact median lines and not EEZ national claims in most cases.

Table 2
List of independent variables considered.

Group type	Variable (unit)	Description	Source
Conservation "identity"	Country size (km^2)	Country area	UN Country Profiles
	Coastal population (thousands of people)	Population within the Coastal Level 3 administrative region. "Coastal" pertains to the Level 3 administrative regions -based on the EU's Nomenclature of Units for Territorial Statistics – situated along a country's coast	Sacchi (2011)
	Coastal density (people per km^2)	See above	Sacchi (2011)
	Country's potential exclusive economic zone (EEZ) (km^2)	Calculations based on downloaded GIS files	VLIZ (2012)
	Number of non-MPA (terrestrial) protected areas	Number of non-MPA (terrestrial) protected areas in country	On-line MPA databases; World Bank
	Terrestrial protected area (km^2)	Area protected in terrestrial (non-MPA) reserves	On-line databases
	Number of MPAs	Number of MPAs by country	On-line MPA databases; Literature
	Area within MPAs (km^2)	Marine area protected	Calculated by authors based on information from on-line MPA databases
	Average MPA size (km^2)	Average MPA size by country	Calculated by authors
	Coastline length (km)	Length of country coastline	Central Intelligence Agency
	Terrestrial portion of MPAs (%)	Percentage of total MPA area that is terrestrial by country	Calculated by authors using MPA polygons downloaded from databases (protectedplanet.net) or reported
	Protected portion of the EEZ (%)	Total percentage of country EEZ protected by MPAs	Calculated by authors using MPA polygons downloaded from databases (protectedplanet.net) and literature
	Portion of non-MPA protected area (%)	Non-MPA (terrestrial) protected area as a percentage of total area of country	Calculation based on databases (i.e., protectedplanet.net)
Economic characteristics	GDP	Country's gross domestic product (GDP) in dollars	World Bank
	Income from fishing exports	Country exports of fishery commodities in dollars in 2008	FAO (2008)
	Fishing activity	Production by capture and aquaculture in the Mediterranean sea by tons	FAO (2008)
	Coastal employment	Percentage of coastal population employed in maritime activities. "Coastal" pertains to the Level 3 administrative regions -based on the EU's Nomenclature of Units for Territorial Statistics (NUTS3) situated along a country's coast.	Sacchi (2011)
Human impact levels	Average HI level within MPAs	This average gives an indication of how impacted the sites of the country's MPAs are by human activity	Calculated by authors using downloaded polygons and combined raster (see description in Portman et al. 2012)
	Average HI level of coastal zone	Based on the scores of the human impact-influence rasters, this average gives an indication of the level of human activity in the coastal zone of the country (territorial waters and 50 km inland combined)	Same as above
	Average HI in territorial sea	Based on the scores of the human impact-influence rasters, this average gives an indication of the level of human activity in the country's territorial waters	Same as above

(gross domestic product (GDP)) and by proxy indicators of dependency on the marine environment for economic well-being (fishing and aquaculture exports and coastal sector employment related to fishing industries).[5] The last variable type indicates average human impact and activity levels at various locations within the coastal zone of each country.

To evaluate human impact we used a combined raster from the Wildlife Conservation Society's Human Footprint (WCS 2011) global data layer and Halpern et al.'s (2008) layer of cumulative impact scores for the marine environment (NCEAS 2008) as was used in Portman et al. (2012). For a map and an explanation of the combining of these two data sets see Portman et al. (2012).

For the statistical analysis we used a stepwise regression. This involved testing the addition of each variable using a comparison criterion, and adding or removing the variable (if any) that improved the model the most. For the first two models (Model I and II), we used a backward elimination process; we based the choice of model on the significance (p-values) of each variable and R-squared value (for both models > 0.75). For models III and IV, we used the lowest Akaike Information Criterion (AIC) value to identify the best fit model. The AIC value is calculated by the estimation of the loss of information (information entropy) that occurs with each run of the regression model.

Results

This study used data for 142 MPAs[6] in 19 countries (see Fig. 1) although for the regression modeling some countries were excluded due to a lack of specific information on the MPAs within them. Our previous study (Portman et al. 2012) surveyed only 117 MPAs, compared to the 142 in this study due to updated information (i.e., from Gabrié et al. 2012), representing a 21% increase in the number of MPAs examined. Some general information gleaned from our analysis follows for this new set of MPAs.

[5] Proxy indicators of dependency on the marine environment for economic well-being were utilized given the difficulty in obtaining extensive data on a country's economic wellbeing from maritime activities, both on a country-by-country basis and generally within the Mediterranean basin.

[6] For a complete list see the Supporting Information in Table S1.

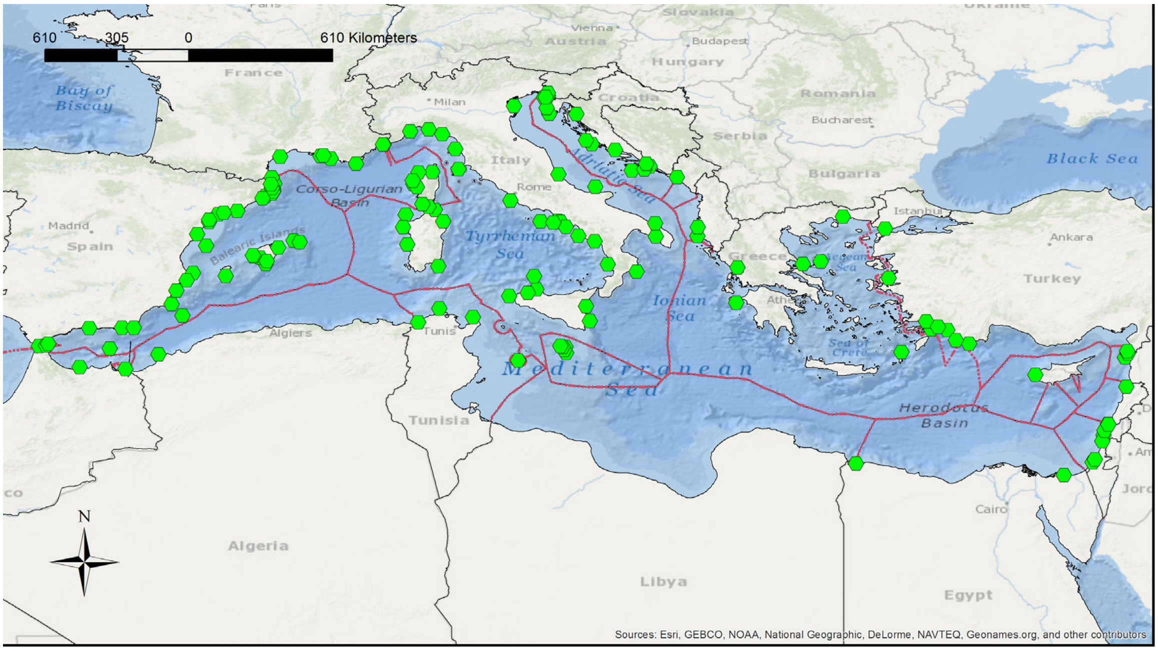

Fig. 1. Map showing the Mediterranean Sea basin and the 136 MPAs used in our study.

The total cumulative area of Mediterranean MPAs is 26,974 km^2 which represents 1.08% of the Mediterranean Sea, without the large Pelagos Sanctuary which is 87,500 km^2 in size. We left the Pelagos out of our database because it is managed by more than one country. The smallest of Mediterranean MPAs is the Grotte Marine de Temuli of France (0.003 km^2), while the largest MPA (excluding the Pelagos Sanctuary), is the Santa Maria di Castellabate MPA of Italy, covering 7094 km^2. By country, the smallest amount of area protected is in the UK (Gibraltar), 0.35 km^2, and the greatest amount is in Italy, approximately 10,694 km^2. For insights on a country's marine conservation context, we considered marine area protected as a percentage of each country's potential EEZ (as indicated using the VLIZ (2012) data layer). This "potential EEZ" area can also be considered simply non-territorial sea and therefore referred hereafter as "EEZ".

As noted in previous studies (e.g., Abdulla et al. 2008; Portman et al. 2012), most of the 142 MPAs are located along the terrestrial coast and in many cases they encompass limited submerged areas. Approximately 26% (7,065 km^2) of the total area included in the 142 MPAs is terrestrial. Some countries (Monaco, Lybia, Syria, Malta and the UK) have no terrestrial area within their MPAs, while in Turkey, Morocco and Albania over 50% of the area protected in MPAs is terrestrial (supra-littoral) upland. As mentioned, many "marine reserves" (identified through internet databases for example) actually include supra-littoral areas within them. For Montenegro the figure is approximately 78%. We use these figures for other variables indicating countries' marine conservation identity.

Spain has the largest amount of small MPAs (37 MPAs with an average size of 76 km^2) and Italy has a relatively large number of medium-sized MPAs (average size 315 km^2); the largest MPAs on average are off the coast of Greece and Turkey. Greece has six MPAs with an average size of 852 km^2 each and Turkey has eight MPAs with an average of 576 km^2 each. In regards to the PL, from the total of 142 MPAs, there were seven MPAs in five countries (Albania, Egypt, Libya, Montenegro and Morocco) without sufficient information to calculate a score as described in the Methods section. This left 136 MPAs (see Fig. 1) that had sufficient information for determining a PL score. In Fig. 2 below, the average PL score for each country is presented, with a majority (nine countries) falling below the average PL score for the entire region (11.29).

Of these 136 MPAs, approximately 95% have core zones prohibiting at least one type of consumptive activity (commercial, recreational or spear fishing). Only 25.9% of MPA plans regulate at least one consumptive activity (Table 3). At least one non-consumptive activity (anchoring, mooring, diving, swimming, tourism, research and boating activities) is prohibited in most (67.2%) of the core zones of MPAs, while in all but one they are regulated in the core. Management of the core sections of these MPAs can be said to be highly prohibitive; a majority of management regimes either prohibit or regulate close to all of the activities listed above within core zones. Consumptive uses are typically prohibited in the core or are highly regulated. In the buffer and periphery areas, non-consumptive uses are by and large allowed, while consumptive uses tend to be conditionally allowed.

Using the PL score as representative of protection *intent* our results showed strong associations with several of the independent variables (Table 4). Associations were apparent only when using the northern Mediterranean countries (Northern 11 and Northern 12).

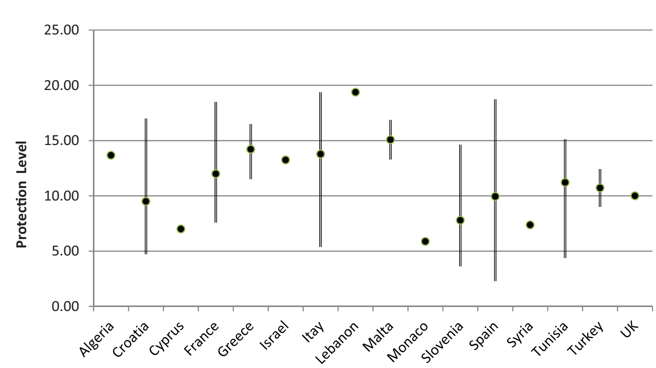

Fig. 2. Plot of average protection levels by country (represented by • and based on the scoring system presented in Table 1). For countries without PL ranges, only one MPA represents the country's protection level (Algeria, Cyrpus, Israel, Lebanon, Monaco, Syria and UK).

Table 3
Frequency of prohibition and regulation of activity types in MPAs that have at least two zones.

	Prohibited (%)	Regulated (%)	Existence of zones (%)
Core			67(47%)
Consumptive use[a]	64(95.5)	21(25.9)	
Non-consumptive use[a]	45(67.2)	74(91.4)	
Buffer			68(47.9%)
Consumptive use[a]	52(76.5)	53(77.9)	
Non-consumptive use[a]	16(23.5)	64(94.1)	
Periphery			47(33.1%)
Consumptive use[a]	30(63.8)	43(91.5)	
Non-consumptive use[a]	8(17.0)	45(95.7)	

[a] At least one activity of each type is prohibited or regulated.

Having a longer coastline, a greater percentage of the EEZ protected in MPAs and a greater percentage of the country protected in terrestrial PAs, greater area in MPAs and larger MPAs are associated with an increase in the average country PL (Models III and Models IV). Furthermore, greater human impacts within the marine area and also within MPAs are associated with greater protection levels, as is greater GDP (Models III and Models IV; R-squares of 1.000 and 0.999 respectively).

A smaller group of variables (used in Models I and II) show that higher PLs are associated with greater fishing exports and activities, and greater terrestrial area protected. Interestingly, a greater PL is associated with a lower percent of terrestrial area within MPAs, perhaps indicating that those countries whose MPAs include more marine area and less terrestrial area within them are also those more serious about MPA management, as indicated by a higher PL score.

Models III and IV include both percent of terrestrial area protected within the country and the number of terrestrial protected areas (non-MPAs) in the models (Pearson's coefficient value of correlation is <0.35 between these two variables). The latter variable is negatively associated with the level of protection within MPAs according to both models. This may indicate a tendency toward larger terrestrial protected areas existing in some countries. Pearson's correlation coefficients for the sets of variables were: Model I and II < 0.66; Model III < 0.88 and Model IV < 0.58.

Also of note is that the human and marine impact averages within the MPAs of each country are primarily greater than the coastal zone averages for the country. In 15 cases out of a total of 21 (72%), human impact averages within MPAs are higher than the average human impacts scores for the country's coastal zone (Fig. 3). Whether these results imply that MPA planning bodies are targeting high impact areas of the country or are a result of increased human impact once the MPA has been established, requires further investigation.

Discussion

In this section we analyze our results in greater detail and discuss their implications. Throughout this discussion, in referencing the results of the regressions, we use the term "associated" to emphasize the relationship between dependent and independent variables as correlation and not causation. In other words, empirical observation and statistical analysis of data have led to empirical insights based on association.

Models III and IV indicate that countries with management plans that on average have higher PLs within MPAs are associated with areas of greater human impact. This contrasts with Seiferling et al. (2012) that found higher protection levels in terrestrial PAs to be associated with areas of lower human impacts which indicated their isolation. Although not studied here or by Seiferling et al. (2012), the age of PAs may be a factor. Seiferling et al's (2012) analysis of the normalized difference vegetation index in terrestrial protected areas over time, shows that human activities encroach on surrounding reserves, although to begin with protected areas are sited in areas of lower human impact (Seiferling et al. 2012). Along these lines, Claudet et al. (2008) point out that positive effects of marine reserves on species richness are linked to the time elapsed since the implementation of the protection scheme. This may give the impression of MPAs being continually "isolated" in contrast to what Seiferling et al. (2012) found regarding terrestrial PAs. The marine study however, addresses only fish assemblages (i.e., the recovery of fish from fishing activ-

Table 4
Best regression models of protection level scores. The values shown for each of the models indicate the unit difference for each variable per point increase in protection level scores. The units for each variable are listed in Table 2.

Explanatory variable[a]	Model I (Northern 12[b]) Coefficient (*p-value*)	Model II (Northern 11[c])	Model III (Northern 11)	Model IV (Northern 11)
Portion of non-MPA protected area	38.99768[***] (*<0.0001*)	37.29827[***] (*0.001*)	45.70781[***] (*0.002*)	45.41676[***] (*<0.0001*)
Terrestrial portion[d] of MPAs	−00.4452973[**] (*0.046*)	−0.4464791[**] (*0.048*)		
Fishing activity	00.0000121[***] (*0.004*)	00.000124[***] (*0.004*)		
Income from fishing exports	01.87e−06[*] (*0.011*)	01.93e−06[**] (*0.012*)		
Protected portion of the EEZ			19.05269[**] (*0.018*)	19.65843[**] (*0.014*)
Coastline length			00.0000618[**] (*0.048*)	–
Number of non-MPA[d] protected areas			−0.0058063[***] (*0.006*)	−0.0053572[***] (*<0.0001*)
Area within MPAs			00.0000097[**] (*0.020*)	00.0001151[***] (*0.010*)
Average MPA size			00.0053134[***] (*0.006*)	00.0058065[***] (*<0.0001*)
Average HI in territorial sea			00.0224098[*] (*0.095*)	–
Average HI level within MPAs			00.0492751[***] (*0.007*)	00.073519[***] (*0.001*)
GDP			02.656e−12[***] (*0.003*)	2.603e−12[***] (*<0.0001*)
Intercept	04.904761[***] (*0.002*)	4.852248[***] (*0.002*)	01.802315[**] (*0.026*)	2.355391[***] (*0.002*)

Note: A single dash indicates variables dropped from the previous model (>10% significant level in the model).

[a] Several variables listed in Table 2 were used in the regressions but found to be insignificant (based on their p-values for Model I and II and based on the AIC value for Models III and IV) in explaining the protection levels: coastal density; coastal employment; country's EEZ; Average HI level of coastal zone (see Table 2 for a description of these variables).

[b] Includes countries: Croatia, Cyprus, France, Greece, Israel, Italy, Malta, Monaco, Slovenia, Spain, Turkey, UK (Gibraltar).

[c] Excludes Israel.

[d] This variable denotes the area within MPAs located on the terrestrial portion of coasts and is an indication of the true "marine" nature of MPAs within each country (see Table 2). This contrasts with the number of non-MPAs which are completely terrestrial protected areas called "non-MPA protected areas".

[*] Denotes significance at 10% significance level.

[**] Denotes significance at 5% significance level.

[***] Denotes significance at 1% significance level.

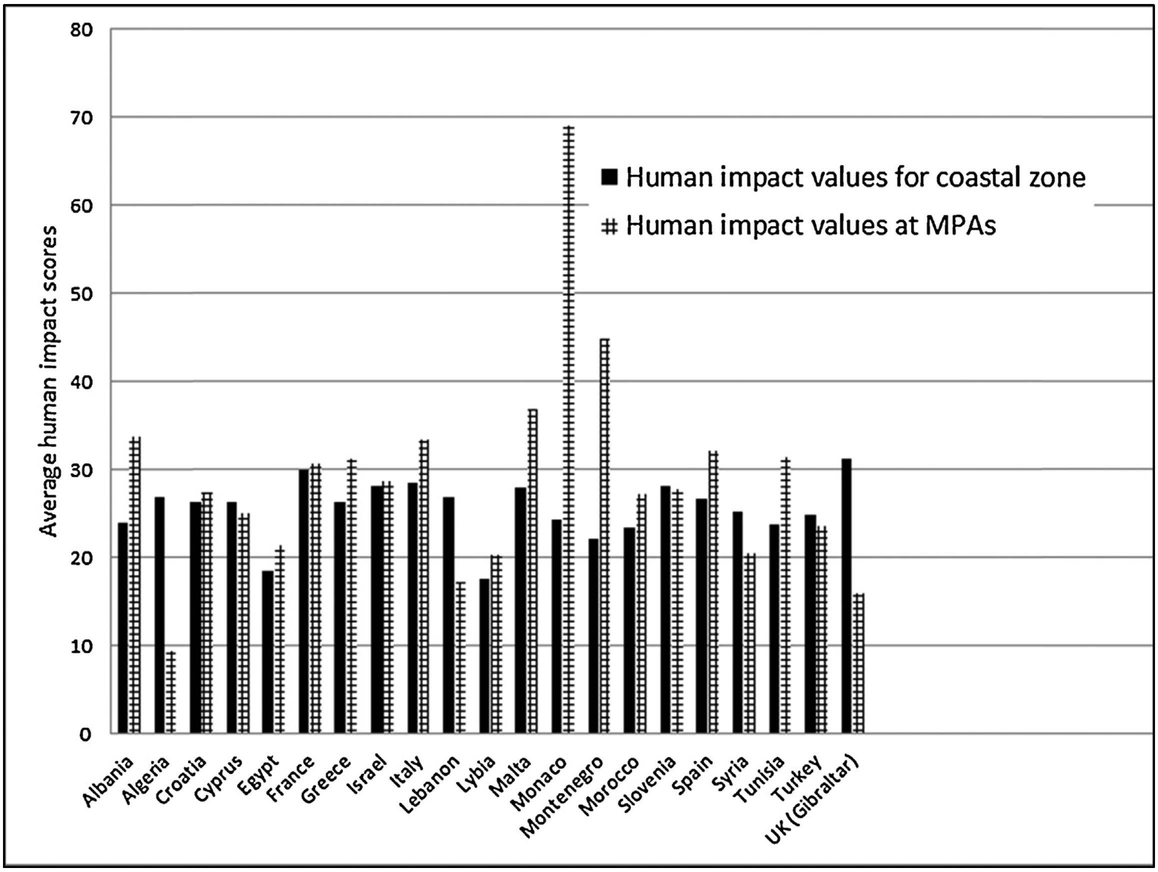

Fig. 3. Human impact value of the locations of the MPAs (based on raster score averages) compared to human impact of the coastal zone area of each country (a zone of 50 km inland and seaward to country's territorial sea limit). Numbers are listed in Table S1.

ities) and not general human impacts. Our results in this regard (greater PLs in areas of higher human impact) may reflect policy makers' tendencies to *anticipate* increasing human activities that require restriction/prohibition within MPAs.

The protected portion of the EEZ, the amount of area within MPAs, and the MPA size are variables associated with higher PLs. These variables are complemented by other explanatory variables in the model that indicate economic dependence on the marine environment (i.e., fishing activity and income from fishing exports). In determining marine conservation priorities, policymakers and marine conservation planners should institute management plans with high PLs (i.e., plans with restrictions of myriad consumptive uses in all zones) in countries with many large MPAs. Such protection management plans are likely to work where they are already commonplace and may be able to exploit economies of scale advantages for enforcement purposes. In countries with higher GDPs, plans have greater restrictions of consumptive uses in the periphery areas showing greater willingness (and perhaps capacity) to implement restrictions. This coincides with other literature suggesting that economic parameters such as GDP indicate greater capacity for achievement in marine conservation (Levin et al. 2013).

The coefficients of percent supra-littoral (terrestrial) area protected within MPAs (in Models I and II) and of the number of terrestrial protected areas (non-marine PAs) in the countries are inversely associated with PLs (See Table 4). The significance of these explanatory variables in Models III and IV suggests that having fewer terrestrial protected areas is associated with higher PLs. Future analysis of PLs for non-marine PAs using the same protection level scoring would allow further comparisons.

The importance of considering the levels of protection in management plans that include zoning has been evidenced by its use in other studies (e.g., Guarderas et al. 2008; Seiferling et al. 2012; Weeks et al. 2010a). Our findings together with further qualitative analysis that identifies to what extent management plans actually match actions, could serve entities when setting priorities for future investments. Such information could be used by consortiums such as CoCoNET (http://www.coconet-fp7.eu/) which seeks to enhance policies aimed at effective environmental management for improved design of MPA networks in the Mediterranean. It may, for instance, be more realistic for MPAs that have highly restrictive zoning (which restricts non-consumptive as well as consumptive uses) to be proposed initially in regions or by countries greatly dependent on fishing than in by those void of such interests. While fishermen may be opposed to no-take zones, the greater fish export and fishing activity in the country may reflect awareness of the marine environment's importance and concern for its protection. Such propositions require further qualitative research.

Beyond our results, we have developed a methodology with unique advantages. These include the consideration of: (1) PLs that reflect restrictions and prohibitions based on MPA zoning; and (2) human impacts in coastal uplands (as in Portman et al. 2012). Considering human impacts along a coastal strip that includes upland areas in addition to the marine portion of the environment could improve upon past studies such as Coll et al. (2011) and Sala et al. (2012). Although different weighting factors could be justified, the PL scoring we have devised improves upon generalized categories of protection, such as those of the IUCN (as used in Guarderas et al. 2008; Seiferling et al. 2012) which do not account for nuanced variations in management zones.

A limitation related to our PL scoring is that is does not incorporate weighting for size so that potentially a country with a tiny MPA that is highly restrictive could receive a higher score than a country with a large MPA that is somewhat less restrictive. Further development of the scoring system should try to solve this issue by weighting for size of zones in addition to the factors considered here (i.e., mostly types of uses and level of restrictions).

Another limitation is that the PL scores devised reflect intentions; they fail to incorporate actual implementation and more study is needed to do so, particularly ground-truthing. Similarly, in Sala et al. (2012) PLs were determined based on "available scientific information, personal experience and knowledge of the MPAs, and interviews with MPA staff" (see also Guidetti et al. 2008). But Sala et al. (2012) covered a small number of MPAs (14). Other studies, such as Guarderas et al. (2008) and Seiferling et al. (2012) that surveyed a large number of MPAs, collected their information on management regimes as we did. They based information on protection categories respectively, on: (1) information from on-line databases and (2) review of management plans. Acquiring information directly from MPA managers (as in Abdulla et al. 2008) would give a better indication of the actual management taking place, but was beyond budgetary constraints of this research. It may be preferable to use the scoring method on a local scale with the advantage of improved data about actual implementation of restrictions and prohibitions.

Analysis of management regimes using this methodology can be enhanced as information is improved and updated and by experimenting with different weighting approaches. In any case, seeking to relate socioeconomic and spatial factors to meaningful indications of readiness for conservation action involving zones with various protection levels can be used to help achieve more effective conservation outcomes.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.jnc.2014.10.001.

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