Review Article

Extinction risk and conservation of critically endangered angel sharks in the Eastern Atlantic and Mediterranean Sea

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Understanding the details of local and regional extinctions allows for more efficient allocation of conservation activities and resources. This involves identifying where populations persist, where populations may still be present, and where populations may be locally extinct. Three threatened angel sharks occur in the Eastern Atlantic and Mediterranean Sea: Sawback Angelshark (*Squatina aculeata*), Smoothback Angelshark (*Squatina oculata*), and Angelshark (*Squatina squatina*). Population sizes and geographic ranges of these species have been reduced due to overfishing and habitat loss, placing them among the world s most threatened chondrichthyans. We revise distribution maps, review global status, and present a Conservation Strategy to protect and restore these angel shark populations by minimizing fishing mortality, protecting critical habitat, and mitigating human disturbance. Updated distributions reveal that a halving of the geographic extent may have occurred for all three species, with potential declines of 51% for Sawback Angelshark, 48% for Smoothback Angelshark, and 58% for Angelshark. While 20 national and international management measures are now in place for Angelshark, only half of these include the other two species. We encourage further conservation action to adopt and develop this Conservation Strategy to restore angel shark populations to robust levels and safeguard them throughout their range.

Keywords: biodiversity, conservation planning, EU fisheries policy, fisheries, fisheries management, implementation, IUCN Red List, overfishing, species at risk, trawling.

Introduction

Fishing is one of the most widespread and intensive uses of the world's oceans and seas. A global increase in fishing effort occurred during the 20th century (Engelhard, 2008; Swartz et al., 2010), leading to the serial depletion of chondrichthyans (sharks, rays, and chimaeras; Ferretti et al., 2010; Dulvy et al., 2014). This phenomenon was well-documented in the coastal waters of the Eastern Atlantic and Mediterranean where the largest and least productive demersal species of chondrichthyans disappeared first. Declines and serial depletions of demersal sharks, rays, and skates are well-documented in these waters (Brander, 1981; Walker and Heessen, 1996; Walker and Hislop, 1998; Dulvy et al., 2000; Rogers and Ellis, 2000; Jukic-Peladic et al., 2001; Ferretti et al., 2005; Walker et al., 2005; Iglésias et al., 2010; De Oliveira et al., 2013; Sguotti et al., 2016), yet we have little understanding of the disappearance of the angel sharks.

Angel sharks are demersal "lie-and-wait" ambush predators found in the soft sediment of shallow coastal and continental shelf habitats. Hence, these sharks are highly susceptible to towed trawl gears and are easily entangled in large-mesh gillnets. As a result, angel sharks (Family Squatinidae) have been identified as one of the most threatened families of chondrichthyans in the world (Dulvy et al., 2014, 2016). Within this family of 22 species, three of the most threatened are the Sawback Angelshark (*Squatina aculeata*), the Smoothback Angelshark (*Squatina oculata*), and the Angelshark (*Squatina squatina*. For consistency, when referring to multiple species within the Family Squatinidae (*Squatina* spp.), this article will use the general term 'angel sharks' and when referring to a species common name, the capitalised one-word 'Angelshark' will be used (e.g. Angelshark is the common name for *Squatina squatina*). Although intrinsic rates of population increase are unknown for these three species, they have long generation lengths and have a small number of young when compared with other chondrichthyans (Table 1). All three species are present with overlapping ranges in parts of the Eastern Atlantic and Mediterranean Sea. The previous IUCN Red List assessments assigned all three species to the highest threat category of Critically Endangered (Morey et al., 2007a, b; Ferretti et al.,

2015) and reassessments published in 2019 reaffirm this status (Morey et al., 2019a, b, c).

Depletion of angel sharks likely began many decades ago, driven by target fisheries and compounded by bycatch mortality as their numbers plummeted below levels worth targeting. Quantifying the decline of these data-limited sharks has proved challenging due to their early depletion before the advent of independent scientific monitoring, thus requiring inference from historical ecology and local ecological knowledge (Giovos et al., 2019; Hiddink et al., 2019; Shephard et al., 2019). Records from the 19th and early 20th centuries suggest that angel sharks were targeted in the Mediterranean Sea and Northeast Atlantic, predominantly for their meat, liver, and skin. Angel sharks were such an important component of fisheries that numerous specialized fishing gears were developed to catch them and have been named after them, for example, in Spain—*escatera* (Morey et al., 2006), Italy—*squaenera*, Croatia—*sklatara* (EVOMED, 2011; Fortibuoni et al., 2016) and France—*martramaou* (Laporte, 1853 cited by Quéro, 1998). The origin of the name Baie des Anges (Alpes-Maritimes, southeast France) is derived from the former abundance of angel sharks there (Gag and Arnulf, 1985).

In addition to poor reporting, issues with renaming and market substitution meant that information often used to assess the status of data-poor fisheries, such as the trajectory of catch landings, were unreliable. The original common and commercial name for Angelshark in some parts of the United Kingdom was Monkfish because the shape of the head resembles the cowl of a monk's habit. As Angelshark stocks declined, anglerfish (*Lophius piscatorius* and *Lophius budegassa*), which were traditionally regarded as "trash fish", largely replaced Angelshark in fisheries and were marketed under the same colloquial common name—Monkfish (ICES, 2017). Angelshark is still commonly referred to as Monkfish or Monk by fishers along some parts of the Welsh coast today. As a consequence, the catch trajectory for "monkfish" remained high, buoyed up by increasing catches of Anglerfishes, and thus possibly masking Angelshark declines. While there is little formal evidence of the renaming and market substitution, anecdotally this is a key factor that contributed to

Table 1. Life history parameters for the three angel shark species occurring in the Eastern Atlantic Ocean and the Mediterranean Sea.

Life History Parameter	Sawback Angelshark *Squatina aculeata*	Smoothback Angelshark *Squatina oculata*	Angelshark *Squatina squatina*
Size at birth (cm TL)	30–35[a]	22–27[d]	20-30[f]
Size at maturity (cm TL)	♀137–143[a]	♀89–100[d, e]	♀128–169[e]
	♂120–122[a]	♂71–82[d, e]	♂80–132[e]
Maximum size (cm TL)	188[b]	160[b]	244[b]
Age at maturity (years)	Unknown	Unknown	Unknown
Longevity (years)	Unknown	Unknown	Unknown
Generation length (years)	15[c]	15[c]	15[c]
Three generation lengths (years)	45	45	45
Reproductive periodicity	2 years[a]	2 years[e]	2 years[a]
Litter size (mean)	8–12[a]	3–8[e]	7–25[b]
Intrinsic rate of population increase, r (year−1)	Unknown	Unknown	Unknown

[a]Capapé et al. (2005).
[b]Compagno et al. (2005).
[c]Based on available proxy data from the congeneric Pacific Angelshark (*Squatina californica*; Cailliet et al., 1992).
[d]Capapé et al. (2002).
[e]Capapé et al. (1990).
[f]Meyers et al. (2017).

the lack of management, decline and near extinction across much of the Angelshark's range.

This article provides the first review and synthesis of the historic and current global ranges for the three Eastern Atlantic and Mediterranean angel sharks (*S. aculeata*, *S. oculata*, and *S. squatina*), and of the international, regional, and national protective measures currently in place for these species. This information is used to develop a Conservation Strategy (aimed at guiding future research, management, policy, and conservation), a list of key policy priorities, and was used to inform the evaluation of these species against the IUCN Red List of Threatened Species Categories and Criteria.

Material and methods
Development of a diverse project team
To develop a Conservation Strategy for the complex and multi-jurisdictional nature of the Eastern Atlantic and Mediterranean, we formed a coalition of non-governmental organizations, charities, environmental consultancies, and educational institutions (Angel Shark Project, a collaboration between the Universidad de Las Palmas de Gran Canaria, Zoological Research Museum Alexander Koenig, and Zoological Society of London; IUCN Species Survival Commission (SSC) Shark Specialist Group; Shark Trust; and Submon). Eight individuals from this coalition participated in two workshops—the first focused predominantly on developing an Angelshark Action Plan for the Canary Islands (held in Las Palmas, Gran Canaria, Spain in 2016; Barker *et al.*, 2016). In addition to coalition members, participants who attended this workshop included local and international biologists, conservationists, fisheries scientists, fishing industry representatives, diving industry representatives, government representatives, and policy experts. A second workshop was focused specifically on developing the Eastern Atlantic and Mediterranean Angel Shark Conservation Strategy (held in Bristol, United Kingdom in 2016; Gordon *et al.*, 2017), and included government representatives, fishing industry representatives, conservationists, policy experts, and historical ecologists who held knowledge on all three angel shark species in the Northeast Atlantic and Mediterranean Sea regions. Before and following the workshops, contributions were sought from additional experts through email correspondence, including those with knowledge of the Eastern Central Atlantic off West Africa.

Geographic range data collection
We sourced distribution maps from the Global Marine Species Assessment (IUCN Marine Biodiversity Unit at Old Dominion University) for all three species of angel shark. These maps were refined during the second workshop, largely based on a database of 131 angel shark records (8 *S. aculeata*, 17 *S. oculata*, and 106 *S. squatina*) from 1818 to 2004, collated by HZ. These records were sourced from northern European museums (MNHN Paris, NHM Oslo, NHMUK London, NRM Stockholm, RMNH Leiden, SMNS Stuttgart, ZMH Hamburg, and ZMUC Copenhagen). Detailed methods and the records for *S. squatina* have been published in Zidowitz *et al.* (2017), and records for the other two species are available upon request. Given the regional bias of the distribution database to the Northeast Atlantic, the best data available were for Angelshark. Museums in the Mediterranean, Black Sea, or West Africa were not surveyed as this was beyond the scope of the project.

We continued to refine and validate the species distribution maps through: (i) literature review, (ii) landings data from the Food and Agriculture Organization of the United Nations (FAO), (iii) results from an expert survey and other personal communications, and (iv) sightings, catches, or landings reported to the Angel Shark Conservation Network Sightings Map (http://angel sharknetwork.com/#map), Marine Fish Information Services database held by Doug Herdson, and the Shark Trust's Angler Recording Project (www.sharktrust.org/angling-project-redirect). See Supplementary Table S1 for a summary of where distribution information was obtained for each species. Our literature review sought information from the library of the Marine Biological Association of the United Kingdom. We also searched Google Scholar in multiple languages with keywords including "angel shark", "*Squatina*", "Squatinidae", and "monkfish" (English); "Angelote" (Spanish); "Ange" and "Ange de Mer" (French); keler balığının (Turkish); Αγγελοκαρχαρίας-Ρίνα (*S. squatina*), Ματορίνα (*S. oculata*) and Ακανθορίνα (*S. aculeata*) (Greek). Most of the available literature focused on the Angelshark rather than the Sawback Angelshark or Smoothback Angelshark. Recent and historical landings of angel shark from FAO were examined, although these landings were not species-specific (they were reported under the generic classifications of "Angelshark" or "Angelsharks, sand devils, nei"). Nineteen angel shark experts responded to our questionnaire (see Supplementary Table S2). Many of these experts worked simultaneously at global, regional, and national levels—with 7 reporting to have global knowledge, 14 with regional knowledge, and 11 with national knowledge. Of those that reported having regionally or nationally specific knowledge, seven held knowledge specific to the Northeast Atlantic, six held knowledge specific to the Mediterranean Sea, and three held knowledge specific to West Africa.

Geographic range mapping
Current presence status was classified using a subset of three of the six IUCN presence codes (Dulvy *et al.*, 2016; IUCN, 2018), namely:

(i) *Extant*, when a "species is known or thought very likely to occur presently in the area, usually encompassing current or recent localities where suitable habitat at appropriate altitudes remains" (or depths in the case of aquatic species);

(ii) *Possibly Extinct*, when "there is no record of the species in the area, but the species was formerly known or thought very likely to have occurred, but it is most likely now locally extinct from the area because habitat loss/other threats are thought likely to have eliminated the species and/or owing to a lack of records in the last 30 years";

(iii) *Presence Uncertain*, when "the species was formerly known or thought very likely to occur in the area, but it is no longer known if it still occurs".

We applied the presence codes independently to nation-states and to associated islands and territories (hereafter referred to collectively as "jurisdictions") for each species across their reported historical ranges. The species was classified *Extant* if a sighting, catch, or landing had occurred within the territorial waters of a particular jurisdiction in the past 30 years (since 1987 in our analysis). Species were classified *Possibly Extinct* in jurisdictions where the last known sighting, catch, or landing records were

older than 30 years (before 1987 in our analysis) or where a previously reported record could not be verified. A summary of how we applied each IUCN presence code to each species and each jurisdiction can be found in Table 2. We considered a species to be *Presence Uncertain* for a given jurisdiction in the following four instances:

(i) Proximity: A species was considered Presence Uncertain if it was Extant in a neighbouring jurisdiction. Neighbouring was defined as Exclusive Economic Zones (EEZs) are touching or coastlines are shared.

(ii) Aggregated landings and historical records: Recent (post-1987) aggregated landing records were reported to family level (Squatinidae, "Angelshark" or "Angelsharks, sand devils nei"), and species-specific historical records (before 1987) support the presence of a particular species.

(iii) Aggregated landings and proximity: recent (post-1987) aggregated landing records were reported to family level (Squatinidae, "Angelshark" or "Angelsharks, sand devils nei"), and close proximity to a neighbouring jurisdiction where the species is Extant.

(iv) Aggregated landings and proximity to (ii) or (iii): A species was considered Presence Uncertain if recent (post-1987) aggregated landing records were reported to family level (Squatinidae, "Angelshark" or "Angelsharks, sand devils nei") it was Presence Uncertain in a neighbouring jurisdiction because that jurisdiction met the conditions of (ii) or (iii). This only occurred in a single instance, for *Squatina squatina* along the Atlantic coast of Spain.

Range areas were calculated using each species' respective known range, restricted to country EEZs, and to its known bathymetry inhabited (30–500 m for *S. aculeata*, 10–500 m for *S. oculata*, and from inshore to 150 m for *S. squatina*) (Weigmann, 2016). Polygons were projected onto a Europe Albers Equal Area coordinate reference system, and areas were calculated for each polygon (Extant, Presence Uncertain, and Possibly Extinct) for each species. Possible per cent declines in range were obtained by adding the area of the Presence Uncertain and Possibly Extinct polygons (i.e. the areal sum of areas where the species no longer exists and of areas where it may no longer exist) and dividing it by the total area of all three polygons (i.e. the known historical range of the species, encompassing areas where it is currently Extant in addition to the other two presence categories). All mapping and spatial analyses were undertaken in QGIS version 2.18 (QGIS Development Team, 2019). "Jurisdictions" that a species occurs or occurred in are defined as countries and islands (countries with coastlines on multiple bodies of water—e.g. France or Italy—were counted as two jurisdictions).

Development of the Eastern Atlantic and Mediterranean Angel Shark Conservation Strategy

Development of the Vision, Goals, and Objectives of the Eastern Atlantic and Mediterranean Angel Shark Conservation Strategy largely followed the method that was used for the Global Sawfish Conservation Strategy (Harrison and Dulvy, 2014; Fordham et al., 2018) and the Global Devil and Manta Ray Conservation Strategy (Lawson et al., 2017), which were based on IUCN guidelines (IUCN-SSC Species Conservation Planning Sub-Committee,

2008, 2017). This approach involves first categorizing threats using the IUCN Red List threat classification criteria (Salafsky et al., 2008) and identifying gaps in knowledge. Second, our facilitator guided participants towards developing SMART (Specific, Measurable, Achievable, Relevant/Realistic, and Time-Bound) criteria as a guide for setting objectives and actions aimed at filling the identified knowledge gaps and addressing threats. However, due to significant gaps in funding and capacity at the national scale most actions are generic and could not be time-bound. Once actions where developed, the workshop participants assigned "low", "medium" and "high" priority scores, as well as estimated costs ranging from low ($) to high ($$$$), to each action. Following the workshop, we revised the Goals, Objectives, and priority actions outlined in the Strategy through email correspondence.

We compared species-specific maps of current distribution ("Extant") with the presence of existing and potential international, regional, and national legislation that protects angel sharks. Information on fisheries and conservation legislation was gathered primarily from expertise within our coalition and was augmented by consulting with those who were part of the wider network of experts. Immediate research, conservation, and legislative priorities were selected based on opportunity, capacity, and the need for mitigation of immediate threats.

IUCN Red List assessment updates

The development of this Strategy revealed an updated, comprehensive, and global perspective on changes in distributions and threats for these three species, which prompting a re-evaluation of the IUCN Red List status for these three angel sharks. All three angel shark species were reassessed in 2017/2018 under the IUCN Red List for Threatened Species, and all retained their status of Critically Endangered (*S. aculeata*—Morey et al., 2019a; *S. oculata*—Morey et al., 2019b; and *S. squatina*—Morey et al., 2019c). The new geographic information presented here helped IUCN Red List assessors infer declines in both Extent of Occurrence (EOO) and Area of Occupancy (AOO).

Results

Our updated distribution information for the three angel shark species revealed substantial differences in geographic range when compared with previous IUCN Red List assessment distribution maps (Figure 1a–f; Table 2). The updated historical and contemporary distributions reveal that the severe population reductions have led to a near-halving of the geographic extent of all three species, with potential declines of 51% (5.0×10^5 km²) for *S. aculeata;* 48% (4.2×10^5 km²) for *S. oculata;* and 58% (8.5×10^5 km²) for *S. squatina* (Figure 2). We confirmed that all three species were Extant in the Aegean Sea, the Levant Sea (particularly the Mediterranean coast of Turkey), and in the central basin of the Mediterranean in the Strait of Sicily. A review of existing protective measures shows that measures have been increasing internationally, regionally, and nationally (Figure 3; Table 3). The Goals and Objectives outlined in our Conservation Strategy aim to address existing gaps and ways to improve or increase angel shark conservation (Table 4), and key policy priorities are identified (Table 5).

In two cases—for Angelshark in Danish waters and for Smoothback Angelshark in the Gulf of Guinea—we made exceptions to our systematic approach of applying IUCN presence codes (as outlined above). For the Angelshark in Danish waters, a

Table 2. Distribution records for the three species of angel shark occurring in the Eastern Atlantic Ocean and Mediterranean Sea.

Region	Jurisdiction	Status	Reason for status or reference(s)
Sawback Angelshark (*Squatina aculeata*)			
Atlantic Ocean			
Iberian Coast	Spain	Presence Uncertain	Aggregated Landings and historical records. FAO records from 2015 under either "Angelshark" or "Angelsharks, sand devils nei"; Lozano Rey (1928)
Northwest Africa	Senegal	Extant	Capapé *et al.* (2005)
	Sierra Leone	Extant	M. Schaber, pers. comm., reviewed by E. Meyers, 2017
	The Gambia	Extant	A. Moore, pers. comm., reviewed by C. Gordon, 2018 (Moore *et al.*, 2019).
	Guinea	Presence Uncertain	Proximity to The Gambia, Senegal, and Sierra Leone
	Guinea-Bissau	Presence Uncertain	Proximity to The Gambia, Senegal, and Sierra Leone
	Liberia	Presence Uncertain	Proximity to Sierra Leone
	Mauritania	Presence Uncertain	Proximity to Senegal and The Gambia
Mediterranean Sea			
Western Basin			
	Algeria	Presence Uncertain	Proximity to Tunisia
Tyrrhenian Sea	Sardinia (Italy)	Presence Uncertain	Proximity to Tunisia
Central Basin			
	Libya	Presence Uncertain	Proximity to Tunisia
	Malta	Presence Uncertain	Proximity to Tunisia
	Tunisia	Extant	Capapé *et al.* (2005)
Ionian Sea	Greece	Presence Uncertain	Proximity to Greece (Aegean)
	Sicily (Italy)	Extant	Angel Shark Sightings Map by iSea, pers. comm., reviewed by J. Barker, 2018; Giovos *et al.* (2019)
Adriatic Sea			
	Albania	Presence Uncertain	Aggregated Landings and proximity to Greece. FAO records from 2015 under either "Angelshark" or "Angelsharks, sand devils nei"
Eastern Basin			
	Cyprus	Presence Uncertain	Proximity to North Cyprus
	North Cyprus	Extant	Başusta (2016)
	Egypt	Presence Uncertain	Proximity to Israel
	Israel	Extant	A. Barash, pers. comm., reviewed by J. Barker, 2017
	Lebanon	Presence Uncertain	Proximity to Israel
	Palestine (State of)	Presence Uncertain	Proximity to Israel
	Syria	Presence Uncertain	Proximity to Turkey
	Turkey	Extant	Başusta (2002, 2016) and Ergüden and Bayhan (2015)
Aegean Sea	Crete (Greece)	Presence Uncertain	Proximity to Greece and Turkey
	Greece	Extant	Machias *et al.* (2001), Filiz *et al.* (2015), and Corsini and Zava (2007); Angel Shark Sightings Map by iSea, pers. comm., reviewed by J. Barker, 2018; Giovos *et al.* (2019)
	Turkey	Extant	Akyol *et al.* (2015)
Smoothback Angelshark (*Squatina oculata*)			
Atlantic Ocean			
Northwest Africa	Benin	Presence Uncertain	Proximity to Ghana
	Cote d'Ivoire	Presence Uncertain	Proximity to Ghana
	Ghana	Extant	FAO, pers. comm., reviewed by C. Gordon, 2016
	Guinea	Extant	Capapé *et al.*, 2002; Dr F. Doumbouya, pers. comm., reviewed by E. Meyers, 2016
	Guinea-Bissau	Presence Uncertain	Proximity to Guinea and Senegal
	Liberia	Presence Uncertain	Proximity to Guinea and Sierra Leone
	Mauritania	Presence Uncertain	Proximity to Senegal
	Nigeria	Presence Uncertain	Proximity to Ghana
	Senegal	Extant	Capapé *et al.* (2002)
	Sierra Leone	Extant	M. Schaber, pers. comm., reviewed by E. Meyers, 2017
	The Gambia	Extant	A. Moore, pers. comm., 2017 (Moore *et al.*, 2019)
	Togo	Presence Uncertain	Proximity to Ghana
Southwest Africa	Angola	Possibly Extinct	Zidowitz unpublished data, 2017 (record from 1964)
	Angola (Cabinda)	Possibly Extinct	Zidowitz unpublished data, 2017 (record from 1964)
	Cameroon	Presence Uncertain	Proximity to Ghana
	Democratic Republic of the Congo	Possibly Extinct	Zidowitz unpublished data, 2017 (record from 1964)

Continued

Table 2. continued

Region	Jurisdiction	Status	Reason for status or reference(s)
	Equatorial Guinea	Presence Uncertain	Proximity to Ghana
	Gabon	Presence Uncertain	Proximity to Ghana
	Republic of the Congo	Presence Uncertain	Proximity to Ghana
Mediterranean Sea			
Western Basin			
	France	Possibly Extinct	Gag and Arnulf (1985; reported as Extant in the mid-1900s and is the origin of the name Baie des Anges).
	Monaco	Possibly Extinct	Proximity to France
Tyrrhenian Sea	Corsica (France)	Presence Uncertain	Proximity to Sicily
	Italy	Presence Uncertain	Proximity to Sicily
	Sardinia (Italy)	Presence Uncertain	Proximity to Sicily
Central Basin			
	Libya	Extant	Ghmati and Turki (2015)
	Malta	Presence Uncertain	Proximity to Sicily and Tunisia
	Tunisia	Extant	Capapé (1990); S. Ben Abdelhamid, pers. comm., reviewed by C. Gordon, 2015
Ionian Sea	Greece	Presence Uncertain	Proximity to Greece (Aegean)
	Sicily (Italy)	Extant	Zava et al. (2016); Angel Shark Sightings Map by iSea, pers. comm., reviewed by J. Barker, 2018; Giovos et al. (2019)
Adriatic Sea			
	Albania	Presence Uncertain	Aggregated Landings and proximity to Greece and Croatia. FAO records from 2015 under either "Angelshark" or "Angelsharks, sand devils nei"
	Bosnia and Herzegovina	Presence Uncertain	Proximity to Croatia
	Croatia	Extant	Holcer and Lazar (2017)
	Italy	Presence Uncertain	Proximity to Croatia
	Montenegro	Presence Uncertain	Proximity to Croatia
	Slovenia	Presence Uncertain	Proximity to Croatia
Eastern Basin			
	Cyprus	Presence Uncertain	Proximity to Turkey and North Cyprus
	North Cyprus	Extant	University of Exeter, pers. comm., reviewed by J. Barker, 2017
	Egypt	Presence Uncertain	Proximity to Turkey and Libya
	Israel	Presence Uncertain	Proximity to Turkey and North Cyprus
	Lebanon	Presence Uncertain	Proximity to Turkey and North Cyprus
	Palestine (State of)	Presence Uncertain	Proximity to Turkey
	Syria	Presence Uncertain	Proximity to Turkey
	Turkey	Extant	Çanakkale Onsekiz Mart University, pers. comm., reviewed by E. Meyers, 2014
Aegean Sea	Crete (Greece)	Extant	Giovos et al. (2019)
	Greece	Extant	Machias et al. (2001), Corsini and Zava (2007); Angel Shark Sightings Map by iSea, pers. comm., reviewed by J. Barker, 2018; Giovos et al. (2019)
	Turkey	Extant	Kabasakal and Kabasakal (2004); Fauna and Flora International Project, pers. comm., reviewed by J. Barker, 2015
Angelshark (*Squatina squatina*)			
Atlantic Ocean			
Skagerrak-Kattegat	Denmark	Possibly Extinct	Zidowitz et al. (2017; record from 1921)
	Norway	Possibly Extinct	Zidowitz et al. (2017; record from 1970)
	Sweden	Possibly Extinct	Stenberg et al. (2015; record from 1925)
North Sea	Belgium	Possibly Extinct	Zidowitz et al. (2017; record from 1974)
	Denmark	Presence Uncertain	Zidowitz et al. (2017; record from 2002); Witte and Zijlstra (1978; considered this species to be rare)
	Germany	Possibly Extinct	Zidowitz et al. (2017; record from 1901); Witte and Zijlstra (1978; considered this species to be absent)
	Netherlands	Possibly Extinct	Zidowitz et al. (2017; record from 1972)
	Norway	Possibly Extinct	Zidowitz et al. (2017; record from 1986)
	United Kingdom	Possibly Extinct	Zidowitz et al. (2017; record from 1966); ICES (2008; considered this species to be extirpated)
Celtic-Biscay Shelf	France	Presence Uncertain	Aggregated landings and historical records. FAO records from 2015 under either "Angelshark" or "Angelsharks, sand devils nei"; Moreau (1881–1891).

Continued

Table 2. continued

Region	Jurisdiction	Status	Reason for status or reference(s)
	United Kingdom and Ireland	Extant	Fitzmaurice *et al.* (2003), Quigley (2006); Bal *et al.* (2014), and Zidowitz *et al.* (2017); Natural Resources Wales and Zoological Society of London unpublished data from Angel Shark Project: Wales, reviewed by J. Barker, 2017; Inland Fisheries Ireland, pers. comm., reviewed by J. Barker, 2017; Shark Trust Angler Recording Project unpublished data, reviewed by C. Gordon, 2017; Marine Fish Information Services unpublished data, reviewed by C. Gordon, 2017.
Iberian Coast	Portugal	Presence Uncertain	Aggregated landings and historical records. Aggregated landings Correia and Smith (2003); historical records Nobre (1935) and Sanches (1986).
	Spain	Presence Uncertain	Aggregated landings. FAO records from 2015 under either "Angelshark" or "Angelsharks, sand devils nei".
Africa, Northwest	Canary Islands (Spain)	Extant	Osaer (2009); Narváez (2013); Osaer *et al.* (2015); Meyers *et al.* (2017)
	Madeira	Presence Uncertain	Proximity to Canary Islands
	Morocco	Presence Uncertain	Proximity to Canary Islands
	Western Sahara	Presence Uncertain	Proximity to Canary Islands
Mediterranean Sea Western Basin			
	Algeria	Extant	Ramdane and Trilles (2008)
	France	Presence Uncertain	Aggregated landings, proximity to Corsica (France) and Italy, and historical records. FAO records from 2015 under either "Angelshark" or "Angelsharks, sand devils nei"; historical record from Zidowitz *et al.* (2017; record from 1869).
	Gibraltar (United Kingdom)	Presence Uncertain	Proximity to Algeria
	Monaco	Presence Uncertain	Proximity to Corsica (France)
	Morocco	Presence Uncertain	Proximity to Algeria
Balearic Sea	Balearic Islands (Spain)	Presence Uncertain	Aggregated landings and Proximity to Algeria. Aggregated landings from Grau *et al.* (2015).
	Spain	Presence Uncertain	Aggregated landings and proximity to Algeria. FAO records from 2015 under either "Angelshark" or "Angelsharks, sand devils nei";
Tyrrhenian Sea	Corsica (France)	Extant	Corsica-Groupe de Recherche sur les Requins de Méditerranée, pers. comm., reviewed by E. Meyers, 2016
	Italy	Presence Uncertain	Proximity to Sicily (Italy)
	Sardinia (Italy)	Presence Uncertain	Proximity to Corsica (France) and Sicily (Italy)
Central Basin			
	Libya	Extant	Angel Shark Sightings Map by iSea, pers. comm., reviewed by J. Barker, 2018 (Giovos *et al.*, 2019)
	Malta	Extant	Ragonese *et al.* (2013)
	Tunisia	Extant	Capapé *et al.* (1990)
Ionian Sea	Greece	Presence Uncertain	Proximity to Greece (Aegean)
	Sicily (Italy)	Extant	Giusto and Ragonese (2014) and Cavallaro *et al.* (2015)
Adriatic Sea			
	Albania	Presence Uncertain	Aggregated landings and proximity to Croatia. FAO records from 2015 under either "Angelshark" or "Angelsharks, sand devils nei".
	Bosnia and Herzegovina	Presence Uncertain	Proximity to Croatia
	Croatia	Extant	Fortibuoni *et al.* (2016) and Holcer and Lazar (2017)
	Italy	Extant	Fortibuoni *et al.* (2016)
	Montenegro	Presence Uncertain	Proximity to Croatia
	Slovenia	Extant	Fortibuoni *et al.* (2016)
Eastern Basin			
	Cyprus	Presence Uncertain	Proximity to North Cyprus
	North Cyprus	Extant	R. Snape, pers. comm. reviewed by A. Hood, 2018
	Egypt	Presence Uncertain	Proximity to Israel
	Israel	Extant	Golani, 2006
	Lebanon	Presence Uncertain	Proximity to Turkey
	Palestine (State of)	Presence Uncertain	Proximity to Israel
	Syria	Presence Uncertain	Proximity to Turkey
	Turkey	Extant	Yaglioglu *et al.* (2015)

Continued

Table 2. continued

Region	Jurisdiction	Status	Reason for status or reference(s)
Aegean Sea	Crete (Greece)	Presence Uncertain	Proximity to Greece and Turkey
	Greece	Extant	Kara *et al.* (2018); Angel Shark Sightings Map by iSea, pers. comm., reviewed by J. Barker, 2018; Giovos *et al.* (2019)
	Turkey	Extant	Kabasakal and Kabasakal (2004), Öğretmen *et al.* (2005), Işmen *et al.* (2009), Akyol *et al.* (2015) and Kara *et al.* (2018); Z. Kizilkaya, pers. comm., reviewed by J. Barker, 2017; Çanakkale Onsekiz Mart University, pers. comm., reviewed by E. Meyers, 2014; Ç. Keskin, pers. comm. reviewed by A. Hood, 2010.
Black Sea			
	Bulgaria	Presence Uncertain	Proximity to Sea of Marmara
	Turkey	Presence Uncertain	Proximity to Sea of Marmara
Sea of Marmara	Turkey	Extant	Kabasakal (2003) and Kabasakal and Kabasakal (2014)

Mediterranean regions roughly follow geographical subareas as defined by the General Fisheries Commission for the Mediterranean (GFCM).
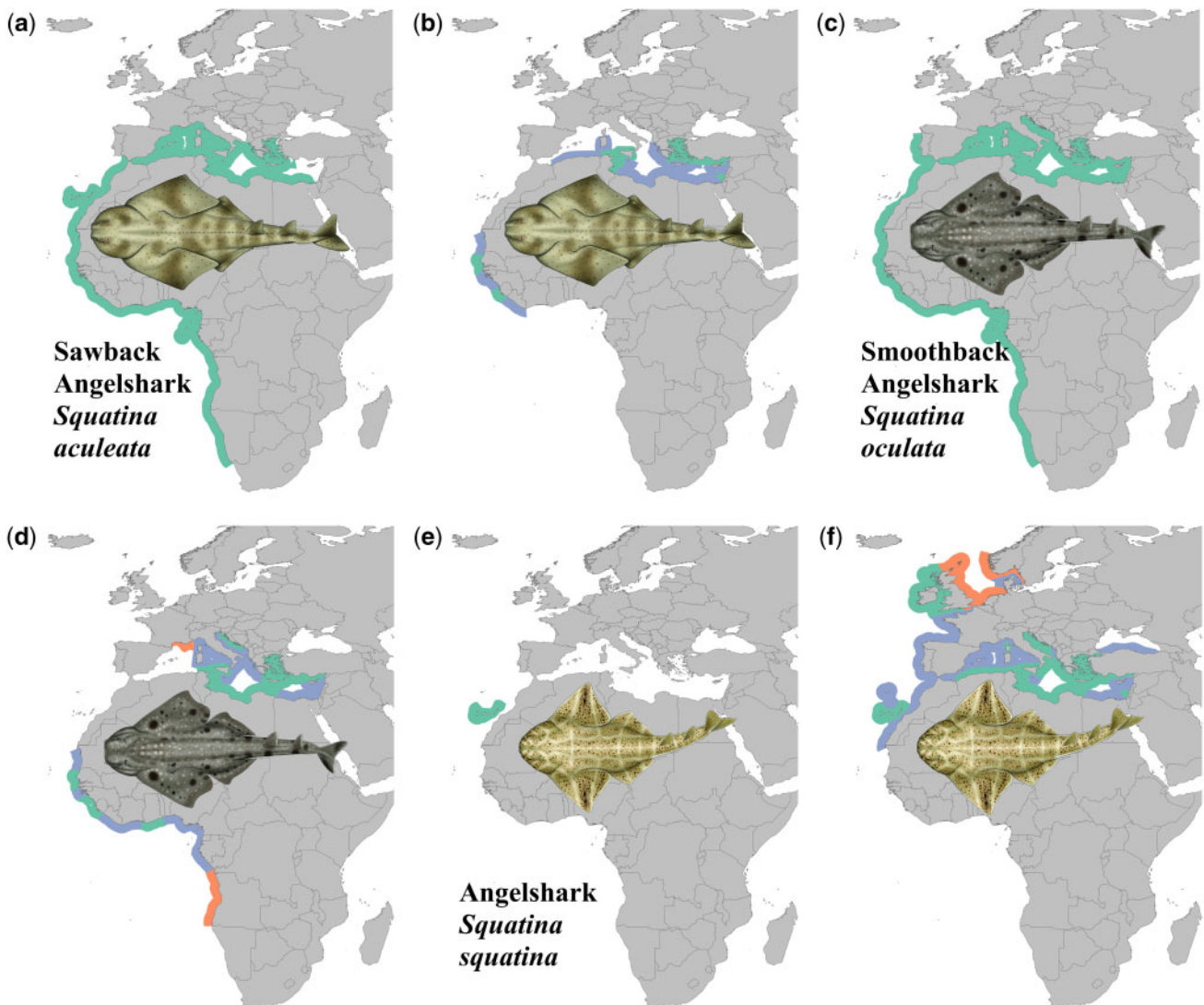

Figure 1. Angel shark species range maps for Sawback Angelshark *Squatina aculeata* (a) as understood in 2007 (Morey *et al.*, 2007a) and (b) as determined in this study; for Smoothback Angelshark *Squatina oculata* (c) as understood in 2007 (Morey *et al.*, 2007b) and (d) as determined in this study; and for Angelshark *Squatina squatina* (e) as understood in 2015 (Ferretti *et al.*, 2015), and (f) as determined in this study. Colours represent IUCN presence definitions as outlined in the text. Green = Extant, Blue = Presence Uncertain, Orange = Possibly Extinct. Maps were created using the IUCN Shorefishes Basemap (which extends out onto the continental shelf to 200 m depth or 100 km). Species ranges extend to whichever comes first of either the edge of the IUCN Shorefishes Basemap polygon or the EEZ of the jurisdiction depicted. Note that these maps are for visualization purposes and do not represent the true Areas of Occupancy inhabited by these species, which would be much truncated based on each species' realised bathymetric niche. Species illustrations courtesy of Marc Dando.
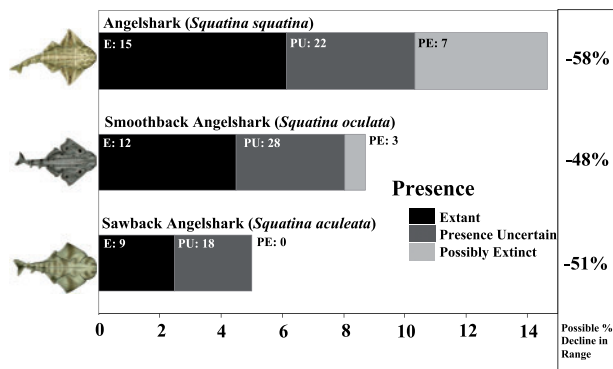
Figure 2. The current geographic range status for Eastern Atlantic and Mediterranean angel sharks. Range is categorized as: Extant (E), Presence Uncertain (PU), or Possibly Extinct (PE) (see Material and Methods section). Angel shark species are arranged in descending order from largest to smallest historical range. The number of jurisdictions in each geographic range category is shown along with the possible percent decline in range. Jurisdictions are defined here as countries or large islands within countries (e.g. Sicily), and jurisdiction coastlines in different basins are counted separately (e.g. France and Spain have coasts in both the Atlantic Ocean and the Mediterranean Sea). Areas were calculated using each species' respective range restricted to its known depth and projected onto a Europe Albers Equal Area coordinate reference system. Species illustrations courtesy of Marc Dando.

single record from 2002 was found (Zidowitz *et al.*, 2017), which would normally lead us to classify this species as "Extant." However, the historical record noted that this species to be extremely rare in these waters (Witte and Zijlstra, 1978). As such, we did not have enough confidence to classify this species as Extant in these waters, so considered it Presence Uncertain (especially considering that Angelshark is considered Possibly Extinct in all other North Sea countries). The second exception we made was for the Gulf of Guinea, an area where little information on angel sharks is available. A handful of historical records of Smoothback Angelshark ranging from 1905 to 1964 have been reported (HZ, pers. comm., as described above). With the precautionary approach in mind, and considering this dearth of information and several narrow and overlapping EEZs in close proximity to Ghana (where the species is Extant), we optimistically classified this species Presence Uncertain in Benin, Cameroon, Equatorial Guinea, Gabon, and the Republic of the Congo despite these jurisdictions not meeting the criteria outlined in our Material and methods section.

Geographic range mapping

The previous IUCN Red List assessment for the Sawback Angelshark indicated that this species was Extant primarily in the western basin of the Mediterranean Sea (Figure 1a; Morey *et al.*, 2007a). Our results confirmed that the species is Extant in the boundary area between the western and central basins (Extant in Tunisia and Sicily), and may be present in some areas of the western basin (Presence Uncertain in Sardinia and Algeria), but is also Extant or Presence Uncertain throughout the central and eastern basins (Figure 1b; Table 2). We found that at its southern extent, this species' range has been truncated significantly compared with that reported in the previous IUCN Red List

assessment: our results do not indicate that any current or historical records have been confirmed south or east of Sierra Leone, whereas the previous assessment suggested that the species occurred south to Namibia (Figure 1a). Our results showed that the Sawback Angelshark was formerly found in 27 jurisdictions (defined as nation states and associated islands and territories). We considered it to be Extant in nine jurisdictions, Presence Uncertain in 18 jurisdictions, and we could not find evidence that this species was considered Possibly Extinct in any jurisdictions. If the species is Extant in all areas where we considered it to be Presence Uncertain, then this species has not undergone any range contraction. If the species is Extinct in all areas where we considered it to be Presence Uncertain, then the geographic range has declined by 51%; ranging from 5.0×10^5 km^2 (assuming no part of the range is Extinct) to 2.5×10^5 km^2 (assuming Presence Uncertain part of the range is Extinct; Figure 2).

For Smoothback Angelshark, the previous IUCN Red List assessment classified this species to be Extant throughout the Mediterranean Sea, including Algeria and the Mediterranean coast of Spain (Figure 1c; Morey *et al.*, 2007b), our review classified Smoothback Angelshark as Extant or Presence Uncertain primarily in the central or eastern basins (Figure 1d; Table 2). On the Atlantic coast, this species was previously reported to occur from Morocco to Angola (Figure 1c). We found that the last report from Angola for this species was from 1964 (NHMUK London, Catalogue No. 1935.5.11.10-11, HZ, unpublished data, 2017), leading us to classify this species as Possibly Extinct south of the Republic of the Congo. We optimistically classified it as Presence Uncertain in the entire Gulf of Guinea, due to a contemporary sighting in Ghana (therefore, we considered it to be Extant in Ghana; FAO, pers. comm., reviewed by C. Gordon, 2016) and historical records from the early 1960s (HZ, unpublished data, 2017; Figure 1d). We found that the Smoothback Angelshark formerly occurred in the waters of 43 jurisdictions. Our results found it to be Extant in 12 jurisdictions, Presence Uncertain in 28, and Possibly Extinct in 3. If the species is Extant in all areas where we considered it to be Presence Uncertain, then this species has undergone a 7.7% contraction in range size. If it is Extinct in all areas where we considered it to be Presence Uncertain, then the geographic range has declined by 48%; from 8.7×10^5 km^2 (assuming no part of the range is Extinct) to 4.5×10^5 km^2 (assuming Presence Uncertain part of the range is Extinct; Figure 2).

Angelshark was described as "locally extinct or extremely rare" over most of its range with the exception of the Canary Islands when it was assessed for the IUCN European Red List in 2014 (Figure 1e; Ferretti *et al.*, 2015). Our results confirm that in addition to being Extant in the coastal waters of the Canary Islands (Figure 1f; Osaer, 2009; Narváez, 2013; Osaer *et al.*, 2015; Meyers *et al.*, 2017), this species is also Extant elsewhere—although likely at much lower abundance than in the Canary Islands. We classified this species as Extant in the Celtic Seas ecoregion (off the western coasts of Ireland, England, and Wales), and as Presence Uncertain along the North Sea coast of Denmark. The latter classification is based on a single record from 2002 (Zidowitz *et al.*, 2017), whereas elsewhere in the North Sea this species was considered Possibly Extinct. We considered the Angelshark as Presence Uncertain along the French Atlantic coast and Iberian Peninsula due to aggregated landings and historical records. In the Mediterranean, we classified this species as Extant or Presence Uncertain in jurisdictions throughout the Mediterranean Sea basin, with the exception of the northern Black Sea (Figure 1f;
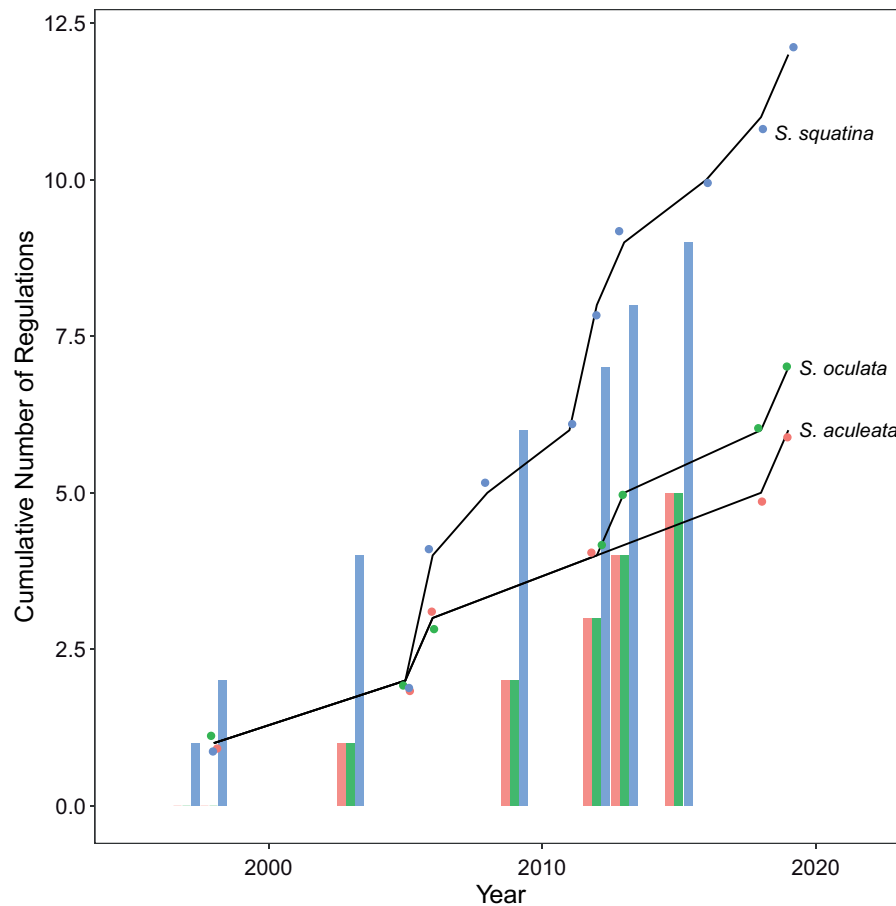
Figure 3. The lines represent the cumulative number of national and territory protective measures for Sawback Angelshark *Squatina aculeata*, Smoothback Angelshark *Squatina oculata*, and Angelshark *Squatina squatina* over time. The bars represent the cumulative number of regional protective measures for Sawback Angelshark *Squatina aculeata* Smoothback Angelshark *Squatina oculata* and Angelshark *Squatina squatina* over time.

Table 2). To our knowledge, there is no evidence that suggests that this species has historically occurred south or east of the Canary Islands. It is classified as Presence Uncertain along the Atlantic coast of Morocco due solely to that country's proximity to the Canary Islands. Our review found that the Angelshark historically occurred in the waters of 43 jurisdictions. We found evidence that this species is Extant in 15 jurisdictions, Presence Uncertain in 21, and Possibly Extinct in 7. If the species is Extant in all areas where we considered it to be Presence Uncertain, then this species has undergone a 3% contraction in range size. If it is Extinct in all areas where we considered it to be Presence Uncertain, then the geographic range has declined by 58%; from 14.7×10^5 km² (assuming no part of the range is Extinct) to 6.1×10^5 km² (assuming Presence Uncertain part of the range is Extinct; Figure 2).

Protective measures

International, regional, and national measures aimed at protecting angel sharks have increased over time for all species, with the Angelshark having the greatest number of protective measures on paper. We found that the Angelshark alone is subject to 20 international, regional, and national protection measures; the other two species lag behind and are listed in only 11 of these measures (Table 3, Figure 3).

International measures

The Angelshark is listed in Appendices I and II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS), and in Annex 1 of the CMS Memorandum of Understanding on the Conservation of Migratory Sharks (CMS Sharks MoU). Species such as the Angelshark that are listed in CMS Appendix I must be strictly protected by Parties that are Range States and these Parties must work collaboratively towards regional protection. Signatories to the CMS Sharks MOU are encouraged to realize actions set out in the Conservation Plan (Annex 3 to the MOU) into national or regional measures for species listed in Annex 1. The CMS Angelshark listing proposal was accompanied by a Concerted Actions (CMS/Sharks/MOS3/Inf.10 2018) document providing a framework of activities to deliver conservation specifically for the Angelshark and at the same time benefit the other two Critically Endangered angel shark species in the Eastern Atlantic and Mediterranean.

While the enforcement of international, regional, and domestic measures on-the-ground is difficult to confirm, we consider these measures to protect angel sharks to be a good first step. A recent review of measures to protect Angelshark found that approximately half of the CMS Range States Parties had national or regional protections in place (Lawson and Fordham, 2018).

Table 3. International, regional, and national measures under which each of the three Eastern Atlantic and Mediterranean angel sharks are intended to be protected.

		Squatina aculeata	*Squatina oculata*	*Squatina squatina*
International measures				
Convention on the Conservation of Migratory Species of Wild Animals (CMS)	20172018	–	–	Appendices I and IIAnnex 1 to the CMS Sharks MOU
Regional measures				
European Commission	2009	–	–	Council Regulation (EC) 43/2009, Annex III Part B (2009)
European Commission (Mediterranean)	2015	EU Regulation 2015/2102 Article 16j	EU Regulation 2015/2102 Article 16j	EU Regulation 2015/2102 Article 16j
European Commission (*finning regulation*)	20032013	EC Regulation No. 1185/2003 (2003) superseded by [(EU) No.605/2013]	EC Regulation No. 1185/2003 (2003) superseded by [(EU) No.605/2013]	EC Regulation No. 1185/2003 (2003) superseded by [(EU) No.605/2013]
OSPAR Convention (Northeast Atlantic)	2003	–	–	List of threatened and/or declining species and habitats
Barcelona Convention (Mediterranean)	2009	Annex II (List of Endangered or Threatened Species)	Annex II (List of Endangered or Threatened Species)	Annex II (List of Endangered or Threatened Species). (Previously Annex III.)
General Fisheries Commission for the Mediterranean (GFCM)	2012	Recommendation GFCM/36/2012/3	Recommendation GFCM/36/2012/3	Recommendation GFCM/36/2012/3
Bern Convention (European Wildlife)	1997	–	–	19.IX.1979 Appendix III, Protected Fauna (Mediterranean)
National and territory measures				
England and Wales	2008	–	–	UK Wildlife and Countryside Act (1981)
Republic of Ireland	2005/2016	–	–	Irish Specimen Fish Committee
Northern Ireland	2011	–	–	Wildlife and Natural Environment Act (Northern Ireland) 1985
Scotland	2012	–	–	Scottish Elasmobranch Protection Order 2012
Spain (Canary Islands)	2019	Order TEC/596/2019 El Catálogo Español de Especies Amenazadas (CEEA): Spanish Catalogue of Threatened Species	Order TEC/596/2019 El Catálogo Español de Especies Amenazadas (CEEA): Spanish Catalogue of Threatened Species	Order TEC/596/2019 El Catálogo Español de Especies Amenazadas (CEEA): Spanish Catalogue of Threatened Species
Spain (Mediterranean)	2012	Orden AAA/75/2012	Orden AAA/75/2012	Orden AAA/75/2012
Croatia	2013		Nature Protection Act (Official Gazette 80/13, Article 151)	Nature Protection Act (Official Gazette 80/13, Article 151)
Israel	2005	National Parks, Nature Reserves, National Sites and Memorial Sites Law, 5758-1998	National Parks, Nature Reserves, National Sites and Memorial Sites Law, 5758-1998	National Parks, Nature Reserves, National Sites and Memorial Sites Law, 5758-1998
Monaco	1998	La legislation nationale en matiere de peche est le Code de la mer crée par la Loi n. 1.198 du 27/03/1998	La legislation nationale en matiere de peche est le Code de la mer crée par la Loi n. 1.198 du 27/03/1998	La legislation nationale en matiere de peche est le Code de la mer crée par la Loi n. 1.198 du 27/03/1998
Malta	2006	Fauna and Natural Habitats Protection Regulations, 2006 (LN311/06), 1999	Fauna and Natural Habitats Protection Regulations, 2006 (LN311/06), 1999	Fauna and Natural Habitats Protection Regulations, 2006 (LN311/06), 1999
Turkey	2018	Article 5 of the Turkish Prohibited Species lists (Communique 2016/35)	Article 5 of the Turkish Prohibited Species lists (Communique 2016/35)	Article 5 of the Turkish Prohibited Species lists (Communique 2016/35)

Our updated distribution map found Angelshark to be absent in some of these Range State jurisdictions (likely due to misidentification, as described previously). When we considered CMS Range States for which Angelshark was confirmed to be Extant or Presence Uncertain in our updated distribution maps (17 Parties), we found that national or EU measures were in place to protect Angelshark in 11 jurisdictions and were lacking in 7 jurisdictions (Egypt, Morocco, Albania, Libya, Syria, Tunisia, and Algeria).

Regional measures

The Angelshark has been listed in Appendix III of the Bern Convention on the Conservation of European Wildlife since 1997. It was included in Annex III (species whose exploitation is regulated) of the Barcelona Convention Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean Sea (SPA/BD Protocol) until 2009, when all three angel shark species were added to Annex II (endangered or threatened species). Subsequently, a binding Recommendation

Table 4. Vision, Goals, and Objectives of the Eastern Atlantic and Mediterranean Angel Shark Conservation Strategy.

VISION

Angel sharks in the Eastern Atlantic and Mediterranean Sea are restored to robust populations and safeguarded throughout their range

	Goal 1	Goal 2	Goal 3
	Fisheries-based angel shark mortality is minimized	**Critical Angel Shark Areas are identified, investigated and protected where appropriate**	**Human interactions are identified and any negative impacts on angel sharks are minimized**
Objective 1	Reporting and monitoring in commercial fisheries is improved	Distribution and presence of angel shark is confirmed and areas of importance are identified and mapped	The extent of human interaction in each region is understood
Objective 2	Existing legislative measures to protect angel sharks are implemented through enforcement and monitoring	Human impact in Critical Angel Shark Areas is quantified and evaluated	The impact of renewable and extractive industries on angel shark populations is understood
Objective 3	Gaps in protective measures are identified and appropriate legislation to fill these gaps is developed and implemented	Critical Angel Shark Areas are protected through spatial management	Critical Angel Shark Areas are considered prior to nearby coastal development so impacts are mitigated
Objective 4	Improved fisher knowledge of angel sharks' threat status reduces retention and encourages better handling to improve post release survival	Angel sharks are protected by regional and domestic management measures	The extent of angel shark related tourism in each region is assessed and any interactions with angel sharks is understood
Objective 5	Incidental catch of angel sharks is quantified and minimized	–	–
Objective 6	The extent of interaction between recreational fishing activities and angel sharks is ascertained	–	–

Three key priority Goals need to be met in order to fulfil the Vision. The associated headline Objectives identify broad themes under which subsequent actions can be grouped. Actions undertaken to help realise these goals and objectives will be varied according to threat, geographic region, and policy measures currently in place (from Gordon *et al.*, 2017).

Table 5. Policy priorities for the conservation of angel sharks in the Eastern Atlantic and Mediterranean.

Policy priorities

Key policy actions	Priority	Cost
Listing in Spanish Domestic Regulations (based on priorities within the *Angelshark Action Plan for the Canary Islands*).[a]	H	$
Implementation of General Fisheries Commission for the Mediterranean Sea (GFCM) measures.	H	$
Expansion of CFP management measures to include additional *Squatina* spp.	H	$
Listing in the Appendices to the Convention on the Conservation of Migratory Species (CMS) and CMS Sharks MOU Annex I (if data available on migratory behaviour).[b]	M	$$
Other national management measures as identified.	M	$$

Effective legislative protection combined with a reduction in incidental catch mortality are key to delivering the Vision of this Conservation Strategy. Key international policy objectives have been identified and additional domestic regulation opportunities sought. H, high priority; M, medium priority; $, low cost (i.e. likely attainable with current existing budgets); $$, high cost (i.e. additional funding is needed). From Gordon *et al.* (2017).
[a]Part of this priority has been achieved because the strategy was developed. All three species have now been included in the Spanish Catalogue of Threatened Species under the category of "in danger of extinction" (the highest category within this legislation), giving them full protection in the Canary Islands.
[b]Part of this priority has been achieved because the strategy was developed. The Angelshark (*S. squatina*) was listed on CMS Appendices I and II at the 12th Conference of the Parties in Manila (2017) and in Annex I to the CMS Sharks MOU (2018).

was adopted by the 24 Parties to the General Fisheries Commission for the Mediterranean (GFCM) [GFCM 42/2018/2 (2018)—amending GFCM 36/2012/3 (2012)] agreeing to ban retention, landing, trans-shipment, display, and sale of species listed on Annex II. Furthermore, in 2015, the European Union (EU) transposed the GFCM Recommendation into EU Regulation (EU 2015/2102). This cemented the prohibition on retention of all three species by the EU fleet in the Mediterranean Sea. This regulation augments the listing of Angelshark as a Prohibited Species under the Common Fisheries Policy (CFP) annual fisheries quotas, which applies to all EU waters (EU 2019/124).

The Angelshark is listed on the OSPAR Convention's list of threatened and/or declining species as under threat and/or in decline in Regions II, III, and IV (OSPAR Commission, 2008). OSPAR Recommendation 10.06 (OSPAR Commission, 2010) requires Contracting Parties to report at 6-year intervals on the implementation of the measures recommended for its protection

and restoration in the OSPAR Maritime Area. Although listed in 2007 as Endangered in the HELCOM (Baltic Marine Environment Protection Commission or Helsinki Commission) Red List, the listing was revised in 2013 and considered "non-applicable" because mature individuals have never regularly occurred in the HELCOM area (HELCOM Red List Fish and Lamprey Species Expert Group, 2013).

National measures

National protection measures that prohibit intentional killing, injuring or retention have been adopted for Angelshark by England and Wales (2008), Northern Ireland (2011), and Scotland (2012). Northern Ireland and England and Wales include additional prohibitions on disturbance and harassment. Listings on Wildlife Orders extend the legal protection to cover the actions of the angling community (and beyond). This serves to highlight the susceptibility of the Angelshark to fishing mortality and the importance of recording accidental catch. In the Mediterranean, all three species were listed in 2012 on the Spanish List of Wild Species under Special Protection (LESPRE), involving special protections related to capture in the wild, transport, and commercial exploitation. All three species have also been included in the Spanish Catalogue of Threatened Species under the category "in danger of extinction" (the highest category within this legislation), giving them full protection in the Canary Islands. Regulations have been adopted prohibiting targeting and retention of Angelshark and Smoothback Angelshark by Croatia, and for all three species by Israel, Monaco, Malta, and Turkey. In April 2018 through Communique 2018/19, the Turkish Government announced updates to Article 5 of the Turkish Prohibited Species lists (Communique 2016/35), with the addition of 14 elasmobranch species, which includes the three species of angel shark found in the Mediterranean.

Development of an Eastern Atlantic and Mediterranean Angel Shark Conservation Strategy

We developed a Vision and three Goals; each Goal included an underlying set of Objectives (Table 4). In addition to these overall Goals and Objectives, experts identified specific Threat, Policy, and Geographic Priorities for four regions. Three regions—the Northeast Atlantic, the Mediterranean, and West Africa—were discussed during the workshop, whereas the fourth region—the Canary Islands—was drawn from the previously developed Angelshark Action Plan for the Canary Islands (Barker *et al.*, 2016). Key high and medium policy priorities, as well as the relative estimated cost of advancing these priorities, were identified and many have been partially or fully realized because the workshop took place, in particular, the listing of all three species in Spanish domestic regulations and the listing of Angelshark on CMS, with accompanying Concerted Actions to encompass the additional two species (Table 5). Recommended next steps are outlined at a broad strategic level but act as guidelines for targeted conservation action and are not exhaustive.

Discussion

We provide the most comprehensive synthesis of the distribution and status of angel sharks in the Eastern Atlantic and Mediterranean to date, revealing extensive contractions in geographic distribution. When our results are considered in light of the steep declines in recreational and commercial fisheries catch, as

reported in recently published IUCN Red List assessments (Morey *et al.*, 2019a, b, c) and other literature (i.e. Hiddink *et al.*, 2019; Shephard *et al.*, 2019), we confirm that there is an extremely high risk of extinction in the wild for these three shark species. Updated information on distributions shows several notable differences when compared with previous knowledge. Some of these changes are classified non-genuine, as they reflect an increase in scientific knowledge rather than an actual recovery or depletion of a population since these species were last assessed. Other changes may represent genuine improvements in status stemming from reduced fishing mortality and improved conservation measures.

Despite signs of hope and increasing protection in the Northeast Atlantic (Fitzmaurice *et al.*, 2003; Quigley, 2006; Bal *et al.*, 2014; Shephard *et al.*, 2019), we can infer that angel sharks further south in the Eastern Central Atlantic and in the Mediterranean continue to be exposed to significant incidental fishing pressure with very limited monitoring or, in the Mediterranean, implementation of protections. This disparity in enforcement of protections can be supported by a recent study, which found that the majority of fish stocks in northern Europe was not overfished, in stark contrast to those in the Mediterranean (Fernandes *et al.*, 2017). Restoring angel sharks to robust (defined here as strong and healthy) populations and safeguarding (defined here as protected from harm or damage) them throughout their range will require effective international and national conservation and fisheries regulations that eliminate or reduce the mortality of angel sharks and harmful fishing gears.

Signs of hope from improved understanding of distributions

One notable non-genuine change that we found is that the distribution of Angelshark reported from the previous IUCN Red List assessment increased from being seemingly isolated to the Canary Islands (Ferretti *et al.*, 2015), to include the Celtic Seas ecoregion (in particular off the Welsh coast and the west coast of Ireland), as well as several other regions in the Mediterranean Sea. A non-genuine change is defined by the IUCN as a change in population, range size, or habitat that results from novel information, taxonomic revision, or an error; rather than a genuine change, which results from the actual improvement or deterioration of a species population, range size, or habitat (IUCN, 2012). The text of the previous IUCN Red List assessment for the Angelshark summarised several dramatic declines in catches and classified it as Presence Uncertain throughout much of its historical range (Ferretti *et al.*, 2015). Limited time and resources were available for this previous IUCN Red List assessment, and as a result authors used a highly precautionary approach. This resulted in the assessment Range Map indicating that the species was only Extant in the Canary Islands. It is now known that the species is extremely rare but still present over a much larger range. In addition, the previous IUCN Red List assessment reported that Angelshark was historically found south to Mauritania. The results presented here provide no evidence that the species was ever recorded anywhere on the Atlantic coast of mainland Africa.

Reducing fishing mortality can halt declines and help angel sharks recover

The Canary Islands, Spain, represent a unique stronghold for the Angelshark as the species is considered relatively common throughout the area, and there are frequent records of adult

mating behaviour and the presence of juveniles (Meyers *et al.,* 2017). The reason why the Canary Islands have maintained a strong, reproductive Angelshark population may be due in part to isolated oceanographic conditions but is more likely to be the result of a 1986 Spanish Royal Decree, which prohibited any form of trawl fishing (Real Decreto 2200/1986).

Hence, reducing the threat of bottom trawling in key habitats is an important component of helping angel shark populations recover. The Canary Island archipelago comprises eight major islands and three islets that have emerged after successive volcanic events (Pascual, 2004). Each island has a narrow insular shelf (only those between La Graciosa, Lanzarote, and Fuerteventura are connected); is separated by abyssal depths, sometimes over 3000 m; and is characterized by oceanographic conditions influenced by a dominant trade wind and longitudinal gradients in sea temperature, salinity and nutrient concentrations related to proximity to African coastal upwelling (Pavón-Salas *et al.,* 2000; Haroun, 2001). These features have led to a rich and diverse marine faunal prey for the Angelshark (Haroun, 2001) and the environmental conditions necessary for each of their life history stages. The productive marine environment, coupled with the ban on trawl fishing in 1986 aimed at reducing harm to the seafloor (Real Decreto, 2200/1986), may have provided the optimal conditions for Angelshark populations to flourish. While the fisheries legislation was not directly put in place to conserve the Angelshark, this species has likely benefitted from reduced fishing mortality in its shallow demersal habitats. Management of other fishing activities in areas known to be important for Angelshark, such as gillnetting or recreational angling, may also be important in helping restore and recover angel sharks in the region.

In the Northeast Atlantic, the last reform of the CFP in 2002 resulted in a substantial drop in effort by demersal fishing gear from 2002 to 2011 (Fernandes and Cook, 2013). There had been two decades of minimal sightings of Angelshark in the 1990s and 2000s, including a period when two of the authors were working extensively in the trawl and gillnet shark and ray fisheries of Wales where there was no evidence of a single capture during that time (pers. obs. from JRE and NKD). A recent increase in records of Angelshark in Wales is likely due to increased reporting by the angling and commercial fishing community (Fitzmaurice *et al.,* 2003; Quigley 2006; Bal *et al.,* 2014; Hiddink *et al.,* 2019; Shephard *et al.,* 2019). This increase in informal reports has largely been augmented by an Angelshark-specific data gathering and conservation project, piloted in 2017. In 2018, these encouraging signs led to the formal launch of a project to improve understanding of this species in the northern part of its range (Angel Shark Project: Wales https://angelsharknetwork.com/wales). In conjunction with domestic protection, the Angelshark receives species-specific protection under the CFP where it is now listed as a Prohibited Species, giving it full protection.

The challenge of misnaming and misidentification

Issues with species misidentification, overlapping ranges, limited data, and poor reporting of these three species continue to cause confusion. Misidentification and overlapping ranges resulted in a notable non-genuine change for the Sawback Angelshark. The previous IUCN Red List assessment reported a range from Morocco to Angola (Morey *et al.,* 2007a). Our distribution review found no records of this species south of Sierra Leone (M. Schaber, pers. comm., reviewed by E. Meyers, 2017), reducing the

known coastal length of this species' range by approximately 5000 km. It is likely that misidentification between the Sawback Angelshark and the Smoothback Angelshark (which historically ranged south to Angola) made it challenging to define the ranges of these two species. West Africa remains chronically understudied for these and most other marine fishes (Polidoro *et al.,* 2016, 2017), meaning that engaging with regional experts to confirm landings and species distributions is key and may uncover further revisions to our work here. Limited data, poor reporting, and the absence of data to species level are also problematic in the Mediterranean Sea, where angel shark records from large swathes of the coastline are only identified to family level. As with Angelshark and Anglerfish in the United Kingdom, changes in distribution and population abundance resulting from misidentification can mask potentially more serious reductions.

The importance of coordinated international conservation actions

The multidisciplinary authorship of this study reflects widespread collaboration with scientists, fishers, governments, conservationists, and archivists from across the ranges of these three angel shark species. This collaboration has proved vital to identify the main priorities and challenges that are faced by conservation efforts for angel sharks. In light of the recent international legislation changes, there is a need for nation states to deliver on their obligations by establishing coordinated cross-boundary conservation initiatives for angel sharks. Range States are encouraged to liaise with each other and with the wider international conservation community to follow the recommendations of the Eastern Atlantic and Mediterranean Angel Shark Conservation Strategy and Angelshark Action Plan for the Canary Islands, along with subsequent Regional Action Plans. Range States of the Angelshark that are also Party to CMS are urged to work together towards implementing the CMS Concerted Actions, adopted by the Conference of the Parties at its 12th Meeting (Manila, October 2017), and Signatories to the CMS Sharks MOU are encouraged to translate Annex I into national and/or regional actions for Angelsharks. Following on from the development of this Conservation Strategy and CMS Concerted Actions, a Mediterranean Angel Shark Regional Action Plan is in development with capacity for Sub-Regional Action Plans to allow consideration of specific threats and engagement with regional authorities and governments to develop detailed actions.

Conclusions

This work represents the first coordinated range-wide effort to illuminate and improve the conservation status of angel sharks in the Eastern Atlantic and Mediterranean. Confirming species distributions and distinguishing genuine from non-genuine changes in these distributions is a critical first step to prioritizing management and conservation actions. In the Northeast Atlantic, the Angelshark shows a promising genuine improvement off the western coasts of the British Isles due to decreased fishing mortality and an increase in public awareness and reporting. This article successfully delineates the ranges of the three species of angel shark in the Mediterranean Sea, determining that the only areas where all three species are confirmed Extant is the Aegean Sea, the Mediterranean coast of Turkey, and in the central basin of the Mediterranean (off the coasts of Tunisia and Sicily). Recent reports of both Sawback and Smoothback Angelshark in West

Africa prioritize this region for proactive management and species-specific surveys. The results presented here confirm that the historical range of only the Smoothback Angelshark extends into Western-Central Africa and that this species has likely undergone range contraction at the southern extent of its range. All three species retain their status as Critically Endangered on the IUCN Red List of Threatened Species. The Conservation Strategy we have outlined here indicates coordinated and tractable research and policy priorities that should help to ensure all three Critically Endangered species of angel shark are restored to robust populations and are safeguarded throughout their range.

Supplementary data

Supplementary material is available at the *ICESJMS* online version of the manuscript.

References

Akyol, O., Ünal, V., and Capapé, C. 2015. Occurrence and biological observations on angel shark *Squatina squatina* (Chondrichthyes: Squatinidae) from the Turkish Waters (Eastern Mediterranean Sea). Turkish Journal of Fisheries and Aquatic Sciences, 15: 951–955.

Bal, G., White, J., Johnston, G., Roche, W., O'Reilly, S., Green, P., and Fitzmaurice, P. 2014. Estimates of yearly population size of Angel Sharks from Tralee Bay. Working Document to the ICES Working Group on Elasmobranch Fishes. 8 pp.

Barker, J., Bartoli, A., Clark, M., Dulvy, N. K., Gordon, C., Hood, A., and Jimenez Alvarado, D. 2016. Angelshark Action Plan for the Canary Islands. Zoological Society of London Technical Publication, London, UK. 28 pp.

Başusta, N. 2002. Occurrence of a Sawback Angelshark (*Squatina aculeata* Cuvier, 1829) off the Eastern Mediterranean Sea Coast of Turkey. Turkish Journal of Veterinary and Animal Sciences, 26: 1177–1179.

Başusta, N. 2016. New records of neonate and juvenile sharks (*Heptranchias perlo, Squatina aculeata, Etmopterus spinax*) from the North-eastern Mediterranean Sea. Marine Biodiversity, 46: 525–527.

Brander, K. 1981. Disappearance of common skate *Raja batis* from Irish Sea. Nature, 290: 48–49.

Cailliet, G. M., Mollet, H. F., Pittenger, G. G., Bedford, D., and Natanson, L. J. 1992. Growth and demography of the Pacific angel shark (*Squatina californica*), based upon tag returns off California. Australian Journal of Marine and Freshwater Research, 43: 1313–1330.

Capapé, C., Diatta, Y., Seck, A. A., Guelorget, O., Ben Souissa, J., and Zaouali, J. 2005. Reproduction of the sawback angelshark *Squatina aculeata* (Chondrichthyes: Squatinidae) off Senegal and Tunisia. Cybium: International Journal of Ichthyology, 29: 147–157.

Capapé, C., Quignard, J. P., and Mellinger, J. 1990. Reproduction and development of two angel sharks, *Squatina squatina* and *S. oculata* (Pisces: Squatinidae), off Tunisian coasts: semi-delayed vitellogenesis, lack of egg capsules, and lecithotrophy. Journal of Fish Biology, 37: 347–356.

Capapé, C., Seck, A. A., Gueye-Ndiaye, A., Diatta, Y., and Diop, M. 2002. Reproductive biology of the smoothback angel shark, *Squatina oculata* (Elasmobranchii: Squatinidae), from the coast of Senegal (eastern tropical Atlantic). Journal of the Marine Biological Association of the United Kingdom, 82: 635–640.

Cavallaro, M., Danze, A., Ammendolia, G., and Navarra, E. 2015. Finding of a rare *Squatina squatina* (Linnaeus, 1758) (Chondrichthyes: Squatinidae) along the Tyrrhenian coast of the Strait of Messina and its maintenance in an aquarium. Marine Biodiversity Records, 8: e44.

CMS/Sharks/MOS3/Inf.10. 2018. Concerted Action for the Angelshark (*Squatina squatina*). 3rd Meeting of the Signatories to the Sharks MOU (MOS3). 10–14 December 2018, Monaco. 11 pp.

Compagno, L., Dando, M., and Fowler, S. 2005. A Field Guide to the Sharks of the World. Harper Collins Publishers Ltd., London.

Correia, J. P. S., and Smith, M. F. L. 2003. Elasmobranch landings from the Portuguese commercial fishery from 1986 to 2001. Marine Fisheries Review, 65: 32–40.

Corsini, M., and Zava, B. 2007. Recent capture of *Squatina oculata* and *Squatina aculeata* from Dodecanese Islands (SE Aegean Sea, Eastern Mediterranean Sea). Biologia Marina Mediterranea, 14: 352–353.

De Oliveira, J. A. A., Ellis, J. R., and Dobby, H. 2013. Incorporating density dependence in pup production in a stock assessment of NE Atlantic spurdog *Squalus acanthias*. ICES Journal of Marine Science, 70: 1341–1353.

Dulvy, N. K., Davidson, L. N. K., Kyne, P. M., Simpfendorfer, C. A., Harrison, L. R., Carlson, J. K., and Fordham, S. V. 2016. Ghosts of the coast: global extinction risk and conservation of sawfishes. Aquatic Conservation: Marine and Freshwater Ecosystems, 26: 134–153.

Dulvy, N. K., Fowler, S. L., Musick, J. A., Cavanagh, R. D., Kyne, P. M., Harrison, L. R., Carlson, J. K., *et al.* 2014. Extinction risk and conservation of the world's sharks and rays. eLife, 3: e00590.

Dulvy, N. K., Metcalfe, J. D., Glanville, J., Pawson, M. G., and Reynolds, J. D. 2000. Fishery stability, local extinctions, and shifts in community structure in skates. Conservation Biology, 14: 283–293.

Engelhard, G. H. 2008. One hundred and twenty years of change in fishing power of English North Sea trawlers. *In* Advances in Fisheries Science: 50 Years on from Beverton and Holt, p. 546. Ed. by A. I. L. Payne, J. Cotter, and T. Potter. Blackwell Publishing/Cefas, Oxford, UK. 25 pp.

Ergüden, D., and Bayhan, K. Y. 2015. Three fish species known to be rare for Turkey, captured from the Northeastern Mediterranean

coast of Turkey, Mersin Bay, *Sudis hyalina* Rafinesque, *Chlopsis bicolor* Rafinesque, *Squatina aculeata* Cuvier. International Journal of Scientific and Technological Research, 1: 1–8.

European Union (EU). 2015. Regulation 2015/2102 of the European Parliament and of the Council of 28 October 2015 amending Regulation (EU) No 1343/2011 on certain provisions for fishing in the GFCM (General Fisheries Commission for the Mediterranean) Agreement area. http://data.europa.eu/eli/reg/2015/2102/oj (last accessed 16 November 2019).

European Union (EU). 2019. Council Regulation 2019/124 of 30 January 2019 fixing for 2019 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters. https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32019R0124&from=EN (last accessed 16 November 2019).

EVOMED. 2011. The 20th Century evolution of Mediterranean exploited demersal resources under increasing fishing disturbance and environmental change: final report draft. EU DGMARE Call for Tenders n° MARE/2008, 11 (Lot 4): 239 pp.

Fernandes, P. G., and Cook, R. M. 2013. Reversal of fish stock decline in the Northeast Atlantic. Current Biology, 23: 1432–1437.

Fernandes, P. G., Ralph, G. M., Nieto, A., Criado, M. G., Vasilakopoulos, P., Maravelias, C. D., and Cook, R. M. 2017. Coherent assessments of Europe's marine fishes show regional divergence and megafauna loss. Nature Ecology & Evolution, 1: 0170.

Ferretti, F., Myers, R. A., Sartor, P., and Serena, F. 2005. Long term dynamics of the Chondrichthyan fish community in the upper Tyrrhenian Sea. ICES Document CM 2005/N: 25. ICES 2005 Annual Science Conference, Aberdeen, UK, 2005. 34 pp.

Ferretti, F., Worm, B., Britten, G. L., Heithaus, M. R., and Lotze, H. K. 2010. Patterns and ecosystem consequences of shark declines in the ocean. Ecology Letters, 13: 1055–1071.

Ferretti, F., G., Serena, F., Morey, Mancusi, C., Fowler, S. L., Dipper, F., and Ellis, J. 2015. *Squatina squatina*. The IUCN Red List of Threatened Species 2015: e.T39332A48933059. https://www.iucnredlist.org/species/39332/48933059 (last accessed 15 May 2019).

Filiz, H., Irmak, E., and Mater, S. 2015. Occurrence of *Squatina aculeata* Cuvier, 1829 (Elasmobranchii, Squatinidae) from the Aegean Sea, Turkey. European Union Journal of Fisheries and Aquatic Sciences, 22: 451–452.

Fitzmaurice, P., Keirse, G., Green, P., and Clarke, M. 2003. Angel Shark Tagging in Irish Waters. Central Fisheries Board, Dublin, Ireland. 19 pp.

Fordham, S. V., Jabado, R., Kyne, P. M., Charvet, P., and Dulvy, N. K. 2018. Saving Sawfish: Progress and Priorities. IUCN Shark Specialist Group, Vancouver, Canada. 6 pp. https://www.iucnssg.org/sawfish-progress--priorities.html (last accessed 16 November 2019).

Fortibuoni, T., Borme, D., Franceschini, G., Giovanardi, O., and Raicevich, S. 2016. Common, rare or extirpated? Shifting baselines for common angelshark, *Squatina squatina* (Elasmobranchii: Squatinidae), in the Northern Adriatic Sea (Mediterranean Sea). Hydrobiologia, 772: 247–259.

Gag, F., and Arnulf, F. 1985. Nice as the Days and Seasons. Alp'Azur Publishing, Antibes, France. 314 pp.

GFCM 36/2012/3. 2012. Recommendation on Fisheries Management Measures for Conservation of Sharks and Rays in the GFCM Area, Rome, Italy. General Fisheries Commission for the Mediterranean.

GFCM 42/2018/2. 2018. Recommendation on Fisheries Management Measures for the Conservation of Sharks and Rays in the GFCM Area of Application, Amending Recommendation GFCM/36/2012/3. http://www.fao.org/3/ca4047en/ca4047en.pdf (last accessed 16 November 2019)

Ghmati, H., and Turki, A. 2015. Elasmobranchs Status in Libya. Occasional paper presented at Working Group on Demersal Fisheries Resources MedsudMed/Copemed. 14–18 September 2015, Palermo, Italy. 30 p.

Giovos, I., Stoilas, V.-O., Al-Mabruk, S. A. A., Doumpas, N., Marakis, P., Maximiadi, M., and Moutopoulos, D. 2019. 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. Aquatic Conservation: Marine and Freshwater Ecosystems, 29: 881–890.

Giusto, G. B., and Ragonese, S. 2014. Finding of the almost disappeared angel shark (Squatina squatina, Linnaeus, 1758) (Chondrichthyes: Squatinidae), off the South coasts of Sicily (Mediterranean Sea). Naturalista Siciliano, 8: 113–114.

Golani, D. 2006. Cartilaginous fishes of the Mediterranean coast of Israel. *In* The Proceedings of the International Workshop on Mediterranean Cartilaginous Fish with Emphasis on Southern and Eastern Mediterranean, pp. 95–100. Ed. by N. Başusta, Ç. Keskin, F. Serena and B. Seret, 14–16 October 2005. Turkish Marine Research Foundation, Istanbul, Turkey. 271 pp.

Gordon, C. A., Hood, A. R., Barker, J., Bartolí, À., Dulvy, N. K., Jiménez Alvarado, D., Lawson, J. M., *et al.* 2017. Eastern Atlantic and Mediterranean Angel Shark Conservation Strategy. The Shark Trust, Plymouth, UK.

Grau, A. M., Mayol, J., Oliver, J., Riera, F., and Riera, M. I., 2015. Llibre Vermell Dels Peixos de Les Illes Balears. Conselleria de Medi Ambient, Agricultura i Pesca, Palma de Mallorca, España. 150 pp.

Haroun, R. 2001. El mar canario. *In* Naturaleza de Las Islas Canarias: Ecología y, Conservación, pp. 103–107. Ed by J. M. Fernández-Palacios and J. L. M Esquivel. Publicaciones Turquesa, Santa Cruz de Tenerife. 474 pp.

Harrison, L. R. and Dulvy, N. K. (Eds.) 2014. Sawfish: A Global Strategy for Conservation. IUCN Species Survival Commission's Shark Specialist Group, Vancouver, Canada. 116 pp.

HELCOM Red List Fish and Lamprey Species Expert Group. 2013. *Squatina squatina* Species Information Sheet. http://www.helcom.fi/baltic-sea-trends/biodiversity/red-list-of-species/red-list-of-fish-and-lamprey-species (last accessed 16 November 2019).

Hiddink, J. G., Shepperson, J., Bater, R., Goonesekera, D., and Dulvy, N. K. 2019. Near disappearance of the Angelshark *Squatina squatina* over half a century of observations. Conservation Science and Practice, 1: e97.

Holcer, D., and Lazar, B. 2017. New data on the occurrence of the critically endangered common angelshark, *Squatina squatina*, in the Croatian Adriatic Sea. Natura Croatica, 26: 313–320.

ICES. 2008. Report of the Working Group on Elasmobranch Fishes (WGEF). 3–6 March 2008, ICES Headquarters. ICES Document CM 2008/ACOM: 16. 13 pp.

ICES. 2017. Report of the Working Group on Elasmobranch Fishes. 31 May-7 June 2017, Lisbon, Portugal. ICES Document CM 2017/ACOM: 16. 1018 pp.

Iglésias, S. P., Toulhoat, L., and Sellos, D. Y. 2010. Taxonomic confusion and market mislabelling of threatened skates: important consequences for their conservation status. Aquatic Conservation: Marine and Freshwater Ecosystems, 20: 319–333.

Işmen, A., ÇiğdemYığın, C., Altınağaç, U., and Ayaz, A. 2009. Length-weight relationships for ten shark species from Saros Bay (North Aegean Sea). Journal of Applied Ichthyology, 25(Suppl. 1): 109–112.

IUCN. 2012. IUCN Red List Categories and Criteria: Version 3.1. 2nd edn. IUCN, Gland, Switzerland and Cambridge, UK. iv + 32 pp.

IUCN. 2018. Mapping Standards and Data Quality for the IUCN Red List Categories and Criteria Version 1.16. Gland, Switzerland and Cambridge, UK. 30 pp. https://nc.iucnredlist.org/redlist/resources/files/1539098236-Mapping_Standards_Version_1.16_2018.pdf (last accessed 16 November 2019).

IUCN - SSC Species Conservation Planning Sub-Committee. 2008. Strategic Planning for Species Conservation: A Handbook, Version 1.0. IUCN Species Survival Commission, Gland, Switzerland. 104 pp.

IUCN—SSC Species Conservation Planning Sub-Committee. 2017. Guidelines for Species Conservation Planning, Version 1.0. IUCN, Gland, Switzerland. xiv + 114 pp.

Jukic-Peladic, S., Vrgoc, N., Krstulovic-Sifner, S., Piccinetti, C., Piccinetti-Manfrin, G., Marano, G., and Ungaro, N. 2001. Long-term changes in demersal resources of the Adriatic Sea: comparison between trawl surveys carried out in 1948 and 1998. Fisheries Research, 53: 95–104.

Kabasakal, H., 2003. Historical and contemporary records of sharks from the Sea of Marmara, Turkey. Annales, Series Historia Naturalis, 13: 1–12.

Kabasakal, H., and Kabasakal, Ö. 2004. Sharks captured by commercial fishing vessels off the coast of Turkey in the northern Aegean Sea. Annales, Series Historia Naturalis, 14: 171–180.

Kabasakal, H., and Kabasakal, Ö. 2014. Status of Angelshark, *Squatina squatina* (Elasmobranchii: Squatiniformes: Squatinidae) in the Sea of Marmara. Annales, Series Historia Naturalis, 9: 41–46.

Kara, A., Sağlam, C., Acarli, D., and Cengiz, Ö. 2018. Length-weight relationships for 48 fish species of the Gediz estuary, in Izmir Bay (central Aegean Sea, Turkey). Journal of the Marine Biological Association of the United Kingdom, 98: 879–884.

Lawson, J. M., and Fordham, S. V. 2018. Sharks Ahead: Realizing the Potential of the Convention on Migratory Species to Conserve Elasmobranchs. Shark Advocates International, The Ocean Foundation, Washington, DC, USA. 76 pp.

Lawson, J. M., Fordham, S. V., O'Malley, M. P., Davidson, L. N. K., Walls, R. H. L., Heupel, M. R., Stevens, G., et al. 2017. Sympathy for the devil: a conservation strategy for devil and manta rays. PeerJ, 5: e3027.

Lozano Rey, L. 1928. Fauna Ibérica: Peces. Museo Nacional de Ciencias naturals, Madrid. 692 pp.

Machias, A., Vassilopoulou, V., Vatsos, D., Bekas, P., Kallianiotis, A., Papaconstantinou, C., and Tsimenides, N. 2001. Bottom trawl discard in the northeastern Mediterranean Sea. Fisheries Research, 53: 181–195.

Meyers, E. K. M., Tuya, F., Barker, J., Jiménez Alvarado, D., Castro-Hernández, J. J., Haroun, R., and Rödder, D. 2017. Population structure, distribution and habitat use of the critically endangered Angelshark, *Squatina squatina*, in the Canary Islands. Aquatic Conservation: Marine and Freshwater Ecosystems, 27: 1133–1144.

Moore, A. B. M., Séret, B., and Armstrong, R. 2019. Risks to biodiversity and coastal livelihoods from artisanal elasmobranch fisheries in a Least Developed Country: the Gambia (West Africa). Biodiversity and Conservation, 28: 1431.

Moreau, E. 1881–1891. Histoire Naturelle des Poissons de la France. Paris, Volumes I–II, and Supplement. Librairie de L'Académie de Médecine. Paris, France. 158 pp.

Morey, G., Barker, J., Bartolí, A., Gordon, C., Hood, A., Jimenez-Alvarado, D., and Meyers, E. K. M. 2019a. *Squatina aculeata*. The IUCN Red List of Threatened Species 2019: e.T61417A116768915. http://dx.doi.org/10.2305/IUCN.UK.2019-1.RLTS.T61417A116768915.en (last accessed 15 May 2019).

Morey, G., Barker, J., Bartolí, A., Gordon, C., Hood, A., Meyers, E. K. M., and Pollom, R. 2019b. *Squatina oculata*. The IUCN Red List of Threatened Species 2019: e.T61418A116782036. http://dx.doi.org/10.2305/IUCN.UK.2019-1.RLTS.T61418A116782036.en (last accessed 15 May 2019).

Morey, G., Barker, J., Hood, A., Gordon, C., Bartolí, A., Meyers, E. K. M., Ellis, J., et al. 2019c. *Squatina squatina*. The IUCN Red List of Threatened Species 2019: e.T39332A117498371. http://dx.doi.org/10.2305/IUCN.UK.2019-1.RLTS.T39332A117498371.en (last accessed 15 May 2019).

Morey, G., Moranta, J., Riera, F., Grau, A., and Morales-Nin, B. 2006. Elasmobranchs in trammel net fishery associated to marine reserves in the Balearic Islands (NW Mediterranean Sea). Cybium, 30: 125–132.

Morey, G., Serena, F., Mancusi, C., Coelho, R., Seisay, M., Litvinov, F., and Dulvy, N. 2007a. *Squatina aculeata*. The IUCN Red List of Threatened Species 2007: e.T61417A12477164. https://www.iucnredlist.org/species/61417/12477164 (last accessed 27 June 2019).

Morey, G., Serena, F., Mancusi, C., Coelho, R., Seisay, M., Litvinov, F., and Dulvy, N. 2007b. *Squatina oculata*. The IUCN Red List of Threatened Species 2007: e.T61418A12477553. https://www.iucnredlist.org/species/61418/12477553 (last accessed 27 June 2019).

Narváez, K. 2013. Aspectos Biológicos y Ecológicos Del Tiburón Ángel Squatina squatina (Linnaeus 1758) en la Isla de Gran Canaria. PhD Thesis, University of Las Palmas de Gran Canaria, Spain. 271 pp.

Nobre, A. 1935. Vertebrados (Mammiferos, Reptis e Peixes), Vol. 1. Fauna marinha de Portugal, Porto, Portugal. 574 pp.

Öğretmen, F., Yılmaz, F., and Torcu Koç, H. 2005. An investigation on fishes of Gökova Bay (Southern Aegean Sea). Balıkesir Üniversitesi Fen Bilimleri Enstitüsü Dergisi, 7: 19–36.

Osaer, F. 2009. Morfometría y Reproducción del Angelote Squatina squatina (Linnaeus, 1758) en la isla de Gran Canaria. PhD Thesis. University of Las Palmas de Gran Canaria, Spain. 173 pp.

Osaer, F., Narváez, K., Pajuelo, J., and Lorenzo, J. 2015. Sexual development and maturity scale for the angel shark *Squatina squatina* (Elasmobranchii: Squatinidae), with comments on the adequacy of general maturity scales. Sexuality and Early Development in Aquatic Organisms, 1: 117–132.

OSPAR Commission. 2008. Case Reports for the OSPAR List of Threatened and/or Declining Species and Habitats. OSPAR Biodiversity Series. 261 pp.

OSPAR Commission. 2010. Background Document for Angel Shark Squatina squatina. OSPAR Commission, UK. Publication Number: 471/2010. 20 pp.

Pascual, J. J. 2004. Littoral fishermen, aquaculture, and tourism in the Canary Islands: attitudes and economic strategies. *In* Contesting the Foreshore: Tourism, Society and Politics on the Coast, pp. 61–82. Ed. by J. Boissevain, and T. Selwyn. MARE Publication Series No. 2. Amsterdam University Press, Amsterdam, Netherlands. 321 pp.

Pavón-Salas, N., Herrera, R., Hernández-Guerra, A., and Haroun, R. 2000. Distributional pattern of seagrasses in the Canary Islands (Central-East Atlantic Ocean). Journal of Coastal Research, 16: 329–335.

Polidoro, B. A., Ralph, G. M., Strongin, K., Harvey, M., Carpenter, K. E., Adeofe, T. A., and Arnold, R. 2016. Red List of Marine Bony Fishes of the Eastern Central Atlantic. IUCN, Gland, Switzerland. 91 pp.

Polidoro, B. A., Ralph, G. M., Strongin, K., Harvey, M., Carpenter, K. E., Arnold, R., Buchanan, J. R., et al. 2017. The status of marine biodiversity in the Eastern Central Atlantic (West and Central Africa). Aquatic Conservation: Marine and Freshwater Ecosystems, 27: 1021–1034.

QGIS Development Team. 2019. QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org (last accessed 16 November 2019).

Quéro, J. 1998. Changes in the Euro-Atlantic fish species composition resulting from fishing and ocean warming. Italian Journal of Zoology, 65: 493–499.

Quigley, D. 2006. Angelshark (*Squatina squatina*) in Irish Waters. Sherkin Comment, 41: 5. 1 pp.

Ragonese, S., Vitale, S., Dimech, M., Mazzola, S., and Sinacori, G. 2013. Abundances of demersal sharks and chimaera from 1994-2009 scientific surveys in the central Mediterranean Sea. PLoS One, 8: e74865.

Ramdane, Z., and Trilles, J. 2008. Cymothoidae and Aegidae (Crustacea, Isopoda) from Algeria. Acta Parasitologica, 53: 173–178.

Real Decreto 2200/1986 de regulacion de artes y modalidades de pesca en las aguas del caladero canario. *Ministerio de Agricultura, Pesca y Alimentación.* 2 pp. www.boe.es/boe/dias/1986/10/24/pdfs/A35819-35820.pdf (last accessed 16 November 2019).

Republic of Turkey. 2016. Turkish Fisheries Regulation (TFR) No 4/1. Instructions for the regulation of commercial marine and inland fishery in 2016–2020 fishing period: Notification No. 2016/35. Republic of Turkey, Ministry of Food, Agriculture and Livestock, General Directorate of Fisheries and Aquaculture. Ankara, 68 pp. (In Turkish.)

Rogers, S. I., and Ellis, J. R. 2000. Changes in the demersal fish assemblages of British coastal waters during the 20th century. ICES Journal of Marine Science, 57: 866–881.

Salafsky, N., Salzer, D., Stattersfield, A. J., Hilton-Taylor, C., Neugarten, R., Butchart, S. H. M., Collen, B. E., *et al.* 2008. A standard lexicon for biodiversity conservation: unified classifications of threats and actions. Conservation Biology, 22: 897–911.

Sanches, J. G. 1986. Nomenclatura e Diagnose Dos Principais Peixes Marinhos de Portugal (Ciclóstomos, Seláceos e Holocéfalos). INIP (Pub. Avulsas. 9), Lisboa. 184 pp.

Sguotti, C., Lynam, C. P., García-Carreras, B., Ellis, J. R., and Engelhard, G. H. 2016. Distribution of skates and sharks in the North Sea: 112 years of change. Global Change Biology, 22: 2729–2743.

Shephard, S., Wögerbauer, C., Green, P., Ellis, J. R., and Roche, W. 2019. Angler catches track the near extirpation of angel shark *Squatina squatina* from two Irish hotspots. Endangered Species Research, 38: 153–158.

Stenberg, C., Nyman, L., and Svensson, M. 2015. Västerhavets Hajar Och Rockor. ArtDatabanken SLU, Uppsala.

Swartz, W., Sala, E., Tracey, S., Watson, R., and Pauly, D. 2010. The spatial expansion and ecological footprint of fisheries (1950 to present). PLoS One, 5: e15143.

Yaglioglu, D., Deniz, T., Gurlek, M., Erguden, D., and Turan, C. 2015. Elasmobranch bycatch in a bottom trawl fishery in the Iskenderun Bay, northeastern Mediterranean. Cahiers de Biologie Marine, 56: 237–243.

Walker, P., Cavanagh, R. D., Ducrocq, M., and Fowler, S. L. 2005. Chapter 7—Regional overviews: northeast Atlantic (including Mediterranean and Black Sea). *In* Sharks, Rays and Chimaeras: The Status of the Chondrichthyan Fishes, p. 86. Ed. by S. L. Fowler, R. D. Cavanagh, M. Camhi, G. H. Burgess, G. M. Cailliet, S. V. Fordham, C. A. Simpfendorfer, J. A. Musick. IUCN SSC Shark Specialist Group, IUCN, Gland, Switzerland and Cambridge, UK.

Walker, P., and Heessen, H. J. L. 1996. Long-term changes in ray populations in the North Sea. ICES Journal of Marine Science, 53: 1085–1093.

Walker, P., and Hislop, J. R. G. 1998. Sensitive skates or resilient rays? Spatial and temporal shifts in ray species composition in the central and north-western North Sea between 1930 and the present day. ICES Journal of Marine Science, 55: 392–402.

Weigmann, S. 2016. Annotated checklist of the living sharks, batoids and chimaeras (Chondrichthyes) of the world, with a focus on biogeographical diversity. Journal of Fish Biology, 88: 837–1037.

Witte, J. Y., and Zijlstra, J. J. 1978. The species of fish occurring in the Wadden Sea. *In* Fishes and Fisheries of the Wadden Sea. Final report of the section "Fishes and Fisheries" of the Wadden Sea Working Group, pp. 10–19. Ed. by N. Dankers, W. J. Wolff, and J. J. Zijlstra. Leiden, Stichting Veth tot Steun aan Waddenonderzoek.

Zava, B., Fiorentino, F., and Serena, F. 2016. Occurrence of juveniles *Squatina oculata* Bonaparte, 1840 (Elasmobranchii: Suatinidae) in the Strait of Sicily (Central Mediterranean Sea). Cybium: International Journal of Ichthyology, 1840: 341–343.

Zidowitz, H., Kaschner, C., Magath, V., Thiel, R., Weigmann, S., and Thiel, R. 2017. Gefährdung und Schutz der Haie und Rochen in den Deutschen Meeresgebieten der Nord- und Ostsee. BfN-Skripten 450, Bundesamt für Naturschutz. Bonn-Bad Godesberg, Germany. 224 pp.

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