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A False Sense of Protection: Recreational Uses and Illegal Behavior in a Mediterranean Marine Protected Area and Implications for Management

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ABSTRACT

Over the last 35 years, at both the European and the Italian level, great efforts have been made to increase the number of Marine Protected Areas (MPAs): they are considered an effective tool for protecting oceans and biodiversity. In recent years, MPAs have become more than simply tools to improve marine conservation. In fact, their management agencies are actively involved in the sustainable development of nearby communities through the promotion of recreational activities (boating, snorkeling, diving). Even if the recreational uses of the marine environment are generally considered benign, they can potentially be highly detrimental for species and their habitats. As a result, these activities should be controlled through the spatial zoning and the regulation of the MPAs. Thus, the achievement of the conservation goals of the MPAs depends primarily on compliance with the regulations of recreational uses inside their boundaries. The objective of this study was to estimate boating usage and the related level of compliance inside the Capo Gallo and Isola delle Femmine (Italy) MPA. The spatial and temporal trend of boating and the behaviors of boaters were measured through direct observation over a period of 2 summer months. The study highlighted a weakness in the effectiveness of this MPA, linked to a social component and compliance with the regulation. Solutions for effective management plans are outlined thanks to an understanding of the limitations and potential of existing MPA policies. *Integr Environ Assess Manag* 2019;15:961–973. © 2019 SETAC

Keywords: Marine protected area   Management plan   Marine conservation compliance   Recreational boat use   Boater behavior

INTRODUCTION

Even though biological and socioeconomic benefits generated by Marine Protected Areas (MPAs) are under debate (Edgar et al. 2014) worldwide, they are considered as one of the most valuable tools in the effort to protect marine habitats and species from extractive and nonconsumptive human activities (Agardy 2000; Salm et al. 2000; Browman and Stergiou 2004) and to increase the resilience of marine life in the face of ongoing threats (such as climate change, MacKinnon et al. 2011). This point of view has also been endorsed by the European and Italian scientific communities and policy makers. In Italy, since the first national law for the creation of protected areas was passed (L. 979/1982 Ministero dell'Ambiente e del Territorio, Repubblica Italiana), 27 MPAs have been established and 17 are in the process of being established.

Although at the initial stage of their establishment, MPAs were primarily aimed at the protection of the environment and the conservation of biodiversity, today promotion of the sustainable development of neighboring communities is a recognized function of MPAs (Claudet and Pelletier 2004; Pomeroy et al. 2005; Angulo-Valdes and Hatcher 2010; Pelletier 2011; Pascual et al. 2016). In fact, with the increasing demand for sea-related tourism activities and the public's greater interest in nature, MPAs attract a large number of visitors and related businesses (Farrow 1996; Badalamenti et al. 2000; Boncoeur et al. 2002; Sanchirico et al. 2002; Ami et al. 2005; Lloret et al. 2008). Thus, MPA management plans have to reconcile apparently conflicting aims: 1) nature conservation, 2) promotion of recreational uses, and 3) socioeconomic development that is compatible with an area's natural environment and landscape (Mangano et al. 2015; sensu Mangano and Sarà 2017). For this reason, the general regulation of Italian MPAs allows nonconsumptive activities, such as boating, diving, snorkeling, swimming, surfing, and kayaking, with no or limited restrictions inside the general or partial protection zones (Zones B and C), while excluding any human activities inside the usually smaller total protection zone (Zone A). Nevertheless, some of the nonconsumptive activities that are generally considered benign can potentially be highly detrimental for species and their habitats. In fact, boating 1) can damage

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seagrass meadows, as well as infralittoral algal and coralligenous assemblages due to anchoring (Francour et al. 1999; Milazzo et al. 2002; La Manna et al. 2014); 2) has a toxic effect on marine organisms due to gasoline, oil, and bilge water discharge (Catania et al. 2017); and 3) affects water quality due to pollutants from vessels (sewage, toxic antifouling materials, and grey water) (Lloret et al. 2008). Furthermore, boat noise induces changes in morphological, behavioral, and physiological traits (e.g., energy budget) of invertebrates, fish, sea birds, and marine mammals (Sarà et al. 2007; Lloret et al. 2008; Bracciali et al. 2012; La Manna et al. 2016). Moreover, a high level of boating activity can lead to social conflict between users (Heatwole and West 1982), such as boaters and fishermen, or to overcrowding and reduction of an MPA's visitor satisfaction (Ashton and Chubb 1972).

In many cases, MPAs are still perceived as negative by local communities (Bennett and Dearden 2013) because they are more aware of the rules restricting their behaviors and economic activities than of the benefits for ecosystems and ecosystem services. Thus, the effectiveness of MPAs is closely related to assessing the different human uses that occur within them and the behavior of visitors, and consequently to the management of people (Arias et al. 2015). For this reason, the European Union Marine Strategy Framework Directive (MSFD; European Parliament and Council of the European Union 2008) recognizes the importance of socioeconomic factors for the achievement of an MPA's ecological goals. Nevertheless, to our knowledge, very few studies have monitored human uses within the boundaries of the Italian MPAs (La Manna et al. 2010, 2016; Venturini et al. 2015; Coomber et al. 2016) and the assessment of social impacts is still generally uncommon (Voyer et al. 2015). Furthermore, compliance with regulations on human activities inside the protected areas is of primary importance for successful conservation (Arias et al. 2015). One of the causes of failing reserves, the so called "paper parks," is ineffective enforcement (Mora et al. 2006). Measuring the "level of compliance" is considered a key performance indicator for MPA success worldwide (Rossiter and Levine 2014). Surprisingly, this aspect has been taken into account in only a limited number of studies (Arias 2015), probably because detecting and measuring the occurrence of illegal events is a complicated task (Bergseth et al. 2015).

The objective of the present study was to estimate boating usage and the level of compliance in an Italian MPA (Capo Gallo and Isola delle Femmine). The spatial and temporal trend of boating and the behaviors of boaters were measured through direct observation over a period of 2 summer months. The Capo Gallo and Isola delle Femmine MPA is a useful case study because it belongs to the municipality of one of the busiest coastal cities in Italy (Palermo) and, therefore, can be subject to a high level of human pressure and potential environment–user conflicts. Therefore, using this MPA as a case study, the limitations and potential of existing MPA policies are discussed, together with solutions for management plans.

METHODS

Study area

The present study was conducted in the Capo Gallo and Isola delle Femmine MPA (Sicily, Italy–Mediterranean Sea; Figure 1). The MPA was established in 2002 and has a total surface area of 2173 ha. The MPA is divided into 3 zones with different levels of protection: 1) Zone A (total protection, no-entry, and no-take zone), where no human uses are allowed except for authorized scientific research; 2) Zone B (general protection), where navigation at a maximum speed of 5 knots, mooring on buoys, authorized diving, swimming, and snorkeling are allowed; and 3) Zone C (partial protection), where authorized fishing, navigation at a maximum speed of 10 knots, anchoring and mooring at sites specified by the management authority, authorized diving, swimming, and snorkeling are allowed. The coastal area is characterized by a trottoir formed by the worm snails *Dendropoma cristatum* and *Vermetus triquetrus*, whereas the seafloor is characterized by rocky substratum and sandy bottom covered by a *Posidonia oceanica* seagrass meadow and by algal coralligenous assemblages formed by *Corallium rubrum* and *Savalia savaglia* at greater depths. The area is populated by Mediterranean fish assemblages that are typical of the rocky bottom, pelagic fish, and sporadically by the loggerhead turtle, *Caretta caretta*, and bottlenose dolphins, *Tursiops truncatus*.

After the legal establishment and approval of the provisional regulation in 2002, the MPA management authority has not yet issued regulations or approved management plans. For 10 years, the management itself has been provisional and entrusted to the "Capitaneria di Porto" of Palermo. Finally, in 2012, a consortium composed of the Metropolitan City of Palermo, the Municipality of Isola delle Femmine, and the Regional Department of Rural and Territorial Development was entrusted with the management of the MPA.

Sampling

During 2009, boating was monitored within the boundaries of the Capo Gallo and Isola delle Femmine MPA by counting the number of boats in the areas where buoy fields are usually deployed. There are 4 buoy fields in the MPA and all were chosen as reference points to monitor boat traffic. The westernmost area (hereafter called "Area 1") is close to Isola delle Femmine whereas Area 2 (Capo Gallo) is located in the eastern part of the MPA. In each area, there were 2 buoy fields: Istmo and Nato (Area 1) and Cimitero and Malpasso (Area 2). Boat traffic was monitored in July and August 2009. These months were chosen because they are central to the summertime and they are usually the most crowded months in the Mediterranean Sea, particularly in southern Italy. Monitoring was performed on 20 sampling days, during weekdays and nonworking days chosen randomly. Thus, trained observers counted the number of transit boats approaching the buoy fields and the number of moored boats for 15 min, during 3 different time slots (morning: 8:30–10:30 AM; midday: 12:30–2:30 PM;

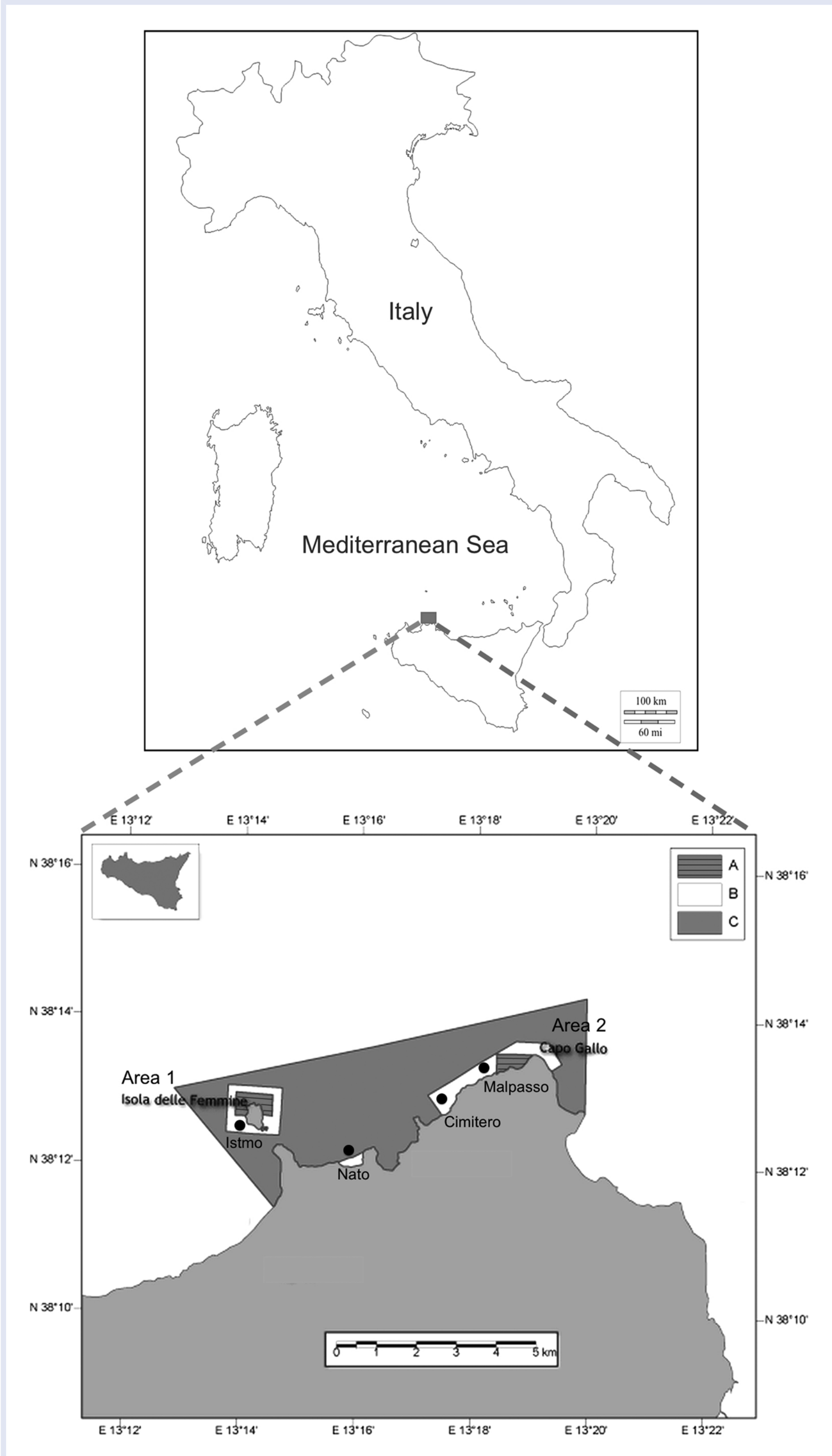

Figure 1. Study area: Marine Protected Area of Capo Gallo Isola delle Femmine (Sicilia, Italy - Mediterranean Sea). Area 1: Isola delle Femmine; Area 2: Capo Gallo.

afternoon: 5:00–7:00 PM) on 2 different types of day (weekday and nonworking day). During each sampling day, all boats at a distance of less than 200 m from the observers were counted with the help of binoculars. To distinguish the different boating usage, boats were classified as follows: motor boats (including inflatable and speed boats), "silent" boats (including sailing boats, rowing boats, pedaloes and surfboards), and professional fishing boats (commercial vessels). Boats were further distinguished on the basis of their movement, namely, in transit or tied up to the mooring buoys of the MPA. The size of a boat was estimated by sight and rated as follows: small (1–5 m), medium (5–10 m), and large (>10 m), together with the power of the engine (<50 horsepower [hp], >50 hp, inboard). The activities of the people on board (swimming, high-speed navigation, sport fishing, anchoring) were also recorded to verify the level of

Table 1. Descriptive statistics on the number of all boats, transit boats, moored boats, as a function of type of boats, size, and engine power, and on the number of illegal events performed by people on board of the boats

	All boats			Transit boats			Moored boats		
Type	MB	SB	FB	MB	SB	FB	MB	SB	FB
Total number	5598	624	245	3345	457	208	2253	167	37
Percentage	87%	10%	4%	83%	11%	5%	92%	7%	2%
Mean	11.66	1.30	0.51	6.97	0.95	0.43	4.69	0.35	0.08
SD	12.56	1.68	1.20	7.07	1.29	0.88	4.69	0.35	0.14
Range	0–82	0–10	0–8	0–40	0–8	0–5	0–42	0–5	0–4

	All boats			Transit boats			Moored boats		
Size	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
Total number	1424	4837	458	794	2833	294	630	2004	164
Percentage	21%	72%	7%	12%	42%	4%	9%	30%	2%
Mean	2.97	10.08	0.95	1.65	5.90	0.61	1.31	4.18	0.34
SD	2.99	8.88	1.40	2.16	6.22	1.03	1.93	5.95	0.95
Range	0–15	0–45	0–9	0–13	0–29	0–7	0–14	0–35	0–8

	All boats			Transit boats			Moored boats		
Engine power (hp)	Inboard	<50	>50	Inboard	<50	>50	Inboard	<50	>50
Total number	1436	1316	2067	995	761	1312	441	555	755
Percentage	30%	27%	43%	32%	25%	43%	25%	32%	43%
Mean	2.99	2.74	4.31	2.07	1.59	2.73	0.92	1.16	1.57
SD	2.74	3.41	4.50	2.19	2.38	3.55	1.57	1.92	2.67
Range	0–19	0–25	0–20	0–12	0–22	0–18	0–10	0–15	0–18

Illegal events	Sport fishing	Mooring	Additional noise	High-speed navigation
Total number	188	166	177	199
Percentage	26%	23%	24%	27%
Mean	0.39	0.35	0.37	0.41
SD	0.77	1.08	2.16	1.23
Range	0–5	0–9	0–22	0–10

FB = fishery boats; hp = horsepower; Large = >10 m; MB = motor boats; Medium = 5–10 m; SB = silent boats; Small = 1–5 m.

compliance with the regulation. Speed navigation was estimated by sight given that only 2 categories were considered of relevance for the study aim: <5 knots or >5 knots. In fact, 5 knots is the maximum speed set (inside Zone B) by the provisional regulation of the MPA. Boats navigating at speeds lower than 5 knots with the engine running at minimum revolutions per minute (rpm) do not produce a stern wave and can be easily recognized by sight.

Statistical analysis

To verify the spatial and temporal trend of boating inside the study area, the total number of all boats, the number of transit boats, and the number of moored boats were analyzed by three 4-way ANOVA analyses, where area (fixed factor, 2 levels: 1 and 2), site (random factor, 2 levels: Nato and Istmo, Cimitero and Malpasso), day type (fixed factor, 2 levels: weekday and nonworking day), and time (fixed factor, 3 levels: morning, midday, and afternoon) were treated as orthogonal. The same ANOVA designs were applied to test differences in the number of all boats combined, the number of transit boats, and the number of moored boats distinguished as a function of size (small, medium, and large). Then, three 4-way ANOVA analyses with the same design were run on the number of illegal events (those

Table 2. Outcomes of 4-way ANOVAs run on the effect of area, site, day type, and time on 1) number of all boats, all moored boats, and all transit boats; 2) all motor boats, all moored motor boats, and all transit motor boats; 3) number of all silent boats, all moored silent boats, and all transit silent boats

		All boats			All moored boats			All transit boats		
Factor	*df*	MS	*F* value	*P* value	MS	*F* value	*P* value	MS	*F* value	*P* value
A	1	5.86	12.01	0.001[a]	4.93	10.95	<0.001[a]	5.11	8.52	0.0037[a]
S	2	20.15	41.27	<0.001[a]	33.42	74.20	<0.001[a]	10.7	17.83	<0.001[a]
D	1	129.5	265.23	<0.001[a]	96.28	213.73	<0.001[a]	93.01	155.00	<0.001[a]
T	2	16.66	31.12	<0.001[a]	27.83	61.77	<0.001[a]	6.23	10.38	<0.001[a]
A × D	1	0.29	0.58	0.4450	0.39	0.88	0.3499	0.00	0.01	0.9326
S × D	2	2.12	4.35	0.0135[a]	0.68	1.51	0.2216	6.21	10.36	<0.001[a]
A × T	2	1.37	2.81	0.0614	3.42	7.59	<0.001[a]	0.48	0.80	0.4502
S × T	4	0.71	1.45	0.2161	2.67	5.93	<0.001[a]	0.39	0.64	0.6331
D × T	2	0.85	1.73	0.1778	2.00	4.45	0.0123[a]	0.67	1.11	0.3308
A × D × T	2	0.04	0.08	0.9282	0.00	0.00	0.9962	0.12	0.19	0.8234
S × D × T	4	0.53	1.10	0.3583	0.60	1.33	0.2587	0.66	1.09	0.3588
Res	456	0.49	—	—	0.45	—	—	0.60	—	—

		All motor boats			Moored motor boats			Transit motor boats		
Factor	*df*	MS	*F* value	*P* value	MS	*F* value	*P* value	MS	*F* value	*P* value
A	1	6.37	11.52	<0.001[a]	3.62	8.37	<0.001[a]	6.29	9.81[a]	0.0018[a]
S	2	19.49	35.24	<0.001[a]	38.22	88.48	<0.001[a]	6.91	10.78[a]	<0.001[a]
D	1	167.55	302.94	<0.001[a]	87.8	203.25	<0.001[a]	135.5	211.49[a]	<0.001[a]
T	2	31.17	56.36	<0.001[a]	38.19	88.42	<0.001[a]	12.7	19.82[a]	<0.001[a]
A × D	1	0.46	0.83	0.3622	0.67	1.54	0.2149	0.03	0.04	0.8367
S × D	2	0.45	0.81	0.4446	1.14	2.63	0.0733	3.2	5.00[a]	0.0071[a]
A × T	2	1.5	2.71	0.0676	2.89	6.69	0.0014[a]	0.27	0.42	0.6608
S × T	4	0.84	1.52	0.1949	2.15	4.98	<0.001[a]	0.65	1.02	0.3979
D × T	2	1.08	1.95	0.1439	2.33	5.40	0.0048[a]	1.39	2.17	0.1155
A × D × T	2	0.17	0.31	0.7344	0.41	0.96	0.3836	0.23	0.36	0.6961
S × D × T	4	0.23	0.42	0.7947	0.68	1.57	0.1813	0.2	0.31	0.8712
Res	456	0.55	—	—	0.43	—	—	0.64	—	—

		All silent boats			Moored silent boats			Transit silent boats		
Factor	*df*	MS	*F* value	*P* value	MS	*F* value	*P* value	MS	*F* value	*P* value
A	1	0.20	0.57	0.449616	0.54	4.06	0.0444[a]	0.02	0.06	0.8016
S	2	1.35	3.83	0.0223[a]	0.74	5.62	0.0039[a]	1.10	3.77	0.0238[a]
D	1	9.52	26.99	<0.001[a]	6.60	49.99	<0.001[a]	2.75	9.38	0.0023[a]
T	2	0.01	0.03	0.9723	0.20	1.50	0.2246	0.11	0.38	0.6873
A × D	1	2.05	5.81	0.0163[a]	0.04	0.29	0.5939	1.68	5.73	0.0171[a]
S × D	2	2.72	7.71	<0.001[a]	0.34	2.61	0.0748	1.87	6.38	0.0019[a]
A × T	2	0.73	2.07	0.1280	0.10	0.74	0.4756	0.94	3.20	0.0416[a]

(*Continued*)

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Table 2. (*Continued*)

		All silent boats			Moored silent boats			Transit silent boats		
Factor	*df*	MS	*F* value	*P* value	MS	*F* value	*P* value	MS	*F* value	*P* value
S × T	4	0.52	1.46	0.2130	0.09	0.69	0.5966	0.56	1.93	0.1045
D × T	2	0.34	0.98	0.3778	0.23	1.76	0.1734	0.30	1.02	0.3620
A × D × T	2	0.15	0.43	0.6503	0.96	7.27	<0.001[a]	0.19	0.65	0.5205
S × D × T	4	0.34	0.98	0.4201	0.45	3.44	<0.001[a]	0.48	1.65	0.1603
Res	456	0.35	—	—	0.13	—	—	0.29	—	—

A = area; D = day type; df = degrees of freedom; MS = mean squares; S = site; T = time.
[a]Significant value.

forbidden by the provisional regulation of the MPA): 1) high speed navigation (>5 knots), 2) recreational fishing, and 3) anchoring. To test for normality and homogeneity of variances, the Shapiro-Wilk test and Levene's test were run, respectively, and all data were log-transformed. The level of significance was set at 0.05. All descriptive statistics and analyses were performed using R for Mac (R Core Team 2017).

RESULTS

The total number, relative percentage, mean ± SD, and range for all categories of boat, boat size, engine power, and illegal events are shown in Table 1. A total of 6467 boats were counted in 20 days of sampling; 62% were in transit and 38% were moored. Istmo (Area 1) was the site with the maximum number of boats, with a total of 2429 boats, followed by Malpasso (1528), Cimitero (1270), and Nato (1241). The number of boats during nonworking days was 3 times higher than on weekdays (4887 vs 1581) and was higher at midday (2959) and in the afternoon (2025) compared to the morning (1484). Motor boats were the most abundant type of boat, accounting for 87% of the total: 40% of them were moored and 60% were in transit. Silent boats represented only 10% of the total: 73% of them were in transit and 17% were moored. Professional fishing boats represented less than 4%, and for this reason, these were not considered for further analysis. With regard to the boats, 93% were of small and medium size, whereas large boats accounted for only 7%. The majority of boats (73%) had an engine power greater than 50 hp or had an inboard engine.

The use of the MPA by boats differed as a function of area, site, day, and time. Generally, the number of boats was greater in Area 1 compared to Area 2, at the Istmo site compared to other sites, during nonworking days compared to weekdays, and at midday and in the afternoon compared to the morning. This was the general trend, regardless of whether the boats were in transit or moored, with few

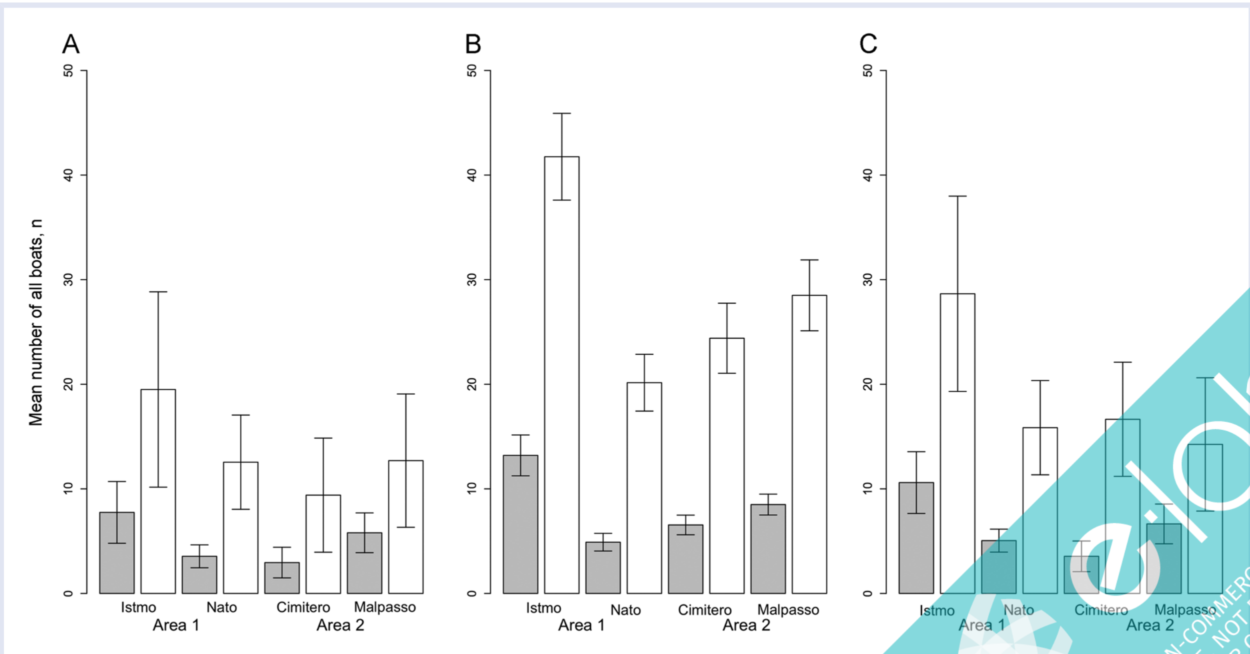

Figure 2. Mean number of boats ± SE, as a function of area, site, day type (gray bars = weekday; white bars = nonworking day), and time. Morning (8:30–10:30 AM) (A); midday (12:30–2:30 PM) (B); afternoon (5:00–7:00 PM) (C).

Table 3. Outcomes of 4-way ANOVAs run on the effect of area, site, day type, and time on the number of all boats, all moored boats, and all transit boats as a function of size

		All small boats			Small moored boats			Small transit boats		
Factor	*df*	MS	*F* value	*P* value	MS	*F* value	*P* value	MS	*F* value	*P* value
A	1	15.37	38.12	<0.001[a]	13.41	42.25	<0.001[a]	0.86	6.39	0.0118[a]
S	2	5.90	14.65	<0.001[a]	0.15	0.47	0.6265	2.45	18.29	<0.001[a]
D	1	33.21	82.38	<0.001[a]	5.16	16.25	<0.001[a]	8.46	63.02	0.001[a]
T	2	0.05	0.13	0.8804	0.28	0.89	0.4117	0.01	0.09	0.9189
A × D	1	0.57	1.41	0.2355	0.01	0.03	0.8680	0.65	4.83	0.0285[a]
S × D	2	0.11	0.27	0.7668	2.08	6.56	0.0016[a]	0.65	4.86	0.0082[a]
A × T	2	0.94	2.33	0.0987	0.76	2.41	0.0912	0.08	0.58	0.5582
S × T	4	1.08	2.67	0.0317[a]	2.23	7.02	<0.001[a]	0.02	0.13	0.9729
D × T	2	3.27	8.13	<0.001[a]	4.61	14.54	<0.001[a]	0.01	0.05	0.9470
A × D× T	2	0.70	1.74	0.1760	0.35	1.09	0.3357	0.16	1.16	0.3139
S × D × T	4	1.13	2.80	0.0255[a]	0.79	2.48	0.0433[a]	1.36	1.36	0.2458
Res	456	0.40	—	—	0.32	—	—	0.13	—	—
		All medium boats			Medium moored boats			Medium transit boats		
Factor	*df*	MS	*F* value	*P* value	MS	*F* value	*P* value	MS	*F* value	*P* value
A	1	27.95	72.26	<0.001[a]	48.36	83.21	<0.001[a]	4.33	6.90[a]	0.0089[a]
S	2	3.66	9.44	<0.001[a]	5.03	8.66	<0.001[a]	4.62	7.37[a]	<0.001[a]
D	1	93.34	240.97	<0.001[a]	27.92	48.03	<0.001[a]	99.30	158.18[a]	<0.001[a]
T	2	3.96	10.21	<0.001[a]	0.15	0.25	0.7774	7.40	11.79[a]	<0.001[a]
A × D	1	0.08	0.20	0.6580	0.12	0.20	0.6528	0.00	0.01	0.9359
S × D	2	0.94	2.44	0.0884	9.99	17.19	<0.001[a]	2.61	4.15[a]	0.0163[a]
A × T	2	1.18	3.03	0.0491[a]	2.10	3.61	0.0279[a]	0.38	0.60	0.5492
S × T	4	3.99	10.29	<0.001[a]	12.24	21.07	<0.001[a]	0.54	0.87	0.4836
D × T	2	3.21	8.29	<0.001[a]	2.95	5.08	0.0066[a]	0.73	1.17	0.3127
A × D × T	2	0.17	0.44	0.6478	0.08	0.14	0.8678	0.22	0.36	0.6997
S × D × T	4	1.47	3.80	0.0047[a]	2.57	4.42	0.0016[a]	0.74	1.18	0.3181
Res	456	0.39	—	—	0.58	—	—	0.63	—	—
		All large boats			Large moored boats			Large transit boats		
Factor	*df*	MS	*F* value	*P* value	MS	*F* value	*P* value	MS	*F* value	*P* value
A	1	0.31	1.52	0.2178	4.67	33.87	<0.001[a]	0.31	1.52	0.2178
S	2	3.21	15.54	<0.001[a]	0.15	1.10	0.3343	3.21	15.54[a]	<0.001[a]
D	1	0.01	0.03	0.8651	0.63	4.56	0.0332	0.01	0.03	0.8651
T	2	0.69	3.35	0.0359[a]	0.19	1.41	0.2457	0.69	3.35[a]	0.0359[a]
A × D	1	2.42	11.73	<0.001[a]	0.33	2.42	0.1209	2.42	11.73[a]	<0.001[a]
S × D	2	2.42	11.72	<0.001[a]	2.75	19.95	<0.001[a]	2.42	11.72[a]	<0.001[a]
A × T	2	0.03	0.14	0.8728	0.15	1.08	0.3405	0.03	0.14	0.8728

(*Continued*)

Table 3. (*Continued*)

Factor	df	All large boats			Large moored boats			Large transit boats		
		MS	*F* value	*P* value	MS	*F* value	*P* value	MS	*F* value	*P* value
S × T	4	0.21	1.01	0.4008	0.74	5.37	<0.001[a]	0.21	1.01	0.4008
D×T	2	0.23	1.10	0.3346	0.66	4.80	0.0087	0.23	1.10	0.3346
A × D × T	2	0.35	1.70	0.1846	0.36	2.60	0.0751	0.35	1.70	0.1846
S × D × T	4	0.19	0.94	0.4414	0.46	3.30	0.0110[a]	0.19	0.94	0.4414
Res	456	0.21	—	—	0.14	—	—	0.21	—	—

A = area; D = day type; df = degrees of freedom; MS = mean squares; S = site; T = time.
[a]Significant value.

exceptions (Table 2, Figure 2). Small, medium, and large boats were more abundant in Area 1 compared to Area 2, on nonworking days, and at midday and in the afternoon (Table 3, Figure 3).

During sampling, 553 illegal events were recorded. Most illegal recreational fishing, mooring, and high-speed navigation events were observed in Area 1 (119, 108, 155). Fishing events occurred mainly in the morning (72) and

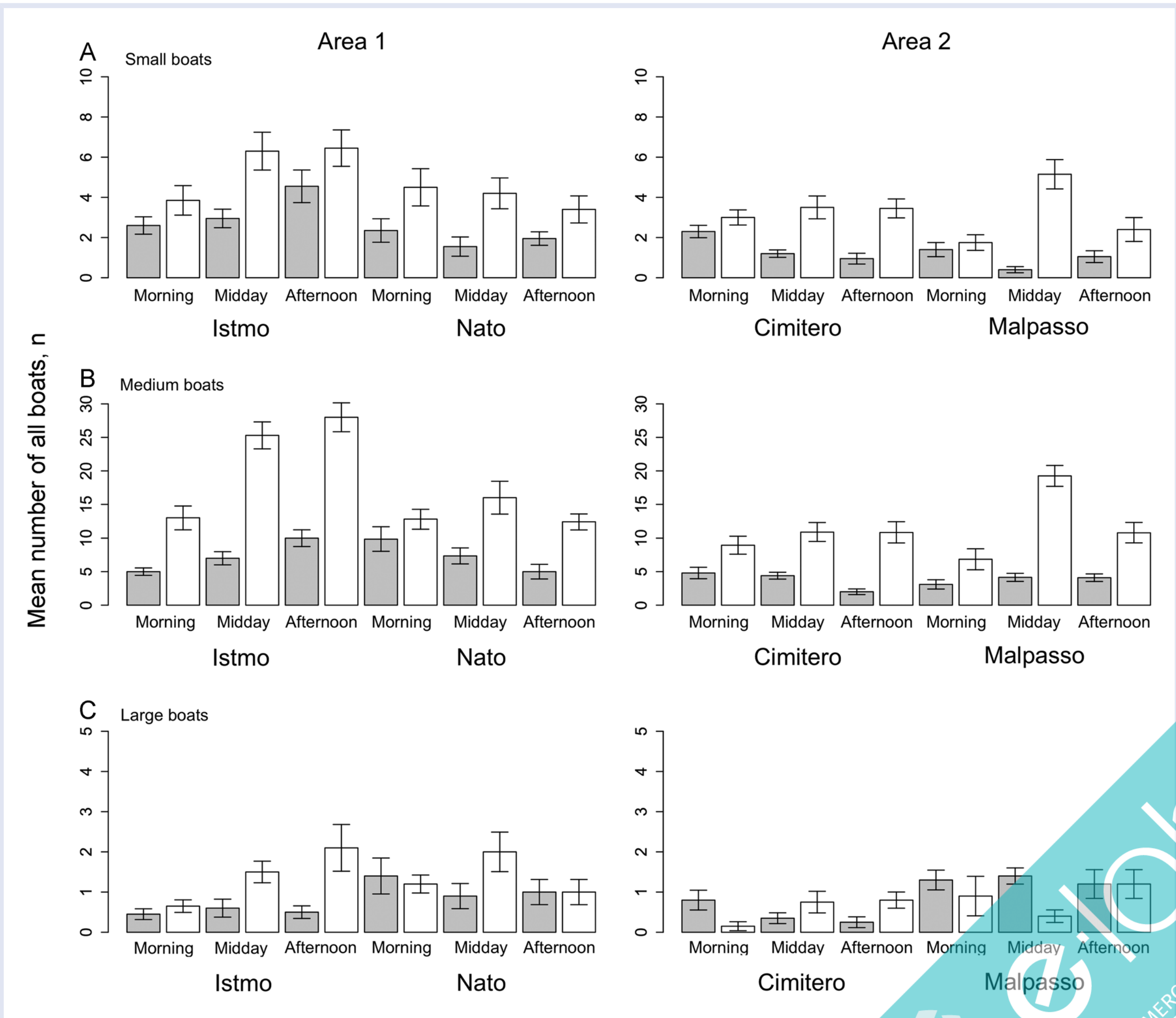

Figure 3. Mean number of boats ± SE, as a function of area, site, day type (gray bars = weekday; white bars = nonworking day), and time. Small boats (1–5 m) (A); medium boats (5–10 m) (B); large boats (>10 m) (C).

Table 4. Outcomes of 4-way ANOVAs run on the effect of area, site, day type, and time on the number of all illegal events

		Sport fishing			Mooring			High-speed navigation		
Factor	*df*	MS	*F* value	*P* value	MS	*F* value	*P* value	MS	*F* value	*P* value
A	1	1.03	6.63	0.0104[a]	1.30	8.19	0.0044[a]	3.08	16.94	<0.001[a]
S	2	0.15	0.96	0.3836	0.15	0.94	0.3916	2.27	12.48	<0.001[a]
D	1	0.21	1.37	0.2419	0.15	0.95	0.3316	4.42	24.37	<0.001[a]
T	2	0.94	6.03	0.0026[a]	0.69	4.33	0.0137[a]	0.17	0.93	0.3974
A × D	1	0.31	1.99	0.1589	0.38	2.38	0.1240	0.71	3.91	0.0486[a]
S × D	2	0.02	0.12	0.8878	0.71	4.46	0.0121[a]	0.88	4.83	0.0084[a]
A × T	2	0.72	4.62	0.0104[a]	1.05	6.62	0.0015[a]	0.02	0.09	0.9107
S × T	4	0.32	2.08	0.0821	0.52	3.29	0.0112[a]	0.30	1.66	0.1585
D × T	2	0.26	1.64	0.1949	0.73	4.61	0.0104[a]	0.28	1.54	0.2156
A × D × T	2	0.21	1.36	0.2570	0.14	0.90	0.4061	0.31	1.70	0.1848
S × D × T	4	0.21	1.34	0.2559	0.77	4.84	<0.001[a]	0.17	0.96	0.4304
Res	456	0.16	—	—	0.16	—	—	0.18	—	—

A = area; D = day type; MS = mean squares; S = site; T = time.
[a]Significant value.

afternoon (78), whereas mooring and high-speed navigation events occurred mainly at midday (56, 75) and in the afternoon (84, 73).

The number of illegal fishing events was statistically greater in Area 1, in the morning and the afternoon. In addition, no difference was found as a function of day type. The number of illegal moorings was greater in Area 1, especially at the Istmo site, at midday and in the afternoon, with no difference as a function of day. Overall, the number of high-speed navigation events was greater in Area 1, especially at the Istmo site, without differences in time or day type (Table 4, Figure 4).

DISCUSSION

Boating usage and implications for management

The present study highlighted for the first time the type of boating usage in this Italian MPA, the temporal and spatial trends of boating, and the behavior of boaters. These results provide essential data to inform the management in this MPA, which still does not have a regulation and is governed by the provisional rules established at the moment of its inception (2002). In fact, the collection of data on boating use, its distribution in space and time, and the factors influencing distribution represent the first step needed to incorporate this knowledge into a proper planning and management process (Newsome et al. 2002; Dalton et al. 2010).

In general, even if a comparison with other studies is difficult due to the different methodology employed, the number of boats inside the MPA appeared to be much higher than in all the other Italian MPAs where data on boat traffic are available (La Manna et al. 2010, 2016; Venturini et al. 2015; Rako Gospìc and Picciulin 2016). This result highlights critical boating usage and the need to consider the management of boating as a priority in highly urbanized MPAs. In this respect, the management of the MPA should consider 1) a set of monitoring actions for impact assessment of wave motion and anchoring on some high risk and high conservation priority habitats and species; 2) given the high number of boats, the insufficient number of mooring buoys, and the high number of illegal anchoring cases, a mooring plan providing ecofriendly moorings, free anchoring zones on sandy bottom, and limitations on the number of boats allowed to enter certain zones of the MPA should be drafted.

The data on the size of boats (93% of the boats are between 5 and 10 m long) provided substantial information on the kind of boat traffic, suggesting that it consists mainly of resident boaters. Silent boats, which have less impact on biodiversity, represented a small percentage alongside commercial fishing boats, both of which do not use this area much. The latter result provides important information on the categories of stakeholders that should be consulted during the process of management proposals. In southern Italy, in many MPAs, fishermen are still highly suspicious about the limits that can be imposed on their activities and resource exploitation, and they are among the stakeholders who still ostracize the establishment and regulation of MPAs (Ornat and Vignes 2015). Moreover, when the objectives of the MPA are not achieved, stakeholders' support for MPAs can be negatively influenced, leading to a decrease in voluntary compliance (Chaigneau and Daw 2015). In our study area, it was noted that fishermen use the area sporadically. This reduces the potential conflict between them and environmental management.

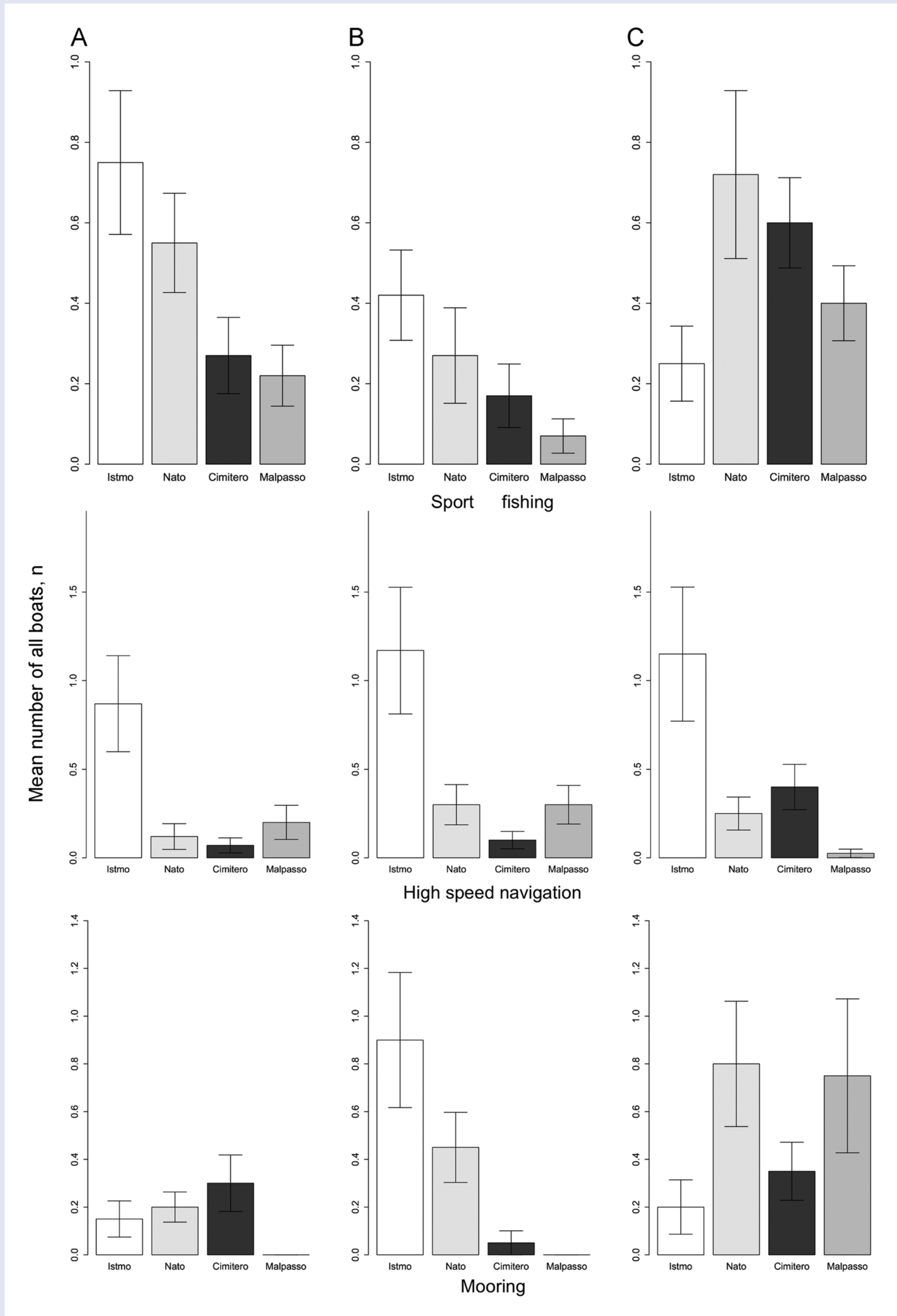

Figure 4. Mean number of illegal events ± SE, as a function of site and time. Morning (8:30–10:30 AM) (A); midday (12:30–2:30 PM) (B); afternoon (5:00–7:00 PM) (C).

Currently, it is widely believed that management strategies will be accepted and supported by local communities and that MPAs will succeed, provided they produce sustainable economic benefits that are directly perceived and experienced (Chaigneau and Daw 2015). In our case, the MPA's largest users, resident boaters, use the MPA for leisure purposes and may therefore be more willing to accept the MPA's constraints. In fact, residents can directly experience the benefit linked with correct behavior and resource uses, and they can be gratified by the success and the improvement of the MPA's effectiveness (Read et al. 2015), while they are not affected, from an economic point of view, by the MPA's regulation. To influence their behavior, effective awareness campaigns can be planned easily because they are residents; external visitors are much more difficult to reach in a sustainable way (Read et al. 2015). The MPAs can have different social impacts on different groups of individuals, and the lack of attention to their different needs is among the major weakness of this management tool (Coulthard et al. 2011). The users of the

MPA belong mainly to a category with no economic interest in the MPA (motor boaters), and they benefit from the aesthetic and environmental value of the MPA. Thus, the management authority can easily satisfy their needs (in terms of services, such as mooring buoys) and obtain their support without the effort of balancing the needs of different economic stakeholders.

Enforcement and compliance

The most important aspect highlighted by the present study is the MPA's limited effectiveness as regards the social component and compliance with regulations. During 20 days of sampling, about 10% of boaters performed acts in violation of the provisional regulations of the MPA. These acts risk disturbing sensitive wildlife species, affect the maintenance of the good state of the seafloor, *P. oceanica* meadows in particular, and affect the maintenance of nonharmful levels of noise for fish and mammals. In addition, this level of noncompliance is a concern because of the "domino effect." As already observed for illegal fishing in MPAs, if visitors believe that others adopt illegal behavior, they can be less motivated to comply themselves, thus leading to a progressive decline of the level of compliance (Arias 2015).

Noncompliance is a problem worldwide. In fact, only 10% of the marine reserves are managed in order to reduce infringement of the regulations (Mora et al. 2006). Despite this, our study is the first one that measured visitor compliance with regulations in an Italian MPA. In fact, monitoring or empirical measurements of compliance levels in reserves are still relatively rare, compared with theoretical or policy-based explorations, and direct observations of noncompliance represent a small percentage (Burger 2002; Bergseth et al. 2015; Lathrop et al. 2017).

Enforcement and compliance are among the most important factors in the achievement of the conservation goal of MPAs (Edgar et al. 2014; Arias et al. 2015). Compliance is related to enforcement and participation of stakeholders (Andrade and Rhodes 2012; Arias 2015). Pollnac and Seara (2011) found that the indicators directly related to compliance included 1) the presence of marine reserve features (such as marker buoys, management plans, and signs), 2) ecological monitoring by both advisors and the community, 3) training, and 4) formal consultation processes with the community. The cause of high levels of noncompliance could be attributed to each of these aspects. In fact, after years of absence, the buoys that mark the boundaries of the MPA were restored only in 2016, and as far as we know there has been no involvement of the local community since the establishment of the MPA. Thus, all these indicators should be considered by the management of the MPA in order to establish a process that fosters compliance. Nevertheless, considering the limited funds usually allocated to conservation, enforcement and surveillance should be optimized (Arias et al. 2014). In this sense, the study presented here provides the data (sites and times most at risk of noncompliance) necessary to make management more efficient in terms of effective surveillance. Nevertheless, voluntary compliance should also be increased (Campbell et al. 2012) by the management authority through education and involvement of visitors and stakeholders in order to improve their trust in the function and effectiveness of the MPA.

CONCLUSION

Although the results outlined in the present study are unique to the MPA, the problems linked with community support, governance, and enforcement pervade MPAs worldwide (Rife et al. 2013; Arias et al. 2015; Ornat and Vignes 2015).

Even if in the last 20 years there has been a strong commitment of the National Authority to the designation of more MPAs, many of them still lack management plans and stable governance, they have insufficient surveillance, and their effectiveness is not monitored. These problems can potentially lead to a false sense of protection (Rife et al. 2013). The success of an MPA is linked to certain factors related to the local population, such as their perception with respect to the need for environmental protection and their awareness that the MPA represents not only a restrictive tool but also an opportunity for economic development. When an MPA fails in the tasks for which it was established, the damage can be serious, for instance, when local communities and stakeholders have lost faith in the MPA functions (Chuenpagdee et al. 2013).

The present case study, together with a few others that have verified the efficiency of Italian MPAs (Guidetti et al. 2008; Giakoumi et al. 2017), highlights the need to concentrate the available resources on the governance, management, enforcing regulations, and increasing surveillance within the existing Italian MPAs, rather than decreeing new parks with a high risk of becoming "paper parks." In Italy, MPAs are usually underfunded and understaffed (Guidetti et al. 2008), whereas resources available for managers to increase monitoring and surveillance programs are usually scarce. Nevertheless, the use of new technology (acoustic-sensing, satellite imaging, drones, underwater video cameras, and automatic radio-AIS systems [Automatic Identification System]), citizen science programs (Rose et al. 2015; Edgar et al. 2016), and cooperation with nonprofit organizations can considerably reduce these costs by making these programs economically sustainable in the long term.

Finally, although the present study concerns only a small MPA, the methodology applied could be used in other MPAs with the aim to characterize boating usage and level of compliance at the national level. By clarifying the most critical aspects relating to the social context of an MPA, it was possible to identify guidelines for future management planning.

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Data Accessibility—All data can be made available upon request by contacting corresponding author Gianluca Sarà (gianluca.sara@unipa.it).

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