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Subject:		"Report of Ad hoc Working Group - Elasmobranchs Fisheries"

Delegations will find attached Commission document SEC(2003) 1427.

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[1] The text annexed hereto has been received in English only by the General Secretariat of the Council.

COMMISSION OF THE EUROPEAN COMMUNITIES

Brussels, 5.12.2003
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COMMISSION STAFF WORKING PAPER

REPORT OF AD WORKING GROUP

ELASMOBRANCHS FISHERIES

Brussels, 22-25 July 2003

This report has been evaluated and endorsed by the Scientific, Technical and Economic Committee for Fisheries (STECF) in its plenary session of 3-7 November 2003.

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EXECUTIVE SUMMARY

The principle aim of the meeting was to collate, update and comment as appropriate, on available commercial, scientific and technical information on elasmobranch fisheries, biological and ecological data of relevance to fisheries managers, and the status of elasmobranch stocks. This report, the previous STECF report, and other sources of information already available to the Commission (e.g. the DELASS report), present the background information that is required for the preparation of a European Community Plan of Action for elasmobranch fishes.

Chapter 1 provides the Terms of Reference and the list of participants.

Chapter 2 provides an overview of Community fisheries that catch elasmobranchs (TOR 1, 8). It gives an updated description of the commercial and recreational fisheries for elasmobranchs in the Northeast Atlantic (Section 2.1), Mediterranean Sea (Section 2.2) and for Community fisheries that catch elasmobranchs in other waters (Section 2.3). These descriptions were also given in the previous report of this subgroup (STECF 2002), but have now been updated, specifically with regards to more detailed landings data, and a more complete description of the fisheries in the Mediterranean.

In Chapter 3, details are given on species distribution and stock structure of the nine species that were studied in the DELASS project (Development of Elasmobranch Assessments, DG Fish Study Contract 99/055). Length-Weight relationships and other conversion factors for a wide variety of elasmobranchs, plus information on length at maturity for a limited number of species are also provided (TOR 2-3).

Chapter 4 deals with the ecology of elasmobranchs, with particular emphasis on breeding seasons, breeding grounds, spawning and nursery grounds, feeding grounds, essential fish habitats and other ecosystem considerations (TOR 4, 9, 10).

The main chapter is Chapter 5, which addresses management considerations (TOR 6-8, 11-13). This chapter first focuses on appropriate management units for elasmobranch fisheries in and outside Community waters. Then it describes trends in the abundance of the 9 DELASS species, and gives some general information on stock assessment methods. An important Section is 5.5, which lists the data requirements, again for the DELASS species but also for other major elasmobranchs. It is important to note that for many species of elasmobranch, often even the most basic data are missing. Section 5.6 reviews the major species that are priority species from a fishery management's point of view, and from the point of view of nature conservation, including prioritisation of the species. Section 5.7 discusses some case studies of existing International Plans of Action, and provides details that could form the basis for a European Community Plan of Action.

1. Introduction

Both in 2002 and in 2003 STECF organised a meeting dedicated to elasmobranch fisheries. The report of the 2002 meeting has been published as Commission Staff Working Paper SEC(2002)1160. The principle aim of both meetings was to collate, update and comment as appropriate, on available commercial, scientific and technical information on elasmobranch fisheries, and the status of the stocks. The reports of both meetings, together with other sources of information as well as knowledge already available to the Commission, present background information for the preparation of a Community Plan of Action on Elasmobranchs.

Where insufficient, robust scientific information was available, STECF has been requested to provide its expert judgement.

1.1 Terms of reference

In its terms of reference, supplied by the Commission, the subgroup was asked to:

1. To provide a comprehensive and updated overview of Community fisheries, both commercial and recreational, that catch elasmobranch stocks, either as target or by catch species. These fisheries should be briefly described in terms of target species or group of species, fishing gear (average length, mesh size, hanging ratio etc.), fishing regime, catch composition, catch rates, average size of catches, size distribution of main target species, discard rate and its size composition, number of fishing vessels, fleet dynamics and characteristics. Fishing grounds of the main target species or group of species should be mapped

2. To provide, by species, the allometric relationships between different portion of elasmobranches body, including fins

3. To provide a comprehensive and updated overview of maturity ogives, by length and/or age, for the main species identified

4. To provide a comprehensive overview of breeding and spawning seasons (overall period and peak of spawning) and map breeding and nursery areas

5. To provide a comprehensive and updated overview of lengths at first capture and selectivity parameters by hook size, mesh size, hanging ratio etc.

6. To review and identify appropriate stock units for management of elasmobranch fisheries. For deep water sharks, see also STECF-SGFEN report SEC(2002)133.

7. To provide past and recent trends in abundance of major elasmobranch stocks

8. To provide the status of major elasmobranch stocks as well as an explicit ranking of stocks which are at different level of risk according to the most updated evaluation or expert judgment

9. To identify, to describe and possibly map essential fish habitats and pelagic/benthic communities, either in shallow or deep sea waters, which are considered important for the production of elasmobranch stocks

10. To point out ecosystem considerations considering both of the ecological requirements and roles of most important elasmobranch species in structuring and functioning of marine communities. In the light of this, experts shall assess possible bottom-up or top-down effects of more abundant elasmobranch populations.

11. To identify gaps in the current knowledge of fishery systems and assess the suitability for elasmobranchs of traditional stock assessment methods. Possible future monitoring and research needs should be highlighted.

12. To identify possible desirable management objectives and strategies for the various species or group of species and fisheries targeting elasmobranches. Possible ways to improve inter-species selectivity, in order to reduce elasmobranchs by-catches without affecting the target species, should be identified, if necessary.

13. To report case studies of management of elasmobranch fisheries undertaken at national level

1.2 Participants

The participants are listed below and contact details are given in **Annex 1.**

Members of STECF

Di Natale, Antonio

Helle, Kristin

Invited experts

Clarke, Maurice

Blasdale, Tom

Diez, Guzman

Ellis, Jim

Figueiredo, Ivone Maria

Fowler, Sarah

Heessen, Henk (chair)

Megalofonou, Persefoni

Meliane, Imène

Olaso, Ignaçio

Serena, Fabrizio

Seret, Bernard

Vacchi, Marino

STECF Secretariat

Biagi, Franco (EC Commission)

1.3 Methods and working strategy of the subgroup

In order to assist the Commission to prepare a Community Plan of Action for the conservation and management of elasmobranchs, within the framework of the FAO-IPOA sharks, a group of specialists met at DG Fish from 23-26 September 2002 (see SEC (2002) 1160) and from 22-25 July 2003 as an STECF subgroup on Resource Status (SGRST). In its terms of reference the Group was asked to compile and comment as appropriate, on commercial, scientific and technical information. Moreover, scientific research needs should be pointed out. A second meeting of the group was necessary since the EU funded project "Development of Elasmobranch Assessments DELASS" (CFP 99/055) was only finalized some months after the first meeting in 2002, which means that the conclusions from this Study could now be included in this report. Also some relevant new information became available from the meeting of the ICES Working Group on Elasmobranch Fisheries which met in Vigo in April 2003 (ICES 2003).

The Terms of Reference for both meetings were quite similar. Several ToRs have been revisited as new information has become available. Items that were only dealt with in the 2002 report are the listing of all elasmobranch species, text on maturity ogives, and details on elasmobranch selectivity.

Compared to the meeting in 2002, there was a better representation of scientists from the Mediterranean area. In this report, therefore, it has been possible to expand considerably the information given for Mediterranean fisheries and Mediterranean stocks.

The information on ecology of elasmobranchs has been expanded. A ranking is provided for species which should be assessed from a fisheries management perspective, and research requirements for these species are described. Also a ranking is provided from a conservation perspective.

Apart from background information, this report finally presents a 'skeleton' for a Community Plan of Action.

As last year, the group was asked in its terms of reference, to produce a report on <u>elasmobranch fisheries</u> and <u>elasmobranch stocks</u>. Together with the Holocephali (chimaeras), elasmobranchs (sharks and rays) form the class of Chondrichthyes. When in this report “elasmobranchs” are mentioned, this term is understood to include not only sharks and rays, but also chimaeras, although taxonomically this is not correct.

2 Elasmobranch fisheries

This chapter provides an overview of Community fisheries that catch elasmobranchs (TOR 8). It gives an updated description of the commercial and recreational fisheries for elasmobranchs in the Northeast Atlantic (Section 2.1), in the Mediterranean Sea (Section 2.2) and of Community fisheries that catch elasmobranchs in other waters (Section 2.3). These descriptions were also given in the previous report of this subgroup (STECF 2002), but have now been updated.

2.1 Northeast Atlantic (Baltic, North Sea, Western waters, CECAF area, etc.)

2.1.1 Commercial fisheries

For the purpose of distinguishing and characterizing fisheries, elasmobranchs will be divided into four groups (as in the previous report of this subgroup): coastal sharks and dogfish, pelagic sharks, deep-water sharks, and skates and rays. In the Northeast Atlantic the majority of shark, dogfish, skate and ray landings are made as a by-catch from fisheries directed at teleost species.

The overall description of the Northeastern fisheries follows quite closely the synthesis presented in the final report of DELASS (Heessen 2003). Additionally for some species or groups of species, figures with the catch trends are presented. These figures include also estimates of landings which are not discriminated at the species level but that presumably may be assigned to the group under consideration, thus stressing the high level of uncertainty around the elasmobranch landing estimates and also the urgent necessity of its improvement.

Some directed fisheries for elasmobranch species have developed rapidly, and a locally abundant part of a species' population has been fished intensively until it no longer provided an economic resource. There are numerous examples where, following a number of years of good fishing in a particular locality, the targeted species was reduced to the extent that the fishery was no longer worthwhile (so-called "boom and bust" fisheries). One example is the spurdog fishery in the Irish Sea, where they were initially landed as a by-catch by trawlers targeting other species, but which expanded due to the development of a fleet of longline vessels based at Holyhead. In 1981, 920 t were landed by English and Welsh vessels. By 1984, this had increased to 2,500 t and landings eventually peaked at 3,940 t in 1987. The landings in 1996 amounted to 1,133 t. The Norwegian basking shark and porbeagle fisheries are other examples of this phenomenon.

Except for the basking shark *Cetorhinus maximus* and porbeagle *Lamna nasus* TACs agreed for Norwegian vessels fishing in EU waters, and the new North Sea TACs for spurdog *Squalus acanthias* and skates and rays (Rajidae), none of the elasmobranchs are subject to catch controls. There has, therefore, been no obligation for fishermen to record catches in the logbooks used for monitoring quota uptake of TAC species. As a consequence, there is a lack of information on the fisheries for elasmobranchs, and the compiled landing data are very limited due to the lack of reporting of data by species and/or by métier by most countries. Information and data which can be used to describe the fisheries that catch elasmobranchs in the Northeast Atlantic and their evolution are, therefore, generally scarce compared to those for teleost fisheries, though this situation has improved considerably through the DELASS project.

The major part of the elasmobranch landings are from nine nations for which the evolution of coastal and open-water/offshore fisheries has been shaped by local geological features. Most of the Atlantic coastal countries of Europe lie adjacent to the wide, relatively shallow continental shelf, and their fleets have traditionally fished on the shelf in the Baltic, North, Irish and Celtic Seas, west of Scotland, the Channel and the Bay of Biscay. In Spanish and Portuguese waters, and off Norway, the continental slope lies closer to the coast, and these nations also have a long-standing practice of open-water fisheries. In Portugal, the exploitation of deep-water species by longliners that catch deep-water sharks as a by-catch began in the 17th Century, in particular in Madeira waters (Noronha 1924). Since 1990, however, the expansion of deep-water trawling and longlining for previously unexploited demersal species has resulted in an increase in landings of deep-water sharks.

2.1.1.1 Coastal sharks and dogfish

The main species in this group are spurdog (*Squalus acanthias*), lesser-spotted dogfish (*Scyliorhinus canicula),* nursehound (*Scyliorhinus stellaris*) and smooth-hounds (*Mustelus* spp.). Collectively, landings of this group comprise around half the total weight of elasmobranchs taken from the Northeast Atlantic.

<u>Spurdog</u>

Spurdog is a relatively small (<130 cm TL) squaliform shark and by far the most important of the directed fisheries for elasmobranchs. This species is the most widespread of the coastal elasmobranchs in the Northeast Atlantic, moving in large packs, often segregated by size and sex. This behavior might cause the high variability in catch rates in the commercial fisheries and in surveys. During the early 1900's, spurdog was not of great economic value and landing values were small. As in other parts of the world, spurdog was viewed as a nuisance, as shoals of this species could cause considerable damage to nets in (e.g.) the herring fisheries.

Total landings of spurdog from the Northeast Atlantic are difficult to determine for many years in which some countries combined all species of dogfish in declared landed weights. Even so, ICES and FAO statistics indicate that spurdog landings declined rapidly from the mid-1980s, falling to less than 20,000 t in 1994, a drop of more than 50% from the 43 thousand t reported in 1987. According to Muñoz-Chàpuli *et al.* (1993), there was a gradual decline in landings reported from the Scottish-Norwegian area, followed by a similar trend in the North Sea, though increases in landings have been reported to the west of the UK.

Today, the main fishing grounds for spurdog are: Norwegian Sea (Sub-area II); North Sea (IV); Northwest Scotland (VI) and the Celtic Sea (VII). Some landings are also from the Skagerrak and Kattegat (Sub-area IIIa) and Iceland (V). The UK, France, Ireland and Norway are the major exploiters of spurdog, with annual landings typically in excess of 1,000 t. Smaller quantities are also landed by Germany, Portugal, Belgium, Denmark, Poland, Iceland, Sweden and Spain.

Landings of this species remain difficult to quantify due to differences in the level to which they are identified in national landing statistics (Figure 2.1.1). True figures for landings can be considered to lie between maximum and minimum values. The minimum figure includes only landings which are specifically identified as *S. acanthius* while the maximum includes categories such as "Squalidae", "dogfish" or "dogfish and hounds" which may include a number of other species (eg. deep-water squalids, spotted dogs, smoothhound and tope).

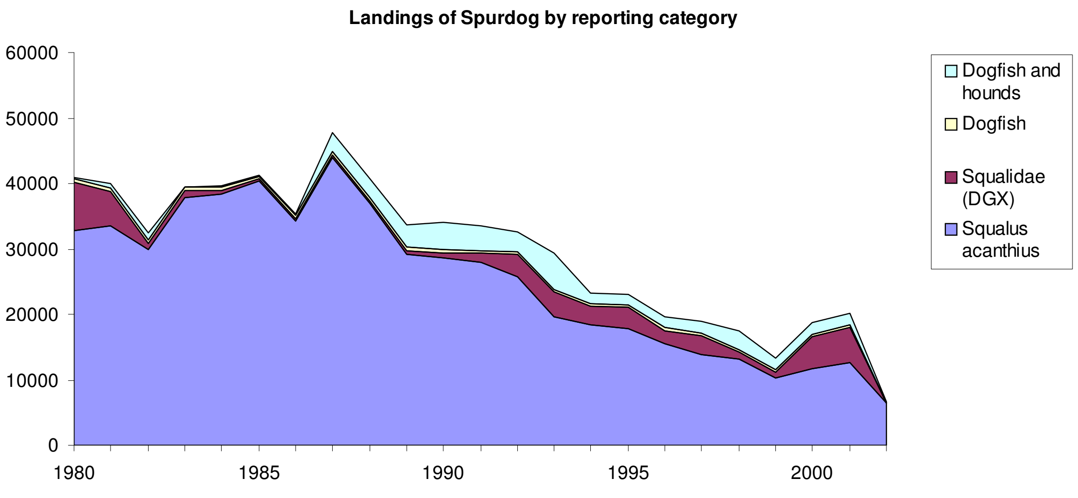


Figure 2.1.1 - Total landings data of *Squalus acanthias*, dogfish and hounds, nei Squalidae and Dogfish for ICES subareas combined.

Note: There is some uncertainty on the landing estimates from the two most recent years (2001 and 2002). Also it is known, that not all countries have always reported their elasmobranch landings. The same comment holds for all plots of landings presented in this section.

Although most spurdog are now taken as by-catch in otter trawls and seines aimed principally at whitefish, directed fisheries for this species continue to operate locally and seasonally. As in the past, the spurdog is exploited by towed and passive gear, such as trawlers, seine nets, longlines and gillnets (Muñoz-Chàpuli *et a1.,* 1993). In the Celtic Sea, this species is caught primarily by French trawlers, and by English and Welsh longliners and in fixed gill nets in the Bristol Channel and Irish Sea. To the west and north of Ireland, vessels engaged in the salmon fishery began to target spurdogs in the late 1970's . Between 1977 and 1985 landings increased from 116 t to almost 8,000 t annually, declining to low levels by the early 1990's (Fahy, 1989). Some revival of this gillnet fishery has taken place off southwest Ireland in recent years.

Scottish and Irish trawlers and seiners fish for spurdog off the west coast of Scotland, with the recent addition of some English longliners from the east coast that moved into the area after continuous poor fishing in the North Sea (Vince, 1991). They are also taken in small quantities in the Bay of Biscay and off Greenland. These last areas are considered to be outside the main area of the Northeast Atlantic stock, which is also considered to be separate (at least for assessment and management purposes) from the Northwest Atlantic stock. Recent landings figures (ICES Fisheries Statistics) show over half the total landings of spurdog as coming from the northern North Sea and west coast of Scotland. Landings by Scottish vessels accounted for 43% of the total of 16,000 t landed from the Northeast Atlantic in 1996. Catches in 1997 - 99 have been around 15,000 t per year.

Catsharks and nursehounds

Catshark species in the Northeast Atlantic appear to be much more sedentary than the spurdog, and the few available tagging results indicate quite restricted movement. The lesser-spotted dogfish *Scyliorhinus canicula* is common on all coasts, from Mediterranean latitudes to south Norway, and contributes substantially to the landings of 'dogfish' from the North Sea, English Channel, Celtic Sea and Iberian waters. This species is usually mixed with other species in "dogfish" landings data. Most of the landings in the UK are from the by-catch in towed demersal gears, usually in otter trawls and seines, mainly targeted at gadoids and flatfish, although in some coastal areas there are a few, seasonal, small-scale directed fisheries. The 'dogfish' landings consist principally of the spurdog and lesser-spotted dogfish.

French fleets catch about 20 species of elasmobranchs, and France is the major fishing nation for elasmobranchs in the Northeast Atlantic. Most elasmobranch landings are taken as a by-catch and occur in all métiers of the commercial fleet. In 1993, trawlers landed around 85% of the elasmobranch catch, of which the most abundant species was the lesser-spotted dogfish (4,445 t, 21.5%). In Spain, lesser-spotted dogfish is the most important shark species in the by-catch of the demersal fishery that operates along the north and northwest coast (Table 2.1.1). However most of the species is discarded (only 10% is actually landed, which represents around 200 t) as observed in the Spanish fishing fleets operating in the Cantabrian Sea. In Mainland Portugal, lesser-spotted dogfish is mainly caught by coastal trawlers and by the artisanal fishing fleet. However most of the landings are recorded under the generic name of *Scyliorhinus* spp. For the period between 1989 and 2001 landings were around 600 t.

Table 2.1.1 - Spanish landing of lesser-spotted dogfish by ICES Sub-area, in t.

Year	IXa	VIIIc	VIIIab	VI	VII	NE Atlantic	TOTAL
1996	3.0	194.7	222.7	0	50.5		470.9
1997	5.9	183.5	274.2	0	73.1		536.7
1998	19.1	194.6	340.9	0	21.7		576.3
1999	33.9	191.0	257.2	0	66.5		548.7
2000	71.0	229.4	251.8	0.8	76.1		629.2
2001	38.9	259.5	253.0	2.3	44.1		597.7
2002*	38.8	101.9	380.8	0.7	48.8	71.0	642.0
TOTAL	171.9	1252.6	1599.9	3.1	332.1	71.0	4001.5

The nursehound (*Scyliorhinus stellaris*) is found on rough, even rocky grounds to the south and west of the UK, extending to the Mediterranean. Because it is comparatively scarce it has only a minor contribution to commercial fisheries.

2.1.1.2 Pelagic sharks

Basking shark

The earliest directed fisheries for pelagic sharks in the Northeast Atlantic were probably for the basking shark. Several nations have exploited these large planktivores during their inshore movements in the warmer months, and the history of some fisheries extends back hundreds of years. Until the 20th Century, such fisheries generally depended on the use of hand harpoons launched from small boats to catch their quarry, but this gradually gave way to the use of non-explosive harpoons fired from small whale guns and, in one case, large gillnets. Historical international catches of basking shark are given for the period 1946 - 2001 in Table 2.1.2.

Table 2.1.2 – Northeast Atlantic basking shark landings (no. of sharks caught), 1946 - 2001.

Year	Ireland Achill Island	Other Irish Catches	Scotland*	Norway*	Total
1946	0		66	426	492
1947	6		245	250	501
1948	80		222	964	1,266
1949	450		35	782	1,267
1950	905		77	1,764	2,746
1951	1,630		147	806	2,583
1952	1,808		68	392	2,268
1953	1,068		110	596	1,774
1954	1,162		0	682	1,844
1955	1,708			294	2,002
1956	977			528	1,505
1957	468			258	726
1958	500			122	622
1959	280			2,532	2,812
1960	219			4,266	4,485
1961	258			2,042	2,300
1962	116			1,266	1,382
1963	75			2,210	2,285
1964	39			2,138	2,177
1965	47			1,304	1,351
1966	46			1,822	1,868
1967	41			4,180	4,221

1968	75			3,160	3,235
1969	113			3,130	3,243
1970	42			3,774	3,816
1971	29			1,708	1,737
1972	62			1,438	1,500
1973	85	0		2,214	2,299
1974	33	150		2,148	2,331
1975	38	350		3,670	4,058
1976	0	?		1,502	1,502
1977				1,586	1,586

Year	**Ireland Achill Island**	**Other Irish catches**	**Scotland***	**Norway***	**Total**
1979				2,268	2,268
1980				1,606	1,606
1981			0	776	776
1982			1	930	931
1983			122	758	880
1984			92	888	980
1985			40	631	671
1986			38	493	531
1987			1	70	71
1988			15	46	61
1989			3	256	259
1990			2	387	389
1991			1	325	326
1992			9	732	741
1993			0	582	582
1994			9	352	361
1995			0	22	22

1996				396	396
1997				232	232
1998				27	27
1999				15	15
2000				59	59
2001				36	36

*) Numbers of sharks caught by Norway are mainly calculated from landings data in metric t, converted through an estimated mean weight of 5t per shark. This calculation may under- estimate numbers of sharks taken by up to 30%. From 1992 onwards, Norwegian landings were recorded as weight of fins (kg) only, scaled up to total weight in ICES data. Estimates of numbers of sharks landed in 2001 are based on an estimated average weight of 55 kg of fins per individual shark. Data for 2001 are preliminary only.

Norwegian fishermen have always been the major catchers of basking sharks in the Northeast Atlantic. Their fisheries generally started around April and May, occasionally as early as March in some years, reached a peak in June and finished in August or, less commonly, September (Myklevoll, 1968). The fleet was composed of small wooden vessels 15 to 25 m in length, which are sometimes used for hunting small whales as well as basking sharks (Kunzlik, 1988). The geographical and temporal distribution of the Norwegian domestic basking shark fishery changes markedly from year to year, possibly due to the unpredictable nature of the sharks' inshore migration (Stott, 1982). The Norwegian fleet has prosecuted local fisheries from the Barents Sea to the Kattegat, as well as more distant fisheries ranging across the North Sea and as far afield as the south and west of Ireland, Iceland and Faeroes. Norwegian fishermen were fishing for porbeagle off the Scottish coast as early as 1934, and it is thought that they first started fishing there for basking sharks in the immediate post-war years after the establishment of several native Scottish fisheries. Similarly, Norwegian vessels took basking sharks in Irish waters following the establishment of Irish fisheries there after the Second World War. During 1959 - 1980, catches ranged between 1,266 and 4,266 sharks per year, but have since declined (Kunzlik, 1988). There is no longer any targeted fishery for basking sharks in Ireland.

The Norwegian fleet targeting basking shark is an ageing one, and as the boats reach the end of their useful working life they are being withdrawn from the fishery with no sign of replacement. In 1983, twelve Norwegian basking shark boats fished the Irish grounds and by 1987, only seven of these remained on the Norwegian registry of fishing boats. In the last ten years, catches of basking shark have varied considerably, partly due to the fishes' fluctuating local availability and market prices. Landings by Norway generally declined between 1992 and 2001, ranging from 741 to 15 t, and came from the Norwegian Sea and the northern North Sea (ICES, 1995).

In recent years the basking shark has become a protected species in some areas. Under UK legislation (Schedule 5 of the Wildlife and Countryside Act of 1981), no basking sharks are allowed to be caught within 12 miles of the coast and none landed even if caught outside territorial limits. They are also protected in Isle of Man waters.

Furthermore, for 2002 there is a complete ban on the landings of this species from within the EU waters of ICES Sub-areas IV, VI and VII (Annex ID of Council Regulation 2555/2001).

Blue shark

Blue shark is taken mainly as a by-catch in surface longline fisheries for tuna and billfish by Spanish fishermen as far south as the west coast of Africa. This fishery has developed rapidly since the 1940s and it is estimated that 2,400 t of blue shark were taken in 1984, up to 82% of which were discarded due to their low value compared to that of swordfish *Xiphias gladius* or even mako and porbeagle sharks (Vas, 1995; Mejuto, 1985). During 1997 and 1998, the total landings of pelagic sharks from the swordfish fishery had risen to 35,000 t and 32,700 t respectively, with 85% of the landings comprising blue shark and 10% shortfin mako (Castro *et al.*, 2000). The remainder includes diverse species of *Carcharhinus* spp., *Alopias* spp. and others. In 1999, the by-catch landings of blue shark from the North Atlantic had fallen to 21,811 t (89% of total pelagic sharks) (Mejuto *et al*., 2002). Both mainland Portugal and the Azores also have longline fisheries for tuna, which take a by-catch of blue sharks. In Mainland Portugal, landings from ICES Sub-area IXa have fluctuated between 340 and 540 t during the 1990s.

Further north, blue sharks are taken by swordfish longline vessels operating from northern Spain (Mejuto, 1985), and a small Spanish longline fishery targets blue shark mainly between June and November in the Bay of Biscay (VIII) (Lucio *et al*., 2002). Annual catches and CPUE data from this fishery in the period 1998 - 2002 are presented at Tables 2.1.3 and 2.1.4. In addition, France, UK and Ireland have had gill-net fisheries for albacore tuna *Thunnus alalunga* beyond the slope of the continental shelf, in which blue sharks are taken as a by-catch. Other pelagic sharks taken in the same fisheries are the mako, hammerhead (Sphyrnidae) and bigeye thresher *Alopias superciliosus*. Given the increasing commercial value of these species, it is assumed that discards of blue shark are decreasing whilst those of shortfin mako are negligible.

Table 2.1.3 - Annual landings, sex ratio, average size and maximum size by sex of blue shark from the directed Spanish longline fishery (Basque Country , Spain) from 1998 to 2002.

Year	1998	1999	2000	2001	2002
landings (ton)	145	335	341	321	234
total number	9558	21821	23661	19560	14129
proportion of males	0.3	0.4	0.4	0.4	0.5
proportion of females	0.7	0.6	0.6	0.6	0.6
average size (cm)	126	132	131	134	136
maximun size (cm)	209	248	251	240	206
average size males (cm)	120	132	131	136	133
average size females (cm)	128	133	131	133	139
maximun size males (cm)	199	210	210	240	206
maximun size females (cm)	209	248	251	240	206

Source: AZTI Database.

Table 2.1.4 - Monthly CPUE estimates of blue shark from the directed Spanish longline fishery (Basque Country , Spain) from 1998 to 2002.

	1998	1999	2000	2001	2002
January				0.14	
May	0.55	1.49		0.19	
June			0.89	0.48	1.03
July			1.72	1.30	1.87
August	1.59	2.26	1.60	1.15	1.88
September	2.12	2.58	1.38	1.06	1.64
October	2.92	1.40	1.10	0.57	0.91
November			0.84		0.74

Source: AZTI Database.

In the summer months, blue sharks move north to cooler waters as far as the south coast of England and southern, western and northern coasts of Ireland. They have been the target of recreational anglers from ports in south-west England since the early 1950s, though the catches taken by this fishery have fallen considerably since 1960 (Vas, 1990). In the UK, a small-scale longline fishery for blue and porbeagle sharks was started off the south coast of Cornwall in 1990. In 1992, vessels registered in England and Wales accounted for 757 t of shark, of which half were landed abroad. The equivalent landings by the 6 boats fishing for sharks in 1994 was 893 t, in a fishery which now appears to take place mainly off the shelf edge in the Celtic Sea and west of Ireland. In Irish waters blue sharks are targeted by anglers in a tag and release fishery (Fitzmaurice and Green, 2000). Since its inception in 1970, this tagging programme has resulted in the release of sharks (Fitzmaurice *et al.*, 2003).

Apart from the European fisheries described above, the most important source of mortality on blue sharks probably arises where they are taken as a by-catch in the high seas longline and driftnet fleets targeting tuna and billfish from the nations Japan, Taiwan, Korea and Russia. These fisheries operate throughout the blue shark's geographical range, including the Mediterranean (De Metrio *et al.*, 1984). There is usually no requirement for these fisheries to record their blue shark catch and, because the entire catch is not retained on all fishing trips, the available landing data might not be indicative of stock trends. Due to the increasing price paid for shark fins, however, it is becoming less clear whether the blue (and other pelagic) shark is the target or by-catch species in these fisheries.

<u>Porbeagle</u>

The porbeagle (*Lamna nasus*) has been exploited commercially since the early 1800s, principally by Scandinavian fishermen. It is taken in much lower numbers than the blue shark, and is subject to a number of fisheries along its migratory route. This includes most of the ICES area, especially the Faeroes (Vb), Skagerrak (IIIa), North Sea (IVa-c), English Channel (VIId-e), Celtic Sea and south-west Ireland (VIIg-k), Bay of Biscay (VIII) and Portugal Mainland and Azorean waters (IX and X). Smaller numbers are also taken from the Irish Sea (VIIa), west coasts of Ireland and Scotland

(VIIb-c and VIa-b), Bristol Channel (VIIf), Iceland (Va) and Norwegian Sea (IIa). Landings off Spain tend to be greater during the spring and autumn, with a drop in the summer (Mejuto 1985; Lallemand-Lemoine 1991).

Porbeagle sharks are often taken as a by-catch in trawls, seines, pelagic and bottom gill nets and by surface longlines set for billfish and tunas. Traditional line fisheries directed at porbeagle (which also take occasional tope and blue sharks) in the northern North Sea and off the Scottish coast have involved specialised vessels from Norway and, to a lesser extent, Denmark and the UK, and French vessels fishing to the south and west of England. Prior to 1930, the Norwegian fleet used shark lines in the eastern North Sea, mainly during July - October. Over the period 1930 - 1965, Norway was the principal country fishing for porbeagle, and it extended the fishery to the Orkney-Shetland area and the Faeroes and then to the waters off Ireland and offshore banks by the 1950s. Landings by Norway first reached a peak of 3,884 t in 1933, and about 6,000 t were taken by the Norwegian fleet in 1947, when the fishery reopened after the Second World War. A progressive drop in Northeast Atlantic landings followed from 1953 - 1960, to around 1,200 - 1,900 t annually. In 1961, a fleet of Norwegian longliners extended their fishing for porbeagle to Northwest Atlantic waters off the coast of New England and Newfoundland. Catches of porbeagle had declined by 1965, when many of the vessels switched to other species or moved to West African grounds to fish for mako shark and swordfish (Gauld 1989). Norwegian landings from the Northeast Atlantic continued to decrease from 160 - 300 t/annum in the early 1970s to around 10 - 40 t/annum in the late 1980s/early 1990s.

Denmark’s small fleet of specialised shark longline vessels formerly operated in the summer months, predominantly in the North Sea but extending into the Northwest Atlantic in the 1980s (Gauld 1989). Average landings from the Danish porbeagle fishery fell from 500 - 600 t/annum in the 1950s to under 50 t in 1984. More recently, a minimum of 32 t was landed by Denmark in 1988, rising to 94 t in 1994 (ICES 1995). Porbeagles were reported in landings statistics by Scotland in the mid to late 1950’s (Rae 1962; Gauld 1989). The Faeroes, France, England, Iceland, Germany and Sweden started landing significant quantities in the 1970’s. French longliners have operated a directed fishery for porbeagle from Isle d’ Yeu, landing into La Rochelle (Lallemand-Lemoine 1991). The main fishing grounds were in the Celtic Sea and Bay of Biscay, from where over 77% of the total French catch of 640 t recorded by all gears in 1993 was landed. Their activity is now decreasing. Similarly, localfisheries in the Bristol Channel occasionally deploy longlines for porbeagle (Ellis & Shackley, 1995).

Porbeagle are currently landed by many European countries, principally Denmark, the Faeroes, France, Norway and Spain. Smaller quantities are landed by the Channel Islands, Iceland, Portugal, Sweden, Germany, Ireland and the United Kingdom. According to the FAO Yearbook of fisheries statistics, porbeagle landings in 1994 by all countries fishing the Northeast Atlantic totalled 985 t, of which Norway landed only 25 t. Annual landings during the period 1995 - 1999 have been in the range of 400 - 700 t.

Tope

In European waters, tope (*Galeorhinus galeus*) is not a target species from a comercial fishery, though some recreational anglers specialise in tope catching. Tope is mainly taken as a by-catch in bottom trawl, net and line fisheries of all countries bordering the Northeast Atlantic, and especially by French vessels fishing in the English Channel, Western Approaches and northern Bay of Biscay (Bonfil 1994). According to French catch statistics for 1987, it ranked third (at about 600 t, some 6% of the total shark catches) behind spurdog and lesser-spotted dogfish. Tope are caught by Spanish vessels in the western Cantabrian Sea (Galicia), and around 80% of the landings are from longline vessels, the remainder from trawl and small gillnets. Tope also feature in catch statistics for mainland Portugal and the Azores.

2.1.1.3 Deep-water sharks

Deep-water sharks are mainly taken in mixed fisheries, although some directed fisheries also exist. In recent years the landings have increased, especially at the northern ICES Subareas. Despite some effort already initiated towards the discrimination of landings at species level, this goal is not effectively attained yet. Deep-water shark landings by ICES Subarea are briefly described below.

Sub-areas I, II, III and IV

There have been no reported landings of sharks in Sub-areas I and II since 1990 (ICES, 2000) and the previous data almost certainly referred to Greenland shark *Somniosus microcephalus*. Commercial fishing for the Greenland shark was conducted in Arctic waters as a supplement to seal hunting and on coastal banks and in the fjords in western and northern Norway. This fishery ceased around 1960. Off the coasts of Norway this species is now depleted. Landing data for velvet belly *Etmopterus spinax* in Division IVa rose to over 350 t in 1998, but declined to 52 t in 2001 (Figure 2.1.2). Landings of leafscale gulper shark *Centrophorus squamosus* and Portuguese dogfish *Centroscymnus coelolepis* reported by France and the UK, probably refer to fisheries south-west of the Wyville-Thompson Ridge. The main discard species in the Norwegian longline fisheries for ling and tusk in Sub-area IVa are blackmouth catshark *Galeus melastomus*, and spurdog.

Most of the available landing estimates of deep-water sharks in ICES Subarea IV are not discriminated at species level but by group categories, namely *Siki* and *Anguillat noir*. Siki is mainly composed of leafscale gulper shark and Portuguese dogfish while Anguillat noir refers to other deep-water shark species commonly of smaller sizes (Fig. 2.1.2). It is not thought that any deepwater species were reported as Squalidae “DGX” or “Various “sharks NEI” in this area.

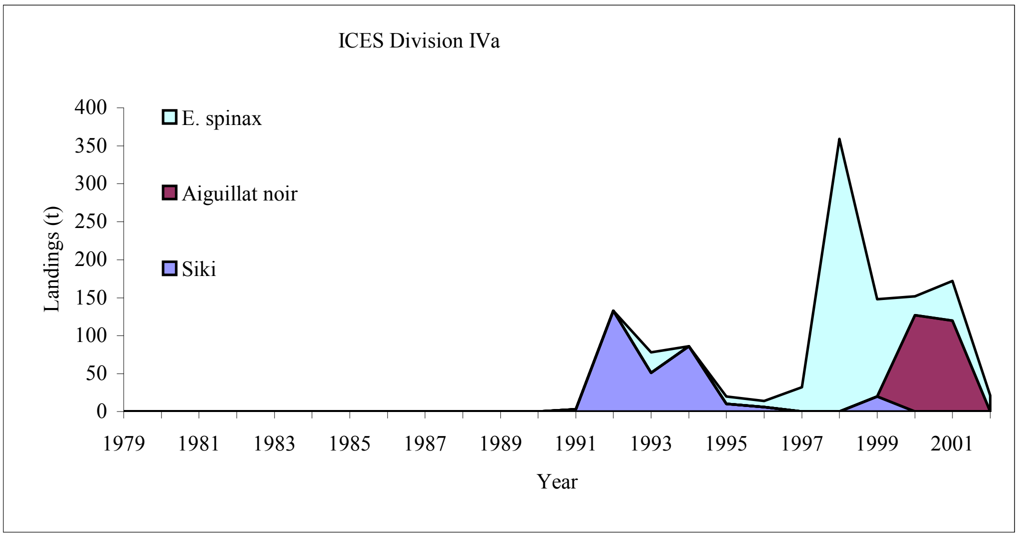


Figure 2.1.2 - Total landings of *Etmopterus spinax*, Aiguillat noir and Siki in ICES Division IVa. Data for most recent years incomplete.

<u>Sub-areas V, VI and VII</u>

Landings of Greenland shark by Iceland in Division Va have fluctuated between 30 and 82 t since 1989. In Division Vb, France has made the largest landings of Portuguese dogfish, fluctuating around 200 to 300 t in most years and reached a peak of 460 t in 1999. There have been some catches of Portuguese dogfish by the Faeroes and, in 2001, also of leafscale gulper shark. UK began to collect separate landings data for deep-water sharks (almost exclusively leafscale gulper shark and Portuguese dogfish) since 1999, but it is not possible to ascertain what proportion of earlier landings of "sharks NEI" (sharks not elsewhere identified) for these countries, or for Germany, were deep-water sharks. Norwegian landings of unspecified dogfishes and hounds in this region are almost certainly deep-water species. Landings of Squalidae "DGX" by France and other countries may contain some deep-water species, but it is unclear (Figure 2.1.3).

In Sub-areas VI and VII, leafscale gulper shark and Portuguese dogfish are routinely landed for their flesh and livers. These two species are collectively called “siki” in French fishery records (Gordon, 1999), and they are also marketed elsewhere under this name. French landings of these species in the mixed-species bottom trawl fishery have increased from 302 t in 1991 to 3,284 t in 1996, declining to 1,939 t in 1999 (ICES, 2000).

The main discard species in the Norwegian longline fisheries for ling and tusk in Sub-area VIa are *Galeus melostomus* and *Chimaera monstrosa*. As this fishery has expanded to deeper waters during the last 2 years to target *Mora moro* and *Phycis blennoides*, the by-catch of Portuguese dogfish and leafscale gulper shark has increased as deeper waters are exploited, but these two species are discarded by most vessels.

In Spain, a fishery for deep-water sharks started in 1991 in ICES Sub-area VII, where a number of longliners, which traditionally fished for hake in this area but had difficulties in maintaining profitability, began to fish for sharks in waters deeper than 1,000 m. It is difficult to quantify landings as statistics are not collected by species for these vessels (Pineiro *et al.,* 2001). More recently, longliners from Norway and trawlers and longliners from Scotland and Ireland have caught deep-water sharks. Black dogfish *Centroscyllium fabricii*, birdbeak dogfish *Deania calcea* and long-nose velvet dogfish *Centroscymnus crepidater* are now being landed, or in some cases livers or fins are retained and the carcasses discarded. In this area, deep-water sharks are also taken by gill-netters, but there are no data available.

Landings of deep-water sharks in ICES Subareas V, VI and VII are presented in Figure 2.1.3 and 2.1.4. French landings of Squalidae from Sub-areas VI and VII and landings of Squalidae DGX and Unspecified dogfishes and hounds were included because it is possible that these include deepwater sharks.

Landings estimates of deep-water sharks are highly uncertain with a poor level of species discrimination in national landing statistics. The values presented for the category siki, which is mainly composed of Portuguese dogfish and Leaf scale gulper, can be underestimated (Figure 2.1.3). A fraction of siki can be also included in the categories such as “Squalidae” and "Deep-water sharks", both may also comprise a number of other species.

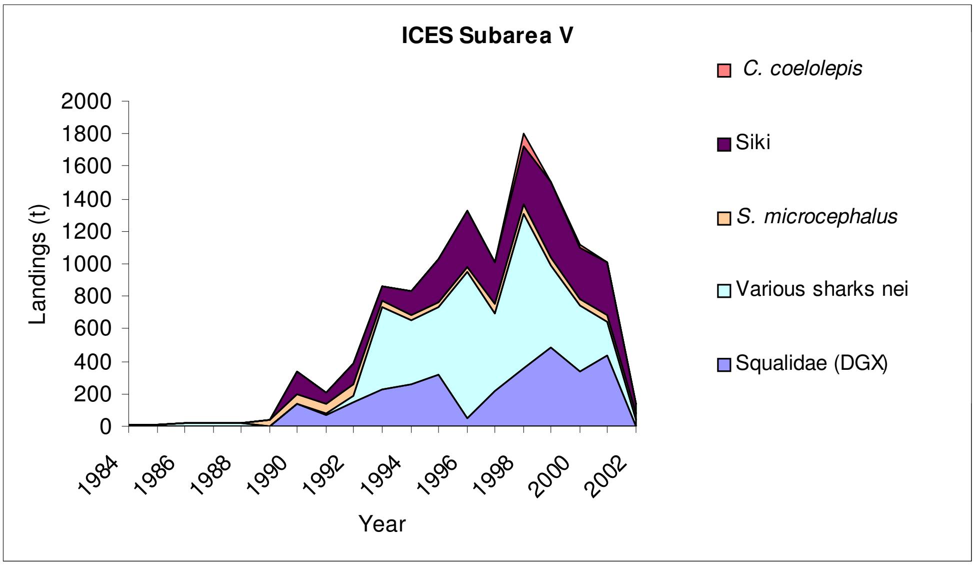


Figure 2.1.3 - Total landings of *Dalatias licha*, *Galeorhinus galeus*, *Galeus melastomus*, *Etmopterus spinax*, *Centroscymnus coelolepis*, *Somniosus microcephalus*, Siki, various unidentified sharks (Various sharks nei) and Squalidae (DGX) in ICES Subarea V. The proportion of deep-water sharks in various sharks nei and Squalidae (DGX) is unknown. Data for most recent years incomplete.

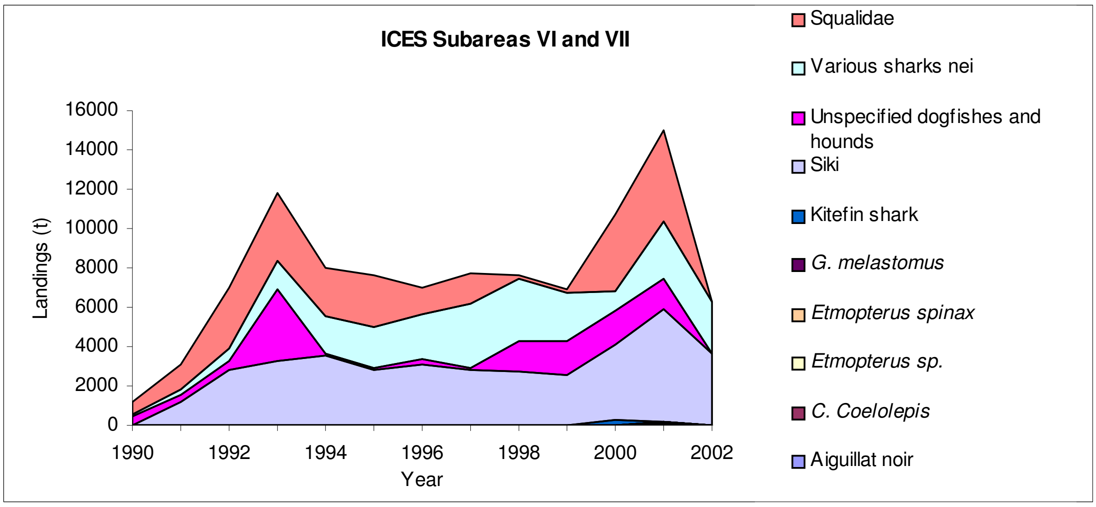


Figure 2.1.4 - Total landings of *Dalatias licha*, *Galeorhinus galeus*, *Galeus melastomus*, *Etmopterus spinax*, *Centroscymnus coelolepis*, *Somniosus microcephalus*, Siki, various unidentified sharks (Various sharks nei, unspecified dogfishes and hounds) and Squalidae (DGX) in ICES Subareas VI and VII b. Proportion of deep-water sharks in various sharks nei, unspecified dogfishes and hounds and Squalidae (DGX) is unknown. Data for most recent years incomplete.

Sub-area VIII

There have been Spanish, French, English/Welsh and Scottish landings of sharks in Sub-area VIII, but the deep-water component is unknown. Part of the landings of deep-water sharks is probably reported under the generic categories “Squalidae” and "Various shark nei", both comprising a large number of shark species (Fig. 2.1.5). The trend on Various shark nei landing is coincident with the one of Spanish landings for this category. For the period between 1982 and 2000 excluding 1983 and 1984 the Spanish landings of Various shark nei relative contribution is higher than 95% of the total.

A Spanish fishery for sharks was developed from Cantabrian and Asturian ports, where, in 1992, 17 vessels landed 340 t of a mixture of gulper shark *Centrophorus granulosus*, great lantern shark *Etmopterus princeps*, kitefin shark *Dalatias licha* and birdbeak dogfish. In 1993, 10 vessels landed 452 t (ICES, 1995). Additionally, a long line fishery for deep-water sharks started in 1995 and finished in 1996 in the northern Bay of Biscay, taking mainly Portuguese dogfish and also leafscale gulper shark and birdbeak dogfish in water depths of 700 to 1,600 m (Pineiro *et al.*, 2001). In the period 1997 - 2002, a small long line fishery landed annually in Basque ports about 150 t in “trunk” weight (i.e. gutted and without head, skin and fins) of deep-water sharks.

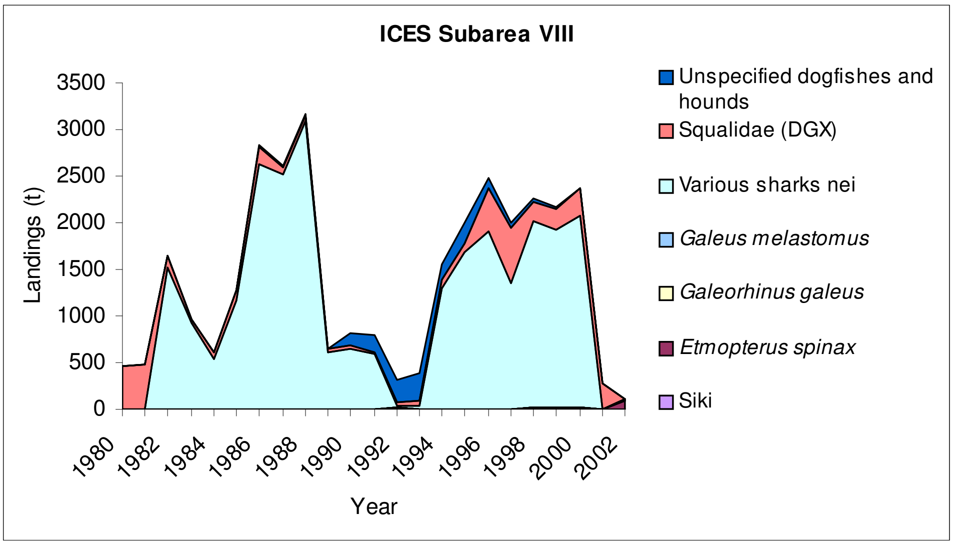


Figure 2.1.5 - Total landings of *Galeorhinus galeus*, *Galeus melastomus*, *Etmopterus spinax*, Siki, various unidentified sharks (Various sharks nei) and Squalidae (DGX) in ICES Subarea VIII. Exact proportion of deep-water sharks in the "Sharks nei" and unspecified dogfishes and hounds categories is unknown. Data for most recent years incomplete.

<u>Sub-area IX</u>

At Sesimbra (Division IXa), the longline fishery targeting black scabbardfish *Aphanopus carbo* takes a by-catch of deep-water sharks, and these provide an important additional income. The most important species are the Portuguese dogfish and leafscale gulper sharks, though kitefin shark, birdbeak dogfish, gulper shark and knifetooth dogfish *Scymnodon ringens* are also caught. Deep-water sharks are also caught by the Portuguese deep-water bottom trawl fishery that targets the rose shrimp *Parapenaeus longirostris* and *Nephrops norvegicus*. This fishery mainly takes place south and southwest of the Portuguese mainland. Deep-water shark species caught in this fishery are: birdbeak dogfish, blackmouth catshark, gulper shark, kitefin shark, leafscale gulper shark, smooth lanternshark *Etmopterus pusillus* and velvet belly. A directed longline fishery for deep-water sharks, based at Viana do Castelo in northern Portugal, was initiated in 1983 and the landings in this fishery predominantly consisted of gulper shark, with leafscale gulper shark and Portuguese dogfish caught in relatively small quantities. In the early years of the fishery, only the livers of the sharks were of commercial value and the carcasses were discarded at sea. Fishermen then started to process part of the catches on board to increase the value of the fish that is landed. In more recent years only one longliner has fished full time.

Although most of the landing of deep-water sharks in ICES Subarea IX is discriminated by species, it is admitted that a small fraction of landings of unidentified shark species (Various shark nei) may also included them (Fig. 2.1.6). The major proportion of "Various sharks nei" landings is probably composed by pelagic shark species taken by the Spanish longline fishery for swordfish. From 1994 to 2000, excluding 1996, the Spanish landings of "Various sharks nei" represent more than 88% of the total of this category in ICES Subarea IX.

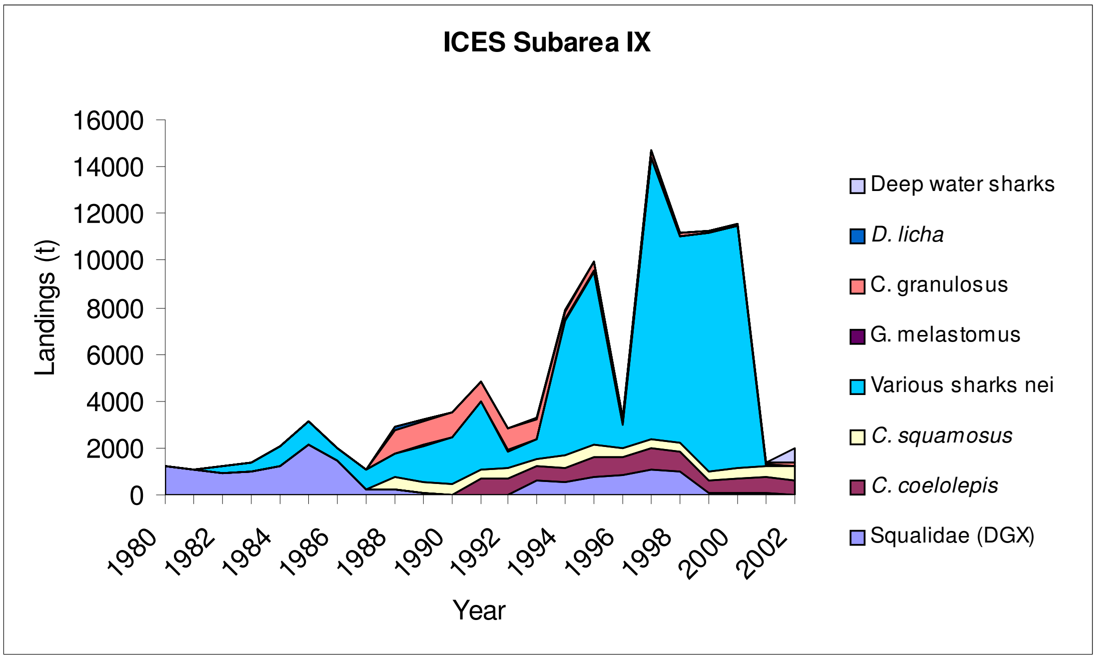


Figure 2.1.6 - Total landings of *Dalatias licha*, *Centrophorus granulosus*, *Centrophorus squamosus*, *Centroscymnus coelolepis*, *Galeus melastomus*, various unidentified deep-water sharks (Deep water sharks) and sharks (Various sharks nei) and Squalidae (DGX) in ICES Subarea VIII. Exact proportion of deep-water sharks in the Squalidae (DGX) category is unknown. Data for most recent years incomplete.

Sub-area X

There is a directed fishery for deep-water sharks in the Azores, in which the kitefin shark has been targeted by both gillnets and handlines, which tend to catch mostly males and females respectively (possibly because there is a bathymetric segregation of the sexes and the gill nets are bottom set, but the handlines attract sharks from a wider depth range). The landings peaked at 950 t in 1981 and have decreased to about 30 t in 1999 - 2001. Deep-water sharks are taken as by-catch both from the general demersal and black scabbardfish fisheries in the Azores, but landing data are not collected by species.

The deep-water shark species caught by these fisheries and identified from demersal surveys are: *Deania profundorum*, birdbeak dogfish, leafscale gulper shark, gulper shark, velvet belly, smooth lanternshark, great lanternshark, kitefin shark, spined pygmy shark *Squaliolus laticaudus*, longnose velvet dogfish, shortnose velvet dogfish *Centroscymnus cryptacanthus*, Portuguese dogfish, little sleeper shark *Somniosus rostratus*, sharpnose sevengill shark *Heptranchias perlo* and *Galeus marinus*.

Landing estimates of deep-water sharks in ICES Subarea X are difficult to quantify particularly in more recent years after the cessation of the Azorean kitefin fishery. A significant part of deep-water shark landings are probably reported under the generic category of “Various shark nei” (Fig.2.1.7). In more recent years, particularly from

1997 to 2001 Spanish landings on “Various shark nei” represent more than 99% of the total.

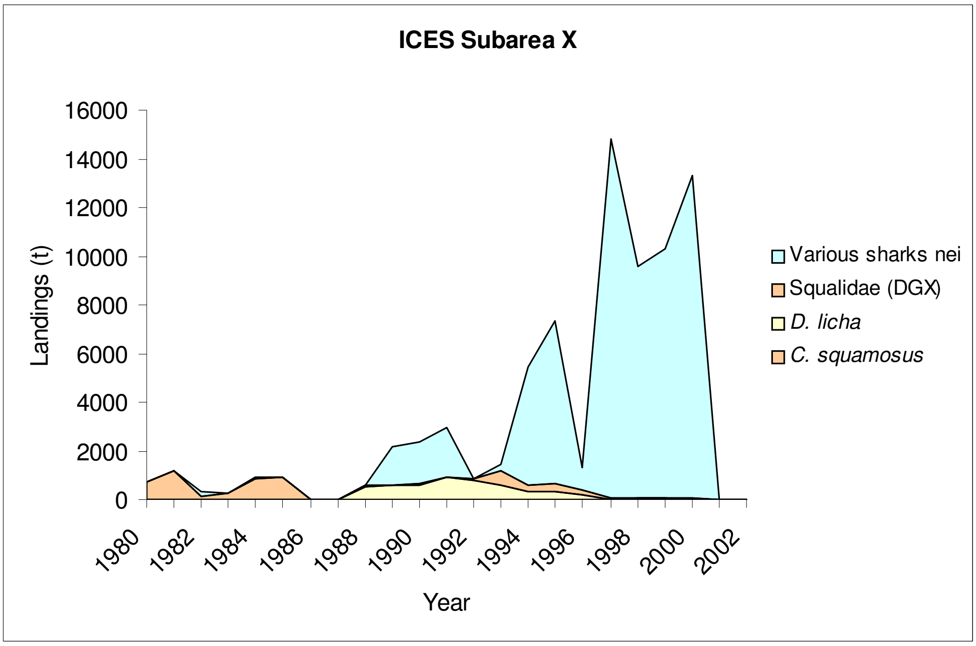


Figure 2.1.7 - Total landings of *Dalatias licha*, *Centrophorus squamosus*, various unidentified deep-water sharks (Deep water sharks) and sharks (Various sharks nei) and Squalidae (DGX) in ICES Subarea X. Exact proportion of deep-water sharks in various sharks nei and Squalidae (DGX) is unknown. Data for most recent years incomplete.

Sub-area XII

In Sub-area XII there have been some French and Spanish landings of deep-water sharks, but it is not possible to detect any trends from the available data, though it is clear that they have increased in recent years. Note that this Sub-area contains both the western part of Hatton Bank and the Mid-Atlantic Ridge. Portuguese dogfish are taken in the Norwegian longline fishery for Greenland halibut on Hatton Bank at depths between 1,300 - 1,600 m.

The uncertainty on deep-water species landing estimates is high. True figures are not available, although in more recent years some effort was done towards the discrimination of the landings at species level (Fig. 2.1.8).

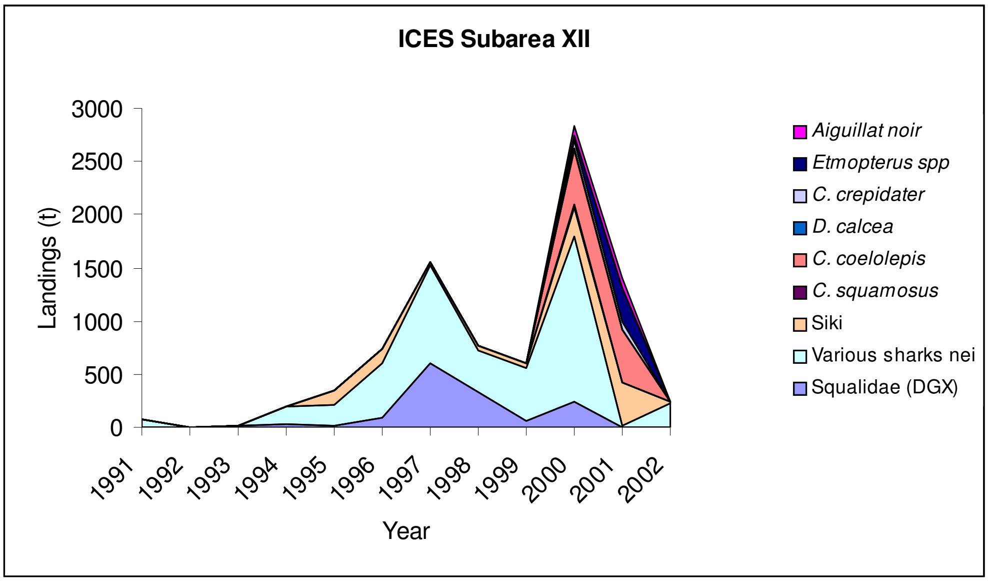


Figure 2.1.8 - Total landings of *Centroscymnus crepidater*, *Deania calcea*, *Centroscymnus coelolepis*, *Centrophorus squamosus*, *Etmopterus* spp., Siki, Anguillat noir, various unidentified deep-water sharks (Various sharks nei) and Squalidae (DGX) in ICES Subarea XII. Exact proportion of deep-water sharks in various sharks nei and Squalidae (DGX) is unknown. Data for most recent years incomplete.

2.1.1.4 Rays and skates

Skate and ray fisheries occur in coastal waters and tend to be seasonal, and the landings from the Northeast Atlantic have virtually all been a by-catch from demersal trawling aimed at gadoids or flatfish. There are, however, a number of small fisheries targeting various species of Rajidae in relatively limited geographical areas.

France, Ireland and the UK have traditionally had some directed fisheries for rays and collectively landed the largest proportion of the catch. Most of the French catches of rays come from the CelticSea and English Channel, though they are taken mainly as a by-catch during bottom trawling. The cuckoo ray has contributed over 30% of the total French ray catch in recent years, taken mainly from the southern part of the Celtic Sea and the northern part of the Bay of Biscay. The thornback ray is often the target of directed seasonal fisheries by France, which takes most of the catch of this species from the Celtic Sea and Irish Sea. Trawlers operating out of Milford Haven in the 1950s and 1960s targeted rays, especially thornback rays, off the south east coast of Ireland. This fishery is still continued on a smaller scale by vessels from the Irish Republic. During the last decade, small-scale fixed-net fisheries targeting thornback ray have developed off the west and north coasts of Wales, and similar fisheries using lines, fixed nets and trawls have taken place in localized coastal regions in the North Sea. In Spain there is no fishery targeting skates and rays, and landings come from the by-catch of fisheries targeting other demersal species such as hake, monkfish and megrim.

In the North Sea, skates and rays have been subjected to intensive exploitation and landings decreased significantly during the 1930s, but increased just after the Second World War, during which period fishing had almost ceased. Total international landings of all rays combined from the North Sea have declined steeply since World War II. In the southern North Sea, landings have declined since 1948, whereas in the northern and central area the major decline started around 1965. Walker (1994) reports that, despite an increase in fishing effort, landings dropped from 12 to 5,000 t between 1954 and 1974. Walker and Heessen (1996) report that no rays were caught along the Dutch coast from 1958 to 1994 in an area in which the thornback ray had previously been common. Since the mid-1970s, total landings of rays from the North Sea have remained more or less constant. Although it appears that most species have experienced similar declines in abundance in the North Sea, where once the thornback ray had been the most abundant ray species, the starry ray *Amblyraja radiata* now comprises 80% of the biomass of the Rajidae (Walker 1995). The contribution from the North Sea to the total ray landings from the Northeast Atlantic has declined from some 25% in 1955 to around 14% in 1996 (ICES Fisheries Statistics). In the past, the common skate *Dipturus batis* was considered to be extensively distributed throughout the central and northern North Sea, but in the last few decades this species appears to have retreated to the very northern North Sea and is currently caught only off Shetland (Walker 1995). The virtual disappearance of the common skate from the Irish Sea was apparently the first case of a marine fish brought to the brink of local extinction by commercial fishing (Brander 1981). Although the common skate was once one of the three most important species landed by France, it is currently rare in landings and, according to Muñoz-Chàpuli *et al.* (1993), white skate *Rostroraja alba*, and common skate have all disappeared from the southern Bay of Biscay. Now caught mainly in the Celtic Sea, the common and long-nosed skates account for only about 4% of the total elasmobranch landings in France (ICES 1989).

Prior to 1960, landings of skates and rays accounted for more than 50% by weight of the elasmobranch catch from the Northeast Atlantic and, in 1948, over 60,000 t of these fish were landed from European coastal waters. Total international catches of rays and skates declined from around 55 thousand t per year in the mid 1950s to 25,000 t in 1975, though there was an apparent increase in the late 1980s, with 38,000 t being landed in 1988 (ICES 1997). In recent years (1985 - 96), the catch of skates and rays has fallen to between a half or a third of the weight landed in 1948 (Figure 2.1.9).

In recent years rays and Skates (Rajidae) have contributed more than 40% by weight to the reported landings of elasmobranchs in the Northeast Atlantic. Despite their high importance, statistical information by species is limited, as most European countries do not differentiate between species in landings statistics and they are collectively recorded as skates and/or rays.

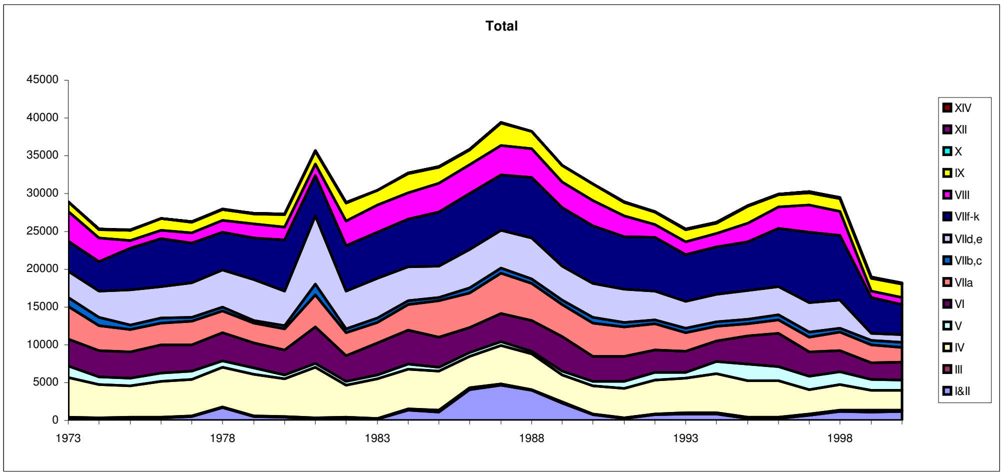


Figure 2.1.9 - Total international landings of skates and rays (all species) by ICES sub-area.

Fishing methods include longlines set for species such as the common skate *Dipturus batis* and, more recently, large meshed fixed gill nets have been set to catch thornback and spotted rays *R. montagui* in coastal areas. However, directed fisheries for rays have been few and small in scale compared with those for spurdog. The practice in most countries for 4 or 5 species of rays to be landed together in particular size categories, rather than by species, makes it difficult to collect accurate quantitative data by species. However, some segregation does take place on French markets, and French fisheries statistics are probably the most detailed in Europe in terms of reporting landings of skates and rays to the species level.

Due to the widespread practice of landing mixed species and the aggregation of species into the general category of skates and rays in the landings statistics of most countries, it has historically been very difficult to quantify total landings for individual species. This makes any attempt at stock assessment and management at species level impossible as well as masking trends in the abundance of individual species. Since the DELASS project, many countries have made considerable progress in establishing market sampling programs to estimate the species composition of catches in order to allow landings to be estimated at species level. Species compositions derived from market sampling data from the Netherlands, UK (Scotland), Denmark, Belgium and Spain are presented in Figures 2.1.10 to 2.1.13 and Tables 2.1.5 to 2.1.7.

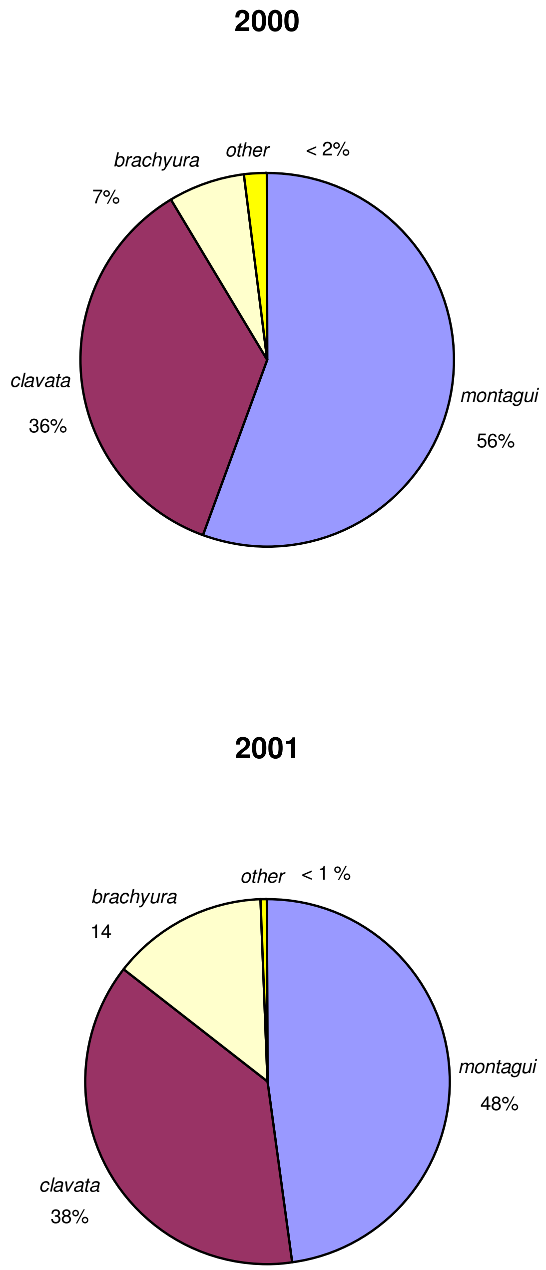


Figure 2.1.10 - Species composition of Dutch ray landings in 2000 and 2001.

Table 2.1.5 - Estimated landings (gutted weight in kg) of skates and rays into Scotland, 2000 and 2001.

Species	2000				2001			
	West Coast	North Sea *	Rockall *	Total	West Coast	North Sea	Rockall	Total
L. naevus	490876	493541		984417	454506	452939		907445
R. montagui	494181	29912	1801	525894	300352	29165	517	330034
R. clavata	59209		93660	152869	175929	0	44345	220274
D. batis	121549	89734	19813	231096	183886	80045	9687	273618
R. alba		14956		14956	3073	16525		19598
L. fullonica		119646	64841	184487		113868	31148	145016
R. brachyura								
Total	1165816	747789	180115	2093719	1117746	692542	85697	1895985

* North Sea and Rockall 2000 data are disaggregated by the species composition obtained in 2001

Table 2.1.6 – Relative species composition (by number and weight) of Danish landings from the North Sea in 2000 - 2001.

	Raja lintea		*Dipturus oxyrhynchus*	
Landings category	Number %	Weight %	Number %	Weight %
Wings	84.9	78.6	1.0	1.5
Gutted, no head no tail	5.6	5.5		
Gutted, head and tail	7.5	12.4	0.3	0.8
Whole fish	0.7	1.3		
All	98.5	97.8	1.5	2.3

Table 2.1.7 – Species composition (2000-2001) of the five most important rays landed in Belgium (values in % weight). Mixed rays are *R. clavata* and *R. montagui* combined (for rays less than 2 kg).

IVb	N	Mean	Confid. -95%	Confid. 95%	Median	Min	Max	Lower Quartile	Upper Quartile	Var.	St. Err.
R. brachyura	44	2.9	0.5	5.2	0.0	0.0	43.7	0.0	2.0	58.2	1.2
R. montagui	44	21.7	18.1	25.3	20.6	0.0	48.0	15.8	28.8	139.5	1.8
R. circularis	44	0.2	-0.2	0.5	0.0	0.0	7.5	0.0	0.0	1.3	0.2
R. naevus	44	2.9	1.4	4.4	0.9	0.0	21.2	0.0	3.0	25.2	0.8
R. clavata	44	12.2	8.8	15.6	9.4	0.0	38.5	3.4	16.4	125.1	1.7
Mixed rays	44	60.2	56.7	63.8	62.3	35.5	90.6	50.2	69.5	136.7	1.8

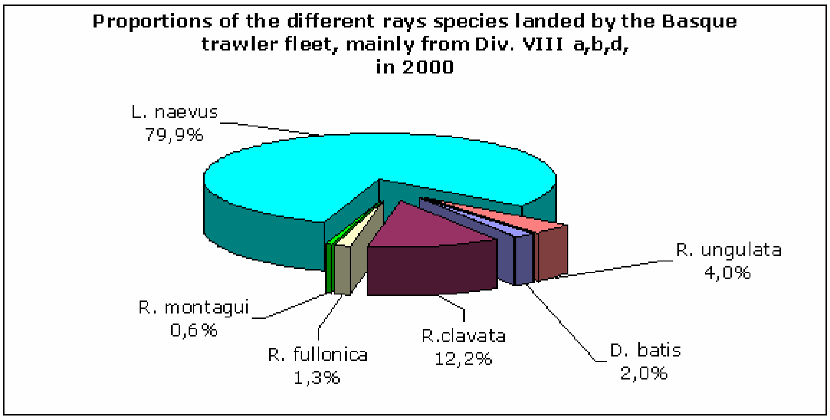
IVc	N	Mean	Confid. -95%	Confid. 95%	Median	Min	Max	Lower Quartile	Upper Quartile	Var.	St. Err.
R. brachyura	41	3.7	2.2	5.2	2.1	0.0	24.7	0.0	5.5	23.2	0.8
R. montagui	41	13.5	10.4	16.6	13.3	0.0	36.1	5.0	20.4	95.3	1.5
R. circularis	41	0.2	-0.1	0.4	0.0	0.0	4.4	0.0	0.0	0.5	0.1
R. naevus	41	0.1	0.0	0.1	0.0	0.0	0.8	0.0	0.0	0.0	0.0
R. clavata	41	22.5	17.9	27.1	20.2	4.2	58.6	9.7	30.7	210.8	2.3
Mixed rays	41	60.1	56.5	63.7	60.3	29.2	84.6	53.7	67.0	131.3	1.8

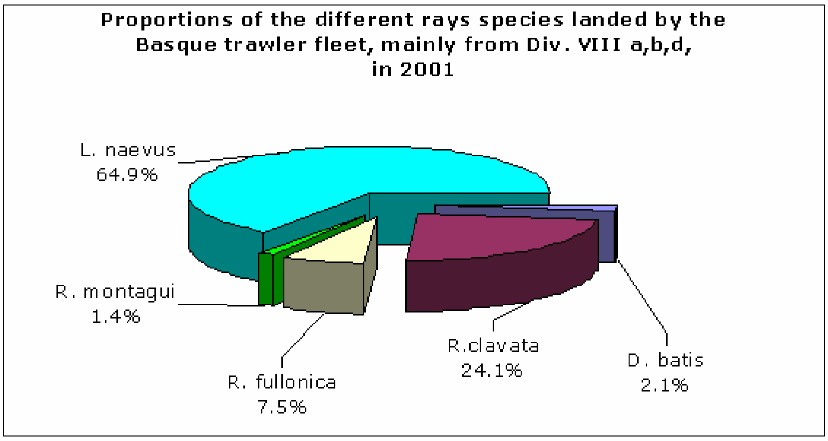
VIIa	N	Mean	Confid. -95%	Confid. 95%	Median	Min	Max	Lower Quartile	Upper Quartile	Var.	St. Err.
R. brachyura	34	19.5	10.4	28.6	5.8	0.0	91.1	0.0	37.7	683.9	4.5
R. montagui	34	7.1	4.7	9.5	5.8	0.0	20.4	0.0	11.2	47.7	1.2
R. circularis	34	1.3	0.1	2.6	0.0	0.0	18.3	0.0	1.0	12.6	0.6
R. naevus	34	11.0	6.8	15.1	8.8	0.0	53.6	0.9	15.6	140.5	2.0
R. clavata	34	27.3	19.0	35.6	21.6	0.0	75.9	10.1	40.0	567.6	4.1
Mixed rays	34	33.8	27.2	40.4	29.4	2.3	71.4	17.7	48.8	354.5	3.2

VIId	N	Mean	Confid. -95%	Confid. 95%	Median	Min	Max	Lower Quartile	Upper Quartile	Var.	St. Err.
R. brachyura	16	10.9	5.1	16.6	7.1	0.0	33.3	0.0	17.8	117.9	2.7
R. montagui	16	5.7	0.9	10.4	1.3	0.0	32.4	0.0	8.5	79.7	2.2
R. circularis	16	6.7	1.3	12.1	0.0	0.0	28.3	0.0	14.6	102.6	2.5
R. naevus	16	0.0	0.0	0.1	0.0	0.0	0.7	0.0	0.0	0.0	0.0
R. clavata	16	21.0	11.6	30.4	21.9	0.0	65.7	4.0	30.2	311.0	4.4
Mixed rays	16	55.7	46.8	64.6	53.5	34.3	92.1	43.6	62.6	281.0	4.2

VIIf,g	N	Mean	Confid. -95%	Confid. 95%	Median	Min	Max	Lower Quartile	Upper Quartile	Var.	St. Err.
R. brachyura	51	8.0	4.9	11.1	2.8	0.0	39.3	0.6	9.3	120.2	1.5
R. montagui	51	9.2	7.6	10.7	9.3	1.4	27.5	4.4	11.8	31.1	0.8
R. circularis	51	30.7	23.0	38.4	22.3	0.0	82.0	2.9	58.4	746.4	3.8
R. naevus	51	8.2	5.3	11.0	3.9	0.0	41.9	1.0	12.4	101.9	1.4
R. clavata	51	16.3	12.3	20.3	11.1	0.0	62.0	6.4	24.4	202.6	2.0
Mixed rays	51	27.6	24.1	31.2	27.7	3.8	57.4	18.1	35.4	158.2	1.8

VIIIa,b	N	Mean	Confid. -95%	Confid. 95%	Median	Min	Max	Lower Quartile	Upper Quartile	Var.	St. Err.
R. brachyura	14	1.7	-0.8	4.2	0.0	0.0	12.6	0.0	0.0	18.6	1.2
R. montagui	14	1.1	-1.2	3.4	0.0	0.0	15.0	0.0	0.0	16.0	1.1
R. circularis	14	0.0	--	–	0.0	0.0	0.0	0.0	0.0	0.0	0.0
R. naevus	14	74.5	58.5	90.6	85.5	14.5	100.0	60.0	100.0	774.8	7.4
R. clavata	14	4.4	0.1	8.7	0.0	0.0	24.7	0.0	8.4	56.0	2.0
Mixed rays	14	18.3	5.7	30.8	11.4	0.0	77.1	0.0	21.0	473.2	5.8





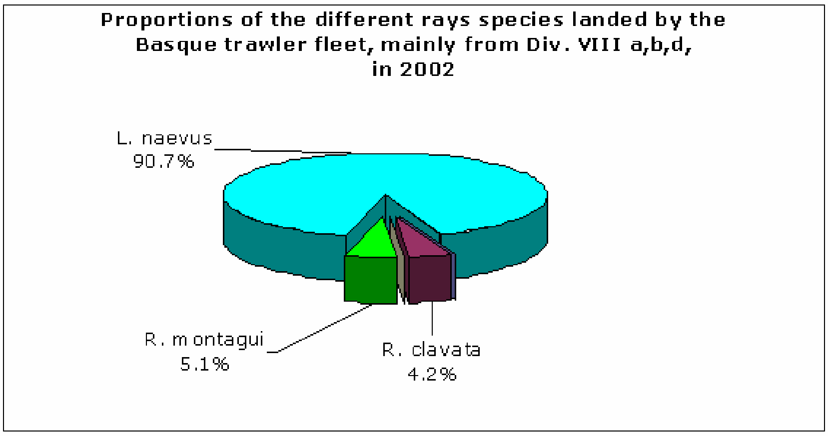


Figure 2.1.11 – Proportions, by weight, of different rays in the landings of the Basque trawl fleet, mainly from Div. VIII a,b,d: for 2000; 2001; and 2002.

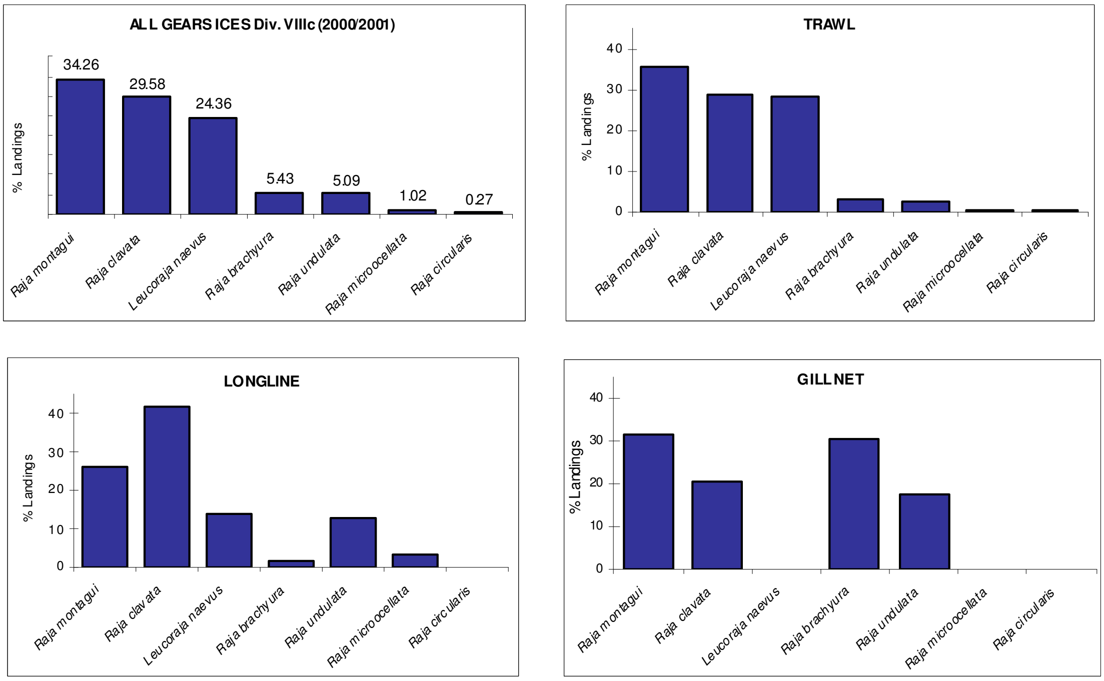


Figure 2.1.12 – Species composition of Spanish landings of rays and skates from ICES Division VIIIc during 2000/2001.

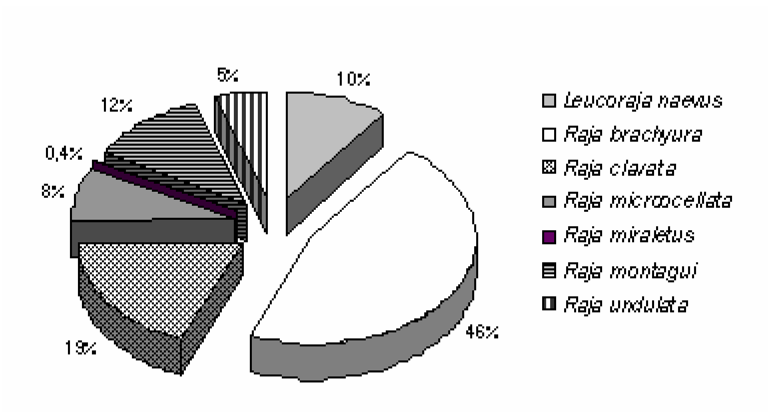


Figure 2.1.13 - Species composition in landings from Portuguese trammel net fisheries sampled at the port of Peniche, Jan to June 2003. Relative frequency of each species is given in percentages.

Caveat

Data from market sampling and discard programmes have resulted in some unusual observations for some of the less abundant skate species. For example R. alba and L. circularis have been reported from areas where they have not been recorded in fishery-independent groundfish surveys. These observations may be due to misidentifications and, therefore, further work on developing user-friendly field keys and training is required to improve the quality of such data.

2.1.1.5 Discards

A brief description of the work done on elasmobranch discards as part of the DELASS Project is given below. To facilitate the presentation it is separated by the Institutions involved.

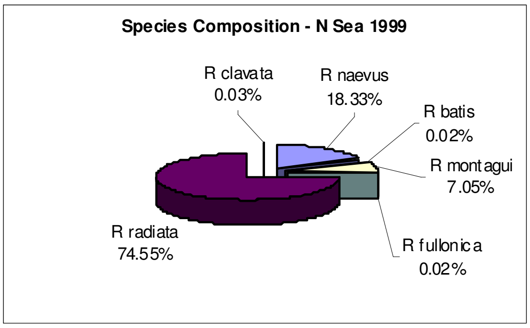
UK Scotland (Marine Laboratory)

Beginning in 1975 in the North Sea, subsequently extended to the West Coast in 1976, the Marine Laboratory has run a continuous annual national project on discard rates. There are a number of different ways of estimating discard rates, but the Marine Laboratory has always used the protocol of sending scientific observers to sea on a number of selected fishing vessels. Whilst this method is expensive in manpower and resources, it does generate the most accurate data and the information is of the highest quality possible. The sampling procedures are closely allied to those employed in sampling landings. It is the aim of the observers to monitor every haul made by the vessel. For many years the information on minor species was excluded from the main database, but, between December 1997 and March 1999, work was undertaken to modernize the database and include all species. These activities were not part of the DELASS project, but participation in the latter permitted the Marine Laboratory, for the first time, to undertake an analysis of the data and make an estimate of elasmobranch discard rates.

Before viewing the data, a couple of caveats should be given. In any given year, about 80 different vessels are sampled for the two areas combined – this is the limit of the national discard project's resources. Thus the initial sampling size is small; any atypical results observed can, and do, skew the final analysis. Secondly, in order to obtain fleet estimates of discards, the raising factors used are of a large order of magnitude. All estimates of total weight discarded must therefore be treated with considerable caution. Having stated these caveats, the following analyses do provide, for the first time, some indication of the discard rates of elasmobranchs by Scottish vessels. The analyses were based on the activities of the main Scottish demersal fleets, i.e. trawl, seine, *Nephrops* trawl and pair trawl vessels. Minor gears such as creels, drift nets etc. were excluded. Raising factors were based on total demersal landings by individual vessels and fleets.

Skates and Rays

Technical problems prevented an analysis of the most recent year's data (2001), so work concentrated on the years 1999 - 2000. For both 1999 and 2000, data for the two ICES sub-areas were analysed separately; 1028 hauls from the North Sea and 532 from the West Coast. Based on prior knowledge gained in the pilot study on market sampling, the discard database was interrogated for all species known to been landed. In addition, the interrogation was extended to any other species that were not landed but may have existed in the total catch composition. Figure 2.1.14 shows the species composition of the elasmobranchs discarded in the Scottish fisheries in the North Sea.



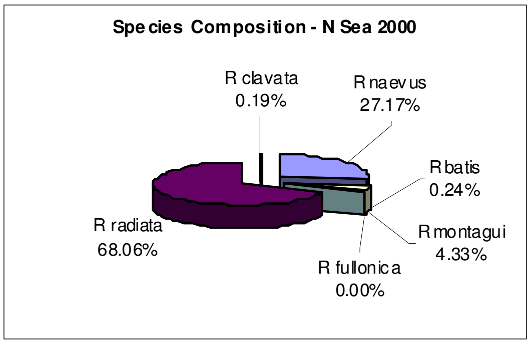


Figure 2.1.14 - Species composition of Rays and Skates in Scottish discards (North Sea) sampling 1999-2000.

In the North Sea, the starry ray *A. radiata* was by far the most dominant species, making up between 68% and 74% of the total skate discards. This species does not appear in the landings data, as it has no commercial importance, but Table 2.1.8 shows that at least 1,400 t may be discarded annually by Scottish vessels in the North Sea. However, *A. radiata* was not found anywhere on the West Coast (VIa). Figure 2.1.15 shows that *L. naevus* was the dominant species discarded in ICES Division VIa. Whilst the inter-annual data in the latter region were remarkably similar for most skates and rays the data for *D. batis* would appear to be unreliable as the discard rate varied from 4 - 45%. This variation was traced back to the sampling of one vessel in the South Minch in 1999, which had very high discards rates of *D. batis* on one particular trip. This was probably an atypical voyage and highlights the dangers of placing too much reliance on data gathered from limited sampling.

Table 2.1.8 - Weights of rays and skates discarded (t) by the Scottish fleets in the North Sea and to the west of Scotland, 1999 - 2000.

Weight discarded (t)				
Species	North Sea		West Coast	
	1999	2000	1999	2000
L. naevus	453.9	548.3	205.8	194.1
D. batis	0.5	4.9	269.1	13.2
R montagui	174.6	87.4	98.3	67.4
L. fullonica	0.4	0	0	3.1
A.radiata	1846.4	1373.4	0	0
R. clavata	0.8	3.9	14.3	16.9
R. alba	4.9	0.4	0.2	0
R. brachyura	0	0	0	0
L. circularis	0	0	0	0
Total	2481.5	2018.3	587.7	294.7

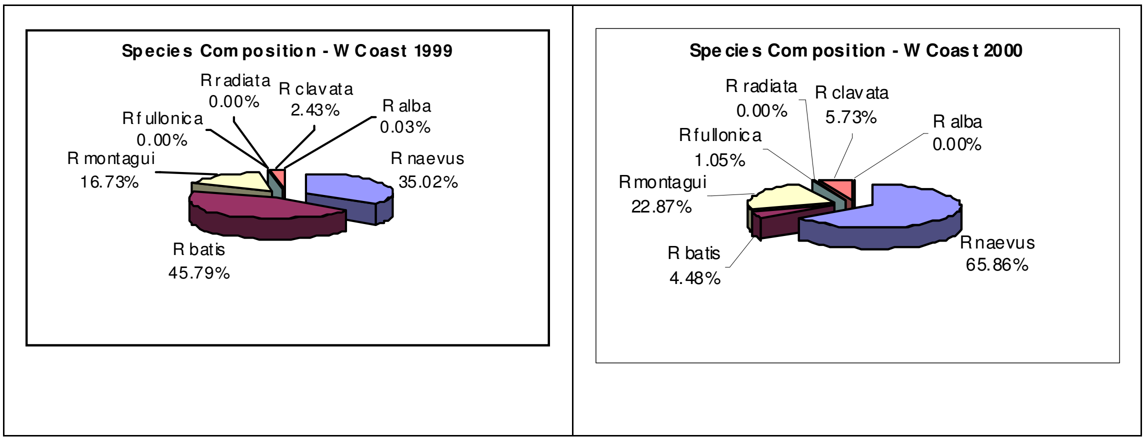


Figure 2.1.15 - Species composition of rays and skates in Scottish discards (West Coast) sampling 1999-2000.

Spurdog and lesser-spotted dogfish

Figures 2.1.16 shows the different aspects of the two species of dogfish landed in Scotland. Only 35.5 t of lesser-spotted dogfish were landed in Scotland for the period 1999 - 2000 combined; whilst the landings of spurdog in the same period were 4,275 t. These marketing practices have a significant impact on discards.

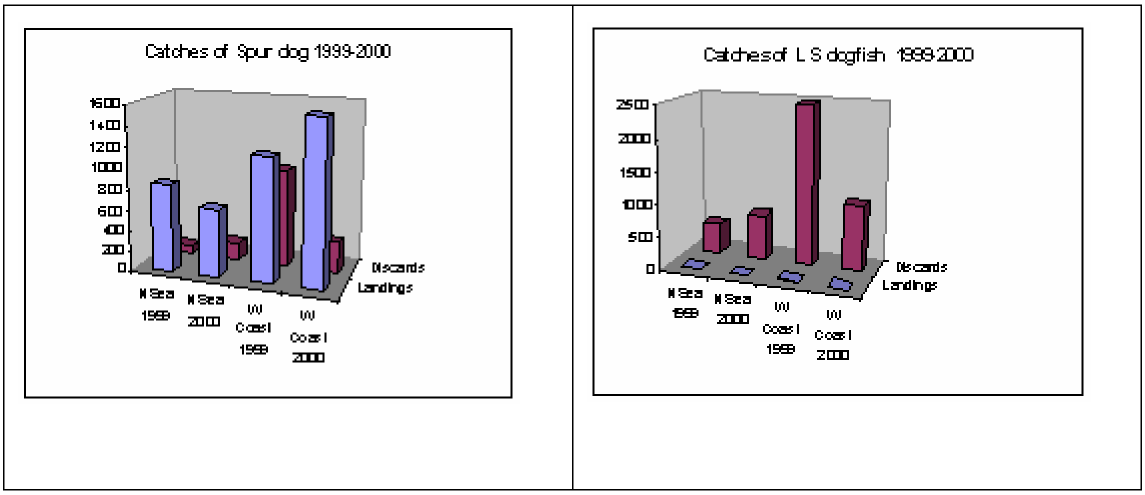


Figure 2.1.16 - Catches and discards of Spurdog and Lesse spotted dogfish from the Scottish fleets 1999-2000.

Lesser-spotted dogfish is not marketed within Scotland. Discards begin at 9 cm and extend up the entire range to approximately 79 cm. The North Sea and West Coast show a very similar distribution at the large end of the range, but the West Coast shows a higher frequency of discards at lengths below 55 cm. Again, these fish were caught in the sea area between the Outer Hebrides and the mainland, the interference being that this may be a nursery area for immature dogfish.

The conclusion to be drawn from the above work on dogfish is that, although they may be of limited significance to Scottish fishermen, and the structure of the lesser-spotted dogfish stock in Scottish waters has still been poorly understood, this contract has provided valuable information on the subject.

Spain (AZTI)

Some information on elasmobranch discards by several Basque Country fleets has been obtained in 2000 from two sources: from observers involved in the present DELASS project, working on board of artisanal longliners targeting blue shark, and from observers involved in the DG Fish Project (Nº98/095) "Monitoring of discarding and retention by trawl fisheries" (Lart *et al*. 2002). The results are presented here for the different métiers and the areas in which the Basque fleets operate (Table 2.1.9).

Mixed Otter Trawl fishery in Sub-area VII

The effort of this bottom trawl métier, "Baka", is mainly concentrated in ICES Divisions VIIh,j, but occasionally they fish further north in Divisions VIIb,c. This métier targets a range of species, mainly anglerfish, megrim, hake and *Nephrops* which, with greater fork beard, rays, short-finned squid, ling, and *Octopus*, form 92% of the total landings (and more than 95% of the economical value) from this area. Anglerfish (2 species) and megrim (2 species) contribute 63 % in weight and 80% in value of the landings.

In the study in 2000, the majority (>95%) of *S. canicula* in number, and 75% in weight, is discarded due to their small size and low market price . About half of the rays in number, but only 5% of the ray catches in weight, were discarded due to their small size. No other information on the ray discards by species is available.

Mixed Otter Trawl fishery in the Bay of Biscay

Effort of this "Baka" fleet, is concentrated in ICES Divisions VIIIa,b,d. This métier catches a very large range of species, that in descending order of landings in 2000 were: pout, red mullet, rays, wedge sole, lesser-spotted dogfish, horse mackerel, hake, black anglerfish, argentine, gurnards, *Octopus*, Mediterranean horse mackerel, white anglerfish, megrim and squid, all together forming 90% in weight of the landings and almost 90% of total economical value. The first five species contribute more than 50% to the total landed weight and almost 50% to the total economical value.

In 2000, more than 80% in number, and 45% in weight, of lesser-spotted dogfish are discarded due to their small size and low market price. About 20% of the rays in numbers, but only 7% of the ray catches in weight, were discarded due to their small sizes. No information on the ray discards by species is available, except for cuckoo ray (*L. naevus*). For this species, 40% of the catch in number was discarded, but only 12% in weight, i.e., only the small specimens. No discards of other sharks (Squalidae, Triakidae) were observed, but their catches were also very low.

Pair Trawl fishery with very high vertical opening nets in the Bay of Biscay

Effort of this métier, named VHVO pair trawl, is mainly concentrated in ICES Divisions VIIIa,b,d. This métier began to work in 1993. Two general types of net are used in this métier: bottom trawls and mid-water trawls.

This métier targets a small number of species, above all hake, but in some trips also Mediterranean horse mackerel and horse mackerel, these 3 species forming 85% of the catch (and more than 85% of the economical value). Hake contributes almost 70% to the total landed weight and almost 80% to the value.

No discards of lesser-spotted dogfish or other sharks (Squalidae, Triakidae) were observed, but their catches were also very low (less than 2 t). No catches of rays were observed.

Pair Trawl fishery with very high vertical opening nets in the Eastern Part of the Cantabrian Sea

Effort of the VHVO pair trawl métier is concentrated in the eastern part of ICES Division VIIIc (i.e. off the Basque coast). This métier began in 1996, and two general types of net are used: bottom trawls and mid-water trawls.

This métier targets blue whiting, mackerel and horse mackerel, which form 90% of the catch in weight and 73% of the economical value. Hake, the fourth species, amounts to 6% of the catch in weight and 18% in economical value. Blue whiting contributes more than 55% to the total landed weight.

In 2000, all lesser-spotted dogfish caught were discarded, but their catches were low (less than 4 t, i.e. 0.1% of total catch). No discards of rays or sharks (Squalidae, Triakidae) were observed, but their catches were also very low (less than 1.5 t).

Artisanal longline targeting blue shark in the Bay of Biscay

Effort of this métier is concentrated in the Bay of Biscay (ICES Divisions VIIIa,b,c,d). For 2000, information is available for 72 trips, from skippers who are obliged to fill in detailed catch forms by trip, or from observers.

This métier targets blue shark (>98% of the catches in number in 2000), with low catches of Lamnidae. According to information from the observers and from the skippers, there are very few discards of blue sharks. These consist mainly of small fish (<65 cm) that are caught alive.

Table 2.1.9 – Estimated catch composition -landings and discards- of sharks and rays taken by some Basque trawl fleets from ICES Sub-area VII and Divisions VIIIa,b,c,d in 2000.

(a) Mixed Otter Trawl fishery in Sub-area VII

	Numbers (x 1000)					Percentage of total catch by Number	Weights (Ton)	
Species	Discarded	± C.V	Retained	± C.V	Total Catch	Discarded	Discarded	Retained
Raja spp.	46.7	± 0.6	39	± 0.4	85	55	4	69
Scyliorhinus canicula	1207.4	± 0.2	36	± 0.2	1244	97	212	74

(b) Mixed Otter Trawl fishery in the Bay of Biscay (Div. VIIIa,b,d)

	Numbers (x 1000)					Percentage of total catch by Number	Weights (Ton)	
Species	Discarded	± C.V	Retained	± C.V	Total Catch	Discarded	Discarded	Retained
Raja spp.	3.9	± 0.8	15.9	± 0.2	19.8	20	2.2	30.1
Scyliorhinus canicula	72.0	± 0.3	16.3	± 0.3	88.3	82	19.1	23.7
Leucoraja naevus	4.7	± 0.5	6.2	± 0.3	10.9	43	0.9	6.4
Squalidae,Triakidae		±		±		0		
Raja clavata	0.14	± 1.39	0.25	± 0.71	0.39	36	0.02	0.32

(c) Pair Trawl fishery with very high vertical opening nets in the Bay of Biscay (Div. VIIIa,b,d)

	Numbers (x 1000)					Percentage of total catch by Number	Weights (Ton)	
Species	Discarded	± C.V	Retained	± C.V	Total Catch	Discarded	Discarded	Retained
Squalidae,Triakidae		±	n.e.b.n.	±	n.e.b.n.	0		1.3
Scyliorhinus canicula		±	n.e.b.n.	±	n.e.b.n.	0		1.9

(d) Pair Trawl fishery with very high vertical opening in Division VIIIc

	Numbers (x 1000)					Percentage of total catch by Number	Weights (Ton)	
Species	Discarded	± C.V	Retained	± C.V	Total Catch	Discarded	Discarded	Retained
Squalidae,Triakidae		±	n.e.b.n.	±	n.e.b.n.	0		1.4
Scyliorhinus canicula	4.5	± 0.5		±	4.5	100	3.8	
Raja spp.		-	n.e.b.n.	-	n.e.b.n.	0		0.4

n.e.b.n.= not estimated by number

Spain (IEO)

Data on elasmobranch discards have been obtained from two sources: a) observers involved in the DELASS project on board bottom trawl vessels, and b) observers involved in the DG Fish Project (nº PEM/93/005) "Discards of the Spanish fleet in ICES area" (Pérez *et al.* 1996).

A study carried out in 1994 (Study Contract DG XIV. Ref. nº: PEM/93/005) to estimate the discards of the Spanish fleet in different ICES areas revealed that almost 90% of the total catch of *S. canicula* in ICES Division VIIIc is discarded. Studies carried out in 1999 and 2000 (not published) estimated proportions of discards of 77 and 83% respectively. For rays the values obtained were 20, 25 and 33% respectively.

A summary of the main elasmobranch species caught and discarded by the Spanish trawl fleet operating in the different ICES Divisions is shown in Tables 2.1.10 and 2.1.11.

Table 2.1.10 - Percentage of discards estimated for the Spanish trawl fleet

	Species / year / %	1994	1999	2000
VIIIc	*Rajidae*	*19.8*	24.9	33.1
	Scyliorhinus canicula	*90.0*	77.4	82.6

Table 2.1.11 – Summary of total catch and discards (t) of the main elasmobranch species by the Spanish trawl fleet, 1994.

Area	Species	Capture	Discard	% Discard
VI y VII	Leucoraja naevus	329	301	91
	Scyliorhinus canicula	697	658	94
VIII a,b	Galeus melastomus	247	245	99
	Leucoraja naevus	155	109	70
	Scyliorhinus canicula	391	253	65
VIII c	Galeus melastomus	1111	1009	91
	Scyliorhinus canicula	1572	1459	93
IX a	Scyliorhinus canicula	1188	986	83

A summary of the main elasmobranch species caught and discarded by the Spanish longline fleet and gillnet fleet operating in different ICES Divisions is shown in Tables 2.1.12 and 2.1.13.

Table 2.1.12 – Summary of total catch and discards (t) of the main elasmobranch species by the longline fleet, 1994.

Area	Species	Catch	Discard	% Discard
VI y VII	Galeus melastomus	31	31	100
	Prionace glauca	58	58	100
	Leucoraja fullonica	19	19	100
	Leucoraja naevus	35	34	97
	Scyliorhinus canicula	76	76	100
	Squalus acanthias	14	14	100
VIII a,b	Galeus melastomus	279	6	2
	Scyliorhinus canicula	33	33	100
VIII c	Deania calceus	90	90	100
	Galeus melastomus	186	140	75
	Scyliorhinus canicula	307	307	100

Table 2.1.13 – Summary of total catch and discards (t) of the main elasmobranch species in the Spanish gillnet fleet, 1994.

Area	Species	Catch	Discard	% Discard
VIII c	Dalatias licha	203	25	12
	Deania calceus	6	6	100
	Scyliorhinus canicula	101	13	13

Norway (Hareide Consultants)

Official landing figures were not yet available from the Norwegian Directorate of Fisheries. Data were therefore collected from sales organizations in co-operation with the Directorate of Fisheries.

Logbooks were collected from three longliners and the trawler which participated in the feasibility study. The logbooks contain information from 19 days trawling and from 72 days longlining.

Data on total effort (days) were made available from the Directorate of Fisheries. These data were obtained from the satellite tracking system. Observers were onboard two of the longline vessels for two weeks each, and collected biological information, trained fishermen in identifying the different fish species and demonstrated the best way of processing the fish (Kjerstad *et al.* 2002). Information on catch, discards and effort was collected during this period, and the skippers collected data on catch and effort for an additional three weeks.

By weight, the discards represented 47% and 43% of the total catch in areas 1a and 2a respectively. Sampling was carried out during the first two weeks of the feasibility fishery and hence before dense concentrations of Greenland halibut were found. The catch compositions therefore do not reflect the real situation in the commercial fishery and cannot be used to calculate total discards in the fishery.

CPUE figures for each species however, give more reliable information on discards. We have therefore raised the CPUE for each discard species for all areas combined by the total effort in depth strata 1100 – 1600 m. Total discards in this interval were estimated to be 429 t (Table 2.1.14).

Table 2.1.14 - Catch composition (kg round weight) from Norwegian feasibility fishery on Hatton Bank 2001, all areas combined, in depths between 1,200 and 1,600 m.

Hooks	82,880				
Species	Kg	Kg/1,000 hooks	% of catch	% discarded	Kg discarded
Centroscyllium fabricii	9,341	112,71	30,94	100	9,341
Hydrolagus affinis	5,222	63,01	17,30	0	0
Reinhardtius hippoglossus	4,413	53,24	14,62	0	0
Centroscymnus coelolepis	4,264	51,45	14,12	0	0
Etmopterus princeps	3,788	45,71	12,55	100	3,788
Macrourus berglax	1,836	22,15	6,08	0	0
Antimora rostrata	475	5,73	1,57	100	475
Skates	372	4,49	1,23	10	37
Centrophorus squamosus	99	1,20	0,33	0	0
Psuedotriakis microdon	85	1,03	0,28	100	85
Lepidion smithi	59	0,71	0,20	100	59
Trachyrhynchus trachyrhynchus	56	0,68	0,19	100	56
Lepidion eques	41	0,50	0,14	100	41
Coelorhychus occa	31	0,37	0,10	100	31
Centroscymnus crepidater	28	0,33	0,09	100	28
Molva dipterygia	22	0,26	0,07	0	0
Galeus murinus	19	0,22	0,06	100	19
Synaphobranchus kaupi	13	0,16	0,04	100	13
Rhinochimaera atlanticus	12	0,14	0,04	100	12
Chimaera monstrosa	8	0,10	0,03	0	0
Cottonculus th omsonii	6	0,08	0,02	100	6
Onogadus argentatus	1	0,01	0,002	100	1
	30,191	364,28	100,00		13,992

2.1.2 Recreational fisheries

There are a number of recreational fisheries for elasmobranchs in Ireland. Blue shark is caught in along the south, west and north coasts, when the water temperature is greater than 14°C. This is a tag and release fishery and the Central Fisheries Board has carried out a tagging programme since 1970 on this species. Unstandardised CPUE (no. blue shark per day) has shown a marked decline in recent years (Figure 2.1.17).

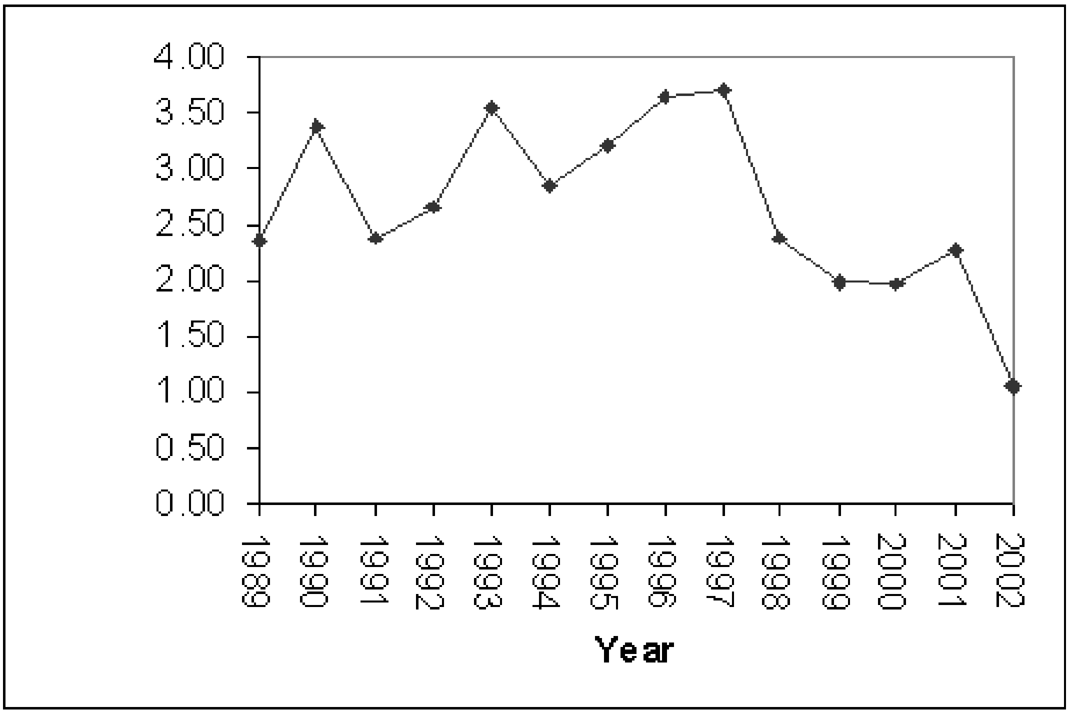


Figure 2.1.17 - Total CPUE (blue shark per day) for the 10 most reliable skippers from the Irish recreational fishery database. From Fitzmaurice *et al.* (2003).

Other pelagic species, porbeagle and thresher and are occasionally caught in this fishery too. Tope is caught in many recreational fisheries around the coast and is subject to the same tag and release studies as the others. In coastal areas rays and skates are targeted by anglers also, the main species being thornback ray. The main areas are Clew Bay and Tralee Bay, both on the west coast. In Tralee Bay there is a sport-fishery for the undulate ray, which is locally abundant in this area, but does not occur elsewhere on the Irish coast. Tagging data from this tag and release fishery confirms that undulate ray is confined to Tralee Bay, with only occasional specimens moving north or south. Angel sharks are caught mainly in Tralee Bay, though catch rates have declined in recent years. The common skate is also caught by Irish anglers. In response to declines in catch rates, the species was removed from the list of species for which specimen records are required in 1976, in order to give some protection to the species.

Recreational sea fisheries in UK play an important role in rural and maritime communities in terms of shore and boat angling, charter fishing and support services (e.g. tackle and bait shops), and may also be an important factor in the tourist industry. Little is known about the economics of these recreational fisheries.

UK recreational fisheries target various skates and rays, dogfishes and hounds, and larger sharks, especially blue and, to a lesser extent, porbeagle, with some specialist clubs for tope and shark fishing. There is also a local recreational fishery targeting common skate in the Sound of Mull (Scotland), with participants in this fishery contributing to a tag-and-release programme.

Some angling clubs now accept length-weight or girth-weight conversion factors, so that fishes can be returned alive. In recent years, a tag-and-release programme has been set up for sharks, primarily smoothhounds and tope, although recapture data are limited at the present time.

2.2 The Mediterranean

2.2.1 Commercial fisheries

As far as the commercial fishery in the Mediterranean Sea is concerned, several demersal elasmobranch species are commercially used, while only a few pelagic species are marketed.

Finning is not known to be practiced by the Italian and Greek fleets in the Mediterranean, although it is not known to what extent finning occurs in other national and international waters within the region. There are non-EC fleets targeting large pelagic fishes in the Mediterranean and here finning is likely to occur.

Table 2.2.1 provides a list of elasmobranch species caught by single gear types in the Mediterranean for the best studied fisheries (trawl, drift net, pelagic long line, tuna trap). Catches are also obtained by set nets, bottom long lines and occasionally by other fishing gear types (purse seine, pots, etc.) but for these gears no species list is available.

Table 2.2.1 – List of elasmobranch species caught by various fisheries in the Mediterranean Sea.

Species	pelagic trawl fishery	bottom trawl fishery	coastal small scale fishery	drift net fishery	pelagic long line fishery	tuna trap fishery
Alopias vulpinus	*			**	**	**
Alopias superciliosus				*	*	
Carcharhinus brachyurus					*	
Carcharhinus brevipinna				*	*	
Carcharhinus falciformis					*	
Carcharhinus limbatus				*	*	
Carcharhinus obscurus				*	*	
Carcharhinus plumbeus				*	**	
Carcharias taurus				*	*	
Carcharodon carcharias				*	*	**
Cetorhinus maximus	*		*	**	**	**
Centrophorus granulosus		**				

Centrophorus uyato		**				
Chimaera monstrosa		**				
Dalatias licha		**	*			
Dasyatis centroura		**				
Dasyatis pastinaca		**	*			
Dasyatis tortonesei		**				
Etmopterus spinax		**				
Galeorhinus galeus		**	*	*	**	
Galeus atlanticus		**				
Galeus melastomus		**				
Heptranchias perlo		**		*	*	
Hexanchus griseus		**	*		**	
Hexanchus nakamurai		**				
Isurus oxyrinchus				**	**	
Lamna nasus				**	**	
Mobula mobular				**	**	**
Mustelus asterias		**	*		*	
Mustelus mustelus		**	*		**	
Mustelus punctulatus		**	*			
Myliobatis aquila		**	*	*	*	
Odontaspis ferox				*	*	
Oxynotus centrina		**				
Prionace glauca	*			**	**	**
Pteromylaeus bovinus			*	*	*	
Pteroplatytrygon violacea		**		**	**	
Rostroraja alba		**				
Raja asterias		**	*			
Dipturus batis		**				

Raja brachyura		**	*			
Leucoraja circularis		**				
Raja clavata		**	*			
Leucoraja fullonica		**			*	
Raja melitensis		**				
Raja miraletus		**	*			
Raja montagui		**				
Leucoaja naevus		**				
Dipturus oxyrhynchus		**				
Raja polystigma		**	*			
Raja radula		**	*			
Raja undulata		**				
Rhinoptera marginata		**				
Scyliorhinus canicula		**	*			
Scyliorhinus stellaris		**	*			
Sphyrna lewini					*	
Sphyrna mokarran					*	**
Sphyrna zygaena				**	**	
Sphyrna sp.				*	*	
Squalus acanthias		**	*		*	
Squalus blainvillei		**	*		*	
Squatina aculeata		**				
Squatina oculata		**				
Squatina squatina		**	*			
Torpedo marmorata		**				
Torpedo nobiliana		**				
Torpedo torpedo		**				

***Legenda*: * = data from literature; ** data from observers**

2.2.1.1 Trawl fishery

Various trawl survey programmes have been carried out in the Mediterranean, but only for a few surveys information on all elasmobranch species that were caught is available. The Mediterranean International Trawl Survey (MEDITS) which is funded by EC, is the most recent and widespread survey.

The MEDITS survey has been carried out for six years, covering an area from the Alboran to the Aegean Sea, between April and June in the period 1994–99 (Serena et al., 2001). Biomass indices (BI; kg/km^2) and standing stocks (swept area method assuming full catchability) were estimated.

The biomass indices refer to 4 arbitrary geographical areas identified by using a land-oriented criterion: Western (WA: coasts of Morocco, Spain and France), Western Central (WCA: Tyrrhenian, Corsica, Sardinia and Sicily coasts), Eastern Central (ECA: Adriatic, Ionian and Albanian), and Eastern (EA: Aegean Sea). The biomass indices by depth stratum were pooled in 4 levels.

In all, 6,336 tows were made in which 45 species of elasmobranchs were identified (Table 2.2.2), consisting of 18 sharks, 14 skates, two angelsharks, four stingrays, three skates, three electric rays and one rabbitfish. Single or sporadic catches were recorded of several species, including *Pteroplatytrygon violacea*, *Hexanchus griseus*, *Mustelus asterias* and *Dipturus batis*. For some species, these figures reflect a true rarity (*Rhinoptera marginata*) or decreased population size (*Squatina* spp.), but in other cases (e.g. *Galeus atlanticus*), there may have been problems with the identification.

Scyliorhinus canicula, Raja clavata, Galeus melastomus and *Squalus acanthias* showed both a high occurrence (>5% of the hauls) and a high abundance (> 10 kg/km^2 or > 10% of relative biomass). Annex 2 provides more information on the distribution and abundance of *G. melastomus*, *S. canicula* and *R. clavata* based on the MEDITS surveys.

Three faunistic groups can be identified with regard to depth: *a)* species that are well represented at all depths such as *R. clavata* and *S. canicula*; *b)* species with a preference for the shelf such as *Dasyatis pastinaca* and *M. mustelus* and *c)* species with a preference for the slope such as *C. granulosus* and *Etmopterus spinax*. Only a handful of species have significant abundance levels and only some are commercially fished. Generally, large-sized species (such as *Mustelus* and *Squalus* spp.) have shown signs of depletion, although there is some evidence of areas with a relatively high density, but it is likely that these areas are avoided by the trawlers because of the rough substrate.

From a geographical point of view, some species are abundant in all areas (*S. canicula, R. clavata, Torpedo marmorata, R. asterias, C. monstrosa),* while others are most common in the west (*T. nobiliana, R. alba, Oxynotus centrina*) or in the east *(S. acantias*, *R. radula, L. naevus, R. brachyura*); some species occur in restricted areas (*Hexachus griseus* and *Raja miraletus* in the Tyrrhenian Sea, *M. mustelus* in the Adriatic Sea, or *R. brachyura* and *R. undulata* in the Aegean Sea). In general, the eastern basins (Adriatic and Aegean Seas) show higher standing stocks, which is probably mainly due to the wider continental shelf in this area.

The catches of *R. clavata*, the most abundant ray in the Mediterranean, seem to reflect mainly a higher ecological performance than a true resilience to exploitation; in fact, concentrations (up to 100 kg/km^2) which are possibly close to the "virgin" state are found only locally in the Gulf of Lions, around Corsica and Sardinia, and in Greek waters. It is worth noting that up to 64% of the total biomass occurs in the Aegean Sea, which is mostly shallower than 400 m.

Table 2.2.2 – Elasmobranch catches during the MEDITS trawl surveys in the Mediterranean Sea during the 6-year period 1994-1999. The biomass indices by depth stratum were pooled in 4 levels: **–** = less than 0.1, **+** = between 0.1 and 1, **o** = between 1 and 10, **O** = more than 10 kg/km^2.

	Frequency of occurence		Standing stock biomass		Depth distribution (m)					Biomass index by geographical area (kg/km^2)				
Species	positive hauls	%	tons	%	0 - 50	50 - 100	100 - 200	200 - 500	500 - 800	WA	WCA	ECA	EA	Overall
Centrophorus granulosus	116	2%	1528	3%		-		o	O	2,7	5,5	0,1	3,1	2,9
Centrophorus uyato	19	0%	318	1%		-		+	o	1,0	1,7			0,6
Chimaera monstrosa	524	8%	2056	4%			-	o	O	8,5	3,3	1,4	4,5	4,0
Dalatias licha	152	2%	780	1%				+	o	3,3	2,8	0,8	0,2	1,5
Dasyatis centroura	1	0%	6	0%	+							0,0		0,0
Dasyatis pastinaca	49	1%	778	1%	o	o	+			0,1	2,9	0,2	1,9	1,5
Dasyatis tortonesi	2	0%	24	0%		+	+						0,1	0,0
Pteroplatytrygon violacea	2	0%	5	0%	+	-				0,0	0,0			0,0
Etmopterus spinax	1173	19%	2248	4%			+	o	o	9,2	6,5	0,9	3,1	4,3
Galeorhinus galeus	5	0%	126	0%	+	-		+	+	0,1	0,2	0,1	0,4	0,2
Galeus atlanticus	1	0%	1	0%					-	0,0				0,0
Galeus melastomus	1702	27%	6891	12%			+	O	O	48,5	16,7	3,0	3,3	13,3
Heptranchias perlo	12	0%	723	1%			+	o	o	0,7	3,9		0,7	1,4
Hexanchus griseus	12	0%	440	1%		-		+	o	0,0	3,1			0,8
Hexanchus vitulus	1	0%	49	0%				+					0,3	0,1
Mustelus asterias	5	0%	87	0%	+	+						0,7		0,2
Mustelus mustelus	111	2%	2645	5%	O	o	+	+	+	0,1	1,1	18,7	0,3	5,1
Mustelus punctulatus	1	0%	2	0%		-						0,0		0,0
Myliobatis aquila	37	1%	626	1%	o	+					0,3	4,3	0,1	1,2

Oxynotus centrina	36	1%	380	1%		+	o	+	+	0,6	1,9		0,4	0,7
Rostroraja alba	9	0%	125	0%	-		o	-	-		0,8		0,0	0,2
Raja asterias	252	4%	1575	3%	o	o	o	o	+	2,2	3,5	1,3	4,4	3,0
Dipturus batis	2	0%	14	0%		+			-	0,2	0,0			0,0
Raja brachyura	21	0%	532	1%	+	+	o	o	-		0,4		2,8	1,0
Leucoraja circularis	12	0%	29	0%		-		-	+	0,2	0,0	0,1		0,1
Raja clavata	1000	16%	8151	15%	o	O	O	O	o	4,6	14,9	7,9	27,0	15,7
Leucoraja fullonica	7	0%	3	0%				-	-		0,0	0,0	0,0	0,0
Raja melitensis	20	0%	705	1%		+	+	o	o		4,9		0,0	1,4
Raja miraletus	422	7%	1729	3%	o	o	o	o	-	1,3	6,4	2,0	2,7	3,3
Raja montagui	107	2%	882	2%	+	+	o	o	-	0,9	2,4	0,1	2,7	1,7
Leucoraja naevus	42	1%	348	1%	+	+	o	+		0,3	0,0	0,1	1,8	0,7
Dipturus oxyrinchus	301	5%	1899	3%		+	o	O	o	1,0	8,1	0,3	3,7	3,7
Raja polystigma	171	3%	568	1%	o	o	o	o		2,4	2,6	0,0	0,2	1,1
Raja radula	21	0%	181	0%	o	+	+				0,0	0,2	0,9	0,3
Raja undulata	6	0%	13	0%	+	-	-						0,1	0,0
Rhinoptera marginata	2	0%	1	0%		-						0,0		0,0
Scyliorhinus canicula	1761	28%	8396	15%	o	O	O	O	o	19,3	14,4	11,8	19,8	16,2
Scyliorhinus stellaris	34	1%	301	1%	+	o	+	+	+		0,7	1,2	0,2	0,6
Squalus acanthias	327	5%	6682	12%	O	o	o	O	o	0,3	1,2	31,3	14,1	12,9
Squalus blainvillei	196	3%	1490	3%	+	+	o	o	+		6,6	1,3	2,1	2,9
Squatina aculeata	1	0%	0,3	0%				-					0,0	0,0
Squatina squatina	2	0%	14	0%		+		-			0,1			0,0
Torpedo marmorata	317	5%	1239	2%	o	o	o	o	-	4,3	3,3	0,9	1,9	2,4
Torpedo nobiliana	73	1%	531	1%	+	+	+	o	+	2,1	2,1	0,0	0,5	1,0
Torpedo torpedo	28	0%	38	0%	+	-	+	-		0,0	0,2	0,0	0,0	0,1
TOTAL	6336		55158							114	122	89	103	106

2.2.1.2 Deep trawl fishery

Observer data from the commercial trawl fishery are scarce for the Mediterranean. Some data, however, are available from a few EC study projects. Study project MED92/005 collected data from the deep trawl fishery targeting red and blue shrimps in the western Italian basins (Ligurian Sea and Tyrrhenian Sea) in 1998-99 (Table 2.2.3). In all, 55 hauls were sampled, representing more than 215 fishing hours (while the trawl net was on the bottom). The data were collected by marine biologists, without interfering with the commercial fishing activities. Fishing depth ranged from 350 to 800 m.

The most common species in this fishery was *Galeus melastomus*, with an average of 1.3 kg/h (ranging from 2.7 kg/h in the central Tyrrhenian Sea to 0.09 kg/h along the northern coast of Sicily), followed by *Hexanchus griseus* with an average of 1.2 kg/h and a maximum of 4.7 kg/h in the northern Tyrrhenian Sea (Table 2.2.3). Around Sardinia this species was not caught at all.

Table 2.2.3 - Elasmobranch catches by the deep trawl fishery targeting red and blue shrimps in the Ligurian and Tyrrhenian Sea from autumn 1998 to summer 1999.

AREA:	WESTERN AND SOUTHERN ITALIAN BASINS							
SEASON:	all seasons (autumn 1998 - summer 1999)							
AREA CODE	LIS	NTS	CTS	STS	NSS	SAS	SSS	ALL
TOTAL NUMBER OF HAULS	8	8	8	8	8	8	8	56
TOTAL HAULING TIME	27.57	30.92	29.51	28.99	36	25.99	36.06	215.04
	gr/h	gr/h	gr/h	gr/h	gr/h	gr/h	gr/h	gr/h
*Centrophorus granulosus**	0	408	0	40	0	185	10	88
Chimaera monstrosa	2	20	22	49	1	0	120	33
*Dalatias licha**	119	283	240	164	0	0	107	129
*Etmopterux spinax**	381	494	561	400	201	1187	599	528
Galeus melastomus *	1126	1466	2735	553	90	2525	842	1266
*Hexanchus griseus**	0	4690	430	470	33	0	2385	1202
*Myliobatis aquila**	0	0	0	210	0	0	0	28
*Dipturus batis**	0	0	0	0	0	5	65	12
*Leucoraja circularis**	0	0	0	0	0	0	0	0
*Dipturus oxyrhyncus**	0	154	30	0	0	0	0	26
Raja sp.	17	1	3	0	0	4	505	88
Scyliorhinus canicula *	0	20	16	6	0	643	331	139
Scyliorhinus stellaris *	12	0	0	0	0	0	43	9
*Squalus blainvillei**	0	0	0	0	0	13	554	94
*Torpedo marmorata**	0	0	0	0	0	0	10	2
Torpedo nobiliana	0	0	0	0	0	0	0	0

LIS: Ligurian Sea; NTS: northern Tyrrhenian Sea; CTS: central Tyrrhenian Sea; STS: southern Tyrrhenian Sea (Italian side); NSS: southern Tyrrhenian Sea (northern Sicilian area); SAS: central Tyrrhenian Sea (Sardinian area); SSS: southern Sardinian area; *: commercial species.

A total of 13 different species of elasmobranchs were identified in this fishery but two of them were very rare (*Leucoraja circularis* and *Torpedo nobiliana*, both with less than 0,1 gr/h on average). Ten of the 13 species were “commercial species” (marked with an asterix in the table), because they were marketed at least once during the study. The yield of commercial elasmobranchs ranges from a minimum of 0.3 kg/ h in the northern Sicilian area, to a maximum of 7.5 kg/h in the northern Tyrrhenian Sea, showing a great variability between areas and seasons.

The commercial elasmobranchs represented on average 25% of the total commercial catch and 20% of the total catch in this particular fishery.

All species were usually marketed entire, sometimes gilled and gutted, sometimes skinned (in the case of small sharks). No finning has been reported so far in this fishery.

2.2.1.3 Large pelagic fisheries

In the Mediterranean Sea there are no large-scale commercial fisheries targeting migratory oceanic sharks. However, fishing fleets targeting large pelagic fishes (such as swordfish, bluefin tuna and albacore) with longlines and drift nets do have a by-catch of pelagic sharks.

Mediterranean surface longlines display a great variability. There is no "standard" gear. The equipment that is used varies according to the area of origin, and the capacity. The material and length of the main and branch lines varies, as well as the fishing depth, size and number of hooks, buoys and/or balls, bait and chemical light used. The main gears used are the swordfish longline, the American type swordfish longline, the albacore longline and the longline targeting bluefin tuna. Drift nets were used mainly by the Italian fleet, until the EC ban came into force in January 2001.

Despite the lack of records on elasmobranch by-catches in the Mediterranean pelagic fisheries, a study carried out in the frame of a project financed by the EC (N° 97/50 DG XIV/C1) during 1998-1999, provides data on the by-catch of sharks and discards from the Greek, Italian and Spanish fleets fishing for swordfish and tunas in the Mediterranean Sea. The fishing grounds investigated by country are shown in Figures 2.2.1-3.

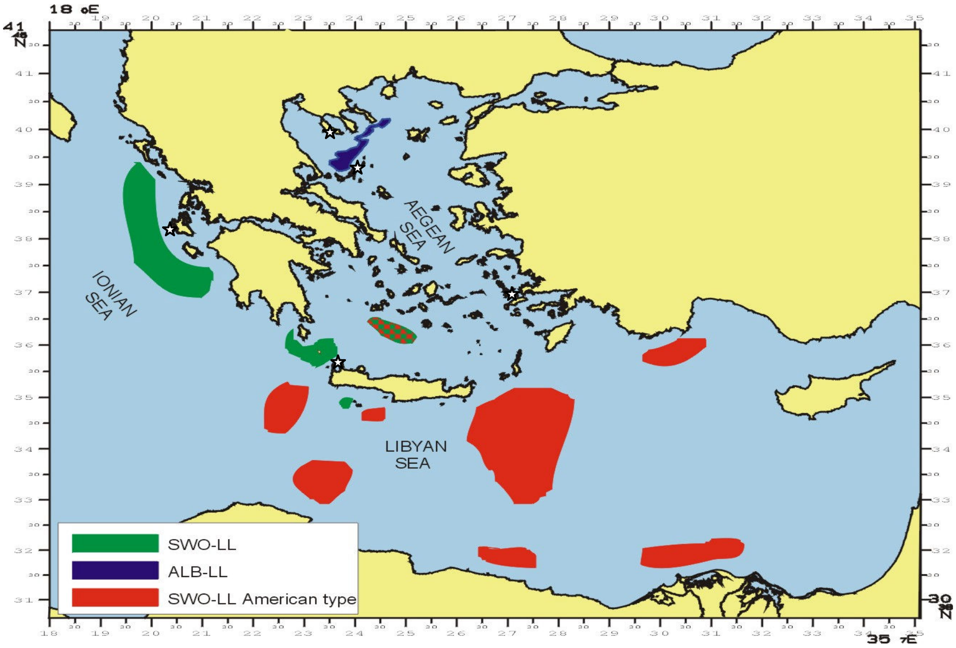


Figure 2.2.1 - Fishing ports (white star) and fishing grounds for the Greek swordfish and albacore fisheries sampled in the Ionian Sea, Aegean Sea and Levantine Basin during 1998-99.

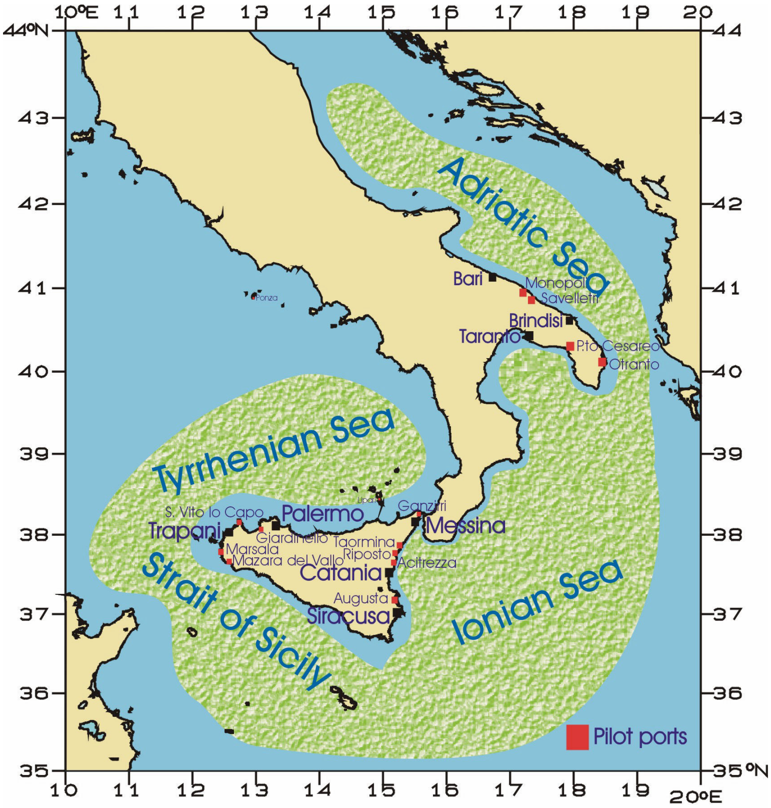


Figure 2.2.2 - Fishing ports and fishing grounds for swordfish, albacore and bluefin tuna fisheries sampled in the southern Italian seas during 1998-99.

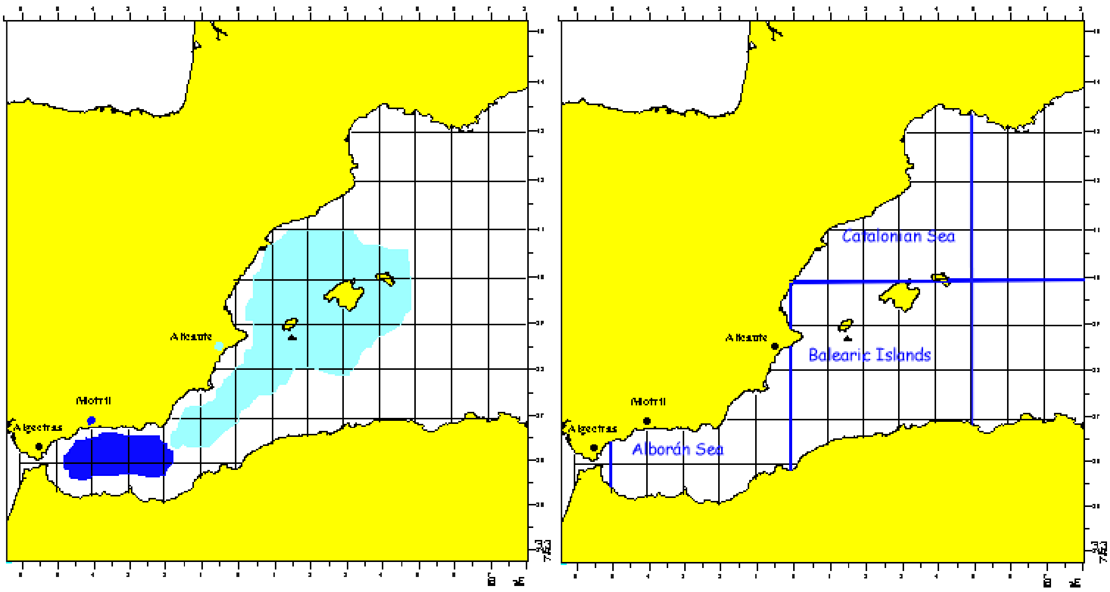


Figure 2.2.3 - Fishing ports and fishing grounds for swordfish, albacore and bluefin tuna fisheries studied in the Spanish seas during 1998-99. In the left map fishing ports and corresponding fishing grounds are marked with the same colour.

Table 2.2.4 - Presence of pelagic shark species throughout the Mediterranean in 1998 and 1999 (project N° 97/50 DG XIV/C1).

COUNTRY	AREA	SPECIES									
		Prionace glauca	*Isurus oxyrinchus*	*Alopias vulpinus*	*Alopias superciliosus*	*Galeorhinus galeus*	*Lamna nasus*	*Cetorhinus maximus*	*Carcharhinus plumbeus*	*Hexanchus griseus*	*Sphyrna zygaena*
SPAIN	Alboran Sea	*	*	*	*	*					
	Balearic Sea	*	*	*		*					

	Catalonian Sea	*	*	*		*					
ITALY	Adriatic Sea	*		*							
	Tyrrhenian Sea	*	*					*			
	Strait of Sicily	*	*	*		*		*	*	*	
	N. Ionian Sea	*		*			*				*
GREECE	S. Ionian Sea	*									
	Aegean Sea	*	*	*		*					
	Levantine basin	*	*	*		*					

At least 10 species of pelagic sharks are frequently taken incidentally in the Mediterranean fisheries for large pelagic species. These species, listed by order of importance, are blue shark *Prionace glauca,* shortfin mako *Isurus oxyrinchus*, common thresher shark *Alopias vulpinus*, porbeagle *Lamna nasus*, tope *Galeorhinus galeus*, bigeye thresher shark *Alopias superciliosus*, sandbar shark *Carcharinus plumbeus*, basking shark *Cetorhinus maximus*[*)], sixgill shark *Hexanchus grisues* and smooth hammerhead *Sphyrna zygaena*.

During the two year period (1998-99) of the study, only four species were observed all over the Mediterranean: blue shark, shortfin mako, common thresher shark and tope (Table 2.2.4). These species were most abundant in the high production areas of the Alboran and Adriatic Seas. The remaining six species were relatively rare in the catches and were observed only in one or two sub-areas. The Strait of Sicily was the most diverse shark area. Seven species were recorded here.

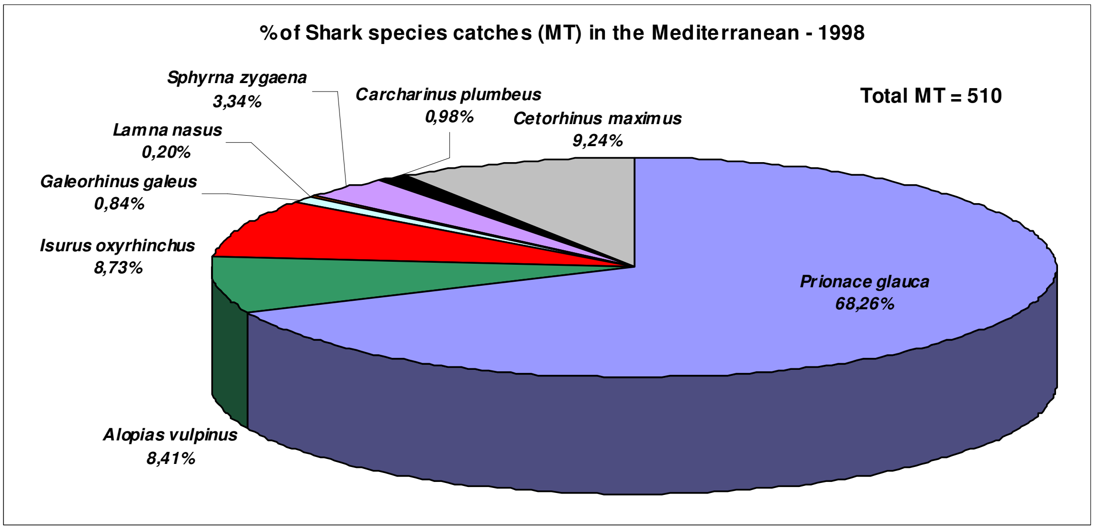
[*)] Some further information on basking shark in the Mediterranean Sea is provided in Annex 1

Blue shark was most abundant in all areas and gears, followed by shortfin mako and common thresher shark. But also smooth hammerhead, big-eye thresher shark, sandbar shark and basking shark were caught in significant numbers.

During 1998 and 1999 the Greek, Italian and Spanish swordfish longline catches of pelagic sharks were estimated to have been 510 and 1100 MT respectively. The catch composition of sharks caught all over the Mediterranean Sea, showed that 68 and 82% of the catches in weight consisted of blue shark in 1998 and in 1999 respectively (Figure 2.2.4).

Data obtained both on board and at the landing site revealed that most sharks are being caught in the swordfish fishery. The incidence of sharks in the longline fishery for albacore was almost negligible.

Since pelagic sharks were mainly caught in the longline fisheries for swordfish, the ratios between shark and swordfish catches in weight were estimated (Figure 2.2.5) to allow an alternative rough estimation of the by-catch of sharks in the Mediterranean Sea (without extrapolation of the observed shark by-catches or using the official data sources).



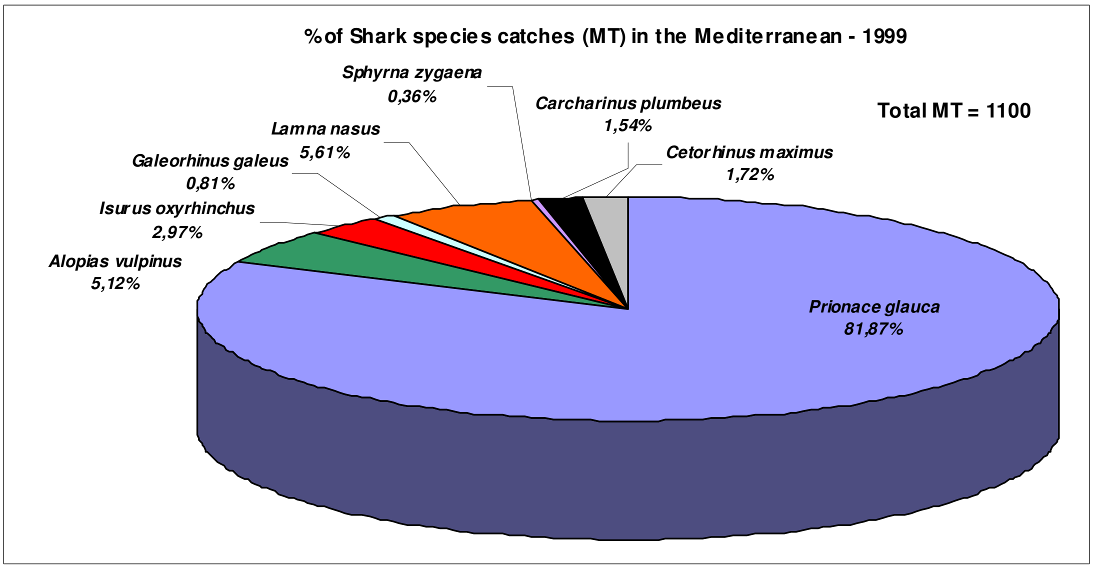
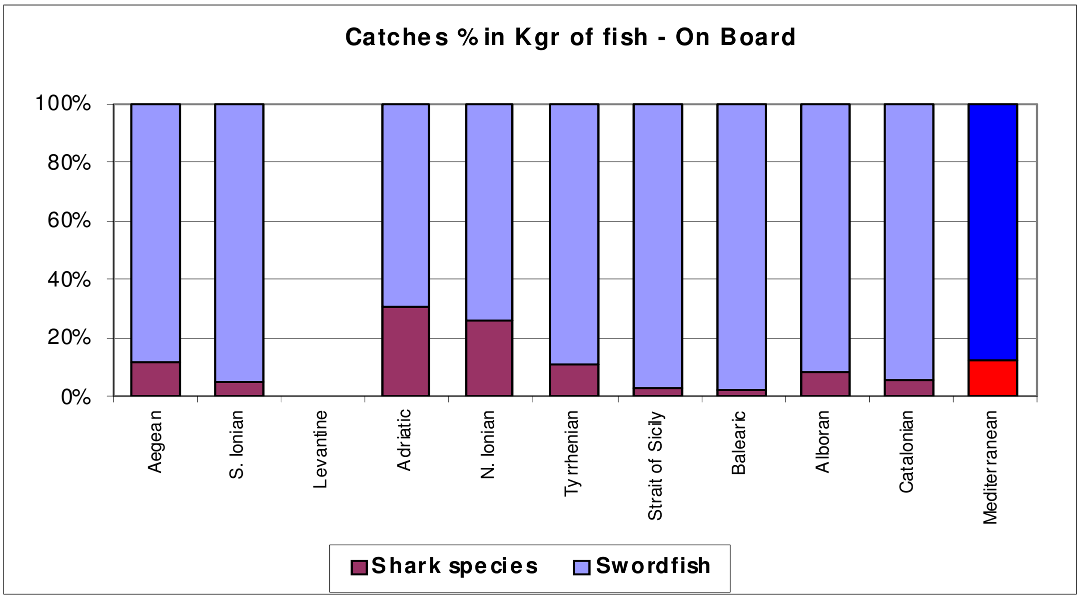


Figure 2.2.4 - Percentage of incidental shark catches by species in the fisheries for large pelagic species in the Mediterranean Sea (Greece-Italy-Spain) during 1998-1999. (Project N° 97/50 DG XIV/C1).



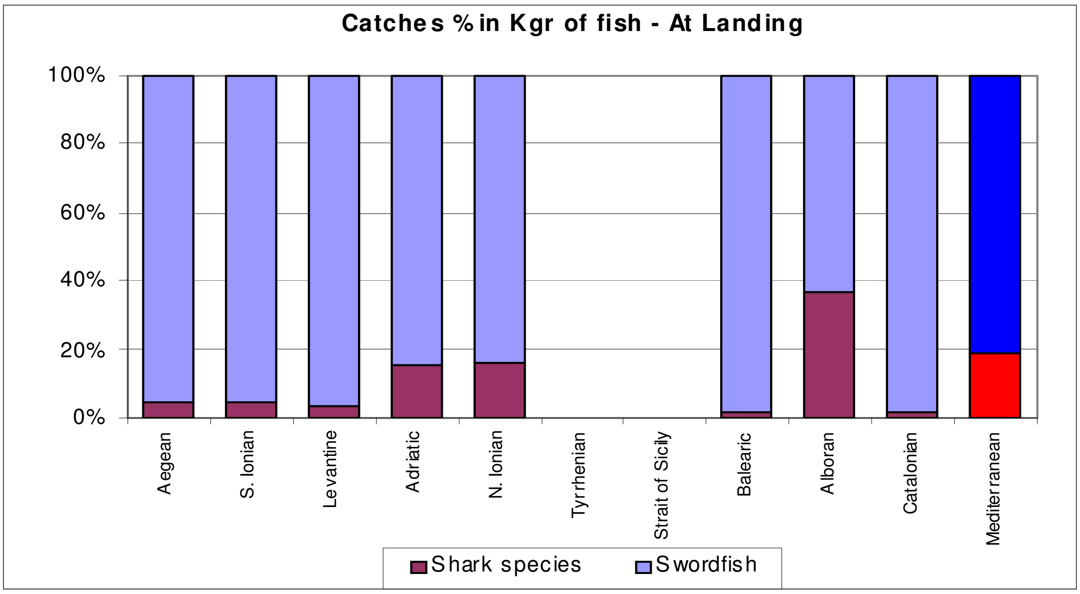


Figure 2.2.5 - Percentage (by weight) of swordfish and sharks in the longline fisheries for swordfish in the Mediterranean Sea, by area during 1998-99 (Project N° 97/50 DG XIV/C1). Last bar: shark catches in red and swordfish catches in blue.

Incidental catches of sharks in the swordfish fisheries were highest in the Alboran Sea (29% of the fish landed in 1998 and 20% in 1999) and in the Adriatic Sea (23% of the fish landed in 1999). Sharks seem to comprise a smaller proportion of the landings in the Mediterranean than in other longline fisheries in the Atlantic (Buencuerpo *et al.*, 1998; Berkeley and Campos, 1988; Tobias, 1991).

If only data collected on board are considered, incidental catches of sharks in the longline fishery for swordfish ranged from 0.4 to 7.6% in Spanish waters, from 1.8 to 4.9% in Greek waters and from 0.7 to 39.7% in Italian waters.

Sharks caught by the drift net fishery in the North Ionian Sea amounted to 1.2% in 1998 and 1.6% in 1999 (in number of fish landed).

CPUE data (number of sharks/1000 hooks) from the various investigated areas showed that Mediterranean long line catch rates were always lower than those in the eastern North Atlantic. According to Buencuerpo et al. (1998), catch rates from the swordfish longline fleet ranged from 9.9 to 37.8 sharks/1000 hooks in the eastern Atlantic. In the Mediterranean Sea, the highest CPUE values were found in the Alboran Sea, reaching 5.6 sharks/1000 hooks during 1998. The overall long line CPUE's per area in the Mediterranean Sea for observations made on board and at landing are shown in Figures 2.2.6 and 2.2.7 respectively. Catch rates usually did not exceed 1 shark/1000 hooks. Comparison of fishing gears shows that the highest catch rates were undoubtedly those of the swordfish longlines. The lowest catch rates for sharks were observed in albacore longlines (Table 2.2.5).

Discards

Discarding depends on the economic value of the fish. In Europe there is a market demand for sharks and therefore the discards observed during the investigations in the two-year period 1998-1999 were very few.

In the North Adriatic and South Ionian fisheries the different species of sharks have a commercial value and therfore they are not discarded. The price of shark flesh on wholesale markets is quite variable, ranging from 1-2 € per kg in different fisheries and seasons. Sometimes, certain agreements are made between fishermen and traders (eg. traders give bait to the fishermen in exchange for the sharks caught). The shark flesh is then sold on retail markets as "pesce palombo" or "pesce penna" (*Mustelus mustelus*), as reported by De Metrio *et al*. (1982, 1983), reaching a price of about 5 € per kg.

In Sicilian fisheries, shark by-catches are usually discarded at sea. This is mainly due to the fact that these boats, fishing for swordfish, make long trips and therefore fishermen prefer to leave space in the hold for storing more valuable species.

In Greece, sharks have a commercial value and therefore most incidental catches of various shark species are not discarded. Blue shark, which is the most common species, is sold in local markets or sent to the central fish market of Athens. Their price varies between 3-4.5 € per kg. The shark flesh sold on retail markets under the name "galeos" can reach a price of 7.5 € per kg. However, during long fishing trips sharks are usually discarded at sea to leave enough space to store more valuable species or they are eaten by the crew during the trip.

Observations carried out on board commercial fishing vessels in the Mediterranean Sea suggest that a high percentage of the pelagic sharks caught by longline have a good chance to survive if discarded at sea, because most of them are alive with good motility and combative behaviour when they are brought on board.

With the moratorium on drift nets in the Mediterranean, starting in January 2002, it is expected that the fishing mortality of elasmobranchs due to this gear will be greatly reduced.

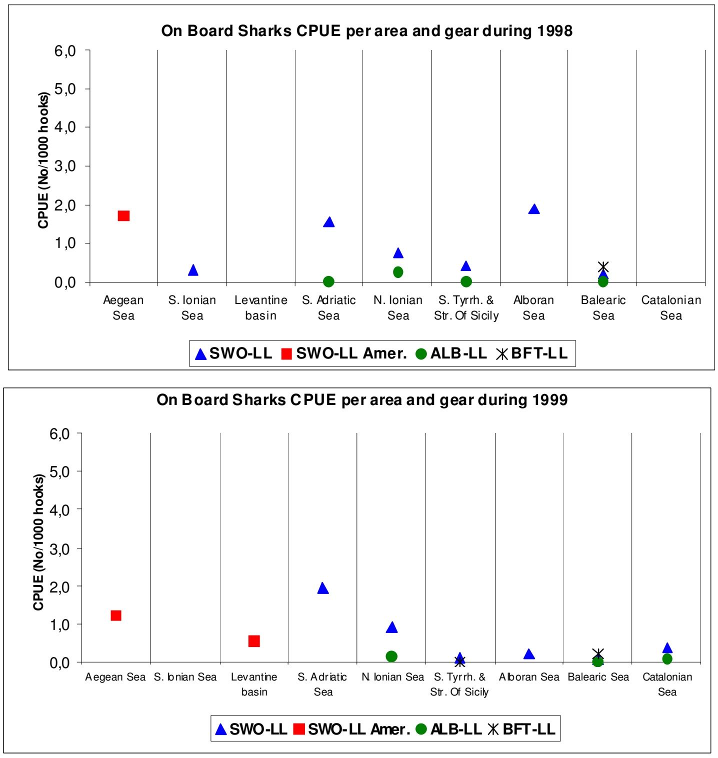
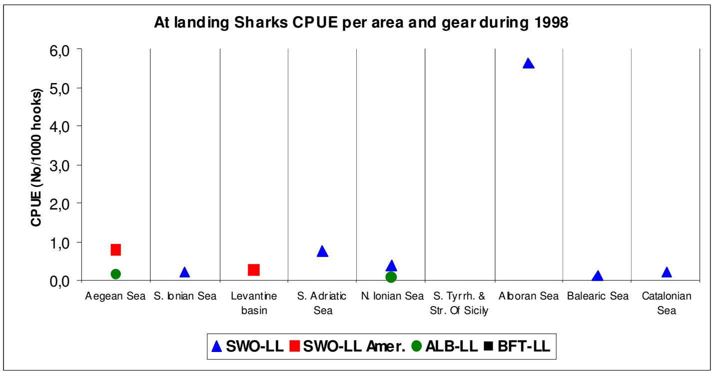


Figure 2.2.6 - Overall CPUE for sharks in No/1000 hooks per gear and area in the Mediterranean during 1998 and 1999 (on board observations). (Project N° 97/50 DG XIV/C1). Fishing gears are the swordfish longline (SWO-LL), "American type" swordfish longline (SWO-LL Amer), albacore longline (ALB-LL) and bluefin tuna longline (BFT-LL).



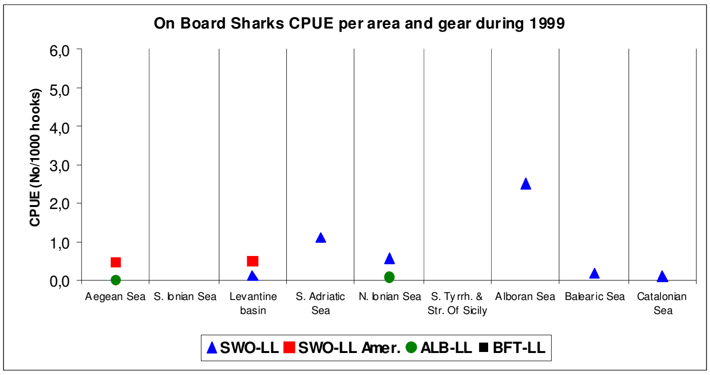


Figure 2.2.7 - Overall CPUE for sharks in No/1000 hooks per gear and area in the Mediterranean during 1998 and 1999 (observations at landing sites) (Project N° 97/50 DG XIV/C1). Fishing gears are the swordfish longline (SWO-LL), "American type" swordfish longline (SWO-LL Amer), albacore longline (ALB-LL) and bluefin tuna longline (BFT-LL).

Table 2.2.5 - Fishing effort and shark catch rates by fishing gear (number of fish/1000 hooks or number of fish/1000 meters of net) and areas sampled during the two-year period 1998-99 in the Mediterranean Sea. Shark species include *Prionace glauca* (PG), *Isurus oxyrinchus* (IO), *Alopias vulpinus* (AV) and *Galeorhinus galeus* (GG) (Megalofonou *et al.* unpublished data).

swordfish longline

Area	Effort (x 1000 hooks)	PG	IO	AV	GG	Other Sharks	Total Sharks
Ionian	1151.0	0.53	0.00	0.001	0.00	0.003	0.53
Levantine	7.0	0.00	0.00	0.00	0.14	0.00	0.14
Adriatic	2061.6	1.00	0.00	0.004	0.00	0.00	1.00
Tyrrhenian	18.5	0.27	0.00	0.00	0.00	0.00	0.27
Strait of Sicily	46.4	0.06	0.00	0.02	0.02	0.11	0.22
Balearic	1168.8	0.07	0.04	0.01	0.003	0.001	0.12
Alboran	1406.7	3.59	0.19	0.008	0.007	0.004	3.80
Catalonian	522.1	0.17	0.004	0.004	0.004	0.004	0.18
TOTAL	6382.0	1.24	0.05	0.006	0.003	0.002	1.30

swordfish/American longline

Area	Effort (x 1000 hooks)	PG	IO	AV	GG	Other Sharks	Total Sharks
Aegean	18.5	1.19	0.00	0.05	0.05	0.00	1.30
Levantine	94.9	0.31	0.08	0.01	0.00	0.01	0.41
TOTAL	113.4	0.45	0.07	0.02	0.01	0.01	0.56

albacore longline

Area	Effort (x 1000 hooks)	PG	IO	AV	GG	Other Sharks	Total Sharks
Aegean	151.0	0.04	0.00	0.00	0.00	0.00	0.04
Adriatic	15.3	0.00	0.00	0.00	0.00	0.00	0.00

Ionian	527.0	0.09	0.00	0.00	0.00	0.00	0.09
Strait of Sicily	17.5	0.00	0.00	0.00	0.00	0.00	0.00
Balearic	158.7	0.00	0.001	0.00	0.00	0.006	0.001
Catalonian	142.1	0.07	0.007	0.00	0.00	0.00	0.08
TOTAL	1011.6	0.07	0.002	0.00	0.00	0.00	0.07

bluefin tuna longline

Area	Effort (x 1000 hooks)	PG	IO	AV	GG	Other Sharks	Total Sharks
Strait of Sicily	2.8	0.00	0.00	0.00	0.00	0.00	0.00
Balearic	20.9	0.29	0.00	0.00	0.00	0.00	0.29
TOTAL	23.7	0.25	0.00	0.00	0.00	0.00	0.25

driftnet

Area	Effort (x1000 meters)	PG	IO	AV	GG	Other Sharks	Total Sharks
Ionian	8336.3	0.03	0.00	0.002	0.00	0.001	0.04

A study on the swordfish long line fishery (Di Natale *et al.*, 1992), conducted with observers on board in 1991 (25 fishing hauls), provided a first overview of the catches in the Tyrrhenian Sea, where only very few species appeared: pelagic stingray *Pteroplatytrygon violacea* (9.3% of total catch), *Prionace glauca* (4.7%) and *Sphyrna zygaena* (0.3%). The elasmobranch species represented 14.2% of the total catch. All the specimens were found to be alive and most of them were released at sea.

Further studies, based on landing controls, showed that the catch of *Prionace glauca* in 1994 was 2,157 specimens (80 t) in the Tyrrhenian Sea and the Strait of Sicily. In 1995 3,193 specimens (157 t) were caught in the same area. Most of the catches were released at sea and still alive. Mako shark *Isurus oxyrhinchus* represented 0.7% of the long-line catches in number in the Strait of Sicily in 1991-92. No landings were reported in 1994 and 1995 in the Tyrrhenian Sea and in the Strait of Sicily, but real catches are estimated to be 5-10 t per year, with landings ranging from 1-2 t.

No catches of *Alopias vulpinus* and *Lamna nasus* were landed or reported from long-liners in the Tyrrhenian Sea and in the Strait of Sicily from 1991 to 1995. No landings of *Sphyrna zygaena* were reported in 1994 and 1995 in the Tyrrhenian Sea and in the Strait of Sicily, but real catches are estimated to be between 2 to 5 t per year, with landings ranging from 0.5 to 1 t. Basking shark *Cethorhinus maximus* was not caught by long-lines between 1991-95.

Another study, funded by the Italian Government, was carried out in 1998-1999 on the Italian large pelagic long-line fishery in the Tyrrhenian Sea and in the Strait of Sicily (Di Natale and Pelusi, 2000), and provided data on CPU (number or kg per haul) and CPUE for elasmobranch species. The data confirm the high relevance of the pelagic sting ray *Pteroplatytrygon violacea* in the pelagic long-line fishery, followed by the blue shark *P. glauca*.

Table 2.2.6 - CPUE and CPU of elasmobranch catches (in biomass) in the Italian large pelagic longline fishery in the Tyrrhenian Sea during 1998-1999. CPUE = kg / 1000 hooks; CPU = kg / haul.

Elasmobranchs	**LL SWO**			**LL ALB**			**LL BFT**			**TOTAL LL 1998-1999**		
species	**Kg**	**CPUE**	**CPU**	**Kg**	**CPUE**	**CPU**	**Kg**	**CPUE**	**CPU**	**Kg**	**CPUE**	**CPU**
Alopias vulpinus	50,0	0,3	0,4				110,0	39,3	36,7	160,0	0,9	1,2
Prionace glauca	2505,0	17,4	20,7							2505,0	13,9	19,1
Carcharhinus plumbeus	66,0	0,5	0,5							66,0	0,4	0,5
Galeorhinus galeus	11,0	0,1	0,1							11,0	0,1	0,1
Isurus oxyrhinchus	155,0	1,1	1,3							155,0	0,9	1,2
Lamna nasus	148,0	1,0	1,2							148,0	0,8	1,1
Sphyrna zygaena	60,0	0,4	0,5							60,0	0,3	0,5
Pteroplatytrygon violacea	1652,0	11,5	13,7	1203,0	36,7	171,9				2855,0	15,9	21,8
Mobula mobular	150,0	1,0	1,2							150,0	0,8	1,1
Total catch (kg)	25490,0	176,8	210,7	10987,2	335,0	1569,6	644,5	230,2	214,8	37121,7	206,5	283,4
Total hooks (E)	144149			32800			2800			179749		
Total observed hauls	121			7			3			131		
Total days on board	175			13			8			196		
Total days in stand-by	208			35			29			250		

Table 2.2.7 - CPUE and CPU of elasmobranch catches (in numbers) in the Italian large pelagic long-line fishery in the Tyrrhenian Sea 1998-1999. CPUE = number / 1000 hooks; CPU = number / haul.

Elasmobranchs	**LL SWO**			**LL ALB**			**LL BFT**			**TOTAL LL 1998-1999**		
species	**No**	**CPUE**	**CPU**	**No**	**CPUE**	**CPU**	**No**	**CPUE**	**CPU**	**No**	**CPUE**	**CPU**
Alopias vulpinus	1	0,01	0,01				16	5,71	5,33	17	0,09	0,13
Prionace glauca	40	0.28	0,33							40	0,22	0,31
Carcharhinus plumbeus	4	0,03	0,03							4	0,02	0,03
Galeorhinus galeus	1	0,01	0,01							1	0,01	0,01
Isurus oxyrhinchus	2	0,01	0,02							2	0,01	0,02
Lamna nasus	1	0,01	0,01							1	0,01	0,01
Sphyrna zygaena	1	0,01	0,01							1	0,01	0,01
Pteroplatytrygon violacea	328	2,28	2,71	306	9,33	43,7				634	3,53	4,84
Mobula mobular	1	0,01	0,01							1	0,01	0,01
Total catch (No)	1612	11,18	13,32	2931	89,36	418,7	16	5,71	5,33	4559	25,36	34,80
Total hooks (E)	144149			32800			2800			179749		
Total observed hauls	121			7			3			131		
Total days on board	175			13			8			196		
Total days in stand-by	208			35			29			250		

The commercial species may vary from area to area and from trip to trip. Almost everywhere, porbeagle and mako are considered as valuable species, whereas the blue shark is more often landed along the Adriatic coast and released at sea in most other areas. Other shark species are sometimes landed, usually from day trips, with the exception of devil rays and blue sting rays, that are normally rejected or released at sea. No finning activities have been reported in the Italian drifting long-line fishery.

The first study on the drift net fishery fishery (Di Natale *et al.,* 1992), funded by the Italian Government and conducted with observers on board in 1990-91 (100 fishing hauls), provided an overview of the catches in the Ligurian Sea and in the Tyrrhenian Sea, where only a few species appeared: *P. violacea* (1.0% of the total catch), *P. glauca* (0.4%), *M. mobular* (0.4%), *A. vulpinus* (0.2%), *C. maximus* (0.1%). All elasmobranch species together represented only 2.1% of the total catch. All specimens were still alive and most of them were released at sea.

Further studies, based on landing controls, show that *P. glauca* represented 0.8% of the catches (in number) in 1991-92 in the Tyrrhenian Sea. In 1994, the blue shark catch was 463 specimens (17 t) in the Tyrrhenian Sea. In 1995 catches reached 587 specimens (29 t) in the same area.

No *A. vulpinus* were landed in 1991-92 and 1994 in the Tyrrhenian Sea, while 998 specimens (117 t) were landed in 1995 from this area. No catches of *L. nasus* were landed in 1991-92 and 1994 in the Tyrrhenian Sea, while 448 specimens (17 t) were landed in 1995 in the same area. No catches of *I. oxyrhinchus* were reported in 1991-92, 1994 and 1995 in the Tyrrhenian Sea, but real catches are estimated to be 5-10 t per year, with landings ranging from 1-2 t. No catches of *S. zygaena* were reported in 1991-92, 1994 and 1995 in the Tyrrhenian Sea, but real catches are estimated to be between 2 to 5 t per year, with landings of up to 1 t.

The basking shark *C. maximus* represented 4.2% of the catches in weight and 0.1% in number in the Tyrrhenian Sea in 1991-92. In 1994, catches raised to 246 specimens (110 t) in the same area, increasing to 395 specimens (179 t) in 1995. Catches of this large species vary a lot from year to year, but they are not usually landed. No finning activities have been reported so far in the Italian drift-net fishery.

Other catches have been reported in the tuna trap fishery, an historical and ancient activity still carried out in a few Mediterranean locations. Although located along the shoreline, fixed tuna traps also catch pelagic species. These structures were distributed all along the Mediterranean coasts, mainly in Italy. About twenty tuna traps were active in the Mediterranean up to thirty-forty years ago, but today their number has decreased and they are now confined to the major Italian islands and North Africa. In the past, numerous large pelagic sharks and other elasmobranchs were caught in tuna traps in the Mediterranean.

Today almost all Mediterranean tuna traps are closed because they are no longer profitable. The historical data from tuna traps are very important and constitute an accurate documentation of the former greater abundance of cartilaginous fish species. Moreover, the tuna trap data show the progressive decrease in elasmobranch biodiversity. The main elasmobranch species that were traditionally caught as a tuna by-catch in the traps were large individuals of thresher (*A. vulpinus*), basking (*C. maximus*), blue (*P. glauca*) and white shark (*C. carcharias*) and, sometimes, hammerhead sharks (*Sphyrna* spp.) and devil rays (*M. mobular*) (Boero & Carli, 1974, Fleming & Papageorgiou, 1997; Muñoz-Chàpuli *et al.*, 1994; Kabasakal, 1998; Hemida, 1998; De Metrio *et al.*, 1999; Garibaldi & Orsi Relini, 2000, Vacchi *et al.*, 2002). Trends in shark catches from this fishery are very difficult to assess, due to the changes in timing and locations of the activity.

2.2.2 Recreational fishery

Recreational fisheries target sharks, especially blue sharks, in the Adriatic Sea and the northern Tyrrhenian Sea, but data are limited.

2.2.3. Landings

Landings of elasmobranchs in the Mediterranean Sea are relatively low. Aldebert (1997) noted major changes in the abundance of elasmobranchs in bottom trawl surveys in the Gulf of Lions from 1957 and 1995 and landings statistics from the fish auction in Sete for the years 1970 to 1995. A clear decline of commercial species took place since the mid-1980s, firstly on the continental shelf and later on the slope. Multivariate analyses showed a high time gradient related to the increase of fishing intensity and the consequences of technological modifications of the fishing gear. All elasmobranch species identified in the landings showed similar declining trends.

In 1999, total landings were 11,265 t. Figure 2.2.8 shows the trend in landings from the Mediterranean and Black Sea during the last thirty years.

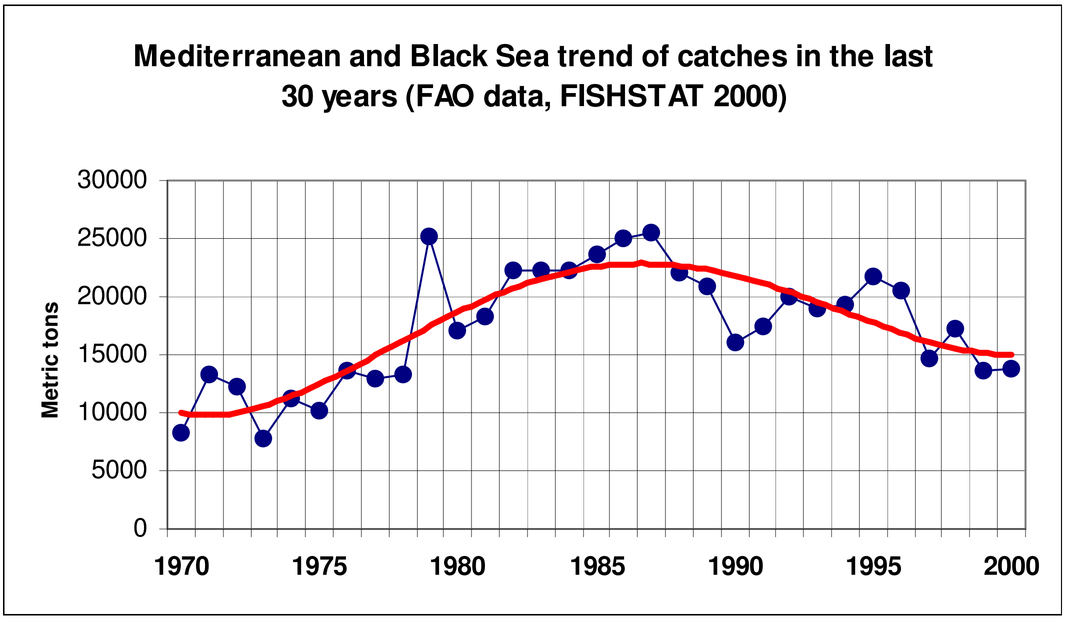


Figure 2.2.8 - Trend in elasmobranch landings from the Mediterranean Sea and the Black Sea during the period 1970 - 2000.

In the period 1970-1985, landings increased from 10,000 to 25,000 metric t and subsequently declined to approximately 15,000 t over the following 15 years. At present the major fishing countries are Turkey (2,115 t), Tunisia (2,018 t), Greece (1,602 t), Italy (1,557 t) and Spain (1,466 t). Minor quantities of elasmobranchs are reported for other Mediterranean countries such as France (63 t). No data are available for some European countries such as Croatia, Slovenia, and Albania.

On average, elasmobranchs account for 1.1% of the total landings in Mediterranean harbours. The most important areas for elasmobranch catches are the Ionian and Black Seas each with 30% of the total Mediterranean catches; catches in Sardinian, Adriatic and Balearic waters account for 12, 8 and 7% respectively of the Mediterranean total.

The official FAO data on commercial elasmobranch catches between 1970 and 2000 indicated GFCM division 2.2 (Ionian and adjacent areas) as one of the most important fishing areas in the Mediterranean Sea.

Elasmobranch catches in the Ionian Sea remained under 4,000 t in the first two decades of the considered period, but increased dramatically since 1982 and they were over 11,000 t in 1985 and 1994 (Figure 2.2.9); in the following years the catches showed a clear decline with only 2,000 t reported in 2000.

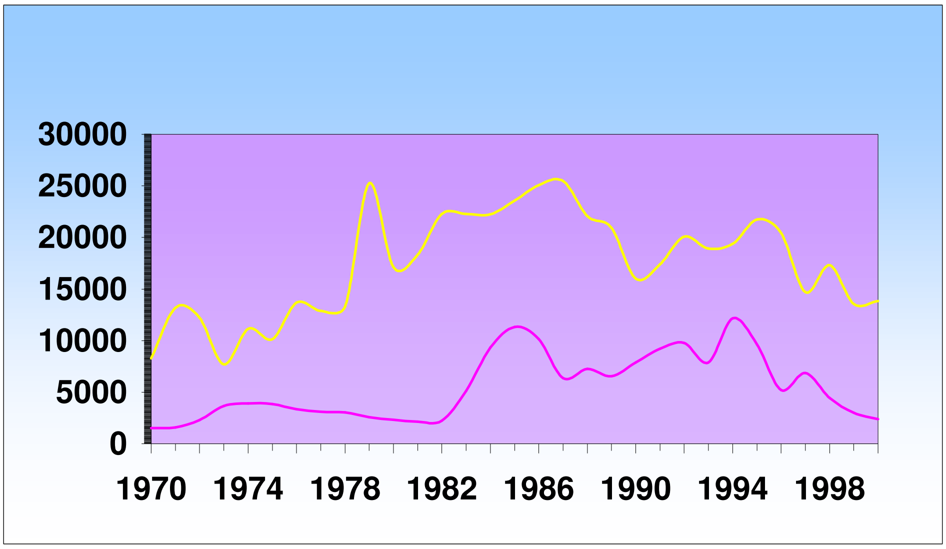


Figure 2.2.9 – Elasmobranch catch trends in the Mediterranean (yellow line) and Ionian and adjacent areas (red line) during the period 1970-2000.

The principal fishing country in the Ionian Sea is Italy, even although from 1998 the Tunisian catches have become the highest in this area (Figure 2.2.10). A more efficient data collection system established in Italy since 1983 (Bazigos *et al.*, 1984; Cingolani *et al.*, 1986) may explain the parallel evolution of the catches of Italy and those of the whole FAO Ionian Area. The fast decline of the catches observed since 1995 may be related to the decreasing size of the Italian artisanal and bottom trawl fleets (Figure 2.2.10) or to a possible local impoverishment of elasmobranch stocks.

Most catches are reported as “smoothhounds nei” and “rays, stingrays and mantas nei”(Figure 2.2.11). It should be stressed that these two categories do not correspond to taxonomic groups, at least not for the Italian catches. The reported catches of “smoothhounds nei” often consist of an aggregation of small-sized demersal sharks including *Mustelus* spp. (the true smoothhounds), *Squalus* spp., *Centrophorus* spp., *Dalatias licha*, *Scyliorhinus* spp., and *Galeus melastomus*. This is due to the fact that these shark species, are usually marketed headed, skinned and eviscerated, and sold under the commercial name of “palombo”, the Italian name of *Mustelus*. In the same way, the FAO category “rays, stingrays and mantas nei”, is an aggregation of all batoids; the bulk of these catches taken in Italy consists of three species of skates: *Raja clavata*, *Raja asterias* and *Raja miraletus*.

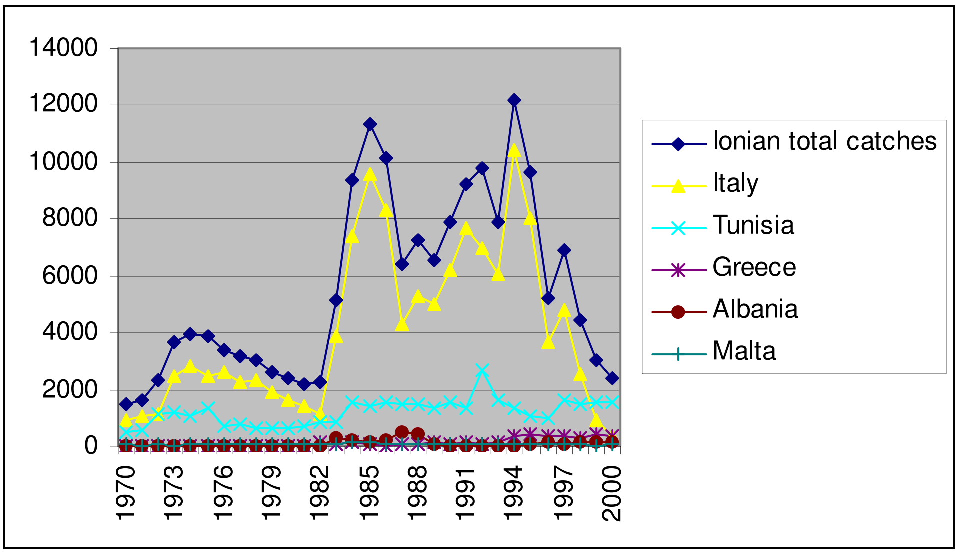


Figure 2.2.10 – Elasmobranch catches per country in the Ionian and adjacent areas during the years 1970-2000.

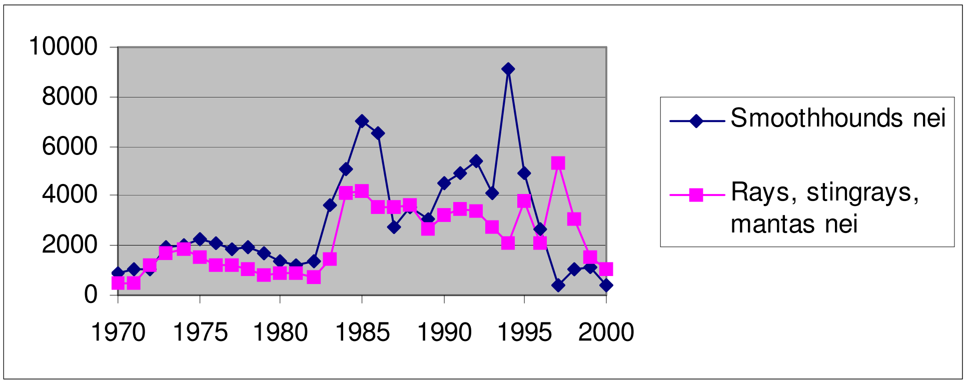


Figure 2.2.11 – Catches of “smoothhounds nei” and “rays, stingrays, mantas nei” in the Ionian and adjacent areas during the years 1970-2000.

Greece

According to the official Greek fisheries statistics, during 1997, 1998 and 1999 elasmobranch landings were 1,682, 1,486 and 1,601 MT respectively. There is no fishery directly targeting these species, and elasmobranchs are only caught as by-catch in longlines, bottom trawl fisheries and other nets. The contribution of elasmobranchs in commercial fisheries is low, ranging from 1.1 to 1.4%.

Data for the large pelagic fishery and the small-scale fishery, available in the national administrations, are generally rather incomplete. Another problem is the fact that in most cases elasmobranch catches are not separated into species, but in broader groups, including several species.

Among the Greek elasmobranch catches reported in the ETANAL database, the only shark species for which there are species-specific catch data is the spurdog (Table 2.2.8). Dogfish as well as large coastal and pelagic sharks landings are reported in two broader groups under the names “skilakia” and “galeos”. However, these data represent only a part of the Greek elasmobranch landings that are sold through the 10 official auctions and monitored by the Ministry of Agriculture. An important part of the shark catches, especially from the small-scale fishery, is landed at a great number of fishing ports along the extensive coasts of Greece and sold directly in local markets, and not recorded in the official ETANAL database.

Table 2.2.8 - Greek commercial shark and dogfish landings (metric t) according to ETANAL data from 2000 to 2002 reporting data from 10 official auction hauls.

	Spurdog	Dogfish	Large Coastal and Pelagic sharks
2000	36,8	17,3	109,6
2001	28,0	20,5	111,7
2002	30,9	19,2	137,7

The most common small coastal sharks and deep-water sharks caught incidentally are: *Squalus acantias, Scyliorhinus canicula, Galeus melastomus, Etmopterous spinax, Dalatias licha, Mustelus mustelus,* and *Centrophorus granulosus.* Various species of rays and skates are caught incidentally too. Some of the most common demersal species are *Raja clavata, Dipturus oxyrhynchus, Raja miratelus, Torpedo marmorata, Raja asterias* and *Dasyatis pastinaca.* Nevertheless, occasionally, some small boats using either bottom gill nets or bottom longlines target sharks. Spurdog, *S. acanthias*, or bluntnose sixgill shark, *Hexanchus griseus*, are the most important sharks species caught. Large pelagic sharks form an important by-catch of the Greek longline fishery targeting either swordfish or albacore.

During the period 1998-2001, the influence of the drifting longline fishery on shark populations was studied in the Eastern Mediterranean Sea. A total of 8 different pelagic shark species were recorded in the catches of the Greek swordfish and albacore longline fisheries. Among them, the bigeyed sixgill shark, *Hexanchus vitulus,* was reported for the first time in the area while the blue shark, *Prionace glauca*, was the most common species in the catches. Shark catches were significant in the Greek swordfish fishery, reaching 3.8% in number and 3.6% in biomass. In the longline fishery for albacore, elasmobranch catches were minor (2.2% in number and 0.9% in biomass). The Levantine basin showed the highest percentage of shark catches (4.6%), followed by the Ionian (4.2%) and the Aegean Sea (2.6%). The average weight of sharks caught was highest in the Levantine (33.7 kg) and smallest in the Ionian Sea (12.4 kg).

Using the observed ratio between sharks/swordfish and sharks/albacore catches (Megalofonou *et al.*, 2000) and the official annual production of swordfish and albacore during 1998-2002, Greek by-catches of pelagic sharks were estimated at approximately 48 to 123 metric t annually in the swordfish and albacore fishery (Table 2.2.9).

Table 2.2.9 - By-catches of pelagic sharks in the Greek longline fisheries targeting swordfish and albacore during the years 1998-2002.

GREEK PELAGIC SHARK BYCATCHES (MT)			
	SWO LL FISHERY	ALB LL FISHERY	TOTAL
1997	40,5	7,4	47,9
1998	89,1	11,5	100,6
1999	82,1	20,1	102,1
2000	105,8	17,9	123,7
2001	93,4	18,4	111,8
2002	52,7	13,5	66,2

Italy

Until 1998, Italy was the main fishing country for the Mediterranean elasmobranch production with a maximum of 12,357 t in 1994, followed by a fast and strong decrease as the Italian production fell down to 1,557 t in 1999.

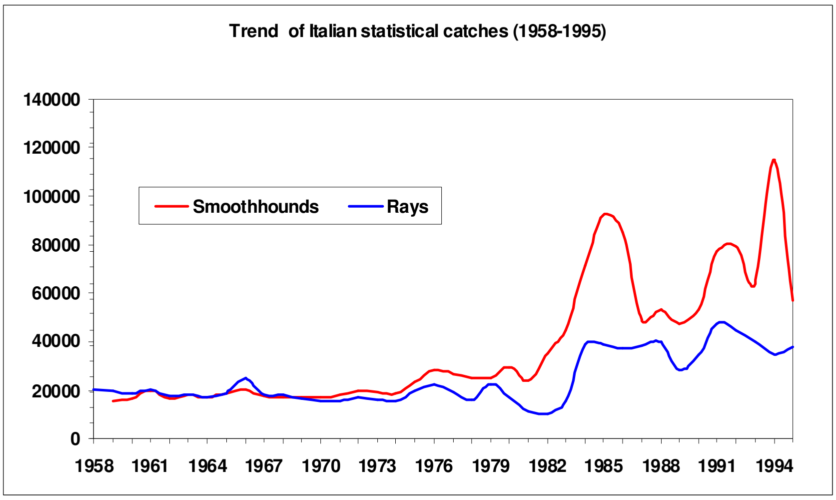


Figure 2.2.12 - Trends of Italian elasmobranch catches (smoothhounds and rays) during 1958-1995.

After a maximum observed in the early eighties, the number of fishing boats (both artisanal and bottom trawl) began to decrease (Figure 2.2.13). The reduction in number is estimated to have been about 40%. Moreover, substantial changes in fishing patterns were noted; in fact most trawlers reduced their fishing activities on offshore fishing grounds and concentrated their effort on inshore continental shelf zones.

The decreasing tonnage of trawler units in this period, can be related to this change in fishing strategy (Figure 2.2.14). Conversely, the artisanal fisheries showed an increase in the individual size of units by using more efficient and safe boats. These big changes in the Italian fleet, coinciding with the increase in effectiveness of the statistical data collection, are possibly important factors affecting the data on Italian landings of cartilaginous fishes.

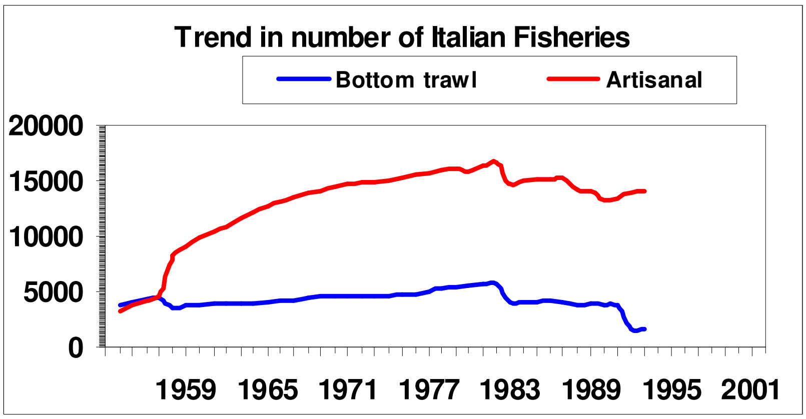


Figure 2.2.13 - Total number of trawl and artisanal vessels in Italian waters during 1959-2001

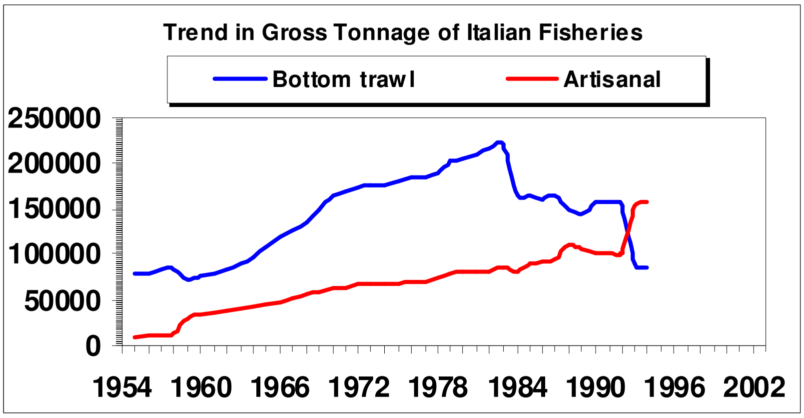


Figure 2.2.14 - Total gross tonnage of trawl and artisanal vessels in Italian waters during 1959-2001

Viareggio

Landings of elasmobranchs in Viareggio, the most important fishing port of the Tyrrhenian and Ligurian Seas, have been monitored in the period 1990-2001. Monthly data on catches were collected by species and gear, as well as length frequency data and spatial information on fishing effort.

Sixteen species of elasmobranchs (6 sharks and 10 rays and skates), representing about 15% of the total amount of fish landed in Viareggio, were recorded. Four species were selected because of their major contribution to the landings and their commercial interest: blackmouth catshark *Galeus melastomus*, lesser spotted dogfish *Scyliorhinus canicula*, thornback ray *Raja clavata* and starry ray *Raja asterias*.

The geographical distribution of fishing effort by fishing gear was represented and analysed. Maps that display the effort distribution pattern by fishing gear and the distribution of catch rates for the main commercial species produced during a previous study (Abella *et al.*, 2001) were used in order to compare the spatial distributional patterns of fleet and resources (Figure 2.2.15).

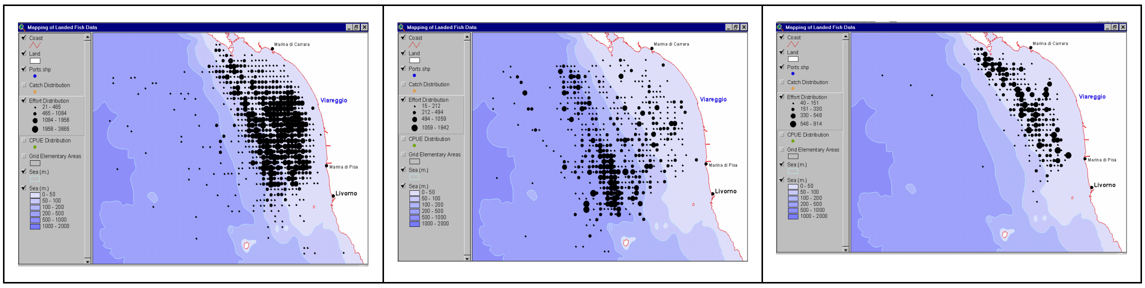


Figure 2.2.15 - Distribution of fishing effort of the Viareggio fleet using a variant of the traditional Italian bottom trawl (volantina), traditional Italian bottom trawl (tartana) and a variant of the beam trawl (rapido).

As far as the landings data are concerned, expressed as catch in kg per hour, the graphs in Figure 2.2.16 suggest a decreasing trend in all species. This is particularly evident in the last 2 years.

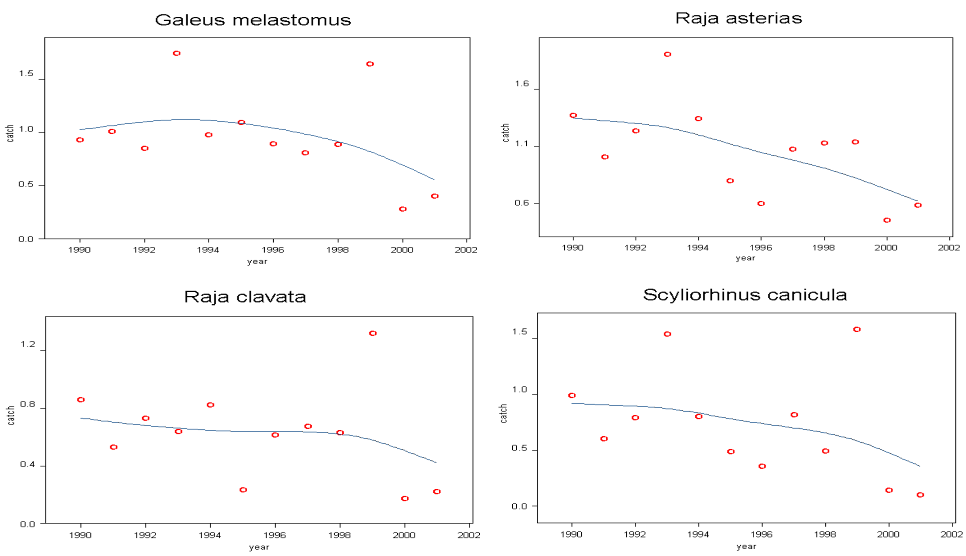


Figure 2.2.16 - Trends in catch rates (kg/h) for *G. melastomus*, *S. canicula*, *R. asterias* and *R. clavata* for the Viareggio fleet between 1990 and 2001. A spline smoother was used.

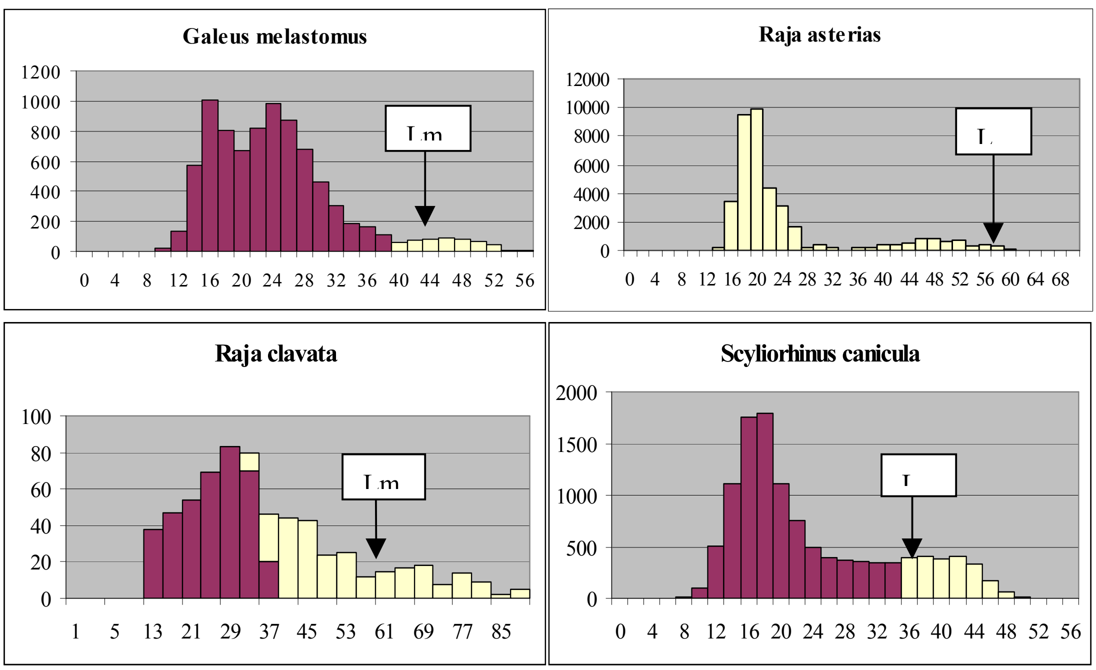


Figure 2.2.17 - Size distribution of the catches of *G. melastomus*, *S. canicula*, *R. asterias* and *R. clavata*, discarded fraction (dark bars) and size at first maturity of females (Lm).

Significant amounts of the species that were studied are being discarded. This was particularly significant in the case of *G. melastomus*. In fact, only a fraction of the larger specimens (> 40 cm) were landed, and exclusively in Viareggio. This is caused by the very limited market demand for this species. In the case of *S. canicula*, a species characterised by a quite high commercial interest, only individuals smaller than about 36 cm were discarded. Whereas almost all individuals of *R. clavata* smaller than 38 cm TL were discarded at sea, most of the small individuals of *R. asterias* caught near shore with trammel and gill nets by the artisanal fisheries of Viareggio were landed (Figure 2.2.16). In Figure 2.2.16 the size distributions in the catches, the fraction discarded and the size of first maturity (Lm) for the 4 species are shown.

In Viareggio, *R. asterias* is mainly caught on the same grounds with a variant of the beam-trawl called "*rapido"*. This species constitutes the main component in weight of the species assemblage caught with this gear and annual catches, mainly composed of adults, are about 14 t. The starry ray is also caught with trammel nets and gillnets in the small-scale fisheries, with a mean annual catch of about 6 t, which is composed almost exclusively of juveniles.

The blackmouth catshark is an important component of the by-catch of the fishery for *Nephrops norvegicus*. Usually all individuals of this species are discarded, and only in some cases, depending on the market demand, a limited quantity of the larger individuals is landed. The mean total annual amount of current landings of blackmouth catshark is about 700 kg.

Lesser-spotted dogfish and thornback ray are in general caught simultaneously on the same grounds (muddy bottoms), mainly at depths between 100 and 250 m. Recently, the fishery in Viareggio has exerted less pressure on these grounds. Mean total landings of these two species in Viareggio do not exceed one metric ton each.

2.3 European elasmobranch fisheries outside Community waters

Western Indian Ocean*)

In the western Indian Ocean, the purse seine tuna fishery is mainly performed by European countries (Spain and France), and has developed in the last decade. In 2000, the total purse seine tuna catch was 330,340 t, achieved by about 50 vessels licensed in the Seychelles. The average catch rate was about 25 t /day, which is the highest CPUE recorded.

The species of sharks caught in tuna fisheries are mainly oceanic whitetip shark *Carcharhinus longimanus*, blue shark *Prionace glauca*, silky shark *Carcharhinus falciformis*, mako shark *Isurus oxyrinchus*, hammerheads *Sphyrna* spp., and thresher sharks *Alopias* spp.. Also some manta rays *Manta birostris* and *Mobula* spp., and pelagic stingrays *Pteroplatytrygon violacea* are taken.

The proportions of sharks vary with the type of sets : school sets, log sets, marine mammals associated sets. As an example, the following data are provided by the IRD

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*) from Séret, 2002 « Shark fisheries and conservation in the Seychelles », SFA report 33 pp.

research programme, including an observer programme, conducted between 1993 and 2001 in the Réunion-Seychelles area :

shark and ray by-catch per 1000 t in the purse seine tuna fishery				
Species	all sets	log sets	school sets	dolphin sets
Silky shark	248	152	76	20
Oceanic whitetip shark	18	15	2	1
Hammerhead sharks	12	5	6	1
Other sharks	68	46	16	6
Manta rays	26	1	21	4
Pelagic stingrays	9	1	6	2
Total	379	220	127	34

The by-catch / set varied from 0.01 to 6.0, allowing to estimate a yearly by-catch of about 55,000 sharks, i .e. about 1,650 t / year (using an average shark weight of 30 kg).

Another study (Romanov, 1998) provides data on the by-catch in purse seine tuna fisheries in the Western Indian Ocean, giving 27.2 t of by-catch species for 1,000 t of target species (tunas), with 3.4 t / 1,000 t in free school sets, 11 t / 10,000 t in whale associated sets and 41.3 t / 1,000 t in log sets. In these fisheries, sharks represent 38 % of the by-catch in free school sets, 94 % in whale associated sets and 22 % in log sets.

If these ratios are applied to the total catch of the purse seiner tuna fishery, i.e. 330,340 t in 2000, an estimated catch of sharks of about 3,600 t/year is obtained.

Southern Ocean[**)]

In the Southern Ocean, some European countries (France, Great Britain, Spain) exploit demersal resources with longlines and bottom trawl nets. For example, the Patagonian toothfish *Dissostichus eleginoides* and the mackerel icefish *Champsocephalus gunnari* fisheries developed in the French EEZ of Kerguelen and Crozet Islands. The by-catches of these fisheries include sleeper sharks *Somniosus*

[**)] this text replaces the paragraph in last year's report spp., porbeagle *Lamna nasus* and various sub-antarctic skates *Bahtyraja* spp.. In the Southern Ocean, all fishing activities are managed by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR).

The sharks and skates recorded by CCAMLR in the Southern Ocean fisheries are the following :

Bathyraja eatoni (Eaton's skate)

Bathyraja meridionalis (darkbelly skate)

Bathyraja murrayi (Murrays' skate)

Bathyraja spp.

*Raja georgiana (*Antarctic starry skate)

Raja spp.

Somnisous spp. (sleeper sharks)

*Lamna nasus (*Porbeagle)

For the period 2001/2002, the CCAMLR fishery statistics reported a catch of 367 t of skates and four tonnes of sharks, out of a total fish catch of 144.160 t. The skates are mainly caught on the Kerguelen plateau by the French fleet. It should be noted that the catch of skates is growing as shown by the increase in catches since 1992 :

Fishing period	Catch of skates in t
1992 / 1993	0
1993 / 1994	14
1994 / 1995	91
1995 / 1996	45
1996 / 1997	39
1997 / 1998	41
1998 / 1999	53
1999 / 2000	97
2000 / 2001	134
2001 / 2002	342

Stock structure, stock size and population dynamics of rajids are virtually unknwon for most areas of the Southern Ocean, except for the multispecies commercial rajid fishery (including mainly the white-spotted skate *Bathyraja albomaculata* managed in the Falkland Islands' waters since 1987. In this fishery, it seems that the skate populations are robust to fluctuations in fishing pressure probably because fishing effort has been regulated within conservative limits.

West African demersal fisheries

Since 1992, Spain has developed a deepwater trawl fishery for Senegalese hake *Merluccius senegalensis* and Benguela hake *M. polli* off Maurtania, in which elasmobranchs represent an important part of the by-catch. A decline of the elasmobranch by-catch was observed, which represented 9.4 % (228 t) of the total catch in 1992 and only 1.4 % (24 t) in 1999.

Spain has also developed a deepwater bottom longline fishery off Mauritania in which elasmobranchs represented 2% of the total catch in number and in weight. The elasmobranchs accounted for 9 - 20 % of the by-catches in the 0 – 100 m depth range and up to 60 % in the deepest stratum (> 500 m depth).

In 2001, Spain carried out a longline survey on the Sierra Leone Rise in order to evaluate the potential of the demersal resources on the seamounts in this area between 200 and 2000 m depth. It was observed that chondrichthyans accounted for 82-85% of the fauna on the deepest seamounts (800 – 1900 m depth) where commercial bony fishes were few ; they represented 2-6 % of the total catch on the seamounts where the alfonsino *Beryx splendens* was dominant.

West African pelagic fisheries

Off the West African coast there are fisheries for small pelagic species by Community vessels which are known to have significant by-catches of elasmobranchs which are discarded at sea.

The main component of the elasmobranch by-catch (about two thirds) consists of hammerheads, mainly *Sphyrna lewini* and *S. zygaena* (juveniles and adults). Other regularly caught species are *Carcharhinus* sp., *Mustelus mustelus*, *Leptocharias smithii*, *Alopias vulpinus*, and *Isurus oxyrinchus*.

Also a variety of rays and skates have been observed in these by-catches: *Raja* sp., *Dasyatis* sp., and mantarays *Rhinoptera* sp. and *Mobula* sp.

3 Biology

3.1 Species distribution and stock structure

Some new information on this topic has been added to this section of last year's report. The following has been copied from the report of the ICES Study Group on Elasmobranch Fishes (ICES, 2003a) and the final report of the DELASS project (Heessen, 2003)). Although this overview is limited to the nine DELASS case study species, the descriptions can be considered as an example of the sort of information that is available for elasmobranchs.

One of the essential requirements in stock assessments is to define the area of distribution and its limits. A number of stock definitions have have been proposed ranging from those that focus on fish stock management to those that deal with genetic discreteness and biological characteristics. Among the methods used in trying to identify stocks are: population parameters, abundance and distribution, tagging, natural marks (parasites), physiological and behavioural characters, morphometric and meristic studies, and genetic studies.

3.1.1 Spurdog (*Squalus acanthias*)

Spurdog has a world-wide distribution, but tends to be coastal. France, United Kingdom, Norway and Ireland all take spurdog in directed fisheries and as an important by-catch. Iceland has a small fishery, but it is not known to which stock these fish belong. There are no detailed studies on parasites nor on genetics and, though life history parameters are well established, different methodologies have been applied which make comparisons difficult. The evidence of stock identity is based on the interpretation of distribution patterns, tagging studies and, to a lesser extent, life-history parameters. These all indicate that there is a single Northeast Atlantic stock. Though there are *Squalus* spp. landings in Sub-area VIII, these may be from a different species.

Life-history data for *S. acanthias* indicate major differences between, for example, the Pacific and Atlantic populations. These differences are particularly noticeable for size at maturity and the maximum observed length, both of which are a lot greater in the Northeast Pacific. The gestation period lasts approximately 22-24 months and the sex ratio of pups is about 1:1 (Gauld 1979; Hanchet 1988). Calculated estimates for the von Bertalanffy equation are given in the DELASS report. Maximum sizes of males and females are 100 and 135 cm respectively (Northwest Pacific), 107 and 130 cm (Northeast Pacific), 86 and 108 cm (Northwest Atlantic) and 83 and 110 cm (Northeast Atlantic).

Hence, the assessment of *S. acanthias* should be based on a single Northeast Atlantic stock that is distributed from the north of the Bay of Biscay to the Norwegian Sea and including the following ICES areas: IIa, IIIa, IV, V, VI ,VII and VIII.

3.1.2 Lesser spotted dogfish (*Scyliorhinus canicula*)

Though the species' geographical distribution extends from Senegal to Norway, it is generally not commercially exploited and the discard rate in the commercial fishery is very high (up to 90% in VIIIc). Some data are available for France and Portugal, but the only useful available data are from Div. VIIIc for Spain. Tagging has resulted in most recaptures being reported from within a distance of 10 miles from the release area and with no apparent relationship between time at liberty and distance travelled. It seems that the species' distribution is continuous but with localised aggregations which are consistent over time. In the Cantabrian Sea, data analysed from a series of bottom trawl surveys carried out annually show that there is no clear discontinuity in the distribution of lesser spotted dogfish in this area. This species usually shows unisexual aggregations and, less frequently, aggregations by size (de la Gándara *et al*., 1994). The spatial distribution of adults obtained from surveys carried out in different seasons showed no differences at all. On the contrary, juveniles were much less abundant than adults, independent of the season, but they were found in high concentrations in the south eastern corner of the Bay of Biscay. The minor abundance of juveniles compared to adults is probably due to the fact that the fishing gear used has poor access to this fraction of the population because juveniles are mainly distributed over rocky bottoms.

A study carried out in 1994 (Rodriguez-Cabello *et al*., 1998) revealed that the maximum proportion of egg-carrying females was found in April, May and June, however the low number of specimens sampled in autumn did not allow to determine whether differences exist with regard to spawning intensity throughout the year. English surveys almost never catch juveniles, though hundreds of egg cases are caught in the Bristol Channel. There have been few studies on life history parameters, though further north specimens grow bigger than in Spanish waters. Spawning is supposed to take place in shallow waters near the coast (Wheeler, 1969; Compagno, 1984; Muñoz-Chápuli, 1984; Capapé *et al.*, 1991). Unfortunately, we do not have information from shallow waters or hard bottoms in the southern area of the Bay of Biscay (North of Spain), so we can not confirm if juveniles are concentrated in these areas along the coast. Another hypothesis suggests that spawning takes places mainly on the slope, for example D'Onghia *et al.* (1995) found juveniles and adults of both sexes and sizes together at depths greater than 200 m in the north Aegean Sea. Because lesser spotted dogfish do not show a clear geographical migration, an assessment could in principle be based on any arbitrary area (e.g. ICES Division).

Stock assessed in DELASS: VIIIc (Cantabrian Sea).

3.1.3 Blue shark (*Prionace galuca*)

Results of US and Irish tagging studies show the blue shark to make extensive movements throughout the North Atlantic. There is little movement across the equator, or to the Mediterranean Sea, indicating a single stock in the North Atlantic.

In North Atlantic populations the size at maturity for blue shark is 180 cm in males and 200 cm in females (Pratt, 1979, Castro & Mejuto 1995). Length frecuency distributions from a fishery in the Bay of Biscay from 1998 show that the main catches consist of immature blue sharks (Lucio *et al.,* 2002), suggesting a segregation by age/maturity in the migratory movements in this area.

As part of project 97/50 DGIV (Megalofonou *et al*., 2000) some observations on the reproductive biology of blue shark were made in the Mediterranean Sea during 1998-1999.

The study of the sexual maturity of males showed that:

a) all the specimens with TL lower than 125 cm were immature;

b) 50% of the specimens with TL ranging from 185 and 195 cm were mature;

c) 100% of the specimens with TL starting from 215 cm were mature.

The study of females showed that:

a) all the specimens with TL lower than 120 cm had immature ovaries without visible eggs;

b) all the specimens with TL ≥ 120 cm had ovaries with visible yolked eggs;

c) 20% of the specimens with TL ranging from 200 and 210 cm were full mature,

d) 100% of the specimens with TL > 220 cm were full mature.

These results are very similar to the observations of Pratt (1979) in the western North Atlantic. The sex-ratio (males/females) was in favour of the males and showed an increase of the males as size progresses (Table 3.1.1).

Table 3.1.1. Sex ratio of blue shark by length class

LT (cm)	M	F	Sex-ratio
< 120	50	37	1.35
120-180	148	79	1.87
> 180	60	28	2.14
Total	258	144	1.79

Extensive tagging programmes within the North Atlantic have indicated a large number of trans-Atlantic migrations of *P. glauca*, possibly following oceanic gyres, with few trans-equatorial recaptures and no recaptures from the Indian and Pacific Oceans. Hence, the assessment of *P. glauca* should be based on a single North Atlantic stock that is distributed from north-eastern South America (e.g. Venezuela) to Canada in the west, and from north-west Africa (e.g. Sierra Leone and Ivory Coast) to Norway and Iceland in the east.

Stock assessed in DELASS: North Atlantic.

3.1.4 Cuckoo ray (*Leucoraja naevus*)

Cuckoo rays occur in the North Sea, Irish Sea (and perhaps further north to the west of Scotland) and Celtic Sea. Life history parameters are available for several areas, though ageing is difficult, and results from the Celtic Sea are similar to those obtained for the North Sea. For most rays, no landings data or length frequency distributions are available by species, but French data are available for cuckoo ray by area since 1985. Not much is known about migrations. Survey data are available from the IBTS surveys in western waters and there are additional English and Irish survey data.

Stock assessed in DELASS: Celtic Sea, area VIIg,h,j and VIII a,b

3.1.5 Thornback ray (*Raja clavata*)

Most commercial landings data are for all *Raja* species combined and data by species are only available for France. However, survey data are available by species from the IBTS in the North Sea, with quarterly data from 1991 to 1996. Tagging data illustrate that fish do not move far, and there seems to be little mixing between the North Sea and the Channel. There is insufficient information on morphology, population genetics and parasites to identify stocks of *R. clavata*. Data from life-history parameters are available, but these studies typically differ in the time and method of data collection. Based on available literature, and analysis of the distribution patterns in survey data, the composition of the commercial landings and tagging data, the central and southern North Sea has been defined as the area in which a stock unit for *R. clavata* is appropriate.

Stock assessed in DELASS: IVb and IVc.

3.1.6 Blackmouth catshark (*Galeus melastomus*)

This species is widely distributed over the Northeast Atlantic, and landings data are available for Spain and Portugal, with CPUE data from Norway and Ireland. It is heavily discarded in large-vessel fisheries in the north and in artisanal fisheries in the south. Abundance estimates and length frequencies are available from Portuguese and Irish deep-water surveys. Though it may be reasonable to nominate two stocks, one off the Portuguese continental coast and one in VII/VI, there are insufficient data to distinguish between them. It is possible that blackmouth catshark populations are essentially local (like lesser spotted dogfish), with one large population in which pseudo population segments can be distinguished.

Stock assessed in DELASS: area IXa.

3.1.7 Portuguese dogfish (*Centroscymnus coelolepis*)

The Portuguese dogfish is distributed over the Northeast Atlantic from Iceland to Senegal and also occurs off South Africa in depths down to 3600 m. Landings data are available for France and Portugal, (and Ireland for 2000 and 2001, and Basque Country (Spain) from 1995-2002) though France only has data for two species combined, *C. coelolepis* and *C. squamosus*, known as “siki”, and Basque Country for *C. coelolepis* and *C. squamosus* and *Deania* spp. combined. There are also data from experimental fishing and surveys, from Norway, IEO, SAMS, MI (Girard, 2000). Very few small individuals have been recorded in the Northeast Atlantic. There is a lack of knowledge on migrations, though it is known that females move to shallower waters for parturition and vertical migration seems to occur (Clarke *et al.* 2001). Stock identity is difficult given that, for many countries, deep-water shark landings often consist of several species.

Stock assessed in DELASS: NE Atlantic.

3.1.8 Leaf-scale gulper shark (*Centrophorus squamosus*)

This species is distributed over the Northeast Atlantic from Iceland to Senegal, but landings data by species are only available for Portugal and the Azores. Data are available from the same experimental fishing and survey sources as for the Portuguese dogfish. Males and immature females dominate samples west of Ireland and Britain and at Hatton Bank, while individuals < 80 cm are only available in Portuguese surveys. Data on stock identity are inconclusive, though available evidence suggests that this species is highly migratory.

Stock assessed in DELASS: Northeast Atlantic.

3.1.9 Kitefin shark (*Dalatias licha*)

The fishery at the Azores started in the early 1970s, but data are fragmented. There are no tagging data, and no knowledge of horizontal migrations, but kitefin shark are caught wherever temperatures are around 10-11 °C. Norwegian data (Hareide and Garnes, 2001) suggest that *D. licha* mainly occurs in area X. There is a lack of data that can accurately identify any different stocks of *D. licha*. In the absence of any evidence of stock separation it is assumed, within DELASS, that the Azorean stock can be assessed as a discrete stock. The assessment of *D. licha* should be based, in the first instance, on the area where the primary fishery occurs, i.e. the Azores (ICES Sub-area X).

Stock assessed in DELASS: Sub-area X.

3.2 Length-weight relationships, conversion factors

Allometric relationships are commonly used in ichthyology to characterize the morphology of the species. Some of these relationships are used by taxonomists in identification keys. These relationships are also used in fishery biology and management in order to estimate the weigth of the catches from length (total length or fork length) frequency distributions recorded on board of fishing boats or at landing sites.

We know that in some fish markets from various countries, rays and skates are only landed eviscerated, or in pieces (without head and tail, as wings or discs), and the sharks are landed eviscerated or dressed. For that reason it is important to collect different measurements.

Tables 3.2.1 to 3.2.5 provide some total length and forklength relationships and length/weight relationships for a number of species caught in European fisheries. These data are compiled from some studies supported by EU projects (e.g. FAIR, DELASS), ICES reports and scientific litterature. The following abreviations are used: TL: total length; FL: fork length; Wth: disc width (for skates); WL: wing length; GW: gutted weight; DW: dressed/gutted weight; WW: wing weight; W: total weight.

Table 3.2.1 - Some allometric relationships for sharks and rays.

Species	TL / FL relationships	TL / W relationships	References
Alopias vulpinus	TL = 1,733 FL + 14,778	$DW = 0{,}298\ TL^{0{,}974}$	97/50 DG XIV
Centrophorus granulosus		$W = 0{,}000338\ TL^{3{,}5902}$	FAIR CT 95 0655
Centrophorus granulosus		$W = 0{,}0002\ TL^{3{,}7225}$	Casas *et al.*, 2001.
Centrophorus squamosus		$W = 0{,}000373\ TL^{2{,}3591}$	FAIR CT 95 0655
Centrophorus squamosus		$W = 0{,}002072\ TL^{3{,}214}$	Irish Marine Inst. Survey
Centrophorus squamosus		Male $W = 2{,}10 \times 10^{-5}\ TL^{2{,}7}$ Fem. $W = 1{,}10 \times 10^{-6}\ TL^{3{,}35}$	Girard, 2000
Centrophorus squamosus		$W = 0{,}0002\ TL^{3{,}6554}$	Casas *et al.*, 2001.
Centroscymnus coelolepis		$W = 0{,}167179\ TL^{2{,}3678}$	FAIR CT 95 0655
Centroscymnus coelolepis		$W = 0{,}0004583\ TL^{3{,}611}$	Irish Marine Inst. Survey
Centroscymnus coelolepis		$W = 0{,}0043\ TL^{3{,}12}$	ICES CM 1997/G :2
Centroscymnus coelolepis		Male $W = 2{,}10 \times 10^{-5}\ TL^{2{,}79}$ Fem. $W = 5{,}10 \times 10^{-7}\ TL^{3{,}61}$	Girard, 2000
Centroscymnus coelolepis		$W = 0{,}0002\ TL^{3{,}8188}$	Casas *et al.*, 2001.
Centroscymnus crepidater		$W = 0{,}0024\ TL^{3{,}25}$	ICES CM 1997/G :2
Dalatias licha		Male $W = 5{,}13 \times 10^{-5}\ TL^{2{,}52}$ Fem. $W = 1{,}50 \times 10^{-4}\ TL^{2{,}35}$	ICES CM 1997/G :2
Deania calcea		$W = 0{,}000190\ TL^{3{,}6890}$	FAIR CT 95 0655
Deania calcea		$W = 0{,}001230\ TL^{3{,}258}$	Irish Marine Inst. Survey
Deania calcea		$W = 0{,}0012\ TL^{3{,}26}$	ICES CM 1997/G :2
Deania calcea		$W = 0{,}0007\ TL^{3{,}4158}$	Casas *et al.*, 2001.
Etmopterus princeps		$W = 0{,}0028\ TL^{3{,}15}$	ICES CM 1997/G :2
Etmopterus spinax		$W = 0{,}002151\ TL^{3{,}1903}$	FAIR CT 95 0655
Etmopterus spinax		$W = 0{,}0018\ TL^{3{,}24}$	ICES CM 1997/G :2

Galeorhinus galeus		$TL = 59,9703\ DW^{0,315287}$	97/50 DG XIV
Galeorhinus galeus		$DW = 0,0099\ FL^{2,8838}$	DELASS (Spain)
Galeus melastomus		$W = 0,008609\ TL^{2,7347}$	FAIR CT 95 0655
Galeus melastomus		Fem. $W = 0,002\ TL^{3.05}$ Male $W = 0,002\ TL^{3.07}$	ICES CM 1997/G :2
Galeus melastomus		$W = 0,0018\ TL^{3,1035}$	DELASS (Spain)
Isurus oxyrinchus	$TL = 1,134\ FL – 1,811$	$TL = 66,7584\ DW^{0,323385}$	97/50 DG XIV
Lamna nasus	$TL = 1,115\ FL + 12,883$	$DW = - 7,680\ TL^{2,050}$	97/50 DG XIV
Leucoraja naevus		$W = 2,36 \times 10^{-6}\ TL^{3,233}$	Charuau & Biseau, 1989
Leucoraja naevus	$TL = 0,5932\ Wth – 1,1682$	$W = 0,0037\ TL^{3,1403}$	DELASS (Spain)
Leucoraja naevus	$Wth = 0.5734\ TL – 0.4038$	$WL = 0.2305\ TL + 0.2003$ $WW = 0.1941\ W + 8.1796$	Fernández *et al.*, 2001
Mustelus asterias		$DW = 0,003\ FL^{3,1196}$	DELASS (Spain)
Mustelus mustelus		$DW = 0,0092\ FL^{2,8563}$	DELASS (Spain)
Prionace glauca	$TL = 1,175\ FL + 4,103$ $W=0.0000031841 * FL\ 3.1313$	$DW = 1,787 \times {}^{10-6}\ TL^{3,096}$ $TW = DW * 2.4074$ $W = GW * 1.1938$	97/50 DG XIV Castro et al., 2000 Mejuto, 2001 Kohler et al., 1995
Raja clavata	$TL = 0,7167\ Wth – 0,343$	$W = 0,0035\ TL^{3,1705}$	DELASS (Spain)
Raja clavata	$Wth = 0.7004\ TL + 0.0773$	WL = wing length $WL = 0.33\ TL – 0.9383$ WW = wing weight $WW = 0.2415\ W + 8.339$	Fernández *et al.*, 2001
Raja montagui		$W = 0,0011\ TL^{3,4613}$	DELASS (Spain)
Raja montagui	$Wth = 0.6491\ TL + 1.4817$	$WL = 0.2919\ TL – 0.2516$ $WW = 0.2422\ W + 11.97$	Fernández *et al.*, 2001
Scyliorhinus canicula	$W = 1.165\ GW + 15.679$	$DW = 0.0563\ TL^{2,3183}$ $W = 0.0021\ TL^{3.1189}$ Male $W = 0.0018\ TL^{3.1573}$	DELASS (Spain)

	Male W=1.156GW+8.28 Fem. W=1.290GW-16.16	GW = 0.0017 $TL^{3.1307}$ Fem. W = 0.0016 $TL^{3.2037}$ GW = 0.0019 $TL^{3.1009}$	
Scymnodon ringens		W = 0,005118 TL ^{3,0857}	FAIR CT 95 0655
Scymnodon ringens		W = 0,005 TL ^{3,0841}	Casas *et al.*, 2001.
Scymnodon ringens		W = 0,0043 TL ^{3,12}	ICES CM 1997/G :2
Sphyrna zygaena	TL = 1,252 FL + 5,215		97/50 DG XIV
Squalus acanthias		DW = 0,0035 FL ^{3,0626}	DELASS (Spain)
Alopias superciliosus	FL = 0.5598 TL + 17.6660	W = 0.00911 FL $^{3.08}$	Kohler *et al.*, 1995
Alopias superciliosus		W = 0.0351 SL $^{2.44}$	Quevedo *et al.*, 1984
Alopias superciliosus		W = 0.00183 SL $^{3.45}$	Guitart Manday, 1975
Alopias vulpinus	FL = 0.5474 TL + 0.8865	W = 0.0183 FL $^{2.52}$	Kohler *et al.*, 1995
Carcharhinus altimus	FL = 0.8074 TL + 0.9872	W = 0.00102 FL $^{3.46}$	Kohler *et al.*, 1995
Carcharhinus brachyurus		W = 0.0104 TL $^{2.9}$	van der Elst, 1981
Carcharhinus brevipinna		W = 0.00751 TL $^{2.97}$	Branstetter, 1987
Carcharhinus falciformis	FL = 0.8388 TL - 2.6510	W = 0.0154 FL $^{2.92}$	Kohler *et al.*, 1995
Carcharhinus falciformis		W = 0.00201 TL $^{3.23}$	Branstetter, 1975
Carcharhinus falciformis		W = 0.00878 SL $^{3.09}$	Guitart Manday, 1975
Carcharhinus falciformis		W = 0.0019 TL $^{3.19}$	Bonfil, 1990
Carcharhinus falciformis		W = 0.0464 SL $^{2.75}$	Brouard *et al.*, 1984
Carcharhinus falciformis		W = 0.019 FL $^{2.93}$	Quevedo *et al.*, 1984
Carcharhinus limbatus		W = 0.00714 TL $^{3.01}$	van der Elst,1981
Carcharhinus limbatus		W = 0.0144 TL $^{2.87}$	Branstetter, 1987
Carcharhinus melanopterus		W = 0.00325 TL $^{3.65}$	Lyle, 1987
Carcharhinus obscurus	FL = 0.8396 TL - 3.1902	W = 0.0324 FL $^{2.79}$	Kohler *et al.*, 1995
Carcharhinus obscurus		W = 0.00945 TL $^{2.93}$	van der Elst, 1981
Carcharhinus plumbeus	FL = 0.8175 TL + 2.5675	W = 0.0109 FL $^{3.01}$	Kohler *et al.*, 1995
Carcharhinus plumbeus		W = 0.00419 TL $^{3.48}$	Bonfil *et al.*, 1990
Carcharhinus plumbeus		W = 0.0058 TL $^{3.31}$	Stevens *et al.*, 1991

Carcharias taurus		$W = 0.0106\ TL^{2.94}$	van der Elst, 1981
Carcharodon carcharias	$FL = 0.9442\ TL - 5.7441$	$W = 0.00758\ FL^{3.09}$	Kohler *et al.*, 1995
Carcharodon carcharias		$W = 0.00827\ TL^{3.14}$	Compagno, 1984
Carcharodon carcharias		$W = 0.00321\ TL^{3.18}$	van der Elst, 1981
Centroscyllium fabricii		$W = 0.0009\ TL^{3.42}$	Gordon *et al.*, 1994
Centroscymnus coelolepis		Fem. $W = 0.00061\ TL^{3.71}$	Yano *et al.*, 1984
Centroscymnus coelolepis		Male $W = 0.0231\ TL^{2.81}$	Yano *et al.*, 1984
Centroscymnus coelolepis		$W = 0.0043\ TL^{3.12}$	Gordon *et al.*, 1994
Centroscymnus crepidater		$W = 0.0024\ TL^{3.25}$	Gordon *et al.*, 1994
Centroscymnus owstoni		Fem. $W = 0.00102\ TL^{3.61}$	Yano *et al.*, 1984
Centroscymnus owstoni		Male $W = 0.0463\ TL^{2.68}$	Yano *et al.*, 1984
Cetorhinus maximus		$W = 0.00494\ TL^{3.00}$	Bigelow *et al.*, 1948
Dasyatis pastinaca		$W = 0.0251\ DW^{3.11}$	van der Elst, 1981
Deania calcea		$W = 0.0012\ TL^{3.26}$	Gordon *et al.*, 1994
Etmopterus princeps		$W = 0.0028\ TL^{3.15}$	Gordon *et al.*, 1994
Etmopterus spinax		$W = 0.0018\ TL^{3.24}$	Gordon *et al.*, 1994
Etmopterus spinax		$W = 0.003\ TL^{3.13}$	Merella *et al.*, 1997
Galeorhinus galeus		$W = 0.0068\ FL^{2.94}$	Hurst *et al.*, 1990
Galeorhinus galeus		$W = 0.0109\ TL^{2.83}$	van der Elst, 1981
Hexanchus nakamurai		$W = 0.00124\ FL^{3.47}$	Brouard *et al.*, 1984
Himantura uarnak		$W = 0.0848\ DW^{2.72}$	van der Elst, 1981
Himantura uarnak		$W = 0.0624\ DW^{2.83}$	van der Elst, 1988
Isurus oxyrinchus	$FL = 0.9286\ TL - 1.7101$	$W = 0.00524\ FL^{3.14}$	Kohler *et al.*, 1995
Isurus oxyrinchus		$W = 0.05\ FL^{2.32}$	Quevedo *et al.*, 1984
Isurus oxyrinchus		$W = 0.0012\ FL^{3.46}$	Guitart Manday, 1975
Lamna nasus	$FL = 0.8971\ TL + 0.9877$	$W = 0.0148\ TL^{2.96}$	Kohler *et al.*, 1995
Leucoraja naevus		$W = 0.00236\ TL^{3.23}$	Dorel, 1986
Odontaspis ferox		$W = 0.00589\ TL^{3.00}$	Bonfil, 1995
Prionace glauca		Fem. $W = 0.0131\ TL^{3.2}$	Stevens, 1975

Prionace glauca		Male $W = 0.00392\ TL^{3.41}$	Stevens, 1975
Prionace glauca	$FL = 0.8313\ TL + 1.3908$	$W = 0.00318\ FL^{3.13}$	Kohler *et al.*, 1995
Pristis pectinata		$W = 0.00171\ TL^{3.04}$	van der Elst, 1981
Pteromylaeus bovinus		$W = 0.00025\ DW^{3.84}$	van der Elst, 1981
Raja asterias		$W = 0.0018\ TL^{3.27}$	Merella *et al.*, 1997
Raja brachyura		$W = 0.00281\ TL^{3.23}$	Dorel, 1986
Raja clavata		Fem. $W = 0.00843\ TL^{3.30}$	Ryland *et al.*, 1984
Raja clavata		Male $W = 0.00187\ TL^{3.17}$	Ryland *et al.*, 1984
Raja clavata		$W = 0.0024\ TL^{3.20}$	Merella *et al.*, 1997
Raja clavata		$W = 0.00319\ TL^{3.19}$	Dorel, 1986
Raja clavata		$W = 0.00324\ TL^{3.20}$	Dorel, 1986
Raja microocellata		Fem. $W = 0.00489\ TL^{3.41}$	Ryland *et al.*, 1984
Raja microocellata		Male $W = 0.00893\ TL^{3.31}$	Ryland *et al.*, 1984
Raja microocellata		$W = 0.00494\ TL^{3.12}$	Dorel, 1986
Raja miraletus		$W = 0.00246\ TL^{3.29}$	Moutopoulos *et al.*, 2000
Raja miraletus		$W = 0.001\ TL^{3.44}$	Ungaro, 2001
Raja miraletus		$W = 0.0018\ TL^{3.25}$	Merella *et al.*, 1997
Raja montagui		Fem. $W = 0.00364\ TL^{3.44}$	Ryland *et al.*, 1984
Raja montagui		Male $W = 0.00183\ TL^{3.24}$	Ryland *et al.*, 1984
Raja montagui		$W = 0.00201\ TL^{3.31}$	Dorel, 1986
Raja polystigma		$W = 0.0003\ TL^{3.78}$	Merella *et al.*, 1997
Raja radula		$W = 0.00515\ TL^{3.07}$	Moutopoulos *et al.*, 2000
Raja undulata		$W = 0.00415\ TL^{3.12}$	Dorel, 1986
Rhizoprionodon acutus		Fem. $W = 0.00233\ FL^{3.14}$	Kasim, 1991
Rhizoprionodon acutus		Male $W = 0.00964\ FL^{2.85}$	Kasim, 1991
Rhizoprionodon acutus		$W = 0.0079\ TL^{2.99}$	Krishnamoorthi *et al.*, 1986
Rhizoprionodon acutus		$W = 0.0151\ TL^{2.72}$	van der Elst, 1981
Scyliorhinus canicula		$W = 0.00364\ TL^{2.78}$	Dorel, 1986
Scyliorhinus canicula		$W = 0.0016\ TL^{3.16}$	Merella *et al.*, 1997

Scyliorhinus canicula		$W = 0.00308\ TL^{3.03}$	Dorel, 1986
Scymnodon ringens		$W = 0.0043\ TL^{3.12}$	Gordon *et al.*, 1994
Sphyrna lewini		Fem. $W = 0.00282\ TL^{3.13}$	Chen *et al.*, 1990
Sphyrna lewini		Male $W = 0.00135\ TL^{3.25}$	Chen *et al.*, 1990
Sphyrna lewini	$FL = 0.7756\ TL - 0.3132$	$W = 0.00777\ FL^{3.07}$	Kohler *et al.*, 1995
Sphyrna lewini		$W = 0.0126\ TL^{2.81}$	Branstetter, 1987
Sphyrna lewini		$W = 0.00556\ TL^{3.16}$	Letourneur *et al.*, 1998
Sphyrna lewini		$W = 0.00399\ TL^{3.03}$	Stevens *et al.*, 1989
Sphyrna mokarran		$W = 0.00123\ TL^{3.24}$	Stevens *et al.*, 1989
Sphyrna zygaena		$W = 0.00142\ TL^{3.3}$	van der Elst, 1981
Squalus acanthias		$W = 0.00396\ TL^{3.00}$	Gunderson *et al.*, 1988
Squalus acanthias		$W = 0.00147\ TL^{3.22}$	van der Elst, 1981
Squalus blainvillei		Fem. $W = 0.0037\ TL^{3.07}$	Cannizzaro *et al.*, 1995
Squalus blainvillei		Male $W = 0.0033\ TL^{3.09}$	Cannizzaro *et al.*, 1995
Squalus blainvillei		$W = 0.012\ TL^{3.37}$	Merella *et al.*, 1997
Squalus megalops		$W = 0.0116\ TL^{2.78}$	van der Elst, 1981
Squalus megalops		$W = 0.0126\ SL^{2.88}$	Brouard *et al.*, 1984

Table 3.2.2. Relationships between morphometric variables and length (TL) for some pelagic sharks caught in the Mediterranean & Atlantic area during 1998, 1999 & 2000. TL = a + (b * Independent variable) (Megalofonou *et al.*, 2000).

FL: Fork Length; HDL: Head Length; P1A: Pectoral Anterior Margin; D1A: First Dorsal Anterior Margin; P2A: Pelvic Anterior Margin; ANA: Anal Anterior Margin; CDM: Dorsal Caudal Margin; CPV:Preventral Caudal Margin.

Depended Variable	N	TL Range	a	b	r
Alopias superciliosus					
HDL	10	183 - 353	2.939	0.154	0.991
D1A	10	183 – 353	-3.931	0.096	0.990
CDM	10	183 – 353	-8.637	0.517	0.994
Alopias vulpinus					
FL	26	146 - 469	-2.211	0.558	0.983
D1A	11	188 - 406	0.019	0.083	0.902
CDM	11	188 - 469	35.036	0.400	0.934
Isurus oxyrinchus					
FL	51	92 - 208	6.667	0.845	0.979
HDL	56	92 - 208	3.814	0.249	0.887
P1A	42	92 - 208	-1.379	0.157	0.889
D1A	56	92 - 208	-5.650	0.152	0.937
CDM	56	92 - 208	-3.805	0.242	0.881
CPV	56	92 - 208	-3.849	0.181	0.873
Lamna nasus					
FL	14	91 - 282	-10.913	0.891	0.997
Prionace glauca					
FL	738	74 – 349	-2.074	0.841	0.994
HDL	83	97 – 239	1.616	0.212	0.939
P1A	59	97 – 239	-7,543	0.234	0.981
D1A	353	74 – 283	-0.974	0.103	0.775
P2A	273	74 – 283	-1.210	0.064	0.956
ANA	248	74 – 283	-0.363	0.054	0.425
CDM	354	74 – 283	3.380	0.237	0.958
CPV	85	97 – 275	-2.934	0.130	0.902
Sphyrna zygaena					
FL	15	161 - 295	-2.262	0.790	0.994
HDL	12	161 – 293	2.773	0.180	0.975
P1A	11	161 – 293	-5.554	0.147	0.985
D1A	11	161 - 293	-4.491	0.174	0.989
CDM	12	161 – 293	12.485	0.221	0.984
CPV	12	161 - 293	-1.597	0.132	0.988

Conversion factors

From the nominal catches recorded at landing places, the equivalent fresh weight of the catch is calculated. Usually fishes are prepared on board (gutted, skinned, headed, finned, etc.) before landing. For these calculations, the national fishery services use a series of conversion factors, i.e. ratios allowing the calculation of the "fresh biomass" from the landed weights. Although these factors change with ontogenic changes for each species and also differ between populations, and seasons, fishery services tend to use the same conversion factors for every species, or more often for species categories whatever the composition of the catch is (juveniles, adolescents, adults). Sometimes, the way in which fish are processed varies, but the same factor is nevertheless used "by habit"!

In France, for example, the conversion factors were the same from 1974 to 1992 and it was impossible to trace how they were originally calculated, except that they should correspond to a fresh weight, gutted weight, etc. The same ratio was used for all shark species (1.33) and all rays (1.21) (Séret, unpublished data). The average conversion factor for the sharks which is now being used is 1.04 (corresponding to the loss of 4% due to finning), which is far from the true value for several sharks, particularly for the deep-water sharks; for example, the conversion factor for "siki" (the commercial category consisting of *C. squamosus* and *C. coelolepis*) should be 1.76 for the males and 1.76 for the females (Girard, 2000). In the Basque Country (Spain) there is a special commercial category for *C. squamosus* and *C. coelolepis* because these species are landed as "trunks" (i.e. gutted and without head, skin and fins) .

Table 3.2.3 - Some allometric relationships for three species of deep-water shark in the Bay of Biscay. Source: AZTI.

	n	W/GW	W/Trunk Weight	Liver Weight/W (%)
C. coelolepis	15	1.62	3.77	26.4%
C. squamosus	12	1.32	3.19	19.4%
Deania spp.	10	1.31	2.83	20.3%

The subgroup considers that there is an urgent need to update the conversion factors, as used in each European country, and maturity ogives, taking into consideration the fishing area, the ontogenic stage and the way of preparation for every major commercial chondrichthyan species.

In order to obtain good comparisons between allometric relationships provided by different authors, the subgroup recommends to record the length range, sample size and R^2 for each species in each sample (see for example Table 3.2.4).

Some of the more useful allometric conversion factors that should be improved are:

Pelagic sharks:	Fin Weight/W;
	Fin Weight/GW;
	W/GW
	TL/FL
Deep-water sharks:	Liver Weight/W
	Liver Weight/GW
	W/Trunk Weight
	GW/Trunk Weight
	W/GW
Rays and skates:	WL/TL
	W/WW
	Wth/TL

Table 3.2.4 - Allometric relationships estimated of shark species (Figueiredo *et al.* in prep.). TL: Total length (mm); SL: Standard length (mm); AL: Anal length (mm); TW: Total weight (g); PCL: Pre-caudal length (mm).

Species		Relationship	R^2	Sample size	Length range (mm)
C. coelolepis	F	$TW= 1x10^{-6} \times TL^{3.279}$	0.767	553	767 - 1208 mm
		SL= 0.826 x TL + 55.364	0.951	104	767 - 1163 mm
	M	$TW= 3x10^{-6} \times TL^{3.119}$	0.884	53	682 - 1000 mm
C. squamosus	F	$TW= 2x10^{-6} \times TL^{3.159}$	0.966	134	347 - 1440 mm
		PCL= 0.839 x TL - 70.565	0.975	90	877 - 1440 mm
	M	$TW= 2x10^{-5} \times TL^{2.837}$	0.810	258	877 - 1204 mm
		PCL= 0.778 x TL - 2.042	0.879	164	877 - 1204 mm
D. licha	F	$TW= 9x10^{-7} \times TL^{3.274}$	0.986	69	364 - 1610 mm
		SL= 0.876 x TL + 20.938	0.952	50	400 - 1610 mm
	M	$TW= 1x10^{-6} \times TL^{3.227}$	0.986	122	321 - 1285 mm
		SL= 0.903 x TL + 13.676	0.933	96	321 - 1285 mm
G. melastomus	F	$TW= 2x10^{-6} \times TL^{3.104}$	0.993	4732	83 - 771 mm
		SL= 0.972 x TL -2.416	0.999	952	134 - 761 mm
	M	$TW= 2x10^{-6} \times TL^{3.044}$	0.994	3902	109 - 963 mm
		SL= 0.978 x TL -4.076	0.999	869	130 - 705 mm
D. calcea	F	$TW= 8x10^{-7} \times TL^{3.232}$	0.994	42	234 - 1420 mm
D. profundorum	F	TW= 5x10-7 x TL3.288	0.996	96	270 - 918 mm
E. pusillus	F	$TW= 1x10^{-6} \times TL^{3.248}$	0.978	34	227 - 456 mm
		SL= 0.978 x TL -4.076	0.996	557	105. - 426 mm
		AL= 0.618 x TL -11.242	0.974	566	105 - 456 mm
	M	$TW= 2x10^{-6} \times TL^{3.111}$	0.991	34	163 - 442 mm
		SL= 0.925 x TL +0.661	0.993	219	119 - 398 mm
		AL= 0.591 x TL -10.110	0.984	232	116 - 470 mm

E. spinax	F	TW= 1x10^{-3} x TL$^{3.413}$	0.983	44	107 - 376 mm
		SL= 0.932 x TL +0.012	0.987	131	126 - 466 mm
		AL= 0.650 x TL -1.806	0.993	63	152 - 466 mm
	M	TW= 2x10^{-3} x TL$^{3.331}$	0.988	36	107 - 394 mm
		SL= 0.932 x TL +0.012	0.987	131	118 - 428 mm
		AL= 0.612 x TL -1.199	0.941	52	163 - 428 mm

Table 3.2.5 - Growth parameters and allometric relationships of rays and sharks in Italian seas.

	Growth parameters (Von Bertalanffy Growth Function)						
	L_∞		**K**		**t_o**		**Source**
	Males	Females	Males	Females	Males	Females	
R. asterias	72.5	76.0	0.42	0.41	0	0	(1)
R. clavata	116.7	126.5	0.106	0.098	-0.412	-0.512	(2)
R. miraletus	87.9	91.9	0.19	0.17	-0.50	-0.25	(9)
C. granulosus	91.1	125.1	0.44	0.241	-1.120	-1.176	(7)
S. blainvillei	96.0	117.9	0.135	0.102	-1.397	-1.380	(2)
M. mustelus							

	Length/weight relationship					**Size of first maturity Lm**		
	Males		Females		Source	Males	Females	Source
R. asterias	a=0.00577	b=0.0124	a=0.00177	b=3.3216	1	45-54	60	(4)
R. clavata	a=0.00358	b=3.1243	a=0.00192	b=3.3076	1	54	60	(5)
R. miraletus	a=0.0039	b=3.0483	a=0.0025	b=3.193	10	36-37	39	(10)
S. canicula	a=0.0015	b=3.210	a=0.0012	b=3.287	1	30-39	35-40	(6)
G. melastomus	a=0.00170	b=3.127	a=0.00130	b=3.207	3	34-45	36-45	(4)
C.granulosus						70-80	89-95	(7)
S.acanthias						59-72	70-100	(4)

S.blainvillei	a=0.0033	b=3.0919	a=0.0037	b=3.0688	2	50	50-65	(2)
M.mustelus						70-75	80	(8)

(**1**) Serena & Abella *In*: Relini *et al*., 1999; (**2**) Cannizzaro *et al*., 1995a; (**3**) Ungaro *et al*., 1994; (**4**) Fischer *et al*., 1987; (**5**) Tortonese, 1956; (**6**) Jardas, 1979. (**7**) Rizzo *et al*., 1997. (**8**) Compagno, 1984. (**9**) Abdel-Asiz, 1992. (**10**) Serena, not published data. (**11**) Cannizzaro *et al*., 1995b

3.3 Maturity

Maturity ogives are only available for some of the species caught in Community fisheries. Table 3.3.1 presents the available data for the ICES area.

Table 3.3.1. Length (L_{50}) and age (Age_{50}) at 50% maturity of some elasmobranchs taken in Community fisheries.

Species	Sex	L_{50} (cm)	Age_{50}	Area	Reference
Centroscymns coelolepis	m	86		NE Atlantic	
	f	102			Girard & DuBuit, 1999
Centrophorus granulosuss	m			NE Atlantic	
	f	144			Casas *et al*., 2001
Centrophorus squamosus	m	98		NE Atlantic	
	f	127			Casas *et al*., 2001
Centrophorus squamosus	m	98		NE Atlantic	
	f	104			Girard & DuBuit, 1999
Centroscymnus crepidater	m	52		NE Atlantic	
	f	68			Clarke *et al.* 2002
Squalus acanthias	m				
	f	74		NE Atlantic	Fahy, 1989
Scyliorhinus canicula	m				
	f	54.2		Cantabrian Sea	Rodríguez-Cabello *et al*., 1998
Dipturus batis	f	180	11	Celtic Sea	DuBuit, 1976
Raja brachyura	f	84		Irish Sea	Gallagher *et al.* 2002
Raja clavata	f	72	10	Irish Sea	Holden 1972; 1976
Leucoraja fullonica	f	85		North Sea	Walker and Hislop, 1998
Raja montagui	f	58	8	Irish Sea	Holden 1972; 1978

Leucoraja naevus	f	59	8	North Sea	Walker and Witte, unpublished
Dipturus oxyrhinchus	f	120			Wheeler, 1978
Amblyraja radiata	f	40	5	North Sea	Walker and Witte, unpublished

4. Ecology

4.1 Introduction

This section briefly summarises the current state of knowledge regarding various aspects of the ecology of elasmobranchs and addresses the following three TORs which were given only marginal attention in last year's meeting of this subgroup:

- TOR 4: To provide a comprehensive and update overview of breeding and spawning seasons (overall and peak of spawning) and map breeding and nursery areas.
- TOR 9: To identify, describe and possibly map essential fish habitats and pelagic/benthic communities, either in shallow or deep sea waters, which are considered important for the production of elasmobranch stocks
- TOR 10: To point out ecosystem considerations considering both of the ecological requirements and roles of most important elasmobranch species in structuring and functioning of marine communities. In the light of this, experts shall assess possible bottom-up or top-down effects of more abundant elasmobranch populations.

4.2 Breeding seasons

Elasmobranch fisheries exhibit a range of reproductive strategies, including oviparity and viviparity (e.g. aplacental viviparity, trophonemata, placental viviparity and oophagy) (Dulvy, 1998).

Within the NE Atlantic, oviparous species include catsharks (Family Scyliorhinidae), skates (Order Rajiformes) and chimaeras (Order Chimaeriformes). Other oviparous taxa include horn sharks (Order Heterodontiformes) and some demersal orectolobiform sharks, and such taxa will occur in Indo-Pacific fishing grounds.

Oviparous species lay egg-cases on the sea floor, usually one pair at a time (single oviparity), although certain scyliorhinids retain several egg-cases *in uteri* and deposit eggs in batches (multiple oviparity). The egg-cases of scyliorhinids are generally rectangular with tendrils on two or four corners of the egg-case. These tendrils are used to anchor the egg-case to structures on the sea floor. Skate egg-cases are broader and typically have horns on the corners of the egg-case. Freshly deposited egg-cases often have an adhesive film to which shell and gravel fragments adhere, helping anchor the egg-case to the sea floor. Egg-cases of oviparous elasmobranchs generally contain one embryo (although the skate *"Raja" binoculata* in the North-east Pacific deposits large egg-cases containing 2-5 embryos), and the development time is usually several months, depending on water temperatures.

The spawning seasons of oviparous elasmobranchs, which tend to be annual reproductive cycles, are traditionally described by determining the proportion of mature females that are observed carrying eggs during the year. It has been suggested that the stress involved with the capture of oviparous elasmobranchs may induce ovulation and egg-case formation

Most oviparous elasmobranchs have relatively protracted breeding seasons, although there may be one or two seasonal peaks in egg-laying. For example, *Scyliorhinus canicula* in the Bristol Channel tend to contain egg-cases from October to July, with peak spawning during June and July (Ellis and Shackley, 1997). Rays tend to have slightly less protracted spawning periods, and the thornback ray, for example, spawns from February to September with a peak in June (Holden, 1975). Whereas field studies can be used to indicate the spawning seasons for the population as a whole, the spawning periods for individual fish may be more restricted (Ellis and Shackley, 1995).

Viviparous species tend to have annual, biannual or triannual reproductive cycles. The young are retained *in uteri* and are nourished through a yolk sac (aplacental viviparity, e.g. *Squalus acanthias*), trophonemata (extensions of the uterine wall that secrete uterine milk, e.g. *Dasyatis pastinaca*), placenta (e.g. *Prionace glauca*), intra-uterine eggs (oophagy, e.g. lamnid sharks) and intra-uterine cannibalism (e.g. *Carcharias taurus*). Gestation periods of viviparous species range up to ca. 22 months.

4.3 Breeding grounds

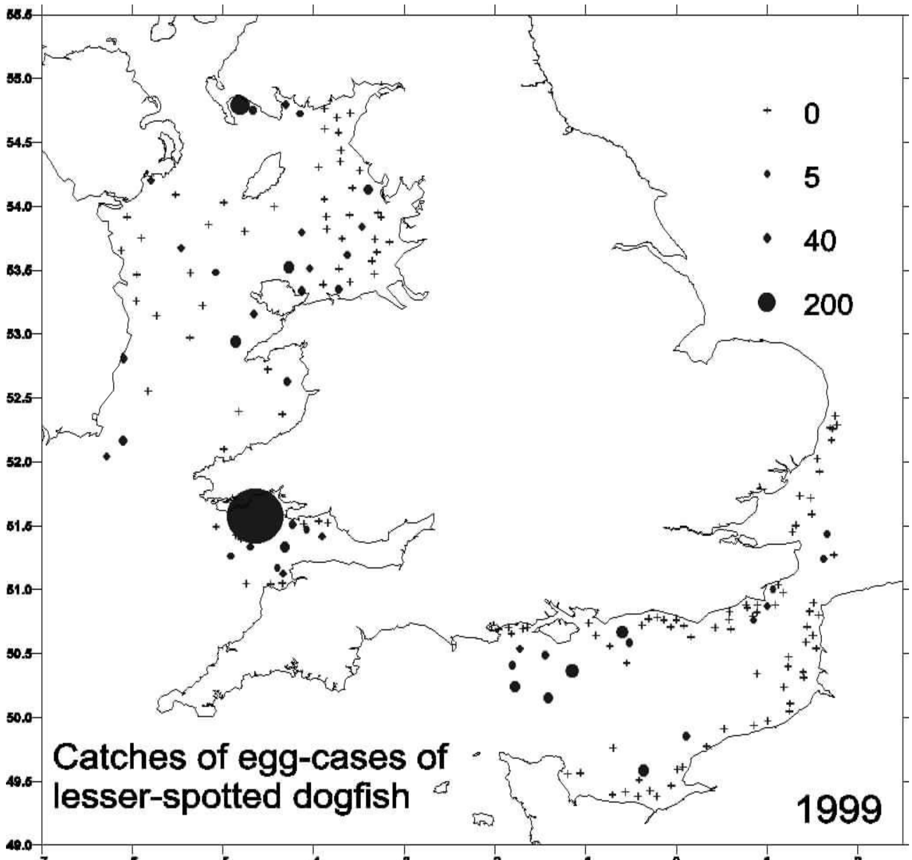
Certain species of shark are known to congregate to mate, and, although little information is available for the NE Atlantic and Mediterranean, there are well-documented examples from other parts of the world. For example the nurse shark *Ginglymostoma cirratum* is known to aggregate at a specific site on the Florida Keys (Carrier and Pratt, 1998), and this area was recognised as "unique and critical to the breeding success of the sharks", as well as serving as a nursery ground for juveniles.

4.4 Parturition and spawning grounds

Female elasmobranchs are often reported to congregate in certain areas in order to lay eggs (spawning grounds) or to give birth to live young (parturition grounds). Such reports are, however, often anecdotal, and little information is available for the North-east Atlantic and Mediterranean.

Spawning grounds may be identified by the presence of egg-cases and there is anecdotal evidence suggesting that rajids and other oviparous chondrichthyans, including chimaeroids, scyliorhinids, heterodontiform sharks and some orectolobiform sharks, have discrete spawning beds (e.g. Dean, 1906; Smith, 1942). Within Australian waters, McLaughlin and O'Gower (1971) reported that the eggs of the Port Jackson shark (*Heterodontus portusjacksoni*) occurred in traditional oviposition sites, which were situated on shallow, sheltered reefs with well-aerated water. In the North-west Atlantic, Able and Flescher (1991) reported 300 egg cases of the chain catshark (*Scyliorhinus retifer*) attached to the hydroid *Eudendrium* being caught in a bottom trawl, and suggested that *S. retifer* deposited their eggs in structured habitats which also served as nursery areas after the young hatched.

Within the North-east Atlantic, *S. canicula* also deposit their eggs on a variety of upright structures, including macro-algae and, on offshore grounds, erect sponges, hydroids, soft corals and bryozoans (Ellis and Shackley, 1997; Rodríguez-Cabello *et al.,* 1998). Indeed, beam trawl surveys can catch large numbers of egg-cases (Figure 4.1), and they are abundant on an *Alcyonium digitatum* bed in the Bristol Channel and *Flustra foliacea* beds in the eastern English Channel.



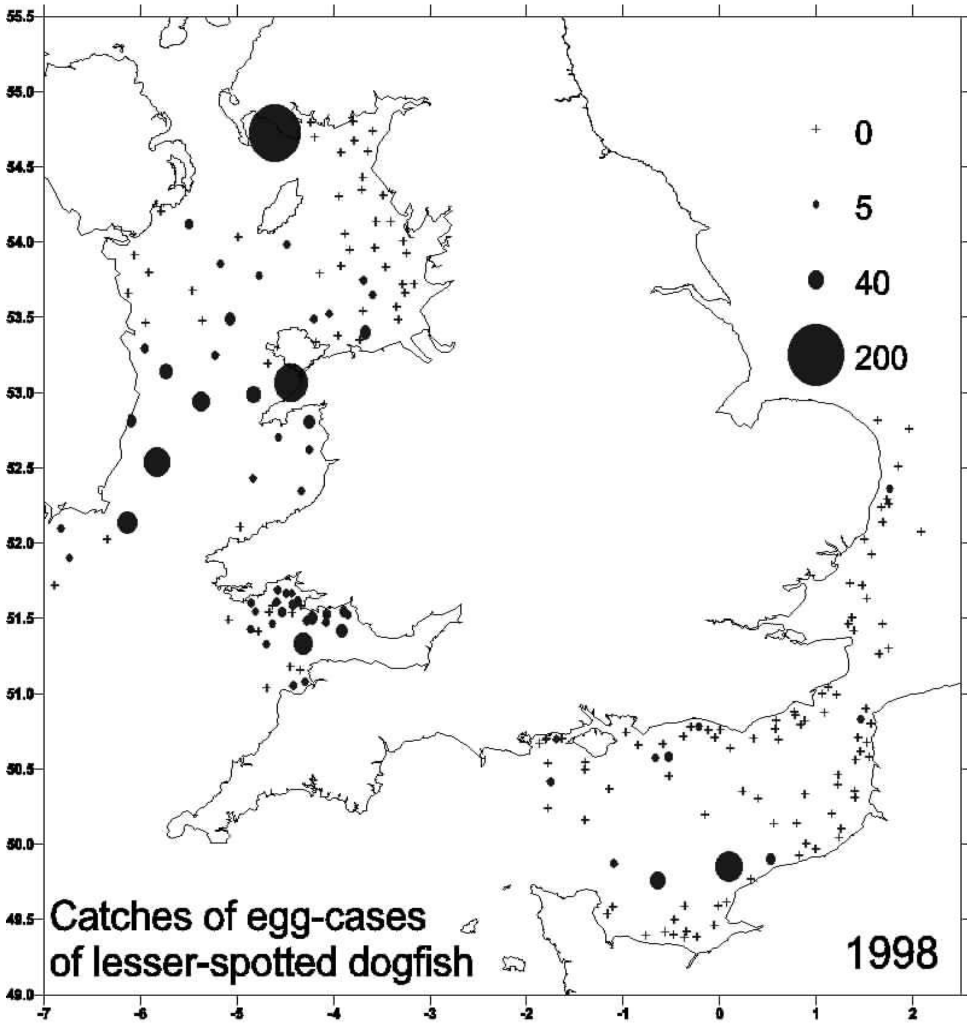


Figure 4.1 - Distribution and relative abundance (numbers per hour) of the egg-cases of lesser-spotted dogfish (*Scyliorhinus canicula*) from CEFAS beam trawl surveys in 1998 and 1999 (From Ellis *et al.*, in press)

The egg-cases of *S. stellaris* are not commonly recorded from offshore waters and it is likely that they are laid primarily in shallow water, attached to macroalgae (Ford, 1921; Orton, 1926). Large numbers of *S. stellaris* egg-cases can be found on the strandline on beaches along the Lleyn Peninsula (Wales) and this region seems to be an important habitat for this species.

Spawning migrations have been suggested for certain elasmobranch species and Holden (1975) described parts of the Wash (UK) as grounds where female *R. clavata* would congregate. Rajid egg cases have horns and an "adhesive film" for anchorage, but little is known about the types of substrates on which they are laid and whether certain sites are preferred. Williamson (1913) reported that large numbers of skate eggs were taken off the shoal water on Aberdeen Bank. Similarly, large numbers of egg cases (up to 152 per 30 minute tow of a scallop dredge) of '*Raja' binoculata* have been reported off the coast of Oregon (Hitz, 1964). Egg-cases are caught only occasionally in beam trawl surveys, and so our current knowledge of the spawning grounds of skates is insufficient to accurately identify important sites or to describe the ecological characteristics of spawning grounds.

Parturition grounds for viviparous species may be identified by the presence of gravid females with near-term embryos and/or the presence of recently born pups (neonates), where the umbilical scar has not fully healed. Data for viviparous species are typically based on anecdotal observations. For example, gravid blue shark *Prionace glauca* have been recorded from the Ionian Sea, and gravid *Oxynotus centrina* from the Aegean Sea and Straits of Messina, although further data are required in order to determine whether there are specific parturition grounds. Further to determining locations that are important for spawning and parturition, it should also be determined whether females are philopatric (i.e. return regularly to these specific sites).

4.5 Nursery grounds

Knowledge of the location of nursery areas of elasmobranch fishes has been identified as an important research requirement for the management of elasmobranch fisheries (e.g. Castro, 1993). Previously published studies have focused on sharks in the North-west Atlantic (Castro, 1993) and Australian waters (Simpfendorfer and Milward, 1993). Nursery areas are often areas with high production, abundant and suitable food and habitat resources, and reduced predation (Castro, 1993; Simpfendorfer and Milward, 1993). The role of nursery areas in the demography and life-history of elasmobranch fishes has been little studied, and little is known about the location and importance of such areas in North-west European waters.

Groundfish surveys catch juveniles of most demersal elasmobranch species and can, therefore, assist in the preliminary identification of nursery grounds. Targeted research is, however, required to determine the functional importance of such areas. Important considerations that need to be addressed include the relative importance of such areas, the extent to which juveniles are site-specific, and the spatial extent of these habitats.

Data for the distribution of juvenile rajids from groundfish surveys indicate that the shallow waters of the northern Bristol Channel are important for juvenile *Raja clavata, R. microocellata* and *R. montagui*, and Cardigan Bay, Luce Bay/Solway Firth and the north-east English Channel are also important for juvenile *R. clavata* and *R. montagui* (Ellis *et al.*, In press; Figure 4.2). In contrast, St George's Channel was important for juvenile *R. brachyura* and *Leucoraja naevus*. Hence, most juvenile and neonatal *Raja* spp. tend to occur in shallow water, especially *R. microocellata* which are regularly caught in beach seine surveys (ca. 1m deep), with other rays (e.g. *Leucoraja* spp.) having nursery grounds further offshore. Similarly, starry ray *Amblyraja radiata* are thought to spawn and have nursery areas in the central North Sea.

Juvenile triakid sharks (*Mustelus* spp. and *Galeorhinus galeus*), including specimens with umbilical scars, are also caught regularly in shallower areas, particularly in the outer reaches of large estuaries, including the Outer Thames Estuary, Isle of Wight and Bristol Channel (Ellis *et al.*, In press; Figure 4.2).

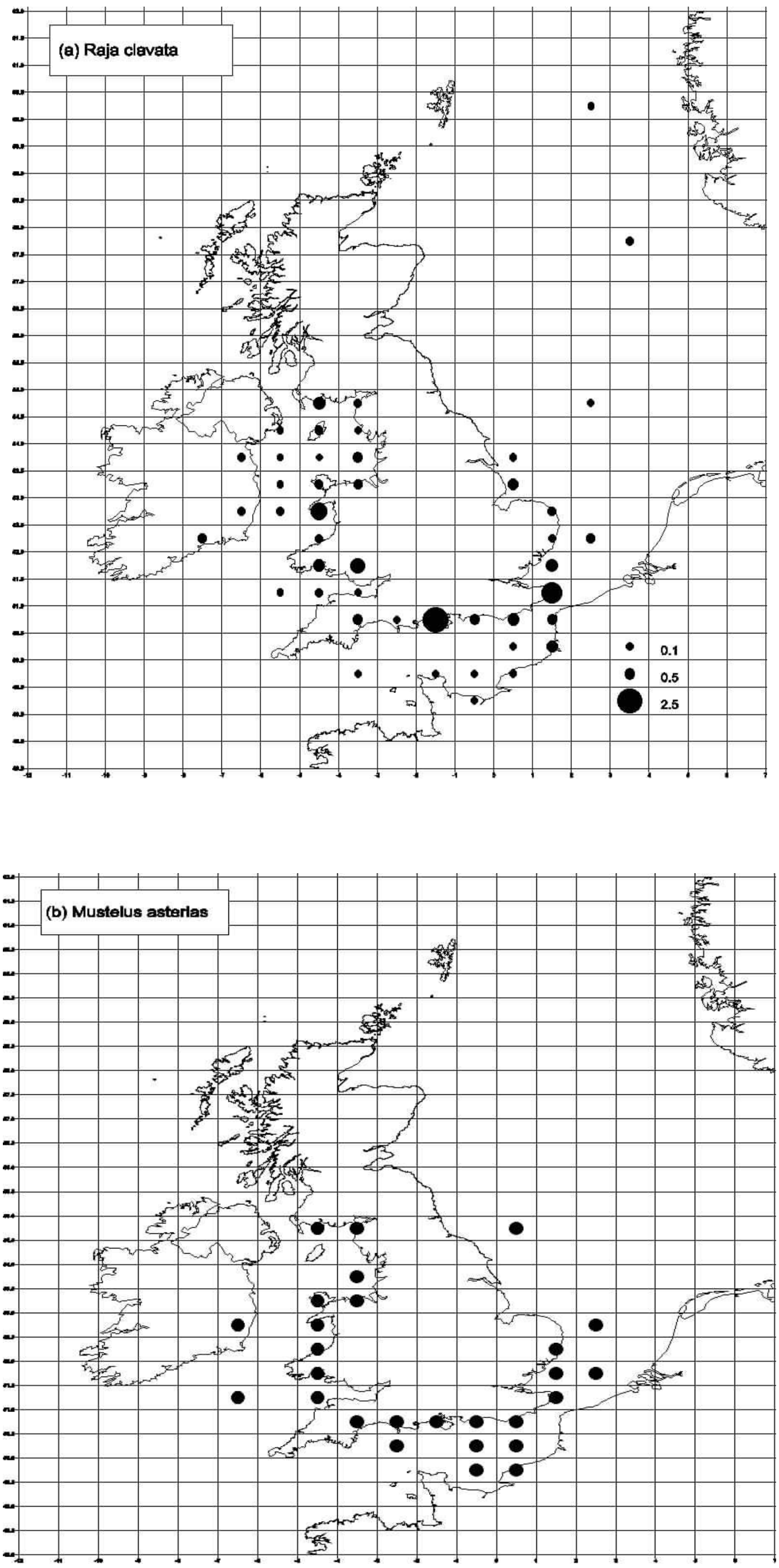


Figure 4.2 - Occurrence of (a) juvenile (≤20cm) thornback ray *Raja clavata* and (b) juvenile (≤ 40cm) starry smoothhound *Mustelus asterias* around the British Isles (From Ellis *et al.*, in press).

Figure 4.3 - Location of nursery grounds of *Scyliorhinus canicula, Galeus melastomus* and *Raja clavata* in the Mediterranean Sea by area and depth

S.canicula — Nursey (milions of individuals with stratum average MW<68g ML<28 cm)

Area =	111a Alboran Sea	112a Alicante sector	113a Catalan Sea	114a W Morocco	114b E Morocco	121a W Gulf of Lions	121b E Gulf of Lions	131a NE Corsica	131b SE Corsica	132a N Ligurian Sea	132b E Ligurian Sea	132c N Tyrrhenian Sea	132d Centr. Tyrrhenian	133a SE Sardinia	133b NE Sardinia	133c N Sardinia	133d NW Sardinia	133e W Sardinia	133f SW Sardinia	133g S Sardinia	134a SE Tyrrhenian	134b SW Tyrrhenian	134c Sicilian Channel	211a N Adriatic Sea	211b Central Adriatic	211c N Adriatic-Slov.	211d NE Adriatic-Croat	221a E Sicily	221b NW Ionian Sea	221c N Ionian Sea	221d N Ionian Sea	221e SW Adriatic Sea	221f SW Adriatic Sea	221g SW Adriatic Sea	221h SW Adriatic Sea	221i SE Adriatic-Alban	222a E Ionian Sea	223a Argosaronikos	224a N Aegean Sea	225a S Aegean Sea
0-50																																								
50-100																																								
100-200				2.4												0.7																								
200-500		0.8						1.3				0.0		0.1	1.2		0.5	0.8	0.5	0.2			0.6				0.5	0.0			0.0					0.1				
500-800				0.0				0.0						0.0				0.0				0.0																		

G.melastomus — Nursey (milions of individuals with stratum average MW<57g ML<28 cm)

Area =	111a Alboran Sea	112a Alicante sector	113a Catalan Sea	114a W Morocco	114b E Morocco	121a W Gulf of Lions	121b E Gulf of Lions	131a NE Corsica	131b SE Corsica	132a N Ligurian Sea	132b E Ligurian Sea	132c N Tyrrhenian Sea	132d Centr. Tyrrhenian	133a SE Sardinia	133b NE Sardinia	133c N Sardinia	133d NW Sardinia	133e W Sardinia	133f SW Sardinia	133g S Sardinia	134a SE Tyrrhenian	134b SW Tyrrhenian	134c Sicilian Channel	211a N Adriatic Sea	211b Central Adriatic	211c N Adriatic-Slov.	211d NE Adriatic-Croat	221a E Sicily	221b NW Ionian Sea	221c N Ionian Sea	221d N Ionian Sea	221e SW Adriatic Sea	221f SW Adriatic Sea	221g SW Adriatic Sea	221h SW Adriatic Sea	221i SE Adriatic-Alban	222a E Ionian Sea	223a Argosaronikos	224a N Aegean Sea	225a S Aegean Sea
0-50																																								
50-100																																								
100-200									0.2																															
200-500	1.3	0.5						0.7	1.0					0.3	2.0	1.0	0.4	1.3		1.2		0.1	0.5					0.0	0.1		0.0		0.1			0.0	0.4	0.5		0.7
500-800																					5.3																			

R.clavata — Nursey (milions of individuals with stratum average MW<300g ML<37 cm)

Area =	111a Alboran Sea	112a Alicante sector	113a Catalan Sea	114a W Morocco	114b E Morocco	121a W Gulf of Lions	121b E Gulf of Lions	131a NE Corsica	131b SE Corsica	132a N Ligurian Sea	132b E Ligurian Sea	132c N Tyrrhenian Sea	132d Centr. Tyrrhenian	133a SE Sardinia	133b NE Sardinia	133c N Sardinia	133d NW Sardinia	133e W Sardinia	133f SW Sardinia	133g S Sardinia	134a SE Tyrrhenian	134b SW Tyrrhenian	134c Sicilian Channel	211a N Adriatic Sea	211b Central Adriatic	211c N Adriatic-Slov.	211d NE Adriatic-Croat	221a E Sicily	221b NW Ionian Sea	221c N Ionian Sea	221d N Ionian Sea	221e SW Adriatic Sea	221f SW Adriatic Sea	221g SW Adriatic Sea	221h SW Adriatic Sea	221i SE Adriatic-Alban	222a E Ionian Sea	223a Argosaronikos	224a N Aegean Sea	225a S Aegean Sea
0-50																											0.0													0.0
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Within the Mediterranean, pupping/nursery grounds are reported for sandbar shark *Carcharhinus plumbeus* in the Gulf of Gabès (Tunisia), Adriatic and off Turkey (e.g. Capapé, 1984), and bigeye thresher shark *Alopias superciliosus* may have a spawning ground in the vicinity of the Gibraltar Straits area (FAO statistical sub-area 1.1) (Moreno & Morón, 1992). The location of nursery grounds for selected demersal elasmobranchs in the Mediterranean Sea is indicated in Figure 4.3.

A specific programme for the assessment of *Aphia minuta* in the Southern Ligurian Sea was conducted in 1995, off Viareggio in Tuscany (Italy) (Abella *et al*., 1997), and revealed high concentrations of juveniles of different species in this coastal area. An area with a high abundance of juveniles of *Raja asterias* was observed at a depth of 8-12 m (Figure 4.4). In order to confirm the presence of a nursery area of R. asterias, a tag and release programme (RAIA TAG project) of juveniles of this species has been carried out (Mancusi *et al*., mimeo; Catalano *et al*., in press). Four tagging campaigns were performed (July and August 2001, March and May 2002), using a small trawler in shallow waters. The length frequency distribution of all catches is shown in Figure 4.5.

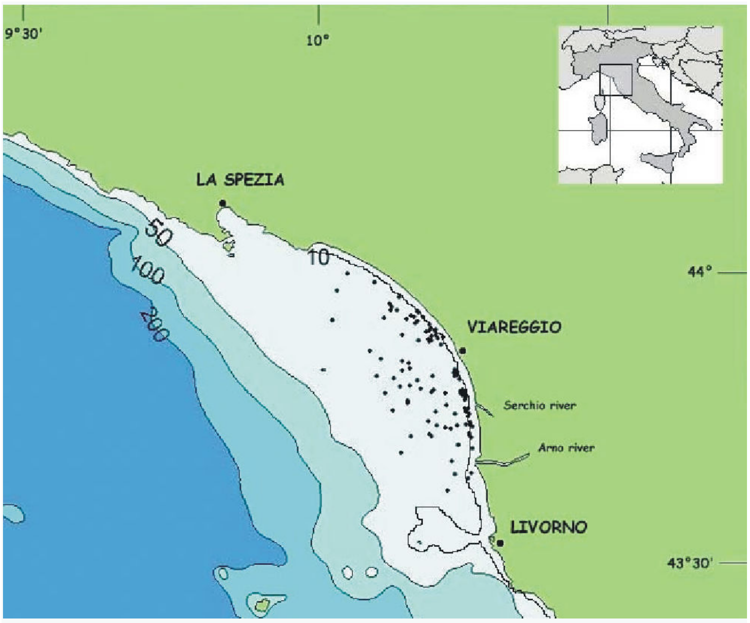

Figure 4.4 – The area studied during the RajaTAG project, a tag and release programme of juvenile *Raja asterias* carried out in the Southern Ligurian Sea, off Viareggio (Tuscany, Italy).

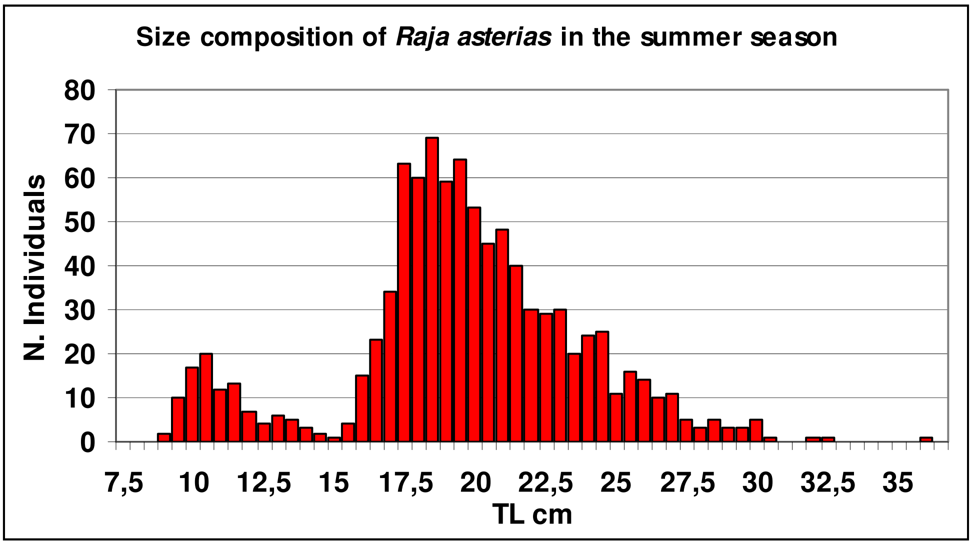

Figure 4.5 – Length frequency distribution of *Raja asterias* caught during the RajaTAG project in the Southern Ligurian Sea, off Viareggio (Tuscany, Italy).

Deep-water elasmobranchs may also have nursery areas. Whereas data may be limited, survey data indicate that there are spatial differences in population structure and the presence of juveniles of deep-water sharks may be restricted to certain grounds (Figures 4.6-4.7). The deep-water scyliorhinid *Galeus melastomus* is known to have spawning grounds in the Porcupine sea bight, and also in the southern part of the Portuguese coast.

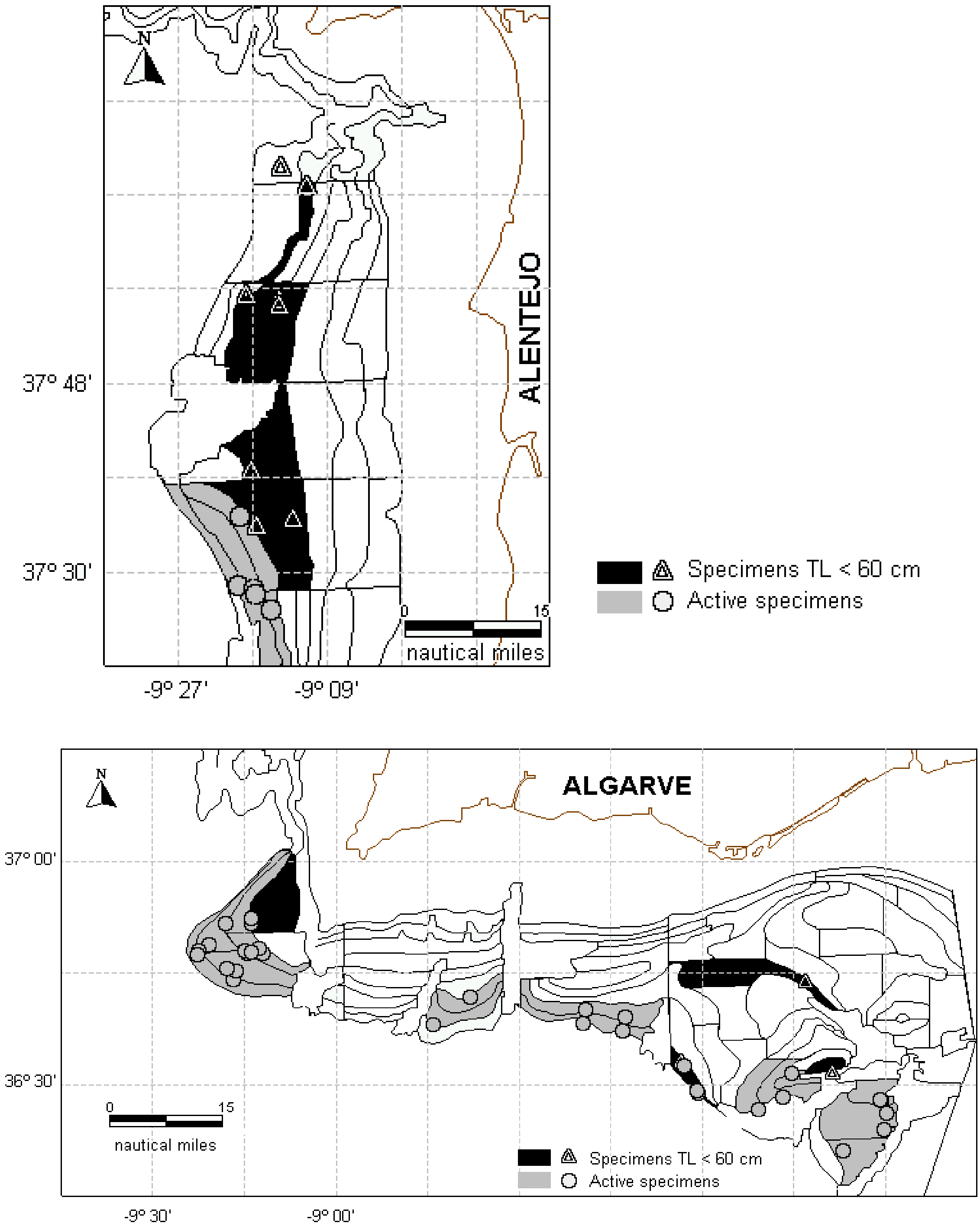

Figure 4.6 - Capture areas of juvenile and active mature kitefin shark *Dalatias licha* in the Alentejo (top) and Algarve (bottom) regions of the Portuguese continental slope.

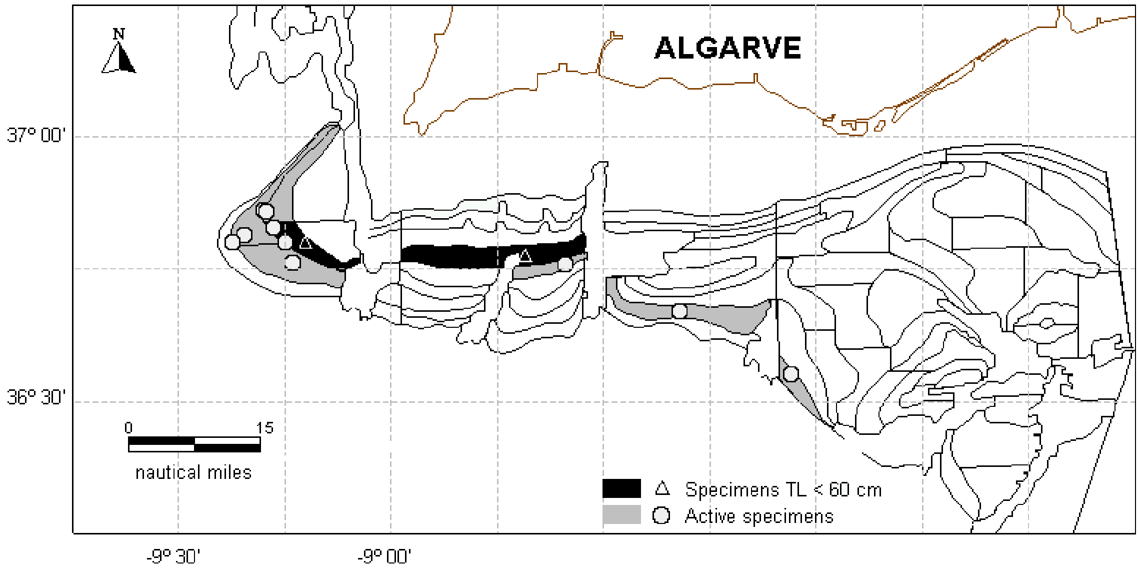

Figure 4.7 - Capture areas of juvenile and active mature leafscale gulper shark *Centrophorus squamosus* in the Algarve region of the Portuguese continental slope.

4.6 Feeding grounds

Many elasmobranch species are opportunistic predators (e.g. Ellis *et al.,* 1996), feeding on a variety of prey species. Therefore, they may often feed on a variety of grounds and there may not be feeding grounds that are of critical importance. Nevertheless, there are some reports of locally and/or seasonally important feeding grounds, although many such reports are anecdotal. Some large predatory sharks (e.g. *Carcharodon carcharias* and *Galeocerdo cuvier*) are known to congregate at certain locations when certain prey species are abundant. Basking sharks *Cetorhinus maximus* are known to aggregate at fronts, where plankton abundance is high (see Annex 1), although the locations of such oceanographic features are variable.

4.7 Essential Fish Habitat

Essential Fish Habitat (EFH) is a major policy driver in the USA and Canada (Benaka, 1999; Rosenberg *et al.*, 2000), and of increased interest in North-east Atlantic waters. In 1996, the USA Congress added habitat conservation measures to the Magnuson-Stevens Fishery Conservation and Management Act, which states: "*One of the greatest long-term threats to the viability of commercial and recreational fisheries is the continuing loss of marine, estuarine, and other aquatic habitats. Habitat considerations should receive increased attention for the conservation and management of fishery resources of the United States*" (16 U.S.C. 1801 (A)(9)).

The USA Congress defined EFH as "*those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity*", where **waters** are “aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate”; **substrate** “includes sediment, hard bottom, structures underlying the waters, and associated biological communities”; **necessary** means “the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem”; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle.

Hence, only a proportion of a fish species’ biogeographical range can be considered as EFH, and in turn only a proportion of its EFH may be considered critical. Habitat Areas of Particular Concern (HAPCs) are the most critical or vulnerable types of EFH (Rosenberg *et al.*, 2000), and such sites are identified by the importance of the ecological function, the extent to which the habitat is sensitive or subject to anthropogenic degradation, and the rarity of the habitat type.

The types of site that may be considered as EFH for particular species/stocks would include:

- Breeding, spawning and parturition grounds
- Nursery grounds (for neonates and juveniles)
- Shelter and natural refuges
- Feeding grounds
- Migratory corridors

Furthermore, the grounds or habitats utilised by those species that exhibit high habitat specificity or are endemic to restricted locations may also be regarded as EFH.

The data requirements for correct identification of EFH/HAPC for any given species will be descriptive or quantitative information on the geographical range of all life-history stages at an appropriate spatial and temporal resolution (Schmitten, 1999). Specifically, the types of information that are required are the:

- Current and historical population (or stock) size
- Biogeographical distribution
- Spatio-temporal distribution and relative abundance of the various life-history stages
- Biological and habitat requirements for the various life-history stages
- Ecological and environmental characteristics, and spatial distribution of the habitats
- Population density, survivorship, growth rate, breeding success and production rates for the various habitats used

The main rationale for identifying critical habitats and EFH is that certain sites may be of significant importance for, for example, increased survivorship and growth of various life-history stages, and reproductive success of a fish species, particularly those of commercial or conservation importance.

Whereas EFH is defined as "*those waters and substrate* <u>*necessary*</u> *to fish for spawning, breeding, feeding, or growth to maturity*", in practical terms habitats should be viewed in terms of their spatial extent and sensitivity, with priority given to those habitats that are of critical importance, spatially restricted and/or sensitive to disturbance.

4.8 Ecosystem considerations

Elasmobranchs are regarded as important components of marine ecosystems, as they are long-lived and some of the top predators in demersal and pelagic environments. Within the North-east Atlantic they are important in fully marine habitats, whereas in other parts of the world, some elasmobranchs are important in estuarine ecosystems.

Despite the perceived importance of elasmobranchs in the ecosystem, there are few studies demonstrating that declines in shark populations have significant impacts on the marine ecosystem. There are, however, some suggestions of negative impacts.

- Brodie & Beck (1983) hypothesised that decreased numbers of sharks in the North-west Atlantic resulted in lower predation rates on seals, which were an intermediate host for codworm, and consequently increased the incidence of parasitism in cod.

- It has recently been suggested that declining numbers of larger batoids in the North Sea enabled an expansion in the distribution and abundance of starry ray *Amblyraja radiata* (Walker & Hislop, 1998), and comparable patterns of competitive release may have also occurred in the Irish Sea, with the small-bodied cuckoo ray *Leucoraja naevus* and spotted ray *Raja montagui* increasing as larger-bodied skates declined (Dulvy *et al.*, 2000).

Hence, declining populations of elasmobranch fishes may result in either competitive release, whereby a species with a similar ecological niche (which may or may not be another elasmobranch species) will increase in distribution and/or abundance, or permit prey populations to expand, which may have ecological implications. There are no studies demonstrating that elasmobranchs are keystone species in the North-east Atlantic, as most species are not selective predators. White sharks *Carcharodon carcharias* may be an important predator of marine mammals in certain parts of the world and may, therefore, be regarded as a keystone species.

Ecosystem modelling, such as Ecopath (e.g. Polovina, 1984; Christensen & Pauly, 1992) and Bayesian approaches (e.g. Hammond & Ellis, 2002) have not been used extensively to examine the role of elasmobranch fishes. Ecopath models have been developed for the Cantabrian Sea ecosystem (Sánchez *et al.*, 2002). This area has many species of demersal elasmobranchs and bottom trawl surveys and the main commercial fisheries carried out in this area suggest that elasmobranchs play an important role in the ecosystem, since they are relatively abundant in all types of habitat (Sánchez, 1993; Sánchez *et al*., 1995, 2002). The main elasmobranch species that inhabit the continental shelf of the Cantabrian Sea, based on the bottom trawl surveys, include *Raja clavata*, *R, montagui* and *Scyliorhinus canicula,* with *Galeus melastomus* more abundant on the outer shelf and deep-water sharks (e.g. *E. spinax* and *D. calcea*) off the shelf edge (Table 4.1).

This trophodynamic model incorporates various types of data, including fisheries data (landings, discards), biomass, biological parameters and feeding habits, and obtains the trophic level of the main elasmobranch groups and the relationship with other species inhabiting the same area.

The main results from this study indicate that, within the benthic and demersal ecosystem, most of the biomass and production is associated with detritus. The detritus in the model accounted for 19.3% of total consumption and constituted one of the main energy flow inputs. Consequently, detritivores (e.g. suspension feeders such as suprabenthic zooplankton and shrimps, and deposit feeders such as polychaetes) were an important component of the Cantabrian Sea ecosystem, and constituted a high percentage of the biomass between trophic levels 2 and 3 (Table 4.2)

Table 4.1 - Main species of elasmobranchs caught during groundfish surveys in the Cantabrian Sea ranked by biomass index (kg/30 min. haul for the period 1997-1999) and percentage of participation in each trophic group in the trophodynamic model (X=<1%). The habitat preference was used in the Ecospace spatial-temporal simulations (Source: Sánchez *et al*., 2002).

		Abundance indices		Trophic group		
Family	Specie	Kg/haul	No./haul	Dogfish	Rays	Habitat preference
Scyliorhinidae	*Scyliorhinus canicula*	3.093	10.396	80%		Inner and middle shelf
Rajidae	*Raja clavata*	0.999	0.926		50%	Coastal and inner shelf
Scyliorhinidae	*Galeus melastomus*	0.600	4.942	15%		Outer shelf
Rajidae	*Raja montagui*	0.565	0.664		30%	Coastal and inner shelf
Squalidae	*Squalus acanthias*	0.369	0.085	X		Middle and outer shelf
Rajidae	*Leucoraja naevus*	0.183	0.298		15%	Inner and middle shelf
Squalidae	*Deania calcea*	0.173	0.432	X		Shelf break
Squalidae	*Etmopterus spinax*	0.099	1.758	X		Shelf break
Rajidae	*Raja undulata*	0.057	0.024		X	Coastal and inner shelf
Squalidae	*Scymnodom ringens*	0.045	0.129	X		Shelf break
Myliobatidae	*Myliobatis aquila*	0.028	0.022		X	Coastal and inner shelf
Scyliorhinidae	*Scyliorhinus stellaris*	0.022	0.123	X		Inner and middle shelf
Hexanchidae	*Hexanchus griseus*	0.016	0.010	X		Middle and outer shelf
Torpedinidae	*Torpedo marmorata*	0.013	0.009		X	Coastal and inner shelf
Triakidae	*Galeorhinus galeus*	0.001	0.004	X		Inner and middle shelf
Triakidae	*Mustelus mustelus*	0.001	0.004	X		Inner and middle shelf
Rajidae	*Raja brachyura*	0.000	0.004		X	Coastal and inner shelf
Rajidae	*Leucoraja circularis*	0.000	0.002		X	Inner and middle shelf

This has significance for dogfish and rays, since it provides important food resources (i.e. benthic invertebrates), and supports a high level of biomass for the demersal elasmobranchs in this area (e.g. Sánchez *et al*., 1995 and 2002). The model showed that the fisheries utilised 36.6% of the total primary production. This high PPR (primary production required) value corroborates the conclusion that the fisheries of the Cantabrian Sea use a large proportion of the productive capacity of the shelf ecosystem (Sánchez and Olaso, In press). The results indicate a level of fisheries impact in the Cantabrian Sea comparable to other intensively exploited temperate shelf ecosystems. That demersal elasmobranchs have increased in recent years could be related to decreased fishing mortality associated with a reduction in trawling effort. Recent management measures, including the deployment of anti-trawling devices (artificial reefs) on certain grounds in less than 100 m may have facilitated the recovery of dogfish and ray populations.

Table 4.2 - Input values (in italics) and estimates (non italics) of some parameters in the balanced trophodynamic model of 1994 for each trophic group. TL = Trophic level, PB = Production/Biomass ratio, QB = Consumption/Biomass ratio and EE = Ecotrophic efficiency. Biomass, PB, Food intake, Flow to detritus and Catches (landings+discards) are expressed in t·km^{-2}.

	Group name	TL	Biomass	PB / year	QB / year	EE	Food Intake	Flow to detritus	Catches	Fishing mortality	Natural mortality
1	Tuna	4.7	*0.384*	*0.82*	*9.50*	0.85	3.65	0.76	*0.27*	0.70	0.12
2	Large hake	4.7	*0.876*	*0.53*	*3.90*	0.79	3.42	0.78	*0.37*	0.42	0.11
3	Small hake	4.4	*0.185*	*0.80*	*6.50*	0.91	1.20	0.25	*0.08*	0.45	0.35
4	Anglerfish	4.8	*0.746*	*0.38*	*1.90*	0.56	1.42	0.41	*0.16*	0.21	0.17
5	Megrim	4.2	*0.237*	*0.66*	*3.00*	0.78	0.71	0.18	*0.09*	0.38	0.28
6	Large demersal fish	4.3	*2.115*	*0.60*	*2.70*	0.87	5.71	1.24	*1.08*	0.51	0.09
7	**Dogfish**	**4.0**	***0.330***	***0.25***	***2.50***	**0.42**	**0.83**	**0.22**	***0.04***	**0.11**	**0.15**
8	**Rays**	**3.8**	***0.210***	***0.30***	***2.20***	**0.61**	**0.46**	**0.13**	***0.04***	**0.18**	**0.12**
9	Benthic fish	3.6	*2.940*	*1.20*	*2.80*	0.87	8.23	2.09	*0.23*	0.08	1.12
10	Blue whiting	3.8	*16.415*	*0.48*	*5.30*	0.93	87.00	17.90	*1.50*	0.09	0.39
11	Small demersal fish	3.6	*15.040*	*1.20*	*6.40*	0.84	96.26	22.15	*0.20*	0.01	1.19
12	Horse mackerel	3.8	*14.771*	*0.32*	*4.30*	0.83	63.52	13.52	*1.95*	0.13	0.19
13	Mackerel	3.8	*11.486*	*0.43*	*4.60*	0.28	52.83	14.12	*1.57*	0.14	0.29
14	Anchovy	2.9	*2.832*	*1.98*	*9.13*	0.82	25.86	6.16	*1.24*	0.44	1.54
15	Sardine	2.8	*6.978*	*0.58*	*8.80*	0.60	61.41	13.92	*1.58*	0.23	0.35
16	Squids	4.4	0.929	*3.20*	*7.50*	*0.95*	7.23	1.55	*0.16*	0.17	3.03
17	Benthic cephalopods	3.8	1.072	*3.00*	*6.00*	*0.95*	6.70	1.44	*0.38*	0.35	2.65
18	Benthic invertebrates	2.9	6.564	*2.60*	*5.60*	*0.95*	38.72	8.25	*0.13*	0.02	2.58
19	Shrimps	2.8	8.263	*4.20*	*9.67*	*0.95*	81.63	17.76	*0.02*	0.00	4.20
20	Polychaetes	2.2	11.575	*4.80*	*12.00*	*0.95*	143.33	30.65	*0.08*	0.01	4.79
21	Other invertebrates	2.1	7.642	*2.50*	*6.50*	*0.95*	50.99	10.93	*0.25*	0.03	2.47
22	Zoopl suprabenthic	2.7	12.192	*16.00*	*32.00*	*0.95*	392.36	87.84	*0.00*	0.00	16.00
23	Macrozooplankton	3.1	3.483	*18.00*	*38.00*	*0.95*	133.25	29.62	*0.00*	0.01	17.99
24	Mesozooplankton	2.2	*8.889*	*39.08*	*80.00*	0.99	711.12	144.25	*0.00*	0.00	39.08
25	Microzooplankton	2.1	3.973	*45.28*	*120.00*	*0.95*	477.71	104.36	*0.05*	0.00	45.28
26	Phytoplankton	1.0	*32.760*	*148.11*	-	0.21	0.00	3064.46	*0.00*	0.00	148.11
27	Discards	1.0	*2.400*	-	-	0.98	0.00	0.03	*0.00*	0.00	0.00
28	Detritus	1.0	*50.000*	-	-	0.13	0.00	0.00	*0.00*	0.00	0.00

5 Management Considerations

5.1 Introduction

This section considers several aspects which are related to the management of elasmobranchs and addresses the following TORs:

- TOR 6: To review and identify appropriate stock units for management of elasmobranch fisheries (see section 5.2). For deep water sharks, see also STECF-SGFEN report SEC(2002)133.

- TOR 7: To provide past and recent trends in abundance of major elasmobranch stocks (see section 5.3).

- TOR 8: To provide the status of major elasmobranch stocks as well as an explicit ranking of stocks which are at different level of risk according to the most updated evaluation or expert judgment (see section 5.6)

- TOR 11: To identify gaps in the current knowledge of fishery systems and assess the suitability for elasmobranchs of traditional stock assessment methods. Possible future monitoring and research needs should be highlighted (see section 5.5)

- TOR 13: To report case studies of management of elasmobranch fisheries undertaken at national level (see section 5.7)

5.2 Appropriate management units for elasmobranch fisheries

5.2.1 Community waters

This section sets out the opinion of the sub-group on the management units for the main elasmobranchs in Community fisheries. It should be pointed out that these management units do not always coincide with the distribution of the stocks. Therefore these recommended areas should not be considered as the areas for which assessments should be carried out. A stock assessment of a given species should be carried out on a unit stock, and therefore using data for the area of stock distribution.

The concept of a biological stock has been described by Pawson and Ellis (2002) as having sufficient spatial and temporal integrity to be considered as self-perpetuating units. Considerable progress has been made on defining stock structure of elasmobranchs in the ICES area, as part of the DELASS project (Heessen, 2003). The most up to date information on biological stock structure is presented below, to show for what areas assessments should be carried out. For the nine case-studies in the DELASS project, this information is based on the results of detailed deliberations. For the remainder of the species there is still considerable uncertainty about stock structure but nevertheless the sub-group gives some suggestions based on biological and fisheries information.

As concerns the Mediterranean Sea, the scientific evidence available about mixing with Atlantic populations is poor, particularly for pelagic elasmobranch species. Due to practical reasons, the sub-group agreed to temporary consider all the species reported in the Mediterranean as distinct stock units, from a management point of view, until new scientific evidences will demonstrate otherwise. The only exceptions to this are for generic Carcharhinid sharks and Alopiidae (thresher sharks)(see below).

The sub-group points out that management of Community elasmobranch fisheries spans a wide range of international organisations with differing geographic areas and competencies. These include ICCAT, GFCM, CECAF, CCAMLR, IOTC, IATTC and NAFO. It is important that management measures are consistent within Community waters and regional management organisations in order to avoid duplication of effort or a more serious situation where one management regime might actually counteract the efficiency of another one.

Spurdog *Squalus acanthias*

Stock units: Northeast Atlantic comprising ICES Sub-areas or Divisions IIa, IIIa, IV, V, VI, VII and VIII was considered to be a single stock (Heessen, 2003).

Management units: Northeast Atlantic: As for stock units. This sub-group considers that eastern and western Mediterranean waters be considered as separate management units, until information becomes available to suggest otherwise. Separate management unit for Black Sea.

Blue shark *Prionace glauca*

Stock units: North Atlantic, north of equator was considered as a single stock. A separate stock was considered to be present in the Mediterranean (Heessen, 2003).

Management units: North Atlantic stock that is distributed from north-eastern South America (e.g. Venezuela) to Canada in the west, and from north-west Africa (e.g. Sierra Leone and Ivory Coast) to Norway and Iceland in the east. A separate management unit should comprise the entire Mediterranean Sea.

Porbeagle *Lamna nasus*

Stock units: At a meeting of the DELASS project, available data on stock structure of this species were reviewed. It was considered that separate stocks occur in the Northeast and Northwest Atlantic, based on the small number of movements of tagged fish between these areas. It is rare in the Mediterranean.

Management units: Northeast Atlantic comprising ICES area. Northwest Atlantic comprising NAFO area. Separate management unit for Mediterranean.

Mako shark *Isurus oxyrynchus*

Stock units: Available data from tagging programmes and genetics studies for this pelagic and oceanic species would indicate that mako form one North Atlantic stock.

Management units: Separate management units for Atlantic (north of equator) and Mediterranean Sea.

Thresher shark *Alopias vulpinus*

Stock units: Data for this species are limited, although this pelagic species is widely distributed. Data are insufficient to determine if there is a single North Atlantic stock or separate Northeast and North-west Atlantic stocks. The waters in the vicinity of the Gibraltar Straits may be a pupping and nursery area (Moreno *et al.*, 1989), and juveniles are also from the Adriatic Sea.

Management units: Single management unit for Northeast Atlantic (ICES area). Separate management for Mediterranean Sea.

Tope *Galeorhinus galeus*

Stock units: This coastal shark is also known to travel large distances. It does not occur in the North-west Atlantic. Hence, there is likely to be a single Northeast Atlantic stock.

Management units: Single management unit for Northeast Atlantic (ICES area). Separate management for Mediterranean Sea.

Smoothhound *Mustelus mustelus*

Stock units: This coastal shark does not occur in the North-west Atlantic. Hence, there is likely to be a single Northeast Atlantic stock.

Management units: Single management unit for Northeast Atlantic (ICES area). Separate management for Mediterranean Sea.

Starry smoothhound *Mustelus asterias*

Stock units: This coastal shark does not occur in the North-west Atlantic. Hence, there is likely to be a single Northeast Atlantic stock.

Management units: Single management unit for Northeast Atlantic (ICES area). Separate management for Mediterranean Sea.

Basking shark *Cetorhinus maximus*

Stock units: Little is known about the long-distance movements of this species, but it could be considered as either a North or Northeast Atlantic stock. It is more abundant in the western basin of the Mediterranean Sea where it is incidentally caught mainly during late spring and summer in shallow waters.

Management units: Single management unit for Northeast Atlantic (ICES area). Separate management for Mediterranean Sea, where the species is subject to the provisions of Bern and Barcelona Conventions.

Skates and rays Rajidae

Stock units: Skates (Rajiformes) are oviparous elasmobranchs and tagging studies have generally shown that there are no large-scale movements. Juveniles in particular are considered to be very site-specific. Hence, unless contradictory biological information exists, most skate species could be managed on a regional basis. Therefore information on the skate fauna for the main regions around Europe is given below:

Barents Sea (ICES sub-area I)

Eight skate species are reported for the Barents Sea, namely *Amblyraja hyperborea, A. radiata, Bathyraja spinicauda, Dipturus batis, D. oxyrhynchus, Leucoraja fullonica, Rajella fyllae,* and *Dipturus linteus* (Dolgov *et al*., 2002).

Norwegian Sea (ICES Sub-area II)

Amblyraja hyperborean, A. radiata, Bathyraja spinicauda, Dipturus batis, D. linteus and *Rajella fyllae* all occur in the Norwegian Sea (Skjaeraasen & Bergstad, 2000,2001).

North Sea (ICES sub-area IV)

Within the southern and central North Sea, the major skate species are *Raja clavata, R. montagui* and, to a lesser extent, *R. brachyura*, and these species are most common in ICES Divisions IV b-c. All these three species are taken in commercial fisheries. *Amblyraja radiata* is a northerly species and is most abundant in the north and central North Sea, although this species is of negligible importance to commercial fisheries. *Leucoraja naevus* is more abundant in the north-western North Sea (ICES Division IVa). Other skate species that occur occasionally in the northern North Sea include *L. circularis* and *Dipturus batis*. All species are taken in commercial fisheries. Those skates that are most abundant in the northern North Sea also tend to be abundant off

North-west Scotland (ICES Division VI a) and it may be that the appropriate management unit is based on VIa and IVa. Within the deeper waters of the Norwegian Trench and Skagerrak, the skate fauna is different to other parts of the North Sea, with *Dipturus linteus* an important component of Danish fisheries.

Irish Sea, Celtic Sea and Channel (ICES sub-area VII)

Within the shelf waters of the Channel, Bristol Channel and Irish Sea, major skate species include *R. clavata, R. montagui* and, to a lesser extent, *R. brachyura*. Several skate species tend to have restricted distributions in this region, notably *R. microocellata,* which is a dominant species in the Bristol Channel, and *R. undulata,* which is rarely recorded north of the Channel. *L. naevus* is most abundant in the western Channel, Irish Sea, Celtic Sea, and is less common in the inner parts of the Bristol Channel and eastern Channel. Further offshore in the Celtic Sea (VIIe-k), *L. fullonica, L. circularis*, *D. batis, D. oxyrinchus* may be found. All species are commercially landed.

North-west Scotland (ICES sub-area VI)

The dominant species off North-west Scotland, as indicated from survey data, are *R. montagui* and *L. naevus.* Species that are occasionally caught include *L. ciruclaris* and *D. batis*.

Bay of Biscay (ICES sub-area VIIIa, b and d)

Several skate species occur, the main ones are *Leucoraja naevus*, *L. fullonica, R. montagui* and *Raja clavata*. Survey data for other areas within the Bay of Biscay (ICES Divisions VIIIa, b and d) were not available to the group, and so the allocation of species from these areas into potential management units could not be addressed.

Atlantic Iberian coastal waters (ICES Division VIIIc and IXa)

Several skate species occur, and are landed from Iberian coastal waters (VIIIc and IXa), including *R. clavata, R. miraletus, R. brachyura, R. montagui, R. undulata* and *Leucoraja naevus*. *Rostroraja alba* may also be taken in these waters, although it has declined further north (Dulvy *et al.*, 2000).

Mediterranean

Fifteen species of skate occur in the Mediterranean Sea (*Dipturus batis, D. oxyrhynchus, Leucoraja circularis, L. fullonica, L. melitensis, L. naevus, Raja asterias, R. brachyura, R. clavata, R. miraletus, R. montagui, R. polystigma, R. radula, R. undulata* and *Rostroraja alba*), including several species of Atlantic skate that are distributed in the western Mediterranean only, with fewer species occurring in the eastern Mediterranean. As in Atlantic regions, the genus *Raja* dominates in coastal waters, with *Leucoraja* spp. and *Dipturus* spp. abundant further offshore. For example, Italian fisheries operating in deep-waters (350-800 m) take *D. batis, D. oxyrinchus,* and *L. circularis*. There are two endemic skates present: the Maltese ray and speckled ray). For *Raja asterias*, a nursery ground in the Tyrrhenian sea was reported (Abella *et al.*, 1997).

Deep-water skates

Several genera of skate (e.g. *Bathyraja* spp., *Rajella* spp., *Malacoraja* spp. and *Neoraja* spp.) occur in the deep waters of the Northeast Atlantic, and insufficient data are available to accurately ascertain the distribution and relative abundance of these species. Furthermore, the taxonomy is problematic for certain genera, which has implications for market sampling. The main species in Community waters are *Bathyraja richardsonii, Neoraja caerulaea, Dipturus batis, Dipturus nidarosiensis, Dipturus oxyrinchus, Leucoraja circularis, Leucoraja fullonica, Rajella bathyphilla, Rajella bigelow* and *Rajella fyllae.*

Other areas

Skates (Rajiformes) are one of the most speciose orders of elasmobranch fishes and although there are taxonomic patterns in their biogeographical distribution, with some genera restricted to certain ocean basins, the order as a whole is represented throughout the world. As many species have relatively restricted distributions, EU fisheries in other parts of the world would be able to manage stocks on a regional basis. It must be stressed, however, that skate taxonomy is problematic for many regions, especially in deep water.

As with most fish stocks, the degree of separation between Atlantic and Mediterranean is unclear. Furthermore, many of the species involved are widespread in sub-tropical and tropical waters and, are distributed along the western sea board of Africa. It is not currently possible to define the stock status of these species, due to the paucity of data. For practical reasons, separate management units could be applied for Mediterranean and Atlantic populations. The role of African waters for these species is likely to be significant and management would, therefore, have to take this into consideration.

Management units: Unless contradictory biological information exists, most skate species could be managed on a regional basis. Based on information available to the sub-group at the time of writing, Figure 5.1 presents data on skate distributions. Many gaps exist in knowledge of skate distributions, and the process of updating this information is ongoing. However it can be seen from this figure that the distributions of most species is similar among ICES Sub-areas and patterns are recognisable down the columns. Therefore, the sub-group recommends the following management units for skates in the Northeast Atlantic:

- Barents Sea and Norwegian Sea (I and II)
- North Sea, Skagerrak, Kattegat and eastern Channel (III and IV and VIId)

- Iceland (Va)
- Faeroes (Vb)
- West of Scotland (VIa)
- Rockall Plateau (VIb)
- Irish Sea and Bristol Channel (VIIa and VIIf)
- West of Ireland (VIIb,c,j and k)
- Celtic Sea, western Channel (VIIe,g and h)
- Bay of Biscay (VIIIa,b and d)
- Iberian coastal waters (VIIIc and IXa)
- Azores (X)
- Mid-Atlantic Ridge and East Greenland (XII and XIVb).

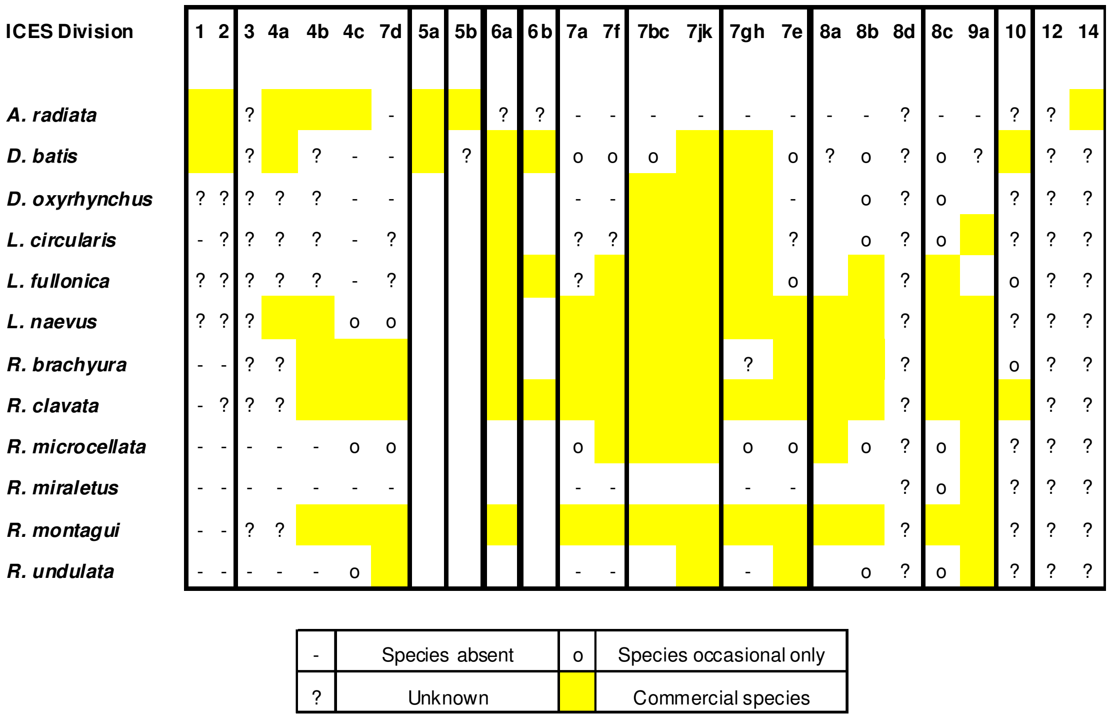

Figure 5.1. - Skate distribution by ICES Sub-area or Division, and proposed management areas (enclosed in borders) for skates in the Northeast Atlantic.

	W.Med	Gulf of Lion	Tyr.Sea	Adriatic	Ionian	Aegean	Turkey	Black Sea
	1.1	1.2	1.3	2.1	2.2	3.1	3.2	4
Dipturus batis	o	o		o			?	-
D. oxyrhynchus	o			o			?	-
L. circularis	o	o		o			?	-
L. fullonica		?		o	o	o	?	-
L. melitensis	?	?		?		o	?	-
L. naevus			o				?	-
R. asterias							?	-
R. brachyura		?					?	-
R. clavata							?	
R. miraletus							?	-
R. montagui							?	-
R. polystigma							?	-
R. radula	?	?	o				?	-
R. undulata		?	?	?	o	o	?	-
R. alba	o	?	o	?	o	o	?	-

-	Species absent
?	Unknown
o	Species occasional only
	Commercial species

Figure 5.2. - Skate distribution by GFCM Sub-area, and proposed management areas (enclosed in borders) for skates in the Mediterranean.

In the Mediterranean (Figure 5.2) the following management units are suggested by the sub-group:

- Western Mediterranean, Sub-areas 1.1, 1.2 and 1.3
- Central Mediterranean, Sub-areas 2.1 and 2.2
- Eastern Mediterranean, 3.1 and 3.2
- Black Sea, Area 4

Leafscale gulper shark *Centrophorus squamosus*

Stock units: There is a lack of data that can accurately identify any different stocks. In the absence of any evidence of stock separation DELASS assumed that there is a single stock in the Northeast Atlantic (Heessen, 2003).

Management Units: Northeast Atlantic (Division Vb, Sub-areas VI, VII, VIII and Hatton Bank (part of VI and XII). Mid-Atlantic Ridge (Part of sub-areas XIV, XII and Division Va. Separate management units in Division IXa, X (Azores) and CECAF 34.1 (STECF, 2002).

Gulper shark *Centrophorus granulosus*

Stock units: The sub-group considers that this species is mainly distributed in the slope waters of the Iberian peninsula, being very infrequently encountered further north. A single stock could be considered to reside in this area. It is an infrequent by-catch in epibathyal and bathyal fishing grounds Sicily Straits and Ionian Sea (FAO statistical sub-area 2.2). Also caught in sub-area 1.1 (Guallart, 1999).

Management units: Separate management areas in VIII and IX. Separate unit in the Mediterranean Sea.

Portuguese dogfish *Centroscymnus coelolepis*

Stock units: There is a lack of data that can accurately identify any different stocks. In the absence of any evidence of stock separation DELASS assumed that there is a single stock in the Northeast Atlantic (Heessen, 2003). Some preliminary morphological analysis of the species in the Mediterranean, sustains the hypothesis that Mediterranean and Atlantic populations are isolated. Furthermore the Strait of Gibraltar is an effective barrier to movements of this species.

Management units: Northeast Atlantic (Division Vb, Sub-areas VI, VII, VIII and Hatton Bank (part of VI and XII)). Mid-Atlantic Ridge (Part of sub-areas XIV, XII and Divisioin Va). Separate management units in Division IXa, X (Azores) and CECAF 34.1. Separate unit also for Mediterranean Sea.

Kitefin shark *Dalatias licha*

Stock units: There is a lack of data that can accurately identify any different stocks of *D. lich*a. In the absence of any evidence of stock separation DELASS assumed the Azorean stock to be a discrete population.

Management units: Northeast Atlantic (Division Vb, Sub-areas VI, VII, VIII and Hatton Bank (part of VI and XII)). Mid-Atlantic Ridge (Part of sub-areas XIV, XII and Divisioin Va). Separate management units in Division IXa, X (Azores) and CECAF 34.1. Mediterrean is considered as a separate managemnt unit.

Lesser spotted dogfish *Scyliorhinus canicula*

Stock units: Available data led DELASS to assume that separate stocks reside in separate ICES Divisions and that immigration and emigration from adjacent populations are either insignificant or on a par (Heessen, 2003).

Management units: It appears that *S. canicula* populations would best be managed as local populations (e.g. on the level of an ICES division).

Angelsharks *Squatina* spp.

Stock units: Throughout its European range angelsharks are now very rare. At present very rare in most of the Mediterranean coasts of the western basin, possibly, more abundant in the eastern basin and along north African coasts.

1.1.1.1. **Management units:** These species should be managed on smallest possible spatial scale.

Guitarfish Rhinobatidae

Stock units: At present very rare along most of Mediterranean coasts of the western basin, possibly, more abundant in the eastern basin and along north African coasts, where there are fisheries.

1.1.1.2. **Management units:** These species should be managed on smallest possible spatial scale.

Carcharhinus spp.

In Mediterranean waters the genus *Carcharhinus* is represented by 7 different species (taxonomic problems possibly exist for the species), many of which occur primarily in the western parts, close to the Gibraltar Straits (FAO statistical sub-area 1.1) and North African coasts (Table 5.1). This genus contains several coastal and oceanic species, and they are often taken as by-catch. In Lybia they can sometimes be considered as target species. Management units are suggested for all species known to occur in the Mediterranean, except for the blacktip shark *C. limbatus*, which is a Lessepsian migrant (i.e. had invaded the eastern Mediterranean from the Red Sea) and not native to EC waters (Branstetter, 1984; Hemida and Labidi, 2002; Ben-Tuvia, 1978; Golani, 1998).

Stock units: Sandbar shark (*Carcharhinus plumbeus*) is one of the most widely distributed members of this genus in the Mediterranean, and it has important nursery grounds in certain areas (e.g. in sub-area 3.1).

Management units: As a preliminary measure the sub-group proposes three separate management, units viz. FAO statistical areas 1, 2 and 3. The sub-group further points out that special management measures should be considered within these areas, to take account of local biological situations.

Stock units: Spinner shark *Carcharhinus brevipinna* and blacktip shark *C. limbatus* are both widely distributed throughout the Mediterranean, although they may be more common along the coasts of North Africa.

Management units: The suggested management unit is the Mediterranean. Northeast Atlantic populations are south of the ICES area.

Stock units: Bignose shark *Carcharhinus altimus,* copper shark *C. brachyurus*, and dusky shark *C. obscurus* are all species that occur in the Northeast Atlantic and western Mediterranean, although occasional specimens are recorded from eastern Mediterranean basins.

Management units: Each of these species should be managed for the Northeast Atlantic, including the Mediterranean.

Stock units: Silky shark *Carcharhinus falciformis* is an oceanic species that is occasionally reported from the Mediterranean and off Spain.

Management units: This species should be managed as a North Atlantic population, which includes the Mediterranean.

Table 5.1 - *Carcharhinus* spp. occurring in the Mediterranean and adjacent waters.

	Branstetter	FishBase	Hemida &	Comments
Bignose shark *Carcharhinus altimus*	-	✓	✓	Widely distributed in tropical, sub-tropical and warm temperate waters along the continental shelves of the Atlantic, Indian and Pacific Oceans, with occasional specimens in the western Mediterranean
Copper shark *Carcharhinus brachyurus*	-	✓	✓	Widely distributed in tropical, sub-tropical and warm temperate waters along the continental shelves of the Atlantic, Indian and Pacific Oceans. Occurs in the western Mediterranean, with occasional specimens in eastern Mediterranean basins
Spinner shark *Carcharhinus brevipinna*	✓	✓	✓	Widely distributed in tropical, sub-tropical and warm temperate waters along the continental shelves of the Atlantic and Indo-west Pacific. Occurs throughout the Mediterranean, primarily along the North African coast
Silky shark *Carcharhinus falciformis*	?	-	✓	Oceanic species that is widely distributed in tropical and sub-tropical coastal and oceanic waters of the Atlantic, Indian and Pacific Oceans, occurs occasionally in the Mediterranean
Bull shark *Carcharhinus leucas*	?	-	-	Large coastal species that is widely distributed in tropical, sub-tropical and warm temperate waters along the continental shelves of the Atlantic, Indian and Pacific Oceans. Although it is reported from the Atlantic coast of Morocco, there are no confirmed records from the Mediterranean or ICES area
Blacktip shark	✓	✓	✓	Widely distributed in tropical, sub-tropical and warm temperate waters along the continental shelves of the

Carcharhinus limbatus				Atlantic, Indian and Pacific Oceans, including the Mediterranean
Oceanic whitetip shark *Carcharhinus longimanus*	?	-	-	Oceanic species that is widely distributed in tropical and sub-tropical oceanic waters of the Atlantic, Indian and Pacific Oceans. No confirmed records from the Mediterranean
Blacktip reef shark *Carcharhinus melanopterus*	✓	✓	✓	Widely distributed in tropical and sub-tropical coastal waters of Indian and western and Central Pacific Oceans, also occurs in the eastern Mediterranean, where it is a Lessepsian migrant from the Red Sea
Dusky shark *Carcharhinus obscurus*	✓	✓	✓	Widely distributed in tropical, sub-tropical and warm temperate waters along the continental shelves of the Atlantic, Indian and Pacific Oceans, with occasional specimens in the western Mediterranean
Sandbar shark *Carcharhinus plumbeus*	✓	✓	✓	Widely distributed in tropical, sub-tropical and warm temperate waters along the continental shelves of the Atlantic, Indian and Pacific Oceans. Occurs throughout the Mediterranean

Bigeye thresher shark *Alopias superciliosus*

Stock units: This pelagic species is widely distributed in offshore waters and is likely to comprise either a single North Atlantic stock or separate Northeast and Northwest Atlantic stocks, although data are insufficient to establish which. It is very rare in Mediterranean waters except in the Gibraltar Straits area (FAO statistical sub-area 1.1) where it is a common by-catch in sword fish fisheries. Aggregations of gravid females were described in this area, and it may be a pupping and nursery ground (Moreno & Morón, 1992).

Management units: Single management unit for Northeast Atlantic (ICES area). Separate management for Mediterranean Sea.

Longnose spurdog *Squalus blainvillei*

Stock units: In the Atlantic mainly distributed in Sub-areas VIII and IX. In Mediterranean found in both west and eastern areas.

Management units: ICES Sub-areas VIII and IX as a management unit. Two separate management units in western and eastern Mediterranean Sea. Black Sea a separate management unit.

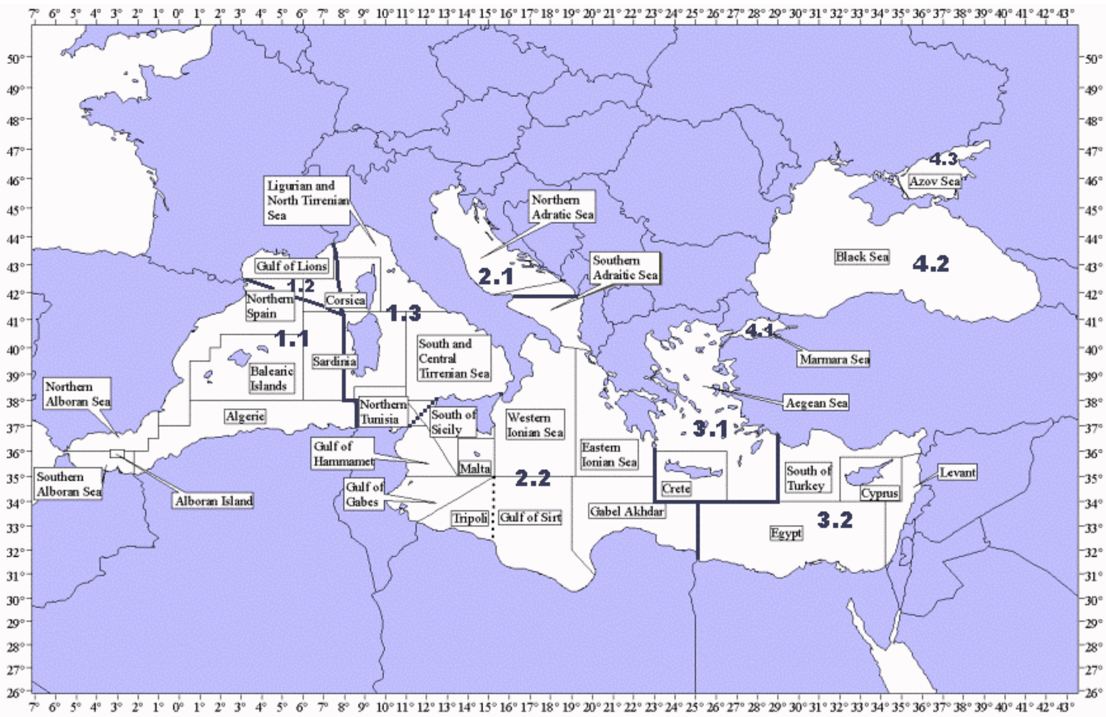

Figure 5.3. - FAO Statistical sub-areas in the Mediterranean Sea.

5.2.2 Non-Community waters

Western Indian Ocean

The following species are found in this area:

- oceanic shark (*Carcharhinus longimanus*)
- blue shark (*Prionace glauca*)
- silky sharks (*Carcharhinus falciformis*)
- mako shark (*Isurus oxyrinchus*)
- hammerheads (*Sphyrna* spp.)
- thresher sharks (*Alopias* spp.)
- manta rays (*Manta birostris* and *Mobula* spp.)
- pelagic stingrays (*Pteroplatytrygon violacea*)

Management units: For widely migratory pelagic sharks the sub-group recommends a single management unit for the western Indian Ocean.

Southern Ocean

The sharks and skates recorded by CCAMLR in the Southern Ocean fisheries are the following:

- Eaton's skate (*Bathyraja eatoni*)
- darkbelly skate (*Bathyraja meridionalis*)
- Murray's skate (*Bathyraja murrayi*)
- *Bathyraja* spp.
- Antarctic starry ray (*Raja georgiana*)
- *Raja* spp.
- sleeper sharks (*Somnisous* spp.)
- Porbeagle (*Lamna nasus*)

Management units: General considerations for management units for fisheries outside community waters:

(a) Coastal and shelf fisheries: Shelf stocks should be managed at either national or regional level, depending on the biogeographical distribution of the species in question. Particular caution should be supported for several groups of coastal species, specifically angelsharks (Squatinidae), guitarfishes (Rhinobatidae) and sawfishes (Pristidae), as these are considered vulnerable species for which much of their population overlaps with areas of human activity and have a history of local depletion.

(b) Deep-sea fisheries: Deep-sea fisheries should be managed on a regional basis, although it must be stressed that topographic features, such as sea mounts and trenches may have some either endemic species or aggregations of species and some more site-specific management may be required. If there is evidence of isolated populations on sea mounts or in trenches, then these should be treated as separate management units.

(c) Oceanic species: Pelagic species that are wide ranging in ocean basins should be managed on this spatial scale, with national and regional bodies involved in management processes, especially with regards to high seas fisheries.

5.3 Abundance trends and stock status of the 9 DELASS species

Latest information on stock abundance will be available from ICES later in 2003, when the report of WGEF of its meeting in April 2003 is available. Considerable progress has been made in making input data available for stock assessment of elasmobranch species. The application of several stock assessment models to the 9 case study species from the DELASS project and the data that are available for these species provided a preliminary basis for information on stock status. The sufficiency of available data, the usefulness of the methods applied and the status of the stocks are summarised below for the 9 species (Heessen, 2003):

Spurdog – Data are sufficient, though Scottish market sampling and Norwegian survey data series are now also have become available to be used in the assessment. The VPA based on data from the length-slicing method, and the Bayesian stock production model further developed in Hammond and Ellis (2002), have utilised the available data. The stock of spurdog in the Northeast Atlantic is estimated to be severely depleted. The Bayesian method suggests that the stock is depleted to 6% of virgin biomass, the frequentist approach suggests that the spurdog stock is at 39% of carrying capacity.

Lesser-spotted dogfish – The CPUE series available are sufficient for the surplus production models as applied (Rodríguez Cabello *et al.* 2002). Better data on growth, mortality and on total catches would be beneficial. The assessment indicates an increase in the stock of lesser-spotted dogfish in the Cantabrian Sea. Possible explanations for this increase in abundance of lesser-spotted dogfish is the tradition of dumping most of the catch alive, plus the fact that other discarded fish might be providing additional food sources to the dogfish (Olaso *et al.* 1998; Olaso *et al.* 2002). The lack of landings and discard data in all ICES areas is a particular impediment to the application of assessments to other areas.

Blue shark – ICCAT collects and collates catch and landings statistics for this species, but these data are not fully compiled at present. The results of the applied life table method might be useful to construct informative priors of parameters for surplus production models. Stock status of blue shark in the North Atlantic is unknown, though newly available unstandardised CPUE from the Irish sport fishery displays a strong decline in abundance to lowest levels in the series (Fitzmaurice *et al.*, 2003), see also Figure 2.1.12.

Portuguese dogfish – CPUE for this species and leafscale gulper shark indicate a decline in abundance in V, VI and VII. However, accurate landings data for this species are missing, and the biology and lifecycle are different from the leafscale gulper shark, and therefore these species should be monitored and assessed separately.

Leafscale gulper shark CPUE for this species and leafscale gulper shark indicate a decline in abundance in V, VI and VII. However, accurate landings data for this species are missing, and the biology and lifecycle are different from the Portuguese dogfish, and therefore these species should be monitored and assessed separately.

Kitefin shark – The assessment indicates a strong decline in biomass which may suggest local depletion.

Thornback ray – Available survey data are of reasonably good quality (but need screening for earlier years). The applied two-stage GLM approach seems relevant for the analysis of survey data for rarely caught species with a clustered distribution pattern. Distribution area and abundance for thornback ray have severely decreased, even though there are still patches left in the North Sea with apparently stable local populations.

Cuckoo ray – Catch data are only available for France, and may be insufficient for the assessment. Various methods were applied, but more work should be done before conclusions about usefulness of particular models can be drawn. The methods gave different answers about stock status, though the stock of cuckoo ray in the Celtic Sea has recently shown signs of increase and then decrease.

5.4 Stock assessment methods

The DELASS project dealt extensively with appropriate assessment methodologies for elasmobranchs (Heessen, 2003). Graphical overviews of the main characteristics of different model types are presented in Figure 5.4. Input variables are given in Table 5.4.1, with output variables given in Table 5.4.2. Software implementations of the methods are presented in Table 5.4.3, The main points about stock assessment of elasmobranchs can be summarised as follows:

- When CPUE data (in biomass) are available, either biomass dynamic models, depletion models or delay-difference models can be used. The latter seem promising candidates for assessing elasmobranch stocks because they allow explicit definition of sub-models for growth, survival and recruitment (Walker 1995). Delay-difference models allow for the possibility to estimate a number of parameters in the model, while presenting other parameters as input, based on e.g. external analysis. There is a need to develop this category of models into more formalized software, instead of the current ad-hoc solutions.

- Length based catch-data can be used to estimate growth rates directly, and can also be used to generate age-distributions if some assumptions are made on growth rates. Stock assessment models can be structured on length in several ways:

  - Catch at size analysis (Sullivan *et al.* 1990),

  - Seasonal or non-seasonal length converted catch curves (needs growth parameters as input),

  - Length structured VPA.

- The latter two are readily available in software. Age-based catch data can be used directly for catch curve analysis or separable VPA analysis for which no external tuning information is needed. Tuned VPA or statistical catch at age models are also described, but these are not likely to be used for elasmobranch assessments.

- Survey only models may present a useful assessment methodology for elasmobranchs since the majority of data on elasmobranch species has been collected during research surveys. Several approaches have been described, ranging from simple swept-area estimates to separable stock trend analysis based on survey data.

- Life table models based on the Leslie matrix approach have been used on several occasions for elasmobranch species. These methods are easy to program and require the types of data that are most often available (e.g. general information on reproduction, number of eggs per female, etc). It is not straightforward to estimate the parameters for the Leslie matrix models directly from the data and the validation of the model results may also be problematic.

- Finally, there is a discussion of Bayesian approaches to stock assessment models in general. This is a different approach to parameter estimation and dealing with uncertainty, rather than a fixed set of models. As such, Bayesian approaches can be applied to most of the models mentioned in this report. For application to elasmobranch assessment, the strong points of Bayesian approaches is that these can use information on similar species or species-groups to derive parameter estimates for the groups we are looking at. Also, the method of meta-analysis can yield relevant information for those parameters that we cannot estimate directly with the data available.

Although a large number of methods have been presented, still other approaches could be explored. An example is presented in the ICES Working Group on marine mammals (ICES 1999b) where instead of a purely quantitative analysis, the approach is more based on qualitative differences between different life-history characteristics and how these work out on a population or ecosystem level.

One of the major problems in setting up stock assessments for elasmobranch species is the availability of data by species. In particular, data from market sampling programmes will often only have landing data by species groups (e.g. rays, sharks) rather than separated by species. As a possible solution to this problem it has been suggested to use survey species composition data to split up the landings-data. This could also be used to extend the historical survey catch composition.

Table 5.4.1 – Input variables needed for different assessment methods.

Input																																								
Class	**Method/model**	Catch at length Numbers)	Catch at age (numbers)	Yield (biomass)	Yield (numbers)	Survey/CPUE at length	Survey/CPUE at age	CPUE (biomass)	CPUE (numers)	Fishing effort	Initial (virgin) biomass (B0)	Initial stock structure	Maximum length (Linf)	Growth rate (K)	Theoretical age at zero length, t(0)	Seasonal growth parameters	Length-weight parameters	Growth increment data	Mark recapture data (numbers)	Length frequency data	Manual selection of cohorts	Number of age-groups and mean length	Population growth rate parameters	Natural mortality (M)	Recruitment index	Assumed recruitment	Proportion of initial stock size to virgin stock	Assumed terminal F	Age at full selection	Selection at oldest true age	Weight at age in catch	Weight at age in stock	Natural mortality	Maturity at age	Several tuning options	Gear efficiency	Sampled area	Total survey area	Fecundity	Survival rate
Biomass dynamic models	Biomass dynamic model			x				x			o																x													
Depletion model	modified deLury model			x	o																			x	x		x				x									
Delay difference	Delay difference model			x				x															x			o							x							
Mark-recapture data	Gulland and Holt method												o					x																						
	Fabens method												o					x																						
	Munro's method												o					x																						
	Appeldoorn's method																	x																						
	Gulland's single experiment method									x									x																					
	Robson and Seber's method									x									x																					
	Hilborn's method									x									x																					
	Jolly Seber's method																		x																					
Length based methods	non-seasonal growth curves																			x																				
	seasonal growth curves																			x																				
	Batthacharya's method																			x	x																			
	NORMSEP																			x		x																		
	Length converted catch curve	x											x	x	o	o																								
	Length based VPA	x											x	x		o	o							x				x												
	Catch at size analysis (CASA)	x				o			o				o	o																										
Age based methods	age based catch curve		x																														o							
	VPA / cohort analysis		x	x																								x			o	o	x	o						
	Separable VPA		x	x																								x	x	x	o	o	x	o						
	Ad-hoc tuned VPA		x	x			x		x																						x	x	x	x	x					
	XSA		x	x			x		x																						x	x	x	x	x					
	ICA		x	x			x	x	x																				x	x	x	x	x	x	x					
	ADAPT		x	x			x	x	x																						x	x		x	x					
Survey only methods	Linear modelling of survey indices						x																																	
	Separable stock trend analysis						x																						x	x		x	x	x	x					
	Swept area estimates	o	x																																	x	x	x		
Life table methods	Time invariant models											x																											x	x
	Time variant models											x																											x	x
	Density dependent models											x																											x	x
Bayesian approaches																																								

Table 5.4.2 Output variables from different assessment methods.

		Output																											
Class	**Method/model**	stock numbers at age	stock numers at length	total stock size (biomass)	total stock size (numbers)	Initial stock size (biomass)	Initial recruitment	SSB	fishing mortality at age	fishing mortality at length	total fishing mortality	total survival rate (S)	total mortality (Z)	Tag reporting rate	Maximum length, L(inf)	Growth rate (K)	Theoretical age at zero length, t(0)	Seasonal growth parameters	Mean length	Population growth rate parameters	Stock-recruitment parameters	catchability (q)	Carrying capacity (K)	Replacement yield	MSY	Selection at age	fitted CPUE	relative recruitment	net reproduction
Biomass dynamic models	*Biomass dynamic model*			x																					x				
Depletion model	*modified deLury model*			x																		x	x	x					
Delay difference	*Delay difference model*					x	x					x									x	x							
Mark-recapture data	*Gulland and Holt method*														o	x													
	Fabens method														o	x													
	Munro's method														o	x													
	Appeldoorn's method														x	x		x											
	Gulland's single experiment method										x		x																
	Robson and Seber's method										x	x																	
	Hilborn's method										x		x	x															
	Jolly Seber's method				x							x																	
Length based methods	*non-seasonal growth curves*														x	x	x												
	seasonal growth curves														x	x	x	x											
	Batthacharya's method	x			x														x										
	NORMSEP	x			x																								
	Length converted catch curve										x		x																
	Length based VPA		x							x																			
	Catch at size analysis (CASA)		x							x																			
Age based methods	*age based catch curve*										o		x																
	VPA / cohort analysis	x		o				o	x																				
	Separable VPA	x		o				o	x																				
	Ad-hoc tuned VPA	x		x				x	x													x							
	XSA	x		x				x	x													x							
	ICA	x		x				x	x													x				x			
	ADAPT	x		x				x	x													x							
Survey only methods	*Linear modelling of survey indices*												x														x	x	
	Separable stock trend analysis	x		x				x	x																		x	x	
	Swept area estimates	x	o									x																	
Life table methods	*Time invariant models*		x																	x									x
	Time variant models		x																	x									x
	Density dependent models		x																	x									x
Bayesian approaches																													

Figure 5.4 Flow-chart of assessment methods (partly after Gayanilo *et al.* 1997).

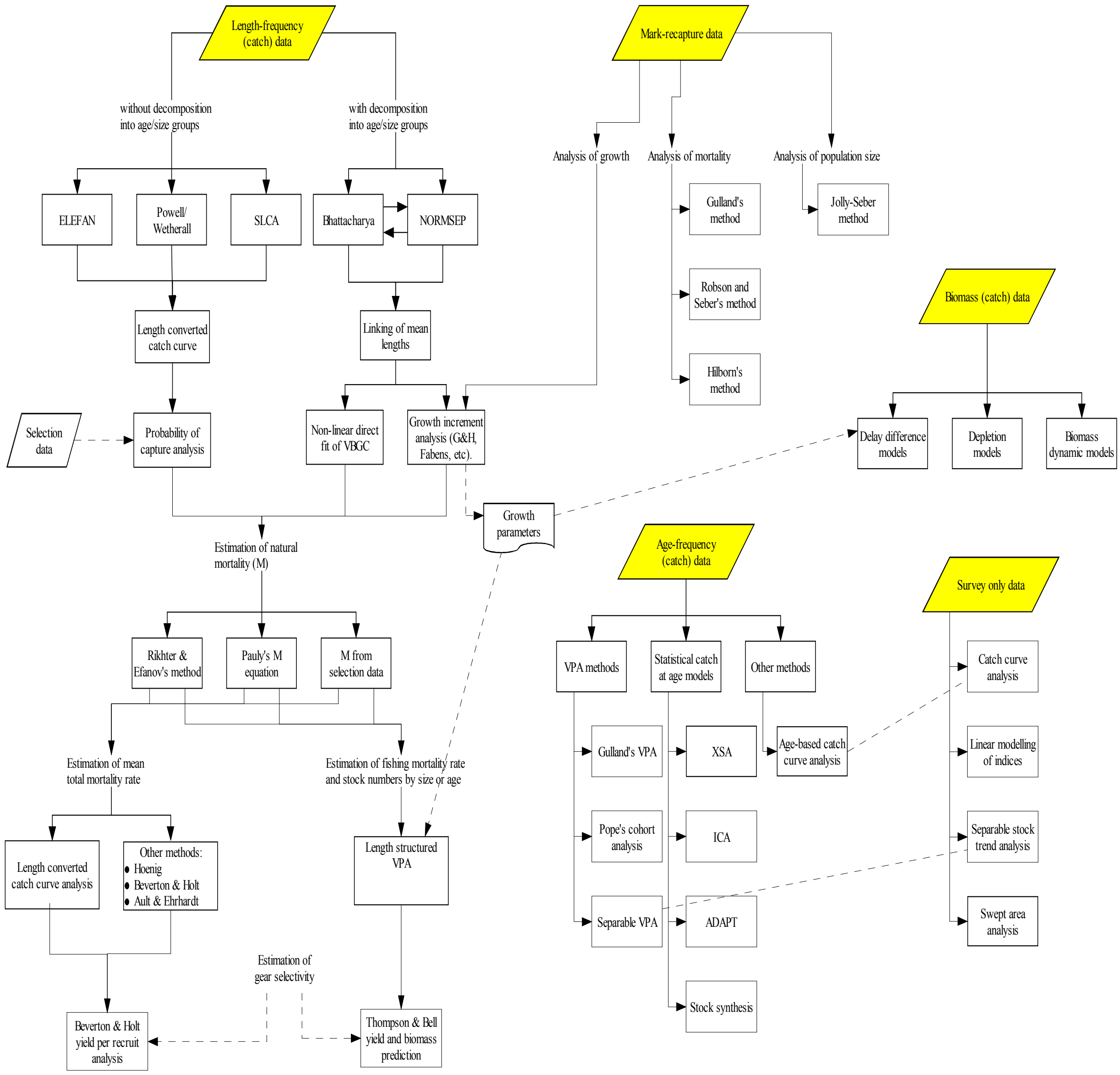

Table 5.4.3. Software implementations for different assessment methods.

		Software											
Class	**Method/model**	ASPIC	CEDA	GENEST	FISAT	LFDA	Lowestoft assessment suite	ICA package	ADAPT package	Stock synthesis package	Compiled Fortran program	Spreadsheet programmable	WinBugs
Biomass dynamic models	Biomass dynamic model	x	x										
Depletion model	modified deLury model		x										
Delay difference	Delay difference model			x								x	
Mark-recapture data	Gulland and Holt method				x								
	Fabens method				x								
	Munro's method				x								
	Appeldoorn's method				x								
	Gulland's single experiment method												
	Robson and Seber's method												
	Hilborn's method												
	Jolly Seber's method												
Length based methods	non-seasonal growth curves				x	x							
	seasonal growth curves				x	x							
	Batthacharya's method				x								
	NORMSEP				x								
	Length converted catch curve				x							x	
	Length based VPA				x								
	Catch at size analysis (CASA)										x		
Age based methods	age based catch curve				x							x	
	VPA / cohort analysis						x						
	Separable VPA						x						
	Ad-hoc tuned VPA						x						
	XSA						x						
	ICA							x					
	ADAPT								x				
Survey only methods	Linear modelling of survey indices										x	x	
	Separable stock trend analysis										x	x	
	Swept area estimates											x	
Life table methods	Time invariant models											x	
	Time variant models											x	
	Density dependent models											x	
Bayesian approaches													x

5.5 Data requirements

The sub-group provided detailed comments on data requirements, including suggestions on improvements to the Data Collection Regulation in the report of its first meeting (STECF, 2002). SGRN at its recent (2003) mid-term review of the Data Collection Regulation recommended a series of changes to the list of species for which catch and landings data must be collected.

This group endorses the recommendations of SGRN that species-specific catch and landings data be collected for the following species:

- Blue shark *Prionace glauca* in the entire ICCAT area
- Mako shark *Isurus oxyrynchus* in the entire ICCAT area
- Porbeagle *Lamna nasus* in the entire ICCAT area
- Species within the family Squalidae in the NAFO area
- Species of deepwater sharks which are subject to management under Council Regulations (EC) No 2340/2002 and No 2347/2002 [2]

The sub-group continues to be concerned with the poor quality of catch statistics for elasmobranchs from member States. A particular difficulty is the use of generic categories for species, such as “Sharks not elsewhere indicated” and “dogfish and hounds” for example. The sub-group recommends that sampling in the markets be extended in order to disaggregate mixed landings. Furthermore, for species that are reported separately within member states, it is recommended that these be reported to ICES and ICCAT at the same specific resolution.

With regard to future assessments of elasmobranchs in the ICES area, the main data requirements by species are as follows:

Spurdog (Atlantic and Mediterranean)

- Landings of spurdog should be monitored quarterly by fishing technique and by ICES/NAFO/GFCM Sub-area in the minimum programme. Data on the size distribution and sex ratio are also required. Hence, sample sizes should be comprised of 50-200 fish, and some of the current sampling levels (e.g. <25 fish in the North Sea) are insufficient.

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[2] COUNCIL REGULATION (EC) No 2340/2002 of 16 December 2002 fixing for 2003 and 2004 the fishing opportunities for deep-sea fish stocks. OJ L 356, 31.12.2002, p.1.

COUNCIL REGULATION (EC) No 2347/2002 of 16 December 2002 establishing specific access requirements and associated conditions applicable to fishing for deep-sea stocks. OJ L3351, 28.12.2002, p.6.

- Landings of spurdog should not be reported as "dogfishes" or as other generic categories. Landings from Iberian waters, Bay of Biscay and Mediterranean Sea should also be examined in order to determine the relative importance of spurdog *Squalus acanthias* and longnose spurdog *Squalus blainvillei.*

- Age and growth

- Effort data

- Length-frequency for landed and discarded fish

- Quantities and survivorship of discarded fish

- Examination of tagging data sets

Small coastal sharks and miscellaneous elasmobranchs (Atlantic and Mediterranean)

- Species-specific landings data should be collected for all other elasmobranch species and should be monitored yearly and by ICES/NAFO division (Z2) and GFCM Sub-area in the minimum programme.

- Age-length sampling schemes and other biological sampling schemes are not appropriate at the present time, although it is acknowledged that locally important fisheries ought to collect biological information

- Groundfish surveys could provide useful data on the biology of many species, and a programme of data collection would enhance the use of life-history models for species of lower commercial importance.

- Improved estimates of the quantities and survivorship of discarded fish, including from areas outside the Cantabrian Sea

- Length-frequencies for landed and discarded fish

- Examination of tagging data sets to evaluate natural mortality

- Effort data

- Improved species-specific landings data, generic categories should not be used.

- The DELASS assessments were restricted by the short data sets and attempts to extend the data set should be investigated (e.g. the use of historical data).

Blue shark, shortfin mako shark and porbeagle (Atlantic and Mediterranean)

- Landings of these sharks should be monitored quarterly by fishing technique and by ICES/NAFO/GFCM Sub-area and by species in the minimum programme.

- Length-frequency and sex ratio should be recorded for the main fleets, and samples should be ideally be comprised of 50-200 individuals, though this is likely to be impossible for all species. Samples should be collected regularly through the fishing season.

- Further biological sampling from commercial catches was not deemed appropriate, although biological data for these species from the Northeast Atlantic are desirable.

- The sub-group recommends member states to submit to ICCAT complete data on time series of catches (including landings, dead discards and finning data) and associated effort, commercial CPUE or fishery-independent abundance time series estimates, and if possible age and sex disaggregated data on catches.

Deepwater shark species

- Catch and effort data should be collected by ICES statistical rectangle and depth range in order that CPUE data be investigated in a more meaningful way.

- Species-specific landings data should be collected for *Centroscymnus coelolepis, Centrophorus squamosus, Centrophorus granulosus,* and *Somniosus microcephalus.* These species should be monitored yearly by fishing technique and by ICES/NAFO Sub-area in the minimum programme. Landings of other species (including *Centroscyllium fabricii, Etmopterus* spp., *Hexanchus griseus, Dalatias licha, Galeus melastomus* and the various other deep-water elasmobranchs and chimaeroids) should also be recorded on a species-specific basis and be monitored yearly by ICES/NAFO Sub-area in the minimum programme.

- In the Mediterranean *Galeus melastomus*, *Etmopterus* spp. *Centroscymnus coelolepis*, *Deania calceus, Hexanchus griseus* and *Centrophorus granulosus* by GFCM Sub-area.

- Length frequency data, by sex should be collected. Representative samples should be collected regularly through the fishing season.

- The use of research vessel surveys to collect biological information (including length, weight, reproductive biology and age) should be considered, as there is need for information on gestation period, age and growth for these species.

- Historic market sampling data from French catches of deepwater sharks need to be collated.

Skates and rays (Atlantic and Mediterranean)

- Preferably, species-specific landings data would be available for all species. Failing that, the species composition of skate/ray landings should be collected on an appropriate spatio-temporal scale, as opposed to specific landings data for selected species.

- In order to obtain appropriate data, landings of Rajidae should be monitored quarterly by fishing technique and by ICES/NAFO division and GFCM Sub-area in the minimum programme.

- Data on the species composition, size distribution and sex ratio are also required. Hence, sample sizes should be comprised of 100-200 fish in the Atlantic and 50-100 fish in the Mediterranean. Regarding the number of samples that should be taken, the sub-group recommends that samples should be collected regularly throughout the year (e.g. monthly) as opposed to one sample per 200-1000 tonnes landed, as is currently suggested.

- Other biological sampling is also required. The current programme lists several ray species for which length, weight and length at maturity should be assessed every three years. The group thought that this level of sampling was appropriate, although data should be collected for all species of ray. Furthermore, it was recognised that several fisheries only land the pectoral fins of skates, and other fisheries land gutted skates and rays. In the latter case, only the maturity of males can be collected. Given that data on fecundity and length at maturity for females are lacking, it was felt that fecundity be included in sampling programmes, which may require obtaining whole fishes from market sources.

Research vessel surveys

Survey data could be used to examine spatial-temporal changes in distribution and relative abundance for many species of elasmobranchs occurring on the continental shelf. During all surveys special attention must be given to correct species identification. For all elasmobranch species length frequency data should be collected by sex. If possible, data should also be collected on length, weight, maturity, fecundity and possibly age.

Whereas the present routine surveys provide a more or less complete coverage for the shelf species, there are currently no surveys for deep-water or pelagic species, except for the area around the Azores. The use of information on pelagic elasmobranchs from this survey should be investigated.

International surveys for deep-water species in the Northeast Atlantic and Mediterranean should be considered. The need for collaborative international survey efforts can’t be understated. Such work may be possible as part of the MAR-ECO project in the Mid-Atlantic Ridge and the MEDITS project in the Mediterranean Sea, but also in adjacent areas. The possibility of extending the MEDITS project to include also North African countries should be considered.

5.6 Priorities for assessment of status

The current policy drivers for elasmobranchs are fishery managers and conservation organisations. The DELASS project has undertaken exploratory analyses for nine case study species, with these species of varying degrees of commercial importance. These assessments were designed primarily to evaluate the types of assessment that can be undertaken for species with data of varying quality, to support the management of fisheries. Hence, all nine species should still be considered as priorities for further assessment. The following sections discuss some of the elasmobranch species/stocks that could also be considered as priorities for fishery management or conservation oriented assessments.

5.6.1 Priority species for fishery management

Shortfin mako *Isurus oxyrinchus* [North Atlantic]: Shortfin mako is an important by-catch species in pelagic long-line fisheries. It is also a high-value species. It is widely distributed in the North Atlantic and highly migratory. ICES, NMFS, DFO and ICCAT should attempt a joint assessment in the future. ICES landings data for the Northeast Atlantic are reported by Portugal and UK, although Spain and France are known to land mako in significant quantities.

Priority: High (providing that an assessment can be undertaken with ICCAT).

Porbeagle *Lamna nasus* [Northeast Atlantic]: Porbeagle is an important species in pelagic long-line fisheries, and is targeted in some areas. It is also a high-value species. DFO/NMFS have assessed stocks in the Northwest Atlantic. Tagging studies have not shown any transatlantic migrations, and so ICES could attempt an assessment of the Northeast Atlantic stock in the future, although data from ICCAT may be required. Major fishing nations for porbeagle include Norway, Denmark, Spain and France, although Germany, Sweden, Ireland, Iceland, UK, Portugal and the Faeroes all land this species.

Priority: High

Tope *Galeorhinus galeus* [Northeast Atlantic]: Tope is of limited commercial importance in commercial fisheries in the Northeast Atlantic, where it is typically a by-catch of mixed demersal and pelagic fisheries. Elsewhere in the world it is a targeted species, although these would be separate stocks. Within European seas, tope is also important in recreational fisheries. Data may be limited, as landings data are often included as “dogfishes and hounds”. Nevertheless, England and France have species-specific landings data and there are also limited data from Denmark and Ireland in recent years. Biological data for Northeast Atlantic stocks are limited, although this species is well studied elsewhere in the world, especially in the South Atlantic and off Australia. Survey data would also be available, although probably limited.

Priority: Medium

Greenland shark *Somniosus microcephalus* [Northern waters, sub-areas I, II and Greenland]: Greenland shark is fished in northern waters and there is some evidence of declines/local extirpations. This is a large-bodied species and, therefore, potentially vulnerable. Some landings data exist for Iceland, Greenland and Norway. Biological data are scant and survey data are probably not available for this species.

Priority: Low

Lesser spotted dogfish *Scyliorhinus canicula* (Areas other than VIII c) DELASS undertook assessments for this species in the Cantabrian Sea and, although a by-catch of various fisheries further north, it is of some importance in the Bay of Biscay and off the Iberian coast and there may be sufficient data for preliminary assessments for localised areas.

Priority: Low or Medium, depending on region

Starry ray *Amblyraja radiata* (Icelandic waters, Division V]: Not of major importance in the North Sea, where it is often discarded, there are fisheries for this species in the Northwest Atlantic (ongoing assessments) and it is fished in northern waters (e.g. Iceland). Iceland has some species-specific landings data, although there are limited species-specific landings data available from other countries.

Priority: High

Common skate *Dipturus batis:* Nominated by OSPAR for listing as a threatened and declining species. Still landed by French fisheries along the continental slope, and species-specific data have been recorded since 1978. Survey data will be of limited use, also biological information is limited.

Priority: Medium

Smalleyed ray *Raja microocellata* [Bristol Channel, VII f]: Commercially important ray species. Most abundant in Bristol Channel and data are available from RV surveys. Species-specific landings data are very limited, and landings would have to be estimated from species composition. Biological data are also required.

Priority: Medium

Skates and rays *Rajidae* [Iberian coast and Bay of Biscay]: Commercially important ray species landed in mixed fisheries. Biological and commercial fisheries data are required. Studies on species composition from commercial catches indicate that several species are landed, including *Raja clavata, R. miraletus, R. brachyura, R. montagui, R. undulata, Leucoraja naevus* and *L. fullonica*.

Priority: High

Skates and rays *Rajidae* [Irish Sea, Bristol Channel and Celtic Sea, VII a,f,g]: Commercially important ray species landed in mixed fisheries. Studies on species composition from commercial catches indicate that the dominant species landed are *Raja clavata, R. brachyura, R. montagui* and *Leucoraja naevus*. Data are available from RV surveys, although biological and commercial fisheries data are required. Species-specific landings data are limited, although France and Belgium have some species composition data, and total landings would have to be estimated from species composition.

Priority: High

Skates and rays *Rajidae* [Channel VII d,e]: Commercially important ray species landed in mixed fisheries. Studies on species composition from commercial catches indicate that the dominant species landed are *Raja clavata, R. montagui* and, in the western Channel, *Leucoraja naevus*. The latter species was assessed during the DELASS project. Data are available from RV surveys, although biological and commercial fisheries data are required. Species-specific landings data are limited, although France and Belgium have some species composition data, and total landings would have to be estimated from species composition.

Priority: High

Skates and rays *Rajidae* [North Sea, Sub-area IV]: Commercially important ray species landed in mixed fisheries. Studies on species composition from commercial catches indicate that the dominant species landed are *Raja clavata, R. brachyura, R. montagui* and *Leucoraja naevus*. Data are available from RV surveys, although biological and commercial fisheries data are required. Species-specific landings data are limited, although various nations have estimates of species composition.

Priority: High

5.6.2 Priority species for conservation assessment

ICES WGEF has listed (Table 5.6.1) species of elasmobranch fishes which are considered to be of special concern within the ICES area because of their biology, vulnerability, biodiversity importance, unfavourable population status or because they are listed on one or more of the international or regional instruments or conventions listed below (ICES, 2003). ICES may, therefore, be asked by relevant authorities to provide data, stock assessments or management advice for such species, even if they would not be of high priority for ICES assessment because of their low importance in commercial fisheries or because data are lacking.

The rationale for listing these species is divided into Biology, Trends, and Policy/legislation. The first two are self-explanatory, although ‘Trends’ may include information from other regions and comparable data may be lacking in the ICES area. The section on policy/legislation refers to international fisheries and environmental instruments (the UN Fish Stocks Agreement, EU Habitats Directive, Bern Convention, Barcelona Convention, Bonn Convention for the Conservation of Migratory Species (CMS), OSPAR Convention, and Convention on International Trade in Endangered Species) that fall under the remit of a number of other authorities or bodies. These are described in more detail below. The last column provides current or pending IUCN Red List Assessments of the global or regional status for reference purposes. Red List assessments have no legal status, but represent an appraisal of the best available information on the current conservation status of listed species. These assessments are regularly updated by a group of international experts as and when additional data become available. Many species have not yet been evaluated.

Each taxon is assigned to one of three priority levels:

Priority 1: Taxa requiring urgent assessment because of their high conservation importance and/or vulnerability and/or inclusion in international instruments. These species are very likely to be the subject of requests to ICES for information.

Priority 2: Taxa requiring analysis of their status in the ICES area because of conservation concerns. Some of these are a higher conservation priority on a world-wide scale, but the ICES area represents only a small part of their range.

Priority 3: Species of lower priority because they may only occur very rarely in the ICES area, are not listed on any international instrument, or although listed where data indicate that they are of favourable biological status in the ICES area.

Available data have been used for the listed species from their entire range and supported by references from other regions where the taxa have declined. In several cases similar data are not yet available from the ICES area.

Below, some international for a and the legislative background are listed.

Bern Convention: Convention on the Conservation of European Wildlife and Natural Habitats. The aims of this Convention are to conserve wild flora and fauna and their natural habitats, especially those species and habitats whose conservation requires the co-operation of several States, and to promote such co-operation. Particular emphasis is given to endangered and vulnerable species, including endangered and vulnerable migratory species. Appendix II (Strictly protected fauna) lists basking shark *Cetorhinus maximus* and devil ray *Mobula mobular*. Appendix III, which requires "regulation of species populations to keep them out of danger", lists mako shark *Isurus oxyrinchus*, porbeagle shark *Lamna nasus*, blue shark *Prionace glauca*, white skate *Raja (*now *Rostroraja) alba*, and angel shark *Squatina squatina*. Species listed on this Convention may, in time, be added to the EU Habitats Directive (Council Directive 92/43/EEC on the conservation of natural habitats and of wild flora and fauna). This requires measures to be taken to maintain or restore to favorable conservation status in their natural range, habitats and species of wild flora and fauna of Community interest and listed in Annexes to the Directive. The directive includes lists of 623 species for which Member States must consider designation of Special Areas of Conservation (SACs).

CITES: (Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between Governments. All ICES Member States are Party to CITES. Its aim is to ensure that international trade in listed species of wild animals and plants does not threaten the survival of the population. The basking shark *Cetorhinus maximus* is listed on Appendix II, meaning that international trade in its products should be accompanied by permit and a 'no-detriment finding' that states that the harvest of the species is sustainable. This infers the need for a stock assessment to determine sustainable levels of harvest for this species. The white shark *Carcharodon carcharias* is listed on Appendix III by Australia.

OSPAR Convention: The Convention for the Protection of the Marine Environment of the Northeast Atlantic ("OSPAR Convention") was opened for signature at the Ministerial Meeting of the Oslo and Paris Commissions in Paris on 22 September 1992. The OSPAR Convention entered into force on 25 March 1998. It replaces the Oslo and Paris Conventions, but Decisions, Recommendations and all other agreements adopted under those Conventions will continue to be applicable, unaltered in their legal nature, unless they are terminated by new measures adopted under the 1992 OSPAR Convention. Annex V to the OSPAR Convention – on the Protection and Conservation of the Ecosystems and Biological Diversity of the Maritime Area – was adopted in July 1998, together with a Strategy on the Protection and Conservation of the Ecosystems and Biological Diversity of the Maritime Area.

Barcelona Convention for the Protection of the Mediterranean Sea: The Barcelona Convention Protocol concerning specially protected areas and biological diversity in the Mediterranean lists three elasmobranchs (white shark *Carcharodon carcharias*, basking shark *Cetorhinus maximus*, and giant devil ray *Mobula mobular*) in Annex II, Endangered or threatened species. These should receive full protection when the Convention is ratified. Annex III, species whose exploitation is regulated, lists shortfin mako *Isurus oxyrinchus*, porbeagle *Lamna nasus*, blue shark *Prionace glauca*, white skate *Raja* (now *Rostroraja*) *alba*, and angel shark *Squatina squatina*.

The national Focal points for the SPA protocol have recently (June 2003) adopted a Mediterranean Action Plan for the conservation of Cartilaginous fishes, which among other measures, proposed new species for urgent legal protection, (*Pritis spp.; Carcharias Taurus; Odontapsis ferox and Dipturus batis*). The Action Plan recognises an urgent need to assess the threatened status of species such *Sphyrna* spp, *Rhinobatos* spp. and *Raja polystgma*; and proposes a list of species for which management programmes should be developed to ensure their sustainable fisheries The Action Plan will be adopted by the contracting parties of the Barcelona Convention in December 2003.

Bonn Convention on the Conservation of Migratory Species of Wild Animals (CMS): This Convention recognises the need for countries to co-operate in the conservation of animals that migrate across national boundaries or between areas of national jurisdiction and the high seas, if an effective response to threats operating throughout a species' range is to be made. It provides a framework within which Parties may: adopt strict protection measures for migratory species that have been categorised as endangered (listed under Appendix I); or conclude Agreements for the conservation and management of migratory species that have an unfavourable conservation status (listed in Appendix II). The white shark *Carcharodon carcharias* is listed on both Appendix I and II.

The Quinquennial Review of protected species, UK: The Quinquennial Review of the Wildlife and Countryside Act (1981) advises the UK Government on which animals and plants should be legally protected by listing on Schedule 5 (animals) and Schedule 8 (plants) of protected species. The Quinquennial Review considers whether those species that are already protected should remain on the schedules and assesses whether other endangered species (such as those listed in Red Data Books) should be legally protected in order to conserve them. The following species of elasmobranchs have been proposed for addition to Schedule 5; angel shark *Squatina squatina*, common skate *Dipturus batis,* black skate *Dipturus nidarosiensis,* long-nose skate *Dipturus oxyrhinchus* and white skate *Rostroraja alba*.

UK Biodiversity Priority List: The UK developed a priority list for species of conservation concern in 1995 to fulfil their obligations under the Convention of Biological Diversity, 1992. Some of the species listed have been addressed by UK Biodiversity Action Plans (basking shark *Cetorhinus maximus* and common skate *Dipturus batis*), other listed species of concern (blue shark *Prionace glauca*, tope *Galeorhinus galeus* and porbeagle *Lamna nasus*).

UN Agreement on Straddling Fish Stocks and Highly Migratory Fish Stocks: This Agreement, adopted in 1995, facilitates implementation of the UN Convention on the Law of the Sea (UNCLOS) provisions relating to the conservation and management of high seas fish stocks. It has now been ratified and is in force for each State or entity that has ratified or acceded to it. It establishes rules and conservation measures for high seas fishery resources (and is complemented by the FAO Code of Conduct for Responsible Fisheries which sets out principles and international standards of behaviour for responsible practices). Specifically, it calls for Parties to protect marine biodiversity, minimise pollution, monitor fishing levels and stocks, provide accurate reporting of and minimise by-catch 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 these species when scientific uncertainty exists. The Agreement also directs States to pursue co-operation in relation to listed species (including *Hexanchus griseus*, *Cetorhinus maximus*, *Rhincodon typus*, and species of Alopiidae, Carcharhinidae, Sphyrnidae and Lamnidae) through appropriate sub-regional fishery management organisations or arrangements. ICES clearly has a role to play for listed species occurring within its area.

Table 5.6.1 Priority species for conservation status assessment (updated from ICES WGEF 2003).

Taxa	Priority	1.2. Rationale				Comments
		Biology	Trend	Policy/Legislation	IUCN Red List	(IUCN Red List 2000) (Cavanagh et al. 2003)
Bluntnose sixgill *Hexanchus griseus*	**2**	Large, deepwater species. Possibly low 'r'	Other regional populations depleted (no data from NE Atlantic)	UN Fish Stocks Agreement	Near Threatened globally	ICES may be asked for assessments and management advice under UNCLOS (Cook et al. in press)
Spurdog *Squalus acanthias*	**1**	Biologically highly vulnerable (low 'r')	Severely depleted		Near Threatened globally. (Provisional: Vulnerable NE Atlantic)	A commercial species assessed under the DELASS project (Heessen, 2003) and likely to be the subject of continued work by WGEF (Fordham et al. in press)
Genus *Centrophorus* Gulper sharks	**1**	Genus extremely vulnerable to exploitation. 'Widely distributed species' may prove to be many similar endemics or completely discrete stocks. All available CPUE and fisheries-independent data indicate steep declines				(Cavanagh et al. 2003) (Daley et al. 2002) (Graham et al. 2001)
Leafscale gulpershark *Centrophorus squamosus*	**1**	"	CPUE decline data in northern area		Not evaluated	A commercial species with preliminary assessment under the DELASS project (Heessen 2003). Likely to be the subject of continued work (SGRST 2002)
Gulper shark *Centrophorus granulosus* type	**1**	"	See *C. uyato*		Vulnerable globally	This may include *C. uyato* (IUCN Red List 2000)

Lowfin gulpershark *Centrophorus lusitanicus*	**1**	"	?		Not evaluated	
Dwarf gulpershark *Centrophorus uyato*-type	**1**	"	Over 99% decline in 20 years off New South Wales, Australia		Critically Endangered in Australasia	This may not be a valid species in the North Atlantic (Cavanagh et al. 2003) (Daley et al. 2002) (Graham et al. 2001)
Greenland shark *Somniosus microcephalus*	**2**	Large-bodied species vulnerable to target fisheries	Evidence of declines and local extirpations		Not evaluated	The relative importance of overfishing and hydrographic changes is unknown (IUCN Red List 2000)
Kitefin shark *Dalatias licha*	**2**	High biological vulnerability (low 'r')	Stock has shown severe decline and may be depleted		Data deficient globally, Near Threatened NE Atlantic	A commercial species with preliminary assessment under the DELASS project. Likely to be the subject of continued work (Heessen 2003) (Compagno et al. in press)
Family Squatinidae Angel sharks	**1**	Highly vulnerable to over-exploitation because of biology and habitat (inshore, large size, low fecundity), low dispersal and limited recolonisation (high endemism). All documented populations apparently in decline &/or with local extirpations. Smoothback *S. oculata* and sawback *S.aculeata* angelsharks are at the edge of their range in the ICES area.				
Angelshark *Squatina squatina*	**1**	As above. Restricted to Northeast Atlantic and Mediterranean. Vulnerable throughout range to by-catch	Becoming increasingly unco Extirpated from parts of its former	UK 4QR. Annex III Barcelona Convention; Annex III Bern Convention	Vulnerable	OSPAR nomination supported by SGEF (2002). (Rogers and Ellis 2000)
Smalltooth sand tiger *Odontaspis ferox*	**2**	Extremely K-selected and rare	Unknown, probably declining in Med.	-	Vulnerable	Likely very rare and at edge of range in ICES area Proposed or urgent legal protection in the Mediterranean

						Action Plan on cartilaginous fishes.
Thresher shark *Alopias vulpinus*	**1**	Biologically vulnerable to target and by-catch fisheries	Severe decline and population collapse in Northwest Atlantic	UN Fish Stocks Agreement	Data deficient (2000), under review: Near Threatened	Requires co-ordinated management and assessment under UNCLOS (Baum et al. 2003).
Bigeye thresher shark *Alopias superciliosus*	**2**	Rarer & biologically more vulnerable than *A. vulpinus*	Unknown	UN Fish Stocks Agreement	Not evaluated	(management programme required in priority for *Alopias spp.* Under the Mediterranean Action Plan on cartilaginous fishes)
Basking shark *Cetorhinus maximus*	**1**	Extremely vulnerable to fisheries (low 'r')	Significant decline in landings while value remained high.	UN Fish Stocks Agreement CITES, OSPAR, CMS?, Bern, Barcelona Conventions. UK BAP species	Vulnerable, Endangered in the Northeast Atlantic	OSPAR nomination supported by SGEF (2002).
White shark *Carcharodon carcharias*	**2**		Severely depleted	CMS/CITES III (Australia)/Bern. UN Fish Stocks Agreement, Bern and Barcelona Convention	Vulnerable	Likely very rare and only occasionally reported in ICES area (Baum et al. 2003).
Longfin mako shark- *Isurus paucus*	**2**	Rare and highly vulnerable.		UN Fish Stocks Agreement	Near threatened (under review)	
Porbeagle *Lamna nasus*	**1**	Biological vulnerability	Extreme depletion	UK Biodiversity priority list. UN Fish Stocks Agreement	Near Threatened, Vulnerable in NE Atlantic	Discussed in section 3.1 (Anon 1995)
Tope *Galeorhinus galeus*	**2**	Biological vulnerable. Some populations severely depleted.		UK Biodiversity priority list	Vulnerable	Discussed in section 3.1 (Anon 1995)

Family Carcharhinidae requiem sharks				UN Fish Stocks Agreement.		
Blue shark *Prionace glauca*	**2**	Moderately fecund	Heavily exploited as target and by-catch. Depleted	UK species of biodiversity concern	Near Threatened	Studied by DELASS and subject to ongoing work by WGEF/ICCAT (Baum et al. 2003) (Anon 1995)
Scalloped hammerhead *Sphyrna lewini*	**1**	Vulnerable to fisheries - very high by-catch mortality	Severely depleted	"UN Fish Stocks Agreement.	Near Threatened	(Baum et al. 2003) Urgent need for information required for status assessment of all Sphyrna (Med Action Plan on Cartilaginous fishes)
Great hammerhead *Sphyrna mokarran*	**2**	"	?	"	Data deficient	
Smalleye hammerhead *Sphyrna tudes*	**2**	"	?	"	Not evaluated	
Smooth hammerhead *Sphyrna zygaena*	**1**	"	?	"	Near Threatened	The species most commonly reported from ICES waters
Smalltooth sawfish *Pristis pectinata*	**2**	Biological and morphologically extremely vulnerable, restricted habitat.	Probably extirpated		Endangered globally. CR N. Atlantic	Only low priority because considered to have been extirpated from ICES area Proposed or urgent legal protection in the Mediterranean Action Plan on cartilaginous fishes.
Common sawfish *Pristis pristis*	**2**	"	Probably extirpated		Critically Endangered globally	Only low priority because considered to have been extirpated from ICES area Proposed or urgent legal protection in the Mediterranean

						Action Plan on cartilaginous fishes.
Blackchin guitarfish *Rhinobatos Glaucostegus cemiculus*	**3**	Highly sensitive biology and morphology. High endemism, low dispersal	Documented declines and extirpations of this genus in other regions. Data from Mediterranean?		Not evaluated	Low priority because at edge of range in ICES area
Common guitar fish- *Rhinobatos rhinobatos*	**3**	"	"		Not evaluated	Low priority because at edge of range in ICES area Urgent need for information required for status assessment (Med Action Plan on Cartilaginous fishes)
White skate *Rostroraja alba*	**1**	Large size, highly vulnerable to over-exploitation	Decline	Annex III Barcelona Conv. Annex III Bern Convention. UK 4QR	Not evaluated	OSPAR nomination supported by SGEF (2002). (Dulvy & Reynolds 2002)
Common skate *Dipturus batis*	**1**	Large size, highly vulnerable to over-exploitation Endemic to NE Atlantic.	Severely declined in shelf seas[3]. Still fished on shelf edge.	UK 4QR. OSPAR. UK Biodiversity Action Plan, Barcelona Convention	EN globally, CR in shelf seas	OSPAR nomination supported by SGEF (2002). (Dulvy and Reynolds 2002) (Brander 1981) Proposed or urgent legal protection in the Mediterranean Action Plan on cartilaginous fishes.
Norwegian skate *Dipturus nidarosiensis*	**2**	Large size, highly vulnerable to over-exploitation	Unknown	UK 4QR	Not evaluated	(Dulvy and Reynolds 2002)
Long-nose skate	**1**	Large size, highly	Declined following historic	UK 4QR	Not evaluated	(Dulvy and Reynolds 2002)

Dipturus oxyrinchus		vulnerable to over-exploitation	records of target fishery			
Thornback ray *Raja clavata*	**2**	Moderately large size, sensitive to exploitation	Severely depleted in North Sea. Still heavily fished.		Near Threatened	North Sea stock nominated for OSPAR, supported by SGEF 2002 (Heessen 2003)
Spotted ray *Raja montagui*	**3**	Small, relatively fecund species	Recent historical increase in abundance and range. Trend stable (if not increasing)	OSPAR Convention	Not evaluated	Would not be included on this list if not proposed for OSPAR listing, which was not supported by SGEF 2002.
Giant devil ray *Mobula mobular*	**2**	Large, highly vulnerable to over-exploitation, single large pup. NE Atlantic/ Mediterranean endemic?	Suspected decline in Mediterranean	Barcelona/Bern Convention	Vulnerable	Likely very rare and at edge of range in ICES area

5.7 Case studies of IPOAs

In 1999, the Committee on Fisheries (COFI) of the United Nations Food and Agriculture Organisation (FAO) adopted a voluntary International Plan of Action for the Conservation and Management of Sharks (IPOA-Sharks). The IPOA highlighted the action required for sharks[*)] within the context of the Code of Conduct for Responsible Fisheries. It called upon all States to produce a Shark Assessment Report (SAR) and, if they have shark fisheries, to develop and implement National Plans of Action (NPOA) by early 2001. The latter should identify research, monitoring and management needs for all chondrichthyan fishes that occur in their waters. In implementing the IPOA, States are also urged to ensure effective conservation and management of sharks that are transboundary, straddling, highly migratory and high seas stocks. FAO published technical guidelines to support the implementation of the IPOA for States to use to develop and implement NPOAs. In 2003 and every 2 years thereafter, States should report progress as part of their biennial reporting to FAO on the Code of Conduct for Responsible Fisheries.

Early in 2002, The IUCN Shark Specialist Group and TRAFFIC prepared for the Animals Committee (AC) of the Convention on International Trade in Endangered Species (CITES) a paper assessing progress with implementation of the IPOA-Sharks (Document 19.2 *Report on the Implementation of the International Plan of Action for Sharks*' http://www.cites.org/eng/cttee/ animals/18/E18-19-2.doc). The tables summarising the IUCN/TRAFFIC appraisal of the few available SARs and NPOAs available for review are presented in Annex 3. The review included the draft Italian Plan of Action for Sharks (which has still not been formally released) and a Preliminary Draft European Plan (which was tabled at COFI in 2001). Because Canada's Atlantic Pelagic Shark Integrated Fisheries Management Plan was limited solely to pelagic species and fisheries, it did not fulfil the role of a National Shark Plan, as defined by FAO, and was not included in this review.

Following the preparation of the CITES AC paper, several more SARs and NPOAs have been drafted or published and the Preliminary Draft EU Plan of Action has been withdrawn. Part of this preliminary draft did meet the requirements of the FAO IPOA and it would be worth considering retaining these points in any future European Shark Plan. Additionally, the DELASS, STECF and ICES WGEF reports fulfil many of the requirements of a European Shark Assessment report and could be amended to produce a formal SAR for Europe.

The NPOAs that have become available since the CITES document was prepared include the following:

- The Australian National Plan of Action for the Conservation and Management of Sharks, released for public consultation in July 2002 and since adopted.
- A Draft Species Action Plan for Sharks and Rays of Malta (this is not yet available for consultation).

[*)] i.e. sharks, skates and rays, and chimaeras

- A Draft Mexican Official Standard Proy-Nom-029-Pesc-1999 Regulating the Exploitation of Sharks and Related Species, not yet adopted.
- The UNEP RAC SPA draft Action Plan for the Conservation of Cartilaginous Fishes in the Mediterranean Sea (this does not include fisheries management measures because this is the purview of fisheries organisations).

Australian NPOA-Sharks

The Australian NPOA will be discussed in some detail here, since it is the most comprehensive NPOA yet available, and is considered by this sub-group as a useful model for the Community Plan of Action.

The Australian NPOA clearly addressed all ten objectives outlined in the FAO IPOA-Sharks (see Box 1), presenting a series of performance indicators for achieving each objective. It is also of particular relevance to the EU because Australia has to address both federal/Commonwealth and state issues. The Australian States and Northern Territory all have their own fisheries and conservation departments and manage their own coastal fisheries; there are seven jurisdictions, led by the Commonwealth Department of Agriculture, Fisheries and Forestry-Australia (AFFA), with varying degrees of responsibility for the delivery of shark management objectives.

Box 1. The ten objectives defined by the FAO IPOA-Sharks

In assessing the framework used by the Australian NPOA and its relevance for a European Plan, it is important to refer back to the ten aims (or objectives) of the FAO IPOA-Sharks, because these are referred to as 'Objectives i-x' in the NPOA and hence in the following text.

i. Ensure that shark catches from directed and non-directed fisheries are sustainable;

ii. Assess threats to shark populations, determine and protect critical habitats and implement harvesting strategies consistent with the principles of biological sustainability and rational long-term economic use;

iii. Identify and provide special attention, in particular to vulnerable or threatened shark stocks;

iv. Improve and develop frameworks for establishing and co-ordinating effective consultation involving all stakeholders in research, management and educational initiatives within and between States;

v. Minimize unutilized incidental catches of sharks;

vi. Contribute to the protection of biodiversity and ecosystem structure and function;

vii. Minimize waste and discards from shark catches in accordance with article 7.2.2.(g) of the Code of Conduct for Responsible Fisheries (for example, requiring the retention of sharks from which fins are removed);

viii. Encourage full use of dead sharks;

ix. Facilitate improved species-specific catch and landings data and monitoring of shark catches;

x. Facilitate the identification and reporting of species-specific biological and trade data.

Australia's Shark Assessment Report identified 24 conservation and management issues, which were subsequently clarified and refined to 18 (see Box 2). The NPOA identified six broad themes to these issues, as follows:

1. Review existing conservation and management measures;
2. Improve existing conservation and management measures;
3. Improve data collection and handling;
4. Undertake targeted research and development;
5. Initiate focused education/awareness raising programs;
6. Improve coordination and consultation.

Box 2: Issues addressed by the Australian NPOA-Sharks

(the relevant FAO objectives i-x (given in Box 1) are referred to in brackets after each issue)

1. The need to improve identification of shark species by all resource users (Objectives ix and x)
2. The need for secure, accessible and validated data sets that are consistent over time with compatible resolution between jurisdictions over the full range of each species from all resource users (Objective ix)
3. The need for an improved understanding of markets for and trade in shark products (Objectives vii, viii and x)
4. The need for coordination of shark research (Objectives iv and vii)
5. The need for continued effort to maintain and improve the standard of stock assessments for target shark species in dedicated shark fisheries (Objective i)
6. The need for reliable assessments for by-catch and byproduct shark species (Objectives i and ii)
7. The need for assessment of the adequacy of management for all shark species and more innovative approaches to dealing with identified shark management issues (Objectives i and ii)
8. The need for improved understanding of the impacts of and, where required, implementation of better management for recreational and game fishing (Objective iv)
9. The need to reduce cryptic (unaccounted) fishing mortality of shark species (Objectives v and vii)
10. The need for an assessment of shark harvesting and handling practices (Objective ii)
11. The need for a better understanding and, where necessary, recognition in management arrangements, of shark fishing by Indigenous people (Objective iv)
12. The need for risk assessments for all shark species from all impacts on those species (Objectives ii, iii and vi)
13. Where necessary develop strategies for the recovery of shark species and populations (Objective iii)
14. The need to reduce or, where necessary, eliminate shark by-catch (Objectives v and vii)
15. The need for a better understanding of the effects of shark fishing, control programs and management practices on ecosystem structure and function (Objective vi)
16. The need to reduce the impact of environmental degradation on sharks (Objectives ii and vi)
17. The need for more information on the impact on sharks of sound waves in the marine environment (Objectives ii and vi)

Forty-seven actions identified across these six themes are prioritized, timetabled, and assigned to the appropriate authority (see Table 6 of the Plan, which is not reproduced here). These actions are intended to promote the ecological sustainable development of shark stocks by:

- improving the ability of all resource users to identify shark species;
- developing consistent, compatible, reliable and secure data sets across all resource users;
- facilitating coordination of shark research;
- promoting a consistent approach to risk assessment of shark species and an agreed risk management framework;
- improving stock assessments for target shark species so that they can be managed sustainably;
- ensuring that information from, and the views of, all resource users are included in management decision making;
- raising the level of awareness of the cultural importance of sharks to Indigenous people;
- reducing shark by-catch;
- where ecologically sustainable, developing markets for shark by-catch;
- improving the understanding of the impacts of changes to the marine environment on shark species and the impact of shark fishing on the ecosystem;
- providing for the recovery of over-exploited shark populations.

These themes and categories of action are almost all relevant and desirable within a Community Plan of Action and could be used as the framework for developing such a plan.

Australia's system for prioritising actions is interesting and could be usefully adapted for European actions. Actions are ranked from Priority 1 (highest) to 3. Priority 1 is further divided into three sub-categories (A-C), recognizing that while all should be initiated as soon as possible (1A and 1B within the first year of the Plan), 1A actions should be completed within 18 months, 1B actions will take longer to complete, and the implementation of 1C actions will be dependent upon the completion of another activity underway. The summary table for these priorities is given below, in Table 5.7.1.

Table 5.7.1 Interpretation of Priorities for Actions (from Table 5, Australian NPOA)

Priority	**Action Initiated**	**Action Completed**	**Management funding (where required)**	**Research funding (where required)**
1A	Within 12 months	Within 18 months, if not sooner	Funding identified immediately on an emergency basis if necessary	Advise funding bodies of the reasons for the high priority Submit funding proposals as a matter of urgency
1B	Within 12 months	In shortest possible timeframe	Funding identified immediately on an emergency basis if necessary	Advise funding bodies of the reasons for the high priority Submit funding proposals as a matter of urgency
1C	Within 12 months of prerequisite work completed	In shortest possible timeframe	Need for funding foreshadowed in management budgets	Advise funding bodies of reasons for the priority of the research required Submit funding proposals based on expected timing of completion of prerequisite work
2	Within 3 years	Within 3 years	Need for funding included in next management budget following adoption of the NPOA	Advise funding bodies of reasons for the level of priority of the research required Submit funding proposals in the next round of funding proposals following adoption of the NPOA
3	Within 4 years if not sooner	As soon as feasible		Advise funding bodies of reasons for the high priority of the research required

The Australian Plan proposes to establish a broadly based implementation and review group in order to accommodate the interests of the broad range of stakeholders interested in implementation of actions under the Plan, including representatives from commercial, recreational and Indigenous sectors, conservationists and science organisations.

The role of the Group will be to:

- develop a strategy for implementation;
- oversee implementation;

- provide any coordination required;
- develop a schedule for undertaking actions within each priority group;
- act as a central depository for advice by responsible agencies on progress;
- disseminate to all interested stakeholders annual advice on progress and any other information relevant to the conservation and management of sharks;
- prepare reports for FAO's Committee on Fisheries on progress in the implementation of the Plan;
- act as the Steering Committee for the proposed FRDC (Fisheries Research & Development Corporation) Shark subprogram;
- initiate and oversee updating of the Shark Assessment Report; and
- initiate and oversee the four yearly review of the Plan.

5.8 Considerations for a Community Plan of Action

5.8.1 Specific concerns

Because of their life history strategies, many sharks are highly vulnerable to over-exploitation, which may lead to population depletion. Some may be particularly susceptible to local or global extinction because of their restricted distribution, small population sizes, or other characteristics, including dependence on nursery grounds or specific habitats, behaviour and morphology. Many species of elasmobranchs have shown decreased catches and, in more extreme circumstances, local extirpations.

The Community Plan of Action should identify actions aiming to reverse this trend and ensure the long term sustainable management and conservation of European shark resources. It should be developed as a response to the FAO IPOA-Sharks and follow its guidelines. It should also be consistent with other fisheries and environmental legislation and conventions, as well as help achieve the relevant targets set out in the Plan of implementation of the World Summit on Sustainable Development (WSSD), namely to "maintain or restore stocks to levels that can produce the maximum sustainable yield with the aim of achieving these goals for depleted stocks on an urgent basis and where possible not later than 2015".

The need for Cooperation and Synergy

Shark conservation and management is a matter of concern to many organisations, and improved cooperation is required. The FAO IPOA-Sharks recognises that 'other forms of cooperation' besides regional and sub-regional fisheries organisations or arrangements may be applied when implementing the IPOA.

Many environmental organisations have programmes on shark conservation, and it is important that the data collected by these programmes, and the guidance provided, is incorporated in EU activities. There is an increased pressure from the international conservation community to include elasmobranchs in international conservation laws, and the use of wildlife instruments for elasmobranch conservation and management, for complementing fisheries management legislation and policy.

The European community is already moving to integrate fisheries and environmental policies to protect the marine environment and to ensure the sustainability of fish stocks and fisheries, and recognises the desirability of an ecosystem approach to fisheries, environmental protection, and conservation and management measures. Elasmobranchs were one of the named species groups for which competent authorities were invited to establish priorities for the elaboration of stock assessments and forecasts, or other appropriate stock indicators.

Trade considerations and the Convention on International Trade in Endangered Species (CITES)

As CITES and the European Commission are concerned with encouraging sustainable management of wild species in trade, including sharks, and all EU shark fishing nations are CITES Parties, there are natural opportunities for the two institutions to work more closely together to achieve mutual goals. This includes in the area of information management and exchange. The success of shark fisheries management, and including any Community Plan of Action, is dependent on accurate trade data at a suitable level of specificity. While there are customs coding systems for the collection of trade data, the shark product codes that most countries have adopted are too general to be of any benefit for the purpose of species-specific management. The EU and CITES need to work together to call for an increase in the specificity of trade data for sharks.

In November 2002, European Union States were among those CITES Parties that supported proposals to list basking shark *Cetorhinus maximus* and whale shark *Rhincodon typus* on Appendix II of the Convention, and to adopt a Resolution on the Conservation and Management of Sharks (Resolution Conf. 12.6). Many European Countries are range countries for the basking shark, and some overseas territories of certain EU countries are also range states for the whale shark.

The listing of the basking shark followed its earlier addition to Appendix III of the Convention in September 2000 by the EU, which brought with it certain obligations under EU Customs Regulations. The most important implication of the Appendix II listing is that international trade can only be undertaken if exports and imports are accompanied by the appropriate permits, which can only be issued if the exporting State issues a ‘no detriment finding’. A no detriment finding can only be made if the harvest of the exported specimens from the wild is demonstrated not to be detrimental to the wild population (in other words, that it comes from a sustainably managed fishery). Norway, which has until recently taken small numbers of basking shark from the Northeast Atlantic (this is a stock shared with the EU), has taken out a reservation on this CITES listing which means that it is not Party to CITES with respect to this listing, does not need to issue permits for international trade in this species nor, therefore, to issue 'no detriment' findings.

The Shark Resolution, *inter alia*, raises concerns over the lack of progress with implementation of the IPOA-Sharks and encourages further progress to be made. It also 'RECOMMENDS that Parties continue to identify endangered shark species that require consideration for inclusion in the Appendices, if their management and conservation status does not improve; and REQUESTS Management Authorities to collaborate with their national Customs authorities to expand their current classification system to allow for the collection of detailed data on shark trade including, where possible, separate categories for processed and unprocessed products, for meat, cartilage, skin and fins, and to distinguish imports, exports and re-exports. Wherever possible these data should be species-specific.'

These activities, which have been endorsed by EU Parties, should be included within the Community Plan of Action. The first is concerned with the status of threatened species, the second with improved data collection.

Funding Strategy

One major cross-cutting theme that must be considered in an overall Shark Action Plan is the issue of **financial resource allocation**. All of these activities are wholly dependent upon significantly increased resources, as recognised by FAO (2000) under section 3 of the proposed Shark Plan format outlined above. This can only be achieved if the actions identified in the Community Plan of Action are incorporated into the whole relevant range of EU environmental management and funding strategies, including research and environmental programmes (e.g. LIFE), technical and higher education granting policies, multi-lateral cooperation projects; as well as fisheries programmes.

Education and Public awareness

Sharks are often portrayed in a negative light, despite the fact that they are some of the most vulnerable groups of marine fauna. Changing the negative public perception of sharks, highlighting the status of threatened species is critical in building the social will to conserve them. The Community Plan of Action should underline the need for education and public awareness and present specific actions to achieve this objective.

5.8.2. Recommended objectives for a Community Plan of Action

The objective of the FAO IPOA-Sharks is '*to ensure the conservation and management of sharks and their long-term sustainable use*'. This is expanded in paragraph 22 of the IPOA to cover ten subsidiary objectives, which are detailed in Box 1 in Section 5.7.

While the objectives of a Community Plan of Action may need to be amended slightly, for example to include references to other EU or international fisheries management or biodiversity conservation policies (some of these were listed in the 2002 STECF report, and see below for new developments since then), the ten objectives provide comprehensive objectives for initial consideration when developing a framework for a European Shark Plan.

5.8.3. Proposed contents for a Community Plan of Action

The Technical Guidelines for the conservation and management of sharks (FAO 2000) identify four main elements of the IPOA-Sharks that should be addressed in Shark Plans:

- species conservation
- biodiversity maintenance
- habitat protection
- management for sustainable use.

5.8.3.1. Proposed structure

There are many potential structures for the development of a Regional Action Plan or an NPOA. The FAO Guidelines (FAO 2000) recommend a format, and Appendix II of the IPOA-Sharks suggests contents for Shark Plans. These two sources are amalgamated in the following draft outline:

1 Introduction

When managing fisheries for sharks, it is important to consider that the state of knowledge of sharks and the practices employed in shark catches may cause problems in the conservation and management of sharks, in particular:

- *Taxonomic problems*
- *Inadequate available data on catches, effort and landings for sharks*
- *Difficulties in identifying species after landing, especially when processed at sea*
- *Insufficient biological and environmental data*
- *Lack of funds for research on sharks*
- *Little coordination on the collection of information on transboundary, straddling, highly migratory and high seas stocks of sharks*
- *Difficulty in achieving shark management goals in multispecies fisheries in which sharks are caught.*

See also Section 5.7, Box 2, for issues identified by the Australian NPOA.

2 Objectives

3 Legal, institutional and management framework requirements

Implementation of the IPOA-Sharks presupposes a minimum set of institutional arrangements and recurrent activities at national and sub-national, regional and sub-regional and global level (depending, of course, upon the area of distribution of the shark stocks under management. See Section 3 of FAO (2000) for more information.

4 Human resources and capacity building requirements

This refers to the need for states to have the scientific capacity and resources to be able to undertake assessments of stocks under their jurisdiction, the impacts of ecosystem changes resulting from the effects of fishing, pollution and habitat change, and the research capacity to assess the effects of environmental change upon stocks. FAO (2000) recognises that in most cases the human and financial resources accessible to shark researchers and managers must increase for conservation and management to improve. Training is crucial for successful data collection programmes, stake-holder participation and training is desirable, and states need not only to improve the resources supporting their own conservation and management programmes but also contribute to regional, bilateral and multilateral programmes.

5 National and regional fishery management data and research

This recognises the necessity of a sound scientific basis to assist fisheries managers and others in decision-making, and the importance of promoting the use of research results as the basis for setting management objectives. See FAO (2000) for more information on each of the following sub-headings.

5.1 Brief shark fishery descriptions

5.2 Associated species as discarded by-catch

5.3 Species identification, distribution and stock structure of harvested species

5.4 Fishery monitoring and data collection methods

5.5 Scientific research

5.6 Data management

5.7 Stock assessment information

5.8 Identification of species requiring ‘special management’

(e.g. legal protection)

6 Fishery management and species conservation

6.1 Resource constraints

This refers to the low productivity and hence special management needs of sharks.

6.2 Sustainable development reference system (SDRS) criteria, objectives, indicators and reference points

See FAO Technical Guidelines for Responsible Fisheries No. 8, Indicators for the sustainable development of marine capture fisheries.

6.3 Options of regulating fishing

These include control of catch or fishing effort, and control of fishing gear.

6.4 By-catch reduction

Including investigating options for fitting by-catch reduction devices in trawl nets and regulating construction of fishing gear and fishing time to promote escape or live release of by-catch.

6.5 Encouragement of full utilization

Includes taking appropriate measures to minimise discards, catch of non-target species and negative impacts on associated or dependent shark species, particularly endangered species. These may include technical measures related to size of shark, quantity or type of gear, discards, closed seasons and closed areas.

6.6 Biodiversity and ecological considerations

Management measures should not only ensure the conservation of target species but also of species belonging to the same ecosystem or associated with or dependent on the target species. Fisheries management is required by the 1982 UN Convention on Law of the Sea and by the Code of Conduct for Responsible Fisheries to restore depleted populations to levels above those at which maximum productivity occurs.

7 Implementation and review

Identification of implementing agencies in each jurisdiction and the stakeholders with interest in implementation of actions under the Plan. A broadly based implementation and review group should be established. Assessment of the implementation of the action Pan should be undertaken, as well as the review of some actions where necessary.

5.8.3.2. Actions that the Community Plan of Action should contain

The following proposed action points are categorised in six themes as identified by the Australian NPOA, with a further sub-categorisation for the broad themes (theme 2 and 3). These six themes address the ten objectives of the FAO-IPOA.

The 6 themes of actions

1. Review existing conservation and management measures;
2. Improve existing conservation and management measures;
   - Sustainable fisheries
   - Protection of habitat, biodiversity, and ecosystem structure and function
   - Reduce by-catch
   - Vulnerable and threatened species
   - Minimising wastes and discards
3. Improve data collection and handling;
   - Data collection and exchange
   - Improve species-specific data
   - Improve trade data
4. Undertake targeted research and development;
5. Initiate focused education/awareness raising programs;
6. Improve coordination and consultation.

It is also possible to use most of the ten FAO IPOA-Shark objectives (section 5.7) as broad headings for categories of actions, although objectives 1 and 2 are rather too broad for this to be useful (it results in too much overlap with other objectives).

Theme 1: Review existing conservation and management measures

There are several existing conservation and management measures that may operate at local, national or international levels. Examples include:

a) National or Local

Legal protection (e.g. UK Wildlife and Countryside Act)

Minimum landing sizes (e.g. Sea Fisheries Committees in England and Wales)

Other (e.g. UK Biodiversity Action Plans for basking shark and common skate, national finning regulations – so far only Spain)

b) Community

Legal protection (Bern Convention listings in the Mediterranean Sea only, because CFP applies outside the Mediterranean. EC has a reservation on the Mediterranean listings until sufficient progress has been made with existing Natura 2000 species)

Quotas (CFP)

Finning Regulation

c) Regional and International

Legal protection (CMS – Appendix 1 listing of white shark. Barcelona Convention for the Conservation of the Mediterranean Sea, Annex II of the SPA Protocol.)

Trade controls (CITES Appendix II listing of basking shark)

Fisheries management (Fish Stocks Agreement, ICCAT, NAFO, NEAFC)

Other ??

Suggested action points:

- Undertake a comprehensive review of the legal instruments that are binding for European States and European Commission; analyse possible conflicts and/or synergies in their jurisdiction (including overseas territories); and identify gaps and inadequacies in implementation and enforcement as well as means for mitigating these.

- Regularly review EU Finning Regulation according to timetable by assessing whether finning bans permitting fins to be landed separately, attached to or accompanied by trunks are being implemented effectively and are achieving their objectives, identifying and addressing any deficiencies.

Theme 2: Improve existing conservation and management measures

It may be argued that there are insufficient species-specific data to enable fisheries managers to undertake traditional stock assessments, and to implement many new or improved conservation and management measures for sharks. Lack of information, however, should not be used to justify lack of management for such a vulnerable group, and there are many potential precautionary management measures that may be taken in the absence of stock assessments (e.g. those based on species biology, which could include minimum or maximum landing sizes, gear regulations, seasonal/permanent closures of critical habitat, or the use of moratoria/zero quotas).

Suggested action points:

Sustainable fisheries

- Preparation, wherever possible, of management advice based on stock assessments at species and stock level for sustainable levels of catch;

- Promote the use of research results as a basis for setting management objectives, biological reference points, sustainability indicators, acceptable risk levels, time frames and performance criteria, as well as ensuring adequate linkages between applied research and fisheries management.

- Establish rebuilding programmes for seriously depleted stocks.

- Maintain or restore stocks to levels that can produce the maximum sustainable yield.

- Ensure that where excess fishing capacity for the capture of sharks exists, mechanisms are established to reduce capacity to levels commensurate with the sustainable use of shark fishery resources.

- Ensure that existing fishing methods and practices that are not consistent with responsible shark fishing are phased out and replaced with more acceptable alternatives. Regulation of fishing gear (e.g. gill net mesh size) can be used to control fishing mortality.

- Use available data from surveys and observer programmes to undertake stock assessments, IUCN Red List Assessments, and/or Stobutzki's rapid assessment methodology for assessing status of vulnerable or threatened stocks and the relative sustainability of by-catch, depending on data quality, with particular emphasis on less common species.

- Examine the relative importance and impacts of commercial and recreational fisheries.

Protection of habitat, biodiversity, and ecosystem structure and function.

- Implementation of the Ecosystem approach to fisheries (already adopted by the EU, but these policies need to include special consideration of elasmobranchs).

- Recognise the functional importance of elasmobranch populations.

- Incorporate critical habitats for elasmobranchs into any EU integrated system of marine protected areas.

- Evaluate the ecosystem effects of fishing on rare, vulnerable and threatened species.

- Assess the impact of shark management and conservation measures on ecosystem structure and function.

- *Restore, protect and remove threats to critical habitat for shark species, e.g. pupping grounds for species that have known pupping aggregations, critical habitats for species that are subject to Biodiversity Action Plans or Recovery Plans within statutory timeframes.*

- *Actively promote identification and protection of critical habitats of endangered species that lie beyond European jurisdiction and in the high seas.*

Reduce by-catch

- Minimize unutilised incidental catches of sharks through permanent/ seasonal closure or gear restrictions, especially in nursery and breeding grounds.

- Investigate gear modifications that reduce by-catch of elasmobranchs.

Vulnerable and threatened species

- Urgent introduction of precautionary management measures for highly vulnerable and depleted stocks

- Pay special attention to the protection and management of vulnerable or threatened species and species with poor conservation status by granting legal protection and/or establishing closed areas or sanctuaries. The latter is particularly appropriate for those species that show high site fidelity.

Minimising wastes and discards

- Encourage full utilisation of sharks and minimise waste.

- Specifically include elasmobranchs in EU strategy for reducing discards of commercial species.

- Ensure that States implement EU Regulation on the finning of sharks.

- Initiate an assessment of opportunities for increasing utilisation/value adding of shark products and encourage commercial fisheries to exploit these opportunities subject to the long-term sustainable harvest of shark species.

Theme 3: Improve data collection and handling;

Data collection and exchange

- Support the establishment of mechanisms, *inter alia*, to facilitate shark research and fishery monitoring at regional and sub-regional levels and encourage the sharing of data and the results of such research between regions and sub-regions.

- Conform to agreed monitoring and research procedures and data resolution to ensure uniform approaches at the regional and sub-regional levels for shared transboundary shark stocks.

- Improve opportunities for data collection by requiring catches to be landed in a form that not only enables species identification, but also promotes the collection of data on maturity, sex, and length (this requires the landing of carcasses with fins/wings, skin, and claspers).

- Catches should be broken down into categories with as much detail as possible. The priority should be by species, location and date. Further breakdown by sex and length of shark (or broad size category or maturity) would facilitate sex-based and length-based stock assessment models.

- Ensure data are well managed in data bases such that data are secure, have automated internal verification and validation checks, are corrected for double reporting and have procedures for efficient data extraction, exchange and summarization.

- Where necessary introduce appropriate and effective supplementary or alternative data collection mechanisms to ensure adequate information on recreational fishing is collected for management purposes.

- Analyse the relative economic importance of commercial and recreational shark fisheries and non-consumptive uses (e.g. tourism).

- Discarding of sharks dead or in poor condition has important biological implications and should be recorded or estimated. Total catch consists of total landings and discards. Shark by-catch, whether retained or discarded, should be recorded.

- Transhipping of sharks at sea must be incorporated into any catch monitoring scheme; otherwise a considerable proportion of the catch may be unaccounted for. This might need to be monitored with on-board observers or contacts through the Flag State of the receiving vessel.

Improve species-specific data

- Ensure that where possible processes for the validation of shark catch data from commercial fisheries using observer, monitoring and/or fishery-independent research programmes have been initiated.

- Require all batoids to be landed with wings attached to carcasses and skin on, in order to ensure their identification at landing points and in markets.

- Regularly review and assess the effectiveness of field guides and keys for European waters (including the Mediterranean)

- Prepare new guides where necessary to enable species identification from whole animals, carcasses and, possibly, fins, skins, vertebrae and heads. These guides should include use of local species names.

- Ensure the best available guides are provided to all user groups, processors, compliance officers, observers and scientists involved in each fishery known to take sharks.

- Improve species identification skills:

    – at sea: fishermen, observers and researchers;

    – at landing points and in markets: fisheries staff, researchers;

    – in trade: customs officers.

Improve Data from trade

- Shark products in trade should be specified by species, as fresh, frozen or dried, and as:
  - whole,
  - headed and gutted carcass with skin on and fins on,
  - headed and gutted carcass with skin on and fins off,
  - headed and gutted carcass with skin off and fins off,
  - filleted meat only,
  - heads only,
  - head cartilage,
  - vertebral cartilage,
  - powdered cartilage,
  - skin only,
  - fins only,
  - whole livers only, or
  - liver-oil.
  - jaws and teeth
- Appropriate conversion factors should also be available.
- Assess availability of European export and import data for shark products against the recommendations of the FAO (FAO, 2000) and CITES decisions on trade codes; identify deficiencies and address these.

N.B. Legislative requirements may require shark products (carcasses, meat, fins, skins, heads, vertebral columns, livers, liver oil and jaws) to be clearly labelled with species' name.

- Initiate an examination of the nature of the current and emerging domestic and international markets for shark products (e.g. from *Squalus acanthias*) to assess the impact on stocks in the waters of the EU and other states.
- Investigate the potential for DNA identification kits for use in identifying the species from which exported or imported shark fins and other products have been derived.
- Implement CITES Resolution 12.6 by expanding current Customs classification systems to allow for the collection of detailed data on shark trade including, where possible, separate categories for processed and unprocessed products, for meat, cartilage, skin and fins, and to distinguish imports, exports and re-exports. Wherever possible these data should be species-specific. (this wording extracted from Res 12.6)

Theme 4: Undertake targeted research and development;

- Data mining: collation of historic, archive data to construct time series of abundance and for use in biodiversity analyses.

- Continued support for fishery independent surveys and investigate the practicalities of establishing additional surveys for those areas/taxa that are not effectively sampled by existing groundfish surveys.

- Collect information on the following, in order to inform fisheries policy decisions:
  - interest groups, their features and their interests in the fishery,
  - the economic factors related to the fishery, particularly the economic and social dependence of the different interest groups on the fishery,
  - details of costs and benefits to the region, nation or local area from the fishery,
  - the role of the fishery in providing employment for the different groups or communities,
  - the alternative sources of employment and income for the different interest groups or communities,
  - the current status of access to or ownership of the resources,
  - the institutions currently involved in decision-making within the fishery, and
  - an outline of the history of the fishery and the historical roles of the different interest groups within the fishery.

- Collect and analyse data and information on each shark fishing fleet such as:
  - the number of vessels or units,
  - their gear characteristics and the selectivity of the gear,
  - any season patterns in the fishing,
  - the locality of fishing in relation to the distribution of the stock and other fleets,
  - any navigational and technological aids which assist in fishing, and
  - other related factors.
  - By-catch, discards and discard mortality
- Biological studies are required to provide more information on the biology and ecology of elasmobranchs, including age and growth, reproductive biology, movements and migrations, and habitat use by various life-history stages.

- Develop appropriate conversion factors for conversion of dressed weight to live weight equivalent units (also called nominal catch or whole or round weight).

- Develop shark habitat mapping projects that encompass critical habitat for shark species.

- Initiate research to determine the impact of other anthropogenic activities on the biology and behaviour of sharks (e.g. electromagnetic fields from sub-sea cables).

- Review and adopt new methods for modelling the population dynamics of chondrichthyans in the ecosystem and develop a basis for distinguishing between natural variation and trends in the system so as to assist in understanding population status, rates of recovery, population structure and distribution.

- Develop a quantitative framework/methodology to assess the population status of listed threatened species.

Theme 5: Initiate focused education/awareness raising programs

- Launch educational programme to raise awareness of the commercial and biodiversity importance and status of sharks and the need for their conservation and management.

- Introduce a community education strategy aimed at the general public, commercial and recreational, fishers. The strategy should aim to:

  a) raise national awareness of the vulnerability of particular shark species and in particular their role in the marine ecosystem, the cumulative impact of shark by-catch, the need to return sharks to the sea and to maximise their chances of survival

  b) educate resource users about the rationale for and use of recorded shark catch data

  d) develop an awareness amongst all resource users of the threatened species provisions, reporting requirements and penalties

  e) encourage the trial of techniques to improve shark species identification (eg photos taken with disposable cameras and retention of unknown species for confirmation of species identification), by user groups

  f) encourage recreational fishing and tourist sectors to address specific issues relevant to those sectors

- Launch specific campaigns to highlight those species that have been granted legal protection and which should **not** be landed or sold.

Theme 6: Improve coordination and consultation.

- Establish, through Regional Fisheries Management Organisations and bilateral and multilateral sub-regional arrangements, collaborative monitoring and research programmes to enable stock assessment of shared transboundary shark species.

- Ensure that, where a species is taken in two or more fisheries within a jurisdiction or in two or more jurisdictions (communitarian or communitarian/international), that:

  a. Processes are in place to collect/report data from all fisheries and jurisdictions involved in the management of that species uniformly and are included, when data become available, in subsequent stock assessments or risk assessments conducted for that species

  b. the potential of 'regional' or 'across-fishery' approaches to shark management have been assessed and introduced where possible

  c. effective communication and consultation mechanisms between all stakeholders are in place; and

  d. management measures are complementary

- Assess sustainability of shark fisheries in countries with which the EU has fisheries agreements, or which fish shark stocks shared with the EU, or from which EU imports shark products, and identify possible responses to situations where those fisheries are considered unsustainable.

- Implement CITES Shark Resolution 12.6 by presenting data on threatened species to CITES Animals Committee and, where appropriate, considering their inclusion in CITES Appendices.

- Development of coordinated European research programmes, including broad dissemination of information, data sharing, contribution of researchers to public awareness materials and educational programmes.

- Ensure that sea angling stakeholders are included in consultations over elasmobranch fisheries management.

- Actively promote the implementation of the IPOA-Sharks particularly with those states with which the EU has fisheries agreements and improved regional management of shark stocks and protection of threatened species in relevant regional fisheries management organisations and under other relevant international conventions and for e.g. CITES, Convention on Migratory Species and OSPAR.

- Initiate negotiations for bilateral /multilateral agreements within regional bodies (e.g. UNEP/MAP, GFCM, ICES, ICCAT, etc) in relation to shared shark stocks.

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ANNEX 1

Presence of Basking shark (*Cetorhinus maximus*) in the coastal waters of the Mediterranean Sea, and incidental catches in trammel nets

The basking shark (*Cetorhinus maximus*) is one of the elasmobranch species that most urgently requires measures of protection in the Mediterranean Sea. Recently it has been granted legal protection status by its inclusion in Annex II (Endangered or Threatened Species) of the Barcelona Convention Protocol for Specially Protected areas and Biological diversity, the Annex II of the Bern convention and the Annex II of CITES.

Records of the presence in the Mediterranean basin were collected from literature and during a monitoring programme that has been carried out since 1985 (Serena *et al*., 1999; Mancusi *et al*., submitted). Valuable miscellaneous information, including catch records starting from 1822, have been acquired so far. Data concerning date, site of capture or sightings, sex, length, weight and other characteristics of the specimens were stored in a comprehensive database. The database was also analysed using ArcView© that enabled the plotting of georeferenced catches and sightings on a chart (Figure 1).

535 records of basking sharks have been collected for the period 1759-2002, for the Mediterranean area. Many of these records are incomplete and lack additional information on size, sex, weight, etc. The frequency of incidental catches and sightings of this shark by year has been analysed based on 522 specimens and it shows three peaks (1920, 1960, 1990), the latter of which is probably explained by the increased scientific interest in this species since 1990 (Figure 2). Information regarding season was available for only 401 records. Catches and sightings of basking shark were higher in spring, from February to June, with a maximum in May (25% of the total) (Figure 3). This period coincides with the peak concentration of plankton in the Mediterranean Sea.

At the moment the only available information on *C. maximus* in the Mediterranean basin comes from occasional sightings (42%) or incidental catches. The gear mainly responsible for catching this shark in coastal waters is the trammel net, accounting for

15% of the total 323 records analysed, although basking sharks are also caught in other fishing gears further offshore.

The length frequency distribution of 284 individuals of basking shark shows a peak at 6 m TL (Figure 4). We also tried to correlate TL and sex; this information is available only for 112 specimens (Figure 5).

Only for 138 of these records were the sex specified, 57% were males and 43% females. In all, 345 records contained information on the size and place where the sharks were caught or seen. With regard to this aspect, the whole Mediterranean Basin has been divided into four “regions”: Adriatic Sea (A), Levantine Sea (L), Tyrrhenian and Ligurian Sea (T), Balearic Ilands and Alboran Sea (B) (Figure 1). Most records (n=155) were collected in the Tyrrhenian area, with large numbers also reported from the Balearic Islands and the Adriatic Sea. Only a few records were available for the Levantine area. For the Adriatic Sea, Balearic Islands and Tyrrhenian Sea, there was a predominance of sub-adult and adult specimens (67, 76 and 51% respectively), ranging in length from 4-9 m TL.

The lack of information on incidental capture and sightings of basking shark along the Levantine region could be explained by the lack of a dedicated (specific) scientific monitoring programme. We therefore stress the necessity of creating a group of Mediterranean researchers interested in collecting standardised information on basking sharks.

In order to improve our understanding of the distribution, abundance and population structure of basking sharks in the Mediterranean, improved data regarding the date, exact place of capture/sighting, gear, size, sex and weight are required.

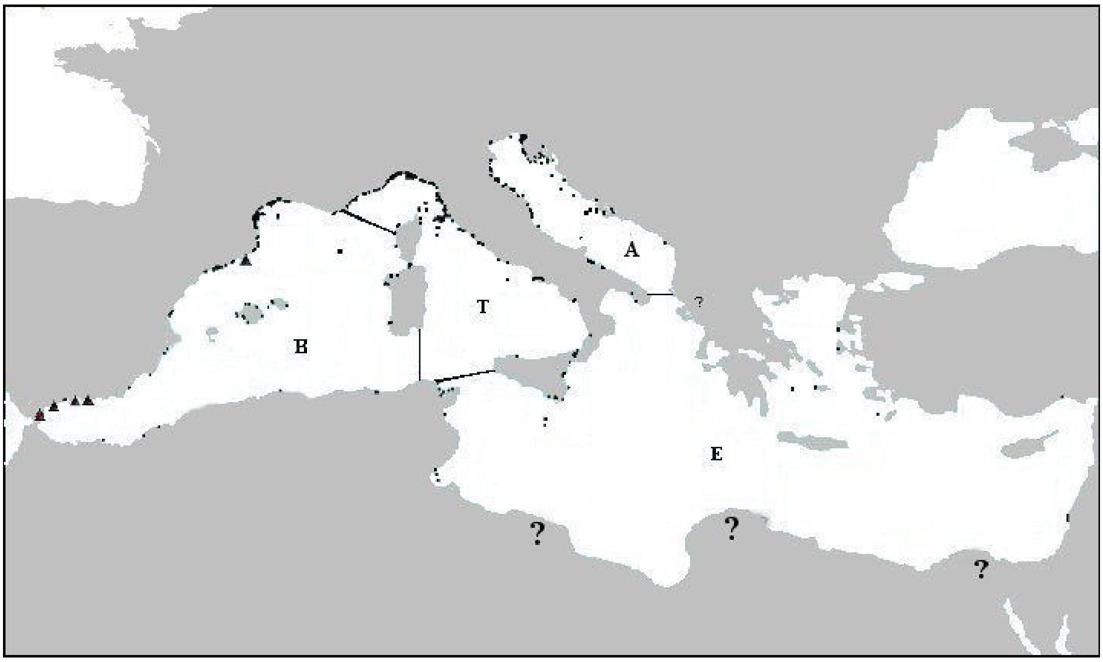

Fig 1 - Geographical distribution of findings of basking shark in the Mediterranean Sea. **B**: Balearic region; **T**: Tyrrherian region; **A**: Adriatic region; **E**: Eastern Mediterranean; Δ = Imprecise geographical position; **?** = Lack of data.

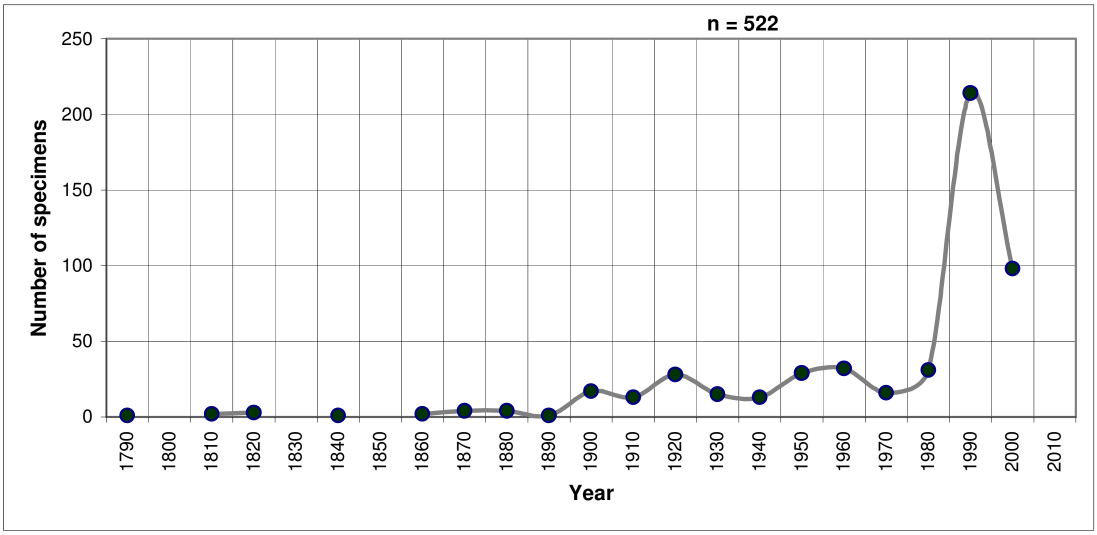

Figure 2 - Frequency of incidental catches of basking shark by year.

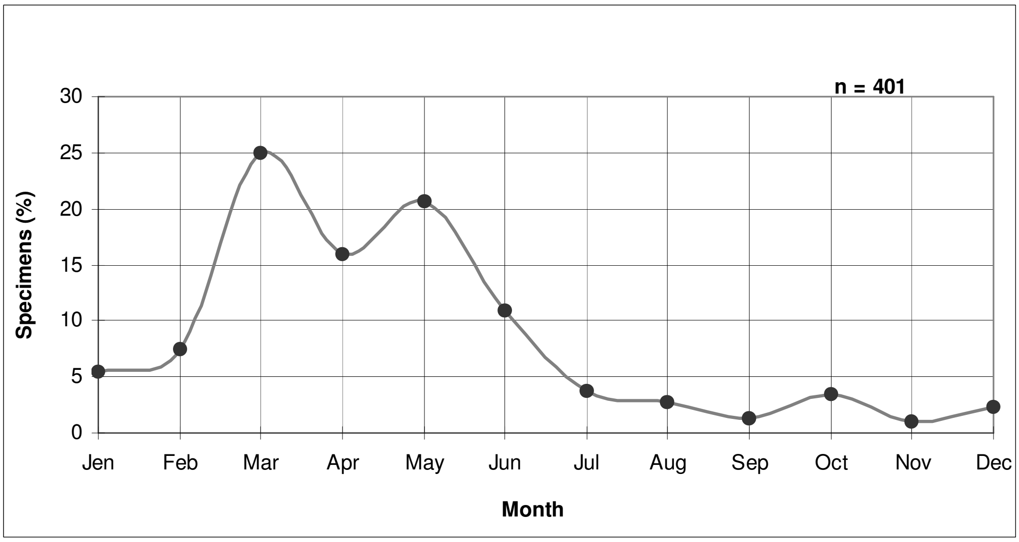

Figure 3 - Frequency of incidental catches of basking shark by month.

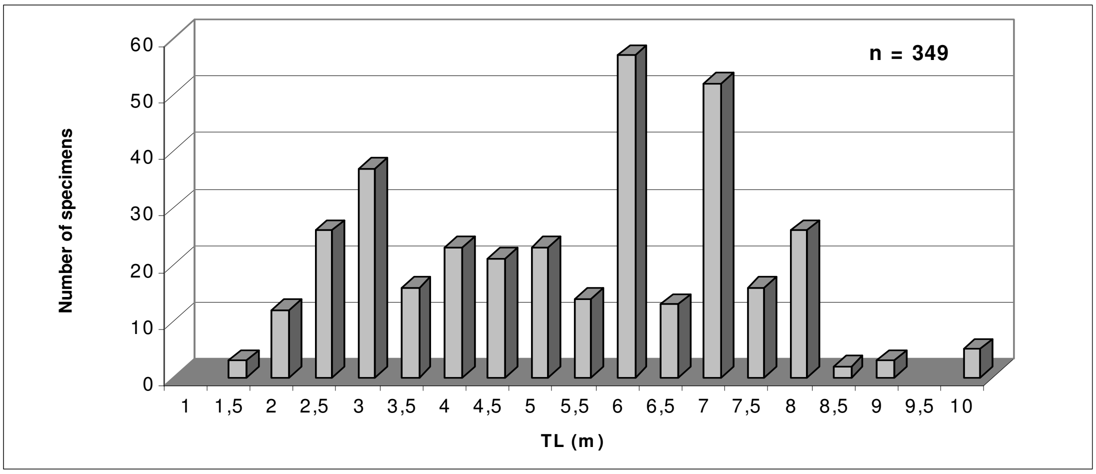

Figure 4 - Frequency distribution of the specimens of *Cetorhinus maximus* for which size is available.

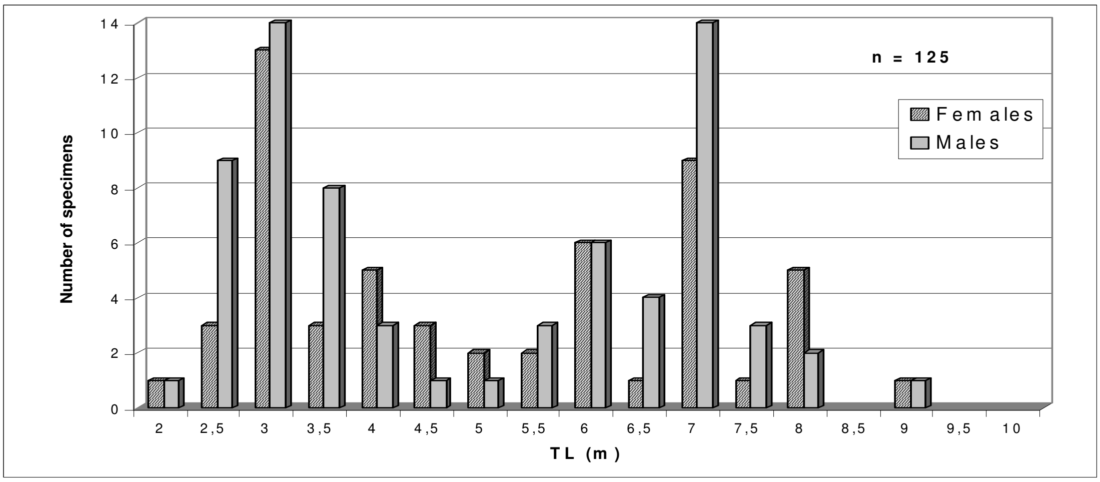

Figure 5 - Frequency distribution of lengths by sex of *Cetorhinus maximus* for which this information is available.

ANNEX 2

Distribution and abundance of *Galeus melastomus, Scyliorhinus canicula,* and *Raja clavata* in the Mediterranean International Trawl Survey (MEDITS)

The following observations are based on average values for the MEDITS surveys in the years 1994 - 1999.

In the MEDITS reference areas (Bertrand *et al*., 1997, 2000), *Galeus melastomus* is most abundant in the Western area with mean catches of 48.5 kg/km^2 and *Raja clavata* in the Eastern area (27.0 kg/km^2). *Scyliorhinus canicula* is fairly uniformly distributed (from 11.8 to 19.8 kg/km^2) in all areas, although local differences can be significant.

As far as the investigated depth strata are concerned, *S. canicula* and *R. clavata* were caught at all depths, but with a preference for depths between 50 and 500 m (with mean densities around 20 kg/km^2), whereas *G. melastomus* occurred almost exclusively on the slope, with mean densities up to 44 kg/km^2.

In the length frequency distributions two basic types were identified for the two sharks, with a predominance of either small or large individuals, suggesting geographical differences in total mortality rates. On the other hand, no apparent geographical heterogeneity was detected in the LFD of *R. clavata* (Serena *et al*., submitted).

Galeus melastomus

The blackmouth catshark was caught in all sub-sectors with the exception of the North Adriatic. The species mainly occurs on the slope. Catch weights higher than 100 kg/km^2 occurred in the Gulf of Lions and in Sardinian waters with a maximum of 1040 kg/km^2 in the Alboran Sea (Figure 1).

Regarding the estimates of total stock biomass, 40% of the Mediterranean stock was found in the Alboran Sea (2600 t); elsewhere the only significant stocks (300-400 t) were in the central Tyrrhenian Sea and in the Sicilian Channel .

Juvenile concentrations roughly indicate depths between 200-500 m as the most likely nursery areas. Only in one sub-sector (South-Eastern Tyrrhenian Sea), the highest concentrations of juveniles were found in deeper water (500-800 m). The highest abundance of juveniles was observed in the Alboran Sea, Sardinian waters, and South-Eastern Tyrrhenian Sea.

The LFD shows a wide range in total length (from 8 to 68 cm), regardless of the area, although there are clear differences in the overall shape (Figure 2).

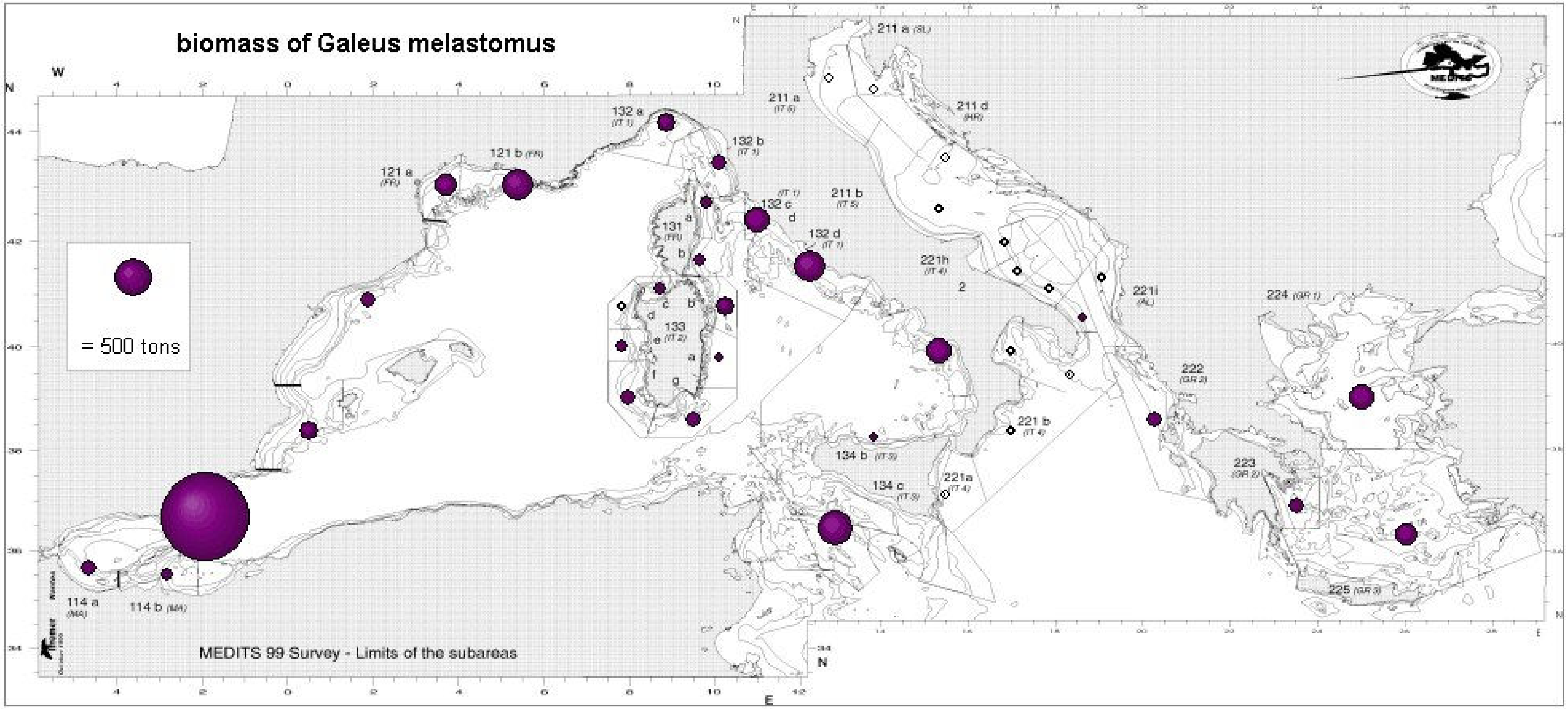

Figure1 – Biomass indices for *G. melastomus* by MEDITS sub-sectors.

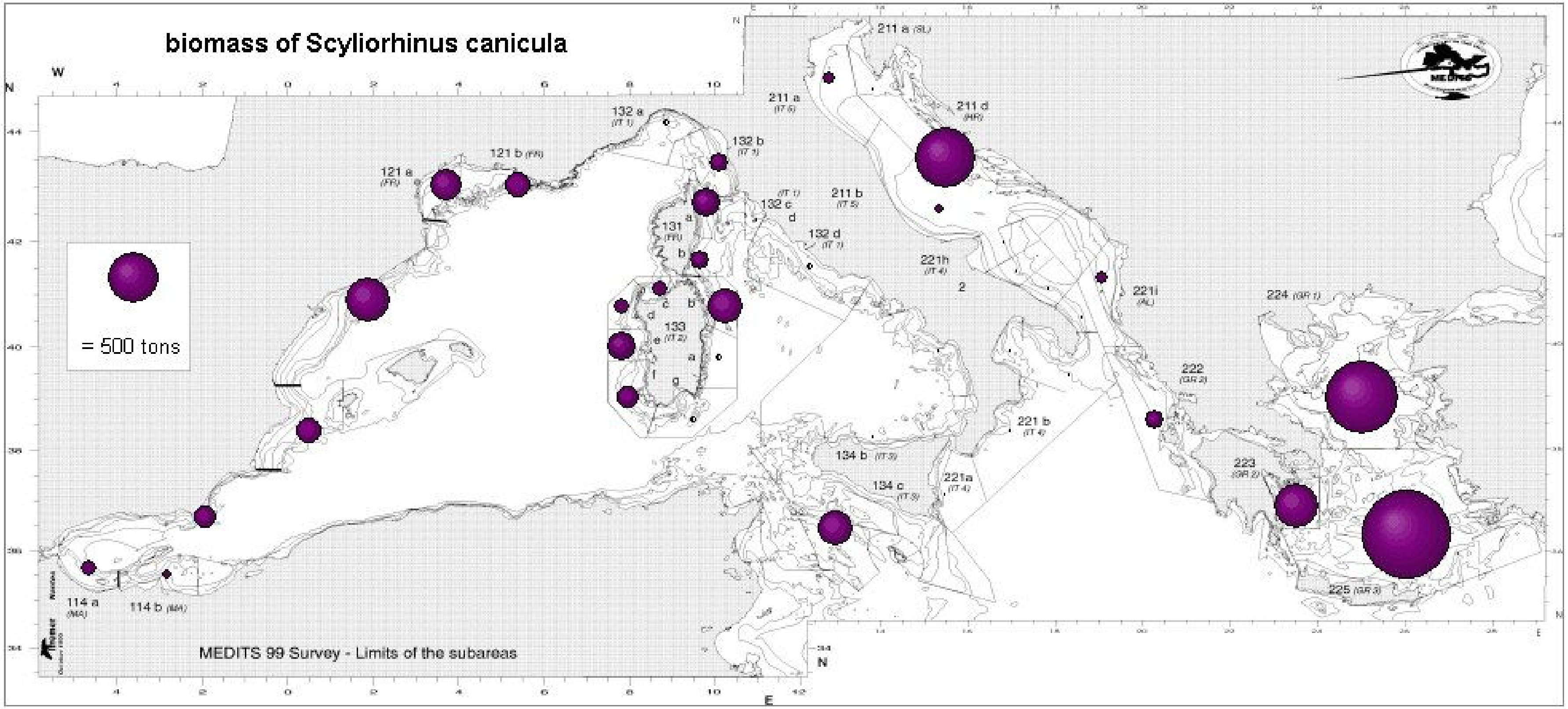

Figure 3 – Biomass indices for *S. canicula* by MEDITS sub-sectors.

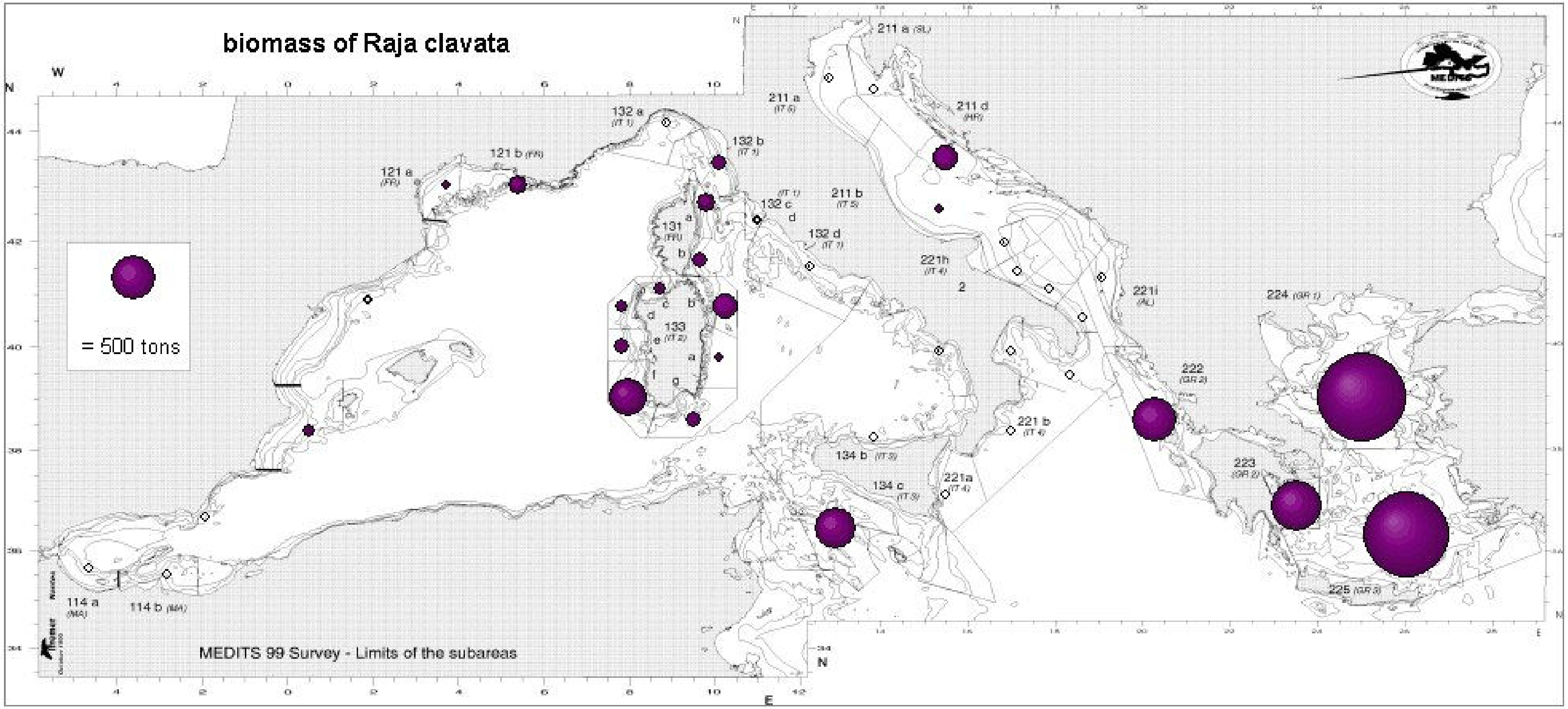

Figure 5 – Biomass indices for *R. clavata* by MEDITS sub-sectors.

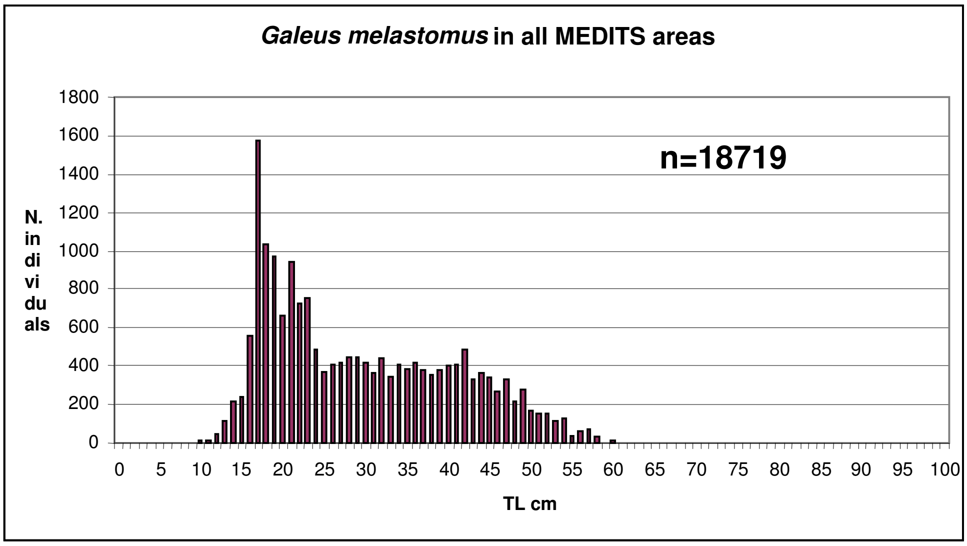

Figure 2 - LFD of *G. melastomus* in the MEDITS area.

Scyliorhinus canicula

The lesser spotted catshark was caught in all 40 sub-sectors and depth strata, with the exception of the North Adriatic, Eastern Sicily, North-Western and Northern Ionian Sea, and South western Adriatic Sea. The highest catch rates (> 100 kg/ km^2) were found on the shelf of Corsica and Sardinia, with a maximum of 340 kg/km^2 in North East Corsica in the 50-100 m depth stratum (Figure 3). Significant catch rates (30-50 kg/km^2) were also found in the Gulf of Lions, in the Catalan and Aegean Seas.

The main concentrations of juveniles were located in the upper slope (200-500 m), especially in North East Corsica and North East Sardinia. The highest concentration (2.4 million juveniles) was, however, found on the edge of the shelf in Western Morocco.

Total length ranged from 10 to 50 cm in all areas, but the shape of the LFD differed between areas (Figure 4).

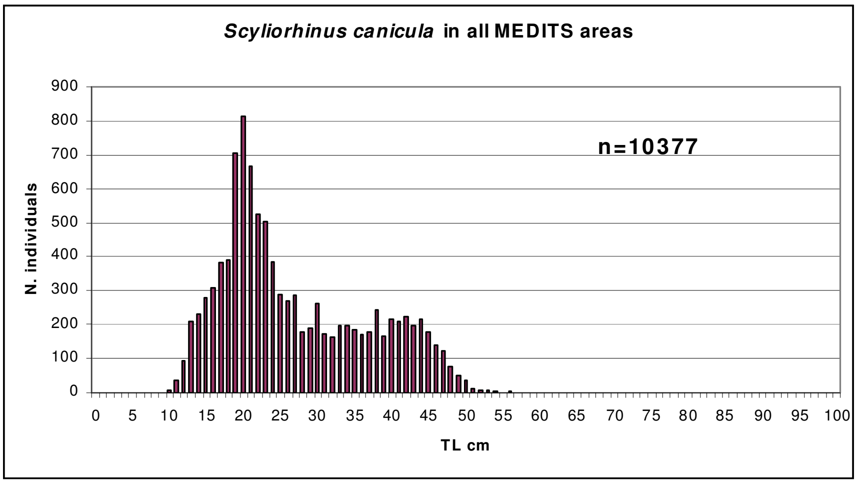

Figure 4 - LFD of *S. canicula* in the MEDITS area.

Raja clavata

The thornback ray mainly occurs at the edge of the shelf (100-200 m) and on the upper slope (200-500 m). The distribution pattern, however, is rather irregular. The species is (almost) completely absent in the westernmost part of the MEDITS area and in the East-Central sub-sectors (Figure 5). The highest catch rates (above 200 kg/km^2) were observed in Sardinian waters, and around Corsica where the maximum catch rate (418 kg/km^2) was found between 50 and 100 m depth.

The highest total biomass estimates of the standing stocks were found in the Easternmost sub-sectors with more than 1,500 t each, but other significant stocks (between 300 and 500 t) can be found in the Aegean area, in South Western Sardinia and in the Sicilian Channel.

Catches of this species usually consist of both juveniles and larger animals. Clear nursery areas were not found. In fact only one concentration was evident in the Eastern Ionian Sea between 50 and 100 m.

Total length ranged from 10 - 95 cm (Figure 6).

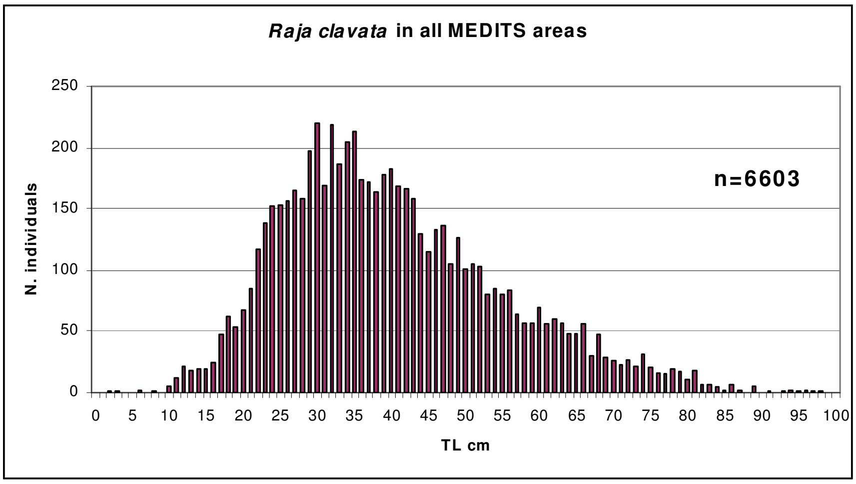

Figure 6 - LFD of *R. clavata* in the MEDITS area.

ANNEX 3

Review of implementation of the FAO International Plan of Action for the Conservation and Management of Sharks (IPOA-Sharks)

Extract from 'CITES 18th meeting of the Animals Committee (April 2002), Document 19.2 *Report on the Implementation of the International Plan of Action for Sharks*.' http://www.cites.org/eng/cttee/animals/18/E18-19-2.doc

Table 2a. The extent to which SARs (shark assessment reports) fulfil the requirements outlined in the IPOA-Sharks and FAO Guidelines.

Country	Effort[1]	Yield[2]	Stocks[3]	Access[4]	Technical Measures[5]	Monitoring[6]	Management effectiveness[7]	Possible Modification of Management[8]
Australia[•]	Yes where it is available	Yes, landed & reported info, but no assessment of discards. No economic info	For the small number of target spp. only, no info on the large number of non target spp.	Yes	Yes	Yes	For target shark spp. only	No, but list of issues identified for action under the NPOA
Seychelles[+]	Yes where it is available	Yes, information only up to 1996	No. Surveys have not been carried out on shark stocks	No restrictions other than access to Marine Parks and Protected Areas	Ban on fishing for sharks with nets is the only measure in place	Inadequate: Artisanal: all species recorded as 'sharks'. Industrial: all species recorded as 'other'	Too early to decide whether ban on nets is effective	Indicates that it may be necessary to direct more management resources into monitoring of the shark fishery

[•] Draft. (Final version to be available end of January 2002)

[+] The Seychelles refers to a Case Study commissioned by FAO in 1998 (before the IPOA-Sharks was drafted) as its SAR (Lestang, 1999)

1.2.1.1.1.1

1.2.1.1.1.1 Codes used in Table 2a (as specified in IPOA-Sharks Appendix III: Suggested contents of a shark assessment report)

1	Effort: directed and non-directed fisheries
2	Yield: physical and economic
3	Status of stocks
4	Control of access to fishing grounds
5	Technical measures (including bycatch reduction measures, the existence of sanctuaries and closed seasons)
6	Monitoring, control and surveillance
7	Effectiveness of management measures
8	Possible modifications of management measures

Note, July 2003. Several new National Shark Assessment Reports or documents that fulfil the same general purpose have been drafted or released since this table was prepared in early 2002. These have not been assessed.

Table 2b. The extent to which NPOAs fulfil the requirements outlined in the IPOA-Sharks and FAO Guidelines.

Country	Sustainable Fisheries [1]	Assess Threats[2]	Protect Stocks[3]	*Consultation* Initiatives[4]	Minimize Incidental Catch[5]	Protect Biodiversity[6]	Minimize Waste[7]	*Encourage Full Use*[8]	Improve Data Collection[9]	Species-specific Biological & Trade data[10]	General Comments
EU (prelim. draft)	Briefly discussed. Ways to achieve this are noted. Precautionary approach mentioned	Harvesting strategies mentioned	Not addressed	Yes, within EU	Mentioned	Mentions EU biodiversity strategy & importance of relationships between fisheries management & conservation	Mentioned	Mentioned	Will rely on existing projects. Does not recognise need for additional research and resources	Biological data mentioned under [9]. Trade data not mentioned	Preliminary, only 15 pages. Needs much more detail. Discusses a range of ideas but no firm plan or actions
Italy (incom-plete draft)	Acknowledged and discussed	Threats to species assessed	Some e.g. basking shark	Yes: other Med. countries	Not addressed	Mentioned, e.g. nursery grounds	Not addressed	Not addressed	Yes	Yes	Draft. A comprehensive list of action points for 2001-2003
Japan	Mentioned as an aim, but no details	Not addressed	Not addressed	Yes	Briefly discussed	Not addressed	Briefly discussed	Briefly discussed	Not addressed	Briefly discusses data collection. No discussion of improvement at species-specific level	Very brief, only 6 pages. Falls far short of a comprehensive NPOA
United States of America	Yes, but no detail on how	To some extent	Yes	Yes, but fails to specify how	Yes	Mentioned	Yes, but not reducing bycatch & bycatch mortality	Yes	Yes	Yes	Very detailed review, but fails to commit to particular actions

Note, July 2003. Several new National Shark Plans have been drafted or released since this table was prepared in early 2002. The Australian National Plan of Action for the Conservation and Management of Sharks was released for public consultation in July 2002 and has since been adopted. Malta has drafted a Species Action Plan for Sharks and Rays (not yet available for consultation). Mexico has prepared Draft Mexican Official Standard Proy-Nom-029-Pesc-1999 Regulating the Exploitation of Sharks and Related Species, which is not yet adopted. UNEP RAC SPA has drafted an Action Plan for the Conservation of Cartilaginous Fishes in the Mediterranean Sea (this does not include fisheries management measures because this is the purview of fisheries organisations). Canada's Atlantic Pelagic Shark Integrated Fisheries Management Plan was not included in this review because this does not fulfil the role of a full National Shark Plan, as defined by FAO.

Update for new NPOAs reviewed by STECF working group meeting.

Country	Sustainable Fisheries [1]	Assess Threats[2]	Protect Stocks[3]	*Consultation* Initiatives[4]	Minimize Incidental Catch[5]	Protect Biodiversity[6]	Minimize Waste[7]	*Encourage Full Use*[8]	Improve Data Collection[9]	Species-specific Biological & Trade data[10]	General Comments
Australia	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	See case study in section 5.6
Malta (Draft National Action Plan)	Base. Plan aims to sustainable shark fisheries, including ways to reduce by-catch in non target fisheries.	Threats to species assessed	Basking shark Great white shark Mediterranean Devil Ray	Yes: other Med. Countries, FAO and GFCM.	Targeted	Target. Protection of critical habitats	Not addressed	Not addressed	Yes	Yes when available. Most of landing data are mixed under "sharks" or "rays"	
UNEP-MAP (draft action Plan for the Med region)	Mentioned but not specifically targeted as it doesn't fall in their direct competence	Not fully addressed	Yes. Proposes additional species for strictly protected status under SPA Protocol.	Yes	Not directly addressed	Target. Protection of critical habitats	Mentioned	Yes	Yes	Encourage to collect.	

Codes used in Table 2b (from Aims of a Shark Plan as defined in IPOA-Sharks Appendix I)

1	Ensure that shark catches from directed and non-directed fisheries are sustainable
2	Assess threats to shark populations, determine and protect critical habitats and implement harvesting strategies consistent with the principles of biological sustainability and rational long-term economic use
3	Identify and provide special attention, in particular to vulnerable or threatened shark stocks
4	Improve and develop frameworks for establishing and coordinating effective consultation involving all stakeholders in research, management and educational initiatives within and between States
5	Minimize unutilised incidental catches of sharks
6	Contribute to the protection of biodiversity and ecosystem structure and function
7	Minimize waste and discards from shark catches
8	Encourage full use of dead sharks
9	Facilitate improved species-specific catch and landings data and monitoring of shark catches
10	Facilitate the identification and reporting of species-specific biological and trade data

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