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SPATIAL ALLOCATION OF FISHING ACTIVITY ON CORALLIGENOUS HABITATS IN PORTOFINO MPA (LIGURIA, ITALY)

Abstract

Coralligenous habitats are considered to be important for Mediterranean coastal biodiversity. One of the widely recognized principal threats to this habitat is recreational and artisanal fishing that may cause severe damage or mortality events to long-lived, key structural species. Consequently, the monitoring and sustainable management of fishing are the most important concerns when protecting vulnerable habitats and their biodiversity. The assessment of fishing activity in the Mediterranean region requires complicated approaches due to the increased heterogeneity and combination of gears, the variation of target species and the poor data availability. Therefore, common strategies in fisheries management have failed to capture this heterogeneity or improve understanding of fleet and effort allocation, and their impacts on benthic habitats. The present study identifies and describes the spatial and temporal patterns of selected recreational and artisanal practices having a direct physical impact on coralligenous habitats, such as nets and longlines, in Portofino MPA (Liguria Sea, Italy). Our results reveal areas vulnerable to the impact of overlapping fishing practices and may additionally provide baseline information on vulnerability and impact assessments, ecological and ecosystem modeling, fisheries resource management and conservation planning. Similar approaches could contribute to the decision-making process with regards to fishing activity and vulnerable habitats in Mediterranean MPAs.

Key-words: Coralligenous habitats; spatial analysis; fishing effort; resource management; Marine Protected Area

Introduction

Coralligenous are vulnerable habitats that confer great structural and functional complexity and biodiversity (Garrabou *et al.*, 2002). Although many vulnerable, endangered or commercially important species are known to live, feed or reproduce in this biotope (Salomidi *et al.*, 2012), there is still a limited understanding of this habitat for achieving adequate monitoring and adaptive management. Fishing activity is considered one of the main threats of coralligenous environments that may cause severe damage to long-lived, key structural species (Piazzi *et al.*, 2012) and may alter the habitat's health status (Ballesteros, 2006), directly through mechanical destruction and abrasion or indirectly, from abandoned gear (Bavestrello *et al.*, 1997). Particularly in Marine Protected Areas (MPAs), even though in most cases these activities are allowed and regulated, due to the considerable numbers of fishermen they involve (Font *et al.*, 2012), a specific management and protection plan should be developed in order to ensure their conservation targets (UNEP-MAP-RAC/SPA, 2008). Artisanal fisheries in the Mediterranean Sea (coastal local activity involving small capital investment and small boats - length ≤ 12 m), has been characterized as a challenging

process that requires complicated approaches due to the strong heterogeneity and combination of gear, the change of target species during the year and poor data availability (Freire & García-Allut, 2000). Several approaches have been suggested to improve the understanding of the patterns of fleet and effort, such as the *métiers*, that describe fisheries with regard to fishing gear used, main target species, fishing area and season (Tzanatos *et al.*, 2013), or indicators measuring the level of fishing intensity and extend on the habitat using spatial analysis tools (*e.g.* Stelzenmüller *et al.*, 2008).

The present study identifies and describes the spatial and temporal patterns of selected recreational and artisanal bottom gear practices (Tab. 1) that may cause an effect on coralligenous habitats of Portofino MPA (Liguria Sea, Italy). This MPA, established in 1999, is the third smallest Italian MPA (3.74 km²). Since 2005 Portofino MPA obtained the *status* of Specially Protected Area of Mediterranean Importance (SPAMI), also for the presence of coralligenous and its key structural species. Fishing activity is regulated and monitored by the MPA. Artisanal fishing is allowed only for the residents of the three municipalities involved in the Consortium of the MPA (Portofino, Santa Margherita Ligure and Camogli), the majority of which are based in Camogli (70%). Recreational fishing is permitted under authorization in Zones B and C for residents of the three municipalities and in Zone C for non-residents. Recreational longlines, trolling and “*natelli*” are regulated through a fixed number of 120 authorizations. For both recreational and artisanal fishing other restrictions such as the fishing of certain species, seasonal closures, prohibitions or modifications of fishing techniques, regulations in fishing effort and minimum landing sizes are also implemented in the MPA in order to control the activities. Results aims to reveal those areas vulnerable to the impact of overlapping fishing practices and may provide a reference point for vulnerability and impact assessments, ecological and ecosystem modeling and conservation planning in Portofino MPA.

Materials and methods

The MPA has been divided into 18 smaller management units for monitoring convenience (Fig.1). Data on fishing activity were obtained by fishing diaries, interviews and mental mapping with fishermen of Portofino MPA during the period 2011-2012 (Canella, 2012; Mariotti, 2013; present study). Information coming from 27 out of 28 artisanal fishermen that use practices that can have a direct impact on the coralligenous, were mapped. Additionally, the areas of activity of 113 recreational fishermen that use the fishing techniques under study were mapped, corresponding to 33.25% of all 400 recreational fishermen estimated in Portofino MPA (Cappanera *et al.*, 2012). Data was charged in a Geographical Information System (ArcGIS 10.2). Spatial allocation of fishing activity was based on integration of heterogeneous data from GPS points indicating the position of the nets, fishing trip routes, fishing depth, bottom type, locate areas with access from the coast using Google Earth, mental maps and acronyms of areas. In the case of artisanal fishing, accounting for uncertainty of the nets' location, the spatial deviation equal to 10% of the net length was drawn around the location of gear deployment (Stelzenmüller *et al.*, 2008). There was no possibility of discrimination between pelagic and bottom longlines as the information monitored does not distinguish between the two activities. The coralligenous habitat layer was retrieved from Liguria Region (2009). Bathymetry was extracted from acoustic data (Zapata-Ramirez *et al.*, 2014). The pressure on sea bottom (hereafter referred to as *fishing effort*) was expressed in total number of hours per year (hrs/yr) in order to compare recreational and artisanal fishing.

We superimposed grids with 1 m² cell sizes and aggregated all fishing effort by the sum total of hours per year for each tool. Most impacted coralligenous habitats were identified as those areas that receive 90% of the total footprint occurring for a specific bottom fishing fleet, in accordance with the suggestion of the Data Collection Framework (DCF) of the Common Fishery Policy (EC, 2008a;b), for long-term surveying and the provision of scientific advices towards ecosystem-based fisheries management. To assess the effect of each type of fishing practice on coralligenous habitats we compared the total area impacted (in m²) and the habitat affected, expressed as surface (in m²) and percentage (%) of the total coralligenous habitat inside the MPA (Tab. 1).

Results

Coralligenous habitats in the wider area of Portofino cover a surface of 1.553 km², of which 11.34% (0.176 km²) are located inside the MPA. The remaining 88.66% (1.377 km²) falls outside the MPA limits and is currently unprotected. The management units with higher surface areas of coralligenous are 6 (19.63%), 7 (14.35%), 11 (11.71%) and 14 (10.98%) (Tab.1; Fig.1). The use of artisanal gears is highly seasonal with gillnets, combined nets and fishing cephalopods mostly employed during autumn (maximum number of boats 9-10, 4 and 2 respectively). During spring and summer, use of trammel nets and longlines is increased (maximum number of boats 8-3 and 4 respectively). October was the most popular month for recreational fishing with 13.3% (337 fishermen) of the annual recreational effort. Data mapping also indicated incidents of fishing within restricted areas. The assessment for each fishing practice and the total fishing effort is shown in Tab. 1. Artisanal fishing effort of tools potentially harmful to coralligenous habitats ranged from 636 to 16098.3 hrs/yr, while recreational fishing was much smaller (0-596.31 hrs/yr). The total fishing effort of artisanal and recreational fishing techniques under study ranged from 693 to 16098 hrs/yr. Most of the impacted coralligenous habitats overlapping with the 90% of the total fishing footprint (14.488 hrs/yr) were located in the management units 6-11 at 30-40 m depth, with surface area exceeding 0.035 km² (20.58%) of the total coralligenous in Portofino MPA.

Discussion and conclusions

Understanding the spatial and temporal patterns of fishing effort is fundamental for the sound conservation of benthic ecosystems and seafloor integrity (Stelzenmüller *et al.*, 2008), particularly for vulnerable habitats of limited extent. The artisanal fishing sector of Portofino MPA resembled a typical northwestern Mediterranean coastal fishery with a mean boat size of <10m and engine power <75kW (Leleu *et al.*, 2014). Even though similar studies allowing the comparison of results are limited, data on the number of boats suggest that Portofino MPA artisanal fishing is rather limited but locally intensive targeting vulnerable habitats. On the contrary, the trend has been for recreational activity to increase since 2008, and it is assessed as high (Cappanera *et al.*, 2012). Due to low representativeness of recreational fishers in the sample this was not so evident in our results. However improved MPA monitoring, particularly for recreational fishing, is expected to improve the pressure assessment of this activity in 2015. The most impacted coralligenous habitats in Portofino MPA are located at a depth of between 40-60 m, with special reference to depths of 30-40 m at the southeastern part. Nets were considered the most impacting tools based on the extent of the pressure (effort, surface, % surface of total habitat). However for a deeper analysis, the intensity and weighting of the different practices should be also included in future analysis.

Tab. 1: MPA of Portofino - Assessment of recreational and artisanal bottom-fishing practices combined: Techniques, range of effort (hrs/yr) and threshold account for 90% of the total activity for identifying most impacted areas, most impacted MPA management units (Fig. 1) and depth range (m), total area (m²) most impacted by a tool, total area (m²) of coralligenous mostly impacted by a tool, % most impacted coralligenous area of the total coralligenous in the MPA. In bold are the values of high concern for coralligenous habitats regarding the above criteria. (§) Artisanal technique; (†) recreational technique (*) Underestimated value due to inadequate data.

Fishing technique	Effort range, threshold (hrs/yr)	Units & depth range most impacted	Total area most impacted (m ²)	Surface area of habitat most impacted (m ²)	% of total habitat most impacted
Big game with rod†	5.5-120.0 (108.8*)	6-9 (15 -85m)	426280.7	67531	38.37
Big game with handline †	7.17-92.93 (83.63*)	14 (20 -50m)	100205	18694	10.62
Bottom longlines †	0.38-175 (157.5*)	6 (50-75m), 14 (40-60m)	278500	14200	8.06
Cephalopods †	0-9.74 (8.76*)	13 (20-50m)	2319947	10052	5.71
Vertical jigging †	5.8-40.34 (36.31*)	14 (20- 55m)	222776	19053	10.82
Bottom troling †	9.95-269.07 (242.16*)	6 (20-80m)	149560	34567	19.64
Bottom fishing †	0.4-323.745 (291.37*)	5,15 (0-30m)	27720	2356	1.33
Gill nets §	540-4980 (4482)	6-11 (35-45m)	363700	33750	19.17
Trammel nets§	96-8878 (7990.2)	6-11(25-35m)	105000	3850	2.18
Combined nets§	0-2608 (2340)	9 (45-55m)	300	200	0.11
Bottom longlines§	57.5-467.5 (420.75)	15 (20-25m), 6-11 (40-45m)	195600	12200	6.93
Cephalopods§	0-285 (256.5)	5-15 (20-80m), 3 (20-25m)	249600	166880	94.81
Overall artisanal and recreational fishing †§	636-16311.5 (14680)	6-11 (30-40m)	88929	36226	20.58

Even though the spatial allocation of some fishing practices was broad, the identification of most impacted areas seems to have been successful. Vezzulli *et al.* (2013) collected data supporting the high vulnerability of gorgonians at depths of 20-50 m in Portofino MPA as being due to high diving pressure and fishing activity that made them susceptible to bacteria. Management units 6, 15 and 16 at depths of 30-40 m have also been reported in the past for the great amount of lost gear originating from the big game fishing (Cattaneo-Vietti, personal communication), and as having suffered from massive mortality events (Cerrano *et al.*, 2000). The mapping of fishing activity outside the MPA still remains a challenging issue that could generate a new management strategy for the enlargement of Portofino MPA and the protection of the deep coralligenous that covers almost 90% of the coralligenous habitats in the wider area. This is a first attempt to map fishing activity in Portofino MPA by integrating information coming from a wide variety

of sources and forms that are regularly adopted in the monitoring strategy of Mediterranean MPAs (Font *et al.*, 2012). The results of this study provide a baseline of information for improving the management of the fishing activities on vulnerable habitats within Portofino MPA.

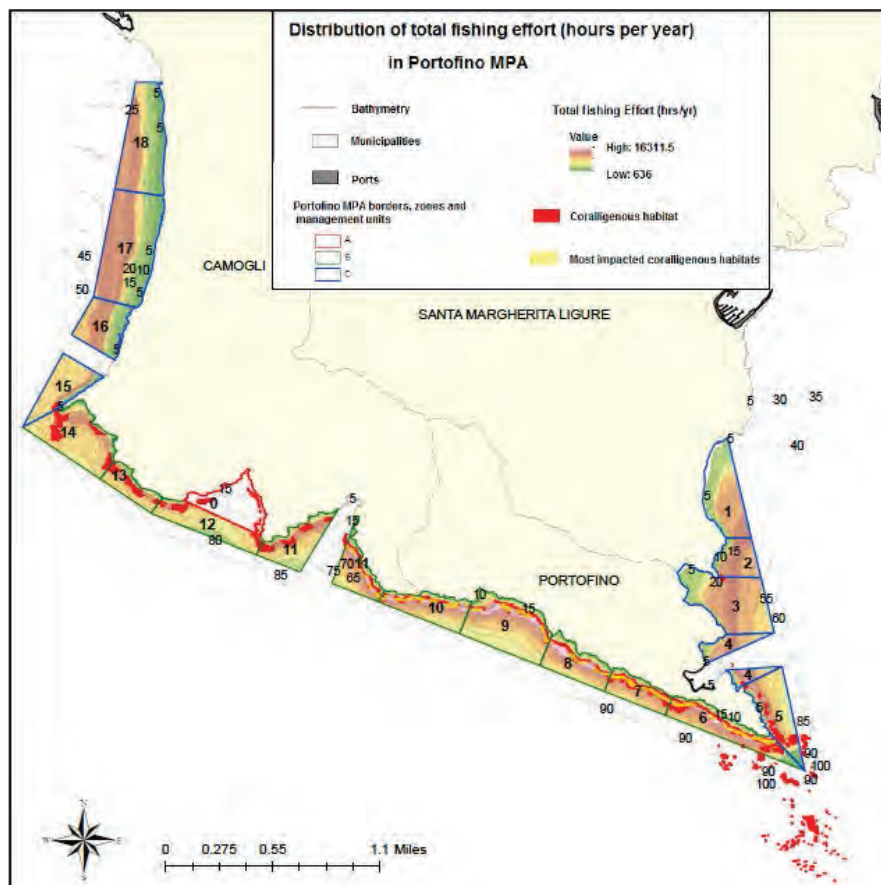


Fig.1: Total effort (hours per year) of all the fishing tools potentially harmful for coralligenous practiced in the Portofino MPA.

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