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Integrating local ecological knowledge, citizen science and long-term historical data for endangered species conservation: Additional records of angel sharks (Chondrichthyes: Squatinidae) in the Mediterranean Sea

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Abstract

1. All three species of angel sharks (genus *Squatina*) inhabiting the Mediterranean Sea are listed as Critically Endangered in the IUCN Red List of Threatened Species due to overexploitation.
2. New records from Cyprus, Greece, Italy and Libya were collected from citizen-scientists integrated with local knowledge obtained using structured-interviews in the four countries.
3. Observations and reports together with an analysis of the reconstructed fisheries data resulted in the identification of areas of interest, a review of the illegal trade of the species and a debate about the credibility of fisheries data for assessing threatened and/or protected species
4. Unconventional sources of information, such as social media, were identified as important tools for monitoring rare and endangered marine wildlife.
5. This work will contribute to promoting international cooperation for advancing angel shark conservation in line with the Eastern Atlantic and Mediterranean angel shark Conservation Strategy.

Keywords: Sawback angelshark, Smoothback angelshark, Mediterranean, unconventional sources, threatened species

1. Introduction

About 16% of the 465 species of sharks are threatened with extinction globally (Bräutigam *et al.*, 2015; Dulvy *et al.,* 2014). The single genus *Squatina,* includes 24 species (Froese & Pauly, 2018), 11 of which are listed as Threatened in the IUCN Red List of Threatened Species (IUCN, 2018). Angel sharks are flat-bodied coastal species, with extremely broad pectoral fins, dorsally located eyes and spiracles. They are moderately sized (average length around 1-1.5 m) and distributed over a wide geographical range,

from temperate to tropical marine waters. The majority of the species are restricted to small areas, inhabiting the continental shelf and upper slopes down to 500 m (Compagno, 1984; Compagno, Dando, & Fowler, 2005; Last & White, 2008; Stelbrink, von Rintelen, Cliff, & Kriwet, 2010). Because of their life characteristics (i.e. slow growth, low reproductive rate and demersal nature), and due to the intensification of fisheries, angel sharks are now the second, after sawfishes, most threatened family of elasmobranchs in the world (Pristidae) (Dulvy et al., 2014).

The Mediterranean Sea is an important habitat for cartilaginous fish (Bradai, Saidi, & Enajjar, 2018), and hosts three angel shark species; the sawback angelshark (*Squatina aculeata* Cuvier, 1829), the smoothback angelshark (*Squatina oculata* Bonaparte, 1840) and the angelshark (*Squatina squatina* Linnaeus, 1758). The Mediterranean populations of all three species are listed as "Critically Endangered" in the IUCN Red List of Threatened Species (IUCN, 2018), due to their steep decline and local extinctions, as a result of the historical and current overexploitation by demersal fisheries and primarily trawl fishing (De Maddalena, Baensch, & Heim, 2016; Gordon *et al.,* 2017; Miller, 2016; Nieto *et al.,* 2015; Walker, Cavanagh, Ducrocq, & Fowler, 2005). Currently, their distribution in the basin appears scattered with several local extinctions (Gordon *et al.,* 2017; Ferretti et al., 2016; Soldo & Bariche, 2016) while observations are extremely limited and the species are commercially extinct (Cavanagh and Gibson, 2007; Gordon *et al.,* 2017; angel shark Sightings Map, 2018).

Official fishery catch data can potentially provide valuable information and an extended time series of data, regarding population trends of primarily commercial and relatively abundant species, as angel sharks in the past (Cavanagh et al., 2007). However, in many cases, catch data lack accuracy (Pauly & Froese, 2012) because they do not include discarded, subsistence, recreational and non-reported catches, all of which are referred to as Illegal, Unreported and Unregulated catches (IUU). In addition, angel sharks, although not targeted nowadays due to their scarcity, it is possible that when they are caught are, often deliberately or unintentionally misreported (Dulvy *et al.,* 2014) and recorded within another group of elasmobranchs (e.g. guitarfish, rays, etc.), thus jeopardizing accurate data reporting about these species.

The scarcity of the observations, the deficiencies in the poor monitoring of angel sharks by the official authorities and the low economic value of their catches make the use of non-conventional information such as Local Ecological Knowledge (LEK) (Stephenson *et al.*, 2016), social media and citizen science vital. These are frequently used as alternative sources of information when conventional data are not available (Moutopoulos, Dimitriou, Katselis & Koutsikopoulos, 2017); supplementing and validating scientific knowledge, thus empowering marine scientists and managers to improve conservation and policy (e.g. Giovos, Chatzispyrou, Doumpas, Stoilas, & Moutopoulos, 2018; Johannes, Freeman, & Hamilton, 2000) even in the case of the extremely rare angel sharks in the Canary Islands and the Adriatic Sea (Meyers *et al.*, 2017 and Holcer & Lazar 2017, respectively).

This study presents additional records of the three Mediterranean angel shark species from Cyprus, Greece, Italy and Libya, collected in the context of three citizen science projects, and complemented with information obtained through targeted interviews and reconstructed fisheries data (Pauly & Zeller, 2016). Through the integration and the analysis of such a multidisciplinary information will: (a) facilitate the identification of potentially important regions for the angel shark populations in the Central and Eastern Mediterranean Sea, (b) initiate the discussion on the illegal trade of the species in the basin, (c) debate about the credibility of fisheries data for threatened and/or protected species, and (d) highlight the importance to utilize unconventional sources, such as social media, for monitoring rare marine wildlife. It also aims to promote international cooperation for advancing angel shark conservation in the Mediterranean Sea.

2. Materials and Methods

In the context of this study, a variety of sources were used to collect data about occurrences of angel sharks from four Mediterranean countries; namely Italy, Libya, Cyprus and Greece. Citizen science reports accompanied by photographic evidence and data on the historical and current occurrence of the species were collected, based on targeted interviews. The findings were complemented with an analysis of the reconstructed fisheries data found in the Sea Around Us catch database.

2.1. Citizen Science Reports (CSR)

CSR reports were collected in the context of three citizen science projects, utilizing to a large extent social media for broadcasting a call for reports. The projects were: "Sharks and Rays in Greece and Cyprus" by iSea, taking place in Greece and Cyprus as part of the Mediterranean Elasmobranch Citizens Observation (M.E.C.O.) project, "AlienFish – alien and rare fish species" by ENTE Fauna Marina Mediterranean, taking place in Italy (Tiralongo, Messina, Coco, & Lombardo, 2018), and "Marine Biology Libya" by Marine Biology Libya, taking place in Libya. These are long term projects that between 1/1/2018-1/5/2018 posted an open call on their social media platforms requesting reports and pictures of angel sharks. People reporting sightings were further requested to provide photographic evidence of the observed specimens and information on the specimens' size (total length) and/or weight, depth of the observation (when applicable), date of the observation, the exact location (if possible, with coordinates), and the number of observed individuals. All pictures reported, were checked for their authenticity and originality using the automatic image recognition tool of Google. All original images were recorded in a single Excel spreadsheet and photo-identified to the lowest possible taxonomic level. Thus, a verified citizen science model was utilized, in which observations were checked by experts (Gardiner *et al*., 2012).

2.2. Targeted Interviews

LEK of marine observers was used to complement CSR and collect additional information on the historical occurrence of angel sharks in the four countries. Credibility of interviewees is a known problem of LEK data that can compromise the quality of the information (Davis & Wagner, 2003). In the above-mentioned projects even though a large number of people participate (approximately 5000), only a small fraction of them were selected based on the following criteria: (i) regularly report observations of elasmobranch species to the projects, (ii) display high success in self-identifying the elasmobranch species they report before the expert identification and (iii) appear to be highly motivated in helping and participating. Each criterion was scored either 0 or 1 based on the three criteria. Only those participants who scored 3 were included in the study independently of the spatial coverage. The structured questionnaire used during the interviews, had a skip-logic structure,

providing different options according to whether the respondent observed an angel shark species or not (See Appendices). The aim was to retrieve **current observations (CO)** and **historical observations (HO)** of the species. All interviews were conducted by three independent researchers, one from each project (Cyprus-Greece, Italy and Libya) in situ or via skype. Before conducting the interviews, the researchers were instructed to present the questionnaire in the same way.

2.3. Fisheries data

The reconstructed Sea Around Us catch data, available at www.seaaroundus.org, (Pauly & Zeller, 2016), were used. Data were organized by fishing country and fishing sector, using the data series between 1950-2014. Reconstructed catches combine official reported landings from the Food and Agriculture Organization of the United Nations (FAO) (FishStat Plus, 2018: http://www.fao.org/fishery/statistics/en) and reconstructed estimates provided by the SeaAroundUs database for each studied country. The latter includes an unreported portion of the catches that is not properly covered by the official national statistics, such as artisanal catches, discards, recreational and subsistence fisheries that are derived from government sources, independent studies and surveys, local experts and the grey literature, and followed the general catch reconstruction approach outlined in Zeller & Pauly (2006). Hence, the use of such reconstructed data enhance further the integrated approach to vulnerable species that are not recorded by official authorities. Reports from 11 Mediterranean areas of southern Europe, Northern Africa and East Asia were analysed for the aforementioned period; Cyprus (Ulman *et al.*, 2015), Egypt (Mahmoud, Teh, Khalfallah, & Pauly, 2015), Israel (Edelist *et al.*, 2013), Syria (Ulman, Saad, Zylich, Pauly, & Zeller, 2015b), Malta (Khalfallah, Dimech, Ulman, Zeller, & Pauly, 2017), Tunisia (Halouani, Lasram, Khalfallah, Zeller, & Pauly, 2015), Turkey (Marmara and Mediterranean Seas: Ulman *et al.*, 2013), Morocco (Mediterranean Sea; Belhabib, Harper, Zeller, & Pauly, 2013), Algeria (Belhabib, Pauly, Harper, & Zeller, 2013), Italy (Sicily) (Piroddi *et al.*, 2015) and Libya (Khalfallah, Belhabib, Zeller, & Pauly, 2015).

3. Results

3.1. Citizen Science Reports

Fifteen CSR angel shark records from the four countries were obtained during this study; 14 of which were accompanied with photographic evidences (Table1; Figures 1 and 2). The only observation that was not accompanied by photographic evidence (No 10; Table 1; Figures 1 and 2) was recorded because it was reported by the same person who reported three other records of angel sharks (No 9, 11 and 13 in Table1; Figures 1 and 2). Two observations could not be identified down to species level due to the poor quality of the picture. The most CSR were from Greek waters (≈43%; N=6), followed by Libya (≈36%; N=5), Italy (≈14%; N=2) and Cyprus (≈7%; N=1). Half of the specimens were identified as *S. squatina* (50%; N=7), and the rest were identified as either *S. aculeata* (≈21%; N=3) or *S. oculata* (≈14%; N=2). Unfortunately, in most cases, the individuals were already dead when reported to the projects.

3.2. Targeted Interviews

Thirty-nine targeted interviews were conducted with 19 (≈49%) taking place in Greece, followed by Italy (≈33%; N=13), Cyprus (≈10%; N=4) and Libya (≈8%; N=3). Almost 1/3 of the respondents were professional fishers (≈33%; N=13), followed by recreational fishers (≈31%; N=12), divers (≈28%; N=11), biologists (≈2.5%; N=1), fishmongers (≈2.5%; N=1) and other sea users (≈2.5%; N=1). Only 10 interviewees reported CO of angel sharks in their areas, the majority from Italy (Table 2; Table S1), where six professional fishers reported an area (N-W off the coast of Trapani, 38°24,635 N; 11°34,270 E) that angel sharks are considered relatively common, mostly caught by bottom trawlers. The other four CO were from Greece (N=2; Alexandroupoli and Kos Island) and Libya (N=2; Gulf of Sirte: Ras Lanuf and Qaminis) (Figure 1; Table S1). All who reported CO from Italy and Libya stated that they observe angel sharks frequently in their areas (N-W off the coast of Trapani and Gulf of Sirte respectively). Interestingly, six interviewees from Greece reported HO of angel sharks (Table 2; Figure 1). In Italy, professional fishers from Sicily and Calabria stated that catches of *Squatina* spp. individuals were relatively common off the south-eastern coasts of Sicily (Ionian Sea) 30 years ago, when they were caught with trammel nets and gill nets (140 mm of mesh size), and off the west coast of Calabria 20

years ago, when they were usually caught with longlines. Historical evidence on angel sharks (Figure 1) also overlay with the CSR observations and LEK reports.

3.3. Fisheries Data

In four out of the 11 studied countries (12 areas) catches of angel sharks were recorded in only one or two years out of the 64 years (1950 -2014) analysed (i.e. Morocco, Algeria, Italy (Sicily) and Libya; for these countries separate analyses on annual catches were not included herein. In contrast, only Turkey (for catches derived both from Marmara and Mediterranean Seas) had catch records covering the entire study period 1950-2014 (Figure 3), followed by Malta (records for 59 years), Egypt (records for 57 years) and Syria (records for 54 years) (Figure 3). Turkey accounted for almost 80% of the mean (1964-2014) annual reconstructed angel shark catches throughout the Mediterranean basin (Table 2), with Syria, Tunisia and Egypt cumulatively contributing 20.4% and the remaining countries contributing less than 1% (Table 2). In general, angel sharks represent a very small portion of each country's reported catches (less than 1% in all cases) (%' in Table 2).

The annual landing trends of angel shark catch per country only exhibited a long-term increasing trend in Egypt, whereas a long-term decreasing trend was only exhibited for catches reported by Turkey. It is worth noting that a sudden increase of angel shark was reported from Syria, from around 25t before 2000 to more than 100t during 2002-2006. Likewise, for the catches reported from Tunisia, angel shark records appeared only after 1995, and since 2014 have fluctuated around 25 t/year (Figure 3). With respect to the combined country reconstructed catch data, a declining trend was observed during 1963-1973 followed by an upward trend between 1973-2014, mostly due to the increased catches reported from Syria and Turkey (Figure 4). More than half of the total Mediterranean reconstructed angel shark catches were caught by trawlers (59.9%), mostly originating from Turkey (90% and 60% in Mediterranean and Marmara Sea, respectively) and Libya (70%), whereas small-scale fisheries contributed 39.7% that were mostly derived from Tunisia, Malta and Egypt (collectively more than 90%). Longlines represented a very small portion of the total catches (0.4%), mainly due to their

exclusive use in Algeria (100%), and to a lesser extent in Libya and Tunisia (less than 10% in both countries).

Discussion

These additional records of all three angel shark species found in the Mediterranean Sea were obtained and compared with fisheries-related information derived from LEK through in-depth targeted interviews and complemented with reconstructed catches from official reported data and historical information. All three species are enlisted in the Annex II (list of endangered or threatened species) of the SPA/BD Protocol, which, based on Recommendation GFCM/36/2012/1, cannot be retained on board, trans-shipped, landed, transferred, stored, sold or displayed or offered for sale, and must be released unharmed and alive to the extent possible. In addition, *Squatina squatina* is included in Appendix I and II (2017) of the Convention on the Conservation of Migratory Species of Wild Animals (Appendix I-Endangered migratory species/ Appendix II-Migratory species conserved through Agreements). Law enforcement is poor in all the Mediterranean countries (Beddington, Agnew, & Clark, 2007) and given the fact that in most of them elasmobranchs were landed in aggregated categories, misreporting, mislabeling and illegal trade is potentially taking place in the basin. However, no records of illegal trade or an illegal fishery for angel sharks have been reported in the Greek Seas during the last 15 years, based on the official fisheries infringement data derived from the coast guard authorities of the Ministry of Mercantile Marine (period of 1999-2013: Moutopoulos, Prodromitis, Mantzouni, & Koutsikopoulos, 2016).

Turkey is the only Mediterranean country with continuous landings that either implies a targeted fishery (Kabasakal & Kabasakal, 2014), or that it is the only country reporting angel shark landings accurately. In this context, Turkey is the only country for which discard quantities of angel sharks, especially from trawls, have been also included in the reported catches with a discard/catch ratio estimated of 3.4:1. This is a very high estimate when compared with the corresponding estimates from the adjacent Greek fisheries (for the Aegean Sea: 0.353:1; Machias *et al.*, 2001). On the other hand, Greece is the only country with no reported angel shark landings, according to the taxonomic

disaggregation reported by HELSTAT (1967-2017) (Moutopoulos and Koutsikopoulos, 2014), which is probably due to the aggregated landing categories (6 elasmobranch landing categories).

Angel sharks are not currently target species in the Mediterranean due to their scarcity and normally are caught as a by catch. In both cases (i.e. targeted fishery or incidental catch) fraudulent or erroneous labelling is possibly taking place is all Mediterranean countries, because of four main reasons: (i) aggregated elasmobranch landing categories, (ii) poor training of the monitoring authority staff (iii) the low awareness of the fishing communities about the legal and the conservation status of these species and (iv) spiritual reason (e.g. in Turkey angel shark meat is considered to help fighting cancer) . Illegal trade in elasmobranchs has been found in several markets around the globe (Feitosa et al., 2018) and in some Mediterranean countries (Barbuto *et al.,* 2010; Arculeo, 2015; Pazartzi et al., 2019) while Vasconcellos Bunholi *et al.* (2018) found illegal trade of angel sharks in Brazil. Angel shark landings are might aggregate with the landings of other batoid species, such as *Raja* spp. and guitarfish, as a result of misidentifications, but lately also because of the intentional misreporting due to the legal framework that protects the species. Misreporting is also helped by the morphological characteristics of these species, in this case flat body shape, that can be easily mistaken or sold as batoids once skinned. In Greece, for example, angel sharks used to be a very popular dish in the past, named “Rina” which is the common name of the species in Greek; it is still common to “Rina” in local markets and restaurants however it refers to *Dasyatis* spp. and *Raja* spp. species. Yet, fishmongers, retailers, chefs and restaurant owners, prefer to sell dishes of *Dasyatis* spp. and *Raja* spp. as “Rina” that is well known and more expensive, thus increasing their profitability (pers. obs.). In Libya, commercial fishers normally skin angel sharks and sell them as “Kulb baher” which means sea dog which is the name used for selling almost all shark species (Pers. Comm. with Sara A. A. Almabruk). In Italy, this species is very rare and usually when it is caught is eaten by fishers (Pers. Comm. with Francesco Tiralongo) a common pattern for elasmobranchs globally (Begossi, 2006), which makes impossible to estimate the total elasmobranch fishery as self-consumption is normally not included.

In situ observations of different angel shark species in Cyclades and Dodecanese Islands confirm the current presence of all three angel shark species in Greek waters. It is notable that the three observations of *S. aculeata* reported in this study are the first in the Aegean Sea in the last 10 years (Soldo & Bariche, 2016). The records from South Cyclades (CSR No 9, 10, 11, 13), Rhodes Island (CSR No 2, 15) and the CO and HO off the coast of Rhodes and Alexandroupoli indicate interesting areas for the species within the Greek waters. The statements of the Italian and Libyan fishers about relatively frequent angel shark captures and observation in the Tyrrhenian Sea and the Gulf of Sirte, respectively, could additionally indicate areas of interest for further actions in fisheries management and the decision-making process. In the Tyrrhenian Sea, although fishers did not clearly indicate which angel shark species are present, species of the genus *Squatina* are historically well-known and reported as relatively common in catches with bottom trawl, as supported by the reconstructed catch data from the Sicilian waters. For Cyprus, Hadjichristophoru (2006) mentioned that these species are occasionally found in Cypriot waters. However, their records are almost completely absent from the reconstructed fishery catch data (Ulman et al. 2015a). Nevertheless, it should be noted that close to the island is the Iskenderun Bay, where recent records of juvenile *S. aculeata* were reported, suggesting a reproduction or a nursery ground (Basusta, 2016).

This work, additionally, provides evidence of the important role that citizen science, social media and LEK can play in data gathering but also in the conservation for rare and endangered species. The value of citizen science and social media for data gathering has already been proven for angel sharks (Holcer & Lazar, 2017; Meyers *et al.,* 2017), as well as for other elasmobranch species in the Mediterranean Sea (Giovos *et al.*, 2018), the same is true for LEK (Barash, Pickholtz, Pickholtz, Blaustein, & Rilov, 2018; Coll *et al.*, 2014; Gonzalvo, Giovos, & Moutopoulos, 2015; Fortibuoni, Borme, Franceschini, Giovanardi, & Raicevich, 2016). In this work, citizen science data accompanied with the current knowledge and the official fisheries catch reports provided important information about an extremely threatened family of species. However, as in any other data collection approach, the information obtained through social media, CSR and LEK might include biases and uncertainty (e.g. Davis & Wagner, 2003; Katsanevakis &

Moustakas 2018; Thurstan, Buckley, Ortiz & Pandolfi, 2016), which must be taken into account when policy and conservation measures are designed. It is important to further explore in a larger, massive spatial scale (e.g. the whole Mediterranean with the participation of more projects, organizations and scientists) our understanding about angel sharks and other threatened species distribution in the basin (Tulloch *et al.*, 2018), by designing cooperative communication campaigns asking for information about such species. These efforts work towards two directions, improving data availability and increasing public awareness, advancing conservation.

In 2017, the Eastern Atlantic and Mediterranean Angel Shark Conservation Strategy was presented (Gordon *et al.*, 2017), proposing a first conservation plan for angel sharks specifically for the Mediterranean Sea, including the enhancement of our understanding of the species distribution, the quantification of the incidental catches, and the enforcement of the existing management measures (Gordon *et al.*, 2017). In this context, the Angel Shark Conservation Network (https://angelsharknetwork.com/) was developed for delivering the objectives laid out in the action plan and to receive updates on angel shark conservation news. This network will act as the umbrella for an international effort in the Mediterranean Sea, fostering international cooperation, strengthening our knowledge and influence conservation policy for the threatened angel sharks. Especially in the field of the fish resources, the management of which is performed at a European scale, the development of a database concerning, apart from fisheries information, socio-economic aspects of fisheries will enhancing fisheries' monitoring and contribute to the definition of efficient managerial measures at a regional level. The present study aims to contribute towards this effort by providing additional data about angel shark occurrences in the basin, along with other recent studies (Fortibuoni *et al.*, 2016; Holcer & Lazar, 2017). Further research effort, which could be carried out to reinforce our findings, should be directed towards the incorporation in the official monitoring scheme of the utilization of LEK in the "hot-spot" areas for angel sharks in a broader scale campaign targeting the whole Mediterranean basin with the participation entities from every country, in order to explore additional areas of interest. Field research should include underwater visual census surveys and/or

experimental fishing depending the bathymetry of the locations. An awareness campaign is also of imperative importance, for educating fishers on reporting and safely releasing angel sharks.

Angel sharks are still fished and potentially consumed in the Mediterranean Sea despite the strict and prohibitive legislation that applies in all countries. This must urgently be brought to the attention of the national authorities, while NGOs and other interested parties should work more actively towards the education of the public and, primarily, of professional and recreational fishers.

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Tables

Table 1. Citizen Science observations of angel sharks reported to the three citizen science projects. The location of the observations can be found in Figure 1, while the pictures of the observations are shown in Figure 2.

#	Date	Location	Species observed	N of specimen	Type of observation	Size (m)	Depth (m)	Substrate
1	29/07/2015	Sitia, Crete, GR	*S. oculata*	1	Nets	-	20	-
2	01/07/2017	Rhodes Island, GR	*S. squatina*	1	Found stranded	-	-	-
3	02/12/2017	Marzamemi, Sicily, IT	*S. aculeata*	1	Trammel net	-	70	Sandy with scattered rocks
4	05/12/2017	Marzamemi, Sicily, IT	*S. oculata*	1	Trammel net	-	55	Sandy with scattered rocks
5	14/12/2017	Ras Lanuf, LB	*S. squatina*	3	Recreational fishing	1	-	Sandy-muddy
6	02/02/2018	Brega City, LB	*S. squatina*	2	Professional trammel net	1	50	Sandy-muddy
7	04/02/2018	Brega City, LB	*S. squatina*	1	Professional trammel net	1.1	-	Sandy-muddy
8	04/02/2018	Geminis, LB	*S. squatina*	1	Boat-based Recreational fishing	0.8	-	Sandy-muddy
9	23/02/2018	Cyclades, GR	*S. aculeata*	1	Bottom trawler	1.2	165	Rocky
10	25/02/2018	Cyclades, GR	*Squatina* spp.	1	Bottom trawler	2	229	Rocky
11	11/03/2018	Cyclades, GR	*S. squatina*	1	Bottom trawler	1.5	236	Rocky-muddy
12	14/03/2018	Ras Lanuf, LB	*S. squatina*	1	Recreational fishing	1	-	Sandy-muddy
13	29/04/2018	Cyclades, GR	*S. aculeata*	1	Bottom trawler	1	130	-
14	09/05/2018	Paralimni, CY	*Squatina* spp.	1	Boat-based Recreational fishing	0.7	60	Sandy
15	13/11/2018	Rhodes Island	*S. aculeata*	1	Boat-based Recreational fishing		330	

Table 2. Percentage contribution of the mean annual angel shark reconstructed catches per country for the Mediterranean waters during 1950-2014. %' indicated the percentage representation of angel shark to all combined country reconstructed catches.

Country	%	%'
Cyprus	0.11	0.011
Egypt (Mediterranean)	2.11	0.010
Israel (Mediterranean)	0.05	0.003
Libya	0.01	0.000
Malta	0.42	0.063
Sicily (Italy)	0.04	0.000
Syria	10.72	0.018
Tunisia	7.59	0.787
Turkey (Marmara Sea)	58.19	0.266
Turkey (Mediterranean Sea)	20.75	0.028
Algeria	0.01	0.000

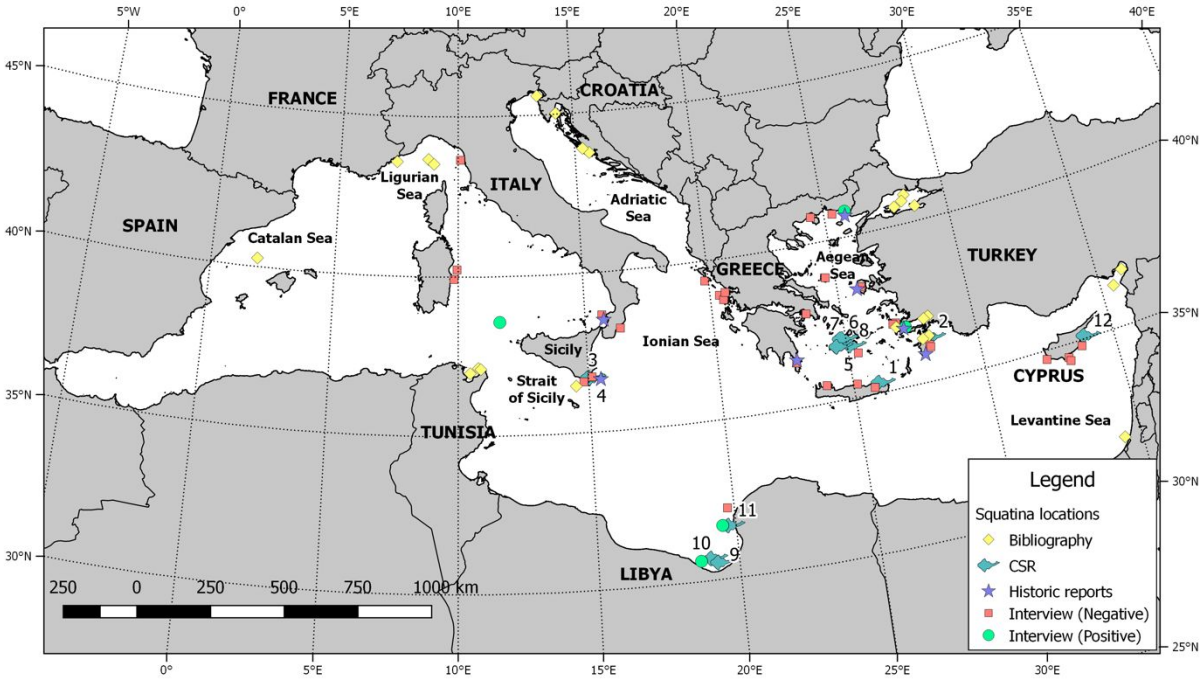

Figure 1. The map displays the CSR observations of angel sharks collected in the context of this study (see also Table 1), the interviews of targeted marine observers (with positive and negative responses about current observations of angel sharks), the reports of historic occurrences of angel sharks collected in the context of this study and the published observation records of angel sharks available in the bibliography and the grey literature (Supporting Table 2).

Figure 2. Angel Shark specimens reported in the context of this study. The numbers correspond to the number of each observation as displayed in Table 1.

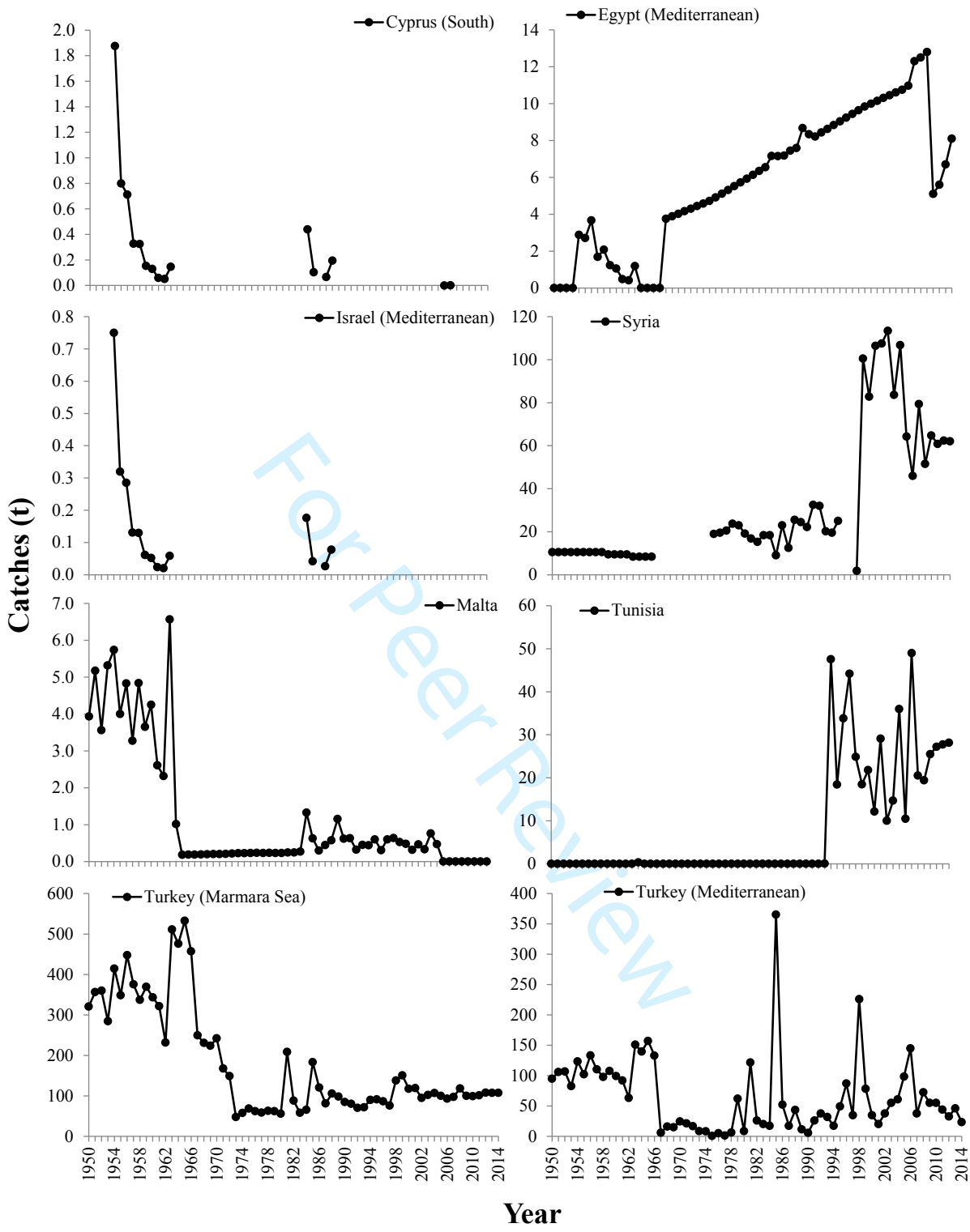

Figure 3. Annual reconstructed catches (in t.) of angel shark per country between 1950-2014.

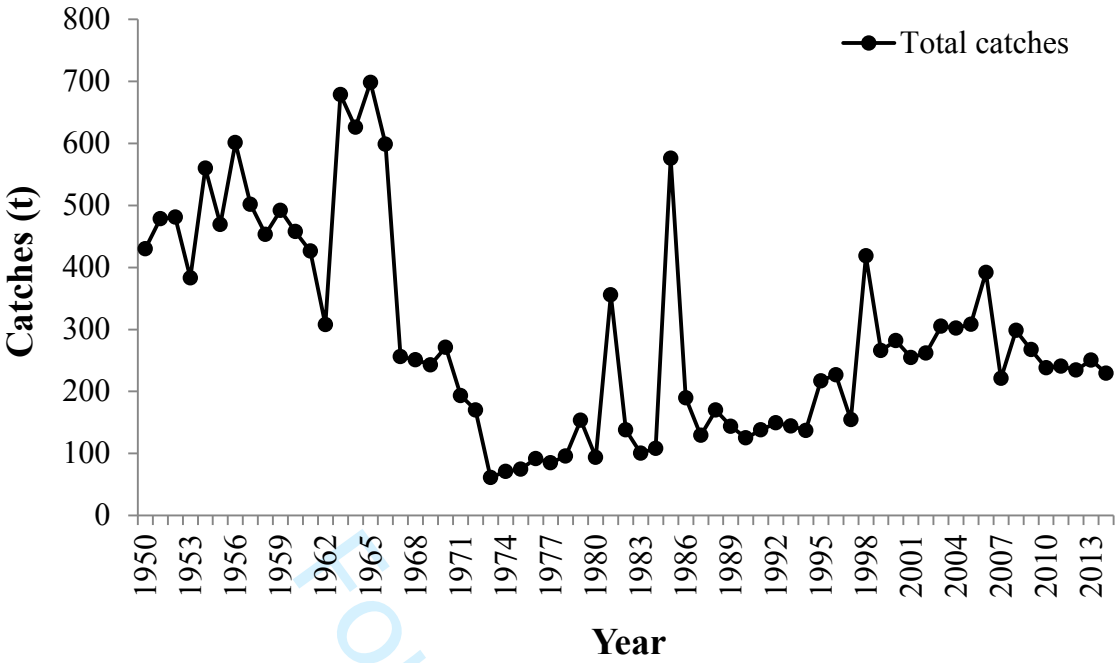

Figure 4. Total reconstructed catches (in t.) of angel shark in the Mediterranean during 1950-2014.