Short Communication

Offshore recreational fisheries of large vulnerable sharks and teleost fish in the Mediterranean Sea: first information on species caught

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Abstract

Large-sized pelagic sharks and teleost fish are vulnerable to overexploitation by professional fisheries. To date, however, little is known about the species caught through recreational fishing. The aim of this study is to assess the catch of pelagic sharks and teleost fish in the Mediterranean Sea by recreational fishermen through an analysis of publicly available videos posted on social media. Results revealed that several vulnerable species are caught by offshore recreational fishermen: blue shark (Prionace glauca), shortfin mako (Isurus oxyrinchus), thresher shark (Alopias vulpinus), sixgill shark (Hexanchus griseus), swordfish (Xiphias gladius), and Mediterranean spearfish (Tetrapturus belone). The most commonly caught species are blue shark and swordfish, the majority of which are juvenile and released back to sea. This paper proposes new measures for handling practices in order to protect these species.

Keywords: Sharks; Pelagic fish; Recreational offshore fishing; Mediterranean Sea.

Introduction

Recreational fishing is one of the most common leisure activities carried out in coastal areas worldwide (Arlinghaus & Cooke, 2009). It brings considerable benefits to both local and national economies (Cowx, 2004), although it may not contribute to sustaining healthy fish populations (Cheung, et al., 2007). Evidence from a study on the impact of commercial fishing (mostly from pelagic longliners) on large vulnerable fish populations in the Mediterranean Sea, shows that several vulnerable species such as large pelagic sharks are caught as bycatch in offshore waters (Biton-Porsmoguer & Lloret, 2018; Mejuto et al., 2008). Several studies support the theory that the impact of recreational fishing on fish stocks could be similar to that of commercial fishing (e.g., Rangel & Erzini, 2007; Lloret et al., 2019). However, little data exists to indicate whether offshore recreational fishing has a negative impact on vulnerable pelagic fish such as sharks and billfish (Lloret et al., 2019). This lack of evidence stems from the absence of monitoring schemes and/or the lack of consistent data collection from recreational fisheries (Font & Lloret, 2014). Hence, the main goal of this study is to provide the first evidence of the impact of offshore recreational fisheries on vulnerable species using social media data. The study focuses on pelagic sharks and other large fish predators that inhabit the offshore waters of the Mediterranean Sea, and for which very little information has been available to date.

Materials and Methods

Information on the species caught was gathered from YouTube as this is one of the most widely used social media platforms around the world (Ricke, 2014). Additional information was also gathered from Twitter and Facebook. This data collection method has already been proven effective by Giovos et al. (2016; 2018) in subjects where data is limited. The search was carried out for various European Mediterranean countries using the native language of each country, using both the common and scientific names of the sharks and fish in question, as well as key words such as “fishing” in order to narrow down the search. Following the above-mentioned search criteria, YouTube videos were found for seven countries: Croatia, Cyprus, France, Greece, Italy, Montenegro and Spain. Regarding France and Spain (both of which have
Atlantic and Mediterranean coastlines), only videos from
the Mediterranean coastlines were used. The criteria for
the videos to be included in the data were that they should
be uploaded and filmed by amateur fishermen fishing
offshore using recreational boats (i.e. more than approxi-
mately 15 km from the shore). The search was restricted
to videos uploaded by fishermen using recreational
vessels and/or videos used for advertising or marketing
purposes. Documentaries and/or research projects were
excluded from the survey (Govios et al., 2018).

The period covered was from 2010 to 2019, and the
information taken from the videos included the species
captured, the estimated total length of the catch (mainly
by comparing the size of the fish with the height of
the fisherman shown, assuming they were of average build
(1.70 m, or the length of its arm), the location and date of
the catch; and most importantly, whether or not the catch
and release method was practiced and also recorded. As
a number of the videos end before showing what hap-
pened to the shark or fish, the number of catches and re-
leases is unknown. The sex of the sharks was determined
by observing visual sexual dimorphism (Colonello et al.,
2007), which was mainly looking for male claspers. Sex
was disaggregated into male, female and unknown, as
some of the videos did not show the genital area clearly.
The sex ratios are presented by percentages of females
to males. The percentage of immature individuals was
based on length at maturity studies conducted in the
Mediterranean. The sexual maturity of the Mediterranean
blue shark (Prionace glauca) is 203 cm for females and
110 centimeters in females and 90 centimeters in males
(Moreno et al., 1995). The thresher shark (Alopias
vulpinus) reaches maturity at approximately 376 cm in
females and 319 cm in males (Moreno et al., 1989). The
swordfish (Xiphias gladius) reaches sexual maturity at
110 centimeters in females and 90 centimeters in males
in the Mediterranean (ICCAT, 2018-2019). Concerning
the female Mediterranean spearfish (Tetrapturus belone),
no information is available regarding the size or weight at
which sexual maturity is reached. However, based on the
size-range found in Sicily, and its similarity with the size
range found in spawning longbill spearfish in the Carib-
bean Sea, it could be inferred that female Mediterranean
spearfish may start spawning at approximately 150 cm
LJFL (ICCAT, 2006).

Results

Four shark species (P. glauca, H. griseus, I. oxyrin-
chus, and A. vulpinus) and two pelagic teleost fish (X.
gladius and T. belone) were identified in the social media
search. The species most frequently found on social me-
dia was P. glauca (Table 1), the majority were caught
in Italy (37%), France (31%) and Spain (20%). The second
most frequent species to appear on social media was H.
gladius, which was caught in Italy (40%) and to a lesser
extent in Greece (27 %) (Fig. 1). I. oxyrinchus and A.
vulpinus were found in similar numbers, I. oxyrinchus
being mostly caught in Italy (66.7%) and A. vulpinus,
mostly caught in Italy and France (42.86% each) (Fig.
1). P. glauca, H. griseus and A. vulpinus had the highest
observed release rate after being caught (between 57% and
80%), in contrast to I. oxyrinchus, which had the lowest
rate (33%). On average, in 23% of cases it is un-
known whether sharks caught were then released. The te-

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Table 1. Recreational fishery. Total number of catches between 2010-2019 by species and country, separated by sex (M, Male; F, Female; ND, Not Determined) including Catch and Release numbers and Unknown. T (Total), (-) no data.

| Countries     | Species | A. vulpinus | H. griseus | I. oxyrinchus | P. glauca | T. belone | X. gladius |
|---------------|---------|-------------|------------|---------------|-----------|-----------|------------|
| Croatia       | M       | 0           | 0          | 0             | 0         | 1         | 3          |
|               | F       | 0           | 1          | 0             | 4         | 2         | 1          |
|               | ND      | 0           | 0          | 0             | 0         | 0         | 0          |
| Cyprus        | M       | 0           | 0          | 1             | 2         | 0         | 0          |
|               | F       | 0           | 0          | 1             | 1         | 1         | 1          |
|               | ND      | 0           | 0          | 0             | 0         | 0         | 0          |
| Greece        | M       | 0           | 0          | 1             | 4         | 0         | 0          |
|               | F       | 2           | 1          | 0             | 0         | 0         | 1         |
|               | ND      | 3           | 0          | 0             | 2         | 0         | 0          |
| France        | M       | 0           | 2          | 1             | 6         | 2         | 10         |
|               | F       | 1           | 0          | 0             | 1         | 2         | 1          |
|               | ND      | 3           | 2          | 1             | 6         | 3         | 5          |
| Italy         | M       | 0           | 0          | 3             | 6         | 1         | 19         |
|               | F       | 0           | 0          | 0             | 0         | 0         | 0          |
|               | ND      | 0           | 0          | 0             | 0         | 0         | 0          |
| Montenegro    | M       | 0           | 0          | 0             | 0         | 0         | 0          |
|               | F       | 0           | 0          | 0             | 0         | 0         | 0          |
|               | ND      | 0           | 0          | 0             | 0         | 0         | 0          |
| Spain         | M       | 0           | 0          | 0             | 0         | 1         | 10         |
|               | F       | 0           | 0          | 0             | 1         | 2         | 1          |
|               | ND      | 0           | 0          | 0             | 0         | 0         | 0          |
| Catch and Release | M       | -          | -          | 4             | -         | -         | 41         |
|               | F       | -          | -          | -             | 3         | -         | 0          |
|               | ND      | -          | -          | -             | -         | 4         | 2          |
| Italy         | M       | 0           | 0          | 3             | 6         | 1         | 19         |
|               | F       | 0           | 0          | 0             | 0         | 0         | 0          |
|               | ND      | -          | -          | -             | 4         | -         | 2          |
| Montenegro    | M       | 0           | 0          | 0             | 0         | 0         | 0          |
|               | F       | 0           | 0          | 0             | 0         | 0         | 0          |
|               | ND      | 0           | 0          | 0             | 0         | 0         | 0          |
| TOTAL         | M       | 0           | 2          | 5             | 7         | 5         | 5          |
|               | F       | 15          | 2          | 4             | 3         | 9         | 7          |
|               | ND      | 10          | 0          | 3             | 1         | 4         | 2          |

Note: The percentage of immature individuals was based on length at maturity studies conducted in the Mediterranean.
leost species most frequently found on social media was X. gladius (Table 1), with more than the half of the total number of videos originating in Greece (67.74%). This was followed by Italy and Spain (9.68% each) (Fig. 1). T. belone was only found in videos from Croatia (Fig. 1). Over half X. gladius catches (58%), and both the T. belone caught were not released.

The estimated size of P. glauca varied greatly. The most common size was 50 cm (11 of the 51 caught), followed by 100 cm and 200 cm (9 and 7 caught, respectively). Other sizes were found in lower numbers. H. griseus was mainly found at 200 cm (5 out of 14), with the rest of the sizes ranging from 100 cm to 340 cm. I. oxyrinchus was mostly observed at 100 cm (5 out of 9), and was even observed as small as 80 cm. A. vulpinus was found twice at 200 cm (out of 7 individuals), with the rest of the sizes ranging from 150 cm to 400 cm, each found once. Female to male ratio was highest for the blue shark P. glauca (68% to 14%), with 18% of unknown sex. Figure 2 shows the location of the points of capture per sex for the blue shark. In contrast, the female to male ratio was lowest for I. oxyrinchus (44.4% to 22.2%), with 33.3% of unknown sex, and for H. griseus (35.7% to 28.6%) with 35.7% of unknown sex. Less than a third of A. vulpinus (28.6%) were females; the rest were of unknown sex (71.43%).

Concerning teleost fish species, X. gladius was mainly caught at 100 cm (26% of all catches). Regarding the sexual maturity of X. gladius (100 cm), more than half of the individuals found on the videos were immature (51.6%).

![Fig. 1: A. Areas where large-sized pelagic sharks and teleost fish species are mainly caught by recreational fisheries in the Mediterranean Sea. B. Areas where the P. glauca are caught by recreational fisheries in the Mediterranean Sea.](image-url)
Discussion

Our results provide, for the first time, information on the large pelagic sharks and teleost fish caught by offshore recreational fisheries in the Mediterranean. These species caught by recreational offshore fisheries, are all vulnerable, and appear on the IUCN Red List and/or in other international conventions for the protection of fauna due to their declining populations. The blue shark (P. glauca) is considered Critically Endangered by the IUCN Red List in the Mediterranean Sea (Sims et al., 2016). Although it is a relatively fast-growing, fecund oceanic shark (Megalofonou, et al., 2009), populations have declined in the Mediterranean Sea by almost 90% in the past 30 years (Sims et al., 2016). The shortfin mako shark (I. oxyrinchus) (Walls et al., 2015) is also considered Critically Endangered in the Mediterranean Sea by the IUCN.

All the shark species included in this study are included in UNCLOS Annex I as Highly Migratory Species. The blue shark and the shortfin mako shark are both in Annex III of the Barcelona and Bern Conventions, which is a list of protected species whose exploitation is regulated (Cavanagh & Gibson, 2007). Another important big game fish in this study was the swordfish (X. gladius), which is subject to Near Threatened (Collette et al., 2011). All are subject to overfishing and poor fishery management practices. For example, catch rates of blue shark in the region have declined considerably due to overexploitation by commercial fisheries (Biton-Porsmoguer, 2017; Biton-Porsmoguer & Lloret, 2018). This could possibly also be due to recreational fisheries, as our study shows.

It is worth noting that a significant portion of the catch of large pelagic shark and teleost species found in the videos, whether caught intentionally or as bycatch of recreational offshore fisheries, mostly consisted of immature individuals (over 90% for sharks). This leads to easy depletion of their populations, with no chance of recovery (Camhi et al., 2008). This is in line with a study by Saidi et al. (2019) which explores the status of exploited shark populations in the Gulf of Gabes between 2007 and 2017, showing that catches mainly comprise juveniles. This is especially the case for catches of the blue shark, the large predatory elasmobranch most captured by offshore pelagic fisheries in the Mediterranean Sea, and mainly consisting of immature individuals (98%).

The smallest sizes of P. glauca (about 50 cm) are found around France and Western Italy, the majority of which are female (Fig. 2). This coincides with data provided by Kohler et al. (2002) which states that the Mediterranean Sea has mainly small-sized, immature blue sharks, with a sex-ratio biased towards females. This could indicate that blue sharks are using the areas as nurseries, as research suggests that juvenile sharks under 130 cm do not migrate long distances (Nakano & Stevens, 2009; Vande-perre et al., 2014). However, a great deal more information is needed to draw conclusions on this.

The impact of offshore recreational fisheries on vulnerable fish species may be minimal as most fish, except for I. oxyrinchus and the billfish, appear to be released back into the water. This means that fishery managers in offshore recreational fisheries need to consider better handling practices in order to release live fish in the best possible condition. The manual “Good practices to reduce the mortality of sharks and rays caught incidentally by tropical tuna purse seiners”, published by ICCAT, provides handling tips that could be followed by recreational fishermen (Poisson et al., 2012). For both the shark’s health, and the safety of the fishermen, it is advisable to keep the shark in the water. Ideally, a recreational fisherman should have pliers or a de-hooker and thick leather gloves onboard so as to be able to remove the hook from the shark’s mouth (Scharf, 2002). Using hooks without bars makes their removal easier, or corrodng bronze-finished hooks which eventually corrode and fall out (Fowler & Partridge, 2012). Nylon leaders have been shown to reduce the catch of sharks (Ward et al., 2008) and result in fewer conflicts with fishermen in cases of recreational fishing. Changing bait is unlikely to result in fewer shark catches as sharks are considered opportunistic feeders (Stevens, 1973). Thus, fishermen should be adequately prepared, and equipped with the right tools to return the animal back to its environment in a way that insures its safety and wellbeing.

All catches reported in this study are from regions within the European Union, with the exception of Montenegro. Since December 2017, the Commission Delegated Regulation N° 2018/19 of the European Union authorizes catching one individual swordfish per day and per fishing vessel. The individual swordfish should not be smaller than 100 cm fork length, or weigh less than 10.2 kg. In Spain, recreational fishermen cannot fish blue sharks or any other pelagic sharks (Spanish law APM/1057/2017), but they are not obligated to report bycatch. In Montenegro the Law on Marine Fisheries and Mariculture (Law Nr. 56/2009, 47/2015) forbids the removal of the head, skin or fins from any shark or ray caught. In addition, 16 shark species are protected by law and a permanent ban on catching them is in place: Cetorhinus maximus, Carcarodon carcharias, Carcharias taurus, Galeorhinus galeus, I. oxyrinchus, Lamna nasus, Odontaspis ferox, Oxynotus centrina, Pristis pristis, Pristis pectinata, Sphyraena lewini, Sphyraena zygaena, Sphyraena mokarran, Squatina aculeata, Squatina oculata and Squatina squatina. Each individual shark of these species must be released alive and unharmed if accidentally caught.

The present study sheds light on critical aspects of abundance of these species, although further research on the impact of recreational offshore fisheries on large pelagic sharks and teleost fish is needed. Future studies could explore the effects of offshore recreational fisheries on shark species and develop a feasible sampling design, which would increase the reliability in the data collection. As with any other data collection method based on social media, the information analyzed herein might include potential bias that should be taken into account (Giovos et al., 2016; 2018).
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