2018-08

Identifying Recreational fisheries in the Mediterranean through Social Media

Giovos, I

10.1111/fme.12293
Fisheries Management and Ecology

Received: 27 January 2018 | Revised: 8 May 2018 | Accepted: 15 May 2018

DOI: 10.1111/fme.12293

ORIGINAL ARTICLE

WILEY Fisheries Management and Ecology

Identifying recreational fisheries in the mediterranean through social media

Ioannis Giovos[1] | Ioannis Keramidas[1] | Charalampos Antoniou[2] | Alan Deidun[3] | Toni Font[4] | Periklis Kleitou[2] | Josep Lloret[5] | Sanja Matić-Skoko[6] | Alicia Said[3] | Francesco Tiralongo[7] | Dimitrios K. Moutopoulos[8]

[1]Fisheries, iSea, Environmental Organization for the Preservation of the Aquatic Ecosystems, Thessaloniki, Greece

[2]Marine & Environmental Research (MER) Lab Ltd., Limassol, Cyprus

[3]Department of Geosciences, University of Malta, Malta, Malta

[4]University of Girona, Pollença, Spain

[5]Department of Environmental Sciences, University of Girona, Girona, Spain

[6]Ichthyology and Coastal Fisheries, Institute of Oceanography and Fisheries, Split, Croatia

[7]Ente Fauna Marina Mediterranea, Avola, Italy

[8]Department of Aquaculture and Fisheries Management, Technological Educational Institute of Mesolonghi, Aquaculture and Fisheries Management, Mesolonghi, Greece

Correspondence
Ioannis Giovos, Fisheries, iSea, Environmental Organization for the Preservation of the Aquatic Ecosystems, Thessaloniki, Greece.
Email: ioannis.giovos@gmail.com

Funding information
Croatian Science Foundation, Grant/Award Number: LEKFishCRO (IP-2016-06-5251)

Abstract

The impact of recreational fishing on fish stocks remains unknown, as this is inherently difficult to monitor, especially in areas such as the Mediterranean Sea where many species are targeted using a variety of fishing gears and techniques. This study attempts to complement existing data sets and construct the profile of recreational fisheries in the EU-Mediterranean countries using videos publicly available on social media. A total of 1526 video records were selected, featuring the capture of 7799 fish specimens. The results show recreational fishing is multispecies in nature (26 species contributed to >80% % of the most numerically important species caught) and exhibits a spatially homogeneous pattern, with differences in species composition being mostly dependent on the fishing technique used rather than on the country. Such findings fill an important knowledge gap on recreational fishing activities, and the methodology provides an innovative approach to gather statistics on data-poor thematic areas that can potentially complement other data sets, such as the EU Data Collection Multi-Annual Programme.

1 | INTRODUCTION

Recreational fishing in the Mediterranean is defined as any fishing activity not conducted for commercial purposes (Commission of the European Communities (CEC), 2001). Recreational fishing involve numerous fishers, fishing boats, types of fisheries and fishing techniques (boat-based, shore-based and underwater) covered by an array of legislative frameworks within different countries (Arlinghaus & Cooke, 2005; Pawson, Glenn & Padda, 2008).

Catches of marine recreational fisheries are unreported, and its upward trend across the Mediterranean Sea (Font & Lloret, 2014; Lloret et al., 2016) is raising concerns about impacts on fisheries resources and marine ecosystems (Lewin, Arlinghaus, & Mehner, 2006; Pawson et al., 2008). It is estimated that more than 10% of the EU population participates in recreational fishing, but can be >25% of the population in some Northern Europe (Arlinghaus, Tillner, & Bork, 2015). Recreational catches from the Mediterranean are remarkably high (Cardona, Lopez, Sales, Caralt, & Diez, 2007; Morales-Nin et al., 2005; Moutopoulos et al., 2013), with significant socio-economic benefits for local and national economies (Arlinghaus & Cooke, 2005; Arlinghaus, Mehner, & Cowx, 2002): in some regions recreational fishing

catches can be equal or even be greater than that of commercial fisheries (Franquesa, Gordoa, Mina, Nuss, & Borrego, 2004; Lloret, Zaragoza, Caballero, & Riera, 2008).

Recreational fishing is particularly popular in the Mediterranean for several reasons such as: (a) the extensive coastline (46,000 km), (b) the large percentage of the population living across coastal areas (250 million people; European Environmental Agency (EEA), 2015), (c) the increasing importance of fishing as leisure/tourism (Hyder et al., 2017). Furthermore, the recent dire economic situation that southern Europe is facing (Machias, Tsagarakis, & Matsaganis, 2016; Verney, 2009) has potentially directed more people towards subsistence fishing as a potential alternative source of food/protein, although the per se nutritional motivation of recreational fishing should not be underestimated (Cooke et al., 2018). The latter increases the complexity to determine when recreational fishing is conducted for pleasure or for subsistence. Poor traditional management of the Mediterranean fisheries resources (Smith & Garcia, 2014), along with the scarcity of available data that are fragmented, outdated or limited (Hyder et al., 2017), and the prevailing lack of funding to gather data and monitor recreational fisheries (Tsikliras, Sumaila, & Stergiou, 2013), make their management in the region very difficult. At the same time, the lack of data and robust collection of data series compromise any effort for incorporating recreational fisheries in stock assessments, as requested by the Common Fisheries Policy (European Commission, 2013).

The information collected on Mediterranean recreational fisheries are mostly derive from local field surveys (e.g., Font, Lloret, & Piante, 2012; Lloret, Zaragoza, Caballero, Font, et al., 2008; Lloret, Zaragoza, Caballero, & Riera, 2008), personal interviews (Maynou et al., 2013), and collective work at the national level by a variety of methods (ICES, 2016). Hyder et al. (2017) investigated recreational fisheries at the European level, including all the EU-Mediterranean countries, and presented catches by country but with high uncertainty due to data scarcity. The absence of adequate data has obscured recreational fisheries impacts to the Mediterranean economy and environment; although a few studies have evaluated its implications at a Mediterranean EU level by collating local information (see, e.g., Font & Lloret, 2014; Hyder et al., 2017). In line with these attempts, this study aims to provide an alternative method, complementary to existing fisheries data sets, building towards the construction of a profile for recreational fisheries over the Mediterranean Sea (eight EU countries) using social media as a source of information.

Social media has recently gained the attention of scientists as an additional and innovative tool that can gather information in a cost-effective and nonobtrusive manner (Kaplan & Haenlein, 2010). Many researchers have utilised different social media platforms for gathering data on recreational fisheries (Belhabib et al., 2016; Martin, Chizinski, Eskridge, & Pope, 2014; Martin, Pracheil, DeBoer, Wilde, & Pope, 2012; Shiffman, Macdonald, Ganz, & Hammerschlag, 2017), and video recordings by recreational spearfishermen have proved useful for monitoring the fish assemblages (Bulleri & Benedetti-Cecchi, 2014).

2 | MATERIALS AND METHODS

In the context of this study, the typology of techniques described in Table 1, partially described in Pawson et al. (2008) and Gaudin and De Young (2007), as well as subtechniques incorporated in each recreational fishing technique, were used to understand recreational fisheries exploitation.

A social media content sharing platform was used to gather video footage data on the species targeted by the different recreational fishing techniques across EU-Mediterranean countries. The search focused exclusively on YouTube content as this is the most popular online video sharing platform (Ricke, 2014). It was assumed that posts by recreational fishers to this social network represent a proxy of recreational fishing variables, such as species caught by gear and country. To ensure sufficient coverage of the EU-Mediterranean, an exhaustive search to retrieving as many videos as possible in eight participating countries (Croatia, Cyprus, France, Greece, Italy, Malta, Slovenia and Spain) was performed. As a rule of thumb, the search was restricted only to videos loaded by fishers who fitted the recreational profile (i.e., using recreational boats, using recreational equipment). Videos uploaded as promotional, documentaries and/or research projects were excluded from the survey to avoid the bias resulting from nonrandom selective efforts.

The online search was based on a "fishing technique/country" query in all eight languages made directly in Google-Search by restricting the search only to YouTube videos (i.e., by selecting "Any source/youtube.com"), using a similar protocol to the one used by Giovos, Ganias, Garagouni, and Gonzalvo (2016). Exceptionally, for Spain and France, which have both an Atlantic and a Mediterranean coastline within their territories, the search was focused on the Mediterranean part and was based on "fishing technique/town or region" criteria, deploying the full array of search facilities offered by YouTube (i.e., geo-tags, lists of related videos, lists of suggested videos and recommended channels). A careful selection of key words used in YouTube metadata to match those currently searched by potential anglers was used. The key words used when looking for the fishing techniques were (Table 1): boat-based angling, trolling, shore-angling, spearfishing, longline and fish trapping, excluding subtechniques to avoid biases from analysing videos because it is not always easy to identify subtechniques. All key words were translated in each of the eight native languages of the countries included. Double entries or fragments of the same clips were carefully excluded from the video list.

The information emerging from the analyses of the downloaded YouTube videos was disaggregated per: (a) country, (b) type of fishing gear, (c) species caught, and (d) number of specimens (for cases where this was available). The resulting list was analysed by one experienced observer to complete species' taxonomic identification. In many cases, the taxonomic identification was a straightforward process, especially for larger species, but for a few specimens, identification up to species level was ambiguous and the specimens were identified to order or genus level. The number of specimens caught per species, recreational fishing technique and country, were

TABLE 1 Fishing techniques (in parentheses, the legend codes used in the analyses) and subtechniques after Pawson et al. (2008) and Gaudin and De Young (2007)

Main technique	Subtechniques
Angling (AN): Fishing by a boat which is not moving and also the fishing equipment is not moving. The hook(s) is attached to a line and is sometimes weighed down by a sinker so it sinks in the water. This is the classic "hook, line and sinker" arrangement. The hook is baited with lures or bait fish.	Droplining: a dropline consists of a long fishing line set vertically down into the water, with a series of baited hooks. Droplines have a weight at the bottom and a float at the top. (deep fishing droplining, pelagic fish droplining) Handlining: Handlining is fishing with a single fishing line, baited with lures or bait fish, which is held in the hands. Handlining can be performed from boats or from the shore.
Trolling (TR): Fishing by a boat which is moving and/or the fishing equipment is also moving. One or more baited lines which are drawn through the water. This may be performed by pulling the line behind a slow moving boat or by slowly winding the line and make motions with the rod.	Jigging: fishing with a jig, a type of fishing lure. A jig consists of a lead sinker with a hook moulded into it and usually covered by a soft body to attract fish. Jigs are intended to create a jerky, vertical motion. Downrigger, pelagic trolling, bottom trolling, Tenya, Inchiku, Tai rubber and others): many subtechniques in which the mechanisms of the bait, the equipment, the movements, the speed, the depth and other thing are different.
Longline (LL): fishing by a moving boat with a long fishing line with a series of hundreds of baited hooks hanging from the main line by means of branch lines called "snoods."	
Shore-angling (SA): fishing from shore without using a boat.	Casting: throwing the fishing line out over the water using a flexible fishing rod. Surfcasting: fishing from a shoreline using a rod to cast into the surf. Rock fishing: fishing from rocky outcrops into the sea (Light rock fishing). Spinning: fishing with spinnerbaits horizontally in the water. Float fishing: fishing with very light fishing equipment.
Fish Trapping (FT): fishing with a portable pot trap, lowered in the water with a line and left at the bottom for an amount of time.	
Spear Fishing (SF): underwater fishing with spear gun and without the use of diving equipment.	

Note. Results are presented by technique only, excluding subtechniques to minimise biases occurring because videos were analysed rather than field observations.

recorded for each video. Data were finally summarised in a single worksheet for qualitative (i.e., frequency tables) and multivariate (cluster) analyses.

Cluster analysis was carried out to compare the percentage species composition between the different countries and identify the most important fishing techniques. To this end, a single data matrix with YouTube video metadata was constructed. Subsequently, the matrix was transformed into a similarity matrix for all country/fishing technique combinations, using Euclidean distance. The latter was applied on transformed species composition data, for which the square root transformation was used to reduce the weighting of abundant species (Field et al., 1982). The nonparametric multivariate analysis of variance PERMANOVA test was used to test for differences between the groups of country–fishing gear combinations identified from the multivariate analysis (Anderson & Walsh, 2013).

PRIMER for Windows (Carr, 1997) was used for all multivariate analysis.

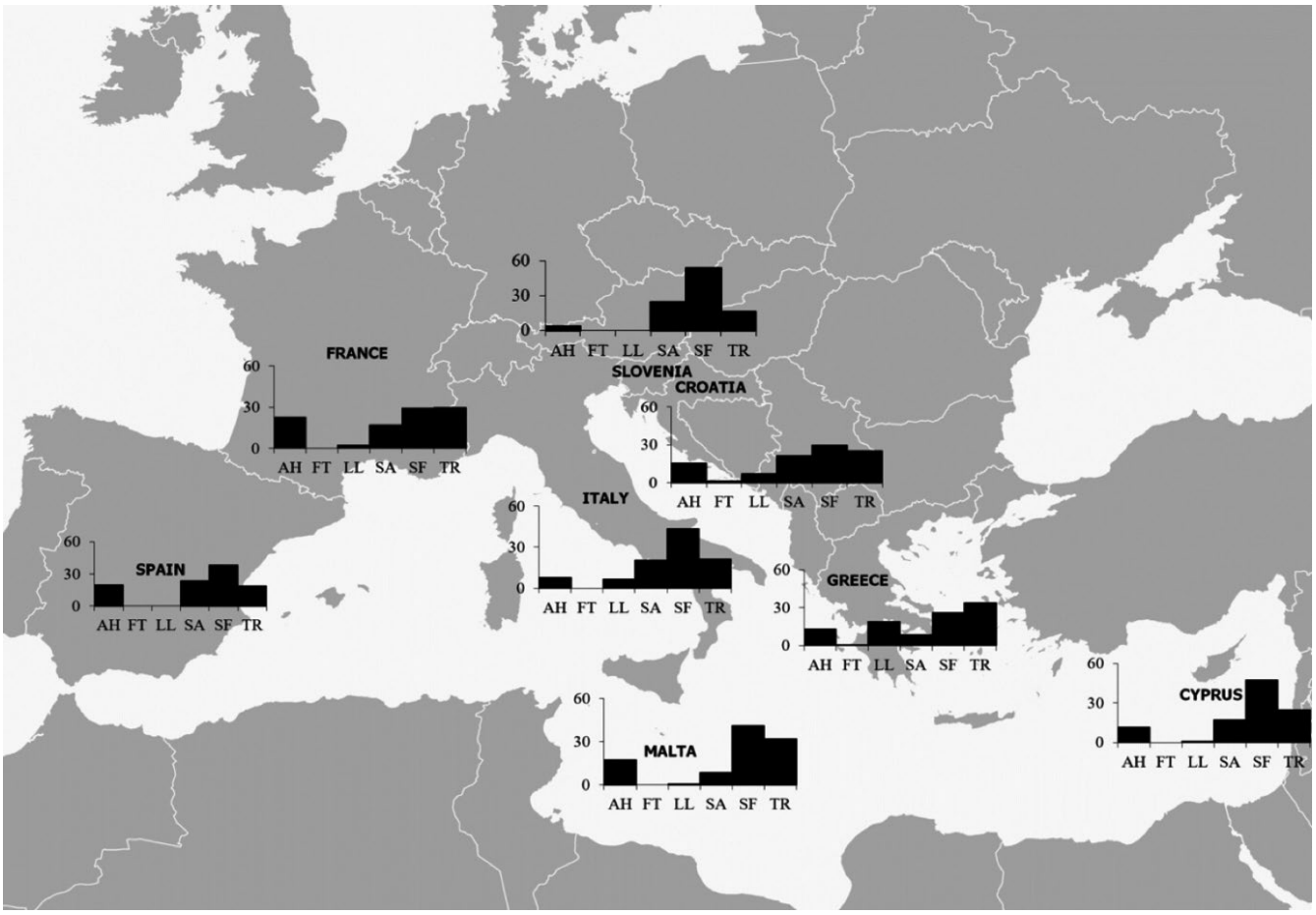
Overall, 1526 YouTube video records were selected, featuring the capture of 7799 fish specimens. The majority of these videos (87.68%) originated from four countries (Greece, France, Spain and Italy each contributed more than 10%, whereas other four (Malta, Cyprus, Croatia and Slovenia) each contributed less than 9%.

3 | RESULTS

Spearfishing (32.8%) and trolling (28.6%) appeared to be the most popular recreational fishing techniques on social media followed by angling (15.0%), shore-angling (14.3%) and longlining (9.1%), as inferred from the number of videos uploaded online. Fish trapping was represented by the lowest number of online videos (0.1%), irrespective of the country of origin. Spearfishing contributed the highest number of specimens caught in Cyprus (69.28%), Slovenia (61.8%), Spain (50.3%) and Croatia (37.3%), whereas the same was also true for longlines in Greece (47.3%), and for angling/handlining in Malta (38.5%) (Figure 1). A total of 113 species or groups of species belonging to 51 families (Supporting Information Table S1), caught using seven fishing techniques, were identified.

Thirty species contributed 83.2% of all the specimens appearing in the videos recorded collectively by all the fishing techniques and countries (Table 2). The species that appeared most frequently,

LOW RESOLUTION FIG



12

FIGURE 1 Percentage of videos utilising different fishing techniques per country. Gear codes: AH, angling; FT, fish trapping; LL, longlines; SA, shore-angling; SF, spearfishing; and TR, trolling

independently of their abundance, were common dentex, *Dentex dentex* (L.) (9.4%), gilt-head seabream, *Sparus aurata* L. (7.4%), white seabream, *Diplodus sargus* L. (7.1%), and greater amberjack, *Seriola dumerili* (Risso) (5.6%). The number of species recorded by fishing technique (all countries combined) was highest for angling and spearfishing and lowest for fish trapping (Table 2). The number of species that cumulatively contributed to 80% of the total numerical abundance was highest for shore-angling and trolling (17 and 16 species, respectively) and lowest for fish trapping and longlines (3 and 8 species, respectively) (Table 2).

Analysis of species composition of recreational fishing catches per country (Table 3) found that 18 species, which included the five most frequently caught species from each country, contributed between 44.1% (in Cyprus) and 72.7% (in Slovenia) of the total fish individual abundance recorded in the videos examined. Gilt-head seabream was the most abundant species caught in France, Slovenia and Spain (Table 3), whereas blackspot seabream, *Pagellus bogaraveo* (Brünnich.), black seabream *Spondyliosoma cantharus* (L.), white seabream and common pandora, *Pagellus erythrinus* (L.), were the species most commonly caught in Malta (24.28%), Croatia (18.63%), Italy (12.46%) and Greece (12.09%), respectively.

The 40 most frequently caught species, which contributed 92.1% to the total number of specimens reported, together with the fishing gear techniques that each contributed >3.0% of reported recreational fishing catches were included in the multivariate analysis. A cluster analysis applied on the percentage species composition reported for different country–gear technique combinations (36) discriminated four significantly different (PERMANOVA test: pseudo F-ratio= 25.50; $p < 0.05$) groups of gear/country combinations, mostly dependent on the fishing technique used rather than on the country of origin (Figure 2). Apart from the angling conducted in Croatia, which separated from the four sub techniques, group A clustered together the angling conducted in all the countries (apart from Cyprus), group B clustered together all the trolling, group C all the longline (and from shore-angling in Croatia and Slovenia and angling in France) and group D all the shore-angling and spearfishing (Figure 2).

4 | DISCUSSION

Unconventional sources of information, such as social network videos, are increasingly being used in recreational fisheries research in other parts of the world (Banha, Veríssimo, Ribeiro & Anastácio, 2017; Belhabib et al., 2016; Shiffman et al., 2017), but never so far in the Mediterranean Sea. Taking into account the scarcity of data regarding recreational fishing in the area (Hyder et al., 2017) and the poor

TABLE 2 Species composition (%) reported per fishing technique used in recreational fisheries in the EU-Mediterranean countries identified through video analysis

Species	AH	FT	LL	SA	SF	TR	%Ns	%Nr
Belone belone				10.13		1.08	1.03	0.35
Boops boops	2.90			2.35			0.83	0.19
Coryphaena hippurus			3.18	2.50		3.94	1.83	1.40
Dentex dentex	1.36		2.18	3.52	6.48	15.06	4.95	9.35
Dicentrarchus labrax	9.13			4.26	8.58	3.44	5.12	4.67
Diplodus sargus			9.44	14.24	14.78		8.15	7.13
Diplodus vulgaris	1.24	5.00	16.06	3.08	1.62		5.72	2.49
Epinephelus aeneus					1.53	3.05	0.96	2.34
Epinephelus costae					1.62	2.56	1.14	2.22
Epinephelus marginatus			1.00		7.34	1.97	2.64	4.36
Euthynnus alletteratus				7.05		4.13	1.44	1.32
Lithognathus mormyrus	1.36		6.05	2.50			2.40	0.93
Loligo spp.	8.83			2.35		7.68	3.15	1.48
Mugil cephalus		30.00		2.50	7.58		2.35	2.53
Mullus surmuletus					3.96		1.06	0.70
Oblada melanura			2.57	2.64		4.82	1.72	1.21
Octopus vulgaris					5.62		1.78	2.92
Pagellus acarne	8.24						2.01	0.47
Pagellus bogaraveo	17.61						3.90	0.90
Pagellus erythrinus	5.57		19.76	1.32			7.15	1.87
Pagrus pagrus			9.27			4.23	3.50	2.69
Sarpa salpa		45.00					0.29	0.58
Sarda sarda				2.20		8.17	1.42	2.14
Scorpaena scrofa					1.86	2.76	1.33	2.22
Seriola dumerili				1.32	4.77	8.56	2.58	5.57
Sparus aurata	10.08	20.00	5.96	14.98	6.91	2.17	7.44	7.36
Spondyliosoma cantharus	2.43		10.27				3.69	1.36
Sphyraena sphyraena				3.08	2.81	2.07	1.29	2.18
Thunnus alalunga						6.10	0.83	1.32
Trachurus spp.	5.22					2.26	1.50	1.05
Other species	21.57		10.27	16.15	21.32	14.98	16.79	24.72
Total number of species	66	4	48	59	61	55		
Number of species 80%	14	3	8	17	15	16		
Total number of specimens	1687	20	2298	681	2097	1016		

Notes. Legend codes of fishing technique are shown in Table 1. %Ns and %Nr are the species percentage contribution of the numbers of specimens reported and of the video records downloaded, respectively. Only percentages higher than 1.0% are shown. Species listed in alphabetic order. Number of species 80% indicates the number of species that cumulatively contributed to 80% of the total numerical abundance of species caught.

situation of the Mediterranean fish stocks (European Environmental Agency (EEA), 2015), this work contributes to understanding recreational fishing in the Mediterranean and the Common Fisheries Policy goal for incorporating recreational fishing in national stock assessments. The potential impact of recreational fishing on fisheries resources in the Mediterranean could be equal or even greater than

TABLE 3 Species composition (%) of the number of specimens and total number of species reported per country for all fishing techniques combined in the recreational fisheries of EU-Mediterranean countries through video analysis

Species	Croatia	Cyprus	France	Greece	Italy	Malta	Slovenia	Spain
Coryphaena hippurus				1.99		5.43		
Dentex dentex	8.70	3.91	12.80	2.95	6.56	3.02	3.64	8.09
Dicentrarchus labrax	5.80	4.10	3.41	5.81	4.43	1.66	12.73	6.44
Diplodus sargus	6.00	10.55	14.22	6.79	12.46	7.39	5.45	6.93
Diplodus vulgaris		2.34	2.42	9.36	1.80		1.82	
Epinephelus marginatus		12.70			5.25	1.96	1.82	3.63
Lithognathus mormyrus				4.08				
Loligo spp.	7.66		5.97	3.17	3.11		14.55	
Mugil cephalus	1.66		4.41	2.45	2.46	2.87	1.82	
Oblada melanura				2.35		3.17	1.82	
Octopus vulgaris	1.66	1.56		1.70	1.64	1.51	5.45	3.47
Pagellus acarne				3.53				
Pagellus bogaraveo	3.31			1.66	4.43	24.28		4.95
Pagellus erythrinus	2.48			12.09	4.26			
Seriola dumerili	2.07	8.98	2.42	1.61	2.30	2.87	5.45	4.13
Sparus aurata	12.22		14.94	6.67	10.00		18.18	9.74
Spondyliosoma cantharus	18.63			4.34				1.82
Trachurus spp.			1.85			2.56		3.47
Other species	29.81	55.86	37.56	29.45	41.30	43.28	27.27	47.33
Total number of species	42	47	60	70	55	56	18	63

Note. The species with percentage for contribution >1.5% are presented.

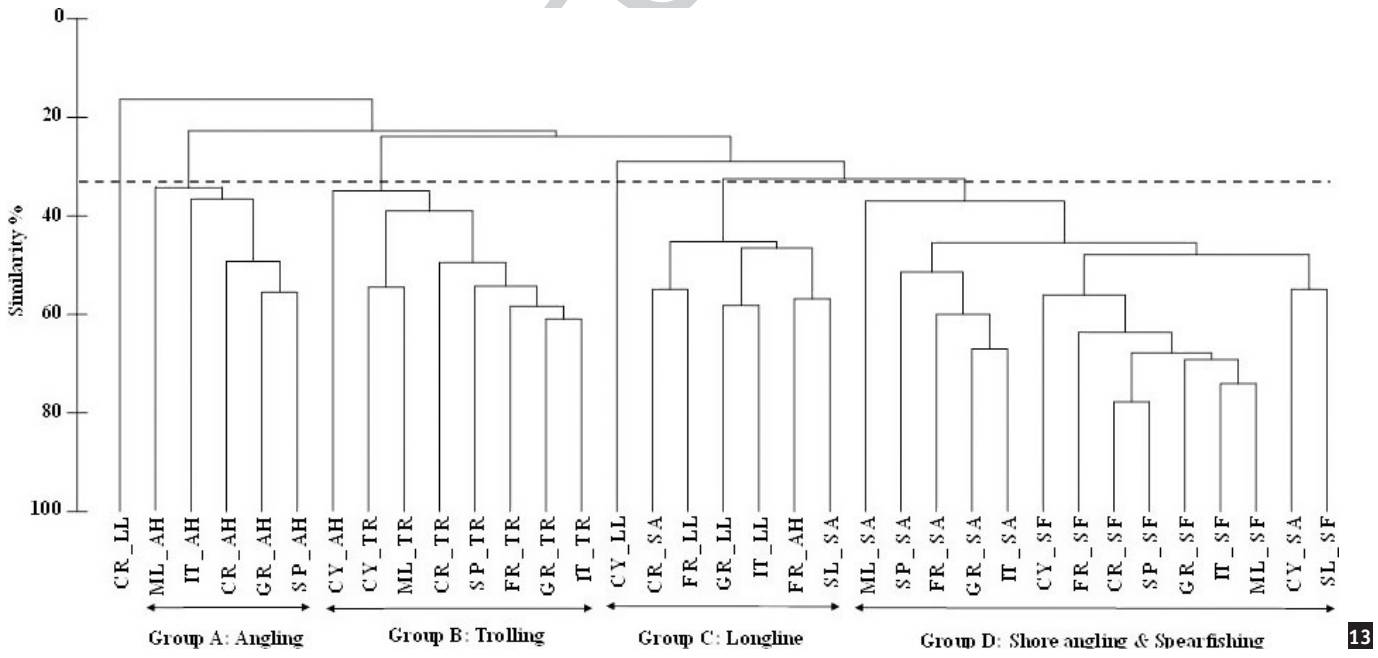


FIGURE 2 Dendrogram for group-average clustering estimated with square Euclidean distances of species composition percentage data between the different country–fishing techniques identified in the recreational fisheries of EU-Mediterranean countries through video analysis. Gear codes: AH, angling; FT, fish trapping; LL, longlines; SA, shore-angling; SF, spearfishing; and TR, trolling. Country codes: CR, Croatia; CY, Cyprus; FR, France; GR, Greece; IT, Italy; ML, Malta; SL, Slovenia; SP, Spain

that of commercial fishing, contributing between 10% and 50% of the total haul of small-scale fisheries (excluding trawls and seines) (Font & Lloret, 2014), occasionally exceeding the small-scale fishery catches (e.g., Malta: Khalfallah, Dimech, Ulman, Zeller, & Pauly, 2017). On the other hand, data derived from recreational fishing are difficult to be obtained as recreational fishers operate in an extensive spatiotemporal framework with multiple access points throughout the year.

The consideration of recreational fishing in stock assessments and fisheries management is crucial. To date, national data collection about recreational fishing is obtained using interviews and phone surveys (ICES, 2016). The actual number of interviews collected (ICES, 2016) are less than the number of the videos analysed in the current study. In addition, videos from YouTube can be seen as in situ data collection of recreational fisheries, but with limitations explained below.

As with any other data collection method, the information obtained from social media includes potential bias, which needs to be accounted for when using such a methodology. In this specific study, there is no factual indication that recreational fishers post videos on social media in any way that may be representative of their actual fishing activity, targeting, catches or sizes. For instance, certain gear types used in recreational fishing seemed to be more spectacular (e.g., spearfishing or fishing from boats), and thus these are likely to appear more often than others (e.g., fishing with handlines from the shore). In addition, catches from certain types of fishing techniques, such as angling, longline, spearfishing and trolling, might be significantly higher than the ones estimated from this study, if videos corresponding to the latter fishing techniques are more selective in what species and specimens are shown, leading to bias in the catch compositions. The tendency of recreational fishers to upload on social media only videos with the "best" fishing trips, which only includes large fishes or big catches in view of their iconic value, is relatively common. However, the absence of size records within the present study is not considered to affect the outcomes of study.

An important gap within the data presented is also related to the searching process (i.e., keywords used, languages), which resulted in the absence of operational information on recreational fishing (e.g., bait used, tactics and spatiotemporal activity). Sampling bias also included the failure to supervise the upload of videos by the same user who might possess different accounts. Therefore, no reliable information could be obtained on the relation between the number of uploaded videos and the number of social media contributors. The differential usage of social networks by different age groups was also a pitfall, as more elderly age groups might not be very proficient with, or even use, social media as a source of information/communication. Despite the above-mentioned data limitations, the present study provides a global picture of recreational fishing in Mediterranean EU countries that could be backed up in future with conventional, on-site, surveys.

One outcome is that species composition within recreational fishing exhibited a homogeneous pattern across different Mediterranean countries; with differences in species composition being mostly dependent on the fishing technique used, rather than on country (Figure 2). This might indicate the similar composition of fish assemblages exist in the Mediterranean (Coll et al., 2012), but more importantly similar strategies deployed by recreational fishers concerning the use of specific fishing techniques. The multispecies nature of Mediterranean recreational fishing is confirmed from the 26 species contributing >80% of the overall EU-Mediterranean catches. Recreational fishing catches might also include a range of other species, including "less attractive" ones (e.g., small fishes from the *Labridae* and *Serranidae* families), which are not uploaded on the social networks, as well as species that are known to constitute significant bycatches of the fishing techniques used (e.g., the European conger, *Conger conger*, for longlines: Stergiou, Moutopoulos, & Erzini, 2002).

The most frequently caught species in all the countries studied were those of the Sparidae family (i.e., white seabream, gilthead seabream, common two-banded seabream-*Diplodus vulgaris* (Geoffroy Saint-Hilaire), common pandora and common dentex), with the identity of the individual species caught being highly depended on the fishing technique used (Table 2). Catches of these species were also dominant in recreational fishing catches from Mediterranean Marine Protected Areas in Spain, France, Italy, Malta, Slovenia, Croatia, Tunisia (Font et al., 2012), and were thus interacting most frequently and in conflict with the commercial small-scale fisheries throughout the Mediterranean (Greece: Tzanatos, Dimitriou, Katselis, Georgiadis, & Koutsikopoulos, 2005; France: Herfaut, Levrel, Thébaud, & Véron, 2013; Spain: Maynou et al., 2013; Lloret & Font, 2013). This seems to amplify the contest between professional small-scale and recreational fishers for the sharing of common resources (Gonzalvo, Giovos, & Moutopoulos, 2015; Matić-Skoko et al., 2011; Tzanatos et al., 2005), apart from the overlap in the spatiotemporal operational strategies used by both (Tzanatos et al., 2005). Moreover, the above is an indication of the validity of this work and in general of the use of social media for such surveys.

Based on interviews conducted with recreational fishers in Greece (Moutopoulos et al., 2013; Tsikliras, 2015), the most representative species of the shore-based recreational fishery (i.e., *Dicentrarchus labrax* (L.), *D. sargus* and *S. aurata*), cumulatively contributed 30% of the total catches of the corresponding fishing technique. Likewise, for spearfishing, both on the island of Mallorca (Morales-Nin et al., 2005) and within the Cape Creus waters (northeastern Catalonia: Lloret, Zaragoza, Caballero, Font, et al., 2008) *D. sargus* was the most frequently caught species. Differences in species composition between the present and the above-mentioned studies were also reported for boat-based and shore-based recreational fishing in Mallorca (*pearly razorfis*, *Xyrichtys novacula* (L.) and bluefish *Pomatomus saltatrix* (L.), respectively) (Morales-Nin et al., 2005) and in the Çanakkale Strait (Mediterranean rainbow wrasse *Coris julis* (L.), and leerfish *Lichia amia* (L.) respectively) (Ünal, Acarli, & Gordoa, 2010).

In some of the study areas, legislative compliance (e.g., in terms of daily bag restrictions– and in terms of fishing gear deployment limits/quotas; Gaudin & De Young, 2007; Pawson et al., 2008) amongst recreational fishers is rather low. Their non-negligible catches are

often sold indiscriminately on fish markets alongside with catches by professional fishers. The difficulty in collecting quantitative data restricts the realistic quantification of the recreational fishing phenomenon. For instance, recreational fishers generally avoid including scenes of illegal fishing, whereas in some cases it is not easy to understand if a documented fishing technique is illegal or not. For example, in Italy, longlines are limited to 200 hooks per boat, but it is not simple to evaluate from a video, whereas in Spain traps are prohibited. In Greece, the use of any source of light for fishing underwater is prohibited, but is not always possible to confirm such an infringement from a video, even though the practice is still very common among spear fishers in Greece.

5 | CONCLUSIONS

The present study described the profile of EU-Mediterranean recreational fishing using social media as a source of information. Although recreational fishing is increasingly popular in the study area, they are characterised by a scarcity of related data, especially on recreational fishing. Thus, there is a need to develop nonconventional methodologies, including the assessment of information posted on social networks, especially when data from conventional surveys are limited (Martin et al., 2012, 2014). The outcomes presented in this study could represent a valuable and important contribution, framing the basic characteristics of this type of fishing activity within a broad management context. In addition, information provided by social media can be both cost-effective and easy to implement, and can be used to complement conventional surveys (e.g., field surveys) to characterise a widespread activity such as recreational fishing.

ACKNOWLEDGMENTS

The authors would like to thank all those unknown or anonymous fishers for contributing to our research. This work has been partially supported by the Croatian Science Foundation under the project LEKFishCRO (IP-2016-06-5251). The authors also thank the two anonymous reviewers for their constructive editing that highly improve the manuscript.

REFERENCES

Anderson, M. J., & Walsh, D. C. (2013). PERMANOVA, ANOSIM, and the Mantel test in the face of heterogeneous dispersions: What null hypothesis are you testing? *Ecological Monographs*, *83*(4), 557–574.

Arlinghaus, R., & Cooke, S. J. (2005). Global impact of recreational fisheries. *Science*, *307*, 1561–1562.

Arlinghaus, R., Mehner, T., & Cowx, I. G. (2002). Reconciling traditional inland fisheries management and sustainability in industrialized countries, with emphasis on Europe. *Fish and Fisheries*, *3*, 261–316. https://doi.org/10.1046/j.1467-2979.2002.00102.x

Arlinghaus, R., Tillner, R., & Bork, M. (2015). Explaining participation rates in recreational fishing across industrialized countries. *Fisheries Management and Ecology*, *22*, 45–55. https://doi.org/10.1111/fme.12075

Banha, F., Veríssimo, A., Ribeiro, F., & Anastácio, P. M. (2017). Forensic reconstruction of *Ictalurus punctatus* invasion routes using on-line fishermen records. *Knowledge and Management of Aquatic Ecosystems*, *418*, 56. https://doi.org/10.1051/kmae/2017045

Belhabib, D., Campredon, P., Lazar, N., Sumaila, R. U., Baye, B. C., Abou-Kane, E., & Pauly, D. (2016). Best for pleasure, not for business: evaluating recreational marine fisheries in West Africa using unconventional sources of data. *Palgrave Communications*, *2*, 15050. https://doi.org/10.1057/palcomms.2015.50

Bulleri, F., & Benedetti-Cecchi, L. (2014). Chasing fish and catching data: Recreational spearfishing videos as a tool for assessing the structure of fish assemblages on shallow rocky reefs. *Marine Ecology Progress Series*, *506*, 255–265. https://doi.org/10.3354/meps10804

Cardona, L., Lopez, D., Sales, M., Caralt, S., & Diez, I. (2007). Effects of recreational fishing on three fish species from the *Posidonia oceanica* meadows off Minorca (Balearic archipelago, western Mediterranean). *Scientia Marina*, *71*(4), 811–820.

Carr, M. R. (1997). *PRIMER User Manual*. Plymouth, UK: Plymouth Marine Laboratory.

Coll, M., Piroddi, C., Albouy, C., Lasram, F. B. R., Cheung, W. W. L., Christensen, V., … Pauly, D. (2012). The Mediterranean Sea under siege: Spatial overlap between marine biodiversity, cumulative threats and marine reserves. *Global Ecology and Biogeography*, *21*(4), 465–480. https://doi.org/10.1111/j.1466-8238.2011.00697.x

Commission of the European Communities (CEC) (2001). *Fisheries control in member states—Belgium*. Commission Staff Working Paper, Commission of the European Communities (p. 1799). Brussels, Belgium: SEC.

Cooke, S. J., Twardek, W. M., Lennox, R. J., Zolderdo, A. J., Bower, S. D., Gutowsky, L. F. G., … Beard, D. (2018). The nexus of fun and nutrition: Recreational fishing is also about food. *Fish and Fisheries*, *19*, 201–224. https://doi.org/10.1111/faf.12246

European Commission (2013). European Regulation (ER) No 1380/2013. On the Common Fisheries Policy, amending Council Regulations (EC) No 1954/2003 and (EC) No 1224/2009 and repealing Council Regulations (EC) No 2371/2002 and (EC) No 639/2004 and Council Decision 2004/585/EC. Retrieved from http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:354:0022:0061:EN:PDF

European Environmental Agency (EEA) (2015). *Mediterranean Sea region briefing - The European environment — state and outlook 2015*. ?????: European Environmental Agency.

Font, T., & Lloret, J. (2014). Biological and ecological impacts derived from recreational fishing in mediterranean coastal areas. *Reviews in Fisheries Science & Aquaculture*, *22*(1), 73–85. https://doi.org/10.1080/10641262.2013.823907

Font, T., Lloret, J., & Piante, C. (2012). *Recreational fishing within Marine Protected Areas in the Mediterranean* (p. 168). ?????: MedPAN North Project. WWF France.

Franquesa, R., Gordoa, A., Mina, T., Nuss, S., & Borrego, J. R. (2004). *The recreational fishing in the Central and Western European Mediterranean frame*. GEM UB. Universität de Barcelona. Retrieved from http://www.gemub.com/pdf/recreofao.pdf.

Gaudin, C., & De Young, C. (2007). *Recreational fisheries in the Mediterranean countries: A review of existing legal frameworks. Studies and Reviews. General Fisheries Commission for the Mediterranean* (p. 85). No. 81. Rome, Italy: FAO.

Giovos, I., Ganias, K., Garagouni, M., & Gonzalvo, J. (2016). Social media in the service of conservation: A case study of dolphins in the hellenic seas. *Aquatic Mammals*, *42*(1), 12–19. https://doi.org/10.1578/AM.42.1.2016.12

Gonzalvo, J., Giovos, I., & Moutopoulos, D. K. (2015). Fishermen perception on the sustainability of small-scale fisheries and dolphin-fisheries interactions in two increasingly fragile coastal ecosystems in Western Greece. *Aquatic Conservation*, *25*, 91–106. https://doi.org/10.1002/aqc.2444

Herfaut, J., Levrel, H., Thébaud, O., & Véron, G. (2013). The nationwide assessment of marine recreational fishing: A French example. *Ocean and Coastal Management*, *78*, 121–131. https://doi.org/10.1016/j.ocecoaman.2013.02.026

Hyder, K., Weltersbach, M. S., Armstrong, M., Ferter, K., Townhill, B., Ahvonen, A., Arlinghaus, R., Baikov, A., Bellanger, M., … Strehlow, H. V. (2017). Recreational sea fishing in Europe in a global context—Participation rates, fishing effort, expenditure, and implications for monitoring and assessment. *Fish and Fisheries*, *19*(2), 225–243.

ICES (2016). Report of the Working Group on Recreational Fisheries Surveys (WGRFS), 6–10 June 2016, Nea Peramos, Greece. ICES CM 2016/SSGIEOM, 10: 76.

Kaplan, A. M., & Haenlein, M. (2010). Users of the world, unite! The challenges and opportunities of Social Media. *Business Horizons*, *53*(1), 59–68. https://doi.org/10.1016/j.bushor.2009.09.003

Khalfallah, M., Dimech, M., Ulman, A., Zeller, D., & Pauly, D. (2017). Reconstruction of Marine Fisheries Catches for the Republic of Malta (1950-2010). *Mediterranean Marine Science*, *18*(2), 241–250https://doi.org/10.12681/mms.1683

Lewin, W. C., Arlinghaus, R., & Mehner, T. (2006). Documented and potential biological impact of recreational fishing: Insight for management and conservation. *Reviews in Fisheries Science*, *14*, 305–367. https://doi.org/10.1080/10641260600886455

Lloret, J., Cowx, I. G., Cabral, H., Castro, M., Font, T., Gonçalves, J. M. S., … Erzini, K. (2016). Coastal fisheries in European Seas are not what they were: Ecological, social and economic changes in small scale fisheries. *Marine Policy*, *????*, ?????–?????. https://doi.org/10.1016/j.marpol.2016.11.007

Lloret, J., & Font, T. (2013). A comparative analysis between recreational and artisanal fisheries in a Mediterranean coastal area. *Fisheries Management and Ecology*, *20*, 148–160. https://doi.org/10.1111/j.1365-2400.2012.00868.x

Lloret, J., Zaragoza, N., Caballero, D., Font, T., Casadevall, M., & Riera, V. (2008). Spearfishing pressure on fish communities in rocky coastal habitats in a Mediterranean marine protected area. *Fisheries Research*, *94*(1), 84–91. https://doi.org/10.1016/j.fishres.2008.07.002

Lloret, J., Zaragoza, N., Caballero, D., & Riera, V. (2008). Biological and socioeconomic implications of recreational boat fishing for the management of fishery resources in the marine reserve of Cap de Creus (NW Mediterranean). *Fisheries Research*, *91*(2–3), 252–259. https://doi.org/10.1016/j.fishres.2007.12.002

Machias, A., Tsagarakis, K., & Matsaganis, M. (2016). Greek fisheries and the economic crisis: Structural analogies. *Ethics in Science and Environmental Politics*, *16*, 19–23. https://doi.org/10.3354/esep00170

Martin, D. R., Chizinski, C. J., Eskridge, K. M., & Pope, K. L. (2014). Using posts to an online social network to assess fishing effort. *Fisheries Research*, *157*, 24–27. https://doi.org/10.1016/j.fishres.2014.03.013

Martin, D. R., Pracheil, B., DeBoer, J. A., Wilde, G. R., & Pope, K. L. (2012). Using the Internet to understand angler behavior in the information age. *Fisheries*, *37*, 458–463. https://doi.org/10.1016/j.fishres.2014.03.013

Matić-Skoko, S., Stagličić, N., Pallaoro, A., Kraljević, M., Dulčić, J., Tutman, P., & Dragičević, B. (2011). Effectiveness of conventional management in Mediterranean type artisanal fisheries. *Estuarine Coastal and Shelf Science*, *91*, 314–324. https://doi.org/10.1016/j.ecss.2010.10.029

Maynou, F., Morales-Nin, B., Cabanellas-Reboredo, M., Palmer, M., García, E., & María Grauc, A. (2013). Small-scale fishery in the Balearic Islands (W Mediterranean): A socio-economic approach. *Fisheries Research*, *139*, 11–17. https://doi.org/10.1016/j.fishres.2012.11.006

Morales-Nin, B., Moranta, J., Garcia, C., Tugores, M. P., Grau, A. M., Riera, F., & Cerda, M. (2005). The recreational fishery off Majorca Island (western Mediterranean): Some implications for coastal resource management. *ICES Journal of Marine Science*, *62*, 727–739. https://doi.org/10.1016/j.icesjms.2005.01.022

Moutopoulos, D. K., Katselis, G., Kios, K., Tsotskou, A., Tsikliras, A. C., & Stergiou, K. I. (2013). Estimation and reconstruction of shore-based recreational angling fisheries catches in the Greek Seas (1950-2010). *Journal of Biological Research-Thessaloniki*, *20*(1), 376–381.

Pawson, M. G., Glenn, H., & Padda, G. (2008). The definition of marine recreational fishing in Europe. *Marine Policy*, *32*, 339–350. https://doi.org/10.1016/j.marpol.2007.07.001

Ricke, L. D. (2014). *"YouTube": Encyclopedia of Social Media and Politics* (pp. 1411–1431). Thousand Oaks, CA: Sage.

Shiffman, D. S., Macdonald, C., Ganz, H. Y., & Hammerschlag, N. (2017). Fishing practices and representations of shark conservation issues among users of a land-based shark angling online forum. *Fisheries Research*, *196*, 13–26. https://doi.org/10.1016/j.fishres.2017.07.031

Smith, A. D. M., & Garcia, S. M. (2014). Fishery management: Contrasts in the mediterranean and the Atlantic. *Current Biology*, *24*(17), R810–R812. https://doi.org/10.1016/j.cub.2014.07.031

Stergiou, K. I., Moutopoulos, D. K., & Erzini, K. (2002). Gill net and longlines fisheries in Cyclades waters (Aegean Sea): Species composition and gear competition. *Fisheries Research*, *57*, 25–37. https://doi.org/10.1016/S0165-7836(01)00334-4

Tsikliras, A. (2015). Social networks reveal catches of spearfishing hunting. *Proceedings of the Hellenic Symposium on Oceanography and Fisheries*, *11*, 213–216.

Tsikliras, A. C., Sumaila, R., & Stergiou, K. I. (2013). Parallels in economic and ecosystem crises. *Ethics in Science and Environmental Politics*, *13*, 23–25. https://doi.org/10.3354/esep00133

Tzanatos, E., Dimitriou, E., Katselis, G., Georgiadis, M., & Koutsikopoulos, C. (2005). Composition, temporal dynamics and regional characteristics of small-scale fisheries in Greece. *Fisheries Research*, *73*, 147–158. https://doi.org/10.1016/j.fishres.2004.12.006

Ünal, V., Acarli, D., & Gordoa, A. (2010). Characteristics of marine recreational fishing in Çanakkale Strait (Turkey). *Mediterranean Marine Science*, *11*(2), 315–330https://doi.org/10.12681/mms.79

Verney, S. (2009). Flaky Fringe? Southern Europe Facing the Financial Crisis. *South European Society and Politics*, *14*(1), 1–6. https://doi.org/10.1080/13608740902995794

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

How to cite this article: Giovos I, Keramidas I, Antoniou C, et al. Identifying recreational fisheries in the mediterranean through social media. *Fish Manag Ecol*. 2018;00:1–9. https://doi.org/10.1111/fme.12293