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THE MEDITERRANEAN CHONDRICHTHYAN FISHES (SHARKS, RAYS, SKATES AND CHIMAERAS): STATUS AND PRIORITIES FOR CONSERVATION

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INTRODUCTION

For about 450 million years, chondrichthyan fishes have inhabited the world's oceans, in which they are nowadays widespread, playing an important ecological part in controlling the populations of the prey on which they feed as apex predators. In their evolutionary process, they have survived several mass extinctions, being perfectly adapted to their function of apex predator and to their environment. But today, they are threatened!

For ages, chondrichthyan fishes have been a valuable resource for many human populations, but since the sixties they have been intensively harvested with the industrialization of fisheries. Chondrichthyans are very sensitive to exploitation because of their particular biology, mainly characterized by low reproductive potential, slow growth, and long life span. Many targeted fisheries on sharks have been showing a 'boom and bust' pattern and for a few decades the decline of chondrichthyan populations has been observed all around the world.

This situation has led to growing international concern for the conservation of this resource. Various national, regional and international initiatives have been undertaken to promote the conservation of chondrichthyan fishes. A major step in this line is the FAO International Plan of Action for the conservation and management of sharks (IPOA-Sharks) endorsed by the member states of the FAO Committee of Fisheries (COFI) at the 26-30 October 1998 meeting. IPOA-Sharks is voluntary, though it is stressed that 'states that contribute to fishing mortality on a species or stock should participate in its management'.

The Contracting Parties to the Barcelona Convention have recommended that RAC/SPA elaborate a Mediterranean Action Plan for the conservation of Mediterranean species of cartilaginous fish. The present document is designed to provide basic information for the preparation of this Action Plan. It consists of a first chapter on the biodiversity of the Mediterranean chondrichthyan fishes and their habitats, a second one on their fisheries, and appendices.

I - BIODIVERSITY AND HABITAT

I-A - BIODIVERSITY

Biodiversity is defined as the variety of living organisms in all their forms: genetic, diversity, species diversity and ecosystem diversity. Biodiversity can be affected by changes in the environment, degradation and loss of habitat and overfishing. Loss of biodiversity would cause ecological disturbance and eventually be damaging to human beings. Hence the maintenance of biodiversity and habitat is a major objective of any action plan.

The biodiversity of chondrichthyan fishes is relatively low compared to that of other fishes, there being only c. 1,200 species as against c. 25,000 bony fishes. However, chondrichthyan fishes occur in a large variety of habitats from near the shore to abyss down to 3,600 m depth; some live or are likely to occur in fresh water. They are distributed from tropical to high latitudes, but are more diverse and abundant in the tropics than in polar seas.

Although the Mediterranean is a semi-enclosed sea, its chondrichthyan fish fauna is rather diverse with about 86 species (Table 1), i.e. about 7 % of the total number of living chondrichthyans. In the Mediterranean, sharks are somewhat more diverse than batoids, with 47 and 38 species respectively. Chimaeras are, so far, represented in the Mediterranean by a single species, possibly because of the hydrological characteristics of its deep waters.

Table 1 - Numbers of orders, families, genera and species of chondrichthyans in the Mediterranean Sea, with corresponding numbers for living chondrichthyans of the world.

	Orders	Families	Genera	Species
Sharks	5 (8)	17 (34)	26 (99)	47 (#470)
Batoids	5 (5)	9 (20)	15 (69)	38 (# 650)
Chimaeras	1 (1)	1 (3)	1 (6)	1 (#50)
Total	11 (14)	27 (57)	42 (174)	86 (#1170)

This fauna is composed of a few endemic species, Atlantic species, cosmopolitan species and some Lessepsian migrants from the Red Sea entering the western basin of the Mediterranean through the Suez Canal. The taxonomic status of some species, as well as some records, is still uncertain and revisions are needed.

Endemic: there is a single strictly endemic chondrichthyan species in the Mediterranean: the speckled skate *Raja polystigma*. However, a few species are mainly Mediterranean, with some extension in the eastern Atlantic (from off Spain or Morocco): the Maltese skate *Raja melitensis*, the starry skate *Raja asterias*, and the rough skate *Raja radula*.

Atlantic: about 37 chondrichthyans occurring in the Mediterranean are Atlantic species, i.e. 43 % of the total number of the species.

Cosmopolitan: about 35 chondrichthyans occurring in the Mediterranean have a wide-ranging geographical distribution, i.e. 41 % of the total number of species.

Lessepsian migrants: there are three species reported as Lessepsian migrants. The blacktip reef shark, *Carcharhinus melanopterus,* which seems to have established a small population in Egypt and Israel (unconfirmed records from Libya); the blackspotted torpedo, *Torpedo fuscomaculata*, which has only been recorded from off Alexandria (but this record should be confirmed); and the Forsskal's stingray *Himantura uarnak,* whose taxonomic status should be reviewed.

Doubtful species:

Squalus megalops: the shortnose spurdog has been recorded all around the world; this species seems to be restricted to southern Australia. Hence, many records are the result of misidentification. A review of the genus *Squalus* is needed on a world basis.

Centrophorus uyato: this little gulper shark, described from off Sicily by Rafinesque (1810), might represent a valid species, but it would fit better in the genus *Squalus!* The difficulty is that there is no type material to solve this case!

Galeus atlanticus: species synonymous with *G. melastomus* but resurrected by Munoz-Chapuli (1985); probably a valid species, but its status should be confirmed.

Raja africana: the species is only known by the type specimens from Mauritania and from Tunisia; the specimen from Tunisia has never been deposited in the MNHN collection, thus only the specimen from Mauritania is available.

Raja rondeleti: this heavy thorny skate is only known from four specimens off the French Mediterranean coast and the Gulf of Genoa. They might represent teratological specimens of *Raja fullonica* with abnormally strong development of the thorns on the disc.

Dasyatis tortonesei: in the Mediterranean, there is a stingray that looks like the common *Dasyatis pasticana* but has several distinct features. However, the holotype of *D. tortonesei* deposited in the MNHN collection is a true *D. pastinaca!* Hence, the problem of nomenclature concerning the validity of the name *tortonesei!* This case is presently under study.

Torpedo alexandrines: This species was described by Mahzar in 1982 from 5 specimens found at the Alexandria fish market and has never been recorded since its original description. The latter does not allow accurate comparison with sibling species and the types are not available, hence its doubtful status.

Doubtful records:

Galecerdo cuvier: the tiger shark has sometimes been recorded in the Mediterranean but these records were not documented. Recently, a photograph of the jaws of a specimen caught by a fisherman in Sicily was published. However, the record of this species had better be confirmed.

Torpedo fuscomaculata: recorded once (in 1982) off Alexandria. The specimens are not available.

Rhizoprionodon acutus: possibly a misidentification with a young requiem shark of the genus *Carcharhinus!*

Mediterranean chondrichthyans consist mainly of coastal species (80%), most of them benthic, hence most of the Mediterranean chondrichthyan fauna is likely to be affected by human activities in the coastal areas. Several species (#12) are mainly coastal pelagic, like the basking shark (which is also found at depth in one period of its life cycle).

The deep-water species (#15) also are mainly benthic and although they have been ‘naturally protected’ by the depth of their habitat, the situation has recently changed as deep-sea fisheries have developed on the continental slopes to find new resources or new stocks of already-exploited species with an extensive bathymetric range.

As with chondrichthyan populations around the world, those in the Mediterranean are affected by a wide range of human activities (fisheries, pollution, littoral development, etc). The Mediterranean being a semi-enclosed sea, the effects of these activities on chondrichthyan populations are increased.

I-B - HABITAT

The Mediterranean constitutes a unique ecological unit. It is an elongated sea, about 4,000 km from east to west, enclosed between the European and African continental

masses in temperate to warm temperate latitudes. It consists of two main deep basins (5,121 m maximum depth, 1,500 m on average) with a narrow continental shelf, separated by the shallow Sicilian sill (430 m depth), and is connected to the Atlantic Ocean by a narrow (#25 km), shallow (#320 m depth) Strait and to the Black and Red Seas by channels.

Despite its geomorphological and climatic unity, the Mediterranean Sea offers a variety of marine habitats from littoral lagoon to abyss, and from coast to high seas, which have been inhabited by a variety of chondrichthyan fishes. Thus, fishing methods are a function of these habitats: coastal pelagic, coastal demersal, high sea pelagic and deep-sea fisheries can be distinguished with their respective adapted gear.

But anthropogenic activities lead to degradation of these habitats and in the end, critical ones such as spawning, nursery, pupping and mating grounds and migration routes could be lost. Also, some areas are feeding grounds for some benthic sharks and skates.

In the Mediterranean Sea, some areas are suspected of being nursery grounds: for example most of the young specimens of the great white shark, *Carcharodon carcharias,* have been observed in Tunisian waters, mainly off Cap Bon, suggesting that this is the nursery area for the Mediterranean population of this shark. In the same way, young sandbar sharks, *Carcharhinus plumbeus*, have recently been spotted off the southern Turkish coasts. A spawning ground of the thornback skate, *Raja clavata*, has been localised in the northern Tyrrhenian Sea, which is presently an important fishing area for trawlers. Also, some sharks have territorial behaviour, like the sand tiger shark, *Odontaspis ferox*, whose small population seems resident around an off-shore shoal off Beirut (Lebanon).

In some cases, nursery grounds are located offshore, generally between 100 and 200 m (i.e. *S. canicula* and *G. melastomus*) (Baino & Serena, 2000), but there is little information about the characteristics of these areas and at this moment it is difficult to find a reliable explanation as to the causes that determine the constant location of nursery areas of the mentioned species at these depths (Camhi *et al*., 1998).

I-C- THREATS

Demographic pressure is very great along the coasts of all the Mediterranean countries, which have high population densities. This has caused the development of important urban and industrial zones, including numerous harbours with heavy traffic. Also, the Mediterranean region is very much prized for tourist activities (about 150 million tourists/year), which induces further littoral development. All these urban, industrial and tourist activities produce huge amounts of waste and effluent, often discarded or discharged into the sea, which modify the quality of the marine habitats and environment, particularly in the coastal areas. The impact of this pollution is likely to increase because the Mediterranean is a semi-enclosed sea with a particular hydrology (water stratification due to thermocline). The extension of aquaculture activities all around the Mediterranean basin contributes to habitat and environment modification, alongside the risk of introducing exotic species. As a result, the coastal zone in many Mediterranean countries has been greatly affected by these human activities.

The degradation of nursery or spawning areas or other critical habitats for chondrichthyan species due to pollution, mechanical alteration by fishing devices and overfishing, has contributed to their depletion. An example is the reduction of suitable places where species like *Raja* spp., and *Scyliorhinus* spp. deposit their egg capsules.

Pollution may harm the marine ecosystem in that contaminants (heavy metals, pesticides, etc.) can concentrate along the food chain. A number of studies have already pointed out the high concentrations of mercury in some Mediterranean sharks, which are sometimes over the legal limit (0.50 mmg/kg) as for the dogfish, *Squalus acanthias*, in the Italian waters in which concentrations up to 6.5 mg/kg have been found. In the same way, trace metals were found in the muscle, liver and kidney of the deep-sea sharks *Centrophorus granulosus* and *Galeus melastomus* (from depths of 1,280 to 1,500 m in the eastern basin). Also, high concentrations of organochlorine residues from the degradation of pesticides (DDT, HCB and PCB) were found in the eggs, muscle and liver of *Centrophorus granulosus and Squalus blainvillei*, confirming that the deep-sea sharks have been contaminated. However, there is not much information on how contaminated habitats or the bioaccumulation of heavy metals may affect the health and productivity of either elasmobranchs or the dynamics of the marine food webs in which elasmobranchs are constituents (Camhi *et al*., 1998). Anyway, these high concentrations of various contaminants might cause serious health problems if humans eat these sharks.

Chondrichthyans are particularly vulnerable to over-exploitation because of their biological characteristics, mainly their low reproductive potential, which limit their capacity to recover from over-fishing. Detailed information on the impact of fishing activity on chondrichthyan fish appears in the section of this document devoted to fishery.

Also, limited knowledge about the biology of chondrichthyans contributes to the present situation.

However, growing international concern has emerged about the need for conservation and protection measures. This concern is best summarized in the FAO International Plan of Action for the conservation and management of sharks (IPOA-Sharks).

To determine the impact of human activities on Mediterranean chondrichthyan populations, a systematic inventory of the species occurring in the Mediterranean is herein provided:

- Annex 1: list of species and zoological classification
- Annex 2: general data on species listed in Annex 1
- Annex 3: 7 plates with illustrations of chondrichthyans occurring in the Mediterranean.

The attached draft action plan for the conservation of Mediterranean chondrichthyan fish includes specific conservation and protection measures. However, a number of species occurring in the Mediterranean have already been listed in Annex II to the Protocol concerning specially protected areas and biological diversity in the Mediterranean (Barcelona, 1995) and appear on the IUCN Red List (2002):

* <u>Species in Annex II to the Barcelona Convention:</u>
Cetorhinus maximus – Basking shark

Carcharodon carcharias – Great white shark
Mobula mobular – Ray
:
* Species on the IUCN Red List:
Status: Critically endangered
Pristis pristis – Common sawfish

Status: Endangered
Cetorhinus maximus – Basking shark
Squatina oculata – Smoothback angel shark
Pristis pectinata – Freshwater sawfish
Dipturus batis –Skate

Status: Vulnerable
Centrophorus granulosus – Gulper shark
Carcharias taurus – Sand tiger shark
Carcharodon carcharias – Great white shark
Squatina squatina – Angel shark
Galeorhinus galeus – Tope shark
Carcharhinus brevipinna – Spinner shark
Carcharhinus limbatus – Blacktip shark
Carcharhinus obscurus – Dusky shark
Carcharhinus plumbeus – Sandbar shark
Mobula mobular –Devil ray

Status: Lower risk, near threatened
Hexanchus griseus – Bluntnose sixgill shark
Squalus acanthias – Spiny dogfish
Dalatias licha – Kitefin shark
Lamna nasus – Porbeagle
Isurus oxyrinchus – Shortfin mako
Carcharhinus melanopterus – Blacktip reef shark`
Galeocerdo cuvier – Tiger shark
Prionace glauca – Blue shark
Sphyrna lewini – Scalloped hammerhead
Sphyrna zygaena – Smooth hammerhead
Raja clavata – Thornback ray

Status: Lower risk (least concern)
Mustelus asterias – Starry smooth-hound
Mustelus mustelus – Smooth-hound
Carcharhinus falciformis – Silky shark

Status: Data deficient
Alopias vulpinus – Thresher shark
Sphyrna mokarran – Great hammerhead

Status given above is for the global population of the species; it should be specifically reviewed for Mediterranean populations.

I-D - CONSERVATION AND PROTECTION OF THE BIODIVERSITY AND HABITAT

In a number of countries, protected areas have already been defined with the legal status of national park or reserve to safeguard this unique biodiversity. However, nothing has been done so far with regard to the conservation of the chondrichthyan habitat in the Mediterranean. Lack of public awareness of the threat, or of political will, could partly explain the absence of such measures, but the main problem is the lack of scientific knowledge about critical habitats for chondrichthyan fishes in the Mediterranean. There is an urgent need to inventory these areas.

Management measures to protect the environment by reducing the impact of human activities, especially in the coastal areas, can improve water quality and benthic complexity, and indirectly can be beneficial for the recovery of depleted species that live in these impoverished grounds. In the Mediterranean Sea, many ray species and some sharks, such as *Carcharhinus* spp., use shallow waters as nursery areas.

In fishery management, sustainability depends upon the productivity of the resource, which in turn depends on the health of the resource, including its habitat. Hence the importance of habitat conservation and protection in management. The value of this has long been recognized for chondrichthyans, but very little has been done to protect critical habitats such as the spawning, nursery, pupping and mating areas or migration routes of sharks.

As an example, an experiment that is still under way in the Florida Keys might well serve as a model, positive results having already been observed. It consists of restricting public access during the mating season of the nurse shark within the national park. Before these steps were taken, it was shown that the decline in the nurse shark population in these waters was due to the increase of coastal urbanization and recreational boat use.

When dealing with conservation and protection measures, the following general principles should be adopted:

- Maintenance of chondrichthyan biodiversity
- When data is insufficient, the precautionary principle should be applied
- Naturally rare and endemic species should have special protection or management
- When rare and endemic species are inevitably killed by any human activity, sanctuaries should be established
- Critically endangered and endangered species should receive conservation or management measures along with the associated species on which they are dependent
- Protection of critical habitats once identified.

I-D - DATA AND SURVEY REQUIREMENTS (BIODIVERSITY AND HABITAT)

There is a crucial need of data in aspects of biology and fishery to better monitor chondrichthyan populations in the Mediterranean, among which the following actions are recommended:

- Complete the inventory of chondrichthyan fishes and review/solve the taxonomic problems of doubtful species and records. Here, the following actions are required:

+ An inventory of those chondrichthyans preserved in the collections of the main European, North African and Near East museums/research institutions
+ A survey of the main landing places in the Mediterranean countries to constitute an updated collection of references (including the collection of genetic samples for molecular biology analysis), also allowing some species, inadequately described, to be re-described
+ An exploratory survey of the deep waters of the eastern and western basins of the Mediterranean (international deep trawling and long-lining cruise).

- Promote new scientific research programmes (such as MEDITS) in all parts of the Mediterranean Sea on the general biology of the chondrichthyans, with priority being given to commercial species (grants for students), including the main life-history parameters: growth, reproduction, diet and trophic relationships, geographical and bathymetric distribution, population structure (sex and length-frequency composition).

II -FISHERIES

Cartilaginous fishes caught in large-scale fisheries have in general little commercial value and, in consequence, have rarely been considered as priority species to be studied, assessed or managed (Bonfil, 2002). Despite this fact, some chondrichthyan species are the target of commercial and recreational fisheries and many of them are taken as by-catch in fisheries that target other species.

Data is lacking because many species are caught and then discarded at sea and the number, weight or size structure of these catches are not recorded. Moreover, even when elasmobranch catches are recorded, their taxonomic identification is usually imprecise due to the objective problem of species identification. The main reason for this fact is that few comprehensive guides for the species as to taxonomy, natural history and distribution have been published and produced in the Mediterranean countries.

There are also real scientific limitations on the application of stock assessment tools, traditionally designed for teleost fish, to chondrichthyan stocks. This is not only due to their particular biology but also, sometimes principally, to the low level of knowledge and the scarcity of fishery-dependent data on this group. Moreover, as elasmobranchs completely lacking in hard structures, they cannot be easily and reliably aged. This fact restricts knowledge about the demographic structure of the populations.

The effects of fishing on marine ecosystems and in particular on cartilaginous fish have been better understood in recent years (Bonfil, 1994; Stevens *et al*., 2000). However, we are still at a first level of knowledge, because we are only able to quantify the changes in abundance that have occurred. We need also to better understand the consequences that changes in biomass of these species, generally positioned at the top of the food chains, have for the whole ecosystem, specially in areas of intense fishing activity.

It is also necessary to better understand which fishing practices are more responsible for them. Finally, it would be necessary to identify suitable measures to restore the biomass of each species and, if possible, return the ecosystem to the situation existing before the excessive development of fisheries.

Scientific knowledge about fish fauna, relative abundance of each species, and their life-history parameters is very recent for most countries in the Mediterranean Sea. Fishing activity in the Mediterranean is very ancient, while research started relatively recently, after these fisheries developed. Thus, it is likely that the current species composition of Mediterranean ecosystems does not represent the original one, but is a product of the more or less severe modifications due to fishing activity over time. Despite this fact, there are some available long data series (Aldebert, 1997), as well as anecdotic information (Serena & Abella, 1999), which suggest that chondrichthyan fishes in the Mediterranean Sea were more abundant and had higher species diversity some decades before the present time.

It is well known that cartilaginous fishes species are characterised by a relatively big maximum size, slow growth rates, low fecundity, great age of maturity, and close stock recruitment relationship and that they are more vulnerable to fishing disturbance than most teleost fish. The negative impact on cartilaginous fishes is particularly evident in species of some economic value, because these are caught

and not discarded, or other species which have no commercial value but are discarded when they are already dead or have little or no likelihood of surviving.

There are classic examples of the serious decline of some elasmobranchs in the North Sea. Two such examples are the case of *Dipturus batis* (Brander, 1981) and of *D. laevis* (Casey & Myers, 1998).

Some contrasting evidence comes from the Georges Bank fisheries, where skate and dogfish have recently shown an increase, probably due to the fact that these species have no commercial value and that most of them are able to survive being discarded at sea (Greenstreet & Rogers, 2000).

Rogers *et al*. (1999) state that dogfish and many ray species are practically absent from the south-east North Sea, where high levels of fishing activity occur. However, not all ray species were equally sensitive to fishing: *Raja radiata* has maintained its population size, probably due to its relatively low age at maturity.

II-A - Population dynamics

Cartilaginous fish are in general long-lived species, with slow growing rates, long life span, late age of maturity, low fecundity and, hence, low population growth rates and turnover. These characteristics made them particularly vulnerable to fishing; the removal of even a small portion of their populations may have a very negative effect. The recovery of depleted populations due to the above-mentioned characteristics of the species is difficult, especially if high fishing pressure is maintained unchanged over a long period.

Length-selective fishing mortality may produce changes in growth rates, affecting the size structure of the population. Jennings and Kaiser (1998) state that fishing exerts a selective action that may modify life-history characteristics such as growth rates that are in principle inheritable but may evolve under sustained exploitation. Changes in fecundity, such as the number of eggs or embryos per female of a given size, or a reduction in natural mortality, may constitute compensatory mechanisms developed in response to changes in population abundance, but these mechanisms alone are not sufficient to compensate for losses due to fishing (Stevens *et al*, 2000).

Another strategy that chondrichthyan species may use to recover depleted local populations is the immigration of individuals from less exploited areas. Stevens *et al. (op. cit.)* stress that the most important element to take into consideration when thinking about population rebuilding is net recruitment. Conservation of the quality of the marine environment where juveniles concentrate is in this case of prime importance.

The resilience of elasmobranchs to fishing pressure depends on their vulnerability and on their natural history characteristics. Hoenig and Gruber (1990) suggest the possibility of proposing that species be ranked according to their resilience. They consider that natural mortality rates, age/size at maturity, fecundity and especially the intrinsic rate of population growth (**r**) are the critical aspects of the natural history of chondrichthyan species to address.

It has been already stressed that elasmobranchs are in general at the top of the marine food chains and that it is likely that their removal will produce changes at lower levels. The most logical consequence of the removal is an increase in the abundance of the predator's preferred prey. Available data suggests, however, that

this is a very simplistic deduction. Marine ecosystems are very complex and, consequently, the effect removing predators has on the abundance of the prey may be extremely slight. The idea of 'cleaning' the sea by removing big predators to increase the presence of certain commercially important species that constitute their natural prey is, however, very popular among fishermen and is difficult to disprove with clear evidence.

II-B - Mediterranean fisheries in which elasmobranchs are involved

Elasmobranch fisheries show a modest production when compared with those that target teleost species. In Italy, for example, elasmobranchs represent less than 2% of total catch (Shotton, 1999); smooth-hounds (*Mustelus* spp.) represent about 50% (4,463 t/yr) and rays 38% (3,340 t/yr). *Mustelus* catches are taken almost exclusively from the Adriatic Sea and southern seas. Catches have shown an upwards trend since 1978, peaking in 1985. The commercial value of chondrichthyan species may vary a lot but in general their prices are low compared with those of teleost fishes and shellfish. This is the reason why chondrichthyans often constitute by-catch in fisheries that target more valuable species. The retention or discard procedures will depend on the local commercial interest of each single chondrichthyan species.

In the Mediterranean countries, landed catches of elasmobranch species are sold and consumed fresh or stored or exported after different technological processes (Vannuccini, 1999). Fresh elasmobranch meat is relatively cheap and appreciated by many consumers due to the absence of bones and spines. Dried shark fins are exported to China and other Far East countries. This market is expanding quickly due to rise in demand and the high price that dried fins reach on the international market. The practice of 'finning' sharks has increased, not only because of the high price of this product but also because fins are easily air-dried and stored, even if available space on board is limited.

Mediterranean fisheries use different gear, which are directed at different species or assemblages, mainly bony fishes, crustaceans and molluscs. Fishing activities, depending on intensity and gear, have different levels of impact on pelagic and demersal communities.

Only a few cartilaginous species are targeted by Mediterranean fisheries. Many local Mediterranean fisheries do not target any particular group of chondrichthyan species, but land elasmobranchs caught as accessory species.

Big selachians are often caught incidentally as by-catch by traditional fisheries, especially in long-lines and trammel nets (Serena & Vacchi, 1997). Significant mortality by discard from trawl nets, gill-nets, purse seines and long-lines is also reported. This impact is rarely monitored but locally can be very important.

A special traditional fishery targeting *Prionace glauca* uses the 'stese', short lines with hooks placed near the surface, used mainly in the spring in Calabria and Apulia, southern parts of Italy.

In the northern Adriatic Sea, gill-nets have traditionally been used to catch *Mustelus mustelus*, *M. punctulatus, Squalus acanthias, Scyliorhinus stellaris, Myliobatis aquila* and *Galeorhinus galeus* during the spring and winter and *P. glauca, Pteromylaeus bovinus* and *A. vulpinus* during the summer (Costantini *et al*., 2000).

Many chondrichthyan species can be considered locally or commercially extinct in the Mediterranean Sea because the biomass of these stocks has been reduced to a minimum level, making the probability of capture near to zero, or because it is no longer profitable to continue fishing for them.

Since they are elasmobranches, a component of by-catch in different fisheries that target other species, the decrease in their biomass has been generally neglected, especially when the target species of the fishery in which they are involved allow current exploitation rates to continue. Most of the time, when their disappearance or increasing rarity has been reported, is already too late to take management measures for their biomass recovery. It is extremely difficult to assess the effect the local depletion or total disappearance of a species has on the viability of the same species at global level. Individuals of the same species that inhabit neighbouring areas can probably compensate for this reduction by moving to depleted areas, but better knowledge of population dynamics and migratory behaviour is necessary to answer this question properly.

The environmental characteristics of the different Mediterranean areas may influence the distribution, species richness, abundance and life history of certain cartilaginous species and other species, despite the fishing pressure exerted in the area. This makes it difficult to offer general considerations regarding the status of the cartilaginous fish in the whole of the Mediterranean Sea.

FAO has attempted to record landings of the most important species that live in the Mediterranean, including certain sharks and batoids. Unfortunately, the statistical data on landings that has been collected is associated with the list of species above (reported in the FAO Yearbook) and this is incomplete, with some of the most important landings not recorded: *L. nasus, Scyliorhinus spp., Mustelus spp., S. acanthias*, Squalidae, *S. squatina*, Squatinidae, Squaliformes, and Rhinobatidae.

Given that sharks are usually not the fishery's target species, catch rates are expected to be highly variable and therefore homogeneous over time for the same gear in each country. Apparently, some major fishing nations report important landings of sharks as by-catch of trawling, long-line and drift-netting, while others, such as Spain, seem not to land any sharks at all in the area, or only record small quantities, as in France. Italy frequently reports large quantities of Mustelus spp. as a result of trawling fleet activity, while France reports catches of only a small quantity of Squalus acanthias.

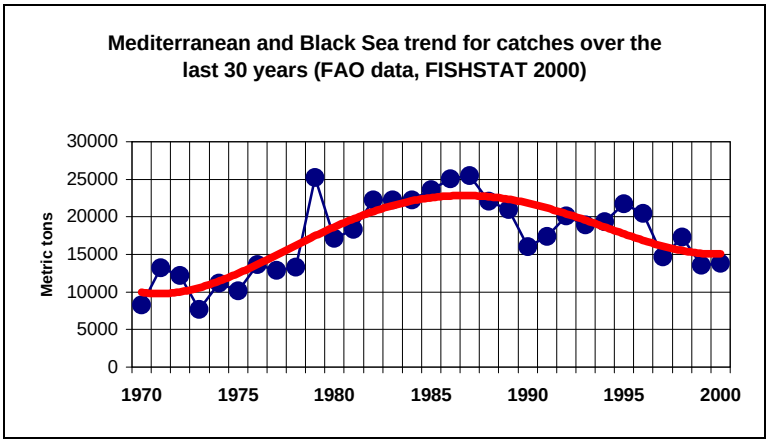
According to official FAO figures, Mediterranean countries were responsible for between 9 and 20% of annual world total landings of a selected species in the period 1990 to 1996. Of course, these figures report official landings and do not include all those catches that are returned to the sea. In many cases, sharks are an undesirable by-catch and are therefore returned to the sea and do not reach the markets. Shark catches can therefore be considered to be underestimated.

Mustelus spp. and *Squalus acanthias* are the two most important elasmobranchs landed in the Mediterranean (FAO Yearbook), but only Mustelus spp. is significant, representing up to 67.7% of total elasmobranch landings in 1994, with an average percentage of 49;5% from 1990 to 1996.

Official figures show Mediterranean landings as being fairly stable over time but fluctuations in landings do occur. These fluctuations are partly related to the level of exploitation, but the overall performance of the fleets in a given fishing season also

has an important role. Italy shows the largest shark landings, even if the trend has been steeply downward since 1994. This can be explained partly by the poor seasons that long-lines have had in recent years and partly by the state of the stocks. Although absolute figures show that Mediterranean landings are fairly minor in the world context, the progressive reduction of catches that fishermen are reporting calls for a conservative approach to the problem, which, in any case, requires more stringent policies in countries where stocks are already considered by scientists to be overexploited.

Elasmobranch catches in the 1970-2000 period represent only 1.1% of total landings in Mediterranean harbours. The most important area for elasmobranch catches are the Ionian and Black Seas, each with 30% of total Mediterranean catch; Sardinian, Adriatic and Balearic waters show catches of respectively 12%, 8% and 7% of the Mediterranean total.



The trend of catches over the last 30 years, as illustrated in the graph, shows an increase from 10,000 to 25,000 metric tons since 1985 and a slow decrease to 15,000 over the following 15 years. This is mainly due to Turkish catches of sharks in the Black Sea and to Italian catches of sharks and rays in the Ionian. Unfortunately it is not clear whether these variations are real or simply due to changes in recording procedure (i.e. some years they are reported as sharks and others generically as marine fishes). (FAO, 2000).

The shark trade is not a major item within the trade flows of the whole European Union but is largely concentrated in the Mediterranean countries. Italy, Spain and France account for more than 70% of sharks traded in the European Union. Italy is by far the largest consumer, with imports of 14,420 tonnes and exports of under 300 tonnes. According to official statistics, Spain and France play an important part in the Mediterranean shark trade, but their official catch records for this area are totally marginal and, apparently, their fleets do not participate in the exploitation of these species.

II-B-1. Chondrichthyans caught in coastal sea fisheries

In the continental shelf, chondrichthyan species are usually caught as by-catch in fisheries that target other species, generally bony fishes (hake, red mullet, sparids),

crustaceans (mainly coastal peneids, mantis shrimp) or molluscs (octopuses, squids, cuttlefish).

Several sharks and rays of different sizes and ages are involved in the fisheries that concentrate their activities near the shore. In this area, enormous quantities of small rays and sharks are caught and systematically discarded. A variable proportion of these individuals can survive being discarded at sea.

Bottom trawl nets may remove important quantities of egg capsules of various chondrichthyan species, especially when the fishing activity occurs near Posidonia beds or other organisms, like yellow gorgonians, where the eggs are fixed.

Some species of ray form part of species assemblages, where they constitute an element of secondary importance, or sometimes they are the most important targets of the fishery. The 'rapido' (a variant of beam trawl) fishery in the north Tyrrhenian, south-east Ligurian and Adriatic Seas, when the drop in catch rates of sole and other highly-priced flat-fishes due to the intense fishing pressure is considered, would not be economically sustainable if *R. asterias* or other low-priced species were discarded. Rays generally represent the predominant species by weight of the daily 'rapido' catch in the north Tyrrhenian Sea (Abella *et al*. 2001). The relatively high abundance of stocks of *R. asterias*, a coastal species present in grounds exploited at relatively high rates, is a rare exception. Its resistance to high fishing pressure can probably be explained by the particular features of their natural history (Serena & Abella, 1999).

For the same area, there is some information on fisheries that target *Squalus spp*. and on the common presence of species such as *Rhinobatos sp., Mustelus spp*. and *Squatina sp*. in the catch of trawlers during the fifties and sixties. The above-mentioned species can today be considered as locally extinct, especially in the northern part of the Mediterranean basin. Many other species of ray, once quite common in the area, can now be considered rare.

Lamboeuf (mimeo), in the recent FAO-COPEMED-MBRC report analysing the traditional fisheries in Libya, gives some examples of selachian target fishery to Carcharinidae, Lamnidae, Rhinobatos and Squatina caught by gill-net, bottom-set and drifting longlines.

Muñoz-Chàpuli (1985) reports data on the Alboran Sea shelf bottom trawl fisheries where two species (*Squatina aculeata* and *Mustelus asterias*) are frequently caught; they have already disappeared in other Mediterranean areas.

Torres *et al*. (2001) studied catch composition in different grounds in the Alboran Sea, especially in some grounds lightly or not exploited, and state that chondrichthyan yields are clearly higher than those in exploited grounds in the area, when the Almeria fleets concentrate their efforts.

The basking shark is incidentally caught with trammel and gill-nets. Young individuals are mainly caught in shallow waters during the spring. Adolescents and adults are also present in the area. The occurrence of the basking shark off the coasts of Tuscany and Liguria in the spring, mainly in May, is probably due to the concentrations of zooplankton found during this period in this area near the shore (Serena *et al*., 1999).

II-B-2. Chondrichthyans caught in deep-sea fisheries

Deep-sea sharks may have very low metabolic and growth rates, and thus are able to sustain only modest levels of capture. The recent development of deep-water fisheries may produce the collapse of some populations of deep-sea elasmobranchs (Musick *et al., 2000).*

Many shark species constitute the by-catch of deep-sea fisheries in the Mediterranean. A European Union research program (EC FAIR Rep. (95-655) 1996) gives a list of the more frequent shark species captured off the southern Balearic islands at the edge of the continental shelf: *G. melastomus* is the most frequent species, followed by *S. canicula, Centrophorus uyato, Centroscymnus coelolepis, Dalatias licha, Etmopterus spinax*, and *Squalus blainvillei*, species quite commonly caught. Many of these species have no commercial value and are systematically discarded at sea. The probability of survival is relatively high, considering that sharks have no swimming bladders, but the mechanical action of the fishing gear, the handling and the difference in atmospheric pressure between the bottom where they live and the sea surface may cause irreversible damage to individuals that is difficult to observe. Despite the above comments, experimental data on discards of small sharks suggests a survival rate of almost 100% for *S. canicula* (Sanchez, 2000).

Similar species composition, sorting and discarding procedures to those in the Balearic area characterise the deep-sea fisheries in the north-west Ionian Sea (Univ. Bari EC FAIR deep fisheries Project 1996).

G. melastomus is the species most frequently caught. *S. canicula, D. licha* and *E. spinax* also form part of the fisheries' by-catch. Only *G. melastomus* and *S. canicula* have some commercial value, the others being discarded. From a different study in the same area (EC-FAIR 1997), S. blainvillei is the most frequent species, followed by *G. melastomus, S. canicula, E. spinax* and *D. licha*.

Along the slope of the continental shelf of Greece (EC FAIR Project 95-655), E. spinax is one of the most important elasmobranchs in the by-catch of shrimp fisheries and is common in the north Aegean and the Thracian Sea, but not in the Ionian Sea. S. canicula and S. blainvillei are other quite common components of the by-catch.

In the eastern Mediterranean, Hornung *et al*. (1993) refer to data from a monitoring survey*: Centrophorus squamosus, G. melastomus, Somniosus rostratus*, *E. spinax* and *H. griseus* are the more important elasmobranch species in the deep-sea fisheries' by-catch.

Relini *et al*. (1999) provide data on by-catch of the red shrimp fishery in the Ligurian Sea, and *G. melastomus* represents the main elasmobranch species in the by-catch. Most individuals, and other small-sized sharks, are discarded.

The main component species involved in the north Tyrrhenian Norway lobster fishery that constitute discard are *Chimaera monstrosa, G. melastomus* and *E. spinax* (Serena, per. com.).

In the area of Majorca, Spain, in deep-water crustacean fisheries, many species of small shark are caught but only individuals of *Squalus* spp., *S. canicula, G. melastomus,* and *Centrophorus granulosus* are landed (EC FAIR 1996).

In Italy, in deep-water trawl fisheries that target red shrimps (*Aristeus antennatus* and *Aristaeomorpha foliacea*), Norway lobster and hake, the only shark marketed is *G. melastomus*.

Dipturus oxyrinchus is commonly captured in the central Ligurian Sea and in other Italian areas, but is extremely rare today. *D. oxyrinchus* is a big-sized, slow-growing species, and can be included among the species that first showed a clear decline due to intensification of fishing pressure. This species, however, is still relatively frequent in the southern Ligurian Sea, probably due to lower fishing pressure on the deep-water grounds where the species lives (Serena, per. com.).

The relatively high abundance of stocks of *R. clavata*, found in deep waters in grounds exploited with relatively high catch rates, represents a rare exception. The resilience of this species to high fishing pressure can probably be explained by the particular features of its natural history (Serena & Abella, 1999).

Trammel nets positioned near the bottom may catch individuals of big-sized sharks. Fergusson (1996) reports the catching of *C. carcharias* individuals with this kind of gear and procedure in Malta and Sicily.

We can notice that there is a strong similarity in the species composition of sharks caught as by-catch in deep-water fisheries for the whole Mediterranean. Many species represent an important proportion of total catch in weight in this depth interval. There are, however, only a few studies on these species; most of them look at their geographical distribution, and others at some biological aspects, but there is a total absence of assessment of the current state of exploitation of these resources.

II-B-3. Chondrichthyans caught in pelagic fisheries

There are no Mediterranean pelagic fisheries that target migratory oceanic sharks, but these species form a large part of the tuna and swordfish by-catch in coastal and offshore fisheries that utilise longlines, drift-nets and purse seines.

Fixed tuna traps represent the fishing activity that has historically had a major impact on cartilaginous fishes. These structures were placed all along the Mediterranean coasts, mainly along the Italian coasts that constitute the most important migration routes to the rich areas of the Ligurian-Provencal basin. About twenty main tuna traps were active in the Mediterranean up to thirty/forty years ago, but today their number is very much reduced and confined to the major Italian islands and North Africa (Cushing 1988).

In the past, numerous large pelagic sharks and other demersal elasmobranchs were caught by tuna traps lying along the tuna migration routes. Today almost all the Mediterranean tuna traps are closed, being no longer profitable. Historical data from the tuna traps records is very important and constitutes an accurate documentation of the former greater abundance of elasmobranch species. Moreover, tuna trap information shows the progressive loss of chondrichthyan biodiversity. The main species of chondrichthyan fish traditionally caught as tuna by-catch in the traps were big-sized individuals of *A. vulpinus, C. maximus, Sphyrna mokarran*, *P. glauca, M. mobular* and, sometimes, the white shark *C. carcharias* (Boero & Carli, 1979; Vacchi *et al*., 2002).

It is generally accepted that the traditional technique most suitable for catching a large number of elasmobranch fishes is the drift-net, in the past widely used all along the Mediterranean basin and currently prohibited by the Commission of the countries in the European Union. This prohibition does not apply to extra-communitarian countries, but it is likely that in the future this fisheries management measure will be

extended to cover the whole Mediterranean and the use of this harmful gear definitively banned. The chondrichthyan species most vulnerable and frequently caught with drift-nets are *P. glauca, A. vulpinus*, *I. oxyrinchus, L. nasus, Carcharhinus spp., Cetorhinus maximus, Sphyrna spp., M. mobular, D. violacea* (De Metrio *et al*., 1999; Muñoz-Chapuli, 1994).

Fishing activity aimed at catching swordfish, more common in the southern part of Mediterranean countries such as Italy, Malta, Morocco, Tunisia and Crete, sometimes uses a small drift-net, producing a sizeable by-catch, mainly of *A. vulpinus* and *P. glauca.*

With the moratorium on drift-nets in the Mediterranean that started in January 2002, it is expected that the undesired fishing mortality of elasmobranchs caught with this gear will be reduced. However, the above-mentioned species are not 'covered' by any international or national conservation plan. There still exists no statistical data on shark by-catch in Mediterranean pelagic fisheries. In spite of this, in some cases we have significant examples of elasmobranchs (e.g. pregnant M. mobular) being caught during purse seine activity that targets anchovy (Notarbartolo & Serena, 1998), or of D. violacea caught in the Ligurian Sea as by-catch in the swordfish fishery (Orsi Relini *et al.,* mimeo) and in the south-western Mediterranean Sea (Aguilar *et al.,* 1992). Although *D. violacea* in the western Ligurian Sea represents the most important catch of the longline fishery that targets swordfish, all specimens are discarded at sea because their commercial value is little or nothing.

Modest catches of *P. glauca* have been landed as by-catch of the swordfish and albacore fisheries with drift longlines. Depending on hook selectivity and seasonal cycle, swordfish fisheries land blue sharks that are bigger (mean weight 25 kg) than albacore (3 kg) (De Metrio *et al*., 1984).

P. glauca is also caught by offshore pelagic fisheries along the Algerian coast. Important catches of carcarinid species (*C. brachyurus, C. brevipinna, C. falciformis, C. obscurus, C. plumbeus* and *C. altimus*) are obtained by the pelagic longline fishery operating from ports in the east of Algeria (Hemida & Labidi, mimeo).

Only one project for collecting statistical data has referred to incidental captures, sightings and strandings of cartilaginous fish in the Mediterranean Sea: it was the MEDLEM (Mediterranean Large Elasmobranch Monitoring) and started in 1985 for Italian waters. Successively it was extended to cover the entire Mediterranean basins as the 'Basking shark protocol' (Proposal at the last meeting of SAC-GFCM in Barcelona, 6-9 May 2002).

This program has allowed the acquisition of valuable miscellaneous information, including several records of captures and sightings of the zooplanktivorous large shark *C. maximus*.

The frequency of incidental catches and sightings of this shark by year has been analysed for about 400 specimens. Information gathered by season shows that the catches and sightings of basking sharks are highest in the spring, from February to June, with a maximum in May (22% of the total). In this period in the Mediterranean Sea we can also register the maximum concentration of plankton (Serena *et al.,* 1999a).

At this moment, the only available information on *C. maximus* in the Mediterranean basin comes from occasional sightings (31%) or incidental catches. The gear mainly

responsible for catching this shark is the trammel net, accounting for the 23% of the total 226 records analysed (Clò *et al*., in press).

Di Natale *et al*. (1992) refer to the by-catch and discarding of large pelagic sharks such as the basking shark, white shark, thresher shark and blue shark in different drift-net fisheries off the North African coast and the Ligurian Sea. This author also cites incidental catches of stingray, and Serena *et al*. (1999b) confirm this, recording a specimen of *Taeniura grabata* caught by a trammel net in shallow water along the Tuscany coasts.

Finally, but in no way negligible, is the removal produced by game fishing, especially because over the past few years this activity has developed markedly and this fast increase is an object for concern. After this type of activity developed in the United States, Australia and other countries, the number of big game fishermen grew, mainly in the Italian Adriatic Sea, but also in the Tyrrhenian Sea and on the Spanish and French coasts (Bianchi *et al*., 1997).

The target species of game fishing are mainly *A. vulpinus* and *P. glauca*. The catch mainly consists of young individuals, sometimes recently-born individuals. At the moment there is a lack of measures that are enforced for the protection of juveniles of most elasmobranch species and, where such measures exist (as for *P. glauca*), the controlling of game fishing activity is in any case very difficult. So there is a real danger that this activity will, in the near future, lead to a population reduction of the involved species, as has occurred in Cornwall (Vas, 1995).

II –C. Management measures in the Mediterranean

As a result of their life strategy, elasmobranchs are not easily able to adapt to changing environmental conditions. The intense fishing pressure that has been exerted on coastal areas in the Mediterranean Sea in the last century has produced a reduction in their number as well as increasing habitat loss and degradation. The illegal fishing that takes place very close to the shore or on the Posidonia or other sea plant beds, has also led to the removal of many egg capsules of rays and sharks, thus reducing recruitment success.

The Mediterranean species listed as protected in the Barcelona and Bern Conventions do not receive real protection because several countries have not ratified them or because management measures are not enforced.

The particular ecological behaviour of chondrichthyan fish requires a conservative management approach: there is little knowledge of the variables to be considered to assess the real state of the populations, and the enforcement of management measures is uncertain. Management measures have to be addressed to avoid recruitment overfishing of exploited species (in direct fisheries or as by-catch), to maintain catches at levels of Maximum Sustainable Yield, to reduce the presence of chondrichthyans in the by-catch, to encourage fishing procedures (even for game fishing) that ensure that non-commercial cartilaginous fish are discarded alive and with a high probability of survival.

Assessments of the state of the stocks should be done using appropriate methods that take the particular characteristics of these species into consideration. Holden (1974) states that fisheries of elasmobranchs could be sustainable if exploitation proceeds slowly for species that are relatively fecund and that can react quickly to

changes in density. Their relatively large size at birth makes them less prone to the effects of environmental changes than teleost fish.

Changes in the structural characteristics of trawling gear (mesh size, square meshes, excluding devices, short duration of hauls) can constitute suitable technical measures to reduce the catch of small-sized individuals, by-catch and discard (Stergiou *et al*., 1998, Moranta *et al*., 2000). This can also be achieved by avoiding fishing in areas where certain species or age classes are concentrated. Exclusion of fishing in certain areas does not necessarily have to be permanent and can be enforced in temporary coincidence with phenomena that can be seasonal only, such as the concentrations of spawning individuals or juveniles; hence, this management measure can be effective even if restricted in time.

An undesired exploitation pattern can be changed by discouraging the use of some non-selective gear that is thought to have a high negative impact on cartilaginous fish.

In relation to generalised, excessive fishing pressure, reducing the fishing effort or the amounts harvested can be useful not only for the species that are the target of a fishery, but also for those that constitute the by-catch, such as most of the elasmobranchs. Professional and recreational catch quotas can be established but, in the case of the Mediterranean Sea fisheries, the enforcement and control of this kind of measure is very difficult. Limiting the entry to some fisheries is an easier way, but the vessels that already fish these resources can improve their fishing ability by gaining experience and using more efficient technology.

Imposition of legal size limits is another management measure that can be very useful. Scientists have frequently recommend that managers set the minimum size of first capture at the size of first maturity. In this way, every specimen can reproduce at least once in its life. This strategy, especially in the Mediterranean bottom trawl fisheries, is difficult to enforce and is likely only to produce increased discard of undersized individuals with low probability of survival after being discarded at sea.

Fecundity is considered as proportional to size and hence changes in the size structure of populations produced by fishing activity, in particular a drop in the mean size of adults due to high levels of fishing pressure, have negative consequences for reproductive success.

Management measures useful for the protection or sustainable harvesting of chondrichthyan species are the implementation of a constant monitoring of the fisheries where chondrichthyans are either the target, or part of the by-catch. This action will allow early detection of any evident decline in their biomasses or size of capture - unequivocal signals of overfishing. This monitoring can be implemented through interviews or direct observation in the landing places or through the filling in of log-books. It is also necessary to improve the collecting of national statistical data.

Restrictions on fishing activity in certain areas or periods where specific phases of life are concentrated (juveniles, spawners, feeding areas) can be enforced; in this way we could reduce the negative impact of fishing on the stocks of chondrichthyan fishes.

Moreover the next measures could be proceeded with:
- Prohibition of ‘finning’
- Increasing the list of endangered species in the Mediterranean Sea, but with enforceable regulations

- Increasing the dissemination of information, education and public awareness.

The entire Mediterranean scientific community would develop a project for assessing the cartilaginous population on a basis of knowledge and the collecting of data on fishing activities in the Mediterranean Sea. This could include game fishery, which can be assessed by analysing fishing club records (Donald *et al*., 1999).

II – D. Data requirements (fisheries)

For the sound management of cartilaginous species, greater knowledge of species taxonomy for Mediterranean species, of their biology, geographical distribution, migratory patterns and population dynamics, is necessary. Only with a sound knowledge of these aspects will it be possible to construct models for assessing the state of exploitation of the stocks and for providing useful advice as to the management of fisheries.

Better knowledge of the fisheries in which these species are involved, and of the impact each one of them has on each single species, is also unavoidable. It is necessary to know, for each species and fishing procedure, the amount of captures and their exploitation patterns (i.e. the levels of fishing pressure exerted on the different age or size classes), the fraction of discard, the likelihood of survival of discarded fish, the catch trends useful for detecting any change in biomass at sea. Fishery-independent methods, such as trawl-surveys, and fishery-dependent methods (catch assessment surveys) are equally useful and complementary approaches to collecting all the necessary information.

Shotton (1999) stresses the need to improve both qualitatively and quantitatively the collecting of statistical data, particularly for sharks, because of the high level of aggregation of species and groups. Data should be also divided by sex, length and size of individual caught. It would be necessary to know whether the catch is completely or partially retained and the reasons of discarding, the life status of individuals when discarded, plus information on trading, and details on importing/exporting countries and the origin of commercialised fish.

Given that sharks form part of marine ecosystems, a better knowledge of Mediterranean marine ecosystems and of the role of chondrichthyans within them is an absolute priority.

Many chondrichthyan species being migratory, there is a need for international collaboration for the exchange of scientific information, the preparation of regional identification guides, the enforcing of protocols for standardised data collection, and the organisation of training programmes for management and data collection (for this reason FAO is preparing a Field Identification Guide to the Sharks and Rays of the Mediterranean Sea). All these activities not only have to be developed by researchers, but have to involve stakeholders. Moreover, national and regional governmental institutions can be also involved.

CONCLUSION

Today, the serious threats to populations of the chondrichthyan fishes of the world are largely acknowledged. These threats affect both their biodiversity and their abundance. This led to the elaborating of an international Action Plan for the conservation and the management of shark populations (FAO-IPOA-Sharks).

Although there is little data, there is evidence that the chondrichthyans of the Mediterranean Sea show a similar decline, possibly having to face a worse situation since it is a semi-closed sea with intense fishing activity all around its coasts as well as offshore. The threats concern coastal and pelagic species and also deep-sea species, whose populations have been exploited for a decade only.

Beside the lack of accurate fishery data on chondrichthyans, we know very little about the biology and ecology of most species. Inventorying the species still has to be reviewed, since a number of taxonomic problems have not yet been solved.

Because of the high trophic level of the chondrichthyan fishes (most are apex predators in the food chain), conservation of their diversity is essential for the health of the whole marine ecosystem. However, a lot of research is needed to better understand their ecological role and assess the ecological risk of their being over-fished. The results of the desired research would be useful for designing suitable conservation and management measures. However, to slow down the decline, immediate conservation measures should be taken according to the precautionary principle.

For this purpose, the present information document would be of help in the preparing of a Mediterranean Action Plan for the conservation and management of chondrichthyan fishes, and consequently for the whole Mediterranean marine ecosystem.

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