Baseline data for marine protected areas planning and fisheries monitoring: Potential conflicts between recreational IUU and commercial fisheries in the proposed "Taza" MPA (Algeria, SW Mediterranean)

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Abbreviations: IUU: Illegal, Unreported, and Unregulated; REC: Recreational fisheries; SSF: Small-Scale Fisheries; MPA: Marine Protected Area; CPUE: Catch Per Unit of Effort; DPRH: Directorate of Fisheries and Aquaculture; RBF: Rrecreational Boat Fishing; MedPAN: Mediterranean Protected Areas Network; SR: Species Richness; MC: Mean Catch; FT: Fishing Trips; TEK: Traditional Ecological Knowledge; ESRI: Environmental Systems Research Institute.

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Abstract

Nowadays, recreational fisheries (REC) have a great impact on marine ecosystems and create conflicts with other human coastal activities such as commercial small-scale fisheries (SSF). In the proposed “Taza” marine protected area (MPA) (Algeria, SW Mediterranean), recreational boat fishing is poorly regulated and its catches remain unmonitored. In addition, a significant number of REC fishers sell their catch illegally, an activity we could refer to as IUU (Illegal, Unreported, and Unregulated) fishing. This study is a good opportunity to evaluate the potential conflicts between recreational IUU and commercial fisheries and can be extremely valuable in terms of MPA planning and fisheries monitoring by providing baseline data for setting up sound fisheries management and conservation plans. Two fishing harbors are located near the proposed “Taza” MPA: Boudis and Ziama. Illegal REC boats from Ziama harbor were studied via a direct observation method of landings developed by the Ifremer (French Research Institute for Exploitation of the Sea). A comparison between illegal REC and SSF boats was highlighted in terms of catches and fishing effort. A total of 54 taxa belonging to 24 families were observed in the catches of the 32 recreational active boats in this harbor between May 2013 and April 2014. The proportion of the harvest attributed to illegal REC represented about 50% of the SSF harvest. Illegal REC in the proposed “Taza” MPA is an important socioeconomic activity which is intensively practiced throughout the year. From November to April, the mean catch was almost the same for both fishing categories. Strong competition between recreational and professional fishers for the natural resources was highlighted as 81% of the 54 caught taxa were present in the catches of both fishing categories (i.e. 44 taxa). Moreover, 4 species of high commercial value were caught exclusively by recreational fishers. Finally, the managers of the proposed “Taza” MPA must address and regulate all fishing activities and use the best available information in order to provide important benefits to marine ecosystems, fishers, and the local population.

Keywords: Recreational fisheries; Small-scale fisheries; Marine protected areas; Mediterranean; Algeria.

1. Introduction

Nowadays, there is growing concern about the impact of recreational fisheries (referred to as REC throughout this article) on marine ecosystems (Lloret et al., 2019) and the related conflicts with other human activities, such as commercial fisheries (Cooke and Cowx, 2006; Arlinghaus and Cooke, 2009). While commercial fisheries are the dominant fisheries worldwide (McPhee et al., 2002; Post et al., 2002; Cooke and Cowx, 2004), a growing portion of many harvested fish stocks over the world is carried out by recreational fishers (Coleman et al., 2004; Arlinghaus and Cooke, 2005; Lewin et al., 2006). According to Hyder et al. (2018), in some European countries, fish removals by marine REC for northern European sea bass (*Dicentrarchus labrax*) and western Baltic cod (*Gadus morhua*) stocks, represent 27% of the total catches (recreational and commercial). In 2012, recreational fishers were responsible for up to 53% of the total fish removals of European sea bass in Belgium (Hyder et al., 2018). In the Mediterranean, REC represent an important share of the fish caught and may locally amount up to 50% of the total commercial catches (European Commission, 2004; FAO, 2008; Font et al., 2012;), however they are still poorly managed and less studied compared to commercial fisheries (Font and Lloret, 2014; Prato et al., 2016; Pita et al., 2020). An increasing number of studies supports the idea that the increasing REC effort can have similar, or even higher effects on fish populations than artisanal fishing (Cooke and Cowx, 2006; Lloret et al., 2008; Zischke et al., 2012).

During the summer, the human population increases considerably in coastal areas, when the pressure of local tourism is highest. Consequently, aquatic leisure activities such as scuba-diving and REC (i.e. boat angling, shore angling, and spearfishing) have flourished on the Mediterranean shores and their additional impact on coastal and maritime ecosystems has grown (Morales-Nin et al., 2005). Therefore, fisheries managers need to consider all forms of harvesting if they are to manage these resources sustainably by improving national data reporting of recreational catches (Hyder et al., 2014; Ryan et al., 2016; Freire et al., 2020).

In Algeria, to practice REC only boat-owners are required to have recreational fishing authorizations (licenses), while spearfishers need an individual license (Babali et al., 2018). These licenses are issued by local fisheries authorities after payment of an annual fee and must be renewed each year. Up until December 2014, in the department of Jijel (SW Mediterranean, NE Algeria) where the proposed “Taza” MPA

is planned (Fig. 1), the fishing fleet had a capacity of 776 fishing boats (309 professional and 467 recreational), with only 292 updated licenses for recreational boat-owners (of these, 59 individual licenses are for spearfishers) issued by the DPRH (Directorate of Fisheries and Aquaculture) of Jijel (DPRH, 2014). Nevertheless, recreational boats have started to become more important since 2012, with their number doubling in a very short timeframe and almost filling the carrying capacity of Ziama fishing harbor (Boubekri and Djebar, 2016). Moreover, the impact of REC on coastal ecosystems can be greater in marine protected areas (MPAs), given the increasing number of visitors fishing for pleasure (Cooke and Cowx, 2006). MPAs are often seen as a way to develop and demonstrate the benefits of management methods that allow multiple-use to coexist sustainably in areas that are subjected to a variety of pressures (Lester et al., 2009; Pike et al., 2010; Horta e Costa et al., 2013).

The recent data on the number of recreational fishers and fishing effort within the European Mediterranean countries has been estimated to be approximately 2.8 million and 20.9 million sea fishing days per year, respectively (Hyder et al., 2018). However, the estimates in non-European Mediterranean countries remain scarce or totally absent despite the popularity of REC in these countries (Belhabib et al., 2013; Babali et al., 2018; Ben Lamine et al., 2018). In Algeria, the REC sector is poorly regulated and its catches remain unmonitored (Babali et al., 2018). More recently, efforts are underway in Algeria to reconstruct preliminary estimates of recreational catches, based on catch data reported by the Ministry of Fisheries and Aquaculture. Between 1970 and 2010, the total estimated landings from recreational boats increased globally until the early 2000s, peaked at 1200 $t \cdot year^{-1}$ in 2002, and began declining thereafter to about 1000 $t \cdot year^{-1}$ in 2010 (Belhabib et al., 2013), raising concerns that the Algerian coastal resources may be overexploited. Another study also highlighted the great economic impact of REC which deprives the Algerian national treasury - through lost tax, license income, and revenues from illegal sales of fish - of 45 million USD annually (Babali et al., 2018). In addition, recreational fishers have been without legal restrictions for a long time (Abdelguerfi, 2002).

The most popular REC technique in Algeria by far is the recreational boat fishing (referred to as RBF throughout this article) which means fishing on board of recreational boats. According to Belhabib et al. (2013), RBF in Algeria represents

80% of REC. The term “recreational fisheries” can be considered as part of “small-scale fisheries” even though many differences between the two fishing categories are pointed out (Table 1). In the present study “professional fisheries” indicates any fishing exercise reserved for fishers holding certificates of registration to a professional category without any reference to fishing boat categories, while “small-scale fisheries” indicates strict implication of the “professional fisheries”. In the Algerian context, the difference between recreational and professional fisheries is so highly nuanced - with many recreational fishers selling illegally their landings - that we could refer to “IUU (Illegal, Unreported, and Unregulated) recreational fishing”. Throughout this article we will refer to “illegal REC” due to the common usage of this term in the Algerian context as well as to SSF (Small-Scale Fisheries) when referring to “commercial fisheries” because all the small-scale boats surveyed were practicing commercial fishing.

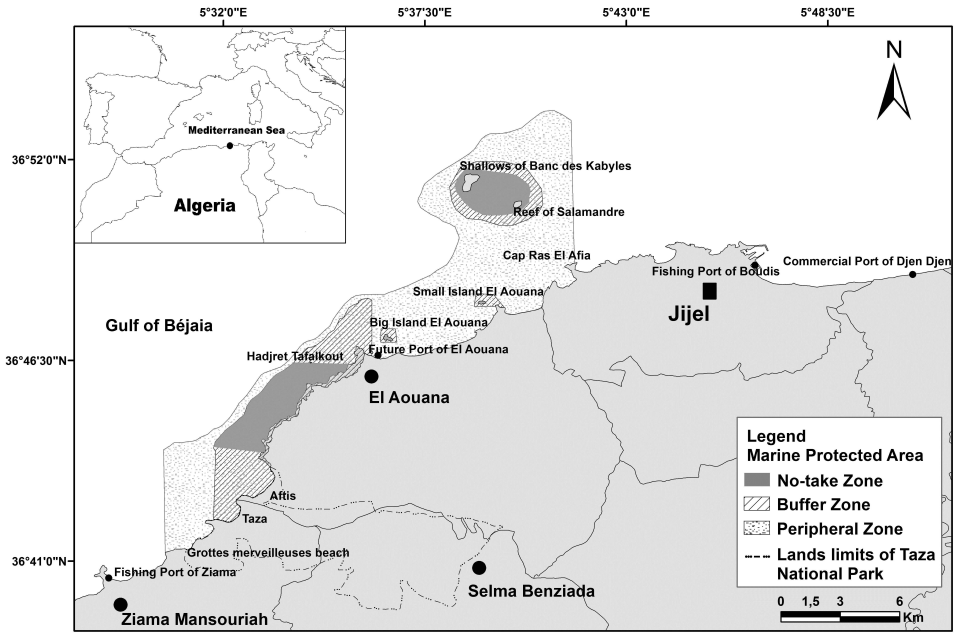
Table 1. Definitions of the different fishing categories in Algeria.

Fishing category	Definition	Foundation text
Recreational fishing (REC)	Any fishing exercise as a sport or as a leisure activity and for non-commercial purposes.	Decree No. 2003-481of 13 December 2003 (Art. 61)
Professional fishing	Any fishing exercise reserved for fishers holding a professional booklet.	Decree No. 2003-481of 13 December 2003 (Art. 3)
Small-Scale Fishing (SSF)	Any traditional fishing practiced in territorial sea. This fishing activity is carried out with boats less than 12 m in length.	Law No. 07-12 of 31 December 2007 (Art. 55)
Commercial fishing	Any fishing exercise reserved for fishers holding a professional booklets onboard professional boats with an active tax assessment.	Decree No. 2003-481of 13 December 2003 (Art. 5)
Recreational Boat Fishing (RBF)	Fishing on board of recreational boats.	Decree No. 2003-481of 13 December 2003 (Art. 13)
Recreational boats	Boats with recreational fishing authorizations (licenses). The fishing authorization is issued to the boat-owner.	Decree No. 2003-481of 13 December 2003 (Art. 13)
Professional boats	Boats with professional fishing authorizations (licenses). The fishing authorization is issued to the boat-owner.	Decree No. 2003-481of 13 December 2003 (Art. 13)

The increase in REC effort can have similar or even greater effects than that of commercial fishing on the structure of some fish populations (Bianchi et al., 2000; Coll et al., 2004; Lewin et al., 2006), and also on the conservation status of certain species (Lloret et al., 2018), such as endangered and vulnerable ones (Morales-Nin et al., 2010; Lloret et al., 2012; Biton-Porsmoguer and Lloret, 2018). Unfortunately no statutory instrument has yet been adopted to date for the creation of the “Taza” MPA and this situation can result in a huge conflict over the exploitation of resources and the use of space between recreational and professional fishers in the near future.

142 The zoning plan of the proposed “Taza” MPA comprises 2 no-take zones (Fig.
143 1). The regulatory proposal for the no-take zones stipulates the authorization of boat
144 navigation without mooring and scientific research, while prohibiting recreational and
145 commercial fisheries as well as all the other marine extractive uses (e.g. extraction of
146 aggregates for construction). However, both REC and SSF are allowed in the buffer
147 and the peripheral zones where fishers can use only lines and trammel nets
148 (Boubekri and Djebar, 2016). Thus, the benefits of the proposed “Taza” MPA in terms
149 of protection and sustainable management of commercial fish stocks can fail if the
150 basic data on REC are missing (e.g. effort and catches). Alongside the ecological
151 impact of REC on coastal fish stocks and the potential risks of overfishing arising
152 from the use of forbidden gears, the illegal selling of recreational catches in the local
153 market is creating unfair competition and conflict between REC and SSF fishers in
154 the area of the proposed “Taza” MPA.

155 The aim of this study is to evaluate the potential conflicts between illegal REC
156 and commercial SSF and to compare their catches and fishing effort in the area of
157 the proposed “Taza” MPA. This study can be extremely valuable in terms of MPA
158 planning and fisheries monitoring by providing baseline data for the managers of this
159 proposed MPA in their work to set up sound fisheries management and conservation
160 plans. To this end, SSF data were used together with REC data from the perspective
161 of the development of integrated fisheries management plans. Therefore, the future
162 management plan of this MPA will serve as a scientific reference for ensuring both
163 safeguarding of the commercial fisheries, especially SSF which is the main socio-
164 economic activity in the study area (Chakour, 2012), and the sustainability of the
165 REC which become increasingly important in the economies of a number of
166 Mediterranean countries (Pita et al., 2017; Babali et al., 2018; Lloret et al., 2018).
167 Moreover, the study is geographically focused on the southern part of the
168 Mediterranean basin, a region where little is known about REC and on a forthcoming
169 MPA that will play a crucial role to stimulate the implementation of specific measures
170 for enhancing fisheries management in this region.



171 **Fig. 1.** Map showing the location and zoning plan of the proposed "Taza" MPA, Algeria.

172 ## 2. Materials and Methods

173 ### *2.1. Study area*

174 Two fishing harbors are located near the proposed "Taza" MPA: Boudis (latitude
175 36° 49′ 6″N, longitude 5° 46′ 27″E) and Ziama (latitude 36° 40′ 37″N, longitude 5° 28′
176 44″E) pending the completion of work to build a third port in the municipality of El-
177 Aouana (Fig. 1).This study was conducted in the fishing harbor of Ziama, located in
178 the South-Western Mediterranean Sea off the Gulf of Béjaia in Algeria (Fig. 1). In
179 2009, with the support of the network of MPA managers in the Mediterranean
180 (MedPAN), Taza National Park began a process to include its adjacent marine area
181 covering 9603 ha (Boubekri and Djebar, 2016). The planned MPA (latitude 36° 41′
182 13″N and 36° 53′ 19″N; longitude 5° 30′ 26″E and 5° 41′ 15″E) is located in the East
183 part of the Gulf of Béjaia and extends about 23 km along rocky coasts and sandy
184 beaches (Fig. 1). Along this Gulf, the fishing harbor of Ziama has traditionally been
185 home to an important fishing community including both recreational and professional
186 fishers (Boubekri et al., 2019).

187 Furthermore, one of the specificities of this fishing harbor is the absence of the
188 Algerian Coast Guard (in Algeria, the Algerian Coast Guard has responsibility for
189 supervising fishing activity), which encouraged a practice of illegal REC on a large

scale (Kacher, 2010). According to Kacher (2010), the use of nets in RBF is now a common fishing technique for almost half of the REC fishers in the study area. It should be noted that nets are not prohibited to REC fishers provided that they are holding a special authorization issued by local fisheries authorities. However, a significant number of recreational fishers sold their catch, a practice which is at odds with what the Algerian regulation defines as recreational fishing (see Table 1).

2.2. Data collection

The fishing harbor of Ziama is the only harbor in the study area where recreational catches are reported. In this study, catch data were collected via a direct observation method of landings (Griffiths et al., 2007; Merrien et al., 2008). On a daily basis from May 2013 to April 2014, and with the help of two observers from the DPRH of Jijel, all the recreational boats involved in illegal REC in the fishing harbor of Ziama were surveyed. In total, 32 recreational boats out of 46 (70%) were considered in this study. For these boats, all fishing trips were taken into account.

It should be noted that the same survey method was used by Boubekri et al. (2018) for SSF for the surveying of 24 small-scale boats. Moreover, both REC and SSF surveys did cover the same study area and were conducted throughout the same studied year. Details of SSF survey are given in Boubekri et al. (2018). The catch and fishing effort data of SSF were used in this article to highlight the potential conflicts between commercial SSF and illegal REC. For each fishing category three variables were considered in this study: 1) the mean Fishing Trips (FT) - this was calculated monthly as the number of fishing trips per boat per day and used as an indicator of fishing effort; 2) the Mean Catch (MC) - this was calculated monthly as mean catch per active boat per day (kg/boat/day); and 3) average Species Richness (SR) in the catch - this was calculated monthly as the total number of species (or higher taxonomic level) caught per boat per day.

The choice of Ziama harbor allowed us to overcome logistical constraints (i.e. widespread geographical dispersion of landing places) while targeting a significant component of illegal recreational boats that are mainly operational in the western perimeter of the proposed “Taza” MPA (Fig. 1). As boats returned to the harbor, catch data was collected by counting the number of fish crates and expressing the weight in (kg). However, when fish crates were not classified by species (i.e. genus

or family), the weights recorded were grouped at a higher taxonomic level (please see Appendix A for more details about the concerned species).

In addition, weekly surveys were conducted using semi-quantitative questionnaires to obtain information on: 1) target species, 2) fishing gear used, and 3) visited fishing ground (depth, location, and habitat characteristics). For the latter, map-based interviews were conducted with fishers, for which the interviewer and the informant used a hard copy map (Close and Hall, 2006). It should be noted that fishers' Traditional Ecological Knowledge (TEK) is recognized as an effective tool for the management of artisanal fisheries and MPAs in the Mediterranean (Coll et al., 2014; Léopold et al., 2014; Pita et al., 2016).

In contrast to the survey carried out for SSF in this fishing harbor (see Boubekri et al., 2018), the collection of catch data classified by gear was not possible because illegal recreational fishers appeared reluctant to provide this information, most likely because they are practicing IUU fishing. In its place, an inventory of the fishing gears used by illegal recreational fishers was listed based on field observation (see Table 3).

2.3. Data analysis

We used a Kruskal-Wallis H test to test for main differences between the three variables: fishing trips (FT), mean catch (MC), and specific richness (SR) among the four seasons, and a Mann-Whitney U test to test the same variables (FT, MC, and SR) using seasonal mean values for comparisons between illegal REC and SSF. In this perspective we ran the Kruskal-Wallis H test among the seasonal mean daily values, while the Mann-Whitney U test was run between the mean daily values of illegal REC and SSF. We have chosen non-parametric statistical tests because our data did not meet the assumptions required for parametric statistics. The level of significance was $\alpha = 0.05$. All the statistical analysis was performed using Prism version 5.03 for Windows.

The fishing grounds visited by recreational and professional fishers as inferred from the map-based interviews, have been processed in relation to the number of fishing trips (frequency of visits), using the software ArcGIS 10.3.1. ESRI (Falautano et al., 2018). In order to evaluate spatial competition between the two fishing

categories, the total counts of fishing trips directed by illegal REC and SSF in each fishing area is represented as a point with geographical coordinates corresponding to the center of that area and visualized on a georeferenced map as a pie chart whose width is proportional to the total frequency of visits partitioned per illegal REC and SSF.

3. Results

3.1. Illegal REC fleet composition, gears used, target species, and fishing effort

3.1.1. Illegal REC fleet composition

In total 1839 fishing trips, covering 16 fishing grounds were completed during the study year and 32 recreational boats were found to be active.

RBF in the area of the proposed "Taza" MPA was carried out by 46 boats. 70% of these boats (32 boats) were considered in this study (Table 2). This is the total number of recreational boats that sold their catches to sale operators inside the fishing harbor of Ziama and involved in illegal REC.

Table 2. Fleet characteristics (range and average) of the overall length (m) and engine power (kW) of the two fishing boats categories: REC, illegal recreational boat (present study) and SSF, small-scale boats (Boubekri et al., 2018).

Boat category	Number of active boats	Fleet characteristics	
		Overall length (m)	Engine power (kW)
Recreational (REC)	32	3.5 – 5.8 (4.61)	7 – 63 (17.05)
Professional (SSF)	24	4.8 – 10 (6.53)	15 – 180 (46.07)

3.1.2. Gears used and target species

The illegal REC fishers of Ziama Harbor use a variety of gears and target a wide range of commercial species (Table 3). Among the gears used, we count nets the use of which is restricted.

Table 3. Gears used and target species of REC (present study) and SSF (Boubekri et al., 2018) at the fishing harbor of Ziama, Jijel, Algeria. (REC, illegal recreational fishing; SSF, small-scale fishing). *Sensu* FAO (1980).

Fishing category	Gear	Standard abbreviation	FAO code	Main target species
SSF & REC	Set gillnets (anchored)	GNS	07.1.0	*Pagellus* spp., European hake, scorpionfish
SSF & REC	Driftnets	GND	07.2.0	Atlantic Bonito, bullet tuna
SSF & REC	Trammel nets	GTR	07.5.0	Red mullets, sparids, cuttlefish
SSF & REC	Gillnets (not specified)	GN	07.9.1	Sparids, Greater amberjack Atlantic bonito
REC	Handlines and pole-lines (hand operated)	LHP	09.1.0	*Serranus* spp., *Dentex* spp. *Pagellus* spp.
REC	Handlines and pole-lines (mechanized)	LHM	09.2.0	*Dentex* spp., *Epinephelus* spp.
REC	Drifting longlines	LLD	09.4.0	Swordfish
REC	Trolling lines	LTL	09.6.0	Greater amberjack, Atlantic bonito
REC	Hooks and lines (not specified)	LX	09.9.0	*Serranus* spp., sparids

3.1.3. Fishing effort

The total counts of fishing trips carried out by recreational fishers identified a more equally distributed effort between spring and summer, where most of the fishing trips occurred, and also between autumn and winter (Table 4). Spring was thus the season where recreational fishers carried out the most fishing trips during the year with 31.64% followed by summer which accounted for 31.04% of the total fishing trips (Table 4).

Table 4. Number of the total fishing trips per month and per season for REC (present study) and SSF (Boubekri et al., 2018) at the fishing harbor of Ziama, Jijel, Algeria. (REC, illegal recreational fishing; SSF, small-scale fishing). The numbers of the total monthly active boats between May 2013 and April 2014 are indicated between brackets. An active boat is defined as a boat carrying out at least 1 fishing trip during the month.

Months	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14
REC	205	227	220	124	114	136	85	125	143	83	123	254
	(22)	(24)	(25)	(19)	(20)	(20)	(18)	(18)	(19)	(20)	(15)	(24)
SSF	175	278	130	98	53	33	43	136	93	39	97	155
	(18)	(21)	(13)	(14)	(10)	(8)	(8)	(10)	(8)	(7)	(19)	(11)
Total		Summer			Autumn			Winter			Spring	
REC		571			335			351			582	
(32)		(27)			(29)			(25)			(31)	
SSF		506			129			268			427	
(24)		(24)			(13)			(11)			(19)	

The difference in fishing effort allocation among seasons was not significant for REC but it was highly significant for SSF (Table 5).

Table 5. Kruskal-Wallis H analysis of variance for FT, MC, and SR and Mann-Whitney U comparisons between REC (present study) and SSF (Boubekri et al., 2018). FT, fishing trips; MC, mean catch; SR, specific richness; REC, recreational boat fishing; SSF, small-scale fishing; SUM, summer; AUT, autumn; WIN, winter; SPR, spring. Between brackets Standard Deviations s.d.

Catch and effort	Kruskal-Wallis H for REC					Kruskal-Wallis H for SSF				
Characteristics	SUM	AUT	WIN	SPR	*P*	SUM	AUT	WIN	SPR	*P*
FT mean values	8.157	6.321	7.313	8.083	0.0526	8.437	3.824	5.000	6.412	< 0.0001
(s.d.)	(4.193)	(3.675)	(3.697)	(4.238)		(4.696)	(1.466)	(1.927)	(2.274)	
MC mean values	5.299	3.343	3.760	4.019	0.0591	21.02	7.866	4.509	9.669	< 0.0001
(s.d.)	(5.202)	(1.851)	(1.654)	(2.024)		(15.54)	(7.623)	(1.689)	(10.59)	
SR mean values	5.942	3.740	5.043	5.761	0.0010	9.371	4.156	4.628	6.368	< 0.0001
(s.d.)	(3.338)	(2.058)	(2.377)	(3.647)		(3.612)	(2.952)	(2.171)	(4.772)	

However, by using seasonal mean values of FT, the Mann-Whitney U test showed significant differences in the fishing effort between REC and SSF only in the cold season (autumn and winter) (Table 6).

Table 6. Mann-Whitney U comparisons for FT, MC, and SR between REC (present study) and SSF (Boubekri et al., 2018). FT, fishing trips; MC, mean catch; SR, specific richness; REC, recreational boat fishing; SSF, small-scale fishing; SUM, summer; AUT, autumn; WIN, winter; SPR, spring. Between brackets Standard Deviations s.d.

Catch and effort Characteristics	Mann-Whitney U test for REC vs. SSF							
REC	SUM		AUT		WIN		SPR	
FT mean values	8.157		6.321		7.313		8.083	
(s.d.)	(4.193)		(3.675)		(3.697)		(4.238)	
MC mean values	5.299		3.343		3.760		4.019	
(s.d.)	(5.202)		(1.851)		(1.654)		(2.024)	
SR mean values	5.942		3.740		5.043		5.761	
(s.d.)	(3.338)		(2.058)		(2.377)		(3.647)	
SSF	SUM		AUT		WIN		SPR	
FT mean values	8.437		3.824		5.000		6.412	
(s.d.)	(4.696)		(1.466)		(1.927)		(2.274)	
MC mean values	21.02		7.866		4.509		9.669	
(s.d.)	(15.54)		(7.623)		(1.689)		(10.59)	
SR mean values	9.371		4.156		4.628		6.368	
(s.d.)	(3.612)		(2.952)		(2.171)		(4.772)	
REC vs. SSF	U	*P*	U	*P*	U	*P*	U	*P*
FT	2481	0.9884	517	0.0008	636	0.0015	1998	0.0585
MC	421	< 0.0001	531.5	0.0013	775	0.0406	1554	0.0002
SR	1201	< 0.0001	798	0.9885	904	0.3877	2375	0.8702

3.2. Catch composition and seasonal distribution patterns

3.2.1. Catch composition

A total of 54 taxa belonging to 24 families were observed in the catches of the 32 illegal recreational active boats, reflecting a highly varied exploitation of the fauna, constituted of 50 species (or higher taxonomic level) of fish (47 Actinopterygii and 3 Elasmobranchii), 2 species of crustaceans *Palinurus elephas* and *Scyllarides latus*, and 2 species of cephalopod molluscs *Octopus vulgaris* and *Sepia officinalis*. The Sparidae family was the best represented in the total catches because 20 of the 54 species belonged to that family. In total, 7.7 tons of illegal REC total catch were assessed, of which 40.58% consisted of the 5 main target species: the bullet tuna *Auxis rochei* (10.78%) and 4 species of Sparidae: *Pagellus acarne* (11.10%), *Diplodus* spp. (7.73%), *Pagrus* spp. (5.71%), and *Pagellus bogaraveo* (5.26%) (Fig. 2). It should be noted that the bullet tuna is the dominant catch during the month of June which coincides with its coastal presence, while it is almost absent the rest of the year as opposed to the other species (Fig. 2). Moreover, the resulting mean catch among seasons was not significant for REC but it was highly significant for SSF (see Table 5). By using the seasonal mean values of the MC, the Mann-Whitney U test showed that the difference in the mean catch between REC and SSF is significant among all seasons, especially in the warm season (spring and summer) (see Table 6).

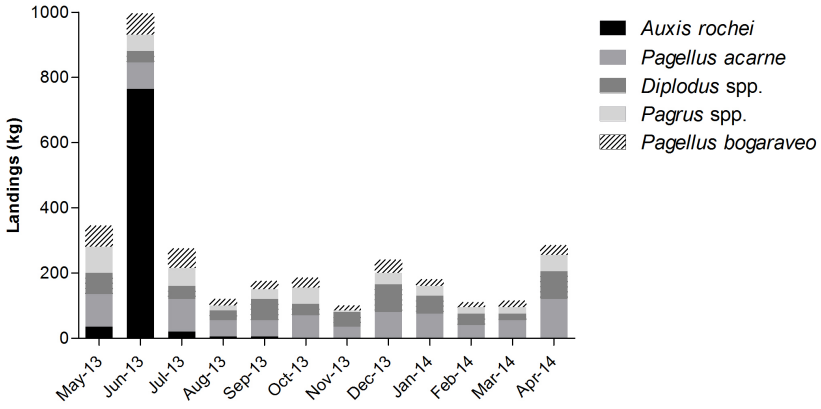


Fig. 2. Monthly mean of daily landings of the most-abundant species (those that accounted for over 5% of the total catch) for illegal REC (present study).

For SSF, a total of 40 taxa belonging to 27 families were observed in the catches of the 28 small-scale boats of the harbor of Ziama between May 2013 and

April 2014, comprising of 36 species (or higher taxonomic level) of fish (31 Actinopterygii and 5 Elasmobranchii), 1 of crustaceans *Palinurus elephas*, and 3 of cephalopod molluscs *Loligo vulgaris*, *Octopus vulgaris*, and *Sepia officinalis*. In total, 15.215 tons of catch were assessed, of which 60.50% consisted of the 5 main target species: *Auxis rochei* (26.55%), *Pagellus acarne* (13.31%), *Euthynnus alletteratus* (7.76%), *Squalus acanthias* (7.46%), and *Scorpaena* spp. (5.42%) (Fig. 3). The data obtained are summarized in Appendix A where the list of species (or higher taxonomic level) caught and their total catches per fishing category are reported.

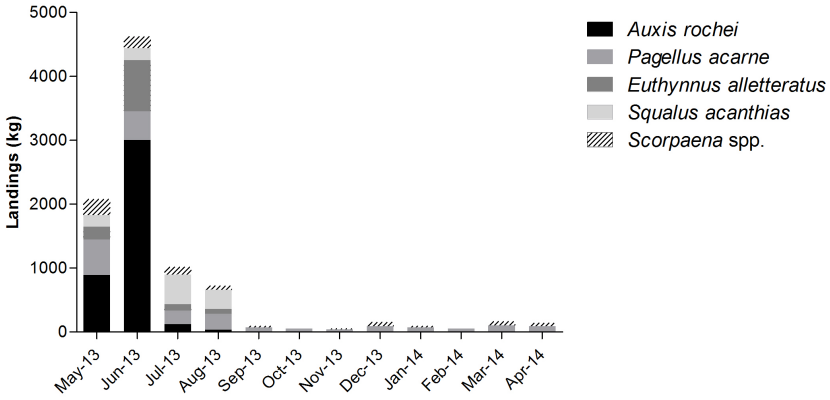
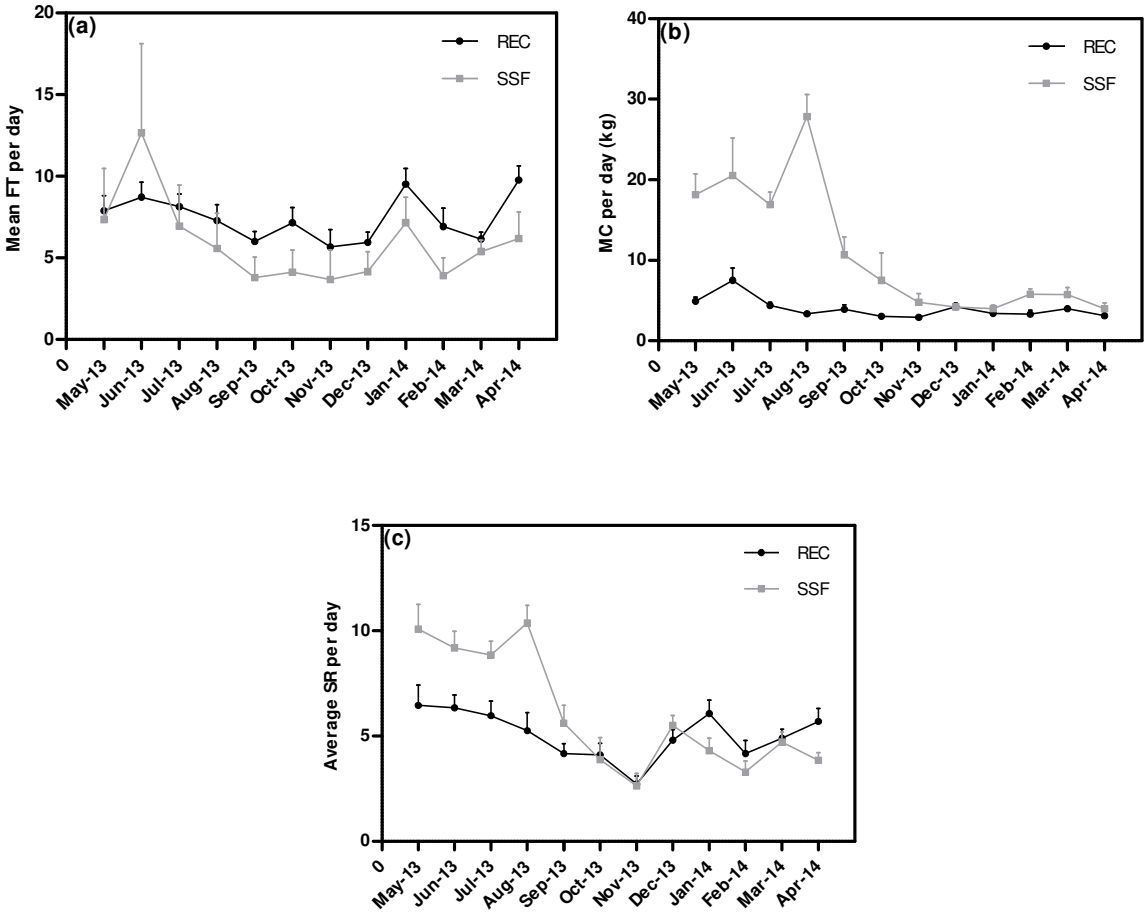


Fig. 3. Monthly mean of daily landings of the most-abundant species (those that accounted for over 5% of the total catch) for SSF (Boubekri et al., 2018).

3.2.2. Seasonal distribution patterns

The monthly mean of daily values for the two variables (MC and SR) showed that illegal REC and SSF varied throughout the year (Fig. 4). However, the results of the Kruskal-Wallis statistical test showed that FT did not vary significantly between seasons for illegal REC (H = 7.704, $P = 0.0526$), while the difference was extremely significant for SSF (H = 53.90, $P < 0.0001$) (see Table 5). Fig. 4b shows that during the warm season (i.e. May to September); MC for SSF was higher than for illegal REC. However, for the rest of the year, this variable was almost the same for both fishing categories. Species richness varied consistently at the temporal scale (i.e. months) for both professional and recreational fisheries, with higher values during the warm season (from May to September) (Fig. 4c). However, the SR in the catches of SSF decreased significantly after September while it increased for illegal REC and maintained such higher values during the whole cold season (i.e. from October to April).



396 **Fig. 4.** (a) Monthly mean of daily Fishing Trips (FT + s.e.), (b) Monthly mean of daily catch (kg) (MC +
397 s.e.), and (c) Monthly average of daily Species Richness (SR + s.e.) for REC (present study) and SSF
398 (Boubekri et al., 2018) at Ziama fishing harbor, Algeria (SW Mediterranean). REC, illegal recreational
399 fishing; SSF, small-scale fishing.

400 *3.3. Catch economic value*

401 High economic value species such as *Scyllarides latus*, *Xiphias gladius*, *Zeus*
402 *faber*, and *Sphyraena* spp. were caught exclusively by illegal REC while
403 *Dicentrarchus labrax* was caught exclusively by SSF (Fig. 5). Whilst the recreational
404 and the professional fishers competed for *Sparus aurata* and *Seriola dumerili*
405 (between 40% and 50% for species caugh respectively by illegal REC), species such
406 as *Mullus barbatus barbatus*, *Mullus surmuletus*, *Balistes carolinensis*, *Merluccius*
407 *merluccius*, and *Palinurus elephas* were caught mainly by SSF (between 73% and
408 94% of species caught). For the remaining high economic value species, they were
409 caught mainly by illegal REC between 70% (i.e. *Phycis* spp. and *Sciaena umbra*),
410 80% (i.e. *Dentex* spp. and *Pagrus* spp.), and 92% and 98% for *Epinephelus costae*
411 and *Epinephelus marginatus*, respectively (Fig. 5).

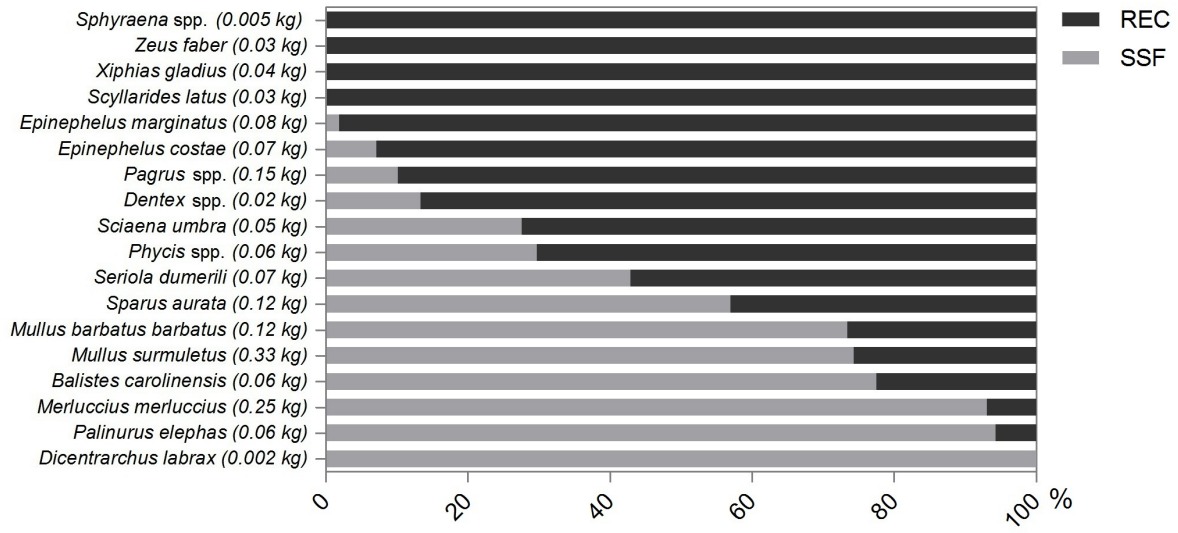
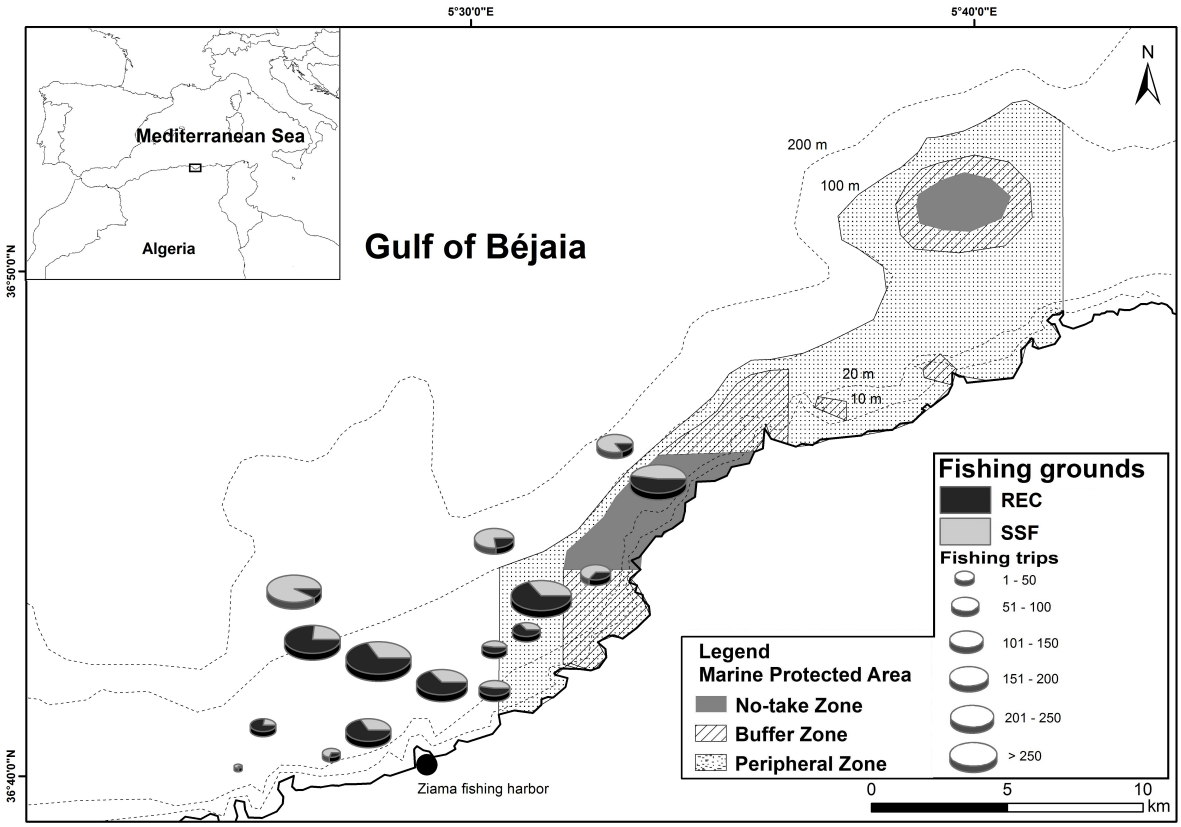


Fig. 5. Mean daily catch (kg) of high economic value fish species (as defined by Ben Lamine et al., 2018, see also Appendix B for further details), for REC (present study) and SSF (Boubekri et al., 2018) and percentage per fishing category. REC, illegal recreational fishing; SSF, small-scale fishing. Daily catch calculated on the number of total fishing trips.

3.4. Spatial fishing effort distribution

The area of the proposed "Taza" MPA is home to many fishing grounds used by both recreational and professional Ziama harbor fleets (Fig. 6). The 16 fishing grounds used by the Ziama harbor SSF boats, as identified in a previous study by Boubekri et al. (2018), were also exploited by the illegal recreational boats in this study (Fig. 6). Four fishing grounds located inside the perimeter of the proposed "Taza" MPA were used by recreational fishers representing 32.08% of total fishing trips. Moreover, the REC spatial patterns showed a high concentration of fishing effort near the harbor, especially at a depth between - 20 and - 100 m (Fig. 6). In addition, the relatively offshore fishing grounds were mainly used by SSF fishers while the most costal ones were largely exploited by recreational fishers (Fig. 6).



427 **Fig. 6.** Concentration of fishing trips within the different fishing grounds. The width of the pie chart is
428 proportional to the total number of fishing trips in each fishing area (frequency of visits) partitioned per
429 REC (present study) and SSF (Boubekri et al., 2018). REC, illegal recreational fishing; SSF, small-
430 scale fishing

431

432 4. Discussion

433 The present study provides relevant information on the illegal REC in the area
434 of the proposed "Taza" MPA (SW Mediterranean, NE Algeria). Illegal recreational
435 fishers use all fishing gears SSF fishers use except the purse seine (Boubekri et al.,
436 2018), they compete in some target species and sell their catch illegally rather than
437 using it for personal or family consumption. This finding is in agreement with what
438 Ben Lamine et al. (2018) have reported at two future MPAs in Tunisia (SW
439 Mediterranean). Furthermore, Kacher (2010) already indicated a strong competition
440 between recreational and professional fishers in the area of the proposed "Taza"
441 MPA. In Mediterranean MPAs, recreational fishing competes for space and resources
442 with other marine uses such as traditional artisanal fishing (Lloret and Font, 2013;
443 Prato et al., 2016; Tunca et al., 2016; Ben Lamine et al., 2018; Venturini et al., 2019).

Given that MPAs are crucial tools for marine biodiversity conservation and sustainable utilization of marine resources through fisheries management (García-Charton et al., 2008; Alós and Arlinghaus, 2013), monitoring of REC must be a priority for MPA managers, or else consequences of such an unmonitored activity may negate the expected conservation outcomes. Moreover, the combined impact of recreational and commercial fisheries leads to serious consequences on the management of coastal fisheries (Albouy et al., 2010; Veiga et al., 2010; Lloret and Font, 2013; Marengo et al., 2015; Prato et al., 2016).

The proposed "Taza" MPA is used extensively as a recreational fishing location by the local population. These recreational fishers use a wide variety of gears and the total count of fishing trips show a more equally distributed effort within two periods of the year; from October to April (cold season) and from May to September (warm season). Our results highlight the pressure that the illegal recreational fishers exert on the coastal resources in this area, where the sea fishing days mean is 7.56 ± 4.04 days per month. Lower values for individual monthly fishing effort have been observed in other western Mediterranean regions (spear fishers included) such as in Majorca Island (5.5 ± 0.11; Morales-Nin et al., 2005), the Portofino MPA (2.08 ± 1.75; Venturini et al., 2019), and in Tunisia (4 ± 2; Ben Lamine et al., 2018), while comparable values have been found in Cap de Creus (8.13, typically during the weekends, and 5.78 typically between April and September; Lloret et al., 2008). Moreover, the monthly fishing effort of illegal REC is also higher than what Boubekri et al. (2018) have found for SSF (i.e. 6.38 ± 2.49 days per month), which can most likely be attributed to the fact that illegal REC is practiced intensively during the whole year.

Spatial information is a crucial element in the zonal management and design of MPAs (Costello et al., 2010; Parnell et al., 2010). The knowledge of the spatial distribution of the fishing effort thus provides valuable elements to the managers of the proposed "Taza" MPA in terms of identification of the most frequented areas in order to estimate the pressures and impacts on the fishing habitats. The proposed zoning plan was conceived with support from the MedPAN network within the MedPAN South Project (Gomei and Di Carlo, 2012). Data from the survey conducted between 2009 and 2012 in this area assessed marine biological diversity (Ramos-Espla, 2010), fisheries (Kacher, 2010), and socio-economic aspects (Chakour, 2012;

Grimes, 2010) and served as a basis to achieve the final proposal which was then subjected to a wide consultation process within the different user-groups of the proposed MPA to avoid social conflicts and economic impacts.

In our case study, the spatial patterns of the fishing activity show a competition between illegal REC and SSF in all the 16 fishing grounds although at different levels. However, the frequency of fishing trips results and their spatial distribution show that both illegal REC and SSF are practiced regularly in one of the proposed no-take zones. This argues for a strengthening of controls in this area once the MPA is established. Moreover, and taking into account the distances to the fishing harbor, our results show a higher concentration of fishing effort by illegal REC than by SSF in fishing grounds near the fishing harbor, while the SSF boats operate mainly in the most remote fishing grounds. This disparity can be related to the differences in boat technical characteristics. In fact, the characteristics of the SSF boats (larger than recreational ones) allow them to explore offshore fishing areas. Furthermore, the results of the monthly distribution of fishing activity do not show seasonality for illegal REC, in contrast to SSF where summer represents the season of highest fishing activity (i.e. maximum number of fishing trips).

According to Boubekri et al. (2018), the activity of SSF in the fishing harbor of Ziama is distinctly seasonal, requiring fishers to rotate between various métiers throughout the year and to adapt to variations in resource availability. Due to the illegal selling of the catch by recreational fishers, a similar behavior to SSF fishers is now observed for REC fishers. Illegal REC is thus practiced year-round with almost the same intensity, using a variety of gears (e.g. rod, lines, nets, etc.) and capturing a total number of 54 fish species. Our results do not coincide with those obtained for recreational boat fishers in Spain which are characterized by a pronounced seasonality in the distribution of fishing activity, with a maximum in summer and a minimum in winter (Morales-Nin et al., 2005; Lloret et al., 2008), nor with those reported by Ünal et al. (2010) in Turkey, where autumn and winter are the preferred seasons for recreational boat-based fishing. These disparities in seasonality are due to the fact that most recreational fishers in the study area are practicing REC for livelihood and commercial purposes rather than leisure as opposed to many especially in developed countries around the Mediterranean basin who practice it mainly for pleasure during summer holidays.

In the proposed “Taza” MPA the SSF show discernible seasonal fishing effort patterns with the highest activity during summer. This corresponds to the period of cessation of trawler activity in the three nautical mile zone (starting on the 1st of May and ending on the 31th of August each year) as advocated by the Algerian legislation (Decree No. 04-74 of 24 April 2004). In fact, this is the period where most of the fishing trips occur for SSF (51.20%) which can be responsible for the statistically significant differences in the fishing trips between illegal REC and SSF (Mann-Whitney test; U = 21386, *P* = 0.0006). Boubekri et al. (2018) have mentioned the spatial competition and conflicts between small-scale and trawl fisheries in relatively offshore areas, while this study shows a new conflict with recreational fishers in most coastal fishing areas (near the harbor). The SSF appear thus to be the most affected by this spatial competition.

Consequent to this high fishing effort, recreational fishers target a large number of species (i.e. 54) and one of the highest compared to the number of species caught in other western Mediterranean regions (e.g. 58 species in the MPA of Cap de Creus; Lloret and Font, 2013; 54 species in Majorca Island; Morales-Nin et al., 2005; 51 species in the Strait of Çanakkale; Ünal et al., 2010; 44 species in Portofino MPA; Venturini et al., 2017; and 32 species in Serra Gelada Marine Park; Luna-Pérez, 2010). According to Sheaves et al. (2016), some recreationally targeted species are being overexploited. As a result, in some cases effort is shifted towards new target species which may include endangered ones (Bower et al., 2014). Thereby, five of the species caught by illegal REC in the study area are included in Annex III of the Barcelona Convention (i.e. *Epinephelus marginatus*, *Palinurus elephas*, *Sciaena umbra, Scyllarides latus*, and *Xiphias gladius*), which lists those species whose exploitation should be regulated because they are vulnerable to fishing (UNEP-MAP-Barcelona Convention, 2011). Furthermore, four species are also included in the Red List of the IUCN as endangered: *Epinephelus marginatus* or vulnerable: *Dentex dentex*, *Merluccius merluccius*, and *Sciaena umbra* (Abdul Malak et al., 2011). However, it is noteworthy to mention here that these species are not yet frequently caught by illegal recreational fishers. The increase of recreational boat anchoring areas also causes huge damages on coastal habitats and especially seagrass meadows, one of the key habitats of two iconic Mediterranean marine coastal fish: *Sciaena umbra* and *Dentex dentex* (Marengo et al., 2015).

543 Comparing illegal REC catches from this study with commercial SSF catches is
544 interesting. In the fishing harbor of Ziama, 24 professional SSF boats operate in the
545 area of the proposed "Taza" MPA, predominantly gillnetters. Their commercial
546 landings amount was 15.2 tons between May 2013 and April 2014 (Boubekri et al.,
547 2018). The annual illegal REC catch studied here for the same period, was about 7.7
548 tons. Consequently, the illegal REC contribute significantly to fishing mortality as the
549 proportion of the harvest attributed to illegal REC represents about 50% of the small-
550 scale fishery harvest. This is by far higher than the world average (12% according to
551 Cooke and Cowx, 2004) and also compared to what has been reported (i.e. ~30%) in
552 many Mediterranean regions such as Cap de Creus in Spain (Lloret et al., 2008) and
553 the Strait of Çanakkale in Turkey (Ünal et al., 2010). Our results therefore show a
554 huge biological impact of illegal REC, which can exacerbate the magnitude of the
555 negative effects of high fishing mortality on coastal fish stocks, especially vulnerable
556 species characterized by slow growth and late maturity, by limiting their reproductive
557 potential (Roberts and Hawkins, 1999). Moreover, the competition between illegal
558 REC and SSF for the natural resources in the proposed "Taza" MPA is highly
559 important since the two main species targeted by SSF (i.e. *Pagellus acarne* and
560 *Auxis rochei*) (Boubekri et al., 2018) are among the most-abundant species
561 (accounting each for over 10% of the total catch) targeted by recreational fishers.

562 In addition, compared with commercial fishing mean catch per day (i.e. 12.08 ±
563 9.42 kg/boat/day) (Boubekri et al., 2018), recreational catches in this study represent
564 ~35% (i.e. 4.18 ± 1.38 kg/boat/day) of the mean catch. In Tunisia, Ben Lamine et al.
565 (2018) have reported a similar value (i.e. 40%) in two future MPAs. However,
566 regarding the temporal variations, for illegal REC the catch rates do not change
567 significantly between seasons, as is the case in Tunisia, but also in other
568 Mediterranean MPAs (Lloret and Font, 2013; Marengo et al., 2015). The CPUEs can
569 be strongly influenced by the varying characteristics of fishing gear, the heterogeneity
570 of fishermen's local knowledge, seasonal patterns of abundance, and outlying data
571 due to exceptional catches (Maunder and Punt, 2004; Smith et al., 2006). For SSF,
572 the results of Boubekri et al. (2018) show the highest catch rate in summer, which
573 may be a consequence of the spatial patterns that characterize the study area
574 instead of the allocated fishing effort. Indeed, during July and August, and despite an
575 almost identical fishing effort intensity (number of fishing trips) to the period from

September to April, SSF record a much higher MC in summer. In fact, the fishing grounds visited by SSF boats during that period, when there is less competition with illegal REC, can be responsible for this situation. This is unfortunate for them, since SSF fishers cannot keep the same yields throughout the year because of the trawling activity carried out in these fishing grounds between September and April, the period where SSF boats are forced to return to explore more coastal fishing grounds and then record a lower MC, almost equivalent to those of illegal REC. The drop in MC observed for SSF between September and May can most likely be attributed to the high competition with illegal recreational boats in exploiting the same fishing grounds. Moreover, the characteristics of the nets (i.e. big size) used by SSF allow fishers to record highest MC in relatively offshore areas characterized by soft bottoms. In more coastal fishing grounds however, recreational fishers are more efficient in terms of fishing techniques. For instance, using small size nets, which are easily manoeuvrable, allows them to explore hard bottoms better than SSF fishers.

Recreational activities have a core social role for coastal populations (Bellanger and Levrel, 2017). In the context of this study, REC includes the activity of people fishing for commercial purposes or to obtain some extra income. The current economic difficulties of the local population therefore, are now putting many recreational fishers in unfair competition with professional ones through selling their catch on the local market. Moreover, this form of IUU fishing leads to a devastating and perverse outcome of encouraging non-compilance. Furthermore, the cost of a professional boat license is about 1200 USD per year while that of a recreational boat is about 30 USD (DPRH of Jijel, 2014). As a consequence, a huge number of small-scale professional fishers prefer to convert to recreational because of the higher operational costs (i.e. from paying taxes) and consequent lower profit they obtain compared to that of recreational fishers. The potential economic impact of illegal REC for the future of commercial fisheries is therefore extremely significant, especially as the Government does not collect any taxes from recreational fishers, assuming fishers abide by the law (Babali et al., 2018).

The establishment of MPAs, particularly of multiple-use areas, aims to protect natural populations and ecosystems and the goods and services they provide to society (Watson et al., 2014; Rodríguez-Rodríguez et al., 2019). Even though partially protected areas (or partial reserves) that restrict some extractive uses or

609 regulate professional and recreational fishing in different ways can potentially
610 enhance fish density and biomass (Zupan et al., 2018), the strongest fisheries
611 outcome benefits occur in areas with total exclusion of fishing activities (Roberts et
612 al., 2008; Di Lorenzo et al., 2016). The proposed “Taza” MPA is conceived as a tool
613 for developing management approaches that enable multiple-use on a sustainable
614 basis (Gomei and Di Carlo, 2012). However, unsuitable MPA establishment might
615 result in low effectiveness or even deterioration of the existing condition. This study
616 shows that REC should be taken into account given its huge impact linked to the
617 rising concern about overfishing. Indeed, the latter represents one of the main
618 challenges in marine conservation, with MPA zoning and multi-use management
619 regarded as a critical fisheries management tool (Costanza et al., 1998). To this end,
620 the development of an efficient monitoring system is a key element for understanding
621 and addressing the issues of REC (Green et al., 2005). However, to assess all
622 recreational boats operating in the area of the proposed “Taza” MPA, survey
623 techniques are required which are usually expensive and onerous to assess because
624 of the widespread geographical distribution of landing places. However, attempts to
625 better quantify the biosocioeconomic implications of REC and its relative contribution
626 to overall fishing pressure will provide managers of the proposed “Taza” MPA the
627 baseline needed to guide management actions and fisheries restrictions.

628 According to Font and Lloret (2014), subsistence fishing appears to be
629 increasing in some areas of the Mediterranean due to the current economic crisis,
630 and it is becoming increasingly difficult to distinguish between people who fish for
631 pleasure and people who fish for food. However, it is noteworthy to mention that this
632 study does not take into account subsistence fishing (i.e. fishing for food rather than
633 for commercial purposes) nor other techniques of recreational fishing (e.g. angling,
634 spearfishing, etc.). It would therefore be recommendable to collect data on all
635 recreational fishing techniques for future monitoring programs. In fact, identifying the
636 impact of each fishing technique would certainly lead to more accurate estimations of
637 recreational fishing pressure on coastal resources.

638

639

640

5. Conclusion

This study highlights the importance of the characterization of REC in a proposed MPA considering the annual dynamic of the fishing effort and the resulting catches in order to set up a sustainable fisheries management, one which takes into account the global picture of the fishing pressure on coastal resources. Our results show the presence of an important illegal REC in the study area with a great potential impact on the coastal resources, but also on the socioeconomic situation because of the unfair competition with commercial fisheries. Therefore, based on the information and the data presented, some fisheries restrictions should be applied to prevent an overexploitation of fishing resources, which could compromise the role of the establishment of this MPA in a context of a data-poor situation and low regulation enforcement. To this end, more monitoring effort is needed to detect the significant number of illegal recreational fishers who use the same fishing gears as the professional ones (i.e. nets) and target the same species. Moreover, illegal REC distort the estimates of the real fishing effort and bias the stock assessment on a national level since REC catches are not reported in official statistics.

Appendix A

List of caught taxa and their total weight (kg) for catches of SSF (Boubekri et al., 2018) and REC (present study). SSF, small-scale fisheries; REC, illegal recreational fisheries. For some species, the recorded weights were grouped at a higher taxonomic level; please see footnote for the concerned species.

Caught taxa	SSF landings (kg)	REC landings (kg)
Elasmobranchii		
Dasyatidae	15	25
Rajidae	195	175
Scyliorhinidae		
Scyliorhinus canicula	750	-
Squalidae		
Squalus acanthias	1135	-
Torpedinidae		
Torpedo spp.	75	125
Actinopterygii		
Balistidae		
Balistes carolinensis	155	45
Carangidae		
Seriola dumerili	90	120
Trachurus trachurus	-	305
Congridae		
Conger conger	20	150
Coryphaenidae		
Coryphaena hippurus	-	5
Gadidae		
Phycis spp.	55	130
Lophiidae		
Lophius spp.	170	-
Merlucciidae		
Merluccius merluccius	735	55
Moronidae		
Dicentrarchus labrax	5	-
Mugilidae[1]	55	70
Mullidae		
Mullus barbatus barbatus	290	105
Mullus surmuletus	780	270
Muraenidae		
Muraena helena	30	165
Sciaenidae		
Sciaena umbra	40	105
Scombridae		
Auxis rochei	4040	830
Euthynnus alletteratus	1180	30.00
Sarda sarda	340	135
Scomber spp.		10
Scorpaenidae		
Scorpaena spp.	825	115
Serranidae		
Epinephelus costae	15	195
Epinephelus marginatus	5	255
Serranus spp.	-	25

Appendix A continued

Caught taxa	SSF landings (kg)	REC landings (kg)
Soleidae	35	-
Sparidae		
Boops boops	-	85
Dentex spp.[2]	10	65
Diplodus spp.[3]	380	595
Lithognathus mormyrus	50	65
Oblada melanura	20	65
Pagellus acarne	2025	855
Pagellus bogaraveo	50	405
Pagellus erythrinus	290	215
Pagrus spp.[4]	50	440
Sarpa salpa	225	160
Sparus aurata	5	170
Spicara smaris	-	150
Sphyraenidae		
Sphyraena spp.	-	15
Xiphiidae		
Xiphias gladius	-	130
Zeidae		
Zeus faber	-	95
Trachinidae		
Trachinus draco	85	-
Triglidae		
Trigla Lucerna	115	-
Cephalopoda		
Loliginidae		
Loligo vulgaris	315	-
Octopodidae		
Octopus vulgaris	135	240
Sepiidae		
Sepia officinalis	260	385
Malacostraca		
Palinuridae		
Palinurus elephas	165	10
Scyllaridae		
Scyllarides latus	-	110
Total (kg)	**15215**	**7700**

[1] *Mugil cephalus, Chelon labrosus, Liza aurata, Liza ramada,* and *Liza saliens*.

[2] *Dentex dentex, Dentex gibbosus, Dentex maroccanus,* and *Dentex macrophthalmus*.

[3] *Diplodus annularis, Diplodus cervinus cervinus, Diplodus puntazzo, Diplodus sargus sargus,* and *Diplous vulgaris*.

[4] *Pagrus auriga,* and *Pagrus pagrus*.

Appendix B

Fish species economic value in Algeria. As defined by Ben Lamine et al. (2018): high economic value species: price per kg>the daily remuneration (i.e. 600 DZD) (18000 DZD is the minimum guaranteed wage per month in 2014 in Algeria http://www.ons.dz/-Masse-Salariale-).

Fish species	Commercial interest	Landing price per kg (DZD)
Palinurus elephas	High	1800
Merluccius merluccius	High	950
Dicentrarchus labrax	High	900
Xiphias gladius	High	900
Zeus faber	High	900
Mullus surmuletus	High	850
Mullus barbatus barbatus	High	800
Dentex spp.	High	800
Scyllarides latus	High	800
Epinephelus marginatus	High	800
Epinephelus costae	High	700
Pagrus spp.	High	700
Sciaena umbra	High	700
Seriola dumerili	High	700
Sparus aurata	High	700
Sphyraena spp.	High	700
Balistes carolinensis	High	600
Phycis spp.	High	600

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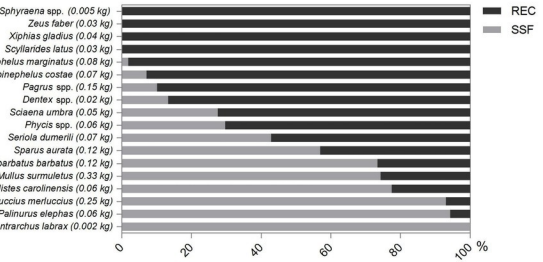
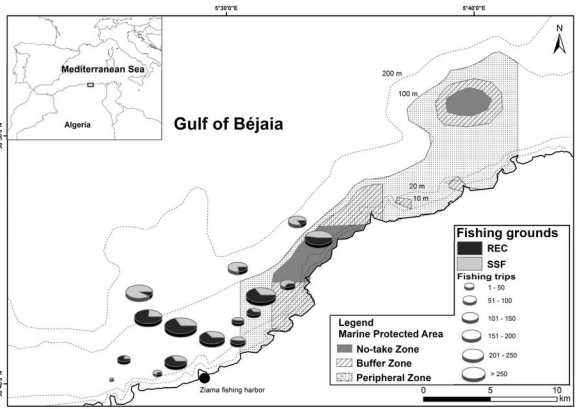


Mean daily catch (kg) of high economic value fish species



Concentration of fishing trips within the different fishing grounds