2024-07-04

Conservation and management of chondrichthyans in the Mediterranean Sea: gaps, overlaps, inconsistencies, and the way forward

Ioannis Giovos *Environmental Organization for the Preservation of the Aquatic Ecosystems*

Jennifer M. Pytka

Jason Lowther *School of Society and Culture*

Lydia Koehler *School of Society and Culture*

Monica Barone

et al. *See next page for additional authors*

Conservation and management of chondrichthyans in the Mediterranean Sea: gaps, overlaps, inconsistencies, and the way forward

Lowther, Jason; Koehler, Lydia; Giovos, Ioannis; Pytka, Jennifer M.; Barone, Monica; Loth, Camille ; Moutoploulos, Dimitirios K.; Niedermuller, Simone ; Mazzoldi, Carlotta

Published in:
Reviews in Fish Biology and Fisheries

DOI:
10.1007/s11160-024-09857-z

Publication date:
2024

Document version:
Publisher's PDF, also known as Version of record

Rev Fish Biol Fisheries (2024) 34:1067–1099
https://doi.org/10.1007/s11160-024-09857-z

ORIGINAL RESEARCH

Conservation and management of chondrichthyans in the Mediterranean Sea: gaps, overlaps, inconsistencies, and the way forward

Ioannis Giovos · Jennifer M. Pytka · Monica Barone · Lydia Koehler · Camille Loth · Jason Lowther · Dimitrios K. Moutopoulos · Simone Niedermüller · Carlotta Mazzoldi

Received: 1 October 2023 / Accepted: 6 April 2024 / Published online: 4 July 2024

Abstract Over one third of sharks, rays and chimaeras (chondrichthyans) are threatened with extinction globally. In the Mediterranean Sea, more than half of chondrichthyan species face this risk, although a variety of international, regional, and national rules and regulations apply directly and indirectly targeting management and conservation for these species. In this work, we provide an overview of relevant legislation and policies in the region, which regulate, inter alia, commercial fisheries, while highlighting through cases studies how implementation in practice at national level looks like. Horizontal gaps and inconsistencies that hinder chondrichthyan management in the region are also illustrated. Furthermore, we present recommendations for improvement and additional tools that can be used, even if not originally or explicitly targeting chondrichthyans, for improving the management of these taxa in the Mediterranean.

Keywords Sharks · Rays · Fisheries · Policy · Governance · Conservation

Introduction

The ocean covers more than 70% of the planet's surface, providing inhabitants with a variety of services and resources critical for their existence (Visbeck 2018). Yet more than ever and as a result of the intensification of human activities, the ocean is facing a vast number of threats posing a clear danger to its viability. Although international environmental law developed extensively in the twentieth century, the marine environment only made it onto the international policy agenda at the 2002 World Summit on Sustainable Development and subsequently through

Ioannis Giovos and Jennifer M. Pytka have contributed equally to this work.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11160-024-09857-z.

I. Giovos (✉) · J. M. Pytka · C. Mazzoldi
Department of Biology, University of Padova, Padua, Italy
e-mail: ioannis.giovos@isea.com.gr

I. Giovos · D. K. Moutopoulos
Department of Fisheries and Aquaculture, University of Patras, Mesolongi, Greece

I. Giovos
Environmental Organisation for the Preservation of the Aquatic Ecosystems, iSea, Thessaloniki, Greece

M. Barone
Rome, Italy

L. Koehler · J. Lowther
School of Society and Culture, University of Plymouth, Plymouth, UK

C. Loth · S. Niedermüller
Mediterranean Marine Initiative, World Wide Fund for Nature, Rome, Italy

the Sustainable Development Goal 14 (Visbeck et al. 2014; Claudet et al. 2021). Ocean governance regulates maritime activities through strict obligations, soft laws, or voluntary agreements at various global scales (Bundy et al. 2017). Solutions to sustainable resources management head towards a more holistic approach (i.e., ecosystem approach), with no single authority in charge (van Tatenhove 2013). Many actors and conflicting policies can create miscommunication, overlapping and/or undefined jurisdiction (Stephenson et al. 2019; Haas et al. 2021) producing inconsistent rather than uniform approaches. Varied governance approaches and fragmented responsibilities, together with severe gaps of knowledge such as consequences of ecosystem alterations due to overfishing, and species-specific impacts, undermine the efforts for effective, streamlined management (Visbeck 2018; Intergovernmental Oceanographic Commission 2020).

Managing fisheries is an urgent topic due to the direct impact fisheries have on environmental stability and the livelihoods of millions of citizens (Worm et al. 2006; Cardinale et al. 2012; Worm and Branch 2012; McCauley et al. 2015). Indeed, fish provide about 17% of the global population's intake of animal proteins, contributing to food security especially in the poorest nations (FAO 2022a). While high biodiversity of fishes is directly linked with fish stock stability, reduced biodiversity affects the functioning of ecosystems and significantly decreases the services that are provided (Cardinale et al. 2012). Biodiversity restoration has become a global priority (Moore and Hiddink 2022); however, the transboundary movements of resources complicate management efforts and necessitates cooperation beyond a national level (Maguire et al. 2006). Migratory species, such as marine megafauna (cetaceans, elasmobranchs, sea turtles, large teleosts) move between national territories (Byrne et al. 2017) with most of these species being generally considered either commercially valuable (e.g., tuna or billfish) or under international conservation protection (e.g., cetaceans and turtles) (Campana 2016). In the case of chondrichthyans (sharks and rays (subclass: elasmobranchs), and chimaeras), management is especially complex as they can be seen at once as wildlife to be conserved for non-consumptive purposes, and as a resource for harvest in fisheries (Techera and Klein 2017). This duality results in an overlap between fisheries and environmental policies, and therefore how they are managed (Lado 2016).

The range of habitats occupied by chondrichthyan species, from nearshore coastal habitats to the pelagic, is varied and many species are highly migratory (Meléndez et al. 2017). Moreover, their life history traits, such as late maturity and low fecundity, result in high susceptibility to overexploitation and slow recovery rates (Musick et al. 2000), therefore traditional stock assessment methods used for teleost (bony) fishes are not always appropriate. The overlap between conservation concerns and implications from fishery regulations and management for this group, make chondrichthyans a complex legal subject (Techera and Klein 2017). This complexity is further pronounced, and scales accordingly, when many coastal states share seas and therefore resources.

Situated between three continents (Europe, Africa, Asia), the Mediterranean Sea is a biodiversity hotspot with a complex sea bottom relief and a variety of oceanological conditions, and habitats (Coll et al. 2010). It is a unique area not only in terms of physical environment, but socially, culturally, and politically. The 21 territories surrounding the basin, including eight European Union (EU) Members, contribute to a complex geopolitical reality. The basin has been described as a "miniature of the ocean" that can be used as a proxy, among others (Bethoux et al. 1999), for better understanding conservation policy processes at a larger scale (Katsanevakis et al. 2015). Fisheries play an important role in Mediterranean communities; on average one in every 1000 coastal residents is employed as a fisher (FAO 2022b). With 73% of stocks considered overfished (i.e., fished beyond safe biological limits) (FAO 2022b), socioeconomic, biological, and ecological consequences must be considered. Moreover, the multispecies nature of Mediterranean fisheries results in relatively high levels of bycatch of vulnerable and protected species (FAO 2019), demersal trawlers contributing the highest discard rations, between 34 and 44% of total discards (FAO 2022b). Of vulnerable groups, chondrichthyans are likely to be the most affected by fisheries in the Mediterranean (Carpentieri et al. 2021; FAO 2022b).

Over half of the 86 chondrichthyan species reported in the Mediterranean (Serena et al. 2020) are regionally assessed as threatened with extinction (Vulnerable, Endangered, or Critically Endangered)

by the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (Ebert and Dando 2021; IUCN 2023). This exceeds the global assessment status of these species with one-third listed as threatened (Dulvy et al. 2021). The Mediterranean Sea has been identified as an extinction hotspot for elasmobranchs (Dulvy et al. 2014) and drastic declines in the region have led to a reduction in historical fisheries targeting elasmobranchs (FAO 2019). Currently, targeted chondrichthyan fisheries in the basin are very few and seasonal (Bradai et al. 2018; Falsone et al. 2022). When accidentally caught, chondrichthyan may be retained for their fins and/or meat. Spain dominates global trade in shark meat by volume and value, and Italy is the top importer by value, with the European Union (EU) being an important bridging trader for ray meat (Niedermuller et al. 2021) while far less is known about the North African countries (like Tunisia or Libya) though regarded as priority areas for global elasmobranch conservation (Dulvy et al. 2014). Species with no commercial value are discarded (Falsonse et al. 2022), used for self consumption (Touloupaki et al. 2020), or used as bait, but available data regarding discards and landings is poor (FAO 2022b).

A variety of management and conservation instruments, from binding to voluntary, has been developed over the last decades within the Mediterranean (Koehler and Lowther 2022). Some are specific to chondrichthyans, ranging from broad (Class-level), and narrowing to include the most relevant elasmobranchs, to species-specific measures. Most have been developed for fisheries management or environmental protection but may affect chondrichthyan populations, like spatio-temporal closures for fisheries, and Marine Protected Areas (MPAs) and others). The instruments have originated and evolved from different political agendas or motivations, covering environmental-, fisheries- and trade-related areas, and have created a complex landscape with gaps, overlaps, and inconsistencies.

In this work, we aim at**:**

I. providing an overview of chondrichthyan relevant international and regional commercial fisheries and environmental legislation in the Mediterranean Sea, for a broad audience, particularly non-policy specialists involved in chondrichthyan management and/or conservation. Recreational fisheries are beyond the scope of this paper;
II. illustrating examples of whether and how these instruments are implemented and enforced in practice at a national level through case studies;
III. highlighting gaps, overlaps, and potential inconsistencies among the available instruments and between countries;
IV. identifying areas of improvement and presenting recommendations.

The paper is structured as follows: (1) Chondrichthyan-related legislation and policies in the Mediterranean Sea, where we provide clarity on the intent and strength of the policies, management bodies, instruments, frameworks and otherwise, available at various regional and international levels; (2) Chondrichthyan tools in practice: Case studies, where we present four national case studies to demonstrate how instruments from the previous section work in practice; (3) Common issues for Mediterranean states, in which we comment on persistent issues for chondrichthyan conservation, that exist throughout the region and beyond; (4) discussion where we synthesize the information from the previous sections and advise on what steps states, management bodies, and policymakers should take going forward.

Chondrichthyan-related legislation and policies in the Mediterranean Sea

The complex and sometimes overlapping legal regime in the Mediterranean Sea has evolved through the various international, regional, and national instruments. The efficiency of the instruments is often dependent on the extent that they are binding and legally enforceable (hard law, e.g., treaties) or non-binding (i.e., soft law, e.g., agreements) on states, as well as their factual enforcement (Koehler and Lowther 2022).

Herein we present the chondrichthyan related instruments for the Mediterranean (Tables 1 and 2 and Online Resource 1) that are currently available at time of submission. Figure 1 represents their nested nature.

We have used the term chondrichthyan for consistency and clarity, except when precise language is required, or more accurate. For example, we use

Table 1 Major chondrichthyan-relevant legislation (at time of writing) available within the Mediterranean

Framework/parties	General purpose	Relevant elasmobranch species	Legal power	References
International				
CITES International Agreement	International Trade		Binding	
All Med	Reporting and Enforcement: High seas	All Lamnidae, Cetorhinidae, Alopiidae, Carcharhinidae, Sphyrnidae, Rhinobatidae, Glaucostegidae	Binding	Dec. 17.181, 18.157-8
	Implementation and Compliance	All Lamnidae, Cetorhinidae, Alopiidae, Carcharhinidae, Sphyrnidae, Rhinobatidae, Glaucostegidae	Binding	Dec. 18.218-18.225
	Reporting and Data Collection	All Lamnidae, Cetorhinidae, Alopiidae, Carcharhinidae, Sphyrnidae, Rhinobatidae, Glaucostegidae	Non-binding	Res. Conf. 12.6 (Rev. COP18)
	Implementation and Reporting	All Lamnidae, Cetorhinidae, Alopiidae, Carcharhinidae, Sphyrnidae, Rhinobatidae, Glaucostegidae	Binding	Dec. 18.132-.134
	Compliance	All Lamnidae, Cetorhinidae, Alopiidae, Carcharhinidae, Sphyrnidae, Rhinobatidae, Glaucostegidae	Non-binding	Res. Conf. 18.7
UNCLOS—International Treaty				
	Conservation and Management and Cooperation	See UNCLOS	Binding	Article 64, Annex I
CMS—Intergovernmental treaty			Binding	
All Med, except Türkiye	Mitigation and Data Collection	See CMS	Binding	Res. 12.22
	Compliance	See CMS	Binding	Res. 13.3
	Management plan	*Squatina squatina*		Concerted Action 12.5
	Management plan	*Rhinobatos rhinobatos*		Concerted Action 13.8, 13.9
	Management plan	*Mobula mobular*		Concerted Action 12.6
Sharks MOU—Memorandum of Understanding			Non-binding	
EUMed, Egypt, Libya, Monaco, Portugal, Syria	Elasmobranch conservation		Non-binding	
	Conservation and Cooperation and Monitoring and Scientific Research	See CMS Sharks MOU	Non-binding	CMS/Sharks/Outcome 2.3
IPOA-Sharks—International Action Plan				
Voluntary	Conservation and Management and Mitigation	All Chondrichthyans	Non-binding	
European Union				
European Commission	Trade and Regulation	All CITES (cell #)	Binding	Reg. (EC) No 338/97

Table 1 (continued)

Framework/parties	General purpose	Relevant elasmobranch species	Legal power	References
CFP—fisheries policy			Binding	
all EUMed	Regulation and Protection (fin ban)	Any species	Binding	Reg. (EU) No 605/2013
	Mitigation and Scientific Research and Protection	All species caught in ICCAT Convention area	Binding	Reg. (EU) no 2017/2107
	Regulation and Protection	varies (*I. oxyrinchus*)	Binding	Reg. (EU) No 2022/109
	Regulation and Protection	*H. griseus, C. maximus*, Alopiidae, Carcharinidae, Sphyrnidae, Isuridae, Lamnidae	Binding	Reg. (EU) 2019/1241
EU-POA—European Action Plan			Non-binding	
All EUMed	Conservation and Management and Mitigation			
Common Market Organisation—Framework (within the Common Agricultural Policy)				
	Compliance and Regulation (markets)	Products from any species	Binding	Reg. (EU) No 1379/2013
Atlantic				
ICCAT—RFMO	Management of tuna and tuna-like species		Binding	
all Med, except Bosnia and Herzegovina, Israel, Lebanaon				
	Cooperation and Trade and Information	All sharks caught in ICCAT Convention area	Non-binding	Res. 95-2
	Data Collection and Information	All sharks caught in ICCAT Convention area	Non-binding	Res. 03-10
	Monitoring and Data Collection	All sharks caught in ICCAT Convention area	Binding	Rec. 03-13
	Reporting and Scientific Research	All sharks caught in ICCAT Convention area	Binding	Rec. 04-10
	Data Collection and Mitigation	All sharks caught in ICCAT Convention area	Binding	Rec. 07-06
	Reporting and Data Collection and Mitigation	Alopiidae	Binding	Rec. 09-07
	Compliance and Data Collection and Reporting	Atlantic *Isurus oxyrinchus*	Binding	Rec. 10-06
	Reporting and Data Collection and Mitigation	Sphyrnidae spp.	Binding	Rec. 10-08
	Reporting and Data Collection and Mitigation	*Carcharhinus falciformis*	Binding	Rec. 11-08

Table 1 (continued)

Framework/parties	General purpose	Relevant elasmobranch species	Legal power	References
	Reporting and Data Collection and Mitigation	All bycatch/discards	Binding	Rec. 11-10
	Scientific Research	All sharks caught in ICCAT Convention area dead at haulback	Binding	Rec. 13-10
	Reporting and Data Collection and Mitigation	*Lamna nasus*	Binding	Rec. 15-06
	Regulation and Scientific Research	North Atlantic *Prionace glauca*	Binding	Rec. 21-10
	Reporting and Data Collection and Mitigation and Scientific Research	2022, 2023 North Atlantic *Isurus oxyrinchus*	Binding	Rec. 21-09
Mediterranean				
GFCM—RFMO			Binding	
all Med, except Bosnia and Herzegovina	Data Collection and Reporting	Any species	Binding	Res. 35/2011/1
	Regulation and Protection and Reporting	Any: finning, and *see* SPA/BD	Binding	Res. 36/2012/3
	Data Collection and Reporting	See GFCM/41/2017/6	Binding	Res. 41/2017/6
	Reporting and Mitigation and Management and Data Collection	SPA/BD, species specific mgmt: Mustelus spp., A. vulpinus, C. plumbeus, C. granulosus, H. perlo, S. acanthias, P. glauca	Binding	Res. 44/2021/16
Barcelona Convention			Binding	
	Conservation and Management and Regulation and Scientific Research*	All Chondrichthyans		UNEP MAP RAC/SPA
SPA/BD Protocol	Protection and Conservation and Cooperation		Binding	SPA/BD, art 11, 12
all Med, except Bosnia and Herzegovina, Israel, Lebanon, Libya	Conservation and Protection	See SPA/BD (Annex II)	Binding	Dec IG.26/7
	Management and Regulation	See SPA/BD (Annex III)	Binding	Dec IG.26/7

Table organization begins with frameworks that extend to an international level, and then narrows in geographic scope. Not all Mediterranean states fall under the frameworks—Column 1 lists the relevant countries or bodies. **All Med** = countries (excluding overseas terrirorities) with a Mediterranean coastline, including Albania, Algeria, Bosnia and Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Libya, Malta, Monaco, Montenegro, Morocco, Slovenia, Spain, Syria, Tunisia, Türkiye); **EUMed** = Mediterranean European Union members (underlined All Med list). If taxa are directly referenced in legislation, they have been provided. When the number of relevant taxa exceeds seven, the reader has been referred to Table 2. For example, *see* UNCLOS, refers to the column in Table 2, which indicates the relevant taxa. Reference refers to the legal reference. Full references and a more detailed table can be found in Online Resource 1, as part of the supplemental materials. Dec = Decision; Res = Resolution; Rec = Recommendation

Table 2 Chondrichthyan species considered to occur or migrate through the Mediterranean Sea and corresponding Conventions, legislation and regulations In addition, the Mediterranean and Global conservation status, as assessed by the IUCN Red List of Threatened Species™ (IUCN 2023), are provided

ORDER/Family/ *Species*	IUCN Assesements		UNCLOS Annex	CITES App		Shark IPOA FAO	Sharks MoU Annex	SPA/BD Protocol Annex	ICCAT		GFCM Recommendations				EU							
															Regulation (EU) No				Council			
	Med	Global			CMS App				All species	Species specific	42/2018/2	45/2022/13	41/2017/6	44/2021/16	605/2013	*43/2014*	017/2017	2019/1241	Reg 2021/92	EU POA	Bern Convention App
SELACHII																					
HEXANCHIFORMES																					
Hexanchidae																					
Heptranchias perlo	DD	NT						III				*	^	x							
Hexanchus griseus	LC	NT	I					III[T]				^						^			
Hexanchus nakamurai	DD	NT										*	^								
LAMNIFORMES																					
Carchariidae			I									^									
Carcharias taurus	CR	CR	I					II				^	^	+							
Odontaspididae			I																		
Odontaspis ferox	CR	VU	I					II				^	^	+							
Lamnidae			I																		
Carcharodon carcharias	CR	VU	I	II	I / II		1	II				^	^	+		Æ		Æ			II
Isurus oxyrinchus	CR	EN	I	II	II		1	II		Rec. 21-09		^	^	+			Æ	Æ			III
Lamna nasus	CR	VU	I	II	II		1	II		Rec. 15-06		^	^	x			Æ	Æ	Æ		III
Cetorhinidae			I		I / II																
Cetorhinus maximus	EN	EN	I	II	I / II		1	II				^	^	+		Æ		Æ			II
Alopiidae			I	II						Rec. 09-07											
Alopias superciliosus	EN	VU	I	II	II		1	II[T]		Rec. 09-07		^	^			Æ	Æ	Æ	Æ		

Table 2 (continued)

Alopias vulpinus	EN	VU	I	II	II		1	III		Rec. 09-07		^	^	x		µ		^	µ		
CARCHARHINIFORMES																						
Pentanchidae																						
Galeus atlanticus	NT	NT										*	^									
Galeus melastomus	LC	LC										*										
Scyliorhinidae																						
Scyliorhinus canicula	LC	LC										*										
Scyliorhinus stellaris	NT	VU										*										
Triakidae																						
Mustelus asterias	VU	NT						III				*		x								
Mustelus mustelus	VU	EN						III				*		x								
Mustelus punctulatus	VU	VU						III				*		x								
Galeorhinus galeus	VU	CR			II			II			^^	*	^	+								
Carcharhinidae			I	II (all)																		
Carcharhinus altimus	DD	NT	I	II								^	^					^				
Carcharhinus brachyurus	DD	VU	I	II								^	^					^				
Carcharhinus brevipinna	VU	NT	I	II								^	^					^				
Carcharinus falciformis	DD	VU	I	II	II		1			Rec. 11-08		^	^				Æ	Æ	Æ			
Carcharinus limbatus	DD	VU	I	II								^	^					^				
Carcharhinus obscurus	DD	EN	I	II	II		1					^	^					^				
Carcharhinus plumbeus	EN	EN	I	II				III				^	^	x				^				
Galeocerdo cuvier	DD	NT	I	II								^	^					^				
Prionace glauca	CR	NT	I	II	II			III		Rec. 21-10		^	^	x				^				III

Table 2 (continued)

Rhizoprionodon acutus	NE	LC	I	II									^					^				
Sphyrnidae			I	II (all)								^										
Sphyrna lewini	DD	CR	I	II	II		1	II		Rec. 10-08		^	^	+			Æ	Æ				
Sphyrna mokarran	DD	CR	I	II	II		1	II		Rec. 10-08		^	^	+			Æ	Æ				
Sphyrna zygaena	CR	VU	I	II	II		1	II		Rec. 10-08			^	+			Æ	Æ				
SQUALIFORMES																						
Dalatiidae												*										
Dalatias licha	VU	VU																				
Etmopteridae																						
Etmopterus spinax	LC	VU										*										
Somniosidae																						
Centroscymnus coelolepis	LC	NT										*	^									
Somniosus rostratus	DD	LC										*	^									
Oxynotidae																						
Oxynotus centrina	CR	EN						II				*	^	+								
Centrophoridae																						
Centrophorus uyato	VU	EN						III				*	^	+								
Squalidae																						
Squalus acanthias	EN	VU			II		1	III				*		x								
Squalus blainville	DD	DD										*										
ECHINORHINIFORMES																						
Echinorhinidae																						
Echinorhinus brucus	EN	EN										*	^									
SQUATINIFORMES																						
Squatinidae																						
Squatina aculeata	CR	CR						II				*	^	+								

Table 2 (continued)

Squatina oculata	CR	CR						II				*	^	+									
Squatina squatina	CR	CR			I / II		1	II				*	^	+		Æ		Æ				III	
BATOIDEA																							
TORPEDINIFORMES																							
Torpedinidae																							
Tetronarce nobiliana	LC	LC										*	^										
Torpedo marmorata	LC	VU										*											
Torpedo torpedo	LC	VU										*											
RHINOPRISTIFORMES				II (all)																			
Rhinobatidae				II (all)																			
Rhinobatos rhinobatos	EN	CR		II	I / II		1	II				*	^	+						Æ			
Glaucostegidae				II (all)																			
Glaucostegus cemiculus (R. rhinobatos)	NE	CR		II				II				*	^	+									
RAJIFORMES																							
Rajidae																							
Dipturus batis	CR	CR						II				*	^	+									
Dipturus nidarosiensis	NT	NT										*	^										
Dipturus oxyrinchus	NT	NT										*											
Leucoraja circularis	CR	EN						II				*	^	+									
Leucoraja fullonica	CR	VU										*	^										
Leucoraja melitensis	CR	CR						II				*	^	+									
Leucoraja naevus	NT	LC										*	^										
Raja asterias	NT	NT										*											
Raja brachyura	NT	NT										*	^										

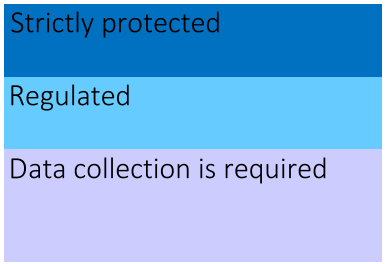
Table 2 (continued)

Raja clavata	NT	NT											*										
Raja miraletus	LC	LC											*										
Raja montagui	LC	LC											*	^									
Raja polystigma	LC	LC											*	^									
Raja radula	EN	EN											*	^									
Raja undulata	NT	EN											*	^									
Rostroraja alba	EN	CR						II					*	^	+								III
MYLIOBATIFORMES																							
Dasyatidae																							
Bathytoshia lata	LC	VU						II[T!]					*	^									
Dasyatis marmorata	DD	NT						III[T]					*	^									
Dasyatis pastinaca	VU	VU						II[T!]					*	^									
Himantura uarnak	NE	EN											*	^									
Pteroplatytrygon violacea	LC	LC						III[T]					*										
Taeniurops grabatus	DD	NT											*	^									
Gymnuridae																							
Gymnura altavela	CR	EN											*	^									
Myliobatidae																							
Aetomylaeus bovinus	CR	CR						II[T!]					*	^									
Myliobatis aquila	VU	CR						II[T!!]					*										
Rhinopteridae																							
Rhinoptera marginata	DD	CR						II[T]					*	^									
Mobulidae																							
Mobula mobular	EN	EN		II	I / II		1	II					*	^	+				Æ	Æ			II
CHIMAERAS																							
CHIMAERIFORMES																							
Chimaeridae																							
Chimaera monstrosa	NT	VU											*										

Table 2 (continued)

For further explanations and full references, refer to Table 1 and Online Resource 1. These data are current as of writing, refer to online repositories of the governing body to ensure the most up to date information

NE not evaluated, *DD* data deficient, *LC* least concern, *NT* near threatened, *VU* vulnerable, *EN* endangered, *CR* critically endangered



*Vessels > 15 m Report all catches > 50 kg per species

^Report number of individuals

+Improve the conservation status

^^Prohibited for driftnets; no more than 3 may be retained when caught with bottomset gillnets, entangling or trammel nets

μDirected fishing prohibited

ÆFishing prohibited

TRecent amendments

!Reservations submitted by Tunisia, Morocco, Libya. Annex III regulations apply for those Parties

!!Reservations submitted by Tunisia, Morocco, Libya and the European Union; Annex III regulations apply for those Parties

elasmobranch only to refer to the subclass including sharks and batoids (i.e., not chimaeras). We have preserved the language used by instruments, in title and text. It is common to refer to all species in the Class as *sharks*, for example, or to refer to the class as *cartilaginous fishes*.

Global binding instruments

The United Nations law of the sea convention (LOSC)

The LOSC, is an international treaty (i.e., legally-binding) adopted at the third UN Conference on the Law of the Sea (UNCLOS III) in 1982 and entered into force in 1994. This convention provides the legal framework for the regulation of human activities at sea (Convention on the Law of the Sea, Dec. 10, 1982, 1833 U.N.T.S 397). In 1995, a Supplementary Agreement on Straddling and Migratory Fish Stocks was established under the LOSC. The Convention provides obligations for states concerning the conservation and management of living resources (e.g., Arts 61; 116–120) by, for example, setting forth that coastal states shall determine allowable catch of living resources within their Exclusive Economic Zones (EEZs; Art. 61(1)) and ensuring living resources are not endangered by overexploitation with the obligation to exchange information on catch and fishing effort (Art. 61(2)). Concerning highly migratory species, Article 64 provides that states shall cooperate directly to conserve and promote optimal utilization of species (listed on Annex I) within and beyond EEZs. (For the relevant Mediterranean chondrichthyan species $n = 29$, see Tables 1 and 2 contained herein).

Convention on the International Trade of Endangered Species (CITES)

CITES is an international agreement, which aims to ensure that international trade in specimens of wild animals and plants does not threaten the survival of the species (CITES 1973). All Mediterranean states and territories are Parties to this Convention. Species are listed on one of three appendices (CITES 1973):

Appendix I international trade is permitted only in exceptional circumstances. Both an import and export permit are required.
Appendix II international trade is permitted but must be controlled in order to avoid utilisation incompatible with their survival. Unless an import permit is required by national law, only an export permit is required.
Appendix III species are included at the request of a Party and international trade is regulated only in States where the species is listed. An export permit is only required if the exporting State has included the species in Appendix III.

Species are proposed by Parties and included on Appendices I or II by decision at the Conference of the Parties (CoP) adopted by a two-thirds majority vote. An Exports permit must include a Non-Detriment Finding (NDF), to be granted only when a scientific authority of the exporting state has advised that such export will not be detrimental to the survival of that species (Article IV (2) of the CITES Convention; CITES 2008). CITES-listed marine animals caught on the high seas (i.e., areas beyond national jurisdiction ABNJ) are subject to introduction from the sea certificates (Resolution Conf.14.6 (rev. COP 16)) which is relevant to the Mediterranean as several countries have not declared an Exclusive Economic Zone (Rodríguez-Rodríguez et al. 2016). Eight families and five chondrichthyan species that are or were present in the Mediterranean and are listed in CITES, all in Appendix II (CITES 2023; see also Tables 1 and 2), while no chondrichthyans have been listed in Appendix III.

The convention on the conservation of migratory species of wild animals (CMS)

The Bonn Convention, or the CMS, is a global treaty for the conservation and sustainable use of migratory animals and their habitats. It brings together the States through which migratory animals pass, referred to as 'Range States', and lays the legal foundation for internationally coordinated conservation measures throughout a migratory range. The CoP of the CMS acts as its principal decision-making forum and it is composed of all signatory states Parties as well as observers that wish to participate. Meetings take place at least every 3 years. The CMS is characterised by the plasticity of the instruments, that can be tailored according to the conservation needs of species and adapted to the requirements of Range States. Proposals for amendment of the appendices may be made by any Party and must be adopted by a two-thirds majority of Parties present and voting in the CoP.

Migratory species to which the Convention applies are listed in one or both appendices:

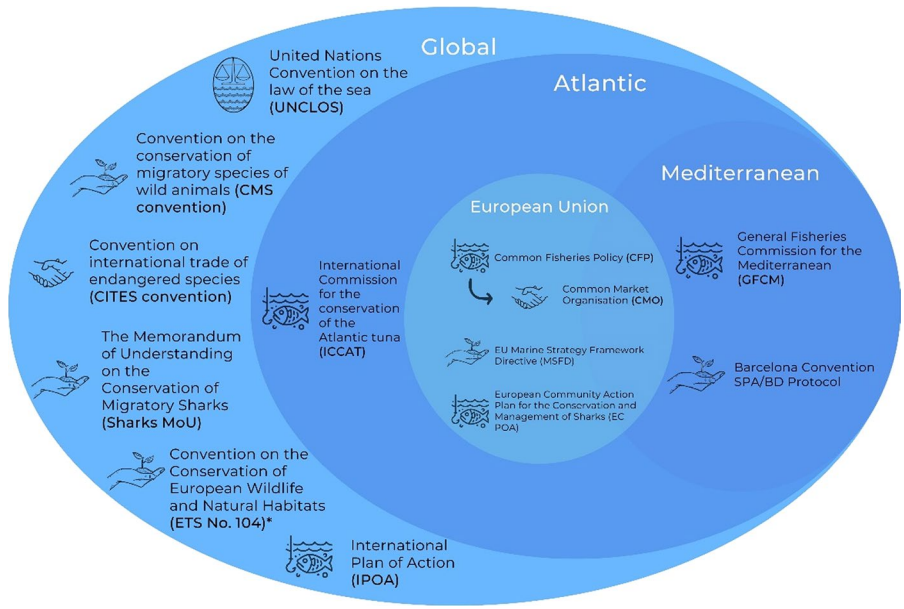


Fig. 1 Representation of the most important available policy frameworks and instruments that target directly or indirectly elasmobranch protection and management in the Mediterranean. *This Convention covers the natural heritage in Europe, as well as in some African countries and has signatories beyond EU, therefore here it is treated as an instrument beyond EU

Appendix I sets out the list of migratory species that are considered endangered, according to the IUCN Red List Threatened categories.
Appendix II sets out the list of species that have an unfavourable conservation status (based on four criteria) and would significantly benefit from international co-operation. Nineteen species that are or were present in the Mediterranean are listed on the CMS (including five species listed in both Appendices) (Tables 1 and 2).

EU Wildlife Trade Regulations: Council Regulation (EC) No 338/97 of 9 December 1996 on the protection of species of wild fauna and flora by regulating trade therein (the Basic Regulation).

The trade of wildlife in the EU is implemented through a set of Regulations. The Basic Regulation imposes an enhanced version of CITES, as described above, upon its EU MS in respect of the trade in specimens (live and dead) or parts of specimens of species contained in the Annexes to that Regulation. Those Annexes map onto the CITES classifications (Tables 1 and 2). The measure is directly applicable to all EU members, although enforcement remains a competence of the national authorities, including transferring enforcement provisions into national legislation (supplemented with national laws; Table 1).

Global non-binding instruments

The Food and Agriculture Organization of the United Nations (FAO) International Plan of Action for the Conservation and Management of Sharks (IPOA-Sharks)

The IPOA-Sharks (herein IPOA) was adopted in 1999 amid concerns of increased shark fishing (FAO, 1999) and is elaborated under the FAO Code of Conduct for Responsible Fisheries (FAO 2000) to provide guidance on binding and voluntary international agreements (Art. 2(d); FAO 1995). It covers all chondrichthyans and aims to ensure their conservation and sustainable use, encourages all states to implement it, and recommends that any states contributing to the mortality of chondrichthyans adopt a national plan of action for sharks (NPOA Sharks, herein NPOA). It is voluntary and proposes a list of issues to be identified and addressed in national, sub-regional or regional plans. The FAO further produced a set of Guidelines for policy and decision-makers to support the implementation process (FAO Marine Resources Service 2000). FAO has the duty to report biennially, through its Committee of Fisheries (COFI), on the progress in the implementation of the IPOA.

The Memorandum of Understanding on the Conservation of Migratory Sharks (Sharks MoU).

The Sharks MoU is a legally non-binding agreement concluded under the CMS. The objective of the Sharks MoU is to encourage collaboration between Signatories and fisheries bodies (regional fisheries management organization [RFMO], and FAO) and Signatories should apply an ecosystem and precautionary approach. It also provides a list of species to be protected (Annex 1). Species listed under the CMS Appendices are not automatically included but are automatically considered by the Signatories for future proposals. Annex 3 of the MoU sets out comprehensive Conservation Plans for Annex 1 species, and an Advisory Committee of eight experts provides advise to the Meeting of the Signatories.

Regional legally-binding instruments in the field of the environment

The Protocol of the Barcelona Convention concerning Specially Protected Areas and Biological Diversity (SPA/BD Protocol)

The United Nations Environment Programme Mediterranean Action Plan (UNEP/MAP; established 1975) is a multilateral environmental agreement (MEA) and it the first regional seas action plan adopted by UNEP. Within the UNEP/MAP framework, the Barcelona Convention was adopted in 1976, amended in 1995, and entered into force in 2004. The Convention and its seven protocols are legally binding and represent the principal MEA in the region. The SPA/BD Protocol (adopted 1995; in force 1999) outlines three main elements to protect the biological diversity in the Mediterranean: (1) the creation, protection, and management of Specially Protected Areas (SPA); (2) the establishment of a list of Specially Protected Areas of Mediterranean Importance (SPAMI; Annex I) and; (3) the protection and conservation of species (Annexes II and III). The Annexes list:

Annex I criteria for selecting SPAMI
Annex II list of Endangered or Threatened Species ($n = 30$*)
Annex III list of species whose exploitation is regulated ($n = 12$*)
See Table 2 for CP reservations

Amendments to Annexes can be proposed by contracting parties until three month before the Focal Point meeting of the Specially Protected Areas/Biodiversity (SPA/BD) protocol and if supported can then be adopted at the Conference of the Parties, held every 2 years, (II and III amended at CoP23, December 2023). Regional Action Plans target taxa groups and provide specific actions [e.g., the RAP for Cartilaginous Fishes (Chondrichthyans)].

Parties have the duty to regulate or prohibit (as necessary) actions such as, the taking, possession or killing (incidental or targeted) of protected species, minimize disturbances during sensitive periods (e.g., breeding, hibernation). Parties shall coordinate their efforts through bilateral or multilateral actions, for the protection and recovery of migratory species whose range extends into the high seas' areas in the Mediterranean. Parties submit national annual reports to the Compliance Committee. The Committee's objective is to facilitate obligations, is non-adversarial, and considers the Party's capacity, "in particular if it is a developing country" (UNEP/MED Decision IG.17/2).

Regional non-binding instruments in the field of the environment

Action Plan for the Conservation of Cartilaginous Fishes (Chondrichthyans) in the Mediterranean Sea (hereafter Mediterranean Shark Action Plan).

The Mediterranean Shark Action Plan (UNEP/MAP RAC/SPA 2003) was approved for revision at the 16th Conference of Contracting Parties to the Barcelona Convention following its development led by RAC/SPA under the mandate of the Barcelona Convention Contracting Parties (UNEP RAC/SPA 2009) and was last updated in 2020 (UNEP MAP RAC/SPA 2020). Following the recommendations of the IPOA-Sharks, it urges contracting parties of the Barcelona Convention to implement national action plans and sets out six objectives within the regional Action Plan. The SPA/BD's National Focal Points are responsible for assessing progress of implementation, at the point of writing no reporting contracting party has reported to have adopted such a national plan of action while three contracting parties reported that an NPOA is under development (UNEP MAP 2023; Gilman et al. 2023), and only four out of seven reporting Contracting Parties indicated a strict legal protection for the species listed in Annex II to the SPA/BD Protocol and GFCM Recommendation through their national laws and regulations (UNEP MAP 2023).

Regional legally-binding instruments in the field of fisheries

The international convention for the conservation of Atlantic tuna (ICCAT)

The ICCAT, adopted in 1966 and ratified in 1969, is the tuna Regional Fisheries Management Organisation (tRFMO) responsible for the conservation and management of tuna and tuna-like species in the Atlantic and its adjacent seas, therefore including the Mediterranean Sea. Fisheries-dependent and -independent data are collected to understand compliance with Recommendations, biological knowledge of species, and statistical data associated with fisheries (ICCAT 2006–2016). ICCAT Recommendations require ratification by a ¾ majority and are binding to all Contracting Parties (CPs; $n = 52$), except in the case of an objection. The 3rd Meeting of the Working Group on the Future of ICCAT agreed that clarifying species managed by ICCAT, and especially sharks, would be beneficial and that expanding the scope of species would require Convention amendment (ICCAT 2012). In 2019 at the Convention's 26th meeting, the convention's text was amended to explicitly include elasmobranchs, "*tuna and tuna-like species or oceanic, pelagic, and highly migratory elasmobranchs*".

General Fisheries Commission for the Mediterranean and the Black Sea (GFCM)

The GFCM (entered into force 1952; GFCM 1949) is a regional fisheries management organization (RFMO) critical to fisheries governance in the Mediterranean and in the Black Sea. It has the authority to make binding measures for fisheries conservation and management, developed through advice provided by its Scientific Advisory Committee (GFCM-SAC).

However, Member States (MSs) must still transpose binding measures into their national legislation. Within the legal framework of the GFCM, 'Resolutions' are legally non-binding, and 'Recommendations' are binding to all Parties. New obligations enter into force if accepted by a two-thirds majority 120 days after the date of first notification (GFCM 2022a). The GFCM has several direct links with other policy frameworks including ICCAT Recommendations which are endorsed by the GFCM at its Annual Sessions and the SPA/BD Protocol. The latter is particularly relevant for chondrichthyans as respective GFCM Recommendations directly refer to the SPA/BD protocol annexes. Within the past 20 years, Recommendations targeting both the protection and management of elasmobranchs have steadily increased. Measures with relevance to elasmobranch conservation and included species can be found in Tables 1 and 2, respectively.

European Union (EU) instruments

The EU has non-binding and binding instruments to set policies or measures. Legally-binding instrument of relevance here, are: Regulations (directly applicable in MSs), Directives (transposition in national law is required and MS are have a certain degree of flexibility with regards to how they will reach the objectives), Decisions (apply to EU as whole, unless stated otherwise), and International Agreements (binding between EU and third countries/institutions).

Field of fisheries

The Common Fisheries Policy (CFP)

The CFP is implemented through EU Regulations, which create direct and binding legal obligations onto MS. The Scientific, Technical and Economic Committee of Fisheries (STECF) is the scientific advisory body for the European Commission, providing fisheries advice in Union waters, including those of the Mediterranean. The Mediterranean receives advice and stock assessments from STECF and GFCM-SAC, though coordination efforts are limited (Cardinale et al. 2021).

The CFP was originally part of the common agricultural policy but has evolved to become independent. The 2002 reform granted fishers more involvement in decisions, through Regional Advisory Councils, and since then the main goals are to ensure sustainable fisheries, and guarantee income and employment for fishers (Breuer 2021). The 2002 and 2013 reforms (Council Regulation (EU) 2371/2002; Council Regulation (EU) 1380/2013) introduced measures to address overfishing, including Technical Measures (see Table 1).The 2013 reform (Council Regulation (EU) 1380/2013) introduced an ecosystem-oriented approach (e.g., through multi-species and multi-fisheries plans), new obligations to MSs regarding data collection and information sharing, and decentralization of governance, and provided a framework MSs to develop implementation measures and cooperate regionally. The 2013 Reform also introduced the discard ban (i.e., Landing Obligation; EU 1380/2013, Article 15) (Breuer 2021).

National authorities must control and enforce the CFP through a system established by the Control Regulation (Regulation (EU) 2023/2842). The previous regulation (Council Regulation (EU) 1224/2009) was adopted prior to the last CFP reform, an amendment was proposed in 2018 and an overhaul to correct deficiencies was adopted November 2023. The Control Regulation, *inter alia*, ensures fisheries catches are within permitted limits, necessary data is collected, inspections are carried out at fishing, landing, processing, transporting, and marketing. Amendments focused on standardization of procedures, increasing transparency, and being more explicit regarding penalty points (Annex III) and what constitutes serious infringements (Annex IV). The requirement to digitize all EU fishing (eLOG book, Vessel Monitoring System, etc.) aims also at uniformity. Ensuring measures and enforcement are accessible to all members, and the information is equally accessible. Most provisions will apply from 10 January 2026, while other transitions are granted a longer period (e.g., provisions for vessels < 12 m will apply from (2028) (Regulation (EU) 2023/2842).

Common market organisation in fishery and aquaculture products (CMO)

The CMO, implemented in 1970 under the legal framework for the Common Agricultural Policy, was

the first separate regulation on fisheries matters when it was implemented in 1970, providing policy for managing fishery products and their sustainability. It represents one of the pillars of the reformed CFP and among its objectives, the CMO aims to: protect producers (improve market stability and strengthen the Union's fisher industry); improve consumer awareness (e.g., through comprehensive labelling information, verifiable product origin, marketing); enable the fishery industry to apply the CFP (Council Regulation (EU) 1379/2013).

Field of the environment

Marine Strategy Framework Directive 2008/56/EC

The MSFD represents the first EU legislative instrument related to marine biodiversity. Adopted in 2008, all EU members were obliged to transpose relevant measures into national law by 17 July 2010.

Commission decision (EU) 2017/848

The MSFD, along with the Habitats Directive (Council Directive 92/43/EEC), focuses on the protection and restoration of representative habitat types, including offshore, to ensure healthy populations of species. The MSFD seeks to establish what is termed Good Environmental Status (Commission Decision (EU) 2017/848) in Union waters, through an ecosystem approach. The descriptors for Good Environmental Status include maintenance of biodiversity and food webs (Descriptors 1 and 4 respectively), Descriptor 3 (Fisheries) applies solely to commercially exploited species. The inclusion and selection of elasmobranchs in the monitoring programmes and measures under the MSFD is at the discretion of the MS and varies between them.

Action plan for the conservation and management of sharks (EU-POA sharks)

In the context of CFP, the EU aims to restore and maintain populations of harvested species above levels which can produce the maximum sustainable yield. To achieve this for chondrichthyans, the EU adopted the non-binding EU-POA in 2009 with the objective to broaden knowledge on sharks and to ensure sustainability of shark fisheries (Commission of the European Communities 2009).

Chondrichthyan tools in practice: case studies

In the section above, and in greater details in supplementary materials, we have presented the Mediterranean instruments most relevant to chondrichthyans. This section provides a brief overview of the structure and the role of fisheries, environmental and trade government bodies in four selected Mediterranean countries, and levels of implementation and enforcement within the given country. The authorities in charge are described and processes related to the creation and implementation of national policies are outlined. Difficulties at national level related to the implementation (e.g., transposition) of chondrichthyan-related obligations and creation of policies are highlighted.

The selected countries have been chosen to reflect the heterogeneous geographic and political circumstances in the basin, such as EU and non-EU members, and states with and without coastlines beyond the Mediterranean.

France

Ascribing fisheries to agriculture ministries rather than environmental ministries is common among EU members, whereby fisheries are given closer access to the government than environmental groups (van Hoof et al. 2005; Beke et al. 2014; Belschner 2015). Evident in the fisheries legislation in France, the sector falls under the Ministry of Agriculture and Fisheries, supervised by the Directorate of Marine Fisheries and Aquaculture (Direction des Pêches Maritimes et de l'Aquaculture). Fishers receive direct representation through various frameworks and administrations. The National Committee of Fisheries and Marine Fish Farming, represented by fishers, processors, traders, and consumers has decision-making powers and serves on advisory boards with the European Commission (EC) alongside the Directorate. Strong decentralization is reflected in the national framework, where regional committees are represented by local committees, distinct from national administration. Outside of the national framework and distinct to the France's Mediterranean sector, *prud'homies* are

an institution dating back hundreds of years, responsible for local fishing regulations, settling disputes, and the management and conservation of resources (van Hoof et al. 2005; Belschner 2015; Frangoudes et al. 2020). France's national management measures extend beyond those imposed by Mediterranean obligations, such as the strict protection of *Raja undulata* (Lloret et al. 2020), and minimum size limits for other *Raja* species (order of 7 June 1994, Cacaud 2003), developed for Atlantic waters but enforced also in French Mediterranean coast. Though France has consistently ranked in the top 20 shark fishing nations (since 2000), landings data are mainly from the North Atlantic Ocean (FAO region 27; STECF 2021). France's regulatory fisheries framework is extensive and includes smaller vessels that would otherwise receive derogations according to the EU. For example, France requires logbook data from vessels < 10 m, unlike rules under the CFP (ECA 2017). However, local fishers in the Mediterranean waters have been resistant to regulations imposed by the EU (Cacaud 2003; Ouest-France 2023).

The *Prefets* are responsible for implementing the fisheries control system, but implementation is handled by interregional directorates who are overseen by the former. France designates specialised fisheries authorities and inspectors to enforce the CFP. France is one of only 3 MSs to allow immediate enforcement measures, which means French inspectors are granted high powers. The Control Regulation is reflected in France's national legislation (Act No 2010-874) and has several measures in their national law. While explicit inclusion in national systems is not necessary here given their direct applicability, it has been argued that the explicit mention helps to define specific provisions and may lead to a higher rate of enforcement in their national law (Angevin et al. 2021). France additionally spells out the activities considered as serious infringements in national guidance, likewise, are the criteria on how to assess their seriousness. Marine spatial planning (MSP) falls under the authority of the Ministry of the Sea (Ministère de la Mer), and on 8 August 2016 the MSP Directive was transposed into French legislation (Law 2016-1087, Article 123). All global and regional policies relevant to Mediterranean MPAs have been transposed into France's national laws (Gomei et al. 2019), and more than half of the French Mediterranean is covered by MPAs. However, levels of protection have remained largely weak and require more regulation to be effective (Claudet et al. 2021).

Greece

In Greece the fisheries sector falls under the Ministry of Rural Development and Food, with a dedicated General Directorate of Sustainable Fisheries, whereas biodiversity protection falls under the Greek Ministry of Environment and Energy, with a Deputy Minister dedicated on biodiversity protection and a Directorate General on Environmental Policy (Koehler et al. 2022). More recently, in 2022, a new commission of fisheries scientists was created to support decision making under the General Directorate of Sustainable Fisheries. The coordination of the enforcement of the environmental policy in Greece is implemented by the Ministry of Environment and Energy, with several state agencies to be involved, while fisheries legislation is implemented by the Hellenic Coast Guards (under the authority of the Ministry of Maritime Affairs and Insular Policy), in collaboration with the General Directorate of Sustainable Fisheries. This division between environmental and fisheries policies is also evident in the implementation as in the example of two shark species, the bluntnose sixgill (*Hexanchus griseus*) and the sharpnose sevengill (*Heptanchias perlo*) sharks. Both are strictly protected in the Greek waters under the Presidential Decree no 67/1981 «On the protection of native flora and fauna» which is described as an environmental legislation monitored by the Greek Ministry of Environment and Energy. In December 2013, the General Directorate of Sustainable Fisheries published an identification guide for all protected species of elasmobranchs, with the aim to ease policy implementation and compliance. However, in the guide both *H. griseus* and *H. perlo* were included under the species listed as "fishing, landing and marketing is permitted". Since its publication, several letters of complaint were sent to the Directorate by several NGOs, but the unofficial response stated that the Directorate is exclusively responsible for the implementation of the fisheries legislation. Finally, four years later, in 2017 the identification guide amended including both species as "protected". Nevertheless, both species are commonly found in the auction markets and viewed by the media as trophies of fishers and fishmongers (Giovos et al. 2020). In addition, several coast guard

offices, responsible for issuing infringements continue to use the out-of-date guide, thereby perpetuation the initial misconception (pers. obs., I. Giovos). Further, the "Species List that Landing is Permitted" produced by the Central Market and Fishery Organizations (CMFO 2022) and regulated by the Greek Ministry of Rural Development and Food includes the porbeagle (*Lamna nasus*) which is a strictly protected species (Table 1). Despite a large effort by NGOs to change this situation the species is still listed as a permitted catch and as a document that is readily available online.

Between 2018 and 2021 NGO iSea started systematically monitoring social and mass media to detect in real time illegal catches of protected elasmobranch species in Greece. This resulted in recording 103 cases; however, only nine were detected in the first few minutes/hours and with enough evidence to apply an official letter of complaint in the local coast guards' departments or the relevant authorities (in two cases the incidents were referring to restaurants). Sanctions were imposed in only two of nine cases: (1) sawback angelshark (*Squatina aculeata*) in Chios Island in 2020; (2) bigeye thresher (*Alopias superciliosus*) from Palaio Faliro, Athens in 2020), both by the local coast guard authorities. For the remaining seven cases, the outcome was either negative or no information about the outcome was provided. However, in contrast with France, neither of the sanctioned cases were reflected in the list of sanctions published by the Hellenic Coast Guards and consequently this information never reached the GFCM or ICCAT fora, implying that the compliance of the country to the relevant policies is excellent. The fact that Greece failed to report CFP infringements without sanctions has been reported also in the latest European Commission Report (Angevin et al. 2021). The absence of reported illegal fishing of protected elasmobranchs is a reality in Greece, which might be attributed to the lack of expertise by the competent patrolling authorities (Port Police, Hellenic Coastguard) and the lack of training and awareness of professional fishers to enforce and abide to the current legislation regarding elasmobranchs.

Tunisia

Tunisia borders the southern Mediterranean and is Africa's northernmost country. Tunisia joined the GFCM and ICCAT in 1954 and 1997 respectively, and the two bodies manage Tunisia's demersal stocks in the Strait of Sicily (GFCM/45/2022/5), and shared pelagic species such as tuna, swordfish, and sharks. The Institut National des Sciences et des Technologies de la Mer (INSTM) oversees stock assessments. The organisation of the Ministry of Agriculture and Environment and Water Resources is divided into two branches: the Secretariat of State of Water and Fishery Resources and the Secretariat of State of the Environment (https://www.fao.org/fishery/docs/DOCUMENT/fcp/fr/FI_CP_TN.pdf). The Directorate-General of Fisheries and Aquaculture is responsible for the oversight of fishing operations, tasked with developing strategic plans, and overseeing various bodies. One body is the Directorate for the Conservation of Fishery Resources, responsible for, among other things, supervising fishers and ensuring the application of legislative texts.

North African countries contribute over 70% of total reported elasmobranch production in the region (FAO 2020), and Libya and Tunisia are the leading chondrichthyan fishing nations, respectively. Tunisia's waters provide critical habitats for many species, such as the white shark (*Carcharodon carcharias*), the sandbar shark *Carcharhinus plumbeus*, and guitarfishes (Rhinopristiformes), (Bradai et al. 2018), and is also one of the few Mediterranean countries with targeted elasmobranch fisheries. Target species include *C. plumbeus*, smoothhounds (*Mustelus* species), and the blackchin guitarfish (*Glaucostegus cemiculus*) (Bradai et al. 2018; Saidi et al. 2019). The Gulf of Gabès, is a highly productive area, hosting one of the country's most important fisheries, and important nursery area for many species (Newell 2017; Bradai et al. 2018). The unregulated shark longline fishery catches a majority of juvenile shark species, dominated by *C. plumbeus* (SPA/BD Protocol Annex III), as well as the shortfin mako (*Isurus oxyrinchus*; SPA/BD Protocol Annex II) (Saidi et al. 2019). Additionally, catches do not seem to be reflected in reports, as required by regional decisions (Milazzo et al. 2021). While the Compliance Committee (CoC) of the GFCM reported that all decisions applicable to reporting requirements have been implemented or partially implemented in Tunisia, in practice, less than 60% of the required data was transmitted (15th Session COC, May 2022; FAO 2022b).

Furthermore, Tunisia has not yet fully implemented GFCM/44/2021/16 (FAO 2022b).

Türkiye

In Türkiye, the Ministry of Environment and Urbanisation is the main authority for deciding and implementing environmental protection policies in the country. The fisheries sector falls under the Ministry of Agriculture and Forestry that is responsible, among others, for determining and implementing all fisheries policies and regulate all activities related to fisheries (Fisheries Law No. 1380 of 1971), while the implementation is supervised by the General Directorate of Fisheries and Aquaculture and the enforcement by the Turkish Coast Guards of the Ministry of Interior of Turkish Republic. The Fisheries Law was amended by Laws 3288 in 1986, 4950 in 2003, and by a new law (No. 7191), in effect since November 2019 (Republic of Türkiye 1971, 2019). The new law makes drastic amendments in the principal law. This Act inserts the additional "Clause 4" stating that the Ministry of Agriculture and Forestry may develop equipment and systems, such as remote sensing system, and strengthen the cooperation with the relevant national and international organizations to collect data, monitor the fishing activities and determine the breaches of law. In addition, the Ministry issues Fishing Notifications to regulate commercial and recreational fishing activities in order to ensure resource conservation and achieve sustainable fishing after consulting with stakeholders including research institutes and universities (FAO 2022c).

The 15th Session of the GFCM CoC confirmed that Türkiye had fully implemented all concerned GFCM decisions (FAO 2022d). Furthermore, two notifications implementing the Fishery Law are particularly relevant for cartilaginous fishes: Notification No. 2020/20 on commercial fishing and Notification No. 2020/21 on recreational fisheries; both provisions shall be implemented between 1 September 2020 and 31 August 2024. Notification No. 2020/20 lays down obligations, restrictions, and prohibitions in commercial fisheries for the conservation of fisheries resources and sustainable fisheries taking into account scientific, environmental, economic and social aspects. This Notification sets forth provisions on marine protected areas in Mediterranean Sea, Aegean Sea, Marmara Sea, Black Sea and other areas; prohibited fishing areas; protected species; minimum size limits for caught fish; and obligations, restrictions and prohibitions in inland fisheries, freshwater fisheries and marine fisheries. Following Chapter 4 "Regulations Regarding Species'', Article 16, on prohibited species, it is prohibited to capture, retaining onboard, transhipping, landing, storing, selling, or offering for sale 21 cartilaginous species (Republic of Türkiye Ministry of Agriculture and Forestry 2020). Among them, 12 are listed in Annex II of the SPA/BD Protocol of the Barcelona Convention for which GFCM CPs shall ensure a high protection from fishing activities. The additional species afforded strict protection in the national framework areinclude, among others, the species regulated by ICCAT: thresher (*Alopias vulpinus*), bigeye thresher (*Alopias supercilious*), silky shark (*Carcharhinus falciformis*), oceanic whitetip (*Carcharhinus longimanus*); sandbar shark (*C. plumbeus*), blue shark (*Prionace glauca*), thornback skate (*Raja clavata*), spiny dogfish or spurdog (*Squalus acanthias*), longnose spurdog (*Squalus blainville*). At the same time Türkiye is one of the very few Mediterranean countries with a proposed NPOA for the conservation of cartilaginous fishes, produced in 2018 (Öztürk 2018). This proposal influenced the preparation of the new law No. 7191 (in effect since November 2019).

Common issues for Mediterranean states

Data requirements and availability: FAIR (findability, accessibility, interoperability, and reusability) of fisheries data

Incidental catches are identified as the main driver of elasmobranch extinctions in the Mediterranean Sea (Dulvy et al. 2016; Serena et al. 2020; Milazzo et al. 2021). Yet only limited information is available about the exact impact of fisheries on the Mediterranean elasmobranch's populations primarily because most countries continue collecting and reporting fisheries data in aggregating taxonomic categories (Cashion et al. 2019). This leads to difficulties or inadequacies in time-series data (FAO 2021).

In some countries, e.g., Morocco and Algeria, categories as broad as "sharks" (GFCM 2018) or "skates and rays" (FAO 2021) are used. The use of aggregated data impairs the estimation of the species-specific

fishing-related mortality, the impact of different fishing gears on different species, and spatiotemporal changes in species catches, therefore making impossible the development of effective management strategies. Almost all the assessment methodologies rely on the biological information at species level. Under the data collection reference framework (DCRF), the GFCM states that every effort should be made to record all commercial landings to the species level, including elasmobranchs (GFCM 2018) and defines the requirements that aim to fill the knowledge gaps and set out the basic information required to conduct assessment and management procedures for chondrichthyans. Firstly, defining the priority species, to reduce the complexity and number of chondrichthyans species for data collection and assessment purposes, and secondly requesting their members to provide data associated with bycatch of these species. Therefore, currently countries are required to provide species specific and possibly individual biological information on the bycatch of few species of elasmobranchs, namely *Galeus melastomus, Raja asterias, R. clavata*, "which are important in terms of landing and/or economic values at regional and subregional level" (GFCM 2018). Furthermore, for the vulnerable elasmobranchs listed on Annex II and III of the SPA/BD Protocol of the Barcelona Convention, the recording of bycatch data becomes mandatory under GFCM Resolution GFCM/44/2021/16.

In practice the implementation of these requirements is quite variable. In Greece, only three landing categories exist for chondrichthyans; recent advice suggested a minimum of 20 landing categories (some at the species level other at the genus level) to improve research and compliance aimed at reducing the high levels of misidentifications and mislabelling (Giovos et al. 2020). While aggregated landings mask declines (Davidson et al. 2016), species-level misidentification is also problematic resulting and can result in inaccurate measures levied. Indeed, there is a common perception of misidentification in official landing statistics, often caused by improper attribution of common names or commercial codes. For example, Malta has reported high quantities of landed *S. acanthias*, that likely refer to the data deficient *S. blainville* (Environment and Resources Authority 2020). Market research suggests misidentification remains and continues at a commercial level (Vella et al. 2017).

Generally, species level reporting by countries such as Spain, France and Italy, lists commonly caught and easy identifiable species, like *P. glauca* and smaller species such as the small-spotted catshark (*Scyliorhinus canicula*) (FAO 2021). Ray and skate species are somewhat specified, for example, the commonly *R. clavata*. But there is scope to improve reporting for less commonly caught species which are misidentified or aggregated. The problem of misreporting is (at minimum) a three-fold problem which includes the set-up of the national reporting system (and related labelling), controls and enforcement checking reporting, and the education and training of fishers and fish mongers in the correct identification of species landed (Giovos et al. 2020). The issues of aggregated landing data and misidentification has been widely highlighted by several scientific papers and FAO reports (Cariani et al. 2017; Cashion et al. 2019; Giovos et al. 2020; FAO 2021; Cattano et al. 2023), highlighting a notable difference in the status of data available for chondrichthyans between tuna fisheries and small-scale fisheries. In tuna fisheries, mechanisms are in place to collect, relatively robust information on chondrichthyans (e.g., electronic logbook and on-board observers). In the case of artisanal fisheries there may be limited or no monitoring requirements, since compiling data for chondrichthyans, even if landed and commercialised is difficult (FAO 2021). To date, stock assessments for Mediterranean chondrichthyans remain limited to *R. clavata* in Cyprus (GFCM 2022b).

Data sharing is an issue relevant for the scientific research focused on providing data for management and policy, to properly evaluate species status at regional or subregional level and effectively develop common management strategies. Programs developed in the framework of EU (e.g., MSFD), national data collection initiatives, regional fisheries management organisation (GFCM, ICCAT), as well as international agreements (e.g., CMS), indicate a requirement to collect catch data of chondrichthyans at national levels. Given the limited availability of these data, FAIR mark an important refinement of the concepts needed to give greater value to these data (European Commission et al. 2018). To allow the free access to trustworthy and accurate marine data, several projects to improve open access to data are being created within that framework (e.g. EMODnet). The "open access policies" from publicly financed research are

promoted by the Open Data Directive (in effect 16 July 2019; Council Directive (EU) 2019) and are particularly defined in Article 10 and Paragraph 1 of the Directive. To create rules for open access to publicly financed research data, the European Commission may help the Member States put this Directive into action. Multidisciplinary data exploration is essential for accelerating the production of value-added EU-wide information products. Data types come in a variety of forms (Article 13(1) of Directive (EU) 2019/1024 is stated in Annex I) (geospatial, earth observation and environment, meteorological, statistics, companies and company ownership and mobility). A GFCM Pan-Mediterranean multi-taxa database for the data on bycatch of vulnerable species has been initiated through the MedBycatch project to improve the centralised collection of data on shark and ray bycatch (Otero et al. 2019). Any development of data sharing platform or framework for Mediterranean and Black Sea data should take into account what has already been developed as standards for data in other areas, notably by the International Council for the Exploration of the Sea (ICES) which is an intergovernmental marine science organization, as well as the general EU guidelines for data policy and the FAIR principles (Council Regulation (EU) 2017/1004, 1380/2013). The amended Fisheries Control Regulation (EU) 2023/2842) should lead to more uniform reporting, but more work will be required to ensure uniformity for countries outside of its prevue (non EU countries).

Time lag of transposition

In relation to the legal obligations of the countries under different instruments, there are several considerations to be aware of. Treaty law, for example, such as the above mentioned Multilateral Agreements, requires State signature and ratification, the formal approval of the treaty by a State, for the provisions of the convention to become binding for that state. The signature of a State to such an agreement expresses the State's intent to ratify and to act in good faith with the requirements of the agreement/convention. The period between signature and ratification may be stipulated by the treaty and allows the state to follow its nationally determined process. The State will then notify other Parties that the treaty has been ratified. Nonetheless, to operationalise individual provisions of a treaty they must be transposed into national law, making them enforceable in national courts.

In the case of Recommendations by ICCAT and the GFCM, those are legally binding following the adoption of the Recommendation but require State Parties to transpose the provisions of the Recommendation into national law to be enforceable at national level and facilitate their implementation. Contracting Parties are obligated to transpose these Recommendations, and are required to report on the implementation on an annual basis. The EU, as member to both the GFCM and ICCAT, also has a duty to transpose provisions adopted through binding Recommendations and does so by transposing them into EU Regulations, which do not require further transposition by the EU MSs to their national legislation.

In 2012, the GFCM parties adopted GFCM 36/2012/3 (amended by GFCM 42/2018/2) that bans the retention, landing, trans-shipment, display, and sale of species listed on Annex II. While automatically transposed into national frameworks in EU MSs ((EU) No. 2015/2102), in several other Mediterranean countries (e.g., Tunisia, Libya) after 10 years (2012–2022) transposition has yet to occur. Under the framework of the Barcelona Convention the low number of contracting parties reporting on the implementation of the regional action plan for Chondrichthyes and lack implementation of measures such as the strict legal protection of species listed under the annex II of the SPA/BD Protocol reflect a general lack of sense of urgency. These examples highlight how the process from the inception of management and conservation measures to enforceable measures can be. The time and the seeming lack of collaboration between fisheries and environmental authorities jeopardise conservation, especially for many chondrichthyans particularly vulnerable to rapid populations declines caused by overexploitation i.e., by the time a measure has been transposed and is enforceable, amendments for stricter protections may already be necessary R. For example, in Fig. 2, the case of *I. oxyrinchus is* highlighted; the species was listed in Annex III of the SPA/BD Protocol and was assessed in 2012 as Vulnerable in the IUCN Red List and only in 2014 was listed as strictly protected in the Annex II of the SPA/BD Protocol but its conservation status had already deteriorated and in 2016 during a new assessment it was listed as Critically Endangered. Also in Fig. 2, the case of *C plumbeus* is even more

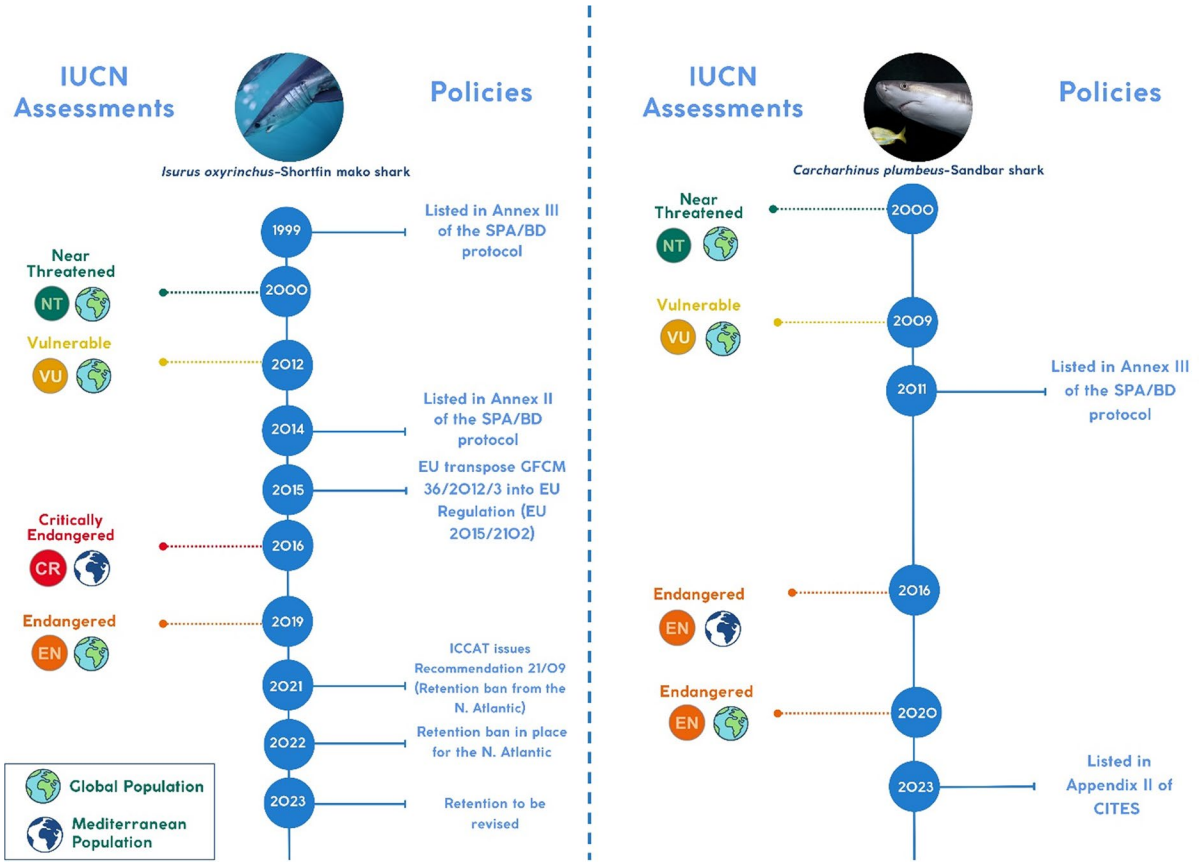


Fig. 2 A timeline of the IUCN Red List evaluations (global and Mediterranean assessments) and the development of Mediterranean-relevant management and conservation measures for a) *Isurus oxyrinchus* (shortfin mako) and b) *Carcharhinus plumbeus* (sandbar shark)

characteristic of the time lag between policies and the actual need for conservation. *C. plumbeus* was assessed as Vulnerable in 2009, in 2011 was listed in Annex III of the SPA/BD Protocol but in the assessment of its conservation status in the Mediterranean in 2016 the species was assessed as Endangered. Despite the deterioration of the species conservation status, the species remains without any protection measure and only the trade is regulated through CITES from 2023.

Discussion

Within the last 50 years, the focus towards conservation and management of chondrichthyans has increased significantly, yet the rate of population decline is outpacing those efforts (Dulvy et al. 2021). In this work, we outlined the most relevant instruments for chondrichthyan management in the Mediterranean Sea. Case studies from EU and non-EU states highlighted variability between factual and practical implementation regarding national legislation and demonstrated that transposition is only one impediment to uptake. We elucidated that despite an increasing holistic approach to marine management (Calado et al. 2023), the fragmentation of competencies and interests within countries can lead to non-uniform and inadequate application and enforcement. In some cases, states afforded higher levels of discretion towards implementation of legislation can lead to strong support and uptake, should the political will and socio-economic conditions be there. We discuss our findings, including gaps and inconsistencies that persist throughout the region, and review the importance and the differences between legally binding and

non-binding international agreements, and we suggest that existing methods and tools should be combined to streamline structures. Lastly, we present our views on how to maximise existing frameworks to the benefit of chondrichthyans and human communities.

Hard law and its implementation

The development of hard law can be stalled by long negotiations caused by differences in political interests. Compromises can lead to weakened legal provisions, and their implementation may require bureaucratic and financial responsibilities that signatories are not ready or equipped to face resulting in late transpositions (see examples provided in Fig. 2). The trade-off is that signatories are held accountable to the provisions and are incentivised by threat of economic sanctions. Politics and economic interests have been problematic for chondrichthyans despite that from the 1990s, scientific evidence has demonstrated that fisheries exploitation (targeted and bycatch) of chondrichthyans is cause for concern, and that action was needed to manage them (Compagno 1990; Branstetter 1993). Despite expert advice to integrate management beyond a national level (Musick et al. 2000), measures to regulate species remained largely inadequate. The legitimacy of chondrichthyans in CITES was debated from the 1990s (CoP9; Vincent et al. 2014), but as of 2022 (CoP19) over 140 elasmobranchs are listed. The CITES is an international tool and does not necessarily impact national regulations. This distinction is relevant to the SPA/BD Annexes II and III (Tables 1 and 2), which require uniform national regulations. This can lead to debate and listing reservations. After Several entities were advocating 3–4 years to adopt new amendments, nine additional chondrichthyans were proposed for the Barcelona Convention at COP23, presented with two amendment options: the first to list six of the species in Annex II and three in Annex III, while the second sought just two in Annex II (UNEP/MED IG.26/7).

The listings in Annex II, includes some species whose status and distribution is largely unknown (e.g. *Bathytoshia lata* in Annex II). These species, through the technical process they were qualified to be listed in the Annex II although potentially listed in Annex III could also benefit more their conservation but (e.g., precluded an immediate Decision, seeing proponents of option 1 (e.g., Israel and the EU), urging a precautionary approach, and those favouring the second option (e.g., Tunisia, Egypt, Libya) stressed the importance of species as a source of income. Eventually, the first option was adopted (UNEP/MAP IG.26/4), with reservations by Libya, Morocco, Tunisia, and the EU (see Table 2).

This is potentially a very interesting development, suspecting a drawing distinctions between advocates of the precautionary approach, symbolic of by the signatory for several chondrichthyan species and might be the start of an attitudinal change shift by policy makers, by some, perceiving chondrichthyans more important as biodiversity and less than fish stocks, given also that some of the newly listed species are very common in the catches (e.g., *Dasyatis pastinaca*). A lack of cohesion may be growing as a result, between the need to preserve biodiversity and to ensure livelihoods—both objectives of SDGs, the Barcelona Convention, and UNEP. The countries that entered reservations are also frequently in non-compliance with respect to their duties (UNEP/MED IG.24/22; UNEP/MED WG.568/20). Compliance is an issue within the CPs, this includes submission of national reports. The non-adversarial approach mandated by the compliance procedures may need to include more measures for accountability, if the Convention is to be successful. Moving forward, it will be necessary to reconcile strategies to to navigate the most harmonious outcome for states. This could include simplifying reporting procedures, reaffirming Party expectations, or increasing in-country support.

Soft law and its implementation

The IPOA-Sharks (FAO 1999) arose as a response to the reluctance to include chondrichthyan species on CITES (CoP9; Vincent et al. 2014), and contributed to the eventual listings of sharks and rays on CITES. Despite initial unsatisfactory implementation of the IPOA (Cavanagh and Gibson 2007; Techera and Klein 2017; Gilman et al 2023) it progressively led to the development and adoption of 55 NPOAs and seven regional action plans (FAO 2022e; Gilman et al 2023). However, despite the presence of EU and Mediterranean action plans, no NPOAs have been adopted in the basin. In fact, European and African countries were found to have a low probability of having adopted an NPOA (Gilman et al. 2023). Moreover, countries outside the Mediterranean, with

the most robust and current NPOA (i.e., ≤4 years since adoption or update), are responsible for ≤12% of total global elasmobranch landings suggesting that more robust plans are needed from areas with the highest landings (Davidson et al. 2016; Gilman et al. 2023). At the time of writing no Mediterranean country had adopted a NPOA. Unlike the obligations imposed by treaties, agreements are based on guidelines and allow for more flexibility towards the adoption of concepts within their framework, and therefore offering the potential for expedited species proposals (Muir and Klein 2018). Despite their absence of legal obligation, international agreements offer the potential for normative influence and conservation which can be crucial (Muir and Klein 2018). The non-binding CMS Sharks MoU, while limited due to its smaller membership and limited listings, is strengthened by its detailed management plans, facilitated under the framework of the CMS. The MoU takes a stronger protectionist standpoint than NPOAs, and strong regulation of commercial species through fisheries management measures is urgent. In both assessments of the RAC/SPA, only half of the CPs had made steps towards improved fisheries management and scientific research, while only 25% of the countries developed training programmes (UNEP RAC/SPA 2009, 2013).

GFCM Recommendation GFCM/42/2018/2 directly refers to the Annex II of the SPA/BD protocol "CPCs shall ensure a high protection from fishing activities for elasmobranch species listed in Annex II of the SPA/BD Protocol of the Barcelona Convention, which must be released unharmed and alive, to the extent possible. Specimens of shark species listed in Annex II of the SPA/BD Protocol and shall not be retained on board, transhipped, landed, transferred, stored, sold or displayed or offered for sale". Any amendment in Annex II of the SPA/BD protocol hence will apply a fishing prohibition for the newly listed species without any further transposition needed in countries where GFCM/42/2018/2 has already been transposed. A recent Recommendation (GFCM/44/2021/16) to include recognition, among others, of more robust data collection and requests contracting parties to develop more comprehensive management measures in particular for species listed in the Annex III of the SPA/BD Protocol is promising for more directed management. A resolution adopted in November 2023 on regional plan of action concerning strategies to mitigate interactions between fisheries and vulnerable species (GFCM/46/2023/4; FAO 2024) also demonstrates a trend of increasing cohension among CPCs.

Compliance with measures will depend among other factors, on fishers. As a first step towards compliance, fishers must be aware of and understand legislation (Sherman et al. 2023). Increased communication and regional collaboration between different stakeholders such as fisheries managers, environmental authorities, fishers, scientists and NGOs could be facilitated through the soft law instruments in place, participatory management approaches could strengthen necessary national-level implementation.

Lessons in governance from the case studies

Apart from soft and hard law, political will, expressed in various ways, can be a powerful factor for advancing policy and legally binding frameworks. This is the case of Türkiye. Though not a signatory to several conventions and protection instruments, Türkiye has made positive and consistent improvements and includes one of the most updated, science-based, and progressive policies for chondrichthyan protection and management in the basin. However, enforcement and compliance need to be carefully evaluated to ensure measures move beyond factual enforcement. Greece and Tunisia have been highlighted in this work for their poor enforcement and implementation although a satisfactory policy exists in both countries. This finding is not extraordinary within the Mediterranean (Cashion et al. 2019; Koehler et al. 2022). One explanation concerns the persistent issue of decentralization which can lead to fragmentation of responsibilities within states, leading to inaccurate materials coming from authorities, as demonstrated above with Greece, or the lack of integrated nature protection within fisheries policies as with France. Fragmentation of marine policy at vertical (from local level to the regional) and horizontal (within a nation's own government) dimensions is well-acknowledged (Boyes and Elliott 2014; Calado et al. 2023), but the dual nature of chondrichthyans as resources and protected species, exacerbates the divisions. Thus, some tools relevant to their protection and management are relegated to fisheries domains while others to environmental and protectionist domains, resulting in dimensions of fragmentation.

The need for data

The commercial value of chondrichthyans is much less compared to other stocks (e.g., bluefin tuna *Thunnus thynnus*, Fromentin et al. 2014), resulting in lower management prioritization towards and less stringent monitoring which negatively impacts data quality, collection, and reporting (Cashion et al. 2019; Serena et al. 2020; Giovos et al. 2020). Data collection through RFMOs should be increased, adding observation coverage where possible. This can be more challenging for species that might not fall under the management mandate of RFMOs. Coordinated efforts between soft law instruments, e.g., the CMS Sharks MoU or the EU Marine Action Plan, could offer support but more importantly the implementation of hard law like GFCM/44/2021/16 and soft law, like GFCM RPOA to mitigate vulnerable species bycatch by the MS can be a game changer in data collection for chondrichthyans. Promotion of data collection and sharing will be important due to the migratory nature of many shark and ray species. Furthermore the implementation will require balancing conservation priorities and socio-economic interests, particularly for small-scale fishing communities financially dependent on landings, as target or bycatch, of sharks and rays.

Tools indirectly can improve chondrichthyan conservation

In this work we have focused on instruments that directly apply to chondrichthyan management in the Mediterranean, though we presented tools that can indirectly support their management. Framework directives, such as the MSFD allow a level of discretion for the EU MSs in determining how policy is regulated at a national level (Boyes and Elliott 2014) while at the same time setting minimum requirements. The evaluation of Good Environmental Status is based on descriptors that are assessed and implemented at a state level. Several Mediterranean EU countries have integrated chondrichthyan species within their programme of measures under the MSFD (unpublished data; L Koehler), but there is still room for improvement.

How spatial management can support chondrichthyan conservation

Among marine spatial management strategies, Marine Protected Areas (MPAs) are the most widely used. MPAs have the potential to benefit chondrichthyans (MacKeracher et al. 2018) but they are usually overlooked during the selection process (Davidson and Dulvy 2017). The Mediterranean Sea has a variety of frameworks for designating marine protected areas, in and outside the EU context, starting with the EU Natura2000 network, moving to Specially Protected Areas of Mediterranean Importance (SPAMI's) resulting from the SPA/BD Protocol and finally nationally designated Marine Parks. Again, in several countries (e.g., Tunisia, Turkey) fisheries measures within MPAs are decided by the fisheries authorities and not the environmental authorities. This reflects the general issue, described above, about elasmobranch chondrichthyan policy and perplex decision making within the MPAs. For the EU member states the inclusion of chondrichthyans is a more challenging topic in the framework of EU Natura 2000 sites that mostly apply in this region, since no chondrichthyan is listed as species of Community interest in the Council Directive 92/43/EEC based on which EU Natura 2000 sites can be developed. Another approach introduced in 2010 by the Convention on Biological Diversity (CBD); namely the Other Effective area-based Conservation Measures (OECMs). These refer to areas outside of MPAs, where other spatial management practises exist but at the same time, they can achieve long-term and effective in-situ biodiversity conservation. There has been an increasing interest recently on the identification of OECMs for contributing to the spatial management of fisheries highlighting the potential of this tool for fisheries management (Petza et al. 2023) that can benefit chondrichthyans as well. In addition, recently, Important Shark and Ray Areas (ISRAs) were identified in the Mediterranean Sea by experts. ISRAs can effectively aid in spatial planning (Kyne et al. 2023) and support the establishment of new spatial management measures including fisheries restricted areas such as spatial temporal fishing closure and no-take zones and MPAs or identified existing MPAs that should include management measures specifically for these species. At it´s 14th Conference of the Parties in 2024 a decision (UNEP/CMS/COP14/Doc.27.4.2/Rev.1 was adopted

that request signatory countries to "take into account identified ISRAs for spatial planning and conservation action with a view to implementing Targets 1 and 3 of the Global Biodiversity Framework (United Nations Environment Programme, 1992) including through National Biodiversity Strategies and Action Plans.

In the Mediterranean there are more than 1000 designated MPAs that cover 8.33% of the Mediterranean Sea, while only 0.04% are strictly protected (MedPAN and UNEP/MAP-SPA/RAC 2021). Despite their commitments to increasing area-based management measures to 30% by 2030 under the Kunming-Montreal Global Biodiversity Framework (CBD 2020) and the Barcelona Convention Post-2020 Strategic Action Program for Biodiversity (UNEP/MAP-SPA/RAC 2020), progress on implementation has been slow. It is expected that in the upcoming years new area-based management measures will be established and it is important that professionals working on chondrichthyans conservation focus their efforts on incorporating this taxa into the development of new measures.

For example, Greece recently has become the first European country to recognise Key Biodiversity Areas (KBAs) as sites of global importance for biodiversity by the Law 5037/2023. The Greek State committed to use KBAs as a key tool for expanding the network of protected areas in the future. Currently all KBAs that exist in Greece ignore chondrichthyans. ISRAs can plan a vital role in informing existing and new KBAs and thus increase chances that these species will be incorporated in more MPAs in the future. The case of Greece, although implementation of this decision is pending, can be a paradigm for shark advocators in other Mediterranean countries, especially in EU MS, because it creates a precedent of Natura 2000 site created for the purpose of protecting chondrichthyans.

Conclusions

The development of law is often retrospective to the actual urgent needs for managing and conserving species like chondrichthyans. The development of a series of policies and legislations that consider chondrichthyans specifically, can only benefit their conservation, especially in a complex area like the Mediterranean Sea, one of the three hotspots for their extinction globally. While some gaps remain e.g., in the list of species that are prohibited in the EU Fisheries Technical measures Regulation, we argue that the Mediterranean's existing policy framework and the mix of formal and informal regional and international instruments appears satisfactory at regional level. The direct reference of binding regional fisheries decision to binding environmental protocols of a regional convention is unique and allows a direct application of changes of the annex of species that should be prohibited or managed in the fisheries legislation. However, for some threatened species gaps remain and the respective legislative annexes should be updated and regularly evaluated for updates. Also data gaps seem to prevent the implementation of existing legislation but new initiatives now promise to fill these gaps especially in relation to spatial management. In any case lack of data should not prevent the implementation of legislation as the precautionary is embedded in several legislation and strategies at regional level. Insufficient implementation and enforcement at national level is evident in the region, partially also due to a lack of resources. The emphasis should be placed on investing into developing and improving the implementation of existing instruments particularly in non-EU countries. Collaboration and coordination among the authorities at horizontal and vertical levels are imperative to create more effective implementation. Soft law provides offer an opportunity for countries to support the implementation of hard law. Dissemination of outcomes is key to prevent duplication of time and resources, and is an area for improvement. Recent decisions adopted at regional and global level to benefit chondrichthyans offer a positive direction forward, and together with regular revision, concerted action to foster cooperation provides hope to the long-term survival for species. Spatial measures should be integrated with species-specific measures, especially regarding fisheries management also at transboundary levels. Strong coordination and partnerships among states to share data, knowledge, and experiences is critical to halt dramatic declines, but so will be finding a balance between immediate economic gain and securing long-term sustainable resources on regional and global scales.

Acknowledgements This work was conceived after an internal WWF Mediterranean Marine Initiative report prepared by

Michel Morin and Simone Niedermueller. It was developed in the context of Ioannis Giovos joint PhD in the University of Patras and the University of Padova and partially supported by iSea under the grants of OceanCare and Shark Foundation/Hai Stiftung and the support WWF Mediterranean Marine Initiative. We would further like to thank Mumtaz Tirasin for commenting and supporting the drafting of the case study from Turkey.

Funding Open access funding provided by Università degli Studi di Padova within the CRUI-CARE Agreement. OceanCare and the Shark Foundation/Hai Stiftung.

Data availability The author confirms that all data generated or analysed during this study are included in this published article.

Declarations

Conflict of interest The authors have no conflict of interest to declare that are relevant to the content of this article.

References

Angevin F, Borrett C, Moreira G, Pavlou P, Rass-Masson N (2021) Study on the sanctioning systems of member states for infringements to the rules of the common fisheries policy EU overall report. European Commission, Brussels

Beke M, Ackermann R, Blomeyer R (2014) The CFP-infringement procedures and imposed sanctions throughout the EU'IP. B/PECH/IC 2021:3-135. Study requested by the European Parliament's Committee on Fisheries

Belschner T (2015) Not so green after all? The EU's role in international fisheries management: the cases of NAFO and ICCAT. J Eur Public Policy 22:985–1003. https://doi.org/10.1080/13501763.2014.989891

Bethoux JP, Gentili B, Morin P, Nicolas E, Pierre C, Ruiz-Pino D (1999) The Mediterranean Sea: a miniature ocean for climatic and environmental studies and a key for the climatic functioning of the North Atlantic. Prog Oceanogr 44:131–146

Boyes SJ, Elliott M (2014) Marine legislation – The ultimate 'horrendogram': International law, European directives & national implementation. Mar Pollut Bull 86:39–47. https://doi.org/10.1016/j.marpolbul.2014.06.055

Bradai MN, Saidi B, Enajjar S (2018) Overview on Mediterranean shark's fisheries: impact on the biodiversity. In: Türkoğlu M, Önal U, Ismen A (eds) Marine ecology—biotic and abiotic interactions. InTech, Rijeka, pp 211–230

Branstetter S (ed) (1993) Conservation biology of elasmobranchs. NOAA Technical Report NMFS 115

Breuer MEG (2021) The common fisheries policy: origins and development-legal basis objectives

Byrne ME, Cortés E, Vaudo JJ, Harvey GCMN, Sampson M, Wetherbee BM, Shivji M (2017) Satellite telemetry reveals higher fishing mortality rates than previously estimated, suggesting overfishing of an apex marine predator. Proc R Soc B 284:20170658. https://doi.org/10.1098/rspb.2017.0658

Bundy A, Chuenpagdee R, Boldt JL, Camara ML, Coll M, Diallo I et al (2017) Strong fisheries management and governance positively impact ecosystem status. Fish Fish 18(3):412–439. https://doi.org/10.1111/faf.12184

Cacaud P (2003) Legal analysis of the measures adopted by Mediterranean coastal states to minimize the impact of fishing activities on marine ecosystems and non-target species. FAO, Rome

Calado H, Vergílio M, Moniz F, Grimmel H, Monwar MM, Papaioannou EA (2023) The diverse legal and regulatory framework for marine sustainability policy in the North Atlantic—horrendograms as tools to assist circumnavigating through a sea of different maritime policies. In: Partelow S, Hadjimichael M, Hornidge AK (eds) Ocean governance. MARE publication series 25. Springer, Cham. https://doi.org/10.1007/978-3-031-20740-2_7

Campana SE (2016) Transboundary movements, unmonitored fishing mortality, and ineffective international fisheries management post risks for pelagic sharks in the Northwest Atlantic. Can J Fish Aquat Sci 73:1599–1607. https://doi.org/10.1139/cjfas-2015-0502

Cardinale BJ, Duffy JE, Gonzalez A, Hooper DU, Perrings C, Venail P et al (2012) Biodiversity loss and its impact on humanity. Nature 486:59–67. https://doi.org/10.1038/nature11148

Cardinale M, Colloca F, Bonanno A, Scarcella G, Arneri E, Jadaud A et al (2021) The Mediterranean fishery management: a call for shifting the current paradigm from duplication to synergy. Marine Policy 131:104612

Cariani A, Messinetti S, Ferrari A et al (2017) Improving the conservation of mediterranean chondrichthyans: the ELASMOMED DNA barcode reference library. PLoS ONE 12:e0170244. https://doi.org/10.1371/journal.pone.0170244

Carpentieri P, Nastasi A, Sessa M, Srour A (eds) (2021) Incidental catch of vulnerable species in Mediterranean and Black Sea fisheries—a review. General Fisheries Commission for the Mediterranean. Studies and Reviews. No. 101. Rome FAO. https://doi.org/10.4060/cb5405en

Cashion M, Bailly N, Pauly D (2019) Official catch data underrepresent shark and ray taxa caught in Mediterranean and

Black Sea fisheries. Marine Policy 105:1–9. https://doi.org/10.1016/j.marpol.2019.02.041
Cattano C, Calò A, Aglieri G et al (2023) Literature, social media and questionnaire surveys identify relevant conservation areas for *Carcharhinus* species in the Mediterranean Sea. Biol Conserv 277:109824. https://doi.org/10.1016/j.biocon.2022.109824
Cavanagh RD, Gibson C (2007) Overview of the conservation status of cartilaginous fishes (Chondrichthyans) in the Mediterranean Sea. IUCN Gland Switzerland and Malaga Spain, vi+42 pp
CBD (2020) Zero draft of post-2020 biodiversity framework. Secr Conv Biol Divers
CITES (Convention on International Trade of Endangered Species) (1973) Convention on international trade of endangered species of fauna and flora. CITES, Washington
CITES, Ninth meeting of the Conference of the Parties (CoP9), Fort Lauderdale, USA. https://cites.org/eng/cop/9
CITES (2023) Appendices I, II and III: valid from 21 May 2023. https://cites.org/eng/app/appendices.php. Accessed 30 Sept 2023
Claudet J, Loiseau C, Pebayle A (2021) Critical gaps in the protection of the second largest exclusive economic zone in the world. Marine Policy 124:104379. https://doi.org/10.1016/J.MARPOL.2020.104379
CMFO (2022) The list of legally landed species in the Greek Auction markets. https://www.okaa.gr/files/1/%CE%9F%CE%9A%CE%91%CE%91/Ixthioskales/%CE%91%CE%9B%CE%99%CE%95%CE%A5%CE%9C%CE%91%CE%A4%CE%91%20%CE%A0%CE%9F%CE%A5%20%CE%94%CE%99%CE%91%CE%9A%CE%99%CE%9D%CE%9F%CE%A5%CE%9D%CE%A4%CE%91%CE%99%20%CE%91%CE%A0%CE%9F%20%CE%A4%CE%99%CE%A3%20%CE%99%CE%A7%CE%98%CE%A5%CE%9F%CE%A3%CE%9A%CE%91%CE%9B%CE%95%CE%A3.pdf. Accessed 16 Sept 2022
Coll M, Piroddi C, Steenbeek J, Kaschner K, Ben Rais Lasram F, Aguzzi J et al (2010) The biodiversity of the Mediterranean Sea: estimates, patterns, and threats. PLoS ONE 5:e11842. https://doi.org/10.1371/journal.pone.0011842
Compagno L (1990) Alternative life-history styles of cartilaginous fishes in time and space. Environ Biol Fishes 28:33–75
Commission Decision (EU) 2017/848 of 17 May 2017 laying down criteria and methodological standards on good environmental status of marine waters and specifications and standardised methods for monitoring and assessment, and repealing Decision 2010/477/EU (Text with EEA relevance.) (2017) OJ L125/43. http://data.europa.eu/eli/dec/2017/848/oj. Accessed 30 Sept 2023
Commission of the European Communities (2009) Communication from the Commission to the European Parliament and the Council on a European Community Action Plan for the Conservation and Management of Sharks. Commission of the European Communities Brussels
Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora [1002] OJ L206/7. http://data.europa.eu/eli/dir/1992/43/oj. Accessed 5 March 2023
Council Directive 2008/56/EC of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) (Text with EEA relevance) (2008) OJ L164/19. http://data.europa.eu/eli/dir/2008/56/oj. Accessed 3 Dec 2022
Council Directive (EU) 2019/1024 of 20 June 2019 on open data and the re-use of public sector information (recast) (2019) OJ L172/56. http://data.europa.eu/eli/dir/2019/1024/oj. Accessed 3 Dec 2022
Council Regulation (EC) 338/97 of 9 December 1996 on the protection of species of wild fauna and flora by regulating trade therein (1997) OJ L61/1. http://data.europa.eu/eli/reg/1997/338/oj. Accessed 3 Dec 2022
Council Regulation (EC) 2371/2002 of 20 December 2002 on the conservation and sustainable exploitation of fisheries resources under the Common Fisheries Policy (2002) OJ 358/59. http://data.europa.eu/eli/reg/2002/2371/oj. Accessed 30 Sept 2023
Council Regulation (EC) 1224/2009 of 20 November 2009 establishing a Community control system for ensuring compliance with the rules of the common fisheries policy, amending Regulations (EC) 847/96, (EC) 2371/2002, (EC) 811/2004, (EC) 768/2005, (EC) 2115/2005, (EC) 2166/2005, (EC) No 388/2006, (EC) 509/2007, (EC) 676/2007, (EC) 1098/2007, (EC) 1300/2008, (EC) 1342/2008 and repealing Regulations (EEC) No 2847/93, (EC) 1627/94 and (EC) 1966/2006 (2009) OJ L343/1. http://data.europa.eu/eli/reg/2009/1224/oj. Accessed 3 Dec 2022
Council Regulation (EU) 605/2013 of 12 June 2013 amending Council Regulation (EC) 1185/2003 on the removal of fins of sharks on board vessels. (2013) OJ L181/1. http://data.europa.eu/eli/reg/2013/605/oj. Accessed 3 Dec 2022
Council Regulation (EU) 1379/2013 of 11 December 2013 on the common organisation of the markets in fishery and aquaculture products, amending Council Regulations (EC) 1184/2006 and (EC) No 1224/2009 and repealing Council Regulation (EC) 104/2000 (2013) OJ L354/1. http://data.europa.eu/eli/reg/2013/1379/oj. Accessed 3 Dec 2022
Council Regulation (EU) 1380/2013 of 11 December 2013 on the Common Fisheries Policy, amending Council Regulations (EC) No 1954/2003 and (EC) No 1224/2009 and repealing Council Regulations (EC) No 2371/2002 and (EC) No 639/2004 and Council Decision 2004/585/EC (2013) OJ L354/22. http://data.europa.eu/eli/reg/2013/1380/oj. Accessed 3 Dec 2022
Council Regulation (EU) 2017/1004 of the European Parliament and of the Council of 17 May 2017 on the establishment of a Union framework for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the common fisheries policy and repealing Council Regulation (EC) No 199/2008 (recast) (2017) OJ L157/1. http://data.europa.eu/eli/reg/2017/1004/2021-07-14
Council Regulation (EU) 2017/2107 of 15 November 2017 laying down management, conservation and control measures applicable in the convention area of the international commission for the conservation of Atlantic

Tunas (ICCAT), and amending Council Regulations (EC) 1936/2001, (EC) 1984/2003 and (EC) 520/2007 (2017) OJ L315/1. http://data.europa.eu/eli/reg/2017/2107/2019-07-15. Accessed 3 Dec 2022

Council Regulation (EU) 2019/1241 of 20 June 2019 on the conservation of fisheries resources and the protection of marine ecosystems through technical measures, amending Council Regulations (EC) No 1967/2006, (EC) No 1224/2009 and Regulations (EU) No 1380/2013, (EU) 2016/1139, (EU) 2018/973, (EU) 2019/472 and (EU) 2019/1022 of the European Parliament and of the Council, and repealing Council Regulations (EC) 894/97, (EC) 850/98, (EC) 2549/2000, (EC) 254/2002, (EC) 812/2004 and (EC) 2187/2005 (2019) OJ L198/105 http://data.europa.eu/eli/reg/2019/1241/2023-01-07. Accessed 3 Dec 2022

Council Regulation (EU) 2021/1888 of 27 October 2021 fixing for 2022 the fishing opportunities for certain fish stocks and groups of fish stocks applicable in the Baltic Sea and amending Regulation (EU) 2021/92 as regards certain fishing opportunities in other waters (2021) OJ L384/1. http://data.europa.eu/eli/reg/2021/1888/oj. Accessed 3 Dec 2022

Davidson LN, Dulvy NK (2017) Global marine protected areas to prevent extinctions. Nat Ecol Evol 1(2):0040

Davidson LNK, Krawchuk MA, Dulvy NK (2016) Why have global shark and ray landings declined: Improved management or overfishing? Fish Fish 17:438–458. https://doi.org/10.1111/faf.12119

Dulvy NK, Fowler SL, Musick JA, Cavanagh RD, Kyne PM, Harrison LR et al (2014) Extinction risk and conservation of the world's sharks and rays. Elife 3:e00590. https://doi.org/10.7554/eLife.00590

Dulvy N, Allen D, Ralph G, Walls R (2016) The conservation status of sharks, rays and chimaeras in the Mediterranean Sea [Brochure]. IUCN, Malaga

Dulvy NK, Pacoureau N, Rigby CL, Pollom RA, Jabado RW, Ebert DA et al (2021) Overfishing drives over one-third of all sharks and rays toward a global extinction crisis. Curr Biol 31:4773–4787. https://doi.org/10.1016/j.cub.2021.08.062

Ebert DA, Dando M (2021) Field guide to sharks, rays and chimaeras of Europe and the Mediterranean. Princeton University Press, Princeton, p 383

ECOSAFIMED (2016) Towards ecosystem conservation and sustainable artisanal fisheries in the Mediterranean basin. https://www.ecosafimed.eu/sites/default/files/layman_ENGLISH.pdf

Environment and Resources Authority (2020) Update on articles 8, 9, and 10 of the marine strategy framework directive (2008/56/EC) in Malta's marine waters. https://era.org.mt/wp-content/uploads/2020/06/MSFD-Art.-17-Update-Malta_FINAL.pdf

EPRS (2023) Revising the fisheries control system. PE 642.281 June 2023. https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/642281/EPRS_BRI(2019)642281_EN.pdf. Accessed 13 Sept 2023

European Commission, Directorate-General for Maritime Affairs and Fisheries, Angevin F, Borrett C, Moreira G (2021) Study on the sanctioning systems of Member States for infringements to the rules of the Common Fisheries Policy: EU overall report: final report. Publications Office. https://data.europa.eu/doi/10.2771/460801

European Commission, Directorate-General for Research and Innovation (2018) Turning FAIR into reality—Final report and action plan from the European Commission expert group on FAIR data. Publications Office. https://data.europa.eu/doi/10.2777/1524

European Court of Auditors (2017) EU fisheries controls: more efforts needed (Special Report No 08/2017). Publications Office of the European Union, Belgium. https://doi.org/10.2865/164227

FAO, International Plan of Action for Conservation and Management of Sharks (1999). http://www.fao.org/docrep/006/x3170e/x3170e03.htm

Falsone F, Gancitano V, Geraci ML, Sardo G, Scaennella D, Serena F, Vitale S, Fiorentino S (2022) Assessing the stock dynamics of Elasmobranchii off the southern coast of Sicily by using trawl survey data. Fishes. https://doi.org/10.3390/fishes703013

FAO (1995) Code of conduct for responsible fisheries. FAO, Rome

FAO (1998) The international plan of action for conservation and management of sharks. Consultation on management of fishing capacity, shark fisheries and incidental catch of seabirds in longline fisheries. FAO, Rome. 26–30 October 1998

FAO (2019) Monitoring the incidental catch of vulnerable species in Mediterranean and Black Sea fisheries: methodology for data collection. FAO Fisheries and Aquaculture Technical Paper No. 640. FAO, Rome

FAO (2021) Better data collection in shark fisheries—learning from practice. FAO Fisheries and Aquaculture Circular No. 1227. Rome. https://doi.org/10.4060/cb5378en

FAO (2022a) The state of world fisheries and aquaculture 2022. Towards Blue Transformation, Rome

FAO (2022b) The state of Mediterranean and Black Sea fisheries 2022. General Fisheries Commission for the Mediterranean, Rome

FAO (2022c) FAOLEX database, fisheries and acquaculture domain. In: Food and agriculture organization of the United Nations [online]. Rome https://www.fao.org/faolex/en/. Accessed 21 July 2022

FAO (2022d) General Fisheries Commission for the Mediterranean—report of the fifteenth session of the Compliance Committee, Larnaca, Cyprus, 27 May 2022/Commission générale des pêches pour la Méditerranée—Rapport de la quinzième session du Comité d'application, Larnaca, Chypre, 27 mai 2022. Rome. FAO Fisheries and Aquaculture Report No. 1396/FAO, Rapport sur les pêches et l'aquaculture no. 1396. Rome. https://doi.org/10.4060/cc2854b

FAO (2022e) Database of measures on conservation and management of sharks. In: Food and Agriculture Organization of the United Nation [online]. Rome. Database version 1–2022. www.fao.org/ipoa-sharks/database-of-measures/en

FAO (2024) General Fisheries Commission for the Mediterranean (GFCM) – Report of the forty-sixth session. Split, Croatia, 6–10 November2023. General Fisheries Commission for the Mediterranean No. 46. Rome: 261p. https://doi.org/10.4060/cd0490en

FAO Marine Resources Service (2000) Fisheries management. 1. Conservation and management of sharks. FAO technical guidelines for responsible fisheries. No. 4, Suppl. 1. Rome

Food and Agriculture Organization of the United Nations,Fisheries Division, Statistics andInformation Branch,"GFCM (Mediterranean and Black Sea) capture production (2020). www.fao.org/fishery/statistics/gfcm-capture-production/en

Frangoudes K, Bellanger M, Curtil O, Guyader O (2020) Small-scale fisheries in France: activities and governance issues, pp 231–252

Fromentin JM, Bonhommeau S, Arrizabalaga H, Kell LT (2014) The spectre of uncertainty in management of exploited fish stocks: the illustrative case of Atlantic bluefin tuna. Marine Policy 47:8–14. https://doi.org/10.1016/j.marpol.2014.01.018

GFCM (1949) Agreement for the Establishment of the General Fisheries Commission for the Mediterranean

GFCM (2018) GFCM data collection reference framework (DCRF). Version: 23.2

GFCM (2022a) Compendium of GFCM decisions. Revised version 6.0. https://www.fao.org/gfcm/decisions/en. Accessed 29 Sept 2023

GFCM (2022b) Stock assessment form *Raja clavata* (RJC). Reference year: 2021. Stock assessment form version 2.0 (2022). https://gfcmsitestorage.blob.core.windows.net/website/5.Data/SAFs/DemersalSpecies/2021/SAF_RJC_25_RefY2021.pdf. Accessed 30 Sept 2023

GFCM Recommendation GFCM/35/2011/3 on reducing incidental bycatch of seabirds in fisheries in the GFCM area of application (2011)

GFCM Recommendation GFCM/36/2012/3 on fisheries management measures for conservation of sharks and rays in the GFCM area of application (2012)

GFCM Resolution GFCM/44/2021/6 on the application of an International Maritime Organization number, amending Resolution GFCM/41/2017/6 (2021)

GFCM Recommendation GFCM/41/2017/1 on reporting of aquaculture data and information, amending and repealing Recommendation GFCM/35/2011/6

GFCM Recommendation GFCM/44/2021/16 on additional conservation and mitigation measures for the conservation of elasmobranchs in the Mediterranean Sea

GFCM Recommendation GFCM/45/2022/4 on a multiannual management plan for the sustainable exploitation of demersal stocks in the Strait of Sicily (geographical subareas 12 to 16), repealing Recommendations GFCM/44/2021/12 and GFCM/42/2018/5

Gilman E, Chaloupka M, Taylor N, Nelson L, Friedman K, Murua H (2023) Global governance guard rails for sharks: progress towards implementing the United Nations international plan of action. Fish Fish. https://doi.org/10.1111/faf.12788

Giovos I, Arculeo M, Doumpas N, Katsada D, Maximiadi M, Mitsou E et al (2020) Assessing multiple sources of data to detect illegal fishing, trade and mislabelling of elasmobranchs in Greek markets. Marine Policy 112:103730. https://doi.org/10.1016/j.marpol.2019.103730

Gomei M, Abdulla A, Schröder C, Yadav S, Sánchez A, Rodríguez D, Abdel Malek D (2019) Towards 2020: how Mediterranean countries are performing to protect their sea

Haas B, Mackay M, Novaglio C, Fullbrook L, Murunga M, Sbrocchi C et al (2021) The future of ocean governance. Rev Fish Biol Fish 32:253–270. https://doi.org/10.1007/s11160-020-09631-x

ICCAT (2006–2016) ICCAT manual. International Commission for the Conservation of Atlantic Tuna. In: ICCAT Publications. Updated 2016

ICCAT (2012) Report of the 3rd meeting of the working group on the future of ICCAT (Madrid, Spain—May 28 to 31, 2012). https://www.iccat.int/Documents/Meetings/Docs/2012_FIWG_REP_ENG.pdf

Intergovernmental Oceanographic Commission (2020) The science we need for the ocean we want: the United Nations Decade of Ocean Science for Sustainable Development (2021–2030). pp 19. https://unesdoc.unesco.org/ark:/48223/pf0000265198.locale=en. Accessed 3 Dec 2022

IUCN (2023) IUCN red list of threatened species. Version 2022–2. https://www.iucnredlist.org/. Accessed 27 June 2023

Katsanevakis S, Levin N, Coll M, Giakoumi S, Shkedi D, Mackelworth P et al (2015) Marine conservation challenges in an era of economic crisis and geopolitical instability: the case of the Mediterranean Sea. Marine Policy 51:31–39. https://doi.org/10.1016/j.marpol.2014.07.013

Koehler L, Lowther J (2022) Policy making for sharks and the role and contribution of non-governmental organisations in the fulfilment of international legal obligations. Marine Policy 1(44):105228. https://doi.org/10.1016/j.marpol.2022.105228

Koehler L, Giovos I, Lowther J (2022) The application of precaution in elasmobranch conservation and management in the Mediterranean Sea. Marine Policy. https://doi.org/10.1016/j.marpol.2021.104830

Kyne PM, di Sciara GN, Morera AB, Charles R, Rodríguez EG, Fernando D et al (2023) Important Shark and Ray Areas: a new tool to optimize spatial planning for sharks. Oryx 57:146–147. https://doi.org/10.1017/S0030605322001624

Lado EP (2016) The Common Fisheries Policy: the quest for sustainability. Wiley-Blackwell. xiv + 375 pp

Lloret J, Biton-Porsmoguer S, Carreño A, Di Franco A, Sahyoun R, Melià P et al (2020) Recreational and small-scale fisheries may pose a threat to vulnerable species in coastal and offshore waters of the western Mediterranean. ICES J Marine Sci 77(6):2255–2264

MacKeracher T, Diedrich A, Simpfendorfer CA (2018) Sharks, rays and marine protected areas: A critical evaluation of current perspectives. Fish Fish. https://doi.org/10.1111/faf.12337

Maguire J-J, Sissenwine M, Csirke J, Grainger R, Garcia S (2006) The state of the world highly migratory, straddling and other high seas fishery resources and associated species. FAO Fisheries Technical Paper. No. 495. FAO, Rome, 84 pp

McCauley DJ, Pinsky ML, Palumbi SR, Estes JA, Joyce FH, Warner RR (2015) Marine defaunation: animal loss in the global ocean. Science 347:1255641. https://doi.org/10.1126/science.1255641

MedPAN and UNEP/MAP-SPA/RAC (2021) The system of Mediterranean marine protected areas in 2020. https://medpan.org/en/system-mediterranean-mpas-2020. Accessed Feb 2024

Meléndez MJ, Báez JC, Serna-Quintero JM, Camiñas JA, Fernández IdL, Real R et al (2017) Historical and ecological drivers of the spatial pattern of Chondrichthyes species richness in the Mediterranean Sea. PLoS ONE 12(4):e0175699. https://doi.org/10.1371/journal.pone.0175699

Milazzo M, Cattano C, Mabruk S, Giovos I (2021) Mediterranean sharks need action. Science 371(6527):355–356. https://doi.org/10.1126/science.abg1943

Moore ABM, Hiddink JG (2022) Identifying critical habitat with archives: 275-year-old naturalist's notes provide high-resolution spatial evidence of long-term core habitat for a critically endangered shark. Biol Conserv 272:109621. https://doi.org/10.1016/j.biocon.2022.109621

Muir L, Klein N (2018) From IPOA sharks to sharks MoU under the convention on migratory species: Progress or clutter in international environmental law? J Int Wildl Law Pol 21(2–3):190–219. https://doi.org/10.1080/13880292.2018.1485957

Musick B, Burgess G, Cailliet G, Camhi M, Fordham S (2000) Management of sharks and their relatives (Elasmobranchii). Am Fish Soc 25(3):9–13

Newell B (2017) Status review report of two species of guitarfish: Rhinobatos rhinobatos and Rhinobatos cemiculus

Niedermüller S, Ainsworth G, de Juan S, Garcia R, Ospina-Alvarez A, Pita P, Villasante S (2021) The shark and ray meat network: A deep dive into a global affair. WWF MMI Rome. https://wwfeu.awsassets.panda.org/downloads/a4_shark_2021_low.pdf. Accessed 3 Dec 2022

Otero MM, Serena F, Gerovasileiou V (2019) Identification guide of vulnerable species incidentally caught in Mediterranean Fisheries. IUCN Malaga, 203 pp

Ouest-France (2023) Ce que l'on sait après l'incendie qui a avage l'immeuble de l'OFB à Brest. https://www.ouest-france.fr/bretagne/bretagne-ce-que-lon-sait-apres-lincendie-qui-a-ravage-limmeuble-de-lofb-a-brest-13bcc2c8-cfa4-11ed-bc6d-ac0c19b03625. Accessed Feb 2024

Öztürk B (2018) National action plan for the conservation of cartilaginous fishes in the Turkish water of the eastern Mediterranean Sea. J Black Sea Mediterr Environ 24:1

Petza D, Anastopoulos P, Kalogirou S, Coll M, Garcia S, Kaiser M, Koukourouvli N, Lourdi I, Rice J, Sciberras M, Katsanevakis S (2023) Contribution of area-based fisheries management measures to fisheries sustainability and marine conservation: a global scoping review. Rev Fish Biol Fish 14:1–25

Regulation (EU) 2023/2842 of the European Parliament and of the Council of 22 November 2023 amending Council Regulation (EC) No 1224/2009, and amending Council Regulations (EC) No 1967/2006 and (EC) No 1005/2008 and Regulations (EU) 2016/1139, (EU) 2017/2403 and (EU) 2019/473 of the European Parliament and of the Council as regards fisheries control (2023) OJ L. https://eur-lex.europa.eu/eli/reg/2023/2842/oj. Accessed 5 Feb 2023

Republic of Türkiye (1971) 1380 Sayili Su Urunleri Kanunu. https://www.tarimorman.gov.tr/

Republic of Türkiye (2019) Su Ürünleri Kanununda Değişiklik Yapılmasına Dair Kanun No: 7191. Official Gazette No. 30956, 22 November 2019. http://www.resmigazete.gov.tr/

Republic of Türkiye Ministry of Agriculture and Forestry (2020) 5/1 numaralı ticari amaçlı su ürünleri avcılığının düzenlenmesi hakkında Tebliğ (Tebliğ No: 2020/20). http://www.mevzuat.gov.tr/

Rodríguez-Rodríguez D, Rodríguez J, Malak DA, Nastasi A, Hernández P (2016) Marine protected areas and fisheries restricted areas in the Mediterranean: assessing "actual" marine biodiversity protection coverage at multiple scales. Marine Policy 64:24–30

Saidi B, Enajjar S, Karaa S, Echwikhi K, Jribi I, Bradai MN (2019) Shark pelagic longline fishery in the Gulf of Gabes: inter-decadal inspection reveals management needs. Mediterr Mar Sci 20(3):532–541

Scientific Technical and Economic Committee for Fisheries (STECF) (2021) Fisheries Dependent -Information –FDI (STECF-21-12). EUR 28359 EN, Publications Office of the European Union, Luxembourg. Publications Office of the European Union, Luxembourg

Serena F, Abella AJ, Bargnesi F, Barone M, Colloca F, Ferretti F et al (2020) Species diversity, taxonomy and distribution of Chondrichthyes in the Mediterranean and Black Sea. Eur Zool J 87(1):497–536. https://doi.org/10.1080/24750263.2020.1805518

Sherman CS, Digel ED, Zubick P, Eged J, Haque AB, Matsushiba JH et al (2023) High overexploitation risk due to management shortfall in highly traded requiem sharks. Conserv Lett 16(2):e12940. https://doi.org/10.1111/conl.12940

SPA/RAC–UN Environment/MAP (2020) Action Plan for the Conservation of Cartilaginous Fishes (Chondrichtyans) in the Mediterranean Sea. By Bradai MN Ed SPA/RAC. Tunis 18 pp

Stephenson RL, Hobday AJ, Cvitanovic C, Alexander KA, Begg GA, Bustamante RH et al (2019) A practical framework for implementing and evaluating integrated management of marine activities. Ocean Coast Manag 177:127–138

Techera E, Klein N (2017) International law of sharks: obstacles, options and opportunities. Brill Nijhoff, Leiden, p 282

Touloupaki E, Doumpas N, Bouziotis D, Rae V, Moutopoulos DK, Giovos I (2020) Sea turtles and sharks bycatch in Greece: Fishers' and stakeholders' knowledge. J Black Sea/Mediterranean Environ 26(1)

UNEP (2012) Decision IG.20/5: Amendments of the Annexes II and III to the protocol concerning specially protected areas and biological diversity in the Mediterranean. Seventeenth ordinary meeting of the contracting parties to the convention for the protection of the marine environment and the coastal region of the Mediterranean and its protocols. https://www.unep.org/unepmap/meetings/cop-decisions/cop17-outcome-documents. Accessed 3 Dec 2022

UN General Assembly, Convention on the Law of the Sea, 10 December 1982. https://www.refworld.org/docid/3dd8fd1b4.html. Accessed 3 Dec 2022

UNEP/MAP (1995) Protocol on specially protected areas and biological diversity in the Mediterranean (SPA/BD protocol) of Barcelona Convention 1995. http://www.rac-spa.org/sites/default/files/protocole_aspdb/protocol_eng.pd. Accessed 3 Dec 2022

UNEP/MAP RAC/SPA (2003) Action Plan for the Conservation of Cartilaginous Fishes (Chondrichthyans) in the Mediterranean Sea. Ed. RAC/SPA, Tunis. 56 pp

UNEP(DEPI)/MED (2008) Decision IG.17/10 Procedures and mechanisms on compliance under the Barcelona Convention and its Protocols. Accessed 6 Feb 2024

UNEP RAC/SPA (2009) Ninth Meeting of the Focal Points for SPAs. Assessment of the Implementation and revision of the Action Plan for the Conservation of Cartilaginous Fishes (Chondrichthyans) in the Mediterranean. Floriana, Malta, 3-6 June 2009. UNEP(DEPI)/MED WG. 331/Inf.13. Tunis: 37p

UNEP/MAP RAC/SPA (2012) Guidelines for shark and ray recreational fishing in the Mediterranean. By S Fowler and E Partridge

UNEP RAC/SPA (2013) Eleventh Meeting of the Focal points for SPAs. Report of the Eleventh Meeting of the Focal points for Specially Protected Areas (SPAs), Rabat, Morocco, 2-5 July 2013. UNEP(DEPI)/MED WG.382/17. Tunis: 286p

UNEP/MED WG.548/3 (2017) Report on the status of implementation of the protocol concerning specially protected areas and biological diversity in the Mediterranean (SPA/BD Protocol)

United Nations (2018) Overview—convention and related agreements. 2018. United Nations. https://www.un.org/Depts/los/convention_agreements/convention_overview_convention.html. Accessed 7 Nov 2022

UNEP MAP RAC/SPA (2020) Action Plan for the Conservation of Cartilaginous Fishes (Chondrichthyans) in the Mediterranean Sea. Ed. RAC/SPA Tunis, 56 pp

UNEP MAP (2023) Report of the Meeting. 23rd Meeting of the Contracting Parties to the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean and its Protocols. Portorož, Slovenia, 5-8 December 2023. UNEP/MED IG.26/22*. Athens: 698p

United Nations Environment Programme (1992). Convention on biological diversity, June 1992. https://wedocs.unep.org/20.500.11822/8340

van Hoof L, Hoefnagel E, van der Schans JW, Nielsen JR, Christensen AS, Sverdrup-Jensen S et al (2005) Sharing responsibilities in fisheries management Part 2-Annex: case studies

Vella A, Vella N, Schembri S (2017) A molecular approach towards taxonomic identification of elasmobranch species from Maltese Fisheries Landings. Mar Genom 36:17–23. https://doi.org/10.1016/j.margen.2017.08.008

Visbeck M (2018) Ocean science research is key for a sustainable future. Nat Commun 9(1):690. https://doi.org/10.1038/s41467-018-03158-3

Visbeck M, Kronfeld-Goharani U, Neumann B, Rickels W, Schmidt J, Van Doorn E et al (2014) Securing blue wealth: The need for a special sustainable development goal for the ocean and coasts. Marine Policy 48:184–191

van Tatenhove JPM (2013) How to turn the tide: developing legitimate marine governance arrangements at the level of the regional seas. Ocean Coast Manag 71:296–304. https://doi.org/10.1016/j.ocecoaman.2012.11.004

Vincent AC, Sadovy de Mitcheson YJ, Fowler SL, Lieberman S (2014) The role of CITES in the conservation of marine fishes subject to international trade. Fish Fish 15(4):563–592

Worm B, Branch TA (2012) The future of fish. Trends Ecol Evol 27(11):594–599. https://doi.org/10.1016/j.tree.2012.07.005

Worm B, Barbier EB, Beaumont N, Duffy JE, Folke C, Halpern BS, Sala E (2006) Impacts of biodiversity loss on ocean ecosystem services. Sci 314(5800):787–790. https://doi.org/10.1126/science.1132294