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ELASMOBRANCHS OF THE MEDITERRANEAN AND BLACK SEA: STATUS, ECOLOGY AND BIOLOGY BIBLIOGRAPHIC ANALYSIS

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ELASMOBRANCHS OF THE MEDITERRANEAN AND BLACK SEA: STATUS, ECOLOGY AND BIOLOGY
BIBLIOGRAPHIC ANALYSIS

by

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PREPARATION OF THIS DOCUMENT

At its fourty–fourth session (Athens, Greece, 12–17 April 2010), the General Fisheries Commission for the Mediterranean (GFCM) endorsed the programme of work on elasmobranchs species proposed by the Scientific Advisory Committee (SAC) and recommended the Sub-Committee on Marine Environment and ecosystems (SCMEE) to implement over the period 2010–2012 different activities on the issue. Among these activities, a First transversal expert meeting on Elasmobranchs in the Mediterranean and Black Sea was organised in Sfax, Tunisia from 20 to 22 September 2010.

This document was firstly elaborated as a working paper for this meeting and then revised to include results of the GFCM Workshop on stock assessment of selected species of elasmobranchs in the GFCM area (12–16 December 2011, Brussels, Belgium) as well as the most recent information published on this issue since 2010. This publication is funded by the EU DG Mare under the project on Stock Assessment of selected species of Elasmobranchs in the GFCM Area.

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ABSTRACT

The authors have compiled published information on taxonomy, distribution, status, statistics, fisheries, bycatch, biologic and ecologic parameters on age and growth, food and feeding habits, reproductive biology and stock assessment of elasmobranchs in the Mediterranean and Black Sea. This bibliographic analysis, through 661 papers dealing with elasmobranchs in the GFCM area, shows that cartilaginous species, including sharks, rays and chimaeras, are by far the most endangered group of marine fish in the Mediterranean Sea, with 31 species (40 percent of all) critically endangered, endangered or vulnerable. The biological characteristics of elasmobranchs (low fecundity, late maturity, slow growth) make them more vulnerable to fishing pressure than most teleost fish. Overfishing, wide use of non-selective fishing practices and habitat degradation are leading to dramatic declines of these species in the Mediterranean Sea. In general, elasmobranchs are not targeted but are caught incidentally. In many fisheries they are, however, often landed and marketed.

The study also highlights the following points:
– Works are concentrated mainly in the western Mediterranean. Few works concern endangered species and those of the GFCM priority list;
– Much systematic confusion persists for some species and some others are doubtful;
– The IUCN red list shows clearly the vulnerability of elasmobranchs and the lack of data;
– A decline in cartilaginous fish species landings has been observed while fishing effort has generally increased;
– A standardization of methods and expression of results on the biology should be generalized in the whole Mediterranean;
– Papers on biologic parameters concern few species primarily in the occidental and central Mediterranean areas.

Therefore, recommendations to fill gaps in order to protect and manage elasmobranchs stocks are proposed in this document. In fact, better understanding of the composition of incidental and targeted catches of sharks by commercial fisheries and biological and ecological parameters are fundamentally important for the conservation of these populations. Moreover, problems encountered by elasmobranchs in the GFCM area are highlighted and conservation measures are suggested.

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ABBREVIATIONS AND ACRONYMS

BRD	Bycatch Reduction Devices
CITES	Convention on International Trade in Endangered Species of wild fauna and flora
CPUE	Capture Per Unit of Effort
CMS	Convention on the Conservation of Migratory Species of Wild Animals (or Bonn Convention)
EC	European Community
EEA	European Elasmobranchs Association
EEZ	Exclusive Economic Zone
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GFCM	General Fisheries Commission for the Mediterranean
GSA	Geographical Sub-aAreas (in GFCM area)
ICCAT	International Commission for the Conservation of Atlantic Tunas
IPOA–Shark	International Plan of Action for the Conservation and Management of Sharks
IUCN	International Union for Conservation of Nature
MEDLEM	Mediterranean Large Elasmobranchs Monitoring
MPAs	Marine Protected Areas
PELAGOS	Sanctuary for cetaceans
RAC/SPA	Regional Activities Center for Specially Protected Areas
SAC	Scientific and Advisory Committee
SPA/BD	Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean
TED	Turtle Excluding Device
UNCLOS	United Nations Convention on the Law of the Sea
UNEP	United Nations Environment Programme
UNFSA	United Nations Agreement on the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks
VBGM	Von Bertalanffy Growth Model
VPA	Virtual Population Analysis

1. INTRODUCTION

In the Mediterranean region, elasmobranchs are characterized by their diversity (49 sharks and 36 rays). The region is known to be an important habitat for cartilaginous fish and is thought to encompass unique breeding grounds for species such as the white shark (*Carcharodon carcharias*) and thornback ray (*Raja clavata*).
Elasmobranchs constitute an important bycatch of commercial fisheries targeting bony fishes, rare are fisheries targeting sharks, but usually almost all specimen bycatch are marketed. Elasmobranchs represent about 1–2 percent of the total landings. These landings increased from 10 000 to 25 000 tonnes between 1970 and 1985, and then slowly decreased to 10 000 tonnes in 2000. Subsequently, reported landings declined to 7 000 tonnes nowadays.

Going back in the history, it has been demonstrated that sharks in the Mediterranean Sea have declined by more than 97 percent in number and "catch weight" over the last 200 years. They risk extinction if current fishing pressure continues (Ferretti et *al*., 2008). The last 200 years have seen a dramatic decline of large predatory sharks in the Mediterranean Sea. This loss of top predators could hold serious implications for the entire marine ecosystem, greatly affecting food webs throughout this region.

There is evidence that the elasmobranchs of the Mediterranean are declining in abundance, diversity and range due to the intense fishing activity primarily in response to the rapidly increasing demand for shark fins, meat and cartilage. However, this direct fishing mortality is not the only impact on elasmobranchs populations. There are fishing impacts on habitats through disturbance of biotic communities and substrates. Shipping and underwater exploration, construction, mining, and electrical installation also affect habitats, and increasing ambient sound, light, electromagnetic fields, and chemical contamination stimulate the sensory systems of these fishes.

Their biological characteristics (low fecundity, late maturity and slow growth rates) also make elasmobranchs vulnerable to fishing pressure. Overfishing, habitat degradation and slow recovery rates are potential factors that lead to such dramatic declines, especially in areas such as the Mediterranean Sea where fishing has long been a way of life and continues to be intense. Some species are already threatened.
Among the 85 species known in the Mediterranean, only 71 were assessed within the framework of the International Union for Conservation of Nature (IUCN) red list. More than 40 percent are vulnerable and endangered to critically endangered (Cavanagh and Gibson, 2007).

In addition, there is a lack of aggregated knowledge on the biology and fishery of elasmobranchs in many parts of the Mediterranean. Of the 71 assessed species, 18 species are data deficient (DD) (Cavanagh and Gibson, 2007).
Taking into account the vulnerability of elasmobranchs and within the framework of a protection and stock management strategy for this group, many action plans were elaborated on this issue (the International Plan of Action for the Conservation and Management of Sharks (FAO IPOA–Shark, 1999), the Action Plan for the Conservation of Cartilaginous Fishes in the Mediterranean (UNEP–RAC/SPA, 2003), the EU Action Plan for the Conservation and Management of Sharks, etc. In this context, the GFCM organized a transversal working group on bycatch/incidental catches (Italy, September 2008) and a transversal workshop on selectivity improvement and bycatch reduction (Tunisia, September 2009) where elasmobranchs were well taken into account.
These last meetings concluded that there was a lack of knowledge on the biology and fishery of elasmobranchs in many parts of the Mediterranean and strongly encouraged more studies on population dynamics (population size, structure and demographics) on species of conservation concern (also in terms of fishery management) in parallel to mitigation measure in those cases where protected species are involved.

The above mentioned workshop held in Tunisia suggested to set up a medium-term working programme to identify and fill gaps in the current knowledge regarding elasmobranchs fisheries, in order to assess and manage the Mediterranean stocks. This programme was upposed to identify the activities to be carried out including the organization of a specific expert meeting on the elasmobranchs during 2010. This bibliographic document is firstly elaborated as a work document prepared for this expert meeting on the status of elasmobranchs in the Mediterranean and Black Sea (Sfax,Tunisia, 20–22 September 2010) in order to implement this programme within the framework of the intersessional activities of the Scientific Advisory Committee (SAC) of the General Fisheries Commission of the Mediterranean (GFCM).

Knowledge on elasmobranchs in the Mediterranean and Black Sea compiled in the present document is based on a very thorough literature search which has led to collect **661** references (Appendix 1), dealing with elasmobranchs, of which a majority of articles published in reputable scientific journals. The chronology of appearance of publications shows that interest in elasmobranchs research is relatively recent. It started by the end of the 1990s when landings decreased and some species became threatened (Figure 1). These references were classified by topic, species or group of species and geographic area (Appendix 2).
Recommendations to fill gaps in order to protect and manage elasmobranchs stocks are also proposed in this document.

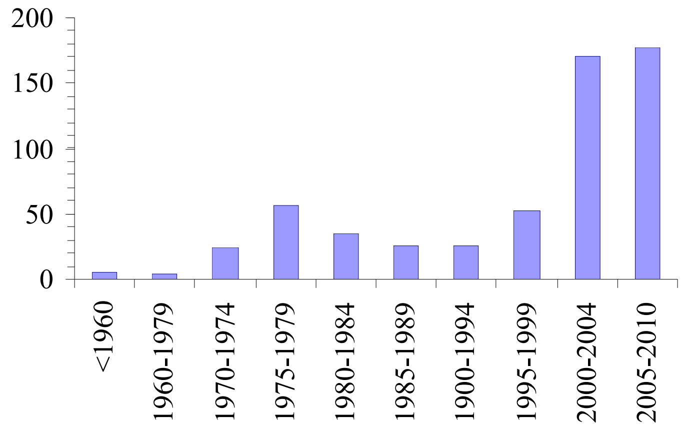


Figure 1 – Temporal distribution of the number of published papers dealing with elasmobranchs in the GFCM area

2. MAIN CHARACTERISTICS OF THE GFCM MARINE AREA

2.1 The Mediterranean

The Mediterranean is the largest (2 969 000 km^2) and deepest (average 1 460 m, maximum 5 267 m) enclosed sea on Earth. It is surrounded by Africa, Europe, and Asia. The Mediterranean Sea connects through the Strait of Gibraltar to the Atlantic Ocean in the west and through the Dardanelles to the Sea of Marmara and the Black Sea in the northeast. In the southeast, the Suez canal links the Mediterranean to the Red Sea and the Indo-Pacific region. A shallow ridge at 400 m depth, between Sicily island and Tunisian coasts, divides the sea into two main subregions: the western and the eastern basins.
The climate in the region is characterized by hot, dry summers and cool, humid winters. The annual mean sea surface temperature shows a high seasonality and important gradients from west to east and north to south. The basin is generally oligotrophic. The biological production decreases from north to south and west to east and is inversely related to the increase in temperature and salinity. The Mediterranean has narrow continental shelves, a large part of the Mediterranean basin can be classified as deep sea and includes some unusual features: (1) high homothermy from 300–500 m to the bottom, where temperatures vary from 12.8 °C–13.5 °C in the western basin to 13.5°C–15.5°C in the eastern, and (2) high salinity of 37.5–39.5 psu. The recent marine biota in the Mediterranean Sea is primarily

derived from the Atlantic Ocean, but the wide range of climate and hydrology has contributed to the co-occurrence and survival of both temperate and subtropical organisms.

The Mediterranean region has been inhabited for millennia, and ecosystems have been altered in many ways. Therefore, impacts of human activities are proportionally stronger in the Mediterranean than in any other sea of the world. Its coasts support a high density of inhabitants. With 200 million tourists per year, the region contributes notably to global economy and trade. More than one percent of world landings come from Mediterranean fisheries. Therefore, combined natural and anthropogenic events shaped the biodiversity of the Mediterranean Sea in the past and are likely to continue to do so (Coll et *al*., 2010).

The Mediterranean is known to encompass a high diversity of elasmobranchs and many very important habitats that are threatened nowadays.

2.2 The Black Sea

The Black Sea is one of the world's most isolated seas and the largest anoxic plan of water on the world (87 percent of its volume is anoxic). The total surface area of the Black Sea is 423 000 km^2 and it is surrounded by Turkey, Bulgaria, Romania, Ukraine, Russia and Georgia (Figure 2). On the northeast, the Black Sea is connected to the Sea of Azov and to the Sea of Marmara on the southwest. The maximum depth is 2 212 m. The most striking characteristics of the Black Sea are the high level of hydrogen sulphide (H2S) and the presence of a permanent halocline between 150 and 200 m.

The average surface salinity is about 18–18.5 per mille during winter, and increases by 1.0–1.5 per mille in summer. The mean annual surface temperature varies from 16°C in the south to 13°C in the northeast and 11°C in the northwest. Seasonal fluctuations in temperature are registered until 50 m depth; the temperature of the deeper water remains constant throughout the year (9°C at a depth of 1 000 m). The gradual increase of temperature during the history (last 10 000 years) has facilitated the penetration of Mediterranean species in the Black Sea. Today, 80 percent of the total fauna in the Black Sea are Mediterranean origin (Ozturk, 2010).

Figure 2 – Map of the Mediterranean and Black Sea (Coll et *al*., 2010)

3. BIODIVERSITY OF ELASMOBRANCHS IN THE MEDITERRANEAN AND BLACK SEA

All cartilaginous fishes belong to the Chondrichthyes class comprising sharks, batoids (skates, stingrays, guitarfishes and sawfishes) and chimaeroid fishes and including about 60 families, 189 genera and about 1 200 living species (Compagno et *al*., 2005). The chimaeras fall in the subclass of Holocephalii and the sharks and rays in the subclass of Elasmobranchii. We deal in this document with this latter subclass, generally named elasmobranchs. Elasmobranchs are divided into sharks (Squalii, Pleurotremata) and rays (Batoidea, Hypotremata).
In all conventions and action plans, the term "sharks" is used to refer to the chondrichthyan or cartilaginous fishes, which comprise elasmobranchs (sharks and batoids) and chimaeras.

According to Compagno (2001), Compagno et *al*. (2005) and Serena (2005), the chondrichthyan fish fauna is relatively diverse with an estimated 80 species (approximately 7 percent of total living chondrichthyans), comprising 45 species of sharks from 17 families, 34 batoid species from nine families and one species of chimaera. In this document we give a new list based on a critical analysis of the literature and taking into account new published data on the systematic of elasmobranchs. In total we consider 86 species of elasmobranchs thought to occur in the Mediterranean Sea. This number comprises 49 species of sharks from 17 families and 37 batoids species from nine families (Appendix 3). Photos of some of them are presented in coulour plates at the end of the document (Appendix 5).

Among the 86 species, 13 species (seven sharks and six batoids) are recorded in the Black Sea (three rays are doubtful). Three species are relatively common: the thornback ray (*Raja clavata)* and the common stingray (*Dasyatis pastinaca)* having no commercial importance due their low market demands and the spiny dogfish (*Squalus acanthias)* which is more common (Appendix2).
However, it should be noted that several species of elasmobranchs have been reported in the Marmara Sea which is, with the Black Sea and the Sea of Azov, in the same FAO subarea: Black Sea subarea. These species are: *Echinorhinus brucus*, *Oxynotus centrina, Alopias superciliosus*, *Carcharodon carcharias*, *Scyliorhinus stellaris*, *Galeus melastomus*, *Mustelus asterias* and *Mustelus mustelus* (Kabasakal, 2003 and 2009; Kabasakal and Karhan, 2007).

3.1 Status of some problematic elasmobranchs species

For some species, taxonomic status is doubtful, considered as valid by certain ichthyologists and invalid by others or synonym of other species. We will try in this section to review the status of these species taking into account new works and observations.

- **The short snout spurdog *Squalus megalops* (Squalidae)**
  Squalus megalops (Macleay, 1881) has been recorded in the western Mediterranean by Muñoz-Chápuli et *al. (*1984). *Squalus megalops* has been recorded from many localities of the eastern Atlantic and Indo-west Pacific (Compagno, 2005). However, its presence in the Mediterranean Sea is considered doubtful by many authors. Last and Stevens (1994) suggest that the southern Australian *S. megalops* is probably distinct from nominal *S. megalops* in other parts of the world and appeared to be endemic to Australia.
  Besides the longnose spurdog *Squalus blainvillei* (Risso, 1827) occurring in the Gulf of Gabès (southern Tunisia, central Mediterranean), a short snout spurdog of the *Squalus megalops-cubensis* group has been identified in this area. Morphometrical and meristic data along with genetic analysis (DNA inter-simple sequence repeat markers and molecular barcoding methods) support the assignation of this short snout spurdog to *Squalus megalops* (Marouani et *al*., 2012). The presence of this species in the Mediterranean is well confirmed. It is recorded in fact recently in Italian waters (Mulas et *al*., 2011). It seems also that *S. megalops* is more common than *S. Blainvillei*.

- **The tortonese stingray *Dasyatis tortonesei* (Capapé, 1975) (Dasyatidae)**

  Dasyatis tortonesei Capapé (1977), has been considered synonym of *D. pastinaca* by Tortonese (1987). Formerly considered dubious by Compagno (1999), it is often confused with *D. pastinaca*. Probably a distinct *Dasyatis* species lives in the Mediterranean but with nomenclature problem and currently under investigation (Serena, 2005). The species *D. tortonesei* is then not considered valid in the *Field identification guide to the sharks and rays of the Mediterranean and Black Sea* (Serena F., 2005).

  Parasitological studies in the Gulf of Gabès distinguish monogeneans specific to *D. pastinaca* and to *D. tortonesi* described by Capapé (1977), *Heterocotyle capapei,* monogenean gill of *D. tortonesei* and *Heterocotyle pastinacae* for *D. pastinaca* (Neifer et *al*., 1998 and 2000). Cestods fauna in spiral intestine of the two species are also different (Zayan and Neifer, personal communication).

  Besides anatomic characteristics and genetics, parasitology studies are in fact a very useful tool for the systematicstudy of elasmobranchs (Ball et *al*., 2003; Beveridge et *al.,* 2004; Essafi, 1975; Euzet, 1959; Euzet and Radujkovic, 1989; Ktari and Maillard, 1972; Maillard,1966; Mokhtar–Maamouri and Zamali,1981 et 1982 ; Neifar et *al*., 1998 and 1999; Neifar, 2001; Tazerouti, 2007).

  Further investigations in the Gulf of Gabès have demonstrated the presence of the two species on the basis of clear differences in morphometric, meristic and anatomic characteristics (Saadaoui, 2010).

  In this document we consider *D. tortonesi* as a valid species.

- **The marbled stingray *Dasyatis marmorata* (Steindachner, 1892) (Dasyatidae)**

  The marbled stingray *Dasyatis marmorata* (Steindachner, 1892) is closely related to *D. pastinaca* (Linnaeus, 1758) and, therefore, the two species are often confused and misidentified. According to Cowley and Compagno (1993), these species can be distinguished by the ratio between the disk length and disk width. In addition, the species differ in coloration: the dorsal surface of *D. pastinaca* is grayish green to olive brown, conspicuous bright blue blotches and branching lines on a golden background on the dorsal surface of the other species.

  Dasyatis marmorata was reported for the first time in the Mediterranean in the Gulf of Gabès (southern Tunisia) by Maurin and Bonnet (1970) as *D. pastinaca* var. *marmorata*. This occurrence was confirmed under the same taxon by Quignard and Capapé (1971).

  Besides, a closely related species, *Dasyatis chrysonota,* is found in Gulf of Guinea (Fowler 1936), Angola (Krefft 1968) and South Africa (Cowley and Compagno 1993).

  Referring probably to earlier taxonomical papers (Cowley and Compagno, 1993) such as Fredj and Maurin (1987) and Capapé and Desoutter (1990), Quignard and Tomasini (2000) considered *D. chrysonota* = *D. marmorata* as a valid species.

  On this consideration, many records of this species as *Dasyatis chrysonota* were reported in the Mediterranean, off the coast of Israel (eastern Mediterranean) (Golani and Capapé, 2004) and in the Lagoon of Bizerte (northeastern Tunisia, central Mediterranean) (El Kamel et *al*., 2009).

  In the *Field identification guide to the sharks and rays of the Mediterranean and Black Sea*, *FAO Species Identification Guide for Fishery Purposes,* Serena (2005) gave the name *Dasyatis chrysonota marmorata* and wrote that this name was an interim solution. It may become *D. marmorata* after DNA studies.

  Considering photos of *D. chrysonata* off Africa (east Atlantic) (Seret, personal communication), a difference seems to be clear between this Atlantic species and *D. marmorata*. In the *Field identification guide to the sharks and rays of the Mediterranean and Black Sea* (Serena, 2005), the pattern of the so-called *Dasyatis chrysonota marmorata* represents *D. chrysonata* and the photo is of *D. marmorata*. Differences interest mainly the body shape and the dorsal coloration.

  Considering tail spine characteristics of stingrays, Schwartz (2007) distinguished *D. chrysonata* and D. *marmorata*.

In conclusion to this bibliographic analysis and following further discussions with colleagues, *Dasyatis marmorata* is a species of western Africa and the Mediterranean (Seret, in press – Dasyatidae, in *FAO species identification guide for Fishery Purposes, The Living Resources of the Eastern Central Atlantic*). *Dasyatis chrysonota* is a South African species. There are several distinctive features (colour and morphology). However, a genetic study should formally reaffirm the validity of *D. marmorata* and redefine the two species (B. Seret, personal communication, 2009).
In this document, we consider only *D. marmorata* and all records of *D. chrysonata* in the Mediterranean as *D. marmorata*. Further investigations should be undertaken.

- **The Halave's guitarfish *Glaucostegus halavi* (Forsskäl, 1775) (Rhinobatidae)**
  The species was recorded firstly by Vinciguerra (1884) in the Gulf of Tunis but, following the morphologic description given by the author, it was *Rhinobatos cemiculus* (Quignard and Capapé, 1971). Tortonese (1951) recorded it also in Egyptian waters but this was not confirmed (Ben-Tuvia, 1966). Later, a single specimen was recorded from the Gulf of Gabès (Tunisia) (Ben Souissi et *al*., 2007). This record seems to be doubtful and a reconsideration of the specimen in question is necessary. It is not considered in this document.

- **Gulper sharks *Centrophorus granulosus* and *Centrophorus uyato* (Centrophoridae)**
  This genus needs revision worldwide (Daley et *al.* 2002, Lloris and Rucabado, 1998).

- **The longfin mako *Isurus paucus* (Lamnidae)**
  It is caught in Algeria (Hemida and Capapé, 2008). It will be considered in the list.

- **The blacktip shark *Carcharhinus melanopterus* (Carcharhinidae)**
  Carcharhinus melanopterus is an Indo-Pacific species present in the Red Sea (Gohar and Mazhar, 1964) which seems to have colonized the southeast Mediterranean. Branstetter (1984) and Fischer et *al*. (1987) considered questionable its presence in the western basin. The species is very rare in the Gulf of Gabès where it is reported for the first time by Quignard and Capapé (1971). The capture of a male specimen of one meter long in the Gulf of Gabès, in December 1993, confirms the previous observations of blacktip shark in south Tunisia (Bradai et *al*., 2002).

- **The tiger shark Galeocerdo cuvier** (**Carcharhinidae**)
  Very rare tropical Atlantic species. Its occurrence in the Mediterranean is doubtful, but two substantiated records have been reported in the Mediterranean, first off Malaga, Spain (Pinto de la Rosa, 1994), then in Messina, Italy (Celona, 2000). It is considered in the list.
  Two other doubtful species of carcharinidae family *C. leucas* and *C. longimanus*, recorded in the Mediterranean, have been considered as not valid (Serena, 2005). They are not included in the present list.

- **Sawfish (Pristidae)**
  Sawfish was once common in the Mediterranean and eastern Atlantic, but it has now been probably extirpated from Europe and the Mediterranean. Populations depleted because of the destruction of littoral and freshwater habitats and its vulnerability to coastal gillnet fisheries. Only historical records exist.

- **The torpedo rays *Torpedo (Torpedo) alexandrinis* (Mazhar, 1982) and *Torpedo (Torpedo) fuscomaculata* (Peters, 1855) (Torpedinidae)**
  These two species are not considered as valid species (Serena, 2005). They are not considered in this document.

- **The African skate *Raja africana* (Capapé, 1977) (Rajidae)**
  The validity of this species is questioned in Compagno's 1999 checklist and Serena (2005). We consider it in the list and further investigation should be undertaken.

- **The Rondelet's skate *Raja rondeleti* (Bougis, 1959) (Rajidae)**
  The taxonomic status of this species is doubtful (Serena, 2005). It is not considered in the list.

- ***Carcharhinus acarenatus* (Carcharhinidae)**
  Moreno and Hoyos (1983) record the presence of a new species *Carcharhinus acarenatus* in the Mediterranean but Compagno (1984) put it in synonymy with the copper shark *C. Brachyurus*.

- **The pigeye shark *Carcharhinus amboinensis* (Müller & Henle, 1839) (Carcharhinidae)**
  De Maddalena and Della Rovere (2005) report the first Mediterranean record of the pigeye shark, *Carcharhinus amboinensis* (Müller and Henle, 1839) in the northwest Ionian Sea on the basis of jaws measurements. We do not consider it in our list.

3.2 Mediterranean shark endemic species

Endemism of chondrichthyans in the Mediterranean is low, with only four batoid species (Maltese skate *Leucoraja melitensis*, speckled skate *Raja polystigma*, rough ray *R. radula* and giant devilray *Mobula mobular*) which could be considered endemic (Serena, 2005). Within the Mediterranean, the distribution of chondrichthyan fishes is not homogenous (Serena, 2005).

3.3 Elasmobranchs alien species in the Mediterranean

Eight chondrichthyan alien species have been recorded in the Mediterranean, five sharks and three batoids:

- **The Bignose shark *Carcharhinus altimus* (Springer, 1950)**
  This tropical Atlantic species was recorded first on the Moroccan coast, Alboran Sea (Moreno and Hoyos, 1983); one record refers to Levantine waters (Golani, 1996), and the species is now frequent in Algerian waters (Hemida and Labidi, 2001). It is considered as established (on the basis of at least three distinct published records well spread out in time and space).

- **The silky shark *Carcharhinus falciformis* (Bibron, in Müller and Henle, 1839)**
  Tropical Atlantic species, recorded first in the Alboran Sea (Moreno, 1987). Subsequently, it was caught in eastern Algerian waters (Hemida and Labidi, 2001) and in Tunisia (Bradai et *al*., 2002 and 2004).

- **The tiger shark *Galeocerdo cuvier* (Peron and Lesueur, in Lesueur, 1822)**
  Very rare tropical Atlantic species; only two substantiated records in the Mediterranean, first off Malaga, Spain (Pinto de la Rosa, 1994), then in Messina, Italy (Celona, 2000).

- **The milk shark *Rhizoprionodon acutus* (Rüppell, 1837)**
  Very rare tropical Atlantic species; only a single specimen recorded in the Mediterranean, in the Gulf of Taranto, Ionian Sea (Pastore and Tortonese, 1984).

- **The great hammerhead *Sphyrna mokarran* (Rüppell, 1837)**
  Very rare, only a single specimen recorded in the Mediterranean in Camogli, Ligurian Sea, western Mediterranean (Boero and Carli, 1977), introduced probably via Gibraltar.

- **The honeycomb whipray *Himantura uarnak* (Forsskael, 1775)**
  Established Indo-Pacific species, introduced via the Suez canal first from Israel (Ben Tuvia, 1955); successive records in Mersin, Turkey (Ben Tuvia, 1966), Lebanon (Mouneinne, 1977), Egypt (El Sayed, 1994), Turkey (Basuta et *al*., 1998).

- **The Halave's guitarfish *Glaucostegus halavi* (Forsskäl, 1775)**
  Only a single record from the Gulf of Gabès (Tunisia) (Ben Souissi et *al*., 2007) is known. This record seems to be doubtful and a reconsideration of the specimen in question is necessary.

- **The torpedo ray *Torpedo (Torpedo) sinuspersici***
  Lessepsian species reported in the Mediterranean, in the Levantine Sea by Saad et *al*. (2004).

3.4 Spatial distribution of elasmobranchs in the GFCM area

Spatial predicted patterns of species richness in the Mediterranean Sea based on the AquaMaps model [80, and File S2] show that the concentration of rays and sharks occurred in coastal waters especially in the waters of Tunisia and Libya (Figure 3).

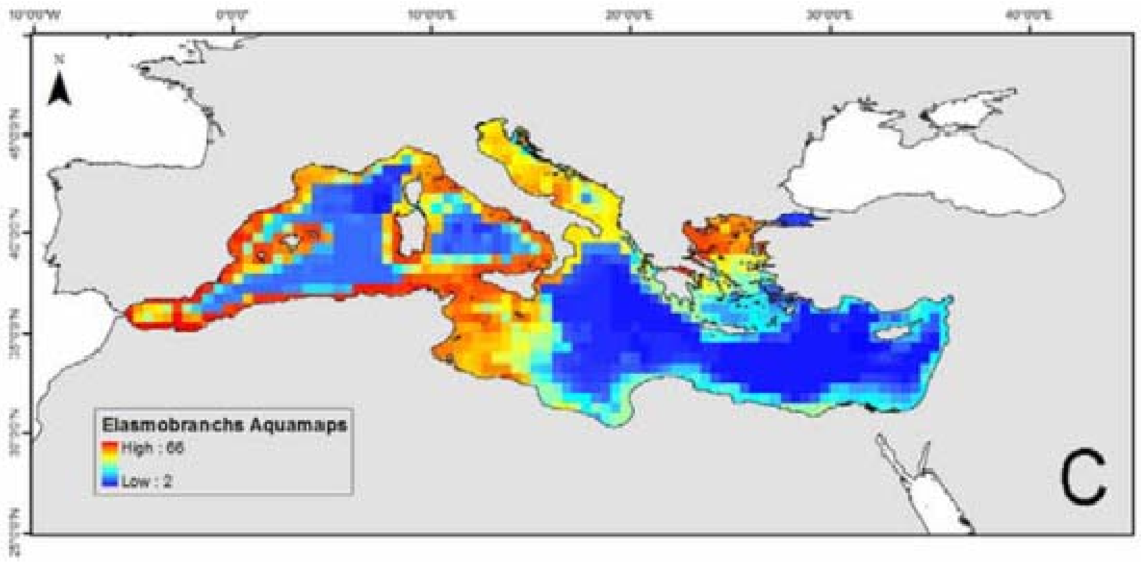


Figure 3 – Spatial predicted patterns of species richness in the Mediterranean Sea based on the AquaMaps model [80, and File S2]. (C) elasmobranchs (n = 74) map was generated without imposing a probability threshold. Colors express species occurrence from blue (little or no occurrence) to red (highest occurrence). The size of the cell is 0.5605 degree (Coll et *al*., 2010)

Within the Mediterranean, the distribution of elasmobranch fishes is not homogenous (Serena, 2005). Some areas are considered critical habitat for elasmobranchs. For example, Tunisian waters provide a nursery area for the great white shark *Carcharodon carcharias*, the sandbar shark *Carcharhinus plumbeus* and probably for many other species (Saidi, 2008 and Enajjar, 2009). Some species have a restricted range within the Mediterranean, for example a small population of the smalltooth sand tiger shark *Odontaspis ferox* seems to be resident in a particular area off Lebanon (Canavagh and Gibson, 2007). In the Adriatic Sea, the presence of cartilaginous fish species is scarce, especially in the northern part. The basking shark is a rather rare but constantly present species in the eastern Adriatic Sea. However, over the period 2000–2002 their occurrence in that area highly increased (Soldo et *al*., 2008). Besides its oceanographic characteristics that may limit biodiversity, this area was populated more recently than other parts of the Mediterranean. A total of 52 species of cartilaginous fish have been recorded in the Adriatic Sea. Only ten species are widely distributed. Some bathyal species of the group inhabit exclusively the central and southern parts of this sea (Serena, 2005). In the Black Sea, the number of cartilaginous fish species is lower. The Black Sea fauna is composed of Mediterranean species and most of the organisms present are eurythermic and euryhaline. Thirteen elasmobranchs species are assumed to live in the Black Sea (Serena, 2005). However, it should be noted that several species of elasmobranchs have been reported in the Marmara Sea which is with the Black Sea and Sea of Azov in the same FAO subarea: Black Sea subarea.

3.4.1 Precisions on the spatial distribution of some elasmobranchs species

- **The dusky shark *Carcharhinus obscurus***
  The species is an occasional transient within the Mediterranean. It was recorded in Malta (Fergusson and Compagno, 2000), in the Gulf of Gabès (Saïdi, 2008), in Syria (Saad et *al*., 2004) and in Palestine (Golani, 2005). Based on capture data, the species may occupy a wider range than supposed.

- **The bronze whaler shark *Carcharhinus brachyurus***
  The species was not cited along the oriental basin. Its occurrence in the Mediterranean Sea may be confined only in the occidental basin. It was recorded on the Algerian coast (Hemida et *al*., 2002), in the Balearic Islands (Moery and Massuti, 2003) and in Sardinian waters (Storai et *al*., 2007).

- **The sandtiger shark *Carcharias taurus***
  The occurrence of the species seems to be restricted to the occidental basin. However, the species is probably disappearing from the area (Fergusson et *al*., 2000).

- **The bramble shark *Echinorhinus brucus***
  In the oriental basin, the species occurred only in the northern coast of the Mediterranean Sea. It was recorded in the Sea of Marmara (Kabasakal, 2003). The species has not been observed along the southern coasts of the oriental basin.

- **The longfin mako *Isurus paucus***
  The species is rare in the area. It is accidentally caught.

- **The angel sharks *Squatina aculeata* and *S. Squatina***
  These two species occurred along all Mediterranean coasts. However we think that these squatinidae are disappearing from several areas.

- **The piked dogfish *Squalus acanthias***
  The species occurs along the occidental basin coasts and only along the northern coast of the oriental basin of the Mediterranean. The species is abundant in the Black Sea (Avsar, 2001; Ademürhan and Seyhan, 2006).

- **The Portugese dogfish *Centroscymnus coelolepis***
  The occurrence of this species may be restricted to the northern occidental basin. According to our investigations and also to the literature, there is no mention of this species along the North African coasts.

- **The bigeye thresher *Alopias superciliosus***
  The species may occupy all the Mediterranean Sea. It has been observed in Syria (Saad et *al*., 2004), the Ionian Sea and the Levantine basin (Megalofonou et *al*., 2005; Golani, 2005).

- **The guitarfishes *Rhinobatos Glaucostegus cemiculus / R. rhinobatos***
  These two species are common off the southern coasts of the Mediterranean and uncommon elswhere (no recorded in MEDITS campaigns) (Bertrand et *al*., 2000; Baino et *al*., 2001).

- **The marbled stingray *Dasyatis marmorata***
  Capapé (1989) suggested that in the southern Tunisian waters, *D. marmorata* undergoes competitive pressure from related dasyatid species. Consequently, it inhabits restricted areas in the Gulf of Gabès, entering a closed hyperhaline lagoon, the Bahiret el Biban (Capapé and

Zaouali, 1992, 1993, 1995). Nowadays, this species extends it distribution area (Enajjar, 2009; El Kamel et *al*., 2009; Golani and Capapé, 2004).

– **The shagreen skate *Leucoraja fullonica***
  L. fullonica is generally distributed in the western Mediterranean Sea and in the Atlantic Ocean from Iceland to Madeira and northern Morocco (Stehmann and Bürkel, 1984). Recently, Zupa et *al*. (2010) have recorded this species, easily misidentified with *Leucoraja circularis* Couch, 1838, in the southern Adriatic Sea.

3.5 Critical habitats of elasmobranchs in the GFCM area

Critical habitats should be identified for conservation purposes. In fact, a big lack of knowledge on critical habitats for this group was noted in the Mediterranean and Black Sea. However, some mapping of nursery areas and spawning ground for some species are being carried out by some countries.
Some areas are considered as critical habitats for chondrichthyans. For example, the Tunisian waters provide a nursery area for the white shark *Carcharodon carcharias* (centre of Tunisia) and for the sandbar shark *Carcharinus plumbeus* (Bradai et *al*., 2005) (Gulf of Gabès – south of Tunisia). This area seems to be also a nursery for many other elasmobranchs (Saidi, 2008 and Enajjar, 2009). However, a large knowledge on the presence of juveniles, gravid females and other biological parameters (i.e. size at first maturity) is srongly needed to identify a nursery area in order to make solid conclusions to restrict the areas to be protected, possibly in order to create MPAs, since the Gulf of Gabès is the most fished area in Tunisian waters.
Aggregations of basking shark *Cetorhinus maximus* have been observed in the northern Balearic region, the Northern Adriatic and the Tyrrhenian Sea (Walker et *al*. 2005).

3.6 Status of the Mediterranean elasmobranchs species in the IUCN Red List

Among 71 Mediterranean species, assessed within the framework of the IUCN red list (2007 regional assessment), 42.25 percent are vulnerable and endangered to critically endangered, 18.31 percent are Near Threatened (NT) and 25.35 percent are Data Deficient (DD) (Table l). The status of all species assessed is represented in appendix IV.

This assessment clearly shows the vulnerability of elasmobranchs and the lack of data on this fish group.

Table 1 – IUCN Red List of Mediterranean elasmobranchs species (Gibson et *al*., 2007)

IUCN Red List categories	Number of species
Critically Endangered (CE)	13
Endangered (E)	08
Vulnerable (VU)	09
Near Threatened (NT)	13
Least Concern (LC)	10
Data Deficient (DD)	18
Not Evaluated (NE)	0
Total number of species	71

4. ELASMOBRANCHS FISHERIES IN THE GFCM AREA

4.1 FAO statistics of elasmobranchs

Elasmobranchs fish species are exploited for their fins, skin, jaws or meat. Sometimes they are directly targeted by commercial and recreational fisheries while in other cases they are incidentally caught as bycatch. In the Mediterranean Sea, elasmobranchs fish catches represent only 1.1 percent of the total landings (Serena, 2005).

In many areas of the world such as the Mediterranean Sea, a decline in cartilaginous fish species landings has been observed while fishing effort has generally increased. The catches during the last 30 years show an increasing trend; 24 000 tonnes attained in 1983 and, since then, a regular decrease has been observed. The elasmobranchs productions in 2007–2008 reach about 7 000 tonnes annually (Figure 4). Sharks represent 1.3 times the production of batoids (Figure 4).

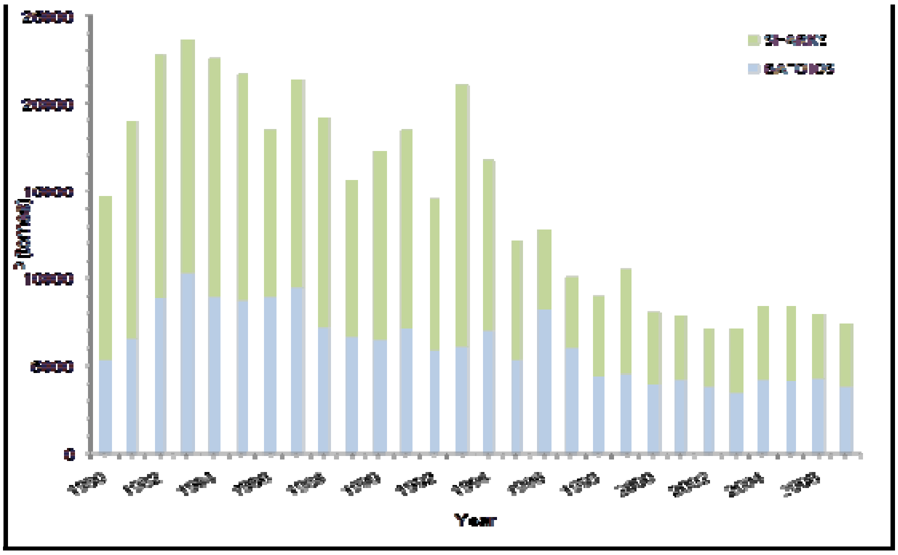


Figure 4 – Mediterranean and Black Sea trends of elasmobranchs catches from 1980 to 2008

Countries generally report shark statistics without distinction between species or, worse still, the species are not recorded at all. Moreover, FAO data only report official landings and therefore bycatch returned to the sea is not included. About 50 percent of the estimated global catches of elasmobranchs fish species is gathered as bycatch and these are not mentioned in official fishery statistics.

In order to improve statistics, the Workshop on selectivity improvement and bycatch reduction (Tunis, Tunisia, 23–25 September 2009) suggested that a protocol should be developed to collect and promote the collection of basic data on species of conservation concern. The aim of the protocol is to collect data which can then be fed into existing databases. The data collection is notably aiming to characterize and assess captures of species of conservation concern including unwanted species and size classes. The data is required by operational unit in order to fit into the GFCM Task I data matrix.

The Triakidae and Rajiiformes groups (without distinction of species) represent, on average, 70 percent and 87 percent respectively of sharks and batoids captured during the last 30 years in the Mediterranean and the Black Sea (Figures 5 and 6).

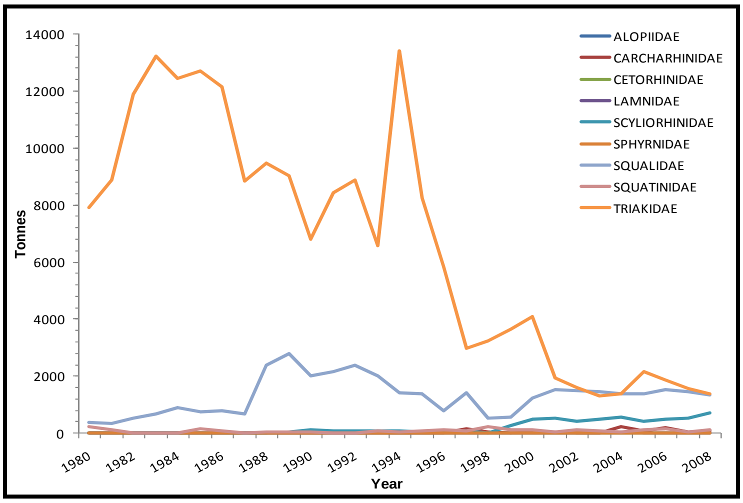


Figure 5 – Mediterranean and Black Sea trend of catches of sharks from 1980 to 2008

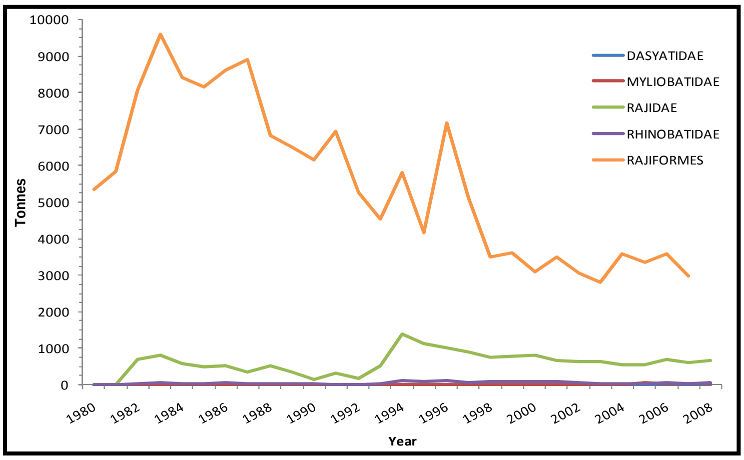


Figure 6 – Mediterranean and Black Sea trend of catches of batoids relatives from 1980 to 2008

The major elasmobranchs fishing countries within the Mediterranean are Italy, Turkey and Tunisia; they contributed on average with 76 percent in the production of elasmobranchs during the period 1980–2008 (Figure 7).

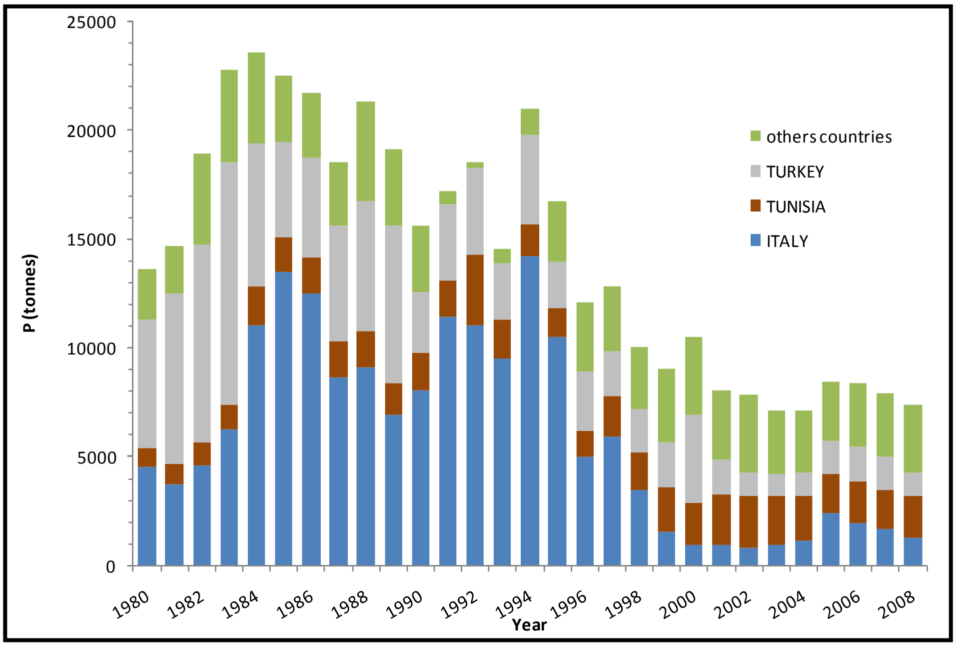


Figure 7 – Contribution of Italy, Turkey and Tunisia in the elasmobranchs production in the Mediterranean and the Black Sea from 1980 to 2008

Low production characterizes priority species of the GFCM (*Rostraraja alba*, *Isurus oxyrinchus, Lamna nasus, Prionace glauca* and *squatina squatina*); this represents about 250 tonnes for *Prionace glauca* and does not exceed tens of tonnes annually for the others species. Statistical information for *Mobula mobular* and *Carcharodon carcharias* are absent (Figure 8).
Raja clavata seems to be among the few species for which production is increasing. This relates to the new fishing habits ant not to the good status of the exploitation of the population (Figure 8).

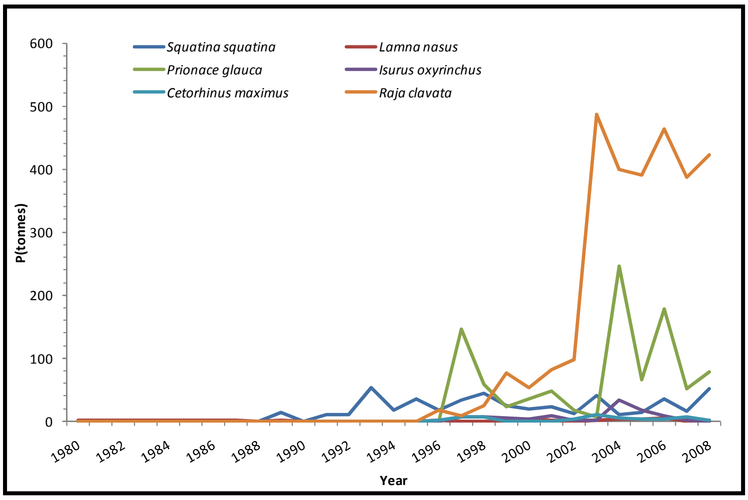


Figure 8 – Landings evolution of some elasmobranchs species in the Mediterranean and the Black Sea between 1980 and 2008

4.2 Fishing gears for elasmobranchs

In the Mediterranean, almost no elasmobranchs are subject to directed fisheries, but elasmobranchs constitute part of the bycatch in most local artisanal fisheries.

Catches of elasmobranchs primarily derive from two different fisheries: the pelagic artisanal fishery with longlines and gillnets, where smoothhounds are the most common group, and the demersal trawl fishery, where rays and catsharks constitute the main groups among elasmobranchs. In both cases, elasmobranchs represent only a bycatch, the longline fishery being directed to swordfish or tunas and the trawl fishery to various assemblages of finfish, shrimps and cephalopods.

4.3 Elasmobranchs bycatch

In recent years, bycatch has become one of the issues to be considered in any development of fisheries. Indeed, in addition to their biological and ecological impacts, incidental catches involve also a loss of biological resources (Hall et *al*., 2000). In 1994, FAO estimated that 27 millions of tonnes of marine products caught were not landed and were non-target species and particularly discards. This is mainly due to the low selectivity of fishing gear used. The bycatch of juveniles of commercial species may adversely affect future stock and catch levels (Hall et *al*., 2000). On the other hand, the ecological consequences of bycatch are worrisome when it comes to endangered species such as marine mammals, seabirds, turtles and elasmobranchs. These groups of species are very sensitive given their particular biological characteristics (Musick et *al*. 2000; Gilmen et *al*., 2006). Bycatch can induce imbalances between top predators and prey and consequently affect biodiversity (Hall et *al*., 2000). The biology of elasmobranchs, late sexual maturity, long life cycle, low fecundity, long lifespan and the fact that they are at the top of the food web, make them more vulnerable to fishing than most teleosts (Stevens et *al*., 2000).

Elasmobranchs in the Mediterranean are mainly coastal species (80 percent) and mostly benthic fauna, and this is likely to be affected by fishing activities, concentrated mainly in coastal areas. Several species (12 species) are pelagic. The species of depths (15 species) are particularly benthic. Target fishing of these species is unusual in these waters. Only a few species of elasmobranch are targeted. In the Mediterranean, more than 100 000 sharks are taken as incidental catch each year. The incidental catch of these species is highly variable in time,space and use of fishing techniques. However, the magnitude of these catches and discards is not well documented.
To this end, the incidental capture of elasmobranchs by commercial fisheries has been subject to a special attention in order to obtain a better knowledge of targeted and incidental catch of sharks and conservation of populations (IPOA–Shark, FAO, 1999).
In this part of the document dealing with elamobranchs bycatch, we analyse the available bibliographic data on this issue in the Mediterranean and Black Sea. Results are given according to geographic fishing areas, fishing gears and species or groups of species.

4.3.1 Elasmobranchs bycatch definitions

There are several definitions of what bycatch or incidental catch is:

- "That portion of the catch returned to the sea as a result of economic, legal or personal consideration plus the retained catch of non–target species" (McCaughran, 1992).
- "Animals other than the target species which are unmarketable because they are too small or for some other reasons" (Alverson et *al*., 1994).
- "That portion of the capture that is discarded at sea dead (or injured to an extent that death is the most likely outcome) because it has little or no economic value or because its retention is prohibited by law" (Hall, 1996).
- "All catches of sharks and rays in fisheries targeting other species" (Bonfil, 2005).

- "The total catches of unwanted animals including vulnerable and endangered species. By–catch of commercial species should be reported as associated species (associated species: commercial non targeted species)" (GFCM fisheries glossary).
- "Part of a catch of a fishing unit taken incidentally in addition to the target species towards which fishing effort is directed. It may be retained for human use or some or all of it may be returned to the sea as discards, usually dead or dying" (among other bycatch definitions in the FAO fisheries glossary).

In simpler words, these definitions say respectively that bycatches are:

- All discards plus retained non–target species;
- Discards of non target species;
- All dead discards.

In this document, we opt for the Bonfil definition. This definition is specific for elasmobranchs.

4.3.2 Literature dealing with fisheries and bycatch of elasmobranchs

Ninety-three papers were identified and analyzed in the context of this topic. They cover many aspects and approaches to fisheries. The chronology of appearance of publications shows that interest in the incidental catch is relatively recent; 7 papers before 1990, 14 in 1990s, 35 from 2000 to 2004 and 40 from 2005 to 2012 (Figure 9).

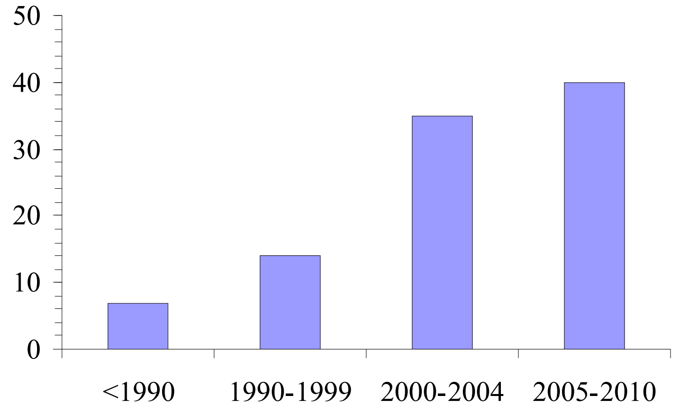


Figure 9 – Temporal distribution of the number of published papers dealing with elasmobranch bycatch in the region

Papers on this issue relate mainly to the western Mediterranean followed by the central Mediterranean on the one hand and trawlers followed by longlines on the other hand (Appendix II).

4.3.3 Elasmobranchs bycatch in trawl fisheries

All cartilaginous fishes are caught accidentally in most fishing gear in the Mediterranean (Cavanagh and Gibson, 2007) (Figure10). It seems that trawlers, longlines and nets pose the major threat.

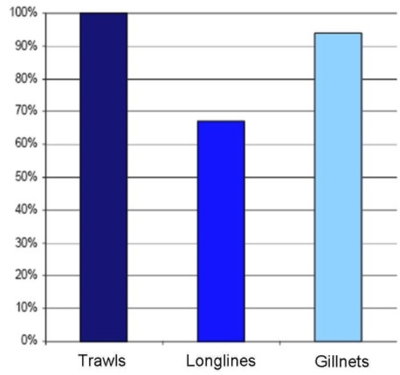


Figure 10 – Percentage of elasmobranch species (n=71) within the Mediterranean, for which bycatch in trawls, longlines and nets, pose a major threat (Cavanagh et Gibson, 2007)

Mediterranean trawling uses various techniques suitable for the production of benthic, demersal and pelagic species. It is practiced by a little more than 10 percent of the Mediterranean fleet. Trawlers contribute approximately to a little more than half of the landed catch, which underlines the importance of this activity.

This technique generates several problems: juvenile catches, important discards and negative impact on the environment (Sacchi, 2007). In the Mediterranean, discards constitute over 40 percent of the catch (Sanchez et *al*., 2004).

There is no fishery targeting elasmobranchs, but all species are mainly caught by this fishing gear; 62 species are listed in trawl fisheries in Greece, 62 in Catalonia and 74 in Italian waters (Bertrand et *al*., 2000). However, demersal species, particularly *Galeus melastomus*, *Etmopterus spinax*, *Scyliorhinus canicula*, *Mustelus sp* and rajidae, are most caught (Baino et *al*. 2001; Massuti and Morant, 2003). The proportion depends on the landed value of species and regions.
In Balearic Islands, *S. canicula*, *G. melastomus*, *E. spinax* represent 4.91 to 8.24 percent by weight of total catches (Carbonell et *al*., 2003). Discards from these species represent 1 to 6.5 percent. In the Alboran Sea, trawlers targeting the red shrimp *Aristeus antennatus*, catch more *G. melastomus* than the target species (Torres et *al*., 2001).

Among rays, it is noted that *Raja clavata*, *R. radula* and *R. miraletus* are the species most commonly caught in the Mediterranean trawling (Bertrand et *al*. 2000; Abella and Serena, 2005).

This technique generates occasional catch of pelagic sharks as *Alopias vulpinus*, *Prionace glauca*, *C. carcharias*, *I oxyrinchus* and rarely the basking shark *Cetorhinus maximus*. In the Mediterranean, 5 percent of the basking shark catches are reported in trawl fisheries (Mancusi et *al*., 2005). Furthermore, this gear generates capture of juvenile white sharks mainly in the central Mediterranean and especially in the Gulf of Gabès, where respectively 30 percent and 80 percent of the white shark and the Bluntnose sixgill shark *Hexanchus griseus* are caught by benthic trawlers (Saidi et *al*., 2007).
For this fishing gear, very often the information concerns a listing of species without an estimate of catch rates by fishing effort. Recently, preliminary information on this issue was reported in the Aegean Sea (Damalas et *al*., 2010) and in the Gulf of Gabès (Hamdaoui, 2010).

The number of individuals for each of the three species caught, percentage of total catch and their occurrence as well as abundance indices (mean CPUE) in the 342 hauls of the bottom trawl experimental surveys in the Aegean Sea (Damalas et *al*., 2010) were as follows:

Raja montagui	Spotted ray	405	0.08 percent	21.3 percent	1.7
Scyliorhinus canicula	Small-spotted catshark	10,909	2.21 percent	67.0 percent	46.2
Torpedo marmorata	Spotted torpedo	259	0.05 percent	21.9 percent	1.3

The study in the Gulf of Gabès shows that Elasmobranchs by catch averaged 5.42 percent of the total landing (1.7 percent sharks and 3.7 percent rays). Fishes, cephalopods and crustaceans represent respectively 74.15 percent, 12.32 percent and 9.4 percent of the total landings. The CPUE was estimated at 70.10 Kg/Landing (CPUE=23.25 Kg/landing for shark and 46.75 for rajiforms). The CPUE (Kg/landings) for the major elasmobranch families caught in the Gulf of Gabès by bottom trawlers are shown in table 2 (Hamdaoui, 2010).

Table 2 – CPUE (Kg/landings) for the major elasmobranch families

Families	CPUE
CARCHARHINIDAE	0.8087
TORPEDINIDAE	1.4407
SCYLIORHINIDAE	2.5908
RHINOBATIDAE	5.1687
SQUALIDAE	5.2494
RAJIDAE	14.0726
TRIAKIDAE	15.0187
MYLIOBATIDAE.	17.7554
DASYATIDAE	19.6659

Bycatch varies greatly, not only in terms of weight, but also in the number of species. The abundance indices (CPUE) was estimated for rare species; *Raja alba* (0.1 specimens/landing), *Gymnura altavela* (0.05 specimens/landing), *Heptranchias perlo* (0.05 specimens/landing), *Mustellus asteria* (0.019 specimens/landing), *Carcharodon carcharias* (0.014 specimens/landing).

The western bassin is relatively the most studied zone (Tyrrhenian Sea, Ionian, Aegean and the Balearics). On the southern side, apart from the Gulf of Gabès, studies of this issue are practically absent.

The sustained increase in trawl fishing effort appears to have contributed to a decline in biodiversity of the Mediterranean elasmobranchs (stock and habitat) (Aldebert, 1997; Peladic-Jukic et *al*., 2001).

4.3.4 Elasmobranch bycatch in longline fisheries

Several types of longlines are used in the Mediterranean. Depending on the species targeted, either demersal or pelagic, there are respectively bottom longline and surface longline. The surface longlines targets, according to the hook size and immersion depth, mainly swordfish (*Xiphias gladius*), albacore (*Thunnus alalunga*) and tuna. These lines generate significant bycatch of sharks.

At least 12 species of sharks (*Prionace glauca*, *Isurus oxyrinchus*, *Alopias vulpinus*, *Galeorhinus galeus*, *Lamna nasus*, *Alopias superciliosus*, *Sphyrna zygaena*, *Hexanchus griseus*, *Carcharinus plumbeus*, *Squalus blainvillei*, *Mustelus mustelus and Cetorhinus maximus*) are affected by surface longline (Di Natale, 1998; Mejuto et *al*. 2002; Megalofonou et *al*., 2005a, b). In addition, bycatch of young white shark (*Carcharodon carcharias*), *Dasyatis violacea* and *Mobula mobular* are also reported in longline fisheries in the Mediterranean (Filanti et *al*., 1986; Garibaldi, 2006; Peristeraki et *al*., 2007).

Generally, sharks are landed to be sold while rays are rejected for most at sea (Di Natale, 1998).

Bottom longlines incidentally bring several demersal species such as *Mustelus sp*, *Squalus sp*., *Torpedo* sp. and some *Rajidae* (Stergiou et *al*., 2002).

A study of pelagic longline fisheries in several northern Mediterranean areas has shown that sharks represent generally 6.2 percent by number and 13.5 percent in biomass in the total catch of these fisheries (Megalofonou et *al*., 2005b). For the study areas, the catch rate was the highest in the Alboran Sea (34.3 percent) followed by the Adriatic (15.11 percent). CPUE averaged 0.74 ind/1000 hooks (Megalofonou et *al*., 2005a, b). CPUE is higher in the Alboran Sea (3.8 percent ind/1000 hook) and Adriatic (1 ind/1000 hook) than in other areas (Megalofonou et *al*., 2005 b).

The importance of sharks in terms of weight in the catch varies with the type of longline; it represents 17.7 percent and 0.3 percent respectively in longline fisheries targeting swordfish and albacore (Megalofonou *et al*., 2005a, b).
Along the coast of Morocco, studies show that shark catches do not exceed 3 percent of total weight landed by surface longline (Srour and Abid, 2004).

In all areas studied, the blue shark, *P. glauca*, is the the most represented species in the catch of surface longline. It represents over 70 percent of the elasmobranchs catch. It is followed by mako *Isurus oxyrinchus*. It also seems that for all species, individuals captured in the Levantine basin are larger than those caught in the western basin of the Mediterranean (Megalofonou et *al*., 2005a, b).

Bottom longline catch especially batoids; in the Aegean Sea, the Rajidae (*Raja radula*, *R. clavata* and *R. miraletus*) represent 6 to 19 percent of the total catch. These rates vary with the hook size (Stergiou et *al*., 2002).

It is finally noted that studies of elasmobranch fishery bycatch by hooks are missing on the southern shore of the Mediterranean.

4.3.5 Elasmobranch bycatch in driftnet fisheries

A driftnet is a net held near the sea surface by floats and drifting with the current. It is most often attached only to the fishing vessel. The drift nets in the Mediterranean are used primarily for large pelagic (bluefin tuna, swordfish). Although banned now, few fleets Mediterranean (France, Italy, Morocco, and Turkey) continue to use it. They generate incidental catch of elasmobranchs (EJF, 2007). Morocco seems to be doing a lot of efforts to ban this net.

Incidental catches of large sharks (*Prionace glauca*, *Carcharhinus carcharias*, *Alopias vulpinus*, *Isurus oxyrinchus and Cethorhinus maximus*), the pelagic stingray *Pteroplatytrygon violacea* and the giant devil ray *Mobula mobular* have been cited in various driftnet fisheries (Di Natale et *al*., 1995; Silvani et *al*., 1999; Celona, 2004 and Tudela et *al*., 2005).

In the Strait of Gibraltar, the monitoring of Moroccan and Spanish driftnet fisheries reveals that elasmobranchs represent less than 1 percent of total catches (Silvani et *al*., 1999).

In Italian waters, CPUE was estimated at 0,005 specimen/km for *A. vulpinus*, 0.009 sharks/km for *P. glauca*, 0,001 specimens/km for *C. maximus*, 0.022 individuals/km for *P. violacea* and 0,005 individuals/km for *M. mobular*.

The monitoring of Moroccan driftnet fisheries reveals that in twelve months this fleet catch 20 000–25 000 pelagic sharks (*P. glauca*, *I. oxyrinchus*, *A. vulpinus*) in the Alboran Sea and from 62 000 to 92 000 individuals in the Strait of Gibraltar (Tudela et *al*., 2005). In the Ionian Sea, sharks represent

11.3 percent by mass of drift net catches (Megalofonou et *al*., 2005). CPUE represents 0.04 individuals/km of net.

For the basking shark *C. maximus*, driftnets contribute to about 1 percent of total catch (Mancusi et *al*., 2005).

4.3.6 Elasmobranch bycatch in trammel nets and gillnets fisheries

Trammel nets and gillnets are the nets most commonly used by small Mediterranean fisheries. These nets are often used at night. The length of set nets depends on the size of the fishing boat.

In the Mediterranean, there is a little use of gillnet targeting sharks. We mention a spring artisanal fishery targeting hound sharks *Mustelus sp.* and dogfish sharks *Squalus sp.* in the north of the Adriatic Sea and one in the Gulf of Gabès targeting *Mustelus sp.*, *Carcharhinus plumbeus* and *Rhinobatos sp.* (Bradai et *al*., 2006). The mesh size varies from one group of species to another. However, these nets bring several other non-target species: species *Scyliorhinus canicula*, *Squalus acanthias*, *S. stellaris*, *Myliobatis aquila*, *Pteromylaeus bovinus Galeus melastomus*, *Centrophorus granulosus Carcharhiuns sp*. *Dasyatis sp.* (Costantini et *al*., 2000 and Morey et *al*., 2006).

Regarding trammel nets, monitoring of fisheries in the Balearic islands shows the capture of 12 species of elasmobranchs (ten sharks and two rays) representing 10 percent in abundance and 28 percent in biomass of the total catch. The most common species are *Dasyatis pastinaca*, *Raja radula* and *Torpedo marmorata* representing respectively 48 percent, 24 percent and 15 percent of catches of elasmobranchs (Morey et *al*., 2006).

In the Aegean, elasmobranchs (mainly Rajidea) represent 6 percent to 10 percent by weight of total catches of trammel (Stergiou et *al*., 2002).

Trammel nets contribute by 30 percent of the total catch of basking shark in the Mediterranean (Mancusi et *al*., 2003).

4.3.7 Elasmobranch bycatch in purse seine fisheries

The purse seine is constituted by a long net made of a series of layers of different mesh sizes with floats on the headline and weights attached to the bottom rope. The codend or "pocket" is located at one end.

Although there is little information available in the literature on the bycatch of encircling nets, these nets occasionally catch pelagic sharks and stingrays in fisheries of the bluefin tuna and small pelagic (Hattour et *al*. , 2000; Fromentin and Farrugio, 2005). In the central Mediterranean over 70 percent of the white shark catches are reported to the purse seine (Fergusson, 1996, Saidi et *al*., 2005). Other species are also reported in the catch, *Isurus oxyrinchus*, *Cetorhinus maximus* and *Alopias vulpinus*.

4.3.8 Elasmobranch bycatch in tuna trap fisheries

These fixed fisheries are placed along the coast, on the passage of migratory species, especially bluefin tuna as they approach the shore. These structures were distributed along the Mediterranean coast, mainly from Italy, but today and after the fall of their productions, many have been abandoned. Some, however, currently remain on the main islands of Italy and Tunisia. Incidental catches of sharks are historically reported (Vacchi et *al*., 2000).

Recent observations show that at least three species of large pelagic sharks are caught in traps. They are the white shark *Carcharodon carcharias*, the mako shark *Isurus oxyrhincus* and the thresher shark *Alopias vulpinus*. In the trap of Sidi Daoud, north of Tunisia, sharks represent 0.3 and 2.3 percent in biomass of total catch (Hatour et *al*., 2004).

4.3.9 Suggestions for reducing the bycatch of elasmobranchs in trawl fisheries

The use of Bycatch Reduction Devices (BRD), similar to those used for marine turtles, TED (Turtle Excluding Device), could be an effective solution for the escape of unwanted animals (Ferretti and Myers, 2006).
These exhaust systems placed in front of the codend and involving a rigid grid splitter and an escape preferably oriented toward the bottom have been successfully tested in Australian fisheries. Among these systems, we cite the NAFTED, Super shooter TED used for turtles, sharks and rays and the SEYMOUR, which is more suitable for large individuals. These systems are effective in reducing the catch of large animals but also small fish, and they can therefore represent significant commercial losses.

4.3.10 Suggestions for reducing the bycatch of elasmobranchs in gillnet fisheries

Based on experiences undertaken in North Carolina on bottom gill nets, it is suggested to increase the tension of nets to reduce catches of sharks. The tension of the net could be amplified by increasing the weights and buoyancy and by adding more floats. The impact on commercial production should be evaluated.

4.3.11 Suggestions for reducing the bycatch of elasmobranchs in longlines fisheries

On the basis of experiences gained in several longline fisheries (Gilman et *al*., 2007), the following recommendations are important:

– Setting longline at day and by depth. In fact the main species of pelagic sharks and stingrays *Dasyatis sp.* are usually taken in surface waters (Williams 1997) and shark activity is generally nocturnal. This recommendation runs counter the conservation of seabirds.

– Avoid attracting sharks and rays by avoiding jettison of waste, viscera and unmarketable fish to not attract night eaters, as are most elasmobranchs.

– Reduce setting time, so that elasmobranchs are attracted in large numbers by the captured preys.

– Avoid certain types of bait which may be more attractive than others; several observations made by professionals have shown that sharks are more attracted by squid than fish. To avoid catching rays and sharks, mackerel or horse mackerel should be used instead of sardines.

– Furthermore, the development of artificial bait may contribute favourably to the reduction of catches of sharks and rays (Erickson et *al*., 2000).

– Reduce the mortality induced by fishing operations. Since the majority of elasmobranchs caught by longline are alive at the time of retrieval of longlines, theyshould be released immediately if possible. In general, the use of monofilament that sharks can more easily cut is preferable to any other type of synthetic braided fibres or steel (De la Serna et *al*., 2002).

– Repel elasmobranchs baited hooks. Pre-treatment of baits with synthetic substances could keep out carcharhinid without affecting other fish (Tachibana and Gruber, 1988).

– Small magnets in alloy steel, neodymium and boron would be able to keep away small sharks and rays of baited hooks (Gilman, 2007).

Many other management tools and technical procedures could be suggested to reduce bycatch:

- **Size limits**
  Size limits can be legal minimum sizes or legal maximum sizes. They can be an effective management measure where sharks are landed from the fishing gear live and in condition where the survival rate of released animals is high. Hence, they are effective for many species that survive release from hooks, seine nets, and fish traps, but are not effective for many species released after capture by gillnets and trawls where survival rates are low.

- **Reducing effort**
  This limitation reduces bycatch in the same proportion as the effort reduction and can be obtained by (1) a limited number of licenses to take fish (2) reducing fishing time (3) restricted capacity of the fleet. These measures are often incompatible with the social objective of providing employment for fishing communities.

- **Regulations on fishing gears**
  Regulations on fishing gears can be used to control fishing mortality, impacts on habitats and ecosystems, and the food quality of retained fish. Regulation is efficient in capturing target species while avoiding small animals to minimize growth overfishing and large breeding animals to minimize recruitment overfishing of the species.

- **Marine Protected Areas**
  It is widely recognized that, in order to achieve biodiversity conservation and recovery of species populations, an overall reduction of trawling effort must be made, involving the closure of fishing areas and creating Marine Protected Areas (MPAs), the most restrictive measure (Fogarty 1999, Lubchenco et *al*., 2003). Existing studies indicate that well managed networks of Marine Protected Areas could save ecosystems from several threats such as climate change and fisheries, protect habitats and allow species to use these habitats for feeding or reproduction (Parnell et *al*., 2006). MPAs are an essential tool for marine conservation in the sense that they are designed to protect pristine areas which are sensitive to human activities and to protect communities from further degradation (Allison et *al*., 1998; Sainsbury and Sumaila 2003). Marine Protected Areas can be efficient to manage sharks fisheries (to protect nursery area, parturition zones, etc.).

- **Temporary closure of fishing areas**
  Temporary closure of fishing areas can be efficient to reduce capture at critical stages of the life history of the species (new born, pregnant females, etc.).

5. DYNAMIC POPULATIONS AND STOCK ASSESSMENT OF ELASMOBRANCHS/ABUNDANCE INDICES

Population dynamics and demographic of elasmobranch fishes are poorly understood worldwide. The paucity of knowledge is due to the difficulty in studying elasmobranch populations and assessing their sizes and to the lack of basic biological and ecological information for numerous species (mainly age and growth parameters).

In the Mediterranean Sea, there are no standardised studies on elasmobranch population dynamics. However, some assessments, based on abundance indices such as elaborated within the framework of MEDITS bottom trawl surveys, are available. Various studies give data on species richness, population structure, distributional pattern, mean catch rates, abundance and biomass, mean weight for many species.

References inventoried on this issue are: 8, 17, 22, 23, 77, 306, 323, 345, 370, 406, 428, 430, 449, 475, 508, 532, 539, 540, 543, 574, 578, 582 and 583 (Appendix I). These references concern the northern part of the Mediterranean.

Among all species, *Galeus melastomus*, *Scyliorhinus canicula*, *Etmopterus spinax*, *Squalus acanthis*, *Raja asterias* and *Raja clavata* are the more studied. Biomasses and abundance indices (kg/km^2 or $individuals/mm^2$) are relatively important for four species: *Etmopterus spinax*, *Scyliorhinus canicula*, *Galeus melastomus* and *Raja clavata*. These species were abundant everywhere in the studied area, i.e. European coasts, northern Mediterranean (Baino et *al*., 2001; Baino and Serena, 2005; Bertrand et *al*., 2000; Rey et *al*., 2004). Series of data based on the MEDITS programme are too short to identify specific trends in species abundances (Bertrand et *al*., 2000). This programme should be extended to the entire region.

Indices of abundance expressed in CPUE are developed in the bycatch section of this document.

5.1 Landings structure of some common elasmobranchs in the Mediterranean

There is evidence that the elasmobranchs of the Mediterranean are declining in abundance and diversity. Their biological characteristics (low fecundity, late maturity and slow growth rates) make them vulnerable to fishing pressure mainly at juvenile stages. A big proportion of landed specimens are generally juvenile. The following studies illustrate clearly this issue.

The size composition of the most bycaught species varies with gears types. Trawls tend to catch more juvenile specimens than longline. Figure 11 shows the landings structure of *Mustelus mustelus* in trawling and longline fisheries of the Gulf of Gabès. Trawl catch consists mainly of immature individuals while longline catches more mature ones.

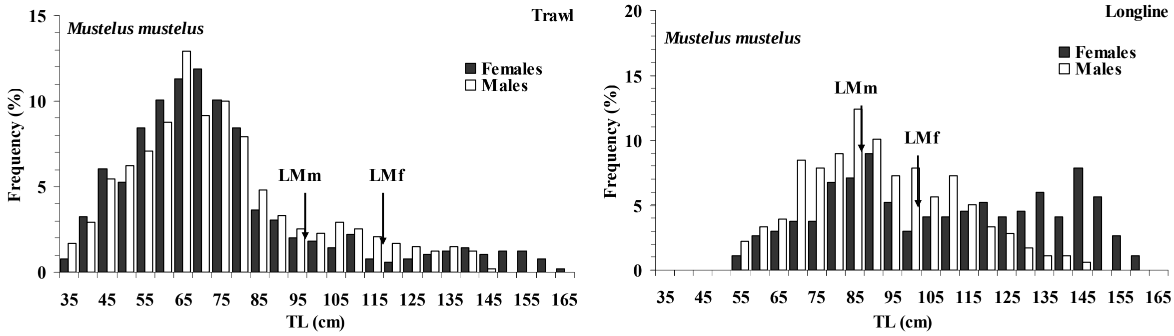


Figure 11– Size distribution in trawl and longline landings of *Mustelus mustelus* in the Gulf of Gabès. LMm and LMf: Size at first maturity respectively of males and females (Saidi, 2008)

In Italian waters, trawling captures demersal species at different stages. All immature individuals of *S. canicula* are discarded while some immature individuals of *R. clavata* are landed. Almost, all specimens of *R. asterias* are immature (Figure 12).

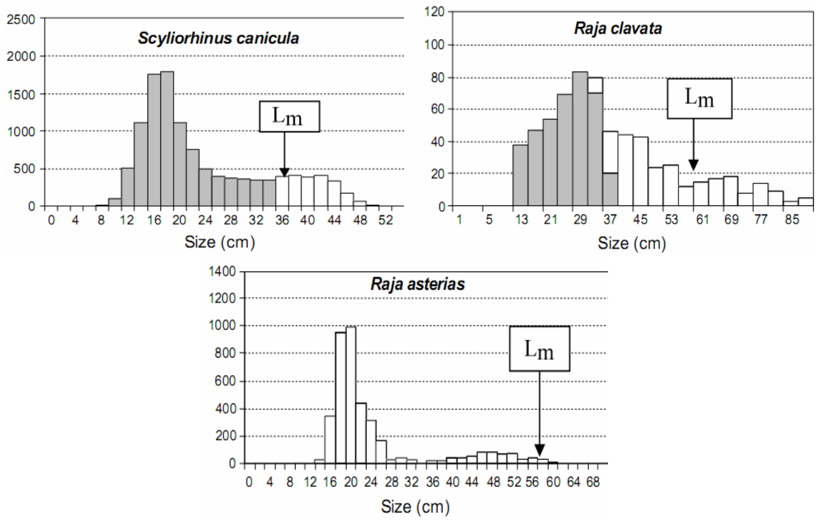


Figure 12 – Size distribution in the trawl catches of *S. canicula, R. asterias* and *R. clavata* (Abella and Serena, 2005). Dark bars: discarded fraction; Lm: size at first maturity of females

In the Gulf of Gabès, gillnet catches of *Glaucostegus cemiculus* consist mainly on adults, whereas juvenile and subadult specimens are more frequent in trawl fisheries (Figure13).

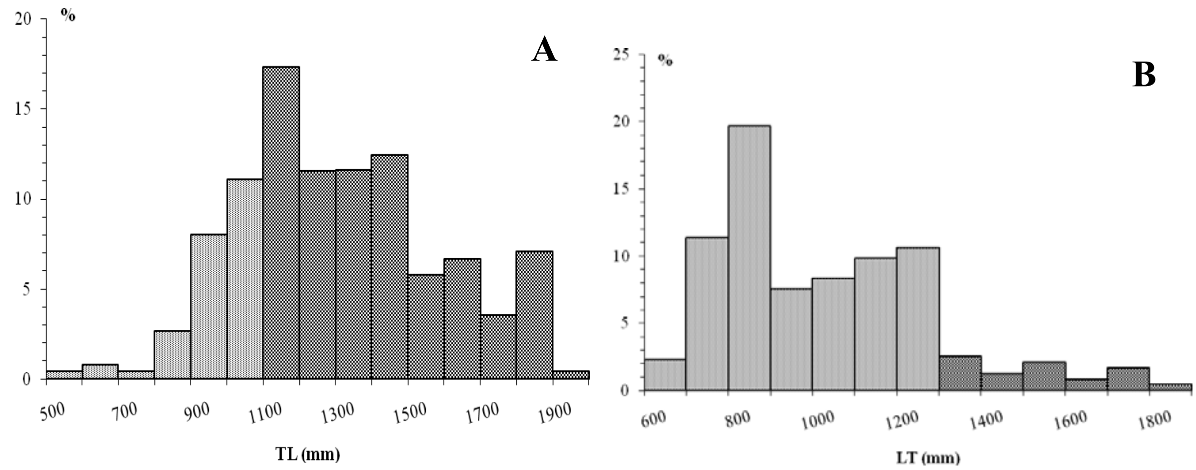


Figure 13 – Size distribution in gillnets (A) and trawl (B) landings of *Glaucostegus cemiculus*. Dark bars indicate the landed mature individuals (S. Enajjar, personal communication, 2009)

The length frequency distribution of large pelagic sharks caught incidentally in the swordfish and tuna fisheries of the Mediterranean Sea show that catch consist mainly of juveniles (Figure14).

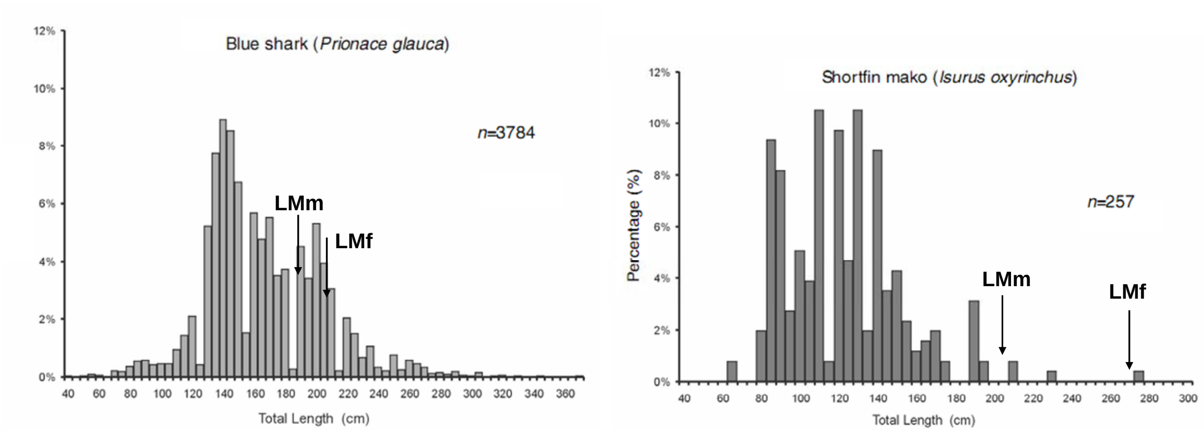


Figure 14 – Length–frequency distribution (in percentage by 5-cm size classes) for *Prionace glauca* and *Isurus oxyrinchus* sampled in the Mediterranean swordfish and tuna fisheries during 1998−2000 (Megalofonou et *al*., 2005)

Size distributions of species show that over 70 percent of landed specimens are immature (except for gillnet landings).

5.2 Landings of common elasmobranchs in the Black Sea

Regarding the lack of information on elasmobranchs in the Black Sea and the few species occurred in this region, we have summarized knowledge on the three main species – *Raja clavata, Dasyatis pastinaca* and *Squalus acanthias* – in some Black Sea countries, following mainly the proceedings of the Workshop on demersal resources in the Black Sea and Azov Sea edited by Ozturk and Karakulak (2003) and the CMS meeting document (MOS1/Inf.5.1) (Radu, 2010). Some papers available in Russian were not analyzed in this document.

***Squalus acanthias,* spiny dogfish**

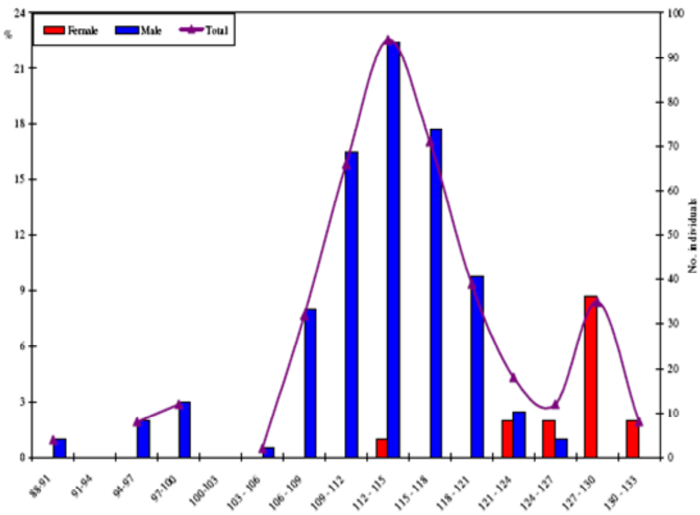
In the Black Sea, the largest catches of spiny dogfish are recorded along the coasts of Turkey, as bycatch in trawl and purse seine fisheries, mainly in winter. Between 1989 and 1995, annual catches varied from 1 055 to 4 558 tonnes (Shlyakhov and Daskalov, 2008). In subsequent years, landings have decreased about 2 times and did not exceed 2 400 tonnes. In Ukraine, spiny dogfish is harvested in spring and autumn months as targeted fish in gillnets 100 mm mesh size and longlines, and as bycatch of sprat trawl fisheries. As in Turkish waters, the maximum annual catches, reaching 1 200–1 300 tonnes, were observed in the period 1989–1995. After 1994, catches decreased representing between 20 and 200 tonnes. In the last 20 years, spiny dogfish lost its commercial importance, the decrease in landings may be due to overfishing.

In other Black Sea countries, spiny dogfish is harvested mainly as a bycatch; annual catches are usually lower than those in Ukraine (Daskalov et *al*., 2009 and 2011; Shlyahov and Daskalov, 2008). The maximum annual catches of spiny dogfish in the period 1989–2005 were: 126 tonnes (Bulgaria), 550 tonnes (Georgia), 52 tonnes (Romania) and 183 tonnes (Russian Federation). It should be noted that in the waters of Bulgaria and Romania, the highest catches were observed in the early 2000s (BSC, 2008). In Romania, catches decreased very much because of decreasing of the trawling effort (Maximov et *al*., 2006 and 2010; Radu et *al*., 2011a and 2011b; Radu, 2011). The landings of spiny dogfish by countries are given in table 3.

Table 3 – Spiny dogfish landings by Black Sea countries (FAO Fisheries Statistics, BSC statistics)

Year	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
1989	28	217	30	135	4558	1191
1990	16	128	45	183	1059	1330
1991	21	18	26	67	2017	775
1992	15	14	52	15	2220	595
1993	12	131	6	5	1055	409
1994	12	45	2	11	2432	148
1995	80	31	7	90	1562	67
1996	64	71	-	19	1748	44
1997	40	1	-	9	1510	20
1998	28	550	-	6	855	38
1999	25	18	-	9	1478	94
2000	102	21	-	12	2390	71
2001	126	27	-	27	576	134
2002	100	65	-	19	316	97
2003	51.3	40	-	29	1840	172
2004	47.2	31	-	34	111	93
2005	14.5	35	5	19	102	75
2006	6.226	10	9	17	193	67
2007	23.98	2	17	28	91	45
2008	22.75	-	10	59	35	79
2009	9.46	-	4	14	156	47
2010	-	-	3	8.5	16	27

In Romanian waters, structure analysis of length and mass classes of spiny dogfish revealed the presence of large specimens, ranging from 90 to 130 cm in length (Figure 15) , and from 3 000 to 1 4950 grammes in mass, the dominant classes were 109–121 cm / 5755–7990g, the average of body length was 114.91 cm and average of body weight was 7 388 grammes. The sex ratio was significantly in favour of males; 84.29 percent were males and 15.61 percent were females (Radu, 2010) (Figure 15).



Lengh classes

Figure –15 Length frequency of spiny dogfish landed in Romania in 2010 (Radu, 2010)

Raja clavata

Raja clavata is a demersal predator species. Commercially, the thornback ray is of secondary importance. It makes up to some extent the Turkish fishery and also appears as a bycatch in the fisheries of Ukraine and Russia.

In the Russian part of the Black Sea, it occupies different ecological niches. Its stock represents about 800 tonnes. Rays are usually caught together with dogfish and flounders.

The mean landing of the thornback ray, during the period 1925–2002, amounted to 1.2 tonnes in Bulgarian waters.

In Ukrainian waters, the bycatches of thornback ray varied within the range 0.3–0.6 thousand tonnes, the stock of this species was assessed through the VPA method using the ANACO software produced by FAO (Shlyakhov, 1997; Shlyakhov and Lushnikov, 1995). For the subsequent years, the intensity of the coastal fisheries became so low that the application of this method was incorrect. For some years, the stock of thornback ray was assessed by trawl surveys data, however, due to the underrecording of fishes in small depths, these assessments were underestimated (Table 4).

Table 4 – Available data on commercial stock (thousand tonnes) of thornback ray in the Ukrainian Black Sea

Years	stock	
	VPA	Trawl survey
1992	2.6	1.1
1994	–	0.9
1998	–	1.0

Dasyatis pastinaca
With water warming in spring, common stingray comes to the coastal shallow water for reproduction and feeding. It belongs to viviparous fish; neonates are born at temperature more than 15°C. It distributes with maximum density in Kalamitsky and Karkinitsky Bays by 5–30 m depth.

Fishing area and gears targeting common stingray are the same used for spiny dogfish.

The common stingray *Dasyatis pastinaca* have no commercial importance due its low market demands in the Bulgarian and Ukraine Black Sea. However, bycatch of this *Rajiforme* in trawls is inconsiderable and usually discarded.

5.3 Stock assessment of selected species of elasmobranchs in the GFCM area

Studies on stock assessment require information on both the fish population and the fishery, but in the case of elasmobranchs species, most of the times such information is lacking or is partial. In general, several problems make the stock assessment of elasmobranchs difficult:

a- Lack of information on fish population

- Difficulties in species identification due to misidentification and/or lack of complete recordings;
- Difficulties in estimating age and growth, as we must use the vertebrae or spines instead of otoliths or scales of bony fish;
- Difficulties in estimating mortality due to data shortage, small catches and age determination;
- Difficulties to estimate fecundity (total number of eggs/embryos that will successfully develop up to hatching). The number of eggs or new born individuals that a female produces is relatively small. The annual average offspring can be from only one to about 300;
- The modest number of individuals caugh by species and the lack of reliable information on size structure, total catches and directed effort make sometimes unsuitable the use of traditional production models, VPA or of many other approaches for stock assessment.

b- Lack of information on the fishery

- In the Mediterranean, few fisheries are targeting elasmobranchs.
- Elasmobranchs are mainly a bycatch of demersal and pelagic fisheries.
- Due to their low commercial interest most of them are discarded.
- There is a lack of recording of landings and discards of elasmobranchs.
- Existing misidentification and recording of landings in large statistical categories.

Taking into account the paucity of knowledge on this issue, as mentioned above, the GFCM has organized, within the framework of the medium-term working programme on elasmobranchs (2010–2012), a Workshop on Stock Assessment of Selected Species of Elasmobranchs in the GFCM area, in Brussels, Belgium, from 12 to 16 December 2011. The workshop aimed to identify appropriate methodologies and approaches to assess the stocks of selected commercial species and required action for the following years. In this section of the document, we compile information and data presented or performed during the workshop, referring to the report of the meeting of the workshop (GFCM:SAC14/2012/Inf.16).

5.3.1 General review on the available methods for stock assessment, especially in data shortage situations

Several types of models have been used for stock assessment, presenting advantages and disadvantages and the choice of which depends on available data. The most complex model is the most data demanding. A summary of different options and data requirements is presented in table 5.

Table 5 – Models used and data requirements for stock assessment
(GFCM:SAC14/2012/Inf.16)

METHOD	DATA sources	Parameters for input	Parameters in output	Reference Point	Software (free shared)	Complexity
VPA, Statistical catch–at age	Commercial data	Total catch by age, M, terminal F	F vector, Numbers at age, Recruitment	Trends	XSA(Lowestoft) VPA (NOAA), others	High
Surplus Production Models	Commercial data	Catch and effort or Catch and Biomass	r, K, q, F per year, etc	fMSY, FMSY, BMSY	ASPIC (NOAA), Spreadsheet (GFCM) CEDA (FAO)	Medium
Yield per Recruit, S/R	Parameters derived from biological sampling studies	L∞; K, to, L/W a and b, M; Lc or selectivity, Lm or maturity ogive	Y/R vs F SSB/R vs F	F0.1, Fmax, Fxpercent SSB	FISAT (FAO), YIELD (FAO), YPR length(NOAA), YPR age(NOAA)	Low
Life tables and Leslie matrices	Biological sampling	Fecundity at age, Survival at age, M	r, net reproductive rate, generation time, etc	Frepl (r=0)	PopTools http://www.cse.csiro.au/poptools/	Low
Surplus Production Models using fishery independent data	Trawl surveys size structure by year and catch per unit of area	M, Z and index of abundance	r, B' (index of Carrying capacity)	FMSY	Excel spreadsheets files	Low
Mortality estimates using trawl surveys	Trawl surveys size distribution by year	Size distributions, M, catchability at age	Z, tm, F, Recruitment per year, SSB per year	Trends	SURBA Coby L. Needle FRS Marine Laboratory Aberdeen	Low
LCA	Commercial catch	Size distribution of commercial catch, M, growth parameters	Vector of F, Numbers at sea, recruitment	Trends	VIT (Lleonart & Salat, 1992) FISAT (FAO) LFDA (CEFAS)	Low
Collie–Sissenwine method	Commercial catch and surveys data	Catch by age and abundance indices of trawl surveys separated by recruits and older inds.	Abundance and mortality rates	Trends	CSA (NOAA)	Medium

5.3.2 Stock assessments of some elasmobranchs species

Several models and software were explored during the workshop and some species were selected to be assessed in the workshop, coming from five areas: *Squalus acanthias* in the Black Sea, *Scyliorhinus canicula* in Algeria, *Glaucostegus cemiculus* in the Gulf of Gabès, Tunisia, and *Raja clavata* in Malta and South Sicily, Italy. Results were preliminary and needed improvement.

Table 6 summarizes the assessments of the elasmobranchs species presented and/or performed during the workshop.

Table 6 – Stock assessments of some elasmobranchs species in the GFCM area (GFCM:SAC14/2012/Inf.16)

* Assessments performed during the practical session of the Workshop/ Assessments presented during the Workshop)

Stock	GSA	Data	Method & Software	Reference Point	Stock Status	Advice & Recommendation
***Raja asterias*◦**	**9** Ligurian and North Tyrrhenia n Sea	Abundance indices from 28 years trawl surveys and 20 years of commercial catch. Age structure of commercial catch 2 yrs. Biological parameters. Natural mortality, fecundity at age	Frm=0 with Leslie matrix, Z with catch curve,and F0.1 with Y/R Software: poptools and YPR NOAA	Frm=0 F30%SSB and F0.1	in overfishing status	Reduction of F
***Raja clavata*◦**	**9** Ligurian and North Tyrrhenia n Sea	Size composition from trawl surveys and 20 years of abundance index of commercial catch. Biological parameters. Growth, natural mortality, fecundity at age	Frm=0 with Leslie matrix, Z with SEINE and F0.1 with Y/R Software: poptools and YPR NOAA	Frm=0 F30%SSB and F0.1	in overfishing status	Reduction of F
***Scyliorhinus canicula*◦**	**9** Ligurian and North Tyrrhenia n Sea	Size composition from trawl surveys and 2 years of commercial catch. Biological parameters. Growth, natural mortality, fecundity at age	Frm=0 with Leslie matrix, Z with SEINE and F0.1 with Y/R Software: poptools and YPR NOAA	Frm=0 F30%SSB and F0.1	in overfishing status	Reduction of F
***Galeus melastomus*◦**	**9** Ligurian and North Tyrrhenia n Sea	Size composition from trawl surveys and 2 years of commercial catch. Biological parameters. Growth, natural mortality, fecundity at age	Frm=0 with Leslie matrix, Z with SEINE and F0.1 with Y/R Software: poptools and YPR NOAA	Frm=0 F30%SSB and F0.1	in overfishing status	Reduction of F
***Raja clavata*◦**	**15,16** Malta Island and South of Sicily	Size distribution and abundance index from trawl surveys. Biological parameters. Growth curve, L/W, M	Catch curve and Y/R analysis Software: LFDA and Yield of CEFAS–FAO	Fmax, F0.1, F30%SSB	in overfishing status	Reduction of F
Scyliorhinus canicula*	**4** Algeria	Size distribution and abundance from trawl surveys. Biological parameters. Growth curve, L/W, M	Catch curve and Y/R analysis Software: LFDA and YPR NOAA	Fmax, F0.1, F30%SSB	in overfishing status	Reduction of F
***Glaucostegu s cemiculus* ***	**14** Gulf of Gabes	Size/Age distribution commercial catches, trawl surveys, Biological parameters. Growth curve, L/W, M, fecundity	Catch curve and Y/R analysis Software: VIT and YPR NOAA	Fmax, F0.1, F30%SSB	Under exploitation status	no recommandations
Squalus acanthias*	**29** Black Sea	Size/Age distribution commercial catches, trawl surveys, Biological parameters. Growth curve, L/W, M	Catch curve and Y/R analysis Software: VIT and YPR NOAA	Fmax, F0.1, F30%SSB	uncertain considering the highly variable natural mortality along time series	Enhance the knowledge on influence of environment and species interactions on abundance and survival

6. AVAILABLE BIOLOGIC PARAMETERS ON ELASMOBRANCHS IN THE GFCM AREA

The bibliographic research highlighted a lack of aggregate knowledge on the biology of elasmobranchs in many parts of the Mediterranean.

6.1 Available data on the reproductive biology of elasmobranchs

One hundred thirty-four references dealing with the biology of the reproduction were inventoried but only 97 papers report detailed data on reproductive parameters, while the others give some general information. About 50 percent of these papers were published in the latest decade (Figure 16) mainly in the western Mediterranean (Appendix II).

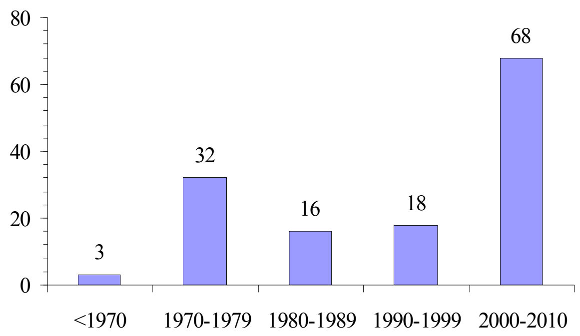


Figure 16 – Chronological apparition of papers on the elasmobranchs reproductive biology in the GFCM area

Information on the biology of the reproduction is available for only 43 species, 33 viviparous and 10 oviparous. The main reproductive parameters are summarised in tables 7 and 8. Studies were carried out mainly in the western Mediterranean and in its central part.

Table 7 – Available reproductive parameters of viviparous elasmobranch species in the GFCM area. Litter size corresponds to uterine. PCL: Pre Caudal Length, DW: Disk Width, TL: Total Length

Scientific name	GSAs	Sex	Size at maturity, (cm TL/DW)	Gestation time (Months)	Reproductive periodicity	Litter size	Size at birth	Reference Number
Heptranchias perlo	12	M	81–92	10	annual	6–18		120
		F	85–100					
Hexanchus griseus	Med	M	300–354	12?	annual?		55.6–68	31/155/382/384
		F	394					
Mustelus asterias	12	M	60–75	12	annual	10–35	28–32?	124
		F	90–96					
Mustelus mustelus	12/17/14	M	96–118	11–12	annual	4–22	34–42	82/237/552/556
		F	108–123					
Mustelus punctulatus	12/14	M	75–90	11–12	annual	5–30	24.5–30.5 (40–43)	175/552/557
		F	87.5–100					
Galeorhinus galeus	4/12/14	M	113–126	12	alternate years	8–41	24–32	142/168
		F	125–140					
Carcharhinus brevipinna	4/12/14	M	172	13–14?	annual?	6–10	61–69	157
		F	196					
Carcharhinus limbatus	4/12/14	M	167	12	biannual	6–8	61–65	187
		F	178					
Carcharhinus plumbeus	14/27	M	160–166	12–14	biannual	3–14	50–65	25/127/552/260
		F	170–172					
Prionace glauca	18,19,20, 21;22, 23,24	M	187–203	–	–	–	–	450/451
		F	203–214.7					
Alopias vulpinus	1/3	M				3–7	117–155	472
		F						
Oxynotus centrina	12/22	M	60	–	annual	10–15	21–24	188/488
		F	65					
Centrophorus granulosus	6/12/23/27	M	74.5–80	–	–	1	27.3–37.2 (PCL)	12/334/ 336/447
		F	80–85					
Squalus blainvillei	23/14/12 /19/20/22	M	40.3–56	–	–	1–6	+19	179/ 403/404/434/439/521/595
		F	52.3–70					
Squalus acanthias	29/23	M	47–82	22–24	biannual	1–8	28–29	223/247/252/253/401
		F	51.5–88					
Etmopterus spinax	12/10/18	M	28–37	12?	–	5–18	9–11	144/213/ 431/579/640
		F	34–46					
Dalatias licha	4/12	M	74			6	32–39	61/156
		F						
Squatina aculeata	12	M	120–122	12	biannual	8–12 (11.1)	30.3–35	151
		F	137–143					
Squatina oculata	12	M	71	–	–	5–8	–	183
		F	90					
Squatina squatina	12	M	80	–	–	7–18	–	183
		F	128					
Rhinobatos rhinobatos	14/26/24	M	68–75	5–12	annual	4–12	22.2–31	6/140/198/ 204/214/282/358
		F	69–87					
Glaucostegus cemiculus	14	M	100–112	8–12	annual	4–12	35–38	198/201/ 204/282/288
		F	110–138					

Scientific name	GSAs	Sex	Size at maturity, (cm TL/DW)	Gestation time (Months)	Reproductive periodicity	Litter size	Size at birth	Reference Number
Dasyatis centroura	12	M	74–80	4	?	2–6	–	83/135
		F	66–100					
Dasyatis pastinaca	26/12/14/24	M	22–31 DW	4	2 times/year	3–6	12	13/94 283/357
		F	24–38 DW					
Dasyatis tortonesei	12	M	38 DW	4	2–3 times/year	3–8	–	110/115
		F	46 DW					
Dasyatis marmorata	14	M	30 DW	3–4	2–3 times/year	2–4	11.8	114/200/202
		F	32 DW					
Pteroplatytrygon violacea	4/12/14	M	42 DW	4–5	1–2 times/year	2–7	–	354
		F	45 DW					
Torpedo nobiliana	12/7	M	55	12	biannual	–	17–22	81/166
		F	90					
Torpedo torpedo	12/14/26/10	M	18–25	12	Annual	1–16	8–9.7	3/232/285/522/527
		F	19/26					
Torpedo marmorata	26/12/10	M	25–29	10–12	three year?	2–19	> 10	3/81/114/134/200/202/232
		F	31–39.5					
Pteromylaeus bovinus	12	M	80 DW	4–8	annual	2–6	–	174
		F	90–100 DW					
Myliobatis aquila	12/7	M	50–54 DW	12	biannual	8–12	21–29 DW	165/170/193
		F	70–73 DW					
Gymnura altavela	12	M	78 DW	9	annual	2–6	+ 29	83/205
		F	68–108 DW					

Table 8 – Available reproductive parameters of oviparous elasmobranchs species in the GFCM area. DW: Disk Width, TL: Total Length

Scientific name	GSAs	Sex	Size at maturity, (cm TL)	Fecundity	References
Scyliorhinus canicula	12/7/18/22	M	40–44	38–190	101/109/185/189/191/ 227/402/555/630/636
		F	35–47		
Scyliorhinus stellaris	12	M	77–79	77–109	102
		F	82		
Galeus melastomus	12/7/16/1/3/18	M	36–43	15–25	167/196/532/540/542/
		F	39–46		
Raja alba	12	M	91 DW	–	96
		F	98 DW		
Raja asterias	12/10/9	M	51.5–54	34–112	27/107/118/543/578
		F	56–61		
Raja miraletus	12/14/26/17/18	M	28–36.4	10–90	4/171/172/173/361/396/634
		F	30–42.3		
Raja melitensis	12/	M	40	10–56	108/116
		F	40		
Raja radula	12	M	48	–	79
		F	52		
Raja clavata	9/12/7/29/17	M	36–48 DW	108–262	26/95/103/112/161/250/549
		F	48–56 DW		
Raja polystigma	12	M	53	20–62	117/160/178
		F	63		

6.2 Available data on age and growth of elasmobranchs

Twenty-two references (Appendix II) refer to age and growth of elasmobranchs and concern only 12 species (about 12 percent of the Mediterranean elasmobranchs fauna). They are: *Dasyatis pastinaca*, *Etmopterus spinax*, *Prionace glauca*, *Rhinobatos rhinobatos*, *Glaucostegus cemiculus*, *Squalus acanthias*, *Squalus blainvillei*, *Raja asterias*, *Raja miraletus*, *Raja clavata, Dipturus oxyrinchus* and *Centrophorus granulosus*.

Age and growth data presented in this section include parameters for the Von Bertalanffy growth model (VBGM) (von Bertalanffy 1938) which provides estimates of L∞, the asymptotic or maximum length (or width for some batoids), k, the growth coefficient, and t0, the age or time when length theoretically equals zero (table 9).

Table 9 – Von Bertalanffy growth model (VBGM) parameters: L_∞ (mm TL), k ($year^{-1}$), t_0 (years); t_{max} oldest fish (years), A_{mat} age at maturity (years). Vert., vertebral band count; Ext DS, external dorsal spine band count; Int DS, internal dorsal spine band count. GSAs: GFCM geographical subareas

Species	GSAs	Methods	Sex	VBGM parameters			t_{max}	A_{mat}	References
				$L_{\infty\ (mm)}$	K	t_0			
Centrophorus granulosus	6	Int. DS	M	917	0.107	-9.78	25	8.5	Guallart (1998)
			F	1094	0.096	-5.48	39	16.5	
Etmopterus spinax	10	Vert.	M	394.3	0.19	-1.41	8		Gennari E. & Scacco U. (2007)
			F	450	0.16	-1.09	10		
	19/20	Vert.	M+F				7	5	Sion et *al*. (2002)
Squalus blainvillei	16	Vert.	M	960	0.135	-1.397	8	3.3	Cannizzaro et *al*. (1995)
			F	1179	0.102	-1.380	8	5.1	
	14	Int. DS	M	91.1	0.14	-1.42	15	4.79	Marouani et *al*. (2010 & 2012)
			F	105.7	0.11	-1.12	19	7.44	
Squalus acanthias	29	Ext DS	M	1245	0.171	-2.62	27		Demirhan & Seyhan (2007)
			F	1405	0.141	-2.69	38		
	29	Int. DS	M	1280	0.20	-0.3	13		Avsar (2001)
			F	1450	0.17	-0.7	14		
Prionace glauca	18,19, 20, 21;22, 23,24	Vert.	M	402	0.13	-0.62	12	4.9	Megalofonou et *al*. (2005, 2009)
			F					5.5	
Dasyatis pastinaca	24	Vert.	M	203.13	0.039	-2.00	8		Yeldan et *al*. (2008)
			F	219.85	0.041	-2.61	12		
			M+F	294.94	0.029	-2.20			
			M+F	121.5	0.089	-1.615	10		Ismen (2003)
Rhinobatos rhinobatos	24	Vert.	M	121.65	0.310	-0.131	15		Başusta et *al*. (208) Ismen et *al*. (2007)
			F	154.88	0.134	-1.264	24		
	24	Vert		128.6	0.29	-0.89			
Glaucostegus cemiculus	14	Vert.	M	181.6	0.272	-0.71	10	2.89	Enajjar (2009)/Enajjar et *al*. (2012)
			F	200	0.202	-0.81	14	5.09	
Raja asterias	9/10	Vert.	M+F	67.45	0.454	-0.23			Serena et *al*. (2005)/ Bono et *al*. (2005)
Raja miraletus	26	Vert	M	87.87	0.19	-0.50	15		Abdel–Aziz (1992)
			F	91.92	0.17	-0.25	17.2		
	14	Vert	M	670	0.22	-1.01	7	2.7	Kadri et *al*. (2012)
			F	692	0.18	-0.11	9	4.41	
Raja clavata	16	Vert	M	116.7	0.106	-0.412	5.9–6.2	11	Cannizzaro et *al*. (1995)
			F	126.5	0.098	-0.512	9–9.4	13	
Dipturus oxyrinchus	22	Vert	M	2518.1	0.04	-0.92	8		Yigin and Ismen (2010)
			F	2338.8	0.04	- 1.34	9		

Only one species, the *Squalus acanthias,* was studied in the Black Sea and not in the Mediterranean, and four species are listed in Annex 3 of the SPA/BD Protocol of the Barcelona Convention. Twelve GSAs, among thirty, are concerned by such studies. Species concerned are generally different from a GSA to another.

The organisation of a training course on age reading and growth parameters of the main elasmobranchs species seems to be very urgent to enhance research in this field. Growth parameters are necessary for stock assessment studies.

6.3 Available data on food and feeding habits of elasmobranchs in the GFCM area

Studies of feeding habits are essential to understand the functional role of fish within the ecosystem. Knowing what a species eats can provide information about its possible distribution and its position in food webs.

Sharks are considered as top predators and may have an important role in the regulation of marine ecosystems at lower trophic levels. Information about the food habits is essential to appreciate the species biology and ecology, since the quality and quantity of food directly affect species growth and their maturation and mortality. In addition, quantitatively describing the diet and foraging habitat and predator–prey interactions of top predators in a community is a key step in ecosystem approaches to fisheries management.

In the Mediterranean and Black Sea, 94 dentified published works report information on the diet of 35 species (Appendix II). More than 55 percent of them appeared last decade (Figure 17).

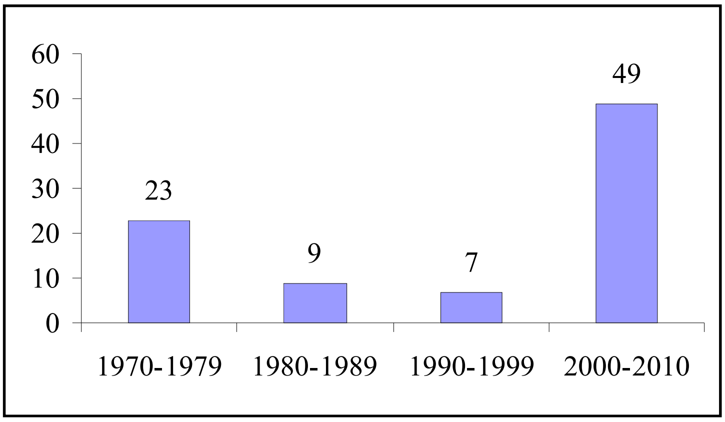


Figure 17 – Chronological apparition of papers on diet

Papers cover all Mediterranean and Black Sea but primarily in the occidental and central areas (Appendix II).

Most species appear to be opportunistic feeding predators, foraging on a broad range of prey species (Table 10). However, crustaceans and teleost fishes are the main preys of elasmobranchs. Cephalopods are a major prey for *Squalus blainvillei, Galeus melastomus, Centroscymnus coelolepis, Prionace glauca, Dasyatis marmorata, Pteromylaeus bovines, Myliobatis aquila*. Polycheates, sipunculids and echinoderms are minor importance food; in contrast, *O. centrina* is the only shark species ingesting polycheates. Chondrchtyans are reported also to be preys for various species.

The giant devilray *Mobula mobular* and the basking shark *Cetorhinus maximus* are mainly planktivorous. It appears that increased basking sharks occurrence is not directly influenced by changes in temperature and salinity. However, some data obtained suggest the relative importance of copepods, especially of *Calanus helgolandicus*, in relation to the occurrence of basking sharks (Soldo et *al*., 2008).

The white shark *Carcharodon carcharias* ingests principally cartilaginous fishes (*Isurus sp*., *Myliobatis aquila*, *Dasyatis sp*.) and bony fishes (*Scomber scombrus*, *Thynnus thunnis*, *Sarda sarda*) and other preys such as marine turtles (*Chelonia mydas*) and cetaceans (*Delphinus sp*.) (Postel, 1958; Capapé, 1975, Bradai, 2000).

Table 10 – Diet composition of elasmobranch species from the Mediterranean Sea (xxx: main preys, xx: secondary items, x: accessory items, –: accidental items), Fish: teleost fishes, Chon: chondrichtyens, Mol: molluscs, An: Annelids, Cr: crustaceans, other: other invertebrates (echinoderms, sipunculids, etc.)

Species	GSAs	Frequency of Prey						Reference number
		Chon	Fish	Cr	Mol	An	Other	
Heptranchias perlo	12	x	xxx	xx	x			103
Hexanchus griseus	22	x	xxx				–	350
Squalus acanthias	29	x	xxx	xx				15/233/234/
Squalus blainvillei	14/22		xxx	xxx	x	–		72/328/347/393
Centrophorus granulosus	12/23/27		xxx	xx				111/302/402
Etmopterus spinax	1/6/10/17/18		xxx	x	x			34/35/268/384/442
Galeus melastomus	1/6/9/10/12	–	x	xxx	x	–	–	35/176/190/268/384/441
Datalis licha	6	xx	xxx	xx	xx			384/399
Centroscymnus coelolepis	6		x	x	xxx		–	190
Oxynotus centrina	7		x	x		xxx	x	120
Carcharhinus plumbeus	14	x	xxx	x	xx	–		492
Mustelus mustelus	6/14/17		xx	xxx	x	–	–	218/334/335/424/497
Mustelus punctulatus	12/14/17		xx	xxx	x	–	–	158/334/336/491
Scyliorhinus canicula	6/11/12/22		xx	xxx	x	–	–	68/284/425/487
Scyliorhinus stellaris	12		xx	xxx	x	–	–	70
Prionace glauca	9	x	x	x	xxx		x	291
Carcharodon carcharias		x	xxx		x		x	274
Rhinobatos rhinobatos	14/24		xxx	xxx	x	–	–	5/30/179/258/262/326
Glaucostegus cemiculus	14		xxx	xxx	x	–	–	258
Dasyatis pastinaca	12/24/29		xx	xxx	x	x		73/325/484/570
Dasyatis tortonesei	12	–	xxx	x	x			94
Dasyatis marmorata	14		x	x	xxx	x	–	181
Pteroplatytrygon violacea	9			xxx				439
Torpedo torpedo	26		xxx	x	–	–	–	3
Torpedo marmorata	7/26		xxx	–	x	–	–	3/129
Pteromylaeus bovinus	14		xxx	x	xxx	–	–	87/113

Species	GSAs	Frequency of Prey						Reference number
		Chon	Fish	Cr	Mol	An	Other	
Myliobatis aquila	12/17		–	–	xxx	–	x	80/113/337
Raja alba	12	x	xxx	x	x			89
Raja asterias	9/10/12		xx	xxx	x	–	–	159/220/479/507
Raja brachyura	11		xxx	xx	x	–		191/287
Raja miraletus	11/12/26		x	xxx	x	–	–	1/121/267/287
Raja melitensis	12			xxx				75
Raja radula	12/26		x	xxx	x	–	–	1/121
Raja clavata	11/12/14/26/29		xx	xxx	x	–	–	1/74/230/264/362/425/485/568
Raja polystigma	12		xx	xxx	x	x	x	96

Although there is an important number of papers dealing with feeding habits of Mediterranean elasmobranch species, our understanding on the issue remains rudimentary. In fact, most papers simply describe stomach contents of a particular species in a particular zone and using few samples.
Among papers on dietary composition, only 16, concerning 12 species, determine dietary indexes Fpercent, Npercent, Mpercent, IRIpercent and study dietary changes in relation to size and/or seasons and sex (table 11).

Table 11– Studies calculating dietary indexes Fpercent, Npercent, Mpercent, IRIpercent and studying dietary changes in relation to size and/or seasons and sex

Species	GSAs	References
Etmopterus spinax	10/1,6	44/ 296
Galeus melastomus	10/1,6	44/209/296
Centroscymnus coelolepis	6	209
Carcharhinus plumbeus	14	552/558
Mustelus mustelus	17/6/14	552/563/366/367/479
Mustelus punctulatus	17/14	368/552/566/
Rhinobatos rhinobatos	26/14	5/282
Glaucostegus cemiculus	14	282
Dasyatis pastinaca	29	550
Raja brachyura	11	315
Raja miraletus	11	315
Raja clavata	29	551

There are relatively few investigations comparing diets of sympatric species of elasmobranchs (one study). In several studies, standard ecological indices of similarity are used to calculate dietary overlap among elasmobranch species, among elasmobranchs and teleosts caught in the same location, or among different size classes of a single species. Such comparisons represent initial attempts to characterize food partitioning and competition among elasmobranchs and co-occurring teleosts. Ecological indices of dietary breadth or diversity have also been calculated for several species of elasmobranchs to examine the degree of feeding specialization.
Rate of consumption, feeding patterns, and the fate of food once ingested have been examined for very few species of elasmobranchs.

7. CONSERVATION MEASURES FOR ELASMOBRANCHS

Protection currently granted to chondrichthyan fish species in the Mediterranean Sea under various regional and international conventions.

7.1 Global instruments

7.1.1 Convention on the Conservation of Migratory Species of Wild Animals (CMS or Bonn Convention, 1979)

Eight migratory shark species are currently included in the Appendices of the Convention on Migratory Species (CMS), in recognition of their unfavourable conservation status and need for concerted international conservation measures:

- The white shark *Carcharodon carcharias i*n Appendices I and II in 2002;
- The basking shark *Cetorhinus maximus* in Appendices I and II in 2005;
- The shortfin mako *Isurus oxyrhinchus* in Appendice II since 2008;
- The porbeagle *Lamna nasus* in Appendice II since 2008;
- The longfin mako shark *Isurus paucus* in Appendice II since 2008;
- The spiny dogfish *Squalus acanthias* (northern Hemisphere populations only) in Appendice II since 2008;
- The giant manta ray *manta Birostris* in Appendices I and II since 2011;
- The whale shark *Rhincodon typus* was listed on Appendix II in 1999.

The first four sharks are known in the GFCM area. Several other highly migratory shark species require concerted international conservation measures and may in the future be nominated for inclusion in the CMS Appendices.

Under the same Convention, a Memorandum of Understanding on the Conservation of Migratory Sharks was finalized and adopted in Manila, Philippines (March 2010). The objective of this Memorandum of Understanding (MoU) is to achieve and maintain a favourable conservation status for migratory sharks based on the best available scientific information, taking into account the socio-economic and other values of these species for the populations of the Signatories. A conservation plan, as Annex III to this MoU, was adopted in the first meeting of the signatories of the MoU on the Conservation of Migratory Sharks (Bonn, Germany, 24–27 September 2012).

7.1.2 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

CITES was established in recognition that international cooperation is essential for the protection of certain species of wild fauna and flora from over-exploitation through international trade. It came into force in 1975, creating an international legal framework for the prevention of trade in endangered species of wild fauna and flora and for the effective regulation of international trade in other species which may become threatened in the absence of such regulation. Three shark species are listed in Appendix II of CITES: basking shark *Cetorhinus maximus*, whale shark *Rhincodon typus*, and white shark *Carcharodon carcharias*, and CITES maintains an active involvement in shark conservation issues under the Resolution on the Conservation and Management of Sharks.

7.1.3 United Nations Convention on the Law of the Sea (UNCLOS)

UNCLOS was adopted in 1982 and came into force in 1994. It provides a framework for the conservation and management of fisheries and other uses of the seas by giving coastal States rights and responsibilities for the management and use of fishery resources within their national jurisdictions

(the territorial sea, which can extend up to 12 nautical miles) and enabling the establishment of an Exclusive economic Zone (EEZ).
For stocks that occur within the Exclusive Economic Zones of two or more coastal States, or both within the EEZ and in an area beyond and adjacent to it, UNCLOS calls upon coastal States and States fishing in the high seas to seek agreement upon the necessary measures for the conservation and development of those stocks in the adjacent high seas area. Such stocks are likely to include the highly migratory species listed in UNCLOS Annex 1 (*Hexanchus griseus*; *Cetorhinus maximus*; Family *Alopiidae*; *Rhincodon typus*; Family *Carcharhinidae*; Family *Sphyrnidae*; Family *Isuridae*) and other species that fall within the CMS definition of migratory. UNCLOS also calls upon coastal States and other States fishing highly migratory species to cooperate in ensuring conservation and promoting the optimum utilization of those resources in their whole area of distribution.

7.1.4 United Nations Agreement on the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (UNFSA)

UNFSA was established to implement the provisions of UNCLOS pertaining to the conservation and management of straddling and highly migratory fish stocks.
UNFSA, adopted in 1995, ratified in 2001, calls Parties to protect marine biodiversity, minimise pollution, monitor fishing levels and stocks, provide accurate reporting of and minimise bycatch and discards, and gather reliable, comprehensive scientific data as the basis for management decisions. It mandates a precautionary, risk-averse approach to the management of straddling and highly migratory stocks and species in cases where scientific uncertainty exists.

7.1.5 FAO International Plan of Action for the Conservation and Management of Sharks (IPOA–Sharks)

By 1999, FAO has developed the International Plan of Action for the Conservation and Management of Sharks (IPOA–Sharks) to form part of the Code of Conduct for Responsible Fisheries. The IPOA-Sharks emphasizes that the harvest of chondrichthyan fishes should be biologically sustainable, economically rational, utilizing all body parts of the sharks killed, and managed to ensure biodiversity conservation and maintenance of ecosystem structure and function. Under this action plan, signatory nations are obliged to develop and implement a National Plan of Action for the conservation and management of sharks.

7.2 Regional protection instruments

7.2.1 Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention, 1982)

The Convention aims to ensure conservation of wild flora and fauna species and their habitats. Special attention is given to endangered and vulnerable species, including endangered and vulnerable migratory species specified in appendices.

The Bern Convention covers most of the natural heritage of the European continent and extends to some States of Africa.

The basking shark *Cetorhinus maximus* and the white shark *Carcharodon carcharias* were listed in Appendix II as strictly protected species.

The following Mediterranean species were listed in Appendices III as protected fauna species:

- **Lamnidae:** *Isurus oxyrinchus /Lamna nasus*
- **Carcharhinidae:** *Prionace glauca*
- **Squatinidae:** *Squatina squatina*
- **Rajidae:** *Raja alba*

7.2.2 Convention for the Protection of the Mediterranean Sea against Pollution (Barcelona Convention, 1976), Protocol on Specially Protected Areas and Biological Diversity (SPA &BD, 1995)

This Protocol, which has come into force in December 1999, lists the basking shark and the great white shark along with the devil ray as Endangered or Threatened species (Appendix II). Parties signing the Protocol must ensure "the maximum protection possible and the recovery of these species". This Protocol recommends that the exploitation of five other species be regulated (Appendix III): *Isurus oxyrinchus*, *Lamna nasus*, *Prionace glauca*, *Squatina squatina* and *Raja alba*.

7.2.3 Action Plan for the Conservation of Cartilaginous Fishes (Chondrichthyans) in the Mediterranean Sea

A specific Plan of Action has been developed by the UNEP for the conservation of cartilaginous fish in the Mediterranean. This plan was drawn up in collaboration with the IUCN Centre for Mediterranean Cooperation and the Shark Specialist Group, and adopted by the contracting parties to the Barcelona Convention in November 2003. This is a very significant step, since it is the first regional plan of action on sharks drawn up by the United Nations Environment Programme (UNEP). The list of Annex III of the Barcelona Convention has been extended to several other protected shark species whose exploitation must be regulated (adopted in 2009): *Mustelus mustelus, Mustelus asterias, Mustelus punctulatus, Rhinobatos rhinobatos, Rhinobatos cemiculus, Sphyrna zygaena, Alopias vulpinus Carcharhinus plumbeus, Centrophorus granulosus, Galeorhinus galeus, Heptranchias perlo* and *Leucoraja melitensis.*

The objectives, as written in this Action plan, are:

- The general conservation of the chondrichthyan populations of the Mediterranean, by supporting and promoting national and regional programmes for sustainable fisheries of commercial stocks either as they are target and accessory species;
- The protection of selected chondrichtyan species, whose populations are considered endangered;
- The protection and the restoration of critical habitats, such as mating, spawning and nursery grounds;
- The improvement of scientific knowledge by research and scientific monitoring, including the creating of regional standardised databases;
- The recovery of depleted chondrichthyan stocks;
- Public awareness and capacity–building about conservation of chodrichthyans.

7.2.4 EU Action Plan for the Conservation and Management of Sharks

In February 2009, the European Commission adopted the first ever EU Action Plan for the Conservation and Management of Sharks. The aim of the plan is to ensure that effective steps are taken to help rebuild shark stocks wherever they are under threat, if necessary on a precautionary basis, and to set down guidelines for the sustainable management of the fisheries concerned, including those where shark are taken as bycatch. The plan also includes measures to improve scientific knowledge on shark stocks and shark fisheries.

7.3 Other initiatives for conservation

7.3.1 IUCN Red List of Threatened Species

The IUCN Red List of Threatened Species is a widely recognised system for classifying species at risk of global extinction. It has no legal standing, but is frequently used by governments and environmental institutions to set priorities and conservation actions.

7.3.2 IUCN Shark Specialist Group (SSG)

This group was established by IUCN, as part of its Species Survival Commission in 1991. The SSG was formed to assess and address the conservation needs of sharks. The SSG is currently part way through a programme to complete global assessments for all chondrichthyan species.

7.3.3 Mediterranean Large Elasmobranchs Monitoring (MEDLEM)

MEDLEM is a monitoring programme on the captures and sightings of the large cartilaginous fishes occurring in the Mediterranean Sea. This programme directly links up with the FAO IPOA–SHARKS and it has been submitted to the discussion of the SAC Sub-Committee on Marine Environment and Ecosystems of the GFCM (Barcelona, 6–9 May 2002) as "subproject Basking shark". In the context of this Sub-Committee, there is a continuous updating of information on incidental catches of protected species and on bycatch of large migratory sharks in the commercial fisheries.
Seventeen great cartilaginous fishes are actually concerned by the programme. The definition of "great cartilaginous fishes" is referred to sharks with total length bigger than 100 cm or batoid fishes (rays and skates) with disc width bigger than 150 cm.

Eighteen Mediterranean research centres and organizations cooperate on this subject and conform in the collection of data. The IUCN (International Union for Conservation of Nature and Natural Resources) and EEA (European Elasmobranch Association) endorsed the project. Eleven different countries are involved, 21 species have been recorded so far and 1300 records are in the database, 24 passwords have been granted for the access to the database.

Another important aspect of this project is the collection of scientific papers related to elasmobranchs in the Mediterranean area. About 400 bibliographic references are currently listed in a specific set of the project database.

7.4 National species protection status

Legislation on species protection is generally elaborated implementing the CITES Convention and/or the Bern Convention and SPA Biodiversity Protocol of the Barcelona Convention (Greece, Italy, Malta, Croatia, Montenegro and Monaco). In this way, *Cetorhinus maximus, Carcharodon carcharias* and *Mobula mobular* benefit from a strict protection. Strict protection is also applied for *Carcharhinus plumbeus* in Turkey. Some species of national interest may be subject to management measures (Malta, Tunisia). In Israel, all Cartilaginous Fishes are protected.

Some information is gathered as follows:

Croatia: Strict protection for *Cetorhinus maximus, Carcharodon carcharias* and *Mobula mobular* (OG n°7/2006, issued by the Nature Protection Directorate, Ministry of Culture).

European community: Catch, retention on board, transhipment and landing prohibited since 2007 for *Cetorhinus maximus* and *Carcharodon carcharias*.

Greece: Protected species are the ones that are mentioned in CITES Bern Convention and SPA Biodiversity Protocol of the Barcelona Convention

Israel: All cartilaginous fishes (2005 declaration within the legislative framework of National Parks, Nature Reserves and National Monuments 1998, Ministry of Environmental Protection).

Italy: Applies to species listed for strict protection under Barcelona Protocol, Bern Convention and in CITES Appendices.

Malta: Strict protection for *Carcharodon carcharias, Cetorhinus maximus* and *Mobula mobular*. Fourteen species of national interest whose taking in the wild and exploitation may be subject to management measures (Sch.VIII): *Alopias vulpinus, Carcharhinus, brevipinna, Carcharhinus limbatus, Carcharhinus plumbeus, Carcharias taurus, Galeorhinus galeus, Hexanchus griseus, Isurus oxyrinchus, Lamna nasus, Leucoraja melitensis, Prionace glauca, Pristis pristis, Rostroraja alba, Squatina squatina*. (Flora, Fauna and Natural Habitats Regulations (311/2006) issued under the Environment Protection Act (Malta Environment and Planning Authority).

Monaco: Species listed in CITES Appendices (Ordonnance Souveraine n° 67 du 23 mai 2005, Journal de Monaco du 26 mai 2006 n° 7757).

Montenegro: Protection for *Carcharodon carcharias* and *Lamna nasus* (Decision on Endangered or Threatened Species of Flora and Fauna (2006) and CITES implementation legislation (Decision on Strict control list of import, export and transit: Official Gazette RME, no. 28/06).

Slovenia: Strict protection for *Carcharodon carcharias* and *Cetorhinus maximus* (Decree on Protected Wild Fauna, Official Bulletin 46/2004 (Ministry of Environment and Physical Planning).

Tunisia: It is prohibited to fish rays and skates less than 40 cm and torpedos below 20 cm in length, measured from tip of snout to start of tail (Decree 28.9.1995, Minister of Agriculture).

Turkey: Strict protection for *Carcharhinus plumbeus* and *Cetorhinus maximus* (Circulars on Fisheries related to Fisheries Law: 1380) (Ministry of Agriculture and Rural Affairs).

7.5 Habitat protection/MPAs to support elasmobranchs conservation

According to the information available, there are no MPAs specifically established for elasmobranchs in the Mediterranean Sea, except in Turkey where mating and breeding habitats of *Carcharhinus plumbeus* in the Bay of Boncuk are protected by the Environmental Protection Agency for Special Areas. The lack of legislation in this issue would come mainly from a lack of knowledge on critical habitats of this group. Some mapping of nursery areas and spawning ground for some species is carried out by some countries. Critical habitats should be identified for conservation purposes. Otherwise, sharks are protected in MPAs along with other marine species but no MPAs are established with reference to these species such as the Pelagos Sanctuary (for cetaceans) and the two MPAs of Larvotto (Ordonnance Souveraine du 25 avril 1978) and Spélugues (Ordonnance Souveraine du 29 août 1986) in Monaco.

Marine Protected Areas can be efficient to manage sharks fisheries, to protect nursery areas, parturition zones, etc.

Temporary closure of fishing areas can be efficient to reduce capture of critical stage of the life history of the species (new born, pregnant females, etc.). In Tunisia, the Gulf of Gabès is closed to trawling fishery from July to September.

7.6 Regulation of shark finning

Shark fins are among the most highly priced fisheries products in eastern Asia and this is stimulating the targeting of sharks and retention of only their fins, a practice known as “finning. This practice is wasteful of protein and other potential products derived from sharks. In fact only fins are used, the remainder being thrown away. Finning causes the death of tens of millions of sharks in the world, directly threatening rare and vulnerable shark species and indirectly impacting other commercial species due to the effects of removal of top predators from these food webs.

As fining activities do not take place generally in Mediterranean countries, there are no national regulations of shark fining except in Spain. However, Regulation EC n°1185/2003 bans the removal of fins followed by discard of the carcass at sea. Finning with retention of carcasses on board is permitted in accordance with the provisions of the Regulation. The theoretical correspondence between the weight of fins retained and the parts of the bodies retained on board should be established by the Member States but cannot exceed 5 percent of the live weight of the shark catch. In the Mediterranean, this activity is likely to interest more and more fishermen.

The ICCAT 2004 regulation and the GFCM 2005 regulation recommend the full utilisation of sharks (only head, skin and guts may be discarded). Landed fins are not to exceed 5 percent of landed shark weight. The live release of incidentally caught sharks is encouraged but not required.

In Spain, the order of the Ministry of Agriculture, Fisheries and Food, dealing with specific conditions for the catching of sharks (June 2005), prohibits shark finning (removal of fins and discarding the carcass at sea). It is prohibited to hold on board, unload, tranship or transport sharks fins without the corresponding weight of the rest of the body. In cases where fins or the rest of the shark’s body are held on board, transhipped, unloaded or transported separately, they should be accompanied by a document certifying the placing on the market of each part, as applicable. Such activity is therefore permitted only under special permit in accordance with EC Regulation n° 1185/2003.

8. GENERAL CONCLUSION

Six hundred and sixty-one references, dealing with elasmobranchs in Mediterranean and Black Sea, were analyzed in this document. The chronological appearance of papers shows that interest for elasmobranchs research is relatively recent and started in the late 1990s. Works were concentrated mainly in the western Mediterranean, followed by the Eastern basin. Few works concerned endangered species and those of the GFCM priority list.

After a critical analysis of the literature and taking into acount new published data on elasmobranchs, we consider that 86 species of elasmobranchs are thought to occur in the Mediterranean Sea (49 species of sharks and 37 batoids). Among the 86 species, 13 species (seven sharks and six batoids) were recorded in the Black Sea. At least eight other species of elasmobranchs have been reported in the Marmara Sea, which is with the Black Sea and the Sea of Azov in the same FAO subarea. However, much confusion persists for some species and some others are doubtful. These species need a more systematic revision.

Endemism of chondrichthyans in the Mediterranean is low: only four batoids species were considered as endemic. Alien species are increasingly recorded: currently eight species are known to occur in the Mediterranean.

Within the Mediterranean, the distribution of elasmobranch fishes is not homogenous. A recent work has showed that the concentration of rays and sharks occurred in coastal waters of the western basin and the central Mediterranean, especially in the waters of Tunisia and Libya. In the Adriatic Sea, the presence of cartilaginous fish species is scarce especially in the northern part. The Black Sea fauna is composed of Mediterranean species. Thirteen elasmobranchs species are assumed to live in the Black Sea, of which three species are relatively common: the thornback ray *Raja clavata* and the common stingray *Dasyatis pastinaca,* having no commercial importance, and the spiny dogfish *Squalus acanthias*. Some areas are considered as critical habitats for elasmobranchs. For example, Tunisian waters provide a nursery area for the great white shark *Carcharodon carcharias*. The gulf of Gabès seems to be also a nursery for many other elasmobranchs.

The IUCN Red List (2007 regional assessment) shows clearly the vulnerability of elasmobranchs and the lack of data on this fish group; 42.5 percent are Vulnerable and Endangered to Critically Endangered, 22.5 percent are Near Threatened (NT) and 21.25 percent are Data Deficient (DD).

Elasmobranchs fish species are exploited for their fins, skin, jaws or meat. Sometimes they are directly targeted by commercial and recreational fisheries while in other cases they are incidentally caught as bycatch. In the Mediterranean Sea, catches represent only 1.1 percent of the total landings. A decline in cartilaginous fish species landings has been observed while fishing effort has generally increased. The catches show an increasing trend; 24 000 tonnes were attained in 1983 and since then a regular decrease are observed. The present elasmobranchs productions are about 7 000 tonnes annually. Sharks represent 1.3 times the production of batoids. The major elasmobranchs fishing countries within the Mediterranean are Italy, Turkey and Tunisia; they have contributed on average to 76 percent in the production of elasmobranchs during the last 30 years. Countries report generally shark statistics without distinction between species or, worse still, the species are not recorded at all. Moreover, FAO data only report official landings and therefore bycatch returned to the sea is not included. A protocol should be developed to collect and promote the collection of basic data on elasmobranchs species.

In the Mediterranean, almost no elasmobranchs are subject to directed fisheries, but elasmobranchs constitute part of the bycatch in most local artisanal fisheries. Catches of elasmobranchs primarily derive from two different fisheries: the pelagic artisanal fishery with longlines and gillnets and the demersal trawl fishery.

Bycatch has become one of the issues to be considered in any development of fisheries. Elasmobranchs which are considered mainly as bycatch are very sensitive given their particular biological characteristics. Bycatch can induce imbalances between top predators and prey and consequently affect biodiversity.

Ninety three papers covering many aspects and approaches to fisheries have been identified and analyzed. The interest in the incidental catch is relatively recent. More than 75 percent of papers on this topic appeared last decade.

Trawling generates several problems: juvenile catches, important discards and negative impact on the environment. In the Mediterranean, discards constitute over 40 percent of the catch. At least 74 species are mainly caught by trawlers. The sustained increase in trawl fishing effort appears to have contributed to a decline in biodiversity in the Mediterranean elasmobranchs (stocks and habitat). For this fishing gear, the information concerns very often a listing of species without an estimate of catch rates by fishing effort. A regional research programme on this issue should be launched.

Surface longlines targeting swordfish, albacore and tuna generate significant bycatch of sharks. At least 15 species of sharks are affected by this gear. In all areas studied, the blue shark, *P. glauca*, is the the most represented species in the catch of surface longline. It represents over 70 percent of the elasmobranchs catch. It is followed by mako *Isurus oxyrinchus*.

The bottom longlines incidentally bring several demersal species such as *Mustelus sp*, *Squalus sp*., *Torpedo sp.* and some Rajidaes. It catches especially batoids.

It is finally noted that studies of elasmobranch fishery bycatch by hooks are missing on the southern shore of the Mediterranean.

Although banned now, few fleets Mediterranean (France, Italy, Morocco, Tukey) continue to use driftnets. They generate incidental catch of elasmobranchs. Incidental catches of large sharks species have been cited in various driftnet fisheries.

In the Mediterranean, there is a little use of gillnet targeting sharks. However, these nets bring several other non target species of elasmobranchs.

Although there is little information available in the literature on the bycatch of encircling nets, these nets occasionally catch pelagic sharks and stingrays in fisheries of the bluefin tuna and small pelagic. In the central Mediterranean over 70 percent of the white shark catches are reported to the purse seine. Many management tools and technical procedures have been suggested to reduce bycatch but a big effort is needed to enhance researches on this issue and to adapt procedures tested worldwide.

Sharks and rays occupy a high level in the trophic webs and are characterised by a K–strategy. This determines a high sensibility to even relatively low fishing pressure, but in the Mediterranean very few stocks assessment and standardised data are available. However, some assessments, based on abundance indices such as those elaborated within the framework of MEDITS bottom trawl surveys, are available. Series of data based on this programme are too short to identify specific trends in species abundances. This programme should be extended to the entire region. Stock assessment of elasmobranchs, based on biologic parameters (mainly age and growth) should be developed.

One hundred thirty-four references dealing with the biology of the reproduction were inventoried but only 97 papers report detailed data on reproductive parameters, while the others give some general information. A standardisation of methods and expression of results should be generalised in the whole Mediterranean. Data is available for only 43 species, 33 viviparous and ten oviparous.

Only 12 species (about 12 percent of the Mediterranean elasmobranchs fauna) have been subject to age and growth studies (22 references in total). Data are scarce.

The organization of a training course on age reading and growth parameters for the main elasmobranchs species seems to be very urgent in order to enhance research in this field. Growth parameters are necessary for stock assessment studies.

Sharks are considered as top predators and may have an important role in the regulation of marine ecosystems at lower trophic levels. In addition, quantitatively describing the diet and foraging habitat and predator–prey interactions of top predators in a community is a key step in ecosystem approaches to fisheries management.

The analysis of bibliography dealing with food and feeding habits shows that most species appear to be opportunistic feeding predators, foraging on a broad range of prey species. However, crustaceans and teleost fishes are the main preys of elasmobranchs. Cephalopods are major prey for some species. Polycheates, sipunculids and echinoderms are food of minor importance; in contrast, *O. centrina* is the only shark species ingesting polycheates. Chondrchtyans are reported to be preys also for various species.

Papers on biologic parameters cover all Mediterranean and Black Sea but primarily in the western and central areas. Their majority appeared in the latest decade.

Few elasmobranchs species occurred in the Black Sea and some data on biology and ecology are available mainly for three common species: *Raja clavata, Dasyatis pastinaca* and *Squalus acanthias*.

Protection is currently granted to chondrichthyan fish species under various regional and international conventions where generally few species are considered. An amendment of some convention lists and action plans should be undertaken in parallel with developing knowledge on this fish group.

Few countries have developed their own legislation on species protection, which is generally elaborated implementing the CITES Convention and/or the Bern Convention and the SPA Biodiversity Protocol of the Barcelona Convention. In Israel, all cartilaginous fishes are protected. National action plans should be elaborated and generalised in the Mediterranean and Black Sea.

According to the information available, there are no MPAs specifically established for elasmobranchs in the Mediterranean and Black Sea. The lack of legislation on this issue would come mainly from a lack of knowledge on critical habitats of this group. Marine Protected Areas can be efficient to manage sharks fisheries (protection of nursery areas, parturition zones, etc.).

As fining activities do not take place generally in Mediterranean countries, there are few national regulations on shark fining, but this activity is likely to interest more and more fishermen. National legislations should also be developed in many countries.

Following the present bibliographic analysis and the diagnostic of the situation of elasmobranchs in the Mediterranean and Black Sea, research programmes and conservation priorities for sharks in the region are as follow:

- Developing research programmes on systematic, general biology, ecology and population dynamics for species of concern;
- Identifying and mapping critical habitats;
- Taking action to collect reliable statistics on landings and bycatch of elasmobranchs;
- Initiating fisheries management strategies for commercially exploited species;
- Developing research programs to reduce elasmobranchs bycatch;
- Developing National Action Plans as recommended by the FAO IPOA–Sharks.

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Appendix II– Distribution of papers on elasmobranchs by geographic areas, species or group of species and topics (numbers are those of references in appendix 1)

1. THE DISTRIBUTION OF ALL AVAILABLE PAPERS BY AREAS

1.1 Black Sea (28 papers)

18, 19, 21, 247, 249, 250, 251, 252, 253, 254, 270, 277, 289, 290, 313, 374, 376, 401, 408, 409, 410, 422, 529, 549, 550, 551, 571 and 572.

1.2 Marmara Sea (6 papers)

372, 380, 381, 386, 387 and 656

1.3 Western Mediterranean (373 papers)

7, 8, 9, 14, 16, 20, 22, 23, 24, 26, 27, 28, 29, 30, 31, 32, 33, 34, 44, 45, 46, 47, 48, 49, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 72, 73, 74, 75, 76, 79, 80, 81, 82, 83, 84, 85, 86, 87, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 135, 136, 137, 138, 139, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 175, 176, 177, 178, 179, 180, 181, 182, 183, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 203, 205, 206, 207, 209, 210, 211, 212, 213, 215, 216, 219, 222, 224, 225, 226, 229, 230, 231, 233, 238, 239, 245, 246, 255, 257, 258, 262, 263, 266, 269, 278, 279, 280, 291, 292, 293, 294, 296, 297, 298, 299, 301, 303, 304, 305, 306, 307, 308, 313, 314, 315, 316, 317, 320, 321, 322, 324, 336, 337, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 407, 411, 412, 413, 420, 421, 424, 425, 426, 428, 429, 440, 441, 442, 443, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 508, 509, 510, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 548, 552, 564, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 599, 607, 608, 610, 613, 614, 615, 617, 618, 619, 620, 621, 622, 624, 625, 628, 632, 633, 638, 639, 640, 642, 643, 644, 645, 646, 647, 648 and 649.

1.4 Central Mediterranean (208 papers)

7, 12, 15, 17, 23, 43, 53, 64, 65, 66, 67, 68, 69, 70, 71, 72, 77, 78, 133, 134, 140, 141, 154, 155, 158, 159, 174, 184, 197, 198, 199, 200, 201, 202, 204, 208, 217, 218, 220, 221, 226, 228, 229, 232, 236, 237, 240, 241, 242, 243, 246, 255, 256, 257, 259, 260, 261, 264, 265, 267, 268, 269, 273, 274, 275, 276, 282, 283, 284, 285, 286, 287, 288, 291, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 313, 318, 319, 323, 325, 339, 340, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 394, 395, 396, 406, 414, 415, 416, 417, 418, 419, 429, 430, 431, 432, 433, 434,435, 436, 437, 438, 439, 445, 446, 450, 451, 453, 454, 481, 482, 503, 504, 505, 506, 507, 510, 511, 512, 513, 524, 525, 528, 530, 531, 532, 536, 548, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 565, 566, 567, 568, 569, 570, 571, 572, 577, 581, 590, 592, 593, 594, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 608, 609, 610, 614, 616, 619, 620, 624, 625, 631, 632, 633, 634, 635, 636, 637, 641, 649, 657, 658, 659, 660 and 661.

1.5 Eastern Mediterranean (134 papers)

1, 2, 3, 4, 5, 6, 7, 10, 11, 13, 25, 35, 36, 37, 38, 39, 40, 41, 42, 50, 51, 52, 72, 155, 214, 223, 227, 228, 234, 235, 244, 248, 270, 271, 272, 281, 291, 295, 297, 305, 306, 309, 310, 311, 312, 313, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 338, 356, 357, 358, 371, 373, 375, 376, 377, 378, 379, 382, 383, 384, 385, 388, 389, 390, 391, 392, 393, 397, 398, 399, 400, 402, 403, 404, 405, 405, 423, 427, 444, 447, 448, 449, 450, 451, 452, 453, 454, 480, 481, 482, 528, 546, 547, 548, 571, 572, 581, 590, 595, 599, 608, 610, 611, 612, 619, 620, 623, 626, 627, 629, 630, 632, 633, 649, 650, 651, 652, 653, 654 and 655.

2. THE DISTRIBUTION OF AVAILABLE PAPERS BY SPECIES OR GROUP OF SPECIES

2.1 Batoids (207 papers)

1, 2, 3, 4, 5, 6, 8, 13, 16, 26, 27, 28, 35, 36, 37, 38, 41, 42, 45, 46, 47, 48, 49, 50, 58, 60, 65, 75, 76, 77, 79, 81, 83, 85, 90, 91, 92, 93, 94, 95, 96, 97, 99, 100, 103, 104, 105, 106, 107, 108, 110, 111, 112, 113, 114, 115, 116, 117, 118, 121, 125, 126, 129, 130, 131, 134, 135, 138, 140, 143, 146, 147, 148, 149, 150, 153, 161, 163, 164, 165, 166, 170, 171, 172, 173, 174, 177, 178, 182, 184, 193, 195, 197, 198, 199, 200, 201, 202, 204, 205, 210, 211, 214, 217, 230, 231, 232, 239, 241, 250, 254, 275, 276, 280, 282, 283, 284, 285, 286, 287, 288, 289, 290, 295, 315, 323, 330, 350, 351, 352, 353, 354, 357, 358, 361, 362, 364, 369, 373, 394, 395, 396, 406, 407, 409, 418, 419, 422, 428, 432, 442, 446, 457, 458, 459, 460, 464, 465, 487, 488, 489, 490, 491, 492, 493, 495, 498, 511, 512, 514, 516, 520, 522, 527, 530, 537, 543, 545, 549, 550, 551, 565, 567, 573, 575, 578, 580, 581, 582, 585, 596, 608, 621, 629, 634, 645, 646, 648, 651, 652, 654, 656, 658 and 661.

2.2 Sharks (293 papers)

7, 10, 12, 18, 19, 21, 25, 29, 30, 31, 32, 33, 34, 36, 40, 43, 44, 53, 54, 56, 59, 61, 62, 63, 67, 69, 71, 72, 73, 74, 78, 80, 82, 84, 87, 88, 89, 101, 102, 109, 119, 120, 122, 123, 124, 127, 128, 136, 137, 139, 142, 144, 151, 154, 155, 156, 157, 158, 160, 167, 168, 175, 176, 179, 180, 183, 185, 186, 187, 188, 189, 190, 191, 192, 194, 196, 203, 206, 207, 208, 209, 213, 215, 216, 218, 219, 220, 221, 223, 224, 225, 226, 227, 228, 229, 233, 235, 236, 237, 238, 240, 242, 244, 245, 246, 247, 248, 251, 252, 253, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 270, 271, 273, 274, 277, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 311, 312, 318, 320, 321, 322, 324, 326, 334, 336, 337, 342, 345, 346, 347, 348, 349, 355, 356, 360, 363, 366, 367, 368, 374, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 401, 402, 403, 404, 408, 410, 411, 412, 414, 415, 416, 417, 425, 429, 431, 433, 434, 435, 436, 437, 438, 439, 443, 447, 448, 449, 450, 451, 452, 453, 454, 462, 463, 468, 469, 470, 471, 472, 474, 475, 478, 479, 481, 483, 484, 485, 496, 497, 500, 501, 505, 508, 509, 515, 519, 521, 526, 529, 532, 538, 539, 540, 541, 542, 544, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 568, 579, 583, 586, 587, 591, 594, 595, 597, 599, 600, 601, 602, 603, 604, 605, 606, 614, 616, 617, 618, 620, 627, 628, 630, 631, 635, 636, 640, 642, 643, 657 and 659.

2.3 Batoids and sharks (142 papers)

9, 15, 17, 20, 22, 23, 57, 70, 80, 86, 98, 132, 133, 141, 145, 152, 159, 162, 169, 181, 212, 222, 234, 243, 249, 254, 269, 272, 278, 279, 281, 291, 292, 293, 307, 308, 309, 310, 313, 319, 325, 327, 329, 335, 338, 339, 340, 341, 343, 344, 359, 365, 370, 371, 372, 375, 376, 378, 397, 398, 399, 400, 405, 413, 420, 421, 423, 424, 426, 427, 430, 440, 444, 445, 455, 456, 465, 466, 473, 476, 477, 480, 482, 486, 494, 499, 502, 503, 504, 506, 507, 510, 513, 517, 518, 523, 524, 525, 528, 531, 533, 534, 535, 536, 546, 547, 548, 564, 566, 569, 570, 572, 574, 576, 577, 584, 589, 590, 592, 593, 598, 609, 610, 611, 612, 613, 615, 619, 621, 622, 624, 626, 632, 633, 637, 638, 639, 641, 644, 649, 655 and 600.

2.4. GFCM priority species

Prionace glauca (Seven papers): 244, 265, 267, 321, 347, 450 and 451.
Isurus oxyrinchus (Three papers): 119, 220 and 221.
Lamna nasus (Three papers): 433, 614.
Squatina squatina (One paper): 183.
Rostroraja (Raja) alba (Two papers): 96, and 106.

2.5. Some endangered species

Carcharodon carcharias **(**27 papers): 29, 33, 216, 218, 220, 238, 255, 256, 257, 259, 263, 298, 299, 300, 302, 318, 381, 392, 463, 474, 515, 559, 601, 604, 620, 616 and 617.

Cetorhinus maximus (13 papers): 154, 266, 377, 383, 415, 429, 586, 587, 604, 605 and 659.

Mobula mobular **(**Seven papers): 65, 143, 195, 217, 350, 495, and 567.

2.6. Papers dealing with fisheries and bycatch of elasmobranchs

9, 11, 15, 21, 23, 28, 53, 57, 70, 73, 77, 207, 237, 244, 245, 246, 249, 264, 265, 267, 268, 269, 270, 273, 277, 282, 284, 291, 305, 308, 317, 320, 339, 340, 341, 343, 344, 345, 371, 390, 400, 406, 413, 423, 424, 427, 428, 429, 440, 449, 452, 453, 454, 456, 457, 466, 473, 477, 497, 499, 506, 508, 510, 511, 512, 513, 531, 535, 536, 538, 543, 546, 548, 552, 554, 562, 564, 566, 573, 574, 576, 583, 584, 591, 607, 609, 611, 612, 622, 627, 628, 638 and 649.

3. DISTRIBUTION OF THE PAPERS ACCORDING FISHING GEARS

– **Trawls** (47 papers): 9, 11, 15, 21, 23, 28, 53, 70, 77, 207, 270, 277, 282, 305, 339, 344, 345, 370, 390, 400, 406, 413, 423, 427, 428, 429, 466, 473, 508, 513, 531, 535, 536, 543, 546, 548, 552, 554, 552, 564, 566, 573, 583, 574, 609, 612 and 622.
– **Longline** (30 papers): 70, 73, 246, 249, 264, 265, 267, 268, 305, 308, 320, 424, 449, 452, 453, 456, 497, 499, 506, 510, 511, 512, 627, 538, 552, 554, 562, 607, 611 and 627.
– **Drifnets** (Four papers)**:** 269, 291, 591 and 628.
– **Gillnets and Trammel nets** (8 papers): 237, 284, 390, 429, 477, 552, 554 and 611.
– **Purse seine** (Two papers): 317 and 429.
– **Tuna trap** (Three papers): 57, 341 and 638.

3.1 Distribution of the papers on fisheries following geographic areas

– **Western Mediterranean** (43 papers): 9, 11, 23, 28, 53, 57, 73, 207, 246, 268, 305, 308, 317, 320, 341, 413, 423, 424, 428, 429, 43, 456, 457, 466, 473, 477, 497, 499, 510, 535, 536, 538, 543, 564, 566, 573, 574, 576, 591, 607, 622, 628 and 638.

– **Central Mediterranean** (24 papers): 15, 23, 53, 70, 237, 246, 265, 267, 268, 269, 284, 305, 339, 427, 429, 453, 454, 506, 510, 511, 531, 536, 552 and 554.

– **Eastern Mediterranean** (11 papers): 270, 305, 371, 390, 452, 453, 454, 546, 611, 612 and 627.

– **Black Sea** (Three papers): 21, 277 and 529.

4. PAPERS ON THE REPRODUCTIVE BIOLOGY OF ELASMOBRANCHS (134 PAPERS)

3, 4, 6, 10, 13, 19, 25, 26, 27, 31, 79, 80, 81, 82, 83, 84, 85, 87, 94, 95, 96, 101, 102, 103, 107, 108, 109, 110, 112, 114, 115, 116, 117, 118, 120, 124, 127, 128, 134, 135, 140, 141, 142, 144, 151, 152, 155, 156, 157, 160, 161, 165, 166, 167, 168, 170, 171, 172, 173, 174, 175, 176, 178, 179, 183, 185, 187, 188, 189, 190, 191, 192, 193, 196, 198, 200, 201, 202, 204, 205, 206, 210, 213, 214, 223, 227, 232, 237, 247, 250, 252, 253, 277, 282, 283, 285, 287, 334, 336, 337, 354, 358, 361, 363, 382, 396, 401, 402, 403, 404, 410, 434, 438, 439, 447, 448, 450, 451, 527, 532, 542, 543, 549, 552, 555, 556, 557, 560, 578, 579, 631, 634, 636 and 640.

4.1 Distribution of Papers on the reproductive biology of elasmobranchs by geographic areas

Western Mediterranean (75 papers)
26, 27, 31, 79, 80, 81, 82, 83, 84, 85, 87, 94, 95, 96, 101, 102, 103, 107, 108, 109, 110, 112, 114, 115, 116, 117, 118, 120, 124, 127, 128, 135, 142, 144, 151, 152, 156, 157, 160, 161, 165, 166, 167, 168, 170, 171, 172, 173, 175, 176, 178, 179, 183, 185, 187, 188, 189, 190, 191, 192, 193, 196, 205, 206, 210, 213, 336, 337, 354, 527, 542, 543, 578, 579 and 640.

Central Mediterranean (33 papers):
134, 140, 141, 155, 174, 198, 200, 201, 202, 204, 232, 237, 282, 283, 285, 287, 354, 361, 363, 396, 434, 438, 439, 450, 451, 532, 552, 555, 556, 557, 560, 634 and 636.

Eastern Mediterranean (20 papers):
3, 4, 6, 10, 13, 25, 214, 223, 227, 334, 358, 382, 402, 403, 404, 447, 448, 450, 451 and 631.

Black Sea (9 papers):
19, 247, 250, 252, 253, 277, 401, 410 and 549.

5. AVAILABLE PAPERS ON AGE AND GROWTH OF ELASMOBRANCHS (22 PAPERS)

2, 18, 19, 37, 42, 58, 77, 78, 248, 251, 288, 324, 357, 358, 396, 438, 439, 450, 578, 594, 652, and 654.

6. PAPERS ON FOOD AND FEEDING HABITS OF ELASMOBRANCHS (94 PAPERS)

1, 3, 5, 19, 20, 38, 43, 44, 84, 87, 88, 89, 90, 91, 92, 97, 104, 105, 106, 111, 113, 120, 128, 129, 130, 131, 137, 138, 146, 176, 177, 197, 199, 209, 218, 2 30, 237, 239,250, 254, 282, 286, 289, 295, 296, 298, 302, 312, 315, 329, 357, 358, 360, 366, 367, 368, 369, 375, 378, 379, 382, 394, 395, 397, 422, 425, 425, 436, 443, 447, 462, 479, 482, 500, 501, 502, 543, 550, 551, 552, 553, 557, 558, 563, 565, 578, 610, 630, 644, 646, 651, 652 and 654.

6.1 Distribution of Papers on Food and feeding habits of elasmobranchs by geographic areas

Western Mediterranean (48 papers)
20, 44, 84, 87, 88, 89, 90, 91, 92, 97, 104, 105, 106, 111, 113, 120, 128, 129, 130, 131, 137, 138, 146, 176, 177, 209, 239, 282, 286, 296, 298, 315, 321, 394, 395, 425, 436, 443, 462, 479, 482, 500, 501, 502, 543, 578, 610 and 644.
Central Mediterranean: (20 papers):
43, 197, 199, 218, 230, 237, 302, 360, 366, 367, 368, 369, 552, 553, 557, 558, 563, 565, 610 and 646.
Eastern Mediterranean (19 papers):
1, 3, 5, 38, 295, 312, 357, 358, 375, 378, 379, 382, 397, 448, 610, 630, 651, 652 and 654.
Black Sea (Seven papers):
18, 250, 254, 289, 422, 550 and 551.

Appendix III – List of elasmobranchs of the Mediterranean and the Black Sea

All listed species are recorded in the Mediterranean Sea
*Species recorded in the Black Sea
? Doubtful presence in the Black Sea

SHARKS

Order **HEXANCHIFORMES**. Cow & frilled sharks
Family **HEXANCHIDAE**. Sixgill & sevengill sharks
Heptranchias perlo (Bonnaterre, 1788). Sharpnose sevengill shark
Hexanchus griseus (Bonnaterre, 1788). Bluntnose sixgill shark
Hexanchus nakamurai Teng, 1962. Bigeye sixgill shark

Order **SQUALIFORMES**. Dogfish sharks
Family **ECHINORHINIDAE**. Bramble sharks
**Echinorhinus brucus* (Bonnaterre, 1788). Bramble shark
Family **SQUALIDAE**. Dogfish sharks
**Squalus acanthias* Linnaeus, 1758. Piked dogfish
**Squalus blainvillei* (Risso, 1826). Longnose spurdog
Squalus megalops (Macleay, 1881). Shortnose spurdog
Family **CENTROPHORIDAE**. Gulper sharks
Centrophorus granulosus (Bloch & Schneider, 1801). Gulper shark
Centrophorus uyato (Rafinesque, 1810)
Family **ETMOPTERIDAE**. Lantern sharks
Etmopterus spinax (Linnaeus, 1758). Velvet belly
Family **SOMNIOSIDAE**. Sleeper sharks
Centroscymnus coelolepis Bocage & Capello, 1864. Portugese dogfish
Somniosus rostratus (Risso, 1810). Little sleeper shark
Family **OXYNOTIDAE**. Roughsharks
Oxynotus centrina (Linnaeus, 1758). Angular roughshark
Family **DALATIIDAE**. Kitefon sharks
Dalatias licha (Bonnaterre, 1788). Kitefin shark

Order **SQUATINIFORMES**. Angel sharks
Family **SQUATINIDAE.** Angel sharks
Squatina aculeata Dumeril, *in* Cuvier, 1817. Sawback angelshark
Squatina oculata Bonaparte, 1840. Smoothback angelshark
**Squatina squatina* (Linnaeus, 1758). Angelshark.

Order **LAMNIFORMES**. Mackerel sharks
Family **ODONTASPIDIDAE**. Sand tiger sharks
Carcharias taurus Rafinesque, 1810. Sand tiger shark
Odontaspis ferox (Risso, 1810). Smalltooth sand tiger
Family **ALOPIIDAE**. Thresher sharks
Alopias superciliosus (Lowe, 1839). Bigeye thresher
Alopias vulpinus (Bonnaterre, 1788). Thresher shark
Family **CETORHINIDAE**. Basking sharks
Cetorhinus maximus (Gunnerus, 1765). Basking shark.
Family **LAMNIDAE**. Mackerel sharks
Carcharodon carcharias (Linnaeus, 1758). Great white shark
Isurus oxyrinchus Rafinesque, 1810. Shortfin mako
Isurus paucus Guitart Manday, 1966. Longfin mako
Lamna nasus (Bonnaterre, 1788). Porbeagle shark.

Order **CARCHARHINIFORMES**. Ground sharks

Family **SCYLIORHINIDAE**. Cat sharks

**Scyliorhinus canicula* (Linnaeus, 1758). Smallspotted catshark
Scyliorhinus stellaris (Linnaeus, 1758). Nursehound
Galeus atlanticus (Vaillant, 1888). Atlantic catshark
Galeus melastomus Rafinesque, 1810. Blackmouth catshark

Family **TRIAKIDAE**. Hound sharks

Galeorhinus galeus (Linnaeus, 1758). Tope shark
Mustelus asterias Cloquet, 1821. Starry smoothhound
Mustelus mustelus (Linnaeus, 1758). Smoothhound
Mustelus punctulatus Risso, 1826. Blackspot smoothhound

Family **CARCHARHINIDAE**. Requiem sharks

Carcharhinus altimus (Springer, 1950). Bignose shark
Carcharhinus brachyurus (Günther, 1870). Bronze whaler shark
Carcharhinus brevipinna (Müller & Henle, 1839). Spinner shark
Carcharhinus falciformis (Bibron, *in* Müller & Henle, 1839). Silky shark
C. limbatus (Valenciennes, *in* Müller & Henle, 1839). Blacktip shark
C. melanopterus (Quoy & Gaimard, 1824). Blacktip reef shark
Carcharhinus obscurus (Lesueur, 1818). Dusky shark
Carcharhinus plumbeus (Nardo, 1827). Sandbar shark
Galeocerdo cuvier (Peron & Lesueur, *in* Lesueur, 1822). Tiger shark
Prionace glauca (Linnaeus, 1758). Blue shark
Rhizoprionodon acutus (Rüppell, 1837). Milk shark

Family **SPHYRNIDAE**. Hammerhead sharks

Sphyrna (Sphyrna) lewini (Griffith & Smith, *in* Cuvier et *al*., 1834). Scalloped hammerhead
Sphyrna (*Sphyrna*) *mokarran* (Rüppell, 1837). Great hammerhead
Sphyrna **(*Mesozygaena*)** *tudes* (Valenciennes, 1822). Smalleye hammerhead
**Sphyrna* (*Sphyrna*) *zygaena* (Linnaeus, 1758). Smooth hammerhead

BATOIDS (SKATES and RAYS)

Order **PRISTIFORMES**. Sawfishes

Family **PRISTIDAE.** Sawfishes

Pristis pectinata Latham, 1794. Smalltooth sawfish
Pristis pristis (Linnaeus, 1758). Common sawfish

Order **RHINOBATIFORMES**. Guitarfishes

Family **RHINOBATIDAE**. Guitarfishes

Rhinobatos (Glaucostegus) cemiculus St. Hilaire, 1817. Blackchin guitarfish
Rhinobatos (Rhinobatos) rhinobatos (Linnaeus, 1758). Common guitarfish

Order **TORPEDINIFORMES**. Electric rays

Family **TORPEDINIDAE**. Torpedo rays

Torpedo (Tetronarce) nobiliana Bonaparte, 1835. Great torpedo
Torpedo(Torpedo) sinuspersici
Torpedo (Torpedo) marmorata Risso, 1810. Spotted torpedo
Torpedo (Torpedo) torpedo (Linnaeus, 1758). Ocellate torpedo

Order **RAJIFORMES**. Skates

Family **RAJIDAE.** Skates

*****_Dipturus batis_ Linnaeus, 1758. Gray skate **?**
Dipturus oxyrhynchus Linnaeus, 1758. Sharpnose skate
Dipturus nidarosiensis (Storm, 1881). Norwegian skate
Leucoraja circularis Couch, 1838. Sandy skate
Leucoraja fullonica Linnaeus, 1758. Shagreen skate
Leucoraja melitensis Clark, 1926. Maltese skate
Leucoraja naevus Müller & Henle, 1841. Cuckoo skate
Raja undulata Lacepede, 1802. Undulate skate
Raja africana Capape, 1977. African skate
Raja asterias Delaroche, 1809. Atlantic starry skate
*****_Raja brachyura_ Lafont, 1873. Blonde skate?
*****_Raja clavata_ Linnaeus, 1758. Thornback skate
Raja miraletus Linnaeus, 1758. Twineye skate
*****_Raja montagui_ Fowler, 1910. Spotted skate**?**
Raja polystigma Regan, 1923. Speckled skate
Raja radula Delaroche, 1809. Rough skate
Rostroraja alba Lacepede, 1803. White skate

Order **MYLIOBATIFORMES**. Stingrays

Family **DASYATIDAE**. Whiptail stingrays

Dasyatis centroura (Mitchill, 1815). Roughtail stingray
Dasyatis marmorata (Steindachner, 1892). Marbled stingray
*****_Dasyatis pastinaca_ (Linnaeus, 1758). Common stingray
Dasyatis tortonesei Capape, 1975. Tortonese's stingray
Himantura uarnak (Forsskael, 1775). Honeycomb whipray
Pteroplatytrygon violacea (Bonaparte, 1832). Pelagic stingray
Taeniura grabata (Geoffroy St. Hilaire, 1817). Round fantail stingray

Family **GYMNURIDAE**. Butterfly rays

*****_Gymnura altavela_ (Linnaeus, 1758). Spiny butterfly ray

Family **MYLIOBATIDAE**. Eagle rays

Myliobatis aquila (Linnaeus, 1758). Common eagle ray
Pteromylaeus bovinus (Geoffroy St. Hilaire, 1817). Bullray

Family **RHINOPTERIDAE**. Cownose rays

Rhinoptera marginata (Geoffroy St. Hilaire, 1817). Lusitanian cownose ray

Family **MOBULIDAE**. Devil rays

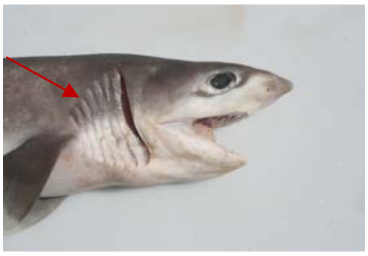
Mobula mobular (Bonnaterre, 1788). Giant devilray

Appendix IV– The regional IUCN Red List status of all assessed Mediterranean elasmobranch species (Gibson et *al*., 2007)

Scientific name	Common name	Threatened Status Mediterranean assessment
Oxynotus centrina	Angular roughshark	CR A2bd
Squatina aculeata	Sawback angelshark	CR A2bcd+3cd+4bcd
Squatina oculata	Smoothback angelshark	CR A2bcd+3cd+4bcd
Squatina squatina	Angelshark	CR A2bcd+3cd+4bcd
Pristis pectinata	Smalltooth sawfish	CR A2bcd+3cd+4bcd
Pristis pristis	Common sawfish	CR A2bcd+3cd+4bcd
Dipturus batis	Common skate	CR A2bcd+4bcd
Leucoraja melitensis	Maltese skate	CR A2bcd+3bcd+4bcd
Rostroraja alba	White skate	CR A2cd+4cd
Gymnura altavela	Spiny butterfly ray	CR A2bcd
Carcharias taurus	Sand tiger shark	CR A2abcd+3cd+4abcd
Isurus oxyrinchus	Shortfin mako	CR A2acd+3cd+4acd
Lamna nasus	Porbeagle shark	CR A2bd
Squalus acanthias	Spiny dogfish	EN A2bd+4bd (VU Black Sea)
Rhinobatos cemiculus	Blackchin guitarfish	EN A4cd
Rhinobatos rhinobatos	Common guitarfish	EN A4cd
Leucoraja circularis	Sandy skate	EN A2bcd+3bcd+4bcd
Giant devilray	Giant devilray	EN A4d
Odontaspis ferox	Smalltooth sand tiger	EN A2abd+4abd
Carcharodon carcharias	Great white shark	EN A2bc+3bc+4bc
Carcharhinus plumbeus	Sandbar shark	EN A2bd+4bd
Heptranchias perlo	Sharpnose sevengill	VU A2d+3d+4d
Centrophorus granulosus	Gulper shark	VU A3d+4d
Alopias vulpinus	Thresher shark	VU A2bd+3bd
Cetorhinus maximus	Basking shark	VU A2bd
Galeorhinus galeus	Tope shark	VU A2bd
Mustelus asterias	Starry smoothhound	VU A2ab+3bd+4ab
Mustelus mustelus	Smoothhound	VU A2ab+3bd+4ab
Prionace glauca	Blue shark	VU A3bd+4bd
Sphyrna zygaena	Smooth hammerhead	VU A4bd
Chimaera monstrosa	Rabbitfish	NT
Hexanchus griseus	Bluntnose sixgill shark	NT
Dipturus oxyrhynchus	Sharpnose skate	NT
Leucoraja naevus	Cuckoo skate	NT
Raja clavata	Thornback skate	NT
Raja polystigma	Speckled skate	NT
Dasyatis centroura	Roughtail stingray	NT
Dasyatis pastinaca	Common stingray	NT
Pteroplatytrygon violacea	Pelagic stingray	NT
Myliobatis aquila	Common eagle ray	NT
Rhinoptera marginata	Lusitanian cownose ray	NT
Galeus atlanticus	Atlantic catshark	NT
Scyliorhinus stellaris	Nursehound	NT
Etmopterus spinax	Velvet belly	LC
Centroscymnus coelolepis	Portuguese dogfish	LC
Somniosus rostratus	Little sleeper shark	LC
Torpedo marmorata	Spotted torpedo ray	LC
Torpedo torpedo	Ocellate torpedo ray	LC

Scientific name	Common name	Threatened Status Mediterranean assessment
Raja asterias	Atlantic starry skate	LC
Raja miraletus	Twineye skate	LC
Raja montagui	Spotted skate	LC
Galeus melastomus	Blackmouth catshark	LC
Scyliorhinus canicula	Smallspotted catshark	LC
Hexanchus nakamurai	Bigeye sixgill shark	DD
Echinorhinus brucus	Bramble shark	DD
Dalatias licha	Kitefin shark	DD
Torpedo nobiliana	Great torpedo ray	DD
Leucoraja fullonica	Shagreen skate	DD
Raja brachyura	Blonde skate	DD
Raja radula	Rough skate	DD
Raja undulata	Undulate skate	DD
Dasyatis chrysonota	Blue stingray	DD
Himantura uarnak	Honeycomb whipray	DD
Taeniura grabata	Round fantail stingray	DD
Alopias superciliosus	Bigeye thresher	DD
Mustelus punctulatus	Blackspot smoothhound	DD
Carcharhinus altimus	Bignose shark	DD
Carcharhinus brachyurus	Bronze whaler shark	DD
Carcharhinus brevipinna	Spinner shark	DD
Carcharhinus limbatus	Blacktip shark	DD
Carcharhinus obscurus	Dusky shark	DD

Appendix V – Colour plates of sharks and rays



HEXANCHIDAE *Heptranchias perlo*

HEXANCHIDAE *Hexanchus griseus*

SQUALIDAE *Squalus megalops*

SQUALIDAE *Squalus blainvillei*

CENTROPHORIDA *Centrophorus granulosus*

OXYNOTIDAE *Oxynotus centrina*

SQUATINIDAE *Squatina squatina*

SQUATINIDAE *Squatina aculeata*

SQUATINIDAE *Squatina oculata*

ALOPIIDAE *Alopias vulpinus*

CETORHINIDAE *Cetorhinus maximus* **(juvenile)**

LAMNIDAE *Carcharodon carcharias*

LAMNIDAE *Isurus oxyrinchus*

SCYLIORHINIDAE *Scyliorhinus canicula*

SCYLIORHINIDAE *Scyliorhinus stellaris*

TRIAKIDAE *Mustelus punctulatus*

TRIAKIDAE *Mustelus mustelus*

TRIAKIDAE *Mustelus asterias*

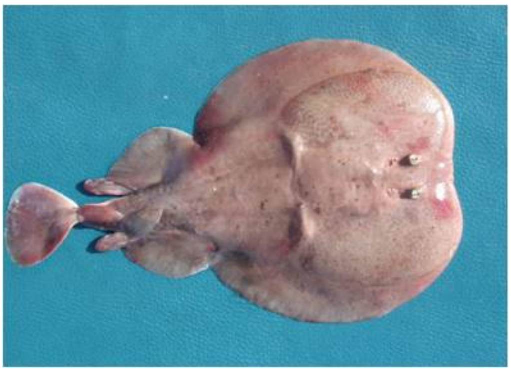
CARCHARHINIDAE *Prionace glauca*

CARCHARHINIDAE *Carcharhinus plumbeus*

CARCHARHINIDAE *Carcharhinus brevipinna*

SPHYRNIDAE *Sphyrna (Sphyrna)* zygaena

RHINOBATIDAE *Rhinobatos (Rhinobatos) rhinobatos*	**RHINOBATIDAE** *Rhinobatos (Glaucostegus) cemiculus*



TORPEDINIDAE *Torpedo marmorata*

TORPEDINIDAE *Torpedo torpedo*

RAJIDAE *Rostroraja alba*

RAJIDAE *Raja asterias*

RAJIDAE *Raja clavata*

RAJIDAE *Leucoraja melitensis*

RAJIDAE *Raja miraletus*

RAJIDAE *Dipturus oxyrinchus*

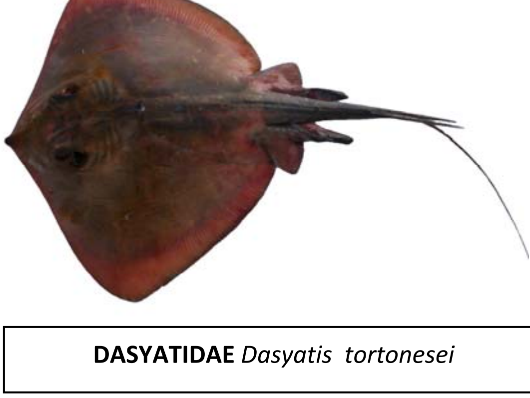
RAJIDAE *Raja radula*

DASYATIDAE *Dasyatis marmorata*

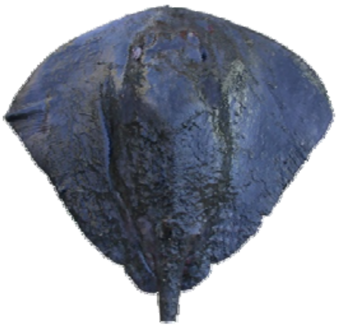
DASYATIDAE *taeniura grabata*

DASYATIDAE *Dasyatis centroura*

DASYATIDAE *Dasyatis pastinaca*



DASYATIDAE *Dasyatis tortonesei*



DASYATIDAE *pteroplatytrygon violacea*

GYMNURIDAE *Gymnura altavela*

MYLIOBATIDAE *Pteromylaeus bovinus*

MYLIOBATIDAE *Myliobatis aquila*

MOBULIDAE *Mobula mobular*

In the document "Elasmobranchs of the Mediterranean and Black Sea: status, ecology and biology. Bibliographic analysis", the authors have compiled published information on taxonomy, distribution, status, statistics, fisheries, bycatch, biologic and ecologic parameters on age and growth, food and feeding habits, reproductive biology and stock assessment of elasmobranchs in the Mediterranean and Black Sea. This bibliographic analysis, through 661 papers dealing with elasmobranchs in the GFCM area, shows that cartilaginous species, including sharks, rays and chimaeras, are by far the most endangered group of marine fish in the Mediterranean Sea, with 31 species (40 percent of all) critically endangered, endangered or vulnerable. The biological characteristics of elasmobranchs (low fecundity, late maturity, slow growth) make them more vulnerable to fishing pressure than most teleost fish. Overfishing, wide use of non-selective fishing practices and habitat degradation are leading to dramatic declines of these species in the Mediterranean Sea. In general, elasmobranchs are not targeted but are caught incidentally. In many fisheries they are, however, often landed and marketed.

Recommendations to fill gaps in order to protect and manage elasmobranchs stocks are proposed. In fact, better understanding of the composition of incidental and targeted catches of sharks by commercial fisheries and biological and ecological parameters are fundamentally important for the conservation of these populations. Moreover, problems encountered by elasmobranchs in the GFCM area are highlighted and conservation measures are suggested.

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