

## Bio-Socioeconomic Study of the Recreational Fishery in the Mostaganem Area: Case of Fishing from a Boat on the Algerian West Coast

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### ABSTRACT

This study aimed to establish a description of the situation of recreational fishing and evaluate its impact on the marine ecosystem in the Mostaganem region through a bio-socioeconomic study. A survey was conducted among 206 recreational fishermen along the Mostaganem Coast, representing a community predominantly composed of young individuals (80% under 50 years old), who rely on fishing as their primary source of food (92%). These fishermen use a variety of fishing gears and techniques, some of which are prohibited by regulations and engage in the sale of their catches. The study revealed that recreational fishing in the region of Mostaganem takes a completely different direction than its legal definition, with infringement of the regulations in force at different levels by different practices. Moreover, this activity is in unfair competition with professional fishing for the exploitation of the fishery resource with a significant annual production of about 345 tons, generating net profits estimated at €1.24 million, which must be taken into account in the planning of the management of a fishery.

### INTRODUCTION

The situation of fisheries in the Mediterranean has become increasingly concerning, with catches declining significantly since 2007. This decline has impacted the majority of the most productive stocks and is attributed to several stressors, including climate change affecting fisheries resources and intense fishing pressure (Cheung *et al.*, 2012). While commercial fisheries exert most of this pressure, recreational fishing, although often overlooked, contributes to the overall strain on marine resources. Recreational fishing, defined as a sport or leisure activity for personal consumption without resale to third parties (Law 01-11; FAO, 1998; Pitcher & Hollingworth, 2002), has gained popularity worldwide. It is widely practiced and even serves as a source of income in some cases (Cook & Cowx, 2006). Countries like the United States of America, Australia, and New

Zealand have embraced recreational fishing as a significant coastal activity (**Sutinen & Johnston, 2003**).

In Algeria, recreational fishing encompasses non-lucrative activities such as shore fishing, underwater fishing, and fishing aboard ships or pleasure boats are subject to specific permits (**Executive Decree n° 03-481, 2003**). Despite regulations, the actual practices often deviate from the prescribed norms. For instance, in the Mostaganem region, recreational boaters constitute 76% of the fishing fleet. This sector has seen an alarming increase, with the number of units rising from 116 in 2008 to 642 in 2018—a remarkable 550% growth in a decade (**Daoudi *et al.*, 2021**).

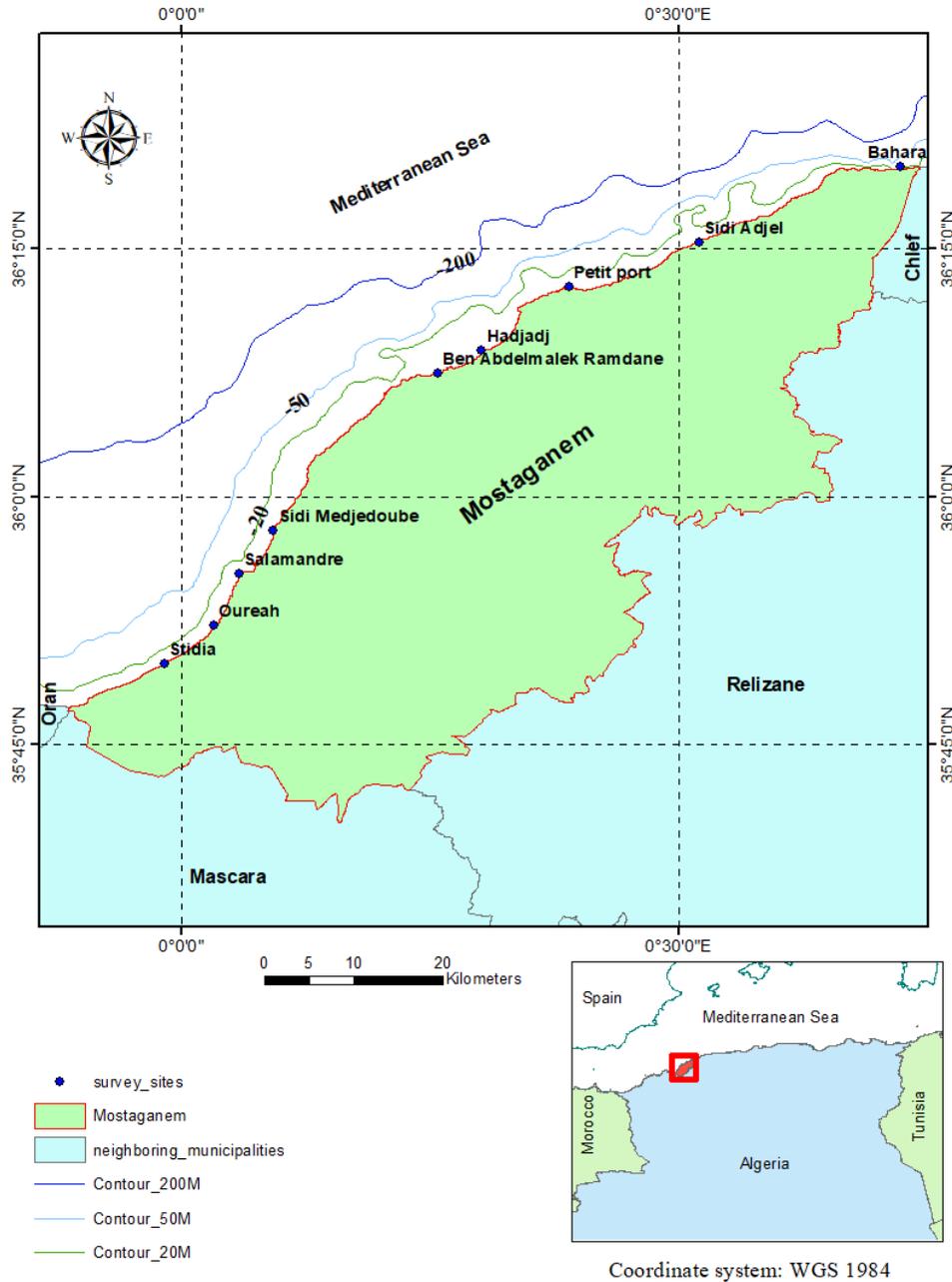
Within this context, this study aimed to provide an in-depth analysis of recreational fishing in the Mostaganem region. Our objectives included describing the current state of recreational fishing, evaluating its significance in the region, and assessing its impact on the marine ecosystem. This comprehensive bio-socioeconomic study will shed light on the complexities of recreational fishing, helping us understand its role and effects with respect to this coastal community.

Mostaganem's coastal area spans 124.5km, extending from the mouth of the Macta River in the west to Cape Negrawa in the east. The region boasts nine landing sites for pleasure boaters, including three major ports: Sidi Lakhdar, Mostaganem, and Salamandre (Fig. 1).

## MATERIALS AND METHODS

A survey was conducted among recreational fishermen along the coast of Mostaganem from September 2019 to March 2020 to assess the fishing effort exerted by this group. The study evaluated the types of gear and techniques employed, the duration of time (in hours and days) spent at sea, and the overall fish production.

The survey was conducted at a fishing site through face-to-face questionnaires and aimed to gather information in five categories: (1) the social profile of the fishermen, including age, marital status, residence, education level, work experience, and main source of income; (2) technical details of the boats, such as length, hull type, age, vessel condition, engine brand, and engine power; (3) fishing activity and marketing aspects, including the number of crew members, types and quantities of gears on board, daily fishing hours, annual fishing days, annual catches in terms of both value and weight, destinations of fishery products, selling price per kilogram, and total earnings; (4) expenses and costs per trip and per year, encompassing diesel, lubricant, bait, food, boat and gear maintenance and repair, insurance, and other miscellaneous costs; (5) governance-related issues, problems encountered, and expectations for sectoral development.



**Fig. 1.** Geographical map of the Mostaganem region, Algerian west coast

In addition, the number of recreational fishing permits in the Mostaganem region was collected in order to estimate the overall production and income of this category of fishing.

The production per unit effort CPUE was estimated following the method applied by Ünal *et al.* (2010).

The average annual effort per angler, expressed in fishing hours, was estimated in two steps. First, for each angler surveyed, annual fishing hours (TAFHF) were estimated by multiplying daily reported fishing hours (DHF) by annual fishing days (ADF).

$$TAFHF_i = DHF_i * ADF_i$$

Second, the average annual effort per angler (MAEF) is calculated as the average annual fishing hours of the respondents.

$$MAEF = \frac{\sum_{i=1}^n TAFHF_i}{n}$$

The average catch per unit effort (MCPUE), expressed as catch (kg) per hour, was estimated following the same procedure.

First, the annual CPUE per angler (ACPUE<sub>i</sub>) was estimated by dividing the annual catch reported by the respondent (ACF<sub>i</sub>) by the number of annual fishing hours (TAFHF<sub>i</sub>):

$$ACPUE_i = \frac{ACF_i}{TAFHF_i}$$

Second, MCPUE was estimated as the average catch per unit effort overall:

$$MCPUE = \frac{\sum_{i=1}^n ACPUE_i}{n}$$

This procedure avoids any bias due to a potential relationship between fishing intensity and fishing efficiency (Ünal *et al.*, 2010; Tunca *et al.*, 2016).

The total production of the recreational fishery in the Mostaganem region (TC) is estimated by multiplying MCPUE (kg/h fisher) by MAEF (average annual fishing hours per fisher) and the number of active fishermen, which is considered as the number of recreational fishing authorizations issued by the maritime administration in the study area.

However, it should be noted that the number of authorizations represents a clear underestimate of the population practicing this category of fishing, given the high number of fishers without fishing licenses.

Recreational production revenues (VCRF) were estimated by considering the average selling price per kilogram declared by each fisherman, multiplied by the overall production (TC) estimated for all fishermen in the study area.

Annual expenditures (EF) are calculated by multiplying the daily costs and expenses reported by each angler by the number of days fished per year (ADF), plus the fixed annual costs and expenses.

Total angler expenditure (TERF) is estimated by multiplying the average annual expenditure per angler (EF) by the number of active anglers in the area.

The gross profits of the recreational fishery are calculated as the difference between the value of the catch (VCRF) and the expenses of the activity (TERF).

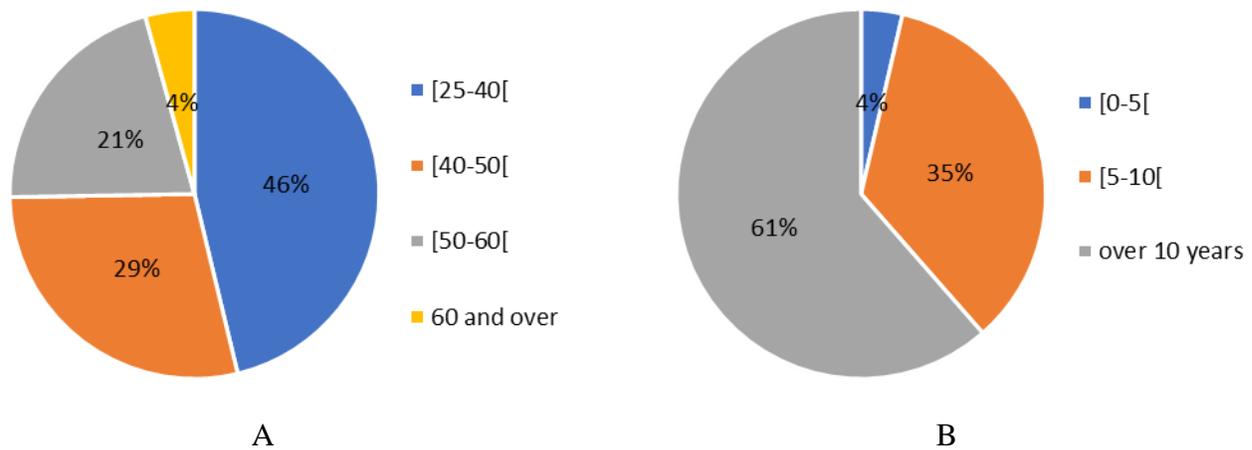
## RESULTS

### 1. Social profile

A total of 206 recreational fishermen were interviewed along the Mostaganem Coast, spread over 8 shore sites: Bahara, Petit Port, Hadjadj, Ben Abdelmalek Ramdane, Sidi Medjedoube, Salamandre, Oureah and Stidia.

Recreational fishers in the Mostaganem area were men from 25 to 63 years of age with an average age of  $42 \pm 0.67$  years, of which almost half (46%) of them were between 25 and 40 years (Fig. 2).

Moreover, the majority of the boaters (75%) were under 50 years of age, a practically young population with a significant field experience. In fact, 61% of these fishermen had more than 10 years of professional experience in the fishing industry (Fig. 2).



**Fig. 2. A. Age B. Professional experience of boaters in Mostaganem**

92% of recreational fishers in Mostaganem rely on fishing as their main source of income and livelihood. All of this community proceed to the sale of these catches, which is illicit and represents a violation of the regulations and the precise meaning of this activity, being a non-lucrative and leisure activity.

The families of these fishermen consist of 2 to 15 people with an average number of  $5 \pm 0.17$  people per family, of which 83% of these boaters are married and responsible for a family to feed. The majority of these fishermen (98%) have no social security coverage.

The level of education varied greatly from one fisherman to another, for example, some fishermen had no education, while some had high degrees, the majority had medium or secondary level (72%). All the fishermen belonged to fishing families where skills were traditionally passed down from fathers to sons, and the trade was practiced from an early age.

The majority of fishers fish close to their home areas (92%), minimizing transportation costs and any additional effort.

Overall, 32% of boaters stated that they suffer from a fishing-related illness such as rheumatism, asthma, back pain and stomach pain.

## 2. Characteristic of the fleet

The pleasure-boat fleet in the region of Mostaganem primarily consists of polyester boats with a length of 4.8m (94%), 90% of which are in good condition and are less than 10 years old since their construction. This indicates a fleet that is well-maintained, active, and powerful.

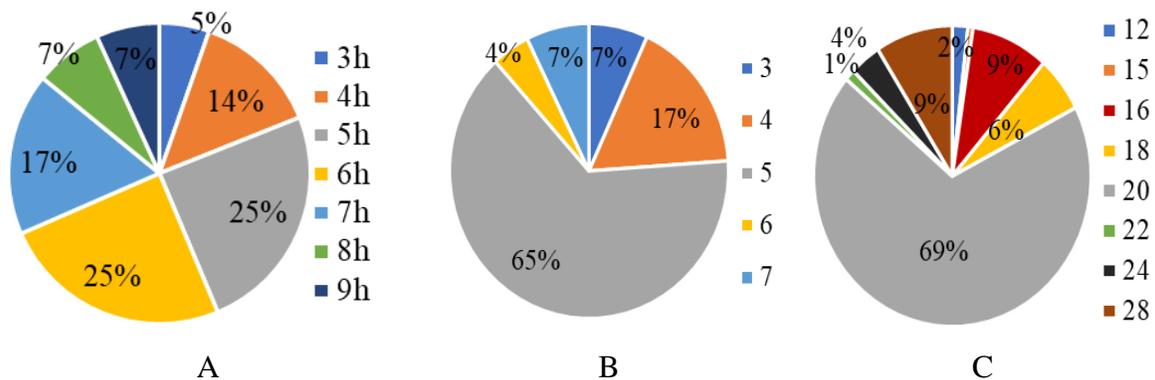
The engine power varied from 6 to 55 HP depending on the used fishing gear (Sahi & Bouaicha, 2003), with more than 50% of the fishermen using 25 or 30HP engines, which provide satisfactory power in terms of the distances to be covered and the price more or less accessible to fishermen. 96% of these engines are Japanese brands, with Yamaha accounting for 71% and Suzuki for 25%. These brands are renowned for their durability and reliability.

## 3. Fishing effort

Since most boats are 4.8m long, it can be assumed that the boat length is consistent, and these vessels frequent the same fishing grounds. The number of boats and the number of hours spent at sea were taken as measures of fishing effort.

Boaters spent between 3 to 9 hours fishing per day, with the majority (67%) spending between 5 and 7 hours, and almost all (96%) fish only once a day. The average duration of a trip was  $6.01 \pm 0.12$  hours.

71 % make 5 trips per week, 20 trips per month for 69%, and 200 trips per year for 67% of these users, as shown in Fig. (3), with an average number of trips per year of about  $210 \pm 2.91$  trips/boat/year.



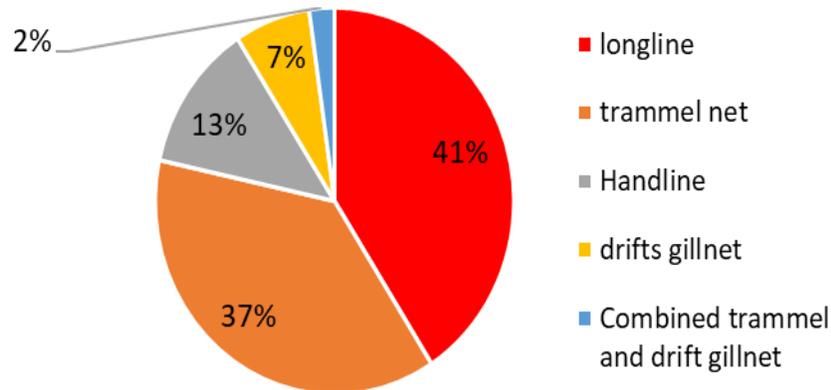
**Fig. 3.** Number of hours and days fished by recreational boaters  
**A.** hours per day; **B.** days per week; **C.** days per month

The annual number of fishing hours per boat varies between 360 and 2400h, with an average MAEF of  $1271.63 \pm 30.47h$ .

The Kruskal-Wallis test revealed a significant difference in annual fishing effort between the different sites studied, with probability of  $P= 7.58 \cdot 10^{-6}$ . The Wilcoxon test indicates that only Bahara had a different and lower annual fishing effort than the Sidi Lakhder, Sidi Medjedoube and Stidia sites.

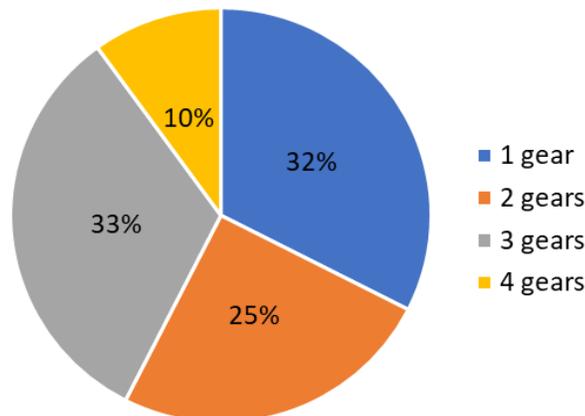
A total of 321 fishing authorizations were provided by the DPRH of Mostaganem for the year 2019, of which we consider this figure as the number of active boats in the region, although the number of vessels counted is more than double of the latter. Moreover, 33% of the fishermen surveyed do not have a fishing authorization. The current case is similar to the fishermen of Cap de Creus in Spain (Lloret *et al.*, 2008).

Recreational boaters use a variety of fishing gears, the main ones being the following: longline (41%), trammel net (37%), handline (13%), drifts gillnet (7%) and combined trammel net and drift gillnet (Fig. 4).



**Fig. 4.** Main gears used in recreational fishing in the Mostaganem region

Throughout the year, 32% of boaters use one gear (trammel 69%, or longline 31%); 25% use two gears (60% trammel and longline); 33% use 3 gears (trammel, longline and drift gillnet), and 10% use 4 gears (Fig. 5).



**Fig. 5.** Number of gears used throughout the year

#### 4. Fisheries production

The average daily landing varied from 2 to 20kg per boat, with an average of  $7 \pm 0.23$ kg.

The production per unit of effort per hour varied between a minimum of 0.21kg/h and a maximum of 2.5kg/h, with an average MCPUE production of about  $0.85 \pm 0.03$ kg/h (Table 1).

**Table 1.** Number of fishing hours, CPUE and estimated total production of recreational fishers in the Mostaganem area

h/day	h/year	CPUE (kg/h)	number of fishermen	h/year population	Annual catch kg
6.01	1271.63	0.85	321	408192.11	345550.19

In accordance with the previously mentioned fishing effort results, which revealed notable differences between certain study sites, the production per unit effort demonstrates a significant variance according to the Kruskal-Wallis test ( $P = 0.000719$ ). This distinction highlights the Hadjadje site's low production (0.61kg/h) compared to Bahara and Stidia, as well as the disparity between the Sidi Adjel site and Stidia. Fishermen in Sidi Adjel engage in fishing activities less frequently than those in Stidia.

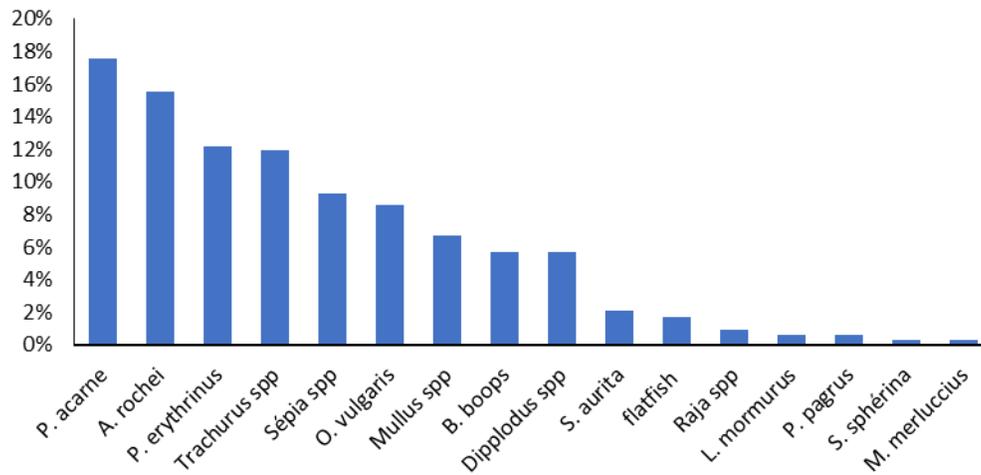
Given that the annual number of fishing hours is about 1271.63h, we estimated an annual CPUE of 1076.4kg/ unit

This provides an overall TC production of 345 tons by the recreational fishing in the Mostaganem area.

This production is composed of different species belonging to the four zoological groups: Osteichthyes, Chondrichthyes, Molluscs and Crustaceans (Fig. 6), of which the sparids dominate the catches with a percentage of 42% (Fig. 7), represented by *P. erythrinus*, *Boops boops*, *Diplodus* spp., *Lithognathus mormyrus*, *Pagrus pagrus* (Linnaeus, 1758), and *Pagellus acarne* (Risso, 1827). Considerable catches of *Trachurus* spp., *Sepia* spp., *Octopus vulgaris* (Cuvier, 1797) and *Mullus* spp., *Auxis rochei* (Risso, 1810), *Pagellus acarne* (Risso, 1827) are reported.

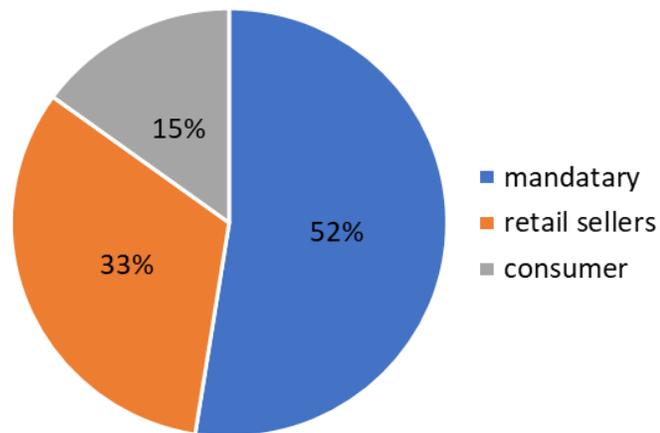


**Fig. 6.** Examples of species caught by recreational fisheries in the Mostaganem region



**Fig. 7.** Species composition of the recreational catch

All boaters in the Mostaganem region sell their caught products on the wholesale or retail market, either by auction through mandatory (52.5%) in the fishing ports or directly to retail sellers (32.5%) installed in the stranding sites. In some cases, the fisherman sells his merchandise directly to the consumer (15%) (Fig. 8).



**Fig. 8.** Destination of recreational fishery products in the Mostaganem region

The selling prices vary according to the species and/or the quantities landed, of which there are selling prices per trap or per lot or per kilogram.

The selling prices per kilo vary between 200 and 1200 DA (1.33 to 8€), with an average price of  $832.23 \pm 17.71$  DA ( $5.55 \pm 0.12$ €).

The annual income per fisherman is estimated at 6000€ (1€ is worth almost 150 Algerian dinars), providing a sum of 1.92 M € generated by recreational fishing in the Mostaganem area (Table 2).

**Table 2.** Economic value of recreational fishing in the Mostaganem region

	Capture value (million €)	Expenses (million €)	Net profits (million €)
Fisherman	0.006	0.002	0.004
recreational fishers population	1.92	0.68	1.24

### 5. Costs and expenses

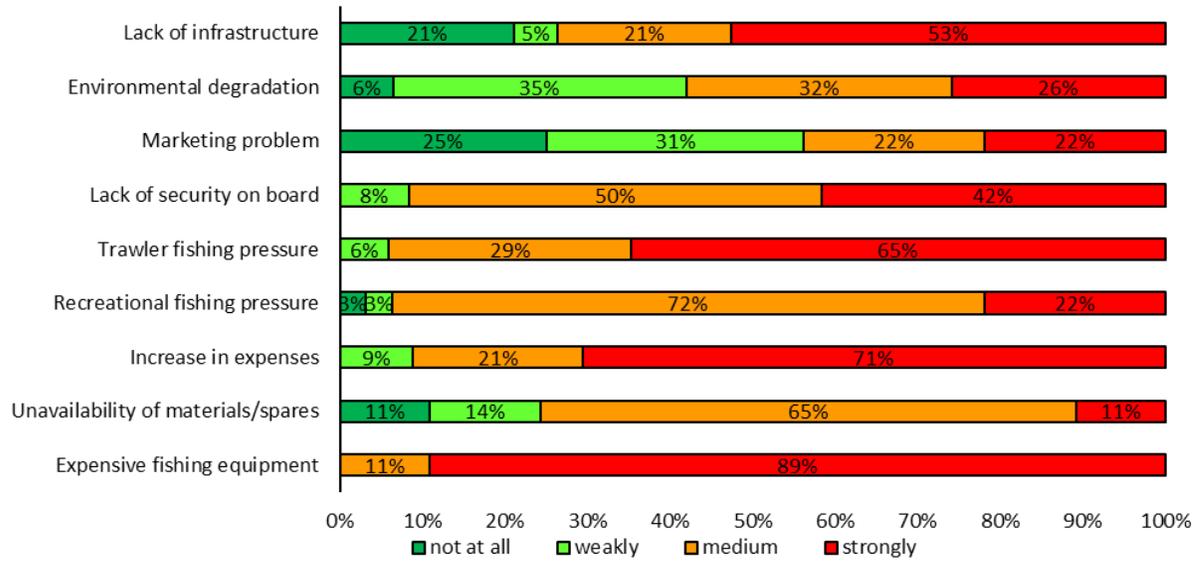
The annual expenses of the activity was estimated at almost €678 thousand. The value of the production is therefore almost 3 times higher than the sum of the annual costs and expenses, providing gross profits of about €1.24 M or a sum of €3860 per fisherman.

Income is divided into shares, with one portion allocated to the boat and the other to the crew. Among the participants, 53% utilizes a distribution model where 70% of the income goes to the crew and 30% to the boat, while 36% opt for an equal split of 50% for both the boat and the crew. A smaller percentage of 6% divides their income into 20% for the boat, 70% for the crew, and 10% for the owner. Consequently, two common formulas used for income distribution are 25% for the boat and 75% for the crew, as well as 33% for the boat and 67% for the crew.

### 6. Governance

Within the framework of governance of the trade, we asked the fishers to classify on a predefined scale (not at all, weakly, moderately or strongly encountered) for some problems posed and encountered in the trade.

Recreational boaters report that all the problems posed are either strongly or moderately addressed, as shown in Fig. (9), with the exception of the marketing of fishery products, where more than 50% reported that the sale of the fish caught is either not a problem or only weakly considered a concern.



**Fig. 9.** Problems encountered by boaters

The fishermen highlight several significant challenges faced in their fishing activities, including the exorbitant cost of fishing equipment, escalating charges and expenses, intensified competition from trawlers, and inadequate infrastructure. Additionally, recreational fishermen express concerns about the pressure exerted by fellow pleasure boaters, the unavailability of equipment and spare parts, the absence of security measures aboard the boats, and environmental degradation caused by factors such as pollution and unregulated fishing and hunting activities.

As a remedy to this situation, boaters suggest some solutions and expectations for development on the part of the authorities concerned in the fishing sector generally and recreational fishing more specifically. The following points are mainly mentioned:

- To provide more attention and support to this fishing sector, promoting financial aid and facilitating the procedures to integrate this profession;
- Strict and firm application of the regulations;
- Establishment of safety measures for fishermen along its fishing activity, whether in fishing ports, on stranding sites or on board;
- To ensure the availability of material, fishing equipment and spare parts at reasonable prices.

## DISCUSSION

This study presented a first bio-socioeconomic analysis conducted on recreational fishing in the Mostaganem region, which allowed to obtain reference data on recreational fishing in the western Algerian basin.

In contrast to the different studies conducted in the Mediterranean basin (Table 3), our study showed that all recreational fishermen in Mostaganem are men (**Morales-Nin *et al.*, 2005; Lloret *et al.*, 2008; Ünal *et al.*, 2010; Font & Lloret, 2011; Tunca *et al.*, 2016**), most of whom are young (under 50 years old) with significant field experience, an age structure almost similar to recreational fishing groups in other Mediterranean regions.

Most of these fishermen are married and serve as the primary providers for their families. They constitute a resilient community striving for subsistence and future security through full-time recreational fishing, often without a fishing license. This situation compels them to exert maximum effort by employing highly profitable fishing techniques, modifying or inventing gear not specified in the regulations, and accessing the most abundant fishing locations, even venturing into prohibited areas.

**Table 3.** Age structure of boaters from previous studies

Author	Region	Male %	Woman %	Modal age	Range	Experience (+ 10 years)	Average age
Tunca <i>et al.</i> , 2016	Gokova	92	8	50-60	39-60	45 %	-
	Foça	98	2	28-38		50 %	-
Font and Lloret 2011	Cap de Creus, Spain	82	18	20-40	15-75	-	39.9
Ünal <i>et al.</i> , 2010	Çanakkale Strait, Turkey	90	10	25-49		-	
Lloret <i>et al.</i> , 2008	Cap de Creus, Spain	88	12	-	-	-	46.7
Morales-Nin <i>et al.</i> , 2005	Majorca Island, Spain	91	9	40-50	-	-	46 ± 2
This study	Mostaganem	100	0	25-40	25-63	61 %	42 ± 0.67

This induces these practitioners to commit various regulatory offenses such as the **Law 01-11; Executive Decree n° 03-481; Executive Decree n°96-121 and the Executive Decree No. 04-86:**

- Use of fishing gear prohibited for this fishing activity (trammel nets, drift nets, octopus traps);
- Sale of recreational fisheries products;
- unauthorized fishing;
- Inshore fishery.

The fishing effort characterized by the annual number of fishing hours (1271.63h) is higher than the different estimates made in the Mediterranean, of which it represents double up to 6 times more than the fishing effort exercised elsewhere (**Lloret *et al.*, 2008; Ünal *et al.*, 2010; Tunca *et al.*, 2016**) (Table 4). This is mainly due to the large

proportion of boaters who practice this fishing activity as their main sources of income (92%). However, the number of fishermen considered is small compared to the numbers recorded in other areas.

The reconstruction of the catches of the recreational fishery in the region of Mostaganem shows a production of 345 tons in representing 6% of the estimated production along the Algerian basin by **Babali *et al.* (2018)**, which is in the order of 6000 t despite the number of fishing authorizations in the region which represents 17% of the Algerian recreational fleet. This is due to the estimated annual CPUE (1076.48kg/unit), which is largely underestimated compared to the estimate of **Babali *et al.* (2018)**, which is of the order of 3325kg/unit/year. This may indicate that the recreational fishing pressure in the Mostaganem region is 3 times lower than the pressure exerted in all Algerian coastal regions.

**Table 4.** Estimates of fishing effort, CPUE, catch and economic value of recreational fisheries from previous studies in the Mediterranean

Author	Region	hr/year	No. of fishermen	CPUE kg/h	Capture t	Expenditure (€ million)	Capture value (million €)
Babali <i>et al.</i> , 2018	Algeria	-	1832	-	6092	1.52	27.87
Tunca <i>et al.</i> , 2016	Gokova	312.8	1106	0.41	141.79	2.38	1.50
	Foça	601.6	8260	0.64	3180.55	17.62	19.17
Ünal <i>et al.</i> , 2010	Çanakkale Strait, Turkey	621	1523	2.77	2623.03	2.09	9.2
Lloret <i>et al.</i> , 2008	Cap de Creus, Spain	193	409	0.09 à 1.1	20	0.20	0.16
This study	Mostaganem	1271.6	321	0.85	345	0.68	1.92

In total, recreational boaters in the Mostaganem region generate substantial net profits, estimated at €1.24 million. This sum is notably significant considering the prevailing neglect and underestimation of this fishing activity. Officially classified as a leisure pursuit rather than a profitable venture, its actual economic significance is grossly underestimated. This activity remains entirely unregulated and disregarded. Since 2008, the number of fishing permits has been on the rise, aligning with the increasing count of registered boats in the area (776 units in 2020, DPRH). This unchecked growth poses a severe threat to fisheries resources due to excessive and unregulated fishing practices.

The findings of this study advocate for rigorous enforcement of existing regulations. It recommends the gradual implementation of conversion formulas towards professional fishing, facilitating legal fishing practices with detailed identification of the types of gear used and their technical specifications. This strategic approach aims to balance the economic benefits of recreational fishing with the urgent need for sustainable resource management.

## CONCLUSION

This study underscores the escalating prevalence of recreational fishing in the Mostaganem region, marked by the use of prohibited fishing gear and, in many cases, the absence of proper authorization documents issued by the competent maritime authority. This trend has led to conflicts arising from the unstructured nature of the activity, negatively impacting fish stocks and creating unfair competition among fishing professionals. Given these challenges, it is imperative to focus on this relatively obscure and unregulated fishing sector. Rigorous monitoring of the landing sites for fished products is essential, necessitating the appointment of fisheries managers and inspectors specifically dedicated to recreational fishing products. There is a crucial need to motivate individuals in this profession to transition from recreational activities to legal, professional fisheries. This transition should be actively encouraged, supported, and widely promoted by the administrative bodies overseeing the fishing sector in the study area. In light of this situation, a comprehensive organizational framework for recreational fishing activities is paramount. Establishing this framework prior to evaluating fishing stocks is essential, as it forms an integral part of the planning and rational management of fisheries in the region.

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