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Shark Assessment Report

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SHARK ASSESSMENT REPORT

A. SHALLOW-WATER SHARKS AND DOGFISH

Spurdog / Piked dogfish (Squalus acanthias)

North-east Atlantic Spurdog *Squalus acanthias*	
Order: Squaliformes	
Family: Squalidae	
English: Spurdog, piked dogfish or spiny dogfish	
French: Aiguillat commun	
Spanish: Mielga	

Overview: spurdogs are long-lived, slow growing, have a high age-at-maturity, and are particularly vulnerable to high levels of fishing mortality. Population productivity is low, with low fecundity and a protracted gestation period. In addition, they form size- and sex-specific shoals and therefore aggregations of large fish (i.e. mature females) are easily exploited by target long-line and gillnet fisheries. There is limited information on the distribution of spurdog pups, though they have been reported to occur in Scottish waters, in the Celtic Sea and off Ireland. The lack of accurate data on the location of pupping and nursery grounds, and their importance to the stock precludes spatial management for this species at the present time.

The spurdog is particularly vulnerable to over-fishing, it has a long life span of up to 100 years, a long generation time of between 25 and 40 years, slow growth rates of up to 3.3mm per year for adult spurdogs and a late age at first maturity of 12–23 years for females, and 6–14 years for males. These characteristics result in the intrinsic population growth rates for spurdog being between 2.3–7% growth per year. This is low for even the majority of shark species.

The spurdog is also highly migratory and strongly aggregated by age and sex, masking stock depletions and allowing targeting of the large pregnant females. This has led to a clear sex bias in heavily exploited populations (becoming male biased) with an associated reduction in pup production (Fordham, 2007). The rate of natural mortality is not known, though estimates ranging from 0.1–0.3 have been described in the scientific literature (Aasen, 1964; Holden, 1968).

The fishery

Spurdog is commercially exploited, principally for human consumption, but markets are limited and large parts of the catch may be discarded. Spurdog fisheries peaked in the late 1950's and early 1960's. Several species of small dogfishes and sharks occur in the North Sea, and these have often been reported as 'mixed dogfishes and hounds', with no information on the species composition.

Gear types, fishing fleets and their distribution: It is mainly caught as by-catch in trawl fisheries, especially otter-trawl fisheries, though directed fisheries using gillnets and long-lines operate at certain times of year, especially in inshore waters. Spurdog are captured less frequently in beam trawl fisheries, which may be due in part to gear selectivity (specifically the low height of the beam may affect the catch rate of a largely pelagic species), but also because most beam trawl activity occurs in the southern North Sea, where spurdog are less abundant.

EC directed catch trends and characteristics: Spurdog in the ICES area are considered to be a single stock, ranging from Sub-area I to Sub-area IX, although landings from the southern end of its range are likely also to include other Squalus species. Spurdog occurs throughout the water column along the continental shelf of north-west Europe and has been recorded to depths of 900 m (Compagno, 1984). However, it is most common from 10–200 m (McEachran, J.D. and Branstetter, S., 1986.). The majority of the landings are from the Norwegian Sea (IIa), Kattegat and Skagerrak (IIIa), North Sea (IV), North-West Scotland (VIa), Irish and Celtic Seas (sub-area VII) and northern Bay of Biscay (VIIIa).

For spurdog, the most accurate species-specific landings data occurred after the fisheries peaked. Annual landings from the North Sea and Skagerrak were in excess of 25 000 tonnes in the 1970's, falling to 1 000 tonnes per year in the 1980's and early 1990's. Landings in recent years have generally been less than 5 000 tonnes per year, and between 1999 and 2003 were lower than the TAC allocated to EU vessels. Landings in 2004 on EU and non-EU fleets were 6 000 t but by 2006 the ICES-reported catch had fallen to less than 3 000, of which two-thirds were caught by EC Member States. The main EC countries exploiting spurdog are France, Ireland, Norway and the UK, and non-EC countries being Iceland and Norway.

In the UK (E&W), just over 50% of spurdog landings were taken in line and net fisheries in 2006, with most landings coming from Sub-area VII and in particular the Irish Sea (ICES, 2007a). Such fisheries are likely to be closer inshore and may target aggregating mature female spurdog. Recent reports from the fishing industry also indicate that fleet behaviour has been affected by rising fuel costs (ICES, 2007b) with many boats fishing closer to home to reduce costs. Such behaviour may mean that there could be increased fishing effort on inshore aggregations. Most Scottish landings are taken from the northern North Sea and west of Scotland. Effort in the Scottish demersal trawl fleet is likely to have reduced in recent years due to decommissioning of vessels and days at sea regulations, and therefore the effort on spurdog due to this fleet may well have been reduced, with about 45% of Scottish spurdog landings originating from demersal trawl fisheries.

The Irish fishery for spurdog mainly consists of bottom otter trawlers, with less than 30% of landings coming from line and gillnet fisheries. Most landings are reported from Division VIa and Division VIIg.

Incidental catch characteristics: While there is no EU minimum landing size for spurdog, there is some discarding of smaller fish, and it is likely that spurdog of <40 or 45 cm are discarded in most fisheries. A recent study on the estimated short-term discard mortality of otter trawl captured spurdog in the Northwest Atlantic showed that mortality 72 hours after capture was in some cases well below the currently estimated 50% for trawling (Mandelman and Farrington, 2006). The survivorship of discards of juvenile spurdog is not known.

<u>Status of stocks</u>

Northeast Atlantic Ocean stocks: a single stock of *Squalus acanthias* is present in the Northeast Atlantic Ocean from the Barents Sea to the Bay of Biscay, with a more southerly Iberian Peninsula stock that is probably distinct from the northern stock. The latest WGEF report (2007) states that in 2006 ICES advised that "The stock (of *S.acanthias*) is depleted and may be in danger of collapse. Target fisheries should not be permitted to continue, and bycatch in mixed fisheries should be reduced to the lowest possible level. A TAC should cover all areas where spurdog are caught in the northeast Atlantic. This TAC should be set at zero for 2007."

Estimates of total amount of spurdog discarded are not routinely provided although some discard sampling does take place. A recent study on the estimated short-term discard mortality of otter trawl captured spurdog in the Northwest Atlantic showed that mortality 72 h after capture was in some cases well below the currently estimated 50% for trawling (Mandelman and Farrington, 2006). When catch weights exceeded 200 kg, there were increases in 72 h mortality that more closely approached prior estimates, indicating that as tows become more heavily packed, there was a greater potential for fatal damage to be inflicted. It should be noted that tow duration in this study was only 45–60 minutes, and additional studies on the discard survivorship in various commercial gears are required, under various deployment times.

In addition to the problems associated with obtaining estimates of the historical total landings of spurdog due to the use of some generic dogfish landing categories, there can be some misreporting (ICES, 2006). While there is no EU minimum landing size for spurdog, there is some discarding of smaller fish, and it is likely that spurdog of <40 or 45 cm are discarded in most fisheries. The survivorship of discards of juvenile spurdog is not known.

Length compositions were presented in ICES (2006), and no new analyses of length data from either market sampling or discard trips were undertaken. WGEF examined length frequency data collected from UK fisheries landings (ICES, 2006), and future studies should examine any data that may also available for other fisheries involved in the spurdog fishery (e.g. from Norway, France and Ireland).

Fishery-independent survey data are available for most regions within the stock area. The overall trends in the various surveys examined by the ICES WGEF indicated a trend of decreasing occurrence and decreasing frequency of large catches, with catch rates also decreasing, although catch rates are highly variable (ICES, 2006). It has been proposed that future studies of survey data for spurdog stock assessment could usefully examine surveys from other parts of the stock area not generally covered by the main fisheries, as well as sex-specific and juvenile abundance trends. (ICES WGEF Report 2007)

Although there have been several studies in the North Atlantic and elsewhere describing the age and growth of spurdog (Holden and Meadows; 1962; Sosinski; 1977, Hendersen *et al.*, 2001), routine ageing of individual from commercial catches or surveys is not carried out.

The last stock assessments of spurdog in the Northeast Atlantic were undertaken by ICES in 2006, with earlier work by Heessen (2003) and Hammond and Ellis (2005). The latest ICES assessment included a delta-lognormal GLM-standardised index of abundance and a population dynamic model. Preliminary results from this model confirmed that spurdog abundance has declined, and that the decline is driven by high exploitation levels in the past, coupled with biological characteristics that make this species particularly vulnerable to such intense exploitation (ICES, 2006). The methods employed during the 2002 SGEF meeting (ICES, 2002) and DELASS project (Heessen, 2003) included catch curve analysis and separable VPA using length distributions sliced according to growth parameters from the scientific literature, and a Bayesian assessment using a stock production model, with a prior for the intrinsic rate of increase set by demographic methods.

The WGEF has provided estimates of total landings of Northeast Atlantic spurdog and has used these, together with UK length frequency distributions in the assessment described above. However, there are still concerns over the quality of these data due to:

- uncertainty in the historical level of catches due to landings being reported by generic dogfish categories
- uncertainty over the accuracy of the landings data due to species mis-reporting
- lack of commercial length frequency information for countries other than the UK
- low levels of sampling of UK landings and lack of length-frequency data in recent years
- lack of discard information

Survey data are particularly important indicators of abundance trends in stocks such as this where an analytical assessment is not available. However, it should be highlighted that the survey data examined by WGEF cover only part of the stock distribution and surveys should be extended to other parts of the stock distribution and not just extrapolated from those areas covered and that survey data are difficult to interpret for the use of assessing the spurdog stocks due to the typically highly skewed distribution of catch per unit effort due to the aggregation effect of the adult females.

Currently no reference points have been proposed for the Northeast Atlantic stock of spurdog. The NE Atlantic stock of spurdog has been declining rapidly and is at its lowest ever level. Preliminary assessments making use of the long time-series of commercial landings data suggest that this decline has been going on over a long period of time and that the current stock size may only be a small fraction of its virgin biomass (< 10%). Although other models have not proved entirely satisfactory (due to the quality of the assessment input data), the exploratory assessments and survey data, also indicate a major decline in spurdog stocks and that most landings since 1946 have been above MSY. Biomass levels are at between 2% and 11% of initial biomass (B_0). The latest stock assessment by ICES in 2006 concluded that the biomass levels were at 5.2 – 6.6% relative to 1905, and 5.2-7.1% relative to 1955 and warned that the stock was in a danger of collapse. The input data available are too limited to give an accurate estimate of current stock status in terms of absolute biomass and fishing mortality, but the trends that have been observed in the stock biomass are worrying.

Mediterranean and Black Sea stocks: spurdog are rare in the Mediterranean, with an estimated biomass of only 6 700t, no stock assessments have been carried out although there is some evidence for localised declines in abundance have been observed around the Balearics. Black Sea stocks have shown a 60% decline based on a previous stock assessment by Prodanov *et al*. (1997). They showed that the exploited stock in the Black Sea rose until 1981 where it peaked at 226 700t but had decreased by 60% to about 90 000t in 1992.

Northwest Atlantic stocks: the Northwest Atlantic stock can be considered one stock, shared by Canada, the United States. In Canada, spurdog quotas are based on historic levels. In the US, the National Marine Fisheries Service (NMFS) imposes science-based trip limits and quotas for spurdogs, but federal management measures are not compulsory in state waters and directed fishing has been occurring at unsustainable levels nearshore.

In 2006, US fishery scientists outlined several reasons for concern about the status of the Northwest Atlantic spurdog stock, including:

- Very low recruitment in recent years

- Imbalance in the sex ratio of the stock, strongly favouring males
- Resulting contraction of overall length range in the population
- Declining average size of females, resulting in fewer and smaller pups.

Research cruises have identified two periods of apparent change in spurdog abundance in the Northwest Atlantic. During the period from the early 1970s to 1992 to abundance and biomass indices from the research surveys increased, but from 1992 to 2002 the abundance had declined from 600 000t to 400 000t, with the majority of this being due to the removal of the larger individuals. When the same pattern is applied only to the biomass of spawning females the biomass has decreased by 75% from 1989 to 1998 and has remained constant since then. This level is at 29% of the target SSB Females.

Recent assessments of the recruitment of spurdogs in the Northwest Atlantic (1997 to 2003) were the seven lowest recruitment estimates (NFSC 2003). This has highlighted the susceptibility of this species to potential collapse due to the slow growth and recruitment rates not being able to replenish the spawning stock biomass quickly. Estimates made by the United States state that the current landings made by the United States and Canada are currently unsustainable.

Recent research on the pupping locations, growth rates, tagging and stock structure have allowed a preliminary population model to be developed for spurdog. The model developed by the DoF in Canada, is an age and sex structured, forward projecting population model, which estimates a starting population size and age structure (in 1960), and projects the population forward by adding recruits (age-1 fish) to the population and subtracting catches and natural mortality. The model is fit to the abundance indices obtained from Canadian and United States research surveys as well as the proportions at length found in the research surveys and commercial catch sampling.

Some of the data series used in the model are short and highly variable, and although the main Canadian data source (the annual summer survey) potentially indicates a stable or slightly increasing population, some of the other surveys indicate a declining trend. As a result, the model in its present form does not provide robust estimates of abundance. There has however been a decline in the total biomass that can be put down to the level of commercial exploitation.

The spring minimum trawlable biomass estimates for spurdog in Canadian and U.S. waters show similar trends, increasing from the early 1980s to the early 1990s, then declining. Mean values for both indices were around 500 000 mt in the early 1990s, declining to about 300 000 mt in 2007 for the Canadian index (a reduction to 60% of the maximum level).

Spiny dogfish are relatively hardy fish, so it is only reasonable to assume that discard mortality is not 100%. There are a few available estimates for dogfish discarding mortality. Published studies report discard mortalities of 0-29% for dogfish caught with OTB (depending on catch size), and 55% mortality for gillnet-caught fish. Therefore, dogfish discard mortality in Canadian waters was calculated as per the following: 25% for OTB catches > 200 kg, 0% for OTB catches < 200 kg, 55% for gillnet catches, 10% for longline catches, and 25% for purse seine catches. The exact values are debatable, although all appear to be consistent with the experimental values reported above and observer observations of the manner in which fishers and their gear treat dogfish catch. Estimated dogfish discard mortality has averaged about 850 mt annually since 1986. Discard mortality often exceeded reported catch prior to 1999, but recent landings have greatly exceeded discard mortality.

Northeast Pacific stocks: the stock of spurdog in the Northeast Pacific has apparently already suffered from two stock collapses in 1910 and in the late 1940s, when it was the most valuable Canadian west coast fishery (Ketchen 1986) most probably for the vitamin A market. The stock has under low levels of commercial exploitation now recovered over most of its original range. The fishery within Canadian waters is now stable with catches of 5 000t – 7 000t from an available quota of around 15 000t. (Wallace *et al.* 2006)

In the US, federal management began in 2006 with trip limits pending stock assessment and development of quotas (possibly in 2007). In Washington State, spurdogs are loosely managed within bottom fish management plans, with mesh restrictions and closure of a pupping ground. Spurdogs are included in an “other species” TAC for bycatch in Alaskan fisheries. Canadian quotas for allocated catches and bycatch were capped at historic levels. Investigations are pending to determine current sustainable exploitation levels. Recent landings are only 30–50% of quotas. In Alaska, direct fishing for sharks is not allowed, although spurdogs are the most common shark species. Currently 90% of spurdog catches within the groundfish fishery is discarded, although the overall abundance appears to be stable or increasing.

Existing specific management measures

Spurdog in the North Sea are currently managed by quota, with a Total Allowable Catch (TAC). In 2007, the TAC was reduced by 20% to 841 t and spurdog bycatch in the North Sea was limited to 5% of the live weight of the retained catch. New for 2007 is a TAC covering areas outside the EC waters of IIa and IV, covering ICES sub-areas IIIa, I, V, VI, VII, VIII, XII and XIV (EU and international waters). The 2008 TAC was set to 2 004 t (total landings for all areas except IIa & IV was 2 087 t in 2006). New for 2008, the quota for this area is allocated eight Member States, with the UK, France and Ireland allocated the largest shares.

In 2007, Norway banned fishing and landing of spurdog in its waters and in international waters in ICES areas I-XIV, except for boats under 28 m using traditional gear inshore and in territorial waters (4 nm). Spurdog bycatch in other fisheries must be landed and Norwegian fisheries managers can stop fisheries when catches reach the prior year’s level. Norway has had a 70 cm minimum landing size limit on spurdog for many years (Shark Alliance, 2007).

Germany, on behalf of the European Community, proposed that *Squalus acanthias* should be included in Appendix II of CITES (CITES, 2007a). However the FAO *Ad Hoc* Expert Panel (FAO, 2007) concluded that: (i) the available evidence does not support the proposal to include *Squalus acanthias* under CITES Appendix II, (ii) the northeast Atlantic population meets the decline criterion for listing on Appendix II and (iii) that there are serious fisheries management failures for some individual populations. Catches from the northeast Atlantic stock, both internally traded in the EU and imported, need to be curtailed.

The quality of catch data for spurdog raises a number of issues including (i) landings being reported as generic dogfish categories, (ii) mis-reporting and (iii) a lack of discard information.

The WGEF has recommended that the next assessment for spurdog be made in 2009.

Effectiveness of management measures

Spurdog are long-lived, slow-growing, have a high age-at-maturity, and are particularly vulnerable to fishing mortality. Population productivity is low, with low fecundity and a protracted gestation period. In the light of this, the risk of depletion of reproduction potential is high.

<u>Recent management advice</u>

According to ICES advice 2008, the only new information available for spurdog (*Squalus acanthias*) is landings data which does not offer any reason to change the advice from 2006. The advice for 2009 and 2010 is therefore the same as the advice given in 2006: *The stock is depleted and may be in danger of collapse. Targeted fisheries should not be permitted to continue, and bycatch in mixed fisheries should be reduced to the lowest possible level. The TAC should cover all areas where spurdog are caught in the northeast Atlantic and should be set at zero (...).*

In addition to the advice of 2006, ICES offers the following considerations:

Simulation modelling has shown there are strong potential benefits to the stock by protecting mature female spurdog in this long-lived species. If a non-zero TAC would be set, ICES recommends the introduction of a **maximum** landing length (MLL). This is expected to deter fisheries targeting areas where large females occur.

The maximum landing length should initially be set at 100 cm. The length at 50% maturity for female spurdog is just over 80 cm and the maximum size of females is about 120 cm. The maximum size of males is about 90 cm. Fecundity of spurdog increases with length and females of 100 120 cm length generally produce the highest amount of pups (10 21). Survivorship of spurdog released from longline fisheries is thought to be high, but will be lower in gillnet and trawl fisheries.

Tope (Galeorhinus galeus)

Tope *Galeorhinus galeus*	
Order: Carcharhiniformes	
Family: Triakidae	
English: School shark, flake, Penny's dog and sharpie shark.	
French: Requin-hâ	
Spanish: Cazón	

Overview

The low population productivity and the tope's relatively low fecundity and protracted reproductive cycle make it highly vulnerable to over-exploitation. The vulnerability of tope to fishery exploitation is emphasized by it being listed as globally vulnerable (IUCN

Red List, 2006).

Tope are taken as a bycatch in trawl, gillnet and longline fisheries, including demersal and pelagic set gears. Though tope are discarded in some fisheries, due to their low market value, other fisheries land this bycatch. Tope is also an important target species in recreational sea angling and charter boat fishing in several areas, with most anglers and angling clubs following catch and release protocols.

The fishery

Gear types, fishing fleets and their distribution: Many of the reported landings are from the English Channel, Celtic Sea and northern Bay of Biscay (Bonfil, 1994). Tope is also caught in Spanish fisheries in the western Cantabrian Sea (Galicia), where about 80% of the landings are from longline vessels, with the remainder from trawl and small gillnets (Anon., 2003). Tope also feature in the catches off mainland Portugal, and are an important component of Azorean bottom long line fisheries (Heessen, 2003; Morato *et al*., 2003). Tope are also caught in offshore long-line fisheries is this area (Pinho, 2005).

EC directed catch trends and characteristics: Tope are often landed as 'dogfishes and hounds' and thus reported species-specific landings are probably an underestimate. Tope catches in ICES areas have increased in the last three years from around 500 t to about 1 000 t, mainly due to increased Spanish landings. The majority of Spanish catches (540 t in 2006) are made in Area IXa, whilst French landings (333 t in 2006) are in Area VII (mainly e).

Incidental catch characteristics: Though some discards information is available for various nations, data are limited for most nations and fisheries. Some UK discard sampling data indicates that juvenile tope tend to be discarded in demersal trawl fisheries, though larger individuals are usually retained, with tope caught in drift and fixed net fisheries usually retained.

Status of stocks

Atlantic Ocean and Mediterranean stocks: in the Atlantic there is one stock of tope, the distribution of which ranges from the southern extremes of the NW coast of Africa and the

Mediterranean Sea northwards to Scotland and Southern Norway. There is no directed fishery for tope in the Atlantic and as such landings of tope are through bycatch, the majority of which is discarded due to its low commercial value (ICES, 2007). There have however, been suggestions that it may be possible to develop a directed tope fishery in the southern North Sea, although this has not become at present.

EU reported landings are mainly from the English Channel, Celtic Sea and northern part of the Bay of Biscay and available from the UK and France fishing vessels. Data shows that the main EU country landing tope is France followed by the UK. Limited data since 2001 is also available from other EU countries such as Denmark, Ireland, Portugal and Spain (ICES, 2007). However, these reported landings of tope are inaccurate as landed tope is commonly included in the generic dogfishes and hounds landings group.

Recordings of tope discards have not been accurately recorded, resulting in there being limited data for most nations and fisheries. Although, once the data is aggregated across years it shows that juvenile specimens are discarded in demersal trawl fisheries, whilst those caught in drift and fixed net fisheries are retained along with larger specimens.

There have been no previous assessments made of tope in the Northeast Atlantic, due to there being insufficient landings data. The lack of data has also prevented recent stock assessments being undertaken.

Indian Ocean stocks: there is an apparent lack of information regarding tope catches in IOTC waters, specifically with regards to their catches and landings. There is very little information prior to the 1970s and there are still problems with obtaining data to present (IOTC, 2007). Shark landing data for the Indian Ocean has a poor resolution due to mis-identification of shark species, consequently any recorded landings will be inaccurate (IOTC, 2007).

A stock assessment for tope in the Indian Ocean has not been identified as a result of the factors that have been previously outlined, which have impeded the possibility of compiling a stock assessment for this region.

<u>Existing specific management measures</u>

Tope are currently a non-target species in commercial fisheries, though some of the bycatch is discarded, due to the low market value in many areas.

Landings data on this species are limited, as they are often included as “dogfishes and hounds”. Catch data are of poor quality, and biological data are not collected under the Data Collection Regulations.

<u>Recent management advice</u>

According to the STECF 2008 report, there is no species specific management advice for Tope in the NE Atlantic. However ICES considers that tope is highly vulnerable to over-exploitation, as they have low population productivity, relatively low fecundity and protracted reproductive cycle. Unmanaged, targeted fisheries elsewhere in the world have resulted in stock collapse (e.g. off California and in South America).

B. PELAGIC SHARKS

Porbeagle shark

Porbeagle shark (*Lamna nasus*)	
Order: Lamniformes	
Family: Lamnidae	
English: Porbeagle	
French: Requin-taupe commun	
Spanish: Marrajo sadinero	

<u>Overview</u>

Porbeagle fisheries are highly profitable (Gauld, 1989). The main countries catching porbeagle are Spain and France. However in the past, important fisheries were prosecuted by Norway, Denmark and the Faeroe Islands. In addition, the species is taken as a bycatch in mixed fisheries, mainly in UK, Ireland, France and Spain. Detailed descriptions of individual national fisheries were presented by WGEF in 2006 (ICES, 2006a).

<u>The fishery</u>

Gear types, fishing fleets and their distribution: The only regular, directed target fishery that still exists is the French fishery, where most of the landings take place during the summer. The majority of landings have come from longliners, mainly from ICES areas VII and VIII. Spanish landings are also from longliners, where the main target species are tuna and swordfish. Landings off Spain have tended to be greater during the spring and autumn, with a drop in the summer (Mejuto, 1985). A reasonably recent analysis of bycatch in Spanish swordfish fisheries did not find porbeagle to be an important component. (ICES, 2006a). Effort has increased in recent years in pelagic longline fisheries for bluefin tuna (Japan, Republic of Korea and Taiwan Province of China) in the North East Atlantic. These fisheries may take porbeagle as a bycatch.

EC directed catch trends and characteristics: Reported landings from the historically most important fisheries, around the United Kingdom and in the North Sea and adjacent inshore waters (ICES areas III & IV) have decreased to very low levels during the past 30–40 years, while catches from the offshore ICES sub-regions west of Portugal (IX), west of the Bay of Biscay (VIII) and around the Azores (X) have increased since 1989. This is attributed to a decline in heavily fished and depleted inshore populations and redirection of effort to previously lightly exploited offshore areas (CITES, 2007b). Since a catch of 1 400 t in 2001, the annual catch has dropped to around 400 t, mostly by France and Spain (214 and 158 t respectively in 2006). The French catch is concentrated in areas VIIj and g and VIIId whilst most of the Spanish catch is from IXa. The French and Spanish are directed longline fisheries although there are now only 8–11 French vessels targeting this species. In 2006, the only other MS to report porbeagle catches were Denmark and Ireland of 3 and 2 t respectively. In the southern part of the stock's distribution, the only ongoing target fishery is that of France. CPUE reached a peak in 1994 and has since declined. The decline since 1999 has been particularly marked, despite relatively constant number of vessels involved (CITES, 2007b). Most recent CPUE is the lowest since the early years of the fishery.

Incidental catch characteristics: This species is taken as a bycatch in mixed fisheries, mainly in UK, Ireland, France (see Biseau, 2006) and Spain. No information is available, although as a high value species, it is likely that specimens caught as bycatch are landed and not discarded. Tuna longliners from Japan, the Republic of Korea and Taiwan, province of China, take an unknown bycatch of L. nasus in the North Atlantic (ICES, 2005). Most of the catch is reportedly discarded or landed at ports near the fishing grounds. Stocks and catches are "under investigation" (Fishery Agency of Japan, 2004).

Status of the stocks

Atlantic Ocean: porbeagles of the Atlantic Ocean appear to constitute two stocks. One stock in the Northwest Atlantic Ocean that undertakes extensive migrations between southern Newfoundland (Canada) in summer to at least Massachusetts (USA) in the winter, and another in the Northeast Atlantic Ocean. Tagging studies suggest there is no mixing between these two populations.

The Northwest Atlantic Ocean porbeagle stock has been assessed using an age and ex structured forward projecting population model, utilising the available landings, CPUE, length frequency and tagging data to estimate the population size. Different scenarios were used for different levels of assumed productivity.

The CPUE data indicate a declining trend in porbeagle numbers from 1985 to 2004. The model estimates the population size in 2005 at between 12% and 24 % of its level in 1961, with the female spawner abundance at about 12% to 15% of its 1961 level. A management plan was introduced to allow the recovery of the porbeagle stock in 2002. The estimated change in population size since the introduction of the plan has resulted in a current estimated population size of 99% to 103% of the 2002 level, indicating that the management plan has appeared to have been effective so far.

Standard reference points to characterise the recovery have not been developed for porbeagle in the Northwest Atlantic. Instead the reference points based on the number of female spawners have been used:

SSN_{MSY} Number of female spawners at MSY

$SSN_{20\%}$ Number of female spawners at 20% of initial unexploited equilibrium levels (SSN_0)

The model uses an integrated approach combining life history parameters and fisheries assessment. A number of different scenarios were used, giving a range for $SSN_{20\%}$ of 14 500 to 17 000 and for SSN_{MSY} a range of 31 000 to 41 000. The model also allowed for the projection of the population and age structure over a 100 year time series with different levels of incidental mortality. The model suggests that the population of porbeagle in the Northwest Atlantic can recover if under the most conservation scenario estimates the incidental mortality rates are kept below 4% of the spawning stock numbers.

The conservation status of the porbeagle is of major concern because of the drastic decline in catches from targeted fisheries in the North Atlantic and continuing exposure of the species to intensive high-seas pelagic longline fisheries (with finning and capture trauma contributing to mortality) wherever it occurs. Recovery is possible if incidental mortality is kept to low levels, but the uncertainty about the porbeagle catch data and life history parameters leads remains a potential block to a clear stock assessment.

A separate stock of porbeagle is considered to occur in the North East Atlantic (Heessen, 2003). A transatlantic migration for this species has been reported (Green, 2007), and so further tagging studies are required to better examine stock structure between the two North Atlantic stocks. The North-eastern Atlantic stock covers part of the CECAF area as well as that covered by ICES, but catch data are unavailable for this part of the stock.

In 2006, ICES advised that no targeted fishing for porbeagle from the Northeast Atlantic stock should be permitted on the basis of its life history and vulnerability to fishing. In addition, measures should be taken to prevent bycatch of porbeagle in fisheries targeting other species, particularly in the depleted northern areas. In 2006, Germany proposed that porbeagle be added to Appendix II of CITES. This proposal did not get the support of the required majority at the CITES Conference of Parties in 2007.

Available landings data are thought to be incomplete for the majority of flag states. For some nations, porbeagle will have been reported within "sharks *nei*", and there can be some confusion with mako (*Isurus oxyrinchus).* In addition there are no fishery-independent survey data are available for the NE Atlantic, although some limited records from recreational fisheries may be available these are unlikely to be of a sufficient level of coverage to provide a good basis for a stock assessment. No stock assessment has therefore been undertaken as the limitations of the available landings data and absence of fishery-independent information hampers assessments of this stock. As a result no reference points have been proposed for this stock.

Indian Ocean stocks: FAO landings data on porbeagle catches for the Indian Ocean are severely limited by the lack of species-specific catch, discard and landings data from the major fleets. Due to the lack of data available no quantitative stock assessment has been undertaken by the IOTC Working Party on Ecosystems and Bycatch and due to the low level of catch data it will likely remain a low priority.

Pacific Ocean stocks: FAO landings data on porbeagle sharks for the Pacific Ocean are limited to the Southeast Pacific Ocean. Due to the lack of data available no quantitative stock assessment has been undertaken.

Existing specific management measures

In 2006, ICES advised that no targeted fishing for porbeagle should be permitted on the basis of its life history and vulnerability to fishing. In addition, measures should be taken to prevent bycatch of porbeagle in fisheries targeting other species, particularly in the depleted northern areas. In 2005, ICES advised that, given the apparent depleted state of this stock, no fishery should be permitted on this stock. This advice was further considered by STECF in 2006 (see Section 3 of STECF, 2006a), and STECF reiterated that no directed fishing for porbeagle in the NE Atlantic be permitted and that additional measures be taken to prevent bycatch of porbeagles in fisheries targeting other species. In 2006 the Commission for the European Communities proposed establishing a TAC for porbeagle for European Community waters and community vessels in ICES Subareas I–XIV of 240 t (CEC, 2006), the final EC regulations No 41/2006 did not list a TAC for porbeagle. The 2008 regulations have set a precautionary TAC at 581 t for EC vessels, mostly allocated to France and Spain.

Germany, on behalf of the European Community, proposed that *Lamnus nasus* should be included in Appendix II of CITES (CITES, 2007b). However the FAO *Ad Hoc* Expert Panel (FAO, 2007) concluded that: (i) the available evidence does not support the proposal to include the porbeagle shark, *Lamna nasus*, in CITES Appendix II, (ii) porbeagles in the northeast Atlantic Ocean may meet Appendix II criteria, but the limited data that were available were not sufficient to assess the extent of the decline and (iii) though adequate management measures are in place in some regions, there are others where some form of management is urgently needed.

Landings data are incomplete and further studies are required to better collate catch data. For some nations, porbeagle is reported within “sharks nei”, and there can be some confusion with mako *Isurus oxyrinchus*.

Assessments have been undertaken for the NW Atlantic stock (e.g. Campana *et al*., 1999, 2001), for which there are more data. WGEF expect to conduct a new assessment of Porbeagle shark in 2008.

Effectiveness of management measures

Porbeagle is long-lived, slow-growing, has a high age-at-maturity, and is particularly vulnerable to fishing mortality. Population productivity is low, with low fecundity and a protracted gestation period. In the light of this, risk of depletion of reproduction potential is high.

Recent management advice

According to ICES advice 2008, available information from Norwegian and Faroese fisheries shows that landings have declined strongly and have almost ceased. The stock is considered to be depleted. The directed fisheries have not resumed, implying that the stock has not recovered, at least in the areas where those fisheries took place.

While the CPUE indices for a targeted fishery may not reflect trends in relative abundance, CPUE data have been relatively stable since 1996. CPUE of the French fishery has declined since a peak in 1994 and has been stable at a lower level since then.

Given the state of the stock, no targeted fishing for porbeagle should be permitted and bycatch should be limited. Landings of porbeagle should not be allowed.

Basking Shark (Cetorhinus maximus)

Basking shark ***Cetorhinus maximus*** Order: Lamniformes Family: Cetorhinidae English: Basking shark, bone shark, elephant shark, hoe-mother, shark, and sun-fish French: Pélerin Spanish: Peregrino	

Overview

The basking shark is listed in Appendix II of CITES (and also covered by the Convention on Migratory Species) and subsequently included in Annex B of the EU Wildlife Trade regulation (EC) No. 338/97.

Historically there has been a Norwegian directed fishery for basking shark using whaling technology in order to obtain their oil. Small fisheries also existed off the Irish west coast and Scotland, with the latter finishing in 1994.

The fishery

Gear types, fishing fleets and their distribution: In 2006 there were no targeted fisheries for basking sharks in Norway, UK or Ireland.

EC directed catch trends and characteristics: In 2006 the only MS to report a catch was France (one tonne). With the exception of a Portuguese catch of around 27 t in 2004, over the last ten years this fishery has been effectively inactive within the EU.

Incidental catch characteristics: Limited quantitative information exists on basking shark discarding in non-directed fisheries. However, anecdotal information is available indicating that this species is caught in gillnet and trawl fisheries in most parts of the ICES area. Most of this bycatch takes place in the summer months as the species moves inshore. The total extent of these catches is unknown.

Status of the stocks

Atlantic Ocean: historically basking sharks have been primarily caught by Norwegian fisherman. The Atlantic North East had a sporadic fishery until the 1920s when the fishery become more industrialised. During the 1930s the basking shark landings increased due to expansion of the fishery. Basking shark catches ranged from 1266 – 4266 sharks / year between 1959 – 1980. Whilst, off the coast of Ireland an average of 1475 sharks / year were caught between 1951 – 1955 (ICES Advisory Committee on Fishery Management, 2007).. The intensive exploitation of basking sharks primarily by Norwegian vessels can be shown by

CPUE data available from 1965 – 1985 (ICES, 2007), which shows that there was a significant decrease in the CPUE during this time, which can be inferred as indicating that the stocks of basking shark have been depleted.

Currently there is no directed fishing for Basking sharks with there being no reported direct catches since 2001, with Norwegian bycatch only 16 tonnes down from 100 tonnes in 2005 (ICES, 2007). As there is no longer a directed fishery it makes compiling a stock assessment more difficult and as such there are no up to date stock assessments available for the basking shark in the NE Atlantic. The difficulty in producing an up to date stock assessment is increased by the requirement of EU fishing vessels to discard all bycatch, therefore meaning no stock assessment can be carried out. Limited data however, is available from these discards of basking sharks from non-directed fisheries (ICES, 2007).

Mediterranean and Black Sea stocks: the Basking shark is listed on Annex II associated with the protocol 'Endangered or Threatened Species' of the Barcelona Convention for the Protection of the Mediterranean Sea (1976). Consequently the Basking Shark receives full protection in the Mediterranean Sea. Although the Basking Shark is fully protected in the Mediterranean there is no international co-operation to introduce a stock assessment for the Mediterranean. As such there have been no stock assessments identified for the Basking Shark in the Mediterranean.

Existing specific management measures

Since 2007, the EU has prohibited fishing for, retaining on board, transhipping or landing basking sharks by any vessel in EU waters or EU vessels fishing anywhere (Council regulation (EC) No 41/2006). ACFM advice in 2006 was for a zero TAC in 2007. Based on this, Norway banned all directed fisheries for basking shark in 2006, and the ban was continued in 2007. Live specimens caught as bycatch must be released, while dead or dying specimens can be landed and sold as before.

The basking shark is listed in Appendix II of CITES (and also covered by the Convention on Migratory Species) and subsequently included in Annex B of the EU Wildlife Trade regulation (EC) No. 338/97.

Basking shark was listed on Appendix II of the Convention on International Trade in Endangered Species (CITES) in 2002. The basking shark was listed on the OSPAR (Convention on the protection of the marine environment of the north-east Atlantic) list of threatened and / or declining species in 2004.

Official live weights reported prior to 1990 probably are overestimations (due to imprecise conversion factors) and should be adjusted downwards.

Effectiveness of management measures

Basking sharks are long-lived, slow-growing, have a high age-at-maturity, and are particularly vulnerable to fishing mortality. Population productivity is low, with low fecundity and a protracted gestation period. In the light of this, the risk of depletion in reproduction potential is high.

Recent management advice

According to ICES advice 2008, the only new information available for basking shark (*Cetorhinus maximus*) is landings data which gives no basis to revise the advice from 2006.

The advice for 2009 and 2010 is therefore the same as the advice given in 2006: *"No targeted fishing for basking shark should be permitted and additional measures should be taken to prevent bycatch of basking shark in fisheries targeting other species. A TAC should cover all areas where basking sharks are caught in the northeast Atlantic. This TAC should be set at zero"*.

ICES notes that from 2007 onwards the TAC covers all areas where basking sharks may be caught.

Blue shark (Prionace glauca)

Blue shark ***Prionace glauca***	
Order: Carcharhiniformes	
Family: Carcharhinidae	
English: Blue shark, blue dog and blue whaler	
French: Peau bleue	
Spanish: Tiburón azul	

<u>Overview</u>

Although there are no large-scale directed fisheries at this species, it is a major bycatch in many fisheries for tunas and billfishes, where it can comprise up to 70% of the total catches (ICCAT, 2005). Observer data indicate that substantially more sharks are caught as bycatch than reported in catch statistics. For the entire North Atlantic, catch is estimated to exceed 100 000 t with mortality estimates between 26 000 to 37 000 t. Blue sharks are also caught in considerable numbers in recreational fisheries, including in the ICES area (Campana *et al.*, 2005).

<u>The fishery</u>

Gear types, fishing fleets and their distribution: An examination of fishing effort in FAO Area 27 (NE Atlantic) shows that the Spanish Basque fleet is currently the predominant EC country catching around 400 t of blue shark per annum, although until 2003 Portugal caught up to 2 000 tonnes yearly. France also catches significant volumes at around 107 t in 2006. Taiwan, Japan and China also catch blue shark, although their catches are not specified to individual FAO area, only the whole Atlantic Ocean. A detailed description of the Basque fishery was presented by Diez *et al*. (2007). This ICES Working Document shows that blue shark used to be a traditional and rather low bycatch of many Basque (Spanish) fleets operating in the Bay of Biscay (ICES Divisions VIIIa, b, c, d). Since 1998 a small fleet of Basque longliners spend part of their yearly activity targeting blue sharks in the Bay of Biscay VIIIa,b,c,d (Diez *et al*, 2007). Blue sharks are caught predominantly in ICES Areas VII, VIII, IX, X and XII.

EC directed catch trends and characteristics: The 2006 EC catch of 4,162 t was mainly caught by Portugal (2 627 t), Spain (1 400 t) and France (134 t). The Portuguese catch is mainly from Area IX, whilst the Spanish catch is from IXa, VIIIa,b,c,d and X.

Incidental catch characteristics: Discards are presumed to be far higher than reported (Campana *et al.*, 2005), especially in high seas fisheries. Shark bycatch in some fisheries are finned, although the USA, Canada and EC have taken measures to stop finning. If left intact, survival rates for discarded sharks can be high, the proportion of blue sharks alive at hauling longlines is given between 80–90% and about 60% of these sharks released may survive (Campana *et al.*, 2005).

<u>Status of the stocks</u>

Atlantic Ocean stocks: the ICCAT pelagic shark assessment working group (ICCAT, 2005) considers there to be a single stock of blue shark (*Prionace glauca*) in the North Atlantic, one in the South Atlantic and one in the Mediterranean (Heessen, 2003; Fitzmaurice *et al.*, 2005, ICCAT, 2004).

ICCAT started collecting data on shark by-catches from the Atlantic tuna fleets only in 1994, and catch reporting of sharks has not been good. Estimates from a study of the Hong Kong shark fin trade (Clarke 2003) showed that blue shark catches were underreported globally. Based on this information ICCAT attempted to construct a more accurate picture of shark catch and mortality in the Atlantic tuna fleets based on ratios of shark to tuna landings from fleets reporting both to ICCAT and using these ratios to reconstruct an example catch history by major gear type.

Several CPUE series have been discussed within ICCAT for use in blue shark stock assessments and the following catch rate series were selected as being the best representative series:

- Japanese longline logbook series (applied to North and South Atlantic separately);
- USA longline logbook series (applied to North Atlantic);
- Chinese Taipei longline series (applied to South Atlantic); and
- Brazil NE and SE longline series (applied to South Atlantic; partial series).

Various different models where used for the stock assessment of Atlantic blue shark. A surplus production model was applied to the catch and CPUE data available at the 2001 ICCAT Bycatch Working Group meeting (SCRS/2001/021), implemented with the BSP (Bayesian Surplus Production) software. The model used informative Bayesian priors for historical catches (before reliable catch data of blue sharks were collected), and the biomass at the beginning of the time series. Model results implied that current levels of harvest are sustainable for blue sharks. The greatest source of uncertainty in the model results was the missing catch data early in the time series. For the North Atlantic stock of the runs that produced results these showed an average current status around 85% of K (although the trajectory was quite variable. The ICCAT Bycatch Working Group noted that there is a wide range of other sensitivity analyses including alternative catch scenarios that could be examined into the future to help define the most appropriate set of model assumptions for these data. The Group noted that the model was not able to track the decrease in CPUE in the recent years. For blue shark in the South Atlantic, six sensitivity analyses were run, and all but one converged. The runs all showed an average current status around 75% of K.

No full-scale benchmark assessment has been conducted to date due to limitations on available data for this species. ICCAT completed a preliminary stock assessment in 2004, but no management recommendations were made. Although the North Atlantic Stock appeared to be above biomass in support of MSY, the assessment remained highly conditional on the assumptions made. These assumptions included (i) estimates of historical shark catch, (ii) the relationship between catch rates and abundance, (iii) the initial state of the stock in 1971, and (iv) various life-history parameters. The authors pointed out that the data used for the assessment did not meet the requirements for proper assessment (ICCAT, 2006), and further research and better resolved data collection for this species was highly recommended. A recent study of the population trends of Atlantic pelagic predatory fishes reported that blue sharks have declined over 60% in recent decades (e.g. Baum *et al*., 2003), though this study has attracted some controversy (see Baum *et al*., 2005 and Burgess *et al*., 2005a,b). Other studies on blue shark have shown smaller declines (e.g. Campana *et al*., 2005), or significant declines in males only (Simpfendorfer *et al*., 2002).

SCRS/2004/105 presented a detailed age-structured population dynamics model which could be used to describe the dynamics of shark populations and evaluate the effects of exploitation. Uncertainty in the understanding of shark dynamics and exploitation patterns was again incorporated using Bayesian methods. The model failed to converge when the complete CPUE series from Japanese longline for blue shark in the North Atlantic was used. However, convergence of the model was achieved when the model was run using the complete CPUE series from the USA longline fishery and the CPUE series from the Japanese longline without the CPUE values for years 1971-1973 (the first 3 points of the series). Thus, the different runs were conducted using the complete USA longline CPUE and the modified CPUE series for the Japanese longline. The model was run using two different assumptions about the weighting of the CPUE series; equal weighting (Run 1) and catch dependent weighting (Run 2). The model was also run assuming options for biannual (Run 1) or annual reproduction cycle (Run 3). The mode of the results of the runs showed the virgin mature fish biomass smaller than 700 000t but also gave considerable probability to much greater values. The probability density function (pdf) for the depletion of the population supported values for population depletion which are close to 50%. However, for all runs considered, the mode of the distribution supported values for the ratio of current stock to virgin stock size which were very close to 1 (i.e. showing no depletion).

In summary, both North and South Atlantic blue shark the current biomass appears to be above the biomass at MSY. In many model runs, stock status appeared to be close to unfished biomass levels. A full evaluation of the sensitivity of model outcomes to the assumptions made by the Working Group (e.g. initial biomass) was not possible and it was recommended that such studies should be carried out before drawing stronger conclusions. The Working Group stated that without solving these problems, they cannot present either more precise or accurate views of the status of these stocks, since the available data are quite uninformative. No reference points have been proposed for this stock.

Document SCRS/2004/112 proposes a statistical framework for estimating blue shark movement and fishing mortality rates from the tag-recapture data of the NMFS Cooperative Shark Tagging Program. The dataset of the NMFS-CSTP shows potential for use in a blue shark stock assessment.

Indian Ocean: in 2005 (the latest data available to the IOTC Working Party on Bycatch and Ecosystems), seven countries reported catches of blue sharks in the IOTC region although this data is not used by IOTC as its likelihood of being representative is highly uncertain. FAO landings data on elasmobranchs for the Indian Ocean are severely limited by the lack of species-specific data and data from the major fleets.

There is little information on blue shark biology in the Indian Ocean and no information is available on stock structure. The catch estimates for blue shark are highly uncertain and CPUE trends are also not available as there are no surveys specifically designed to assess shark catch rates in the Indian Ocean. Trends in localised areas might be possible in the future (for example, from the Kenyan recreational fishery) but these are likely to be of limited use in assessing the stock of the Indian Ocean overall. A standardized CPUE for blue shark caught by the Japanese tuna longline fishery in the Indian Ocean was calculated using logbook data from the period 1971 to 2005. For much of this period, shark catches were not recorded by species, therefore all sharks were assumed to be blue sharks, which would of course lead to some over reporting of blue shark abundance. A recent Japanese observer programme in the Eastern Indian Ocean recorded 77 blue shark out of a total of 3,718 specimens. This was the highest catch rate among sharks species encountered at 0.268 per 1000 hooks. Other studies conducted in the Indian Ocean using observer data have shown that blue sharks constitute 1% of all species caught on longlines by number and up to 4% by weight, with sharks overall making up 1.76% by number and 5.38% by weight at a catch rate of 0.243 per 1000 hooks (MRAG, 2004) The results from the analysis indicate a relatively stable blue shark CPUE except for some relatively high catch rates in 1998 and 1999. Overall, the results of this analysis suggest that the stock status of blue sharks has not changed drastically over the past three decades in the high seas area of the Indian Ocean.

Due to the lack of data available no quantitative stock assessment has been undertaken by the IOTC Working Party on Ecosystems and Bycatch. There is a clear paucity of information available on this species and this situation is not expected to improve in the short to medium term. There is no quantitative stock assessment or basic fishery indicators currently available for blue shark in the Indian Ocean therefore the stock status is highly uncertain. Blue sharks are commonly taken by a range of fisheries in the Indian Ocean and in some areas they are fished in their nursery grounds. Because of their life history characteristics – they are relatively long lived (16-20 years), mature at 4-6 years, and have relativity few offspring (25-50 pups every two years), the blue shark is vulnerable to overfishing.

Pacific Ocean: blue shark is not actively managed internationally within the Pacific and there are no quotas set by any of the RFMOs. Recent studies indicate the species, which may comprise a single Pacific-wide stock, is abundant and healthy ($F/F_{MSY} < 0.5$). There is some evidence for a decline of the stocks of blue shark in the central Pacific (Nakano 1996), but not yet evidence of overfishing. The north Pacific blue shark stock appears healthy (Kleiber *et al*. MS1) with a current population size that is above B_{MSY} with $F/F_{MSY} < 0.5$, and that MSY could be 1.7-3.0 times the catch observed in the late ‘80’s early ‘90s. Sibert *et al.* estimate that the North Pacific blue shark population is at 91% of the unexploited level. In spite of being the largest component of the bycatch incidentally taken by high seas, longline fleets for over 50 years the MSY for the north Pacific stock is tentatively estimated to be approximately 120 000t. No harvest guidelines or reference points have been recommended at this time.

Existing specific management measures

EC Regulation No. 1185/2003 prohibits the removal of shark fins of this species, and subsequent discarding of the body. This regulation is binding on EC vessels in all waters and non-EC vessels in Community waters.

Data quality issues: the landings data for blue shark are unreliable due to the amount of pelagic sharks that are thought to be declared under generic sharks “nei” categories (Johnston *et al*., 2005).

ICCAT completed a preliminary stock assessment in 2004, but no management recommendations were made. A joint ICES / ICCAT working group plan a new assessment in 2009.

Effectiveness of management measures

Catch data of pelagic sharks are considered unreliable as many sharks are not landed whole but are landed as fins. For accurate stock assessments of pelagic sharks, data from throughout the North Atlantic must be made available to the Working Group. In addition, reporting procedures must be strengthened so that all landings are reported, and that landings are reported to species level, rather than generic nei categories.

Recent management advice

According to the 2008 report of the SCRS of ICCAT, for both North and South Atlantic blue shark stocks, although the results are highly uncertain, biomass is believed to be above the biomass that would support MSY and current harvest levels below FMSY. Results from all models used were conditional on the assumptions made (*e.g.*, estimates of historical catches and effort, the relationship between catch rates and abundance, the initial state of the stock in the 1950s, and various life-history parameters), and a full evaluation of the sensitivity of results to these assumptions was not possible during the assessment. Nonetheless, as for the 2004 stock assessment, the weight of available evidence does not support hypotheses that fishing has yet resulted in depletion to levels below the Convention objective.

Shortfin mako shark

Shortfin mako shark *Isurus oxyrinchus*	
Order: Lamniformes	
Family: Lamnidae	
English: Shortfin mako shark, blue pointer, blue shark, bonito shark	
French: Taupe bleue	
Spanish: Marrajo dientuso	

Overview

The shortfin mako is a highly migratory pelagic species that is caught frequently as a bycatch, mostly in longline fisheries targeting tuna and billfish. Like porbeagle shark, it is a relatively high-value species (cf blue shark, which is of lower commercial value). Recreational fisheries on both sides of the North Atlantic also catch this species, although some of these fish are released.

the Shortfin Mako shark (*Isurus oxyrinchus*) is a large pelagic species attaining a maximum total length of 3.94m (DFO Atlantic Fisheries, 1996). The Shortfin Mako frequents warm-temperate and tropical waters circumglobally, preferring water temperatures ranging between 17 – 22 °C (DFO Atlantic Fisheries, 1996., NAFO, 2007). The Shortfin Mako is typically an offshore species that is present between the surface and a depth of 500 m, however they have also been observed in shallower littoral zones (NAFO, 2007). The Shortfin Mako's morphology is characterised by a crescent-shaped tail with pronounced keels in addition to its large fins (ICES, 2007).

The Shortfin Mako is an ovoviviparous species (DFO Atlantic Fisheries, 1996) that has a lifespan of 30 years (NAFO, 2007). Males are sexually mature at 7-9 years old at a total length of 2 – 2.2 m, whilst females become sexually mature at a much later age (18 – 21 years old), at which time their total length is 2.7 – 3 m (NAFO, 2007). The Shortfin Mako has a long gestation period of 15 – 18 months and only produces 11 young every 3 years (NAFO, 2007). The Shortfin Mako can be classified as an K-species due to its life history characteristics of low fecundity and delayed sexual maturity.

The life history characteristics of elasmobranchs that makes them susceptible to exploitation are less apparent in the Shortfin Mako meaning it has a greater recovery potential than other elasmobranch species. The reason for this is due to the fact that the Shortfin Mako' has a rapid growth rate in comparison to other elasmobranchs (DFO Atlantic Fisheries, 1996). However, in comparison to the commercial teleost fisheries species the Shortfin Mako's growth rate is still moderate (NAFO, 2007).

The susceptibility of the Shortfin Mako to exploitation is increased due to their migrational movements. Tagging work on Shortfin Makos in the North Atlantic has shown that they migrate over 3 000 km (ICES, 2007). This is supported by the DFO Atlantic Fisheries (1996) who found that the Shortfin Mako exhibited seasonal movements.

The fishery

Gear types, fishing fleets and their distribution: In the ICES area, shortfin mako sharks are caught predominantly by Portuguese and Spanish vessels in Subareas, VIII, IX, and X. EC vessels also operate in FAO Area 34.

EC directed catch trends and characteristics: the Portuguese catches make up the vast majority of EU landings, accounting for 730 of the 820 t caught over in ICES waters 2006. Over half this was caught in area IX (off the west coast of Portugal), with 141 t caught in area X (Azores).

Incidental catch characteristics: Estimates of shortfin mako bycatch are difficult, as available data are limited and documentation is incomplete. There is considerable bycatch of shortfin mako sharks in Japanese and Taiwanese tuna longliners operating in the Atlantic. Estimates given in Matsunaga and Nakano (2005) indicate bycatch levels in Japanese longline operations of 300 to 500 t of shortfin mako annually for the North Atlantic.

Status of the stocks

Atlantic Ocean stocks: historically the Shortfin Mako has been caught as bycatch predominantly in tuna and billfish longline fisheries. It is a high value species and as such is also targeted by recreational fisheries in both the North East and North West Atlantic. At present there is still no directed fishery towards the Shortfin Mako which is considered to have only a single stock in the North Atlantic.

Current EU catches of the Shortfin Mako are predominantly by Portuguese and Spanish vessels, although landings from Spanish vessels only began in 2004. The UK also have reported landings, but these are negligible being below 3 tonnes. The Portuguese report the largest landings with the maximum reported being 542 tonnes in 2003, which made up 50 % of the total North Atlantic reported landings (ICES, 2007). The catch data provided is incomplete and as such it is difficult to accurately determine catches and produce stock assessments. However, CPUE data has shown that the North Atlantic stock has been declining since 1975 although further analysis is required (ICES, 2007).

Despite the catch data available and the CPUE data indicating declining stocks there have been no recent stock assessments. A decision was taken not to undertake stock assessments as there was limited data all of which was considered poor quality. The lack of accurate precise data is emphasized by the fact that NAFO uses commercial and recreational fisheries to provide them with abundance indices (NAFO, 2007).

Mediterranean stocks: it is considered that there are two stocks of Shortfin Mako in the Mediterranean; a Northern Stock and a Southern Stock (ICCAT, 2005). A lack of available landings data and relevant catch data from commercial fisheries has resulted in no stock assessments being able to be undertaken. Increased levels of data recording are required to enable stock assessment to be achieved.

Indian Ocean stocks: historically there has been very little information on the status of the Shortfin Mako fishery in IOTC waters and it is apparent that landings of Shortfin Mako have gone unreported in the past. Consequently, IOTC catches of Shortfin Mako sharks are highly inaccurate and have little representativeness. (IOTC, 2007)

A lack of representative data is emphasized by the fact there is no extensive FAO data due to a lack of species-specific data from major fleets (IOTC, 2007). A lack of landings information subsequently means it has not been possible to carry out a stock assessment. In addition CPUE has not been available as no surveys have been carried out enabling the suitable data to be obtained to produce the relevant CPUE information.

Existing specific management measures

EC Regulation No. 1185/2003 prohibits the removal of shark fins of this species, and subsequent discarding of the body. This regulation is binding on EC vessels in all waters and non-EC vessels in Community waters.

Effectiveness of management measures

Catch data of pelagic sharks are considered unreliable, as many sharks are not reported on a species-specific basis, and some fisheries may have only landed fins.

Recent management advice

According to the 2008 report of the SCRS of ICCAT, estimates of stock status for the North Atlantic shortfin mako obtained with the different modelling approaches were much more variable than for blue shark. For the North Atlantic, most model outcomes indicated stock depletion to about 50% of biomass estimated for the 1950s. Some model outcomes indicated that the stock biomass was near or below the biomass that would support MSY with current harvest levels above FMSY, whereas others estimated considerably lower levels of depletion and no overfishing. There is a non-negligible probability that the North Atlantic shortfin mako stock could be below the biomass that could support MSY. A similar conclusion was reached by the Committee in 2004, and recent biological data show decreased productivity for this species. Only one modelling approach could be applied to the South Atlantic shortfin mako stock, which resulted in an estimate of unfished biomass which was biologically implausible, and thus the Committee can draw no conclusions about the status of the South stock

Thresher sharks (Alopias spp.)

<table>
<tr><td>
Common thresher Alopias vulpinus and bigeye thresher A. superciliosus
Order: Lamniformes
Family: Alopiidae
English: Thresher shark, common thresher, fox shark, sea fox, swiveltail, and thrasher
French: Renard and renard à gros yeux
Spanish: Zorro and zorro ojón
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The fishery

Gear types, fishing fleets and their distribution: There is no target fisheries for thresher sharks in the NE Atlantic; although they are taken as a bycatch in longline and driftnet fisheries (e.g. Buencuerpo *et al*., 1998; Macias *et al*., 2003; Mejuto *et al*., 2001: Tudela *et al*., 2005). Both species are caught mainly in longline fisheries for tunas and swordfish, although they may also be taken in driftnet and gillnet fisheries. The fisheries data for the ICES area are scarce, and they are mostly unreliable, because it is likely that the two species (*A. vulpinus* and *A. superciliosus*) are mixed in the records.

EC directed catch trends and characteristics: The main landing countries are Portugal (106 t in 2006), Spain (59 t in 2006) and France (23 t in 2006). The majority of the Portuguese and Spanish catches are made in Area IX, whilst the French catch is in Area VIII.

Incidental catch characteristics: No data is available.

Status of the stocks

Atlantic Ocean stocks: two species of thresher sharks occur in the Northeast Atlantic Ocean the common thresher (*Alopias vulpinus*) and bigeye thresher (*A. superciliosus*). Of these, *A. vulpinus* is the dominant species in the ICES area. There is little information on the stock identity of these globally distributed sharks. In the absence of records of transatlantic migrations, assume there to be a single NE Atlantic and Mediterranean stock of *A. vulpinus*. This stock could possibly be extended south in to the CECAF area. No detailed stock assessments have been performed for thresher sharks in the North Atlantic though both the common and bigeye threshers are classified as vulnerable by the IUCN.

Indian Ocean stocks: FAO landings data on elasmobranchs for the Indian Ocean are severely limited by the lack of species-specific catch, discard and landings data from the major fleets. There is also little information on the biology of thresher sharks in the Indian Ocean and no information is available on stock structure, although three species of thresher shark, the pelagic thresher (*A. pelagicus*), common thresher (*A. vulpinus*) and bigeye thresher (*A. superciliosus*). The catch estimates for thresher sharks are highly uncertain and CPUE trends are also not available as there are no surveys specifically designed to assess shark catch rates in the Indian Ocean.

Observer programme estimates conducted in the Indian Ocean using observer data have shown that pelagic thresher sharks constitute 0.22% of all species caught on longlines by number and up to 0.76% by weight, at a catch rate of 0.056kg per 1000 hooks (MRAG, 2004)

Due to the lack of data available no quantitative stock assessment has been undertaken by the IOTC Working Party on Ecosystems and Bycatch. There is a clear paucity of information available on thresher shark species and this situation is not expected to improve in the short to medium term. There is no quantitative stock assessment or basic fishery indicators currently available for thresher sharks in the Indian Ocean therefore the stock status of each species is highly uncertain. All three thresher sharks are classified as vulnerable by the IUCN.

Pacific Ocean stocks: FAO landings data on elasmobranchs for the Pacific Ocean are severely limited by the lack of species-specific catch, discard and landings data from the major fleets.

Existing specific management measures

EC Regulation No. 1185/2003 prohibits the removal of shark fins of this species, and subsequent discarding of the body. This regulation is binding on EC vessels in all waters and non-EC vessels in Community waters.

Despite its midrange intrinsic rebound potential, the management of *A. vulpinus* is of concern, as shown by the quick decline of the USA Pacific fishery targeted on this species and which ended in the 1990 due to overfishing (Hanan *et al*., 1993; Cailliet *et al*., 1983). Liu *et al*. (1998, 2006) consider that *Alopias* spp. are particularly vulnerable to overexploitation and in need of close monitoring because of its high vulnerability resulting from its low fecundity and relatively high age of sexual maturity. Precautionary management measures could be adopted for the NE Atlantic thresher sharks, due to the fishing effort for large pelagic fishes in the region.

The two species are recorded mixed or separately; however analysis of the available data seems to indicate that they are often mixed even when recorded under specific names. Also, some discrepancies are observed when different sources of data are available (e.g. FAO, ICCAT, national data).

Other pelagic sharks

Besides the species examined above, several other pelagic sharks and rays occur in the ICES areas, including:

- White shark, Carcharodon carcharias
- Longfin mako, *Isurus paucus*
- Spinner shark, Carcharhinus brevipinna
- Silky shark, Carcarhinus falciformis
- Oceanic whitetip, Carcharhinus longimanus
- Dusky shark, Carcharhinus obscurus
- Sandbar shark, Carcharhinus plumbeus
- Night shark, Carcharhinus signatus
- Tiger shark, Galeocerdo cuvier
- Scalloped hammerhead, *Sphyrna lewini*
- Great hammerhead, *Sphyrna mokarran*
- Smooth hammerhead, *Sphyrna zygaena*
- Pelagic stingray, Pteroplatytrygon violacea
- Devil ray, Mobula mobular

These pelagic sharks and rays are taken as bycatch in tuna and swordfish fisheries (mainly by longliners, but also by purse seiners). Some of them, like the hammerheads and the requiem sharks, could constitute a noticeable component of the bycatch and are landed, but other are only sporadically recorded (e.g. great white; tiger; pelagic stingray, devil ray). Among these species, some are an important bycatch in high seas fisheries (e.g. silky shark and oceanic whitetip) and others are taken in continental shelf waters of the ICES area (e.g. various requiem sharks and hammerhead).

No accurate estimates of catch are available, as many nations that land various other species of pelagic sharks record them under generic landings categories. Portugal and Spain have reported landings of hammerheads and the requiem sharks in ICES sub-areas VI, VIII, IX and X, totalling 86 t in 2004. Since 1997, landings have been recorded in the ICCAT data base for the NE Atlantic by Spain and Portugal, totalling 475 t of hammerhead and requiem sharks in 2004. See table overleaf for details.

Recent management advice

According to the 2008 report of the SCRS of ICCAT, bigeye threshers, longfin makos, and shortfin makos have the highest vulnerability (and lowest biological productivity) of the shark species examined (with bigeye thresher being substantially less productive than the other species).

Precautionary management measures should be considered for stocks where there is the greatest biological vulnerability and conservation concern, and for which there is very little data. Management measures should ideally be species-specific whenever possible.

For species of high concern, which are expected to have high survivorship on longlines, like the bigeye thresher, prohibition of landings could be effective for conservation. However, for other species which can be easily misidentified, such prohibitions could complicate compliance monitoring.

Great white shark (Carcharodon carcharias)

Overview

The great white shark inhabits coastal and offshore waters from the subarctic to tropical regions, but do not enter brackish or freshwaters. They range from surface waters down to depths as great as 1280 meters. They tolerate a wide range of water temperatures (5 to 27°C), and can maintain body temperatures above the ambient water temperature.

The biology of the great white shark is poorly understood. The life history of the great white shark is indicative of elasmobranchs as it is slow growing with a low fecundity and a relatively long life span (23-60 years) (DFO, 2006). Great white sharks are ovoviviparous and have a gestation period of 14 months. During a females lifetime she will only produce 45 pups with an average of 7 pups per litter (DFO, 2006). Sexual maturity is reached by males in 8 to 10 years (3.5 to 4.1 m), whilst females mature later at 12 to 18 years old at a length of between 4 and 5 m (DFO, 2006). The lack of knowledge in the great white's biology makes stock assessment difficult to achieve. A fact that is compounded by how little we know about the essential fish habitats (EFHs) of great whites, although there is circumstantial evidence that suggests the Mid-Atlantic Bight, between Cape May and Cape Cod, could possibly be a mating area for great whites (DFO, 2006).

Status of the stocks

Atlantic Ocean stocks: the great white sharks in the North Atlantic have experienced a sharp decline in white shark abundance between 1986 and 2000 (between 59 and 89%) (DFO, 2006). The Atlantic population of great white sharks was designated as endangered in April 2006 by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The decline in stocks is emphasized by the rarity of great white shark sightings in the Atlantic, with only been 34 observations of white sharks, one every 2 – 3 years, were recorded from eastern Canada between 1874 and 2004 (DFO, 2006).

This decline in great white sharks in the North Atlantic is indicative of the global situation with all available data suggesting that great white shark numbers are declining worldwide. The great white shark doesn't have a directed fishery but is caught as bycatch in longline fisheries. Baum *et al* (2003) analysed US longline bycatch data from the northwest Atlantic that showed a sharp decline (59 - 89%) in white shark numbers between 1986 and 2000. Whilst, the southern US pelagic longline fleet has been identified as having the most significant source of great white bycatch with more than 400 captures per year on average between 1986 and 2000 (DFO, 2006)

The current status of the great white shark stock in the North Atlantic is unknown, with no stock assessment identified. The lack of a stock assessment is a consequence of the lack of information on the abundance and productivity of the species (DFO, 2006). Subsequently it is not possible to assess and determine the recovery potential of the North Atlantic great white shark population (DFO, 2006). Management of the stock should therefore be conservative and work towards enhancing the recovery of the stock, which would involve the live release of captures (DFO, 2006). The International Commission for the Conservation of Atlantic Tunas (ICCAT) (2005) have previously proposed an approach for managing great white shark stocks involving setting the recovery target as an approximation of maximum sustainable yield (MSY) for shortfin mako: one half the virgin spawning stock biomass (SSB0). This is consistent with the Cautious-Healthy boundary of Precautionary Approach Framework being established by DFO (DFO, 2005). Most importantly the current shortcomings apparent in monitoring, control and surveillance systems will have to be overcome for the recovery of the great white shark to occur (DFO, 2006).

Tiger shark (Galeocerdo cuvier)

Overview: the tiger shark is found throughout the world's temperate and tropical waters, with the exception of the Mediterranean Sea. It is a wide-ranging species that is at home both in the open ocean as well as shallow coastal waters. Reports of individuals from as far north as Iceland and the United Kingdom have been confirmed but are probably a result of roaming sharks following the warmer Gulf Stream north across the Atlantic.

Status of the stocks

Atlantic Ocean stocks: both commercial and recreational fishing catch rates for this species in the mid-Atlantic region have declined since the mid-1980's, indicating that fishing pressure has adversely affected the size of the population. In contrast, relative abundance and catch rates for this species noted by commercial fisheries observers, especially for juveniles, are much higher than in previous fishery-independent and fishery-dependent surveys. The World Conservation Union (IUCN) presently lists the tiger shark as “Near Threatened” throughout its range.

Pacific Ocean stocks: there are no directed fisheries for Tiger sharks in the Pacific Ocean; however they are caught as bycatch in longline fisheries. Tiger sharks are also caught as part of shark control programs introduced around the cost of Australia (QDPI, 2001).

Hammerhead sharks (Sphyrna spp)

Status of the stocks

Pacific Ocean stocks: there are no directed fisheries for Hammerhead sharks in the Pacific Ocean; however they are caught as bycatch in longline fisheries. Hammerhead sharks are also caught as part of shark control programs introduced around the cost of Australia (QDPI, 2001).

Indian Ocean stocks: there is a lack of catch and bycatch data on Hammerheads through the Indian Ocean, with the current available data insufficient to adequately assess the effect fishing is having on the stock (IOTC, 2005). Subsequently little is known about the status of this stock and the CPUE of the stock (IOTC, 2005). The management of Hammerhead shark stocks in the Indian Ocean has been difficult due to the low level of research and monitoring activity of Hammerheads, in addition to the lack of knowledge we have about their biology and critical habitats (IOTC, 2005). This is emphasized by the level of misidentifications with regards to Hammerhead species. Appropriate steps should be introduce to allow stock assessments to be carried out in the future utilizing scientific data (IOTC, 2005).

C. DEEPWATER SHARKS

Siki sharks

Deepwater 'siki' sharks: **Leafscale gulper shark *Centrophorus squamosus* & Portuguese shark *Centroscymnus coelolepis*** Order: Squaliformes Family: Centrophoridae / Somniosidae English: Portuguese shark, Portuguese dogfish and siki shark French: Squale-chagrin de l'Atlantique & pailona commun Spanish: Quelvacho negro & pailona	

Overview: The term "siki" is used to describe the combination of leafscale gulper shark and Portuguese shark. Although these species have very differing biological traits, ICES has had to combine them for assessment purposes. This is because landings data for both species were combined for some of the main countries for most of the time since the beginning of the fishery. The term "siki" as used here does not have the same meaning as in commercial fisheries, where it encompasses all commercially exploited deepwater sharks.

<u>**The fishery**</u>

Gear types, fishing fleets and their distribution: *C. squamosus* and *C. coelolepis* are both taken in several mixed trawl fisheries in the northeast Atlantic and in mixed and directed longline and gillnet fisheries. Fisheries taking these species were extensively described in ICES (2006).

French trawl landings peaked in 2001 at 3 500 tonnes and have since declined to about 800 tonnes. Spain (Galicia) began trawling for these species on the Hatton Bank in 2000 and catches peaked at 1 400 tonnes in 2002. Norwegian longline fisheries began in 1999. Peak catches were about 400 tonnes in 2001 and this fishery has now ceased. Irish fishing (trawl and longline) began in 2000 and catches have been stable at about 400 tonnes. German fishing began in 1992 using longlines. Recorded landings in the UK (England and Wales) fishery began in 1991 and peaked in 1997 at 2 000 tonnes. UK and German fisheries were initially longline but gradually changed to gillnets by 1998. The UK and German longline/gillnet fishery retained only livers before 1998 and therefore landings may be under estimated. Portuguese fisheries have been stable at 500 tonnes of each species since 1988. The banning of gill-netting in waters deeper than 200 m in 2006 led to increased longline effort in deep water. A new gillnet and longline fisheries developed in Subarea VIII and Division IXb in 2006. This represented a displacement of effort from VI and VII, due to the ban on gillnet fishing in those areas. Other information sources on the characteristics of fisheries for these species include Figueiredo, I. and Machado, P., 2006; Hareide *et al*, 2005; and Jones *et al*, 2005.

EC directed catch trends and characteristics: Landings began in 1988 (although an unknown quantity is likely to have been discarded prior to this) and increased rapidly to over 8 000 tonnes in 1997. Since 1997 landings have fluctuated with an overall upward trend, reaching a maximum of over 10 000 tonnes in 2003. Since 2003, reported landings have declined, possibly as a result of the introduction of quotas on deepwater sharks, a ban on gillnetting in waters >200m and the reduction quotas for other species in the mixed trawl fisheries.

Landings of the Portuguese shark *Centroscymnus coelolepis* by EC Member States over the last six years showed a peak in 2003 of 4 229 t and a subsequent decline to 1 274 t in 2006. The main decline has been from the reduced catches by UK vessels (from 1 935 t in 2003 to 274 in 2006). Irish catches have also similarly declined from 729 t to 104 t. The main MS catching these species, Portugal, has also reduced its catch but at a lower rate from 768 t in 2003 to 481 t in 2006. The UK catches are mainly in VIa and Vb (NW Scotland) whilst the Portuguese catches tend to be in area IX (sub-area not specified).

Landings of the Leafscale gulper shark *Centrophorus squamosus* have shown a similar pattern to *C. coelolepis*, declining from just under 4 000 t in 2003 to 758 t in 2006. The 2006 catch was dominated by Portuguese landings of around 758 t.

Incidental catch characteristics: In the early years of the fishery, discarding was thought to be negligible in the majority of trawl and longline fisheries although some discarding may have occurred in the first years before markets were fully developed. However, with the quotas for deepwater sharks becoming restrictive, it is likely that discarding has increased. Discarding can be expected to be greatest where there are relatively high TACs for other species caught along with deepwater sharks. In northern areas, discarding is considered to be lower, because shark abundance in mixed fisheries is much lower in recent years. In southern areas, where shark abundance is relatively stable, it may be expected that discarding has increased, due to restrictive quotas for sharks. Between 2001 and 2004, Irish trawlers have discarded their entire catch of leafscale gulper sharks. This was based on crew preferences, not market factors. Some discarding of rotten deepwater sharks, due to excessive soak times, has been recorded in gillnet fisheries (STECF, 2006b).

Status of the stocks

Both the leafscale gulper shark (*Centrophorus squamosus*) and Portuguese dogfish (*Centroscymnus coelolepis*) have a wide distribution in the North East Atlantic. As there is no clear information on stock identity, a single assessment unit of the Northeast Atlantic has been adopted by ICES For both species the stock structure dynamics are poorly understood, although migratory patterns have been observed. This does not consider that the biology and available information on distribution of these two species is different. However in the absence of better data, it has been put forward by ICES as the best approach possible given the data available. Limited catches of the two species have been made outside of the Northeast Atlantic but these catches are so low that no stock assessment would be undertaken for these species.

In 2006, ICES noted substantial declines in CPUE series for both *C. coelolepis* and *C. squamosus* in Subareas VI, VII and XII, suggesting that the stocks of both species are depleted. CPUE for both species in the northern area have displayed strong downward trends leading to the conclusion that the stocks were being exploited at unsustainable levels. In Division IXa, CPUE series, although short, appear to be stable.

In 2006, ICES advised that no target fisheries should be permitted unless there are reliable estimates of current exploitation rates and stock productivity. ICES advised that the TAC should set at zero for the entire distribution area of the stocks and additional measures should be taken to prevent bycatch of Portuguese dogfish and leafscale gulper shark in fisheries targeting other species.

The working group estimates of total landings of mixed deep-water sharks, believed to be mainly Portuguese dogfish and leafscale gulper shark but possibly also containing a small component of other species. In 2006, WGEF produced estimates of landings of each of these species. This has not been updated for the most recent year, but will be conducted again at the next benchmark assessment.

It can be seen that landings have declined from around 10 000 t from 2001 to 2004, to about 2 000 t in 2006 (Figures 3.1 and 3.2). The decline is due partly to the quota restrictions. Another reason is the gillnet bans, and it can be seen that the proportion of international landings from the gillnet fishing countries (UK and Germany) have declined. Recent landings are the lowest since the fishery reached full development in the early 1990s and much lower than TACs available (7 100 t).

There are no reliable estimates of levels of misreporting of these species as much of the catch data in early years of the fisheries were aggregated. Although recently many nations have improved species-specific reporting of landings in recent years, some of these data may contain mis-identification but it is believed to be a minor problem. Immediately prior to the introduction of quotas for deepwater species in 2001, it is believed that some vessels may have logged deep-water sharks as other species in an effort to build up track record. It is also likely that, before the introduction of quotas for deep-water sharks, some gillnetters may have logged monkfish as sharks. Since the introduction of quotas on deep-water sharks in 2005, it is likely that some under-reporting has occurred. It can be expected that some vessels with restrictive quotas for deepwater fish may misreport more valuable species as deepwater sharks.

IUU fishing is also known to take place, especially in international waters.

Species-specific landings data is not available for either of these species over time, with the exceptions of Portugal. In most cases only estimates of the proportions of these species based on catch ratios are used. These estimates suggest that there has been little difference in the landings of either species from 1990 to 1998, and since 2004. During the period from 1998 to 2004, Portuguese dogfish predominated, which suggests that the fleets were fishing in progressively deeper waters. In addition the true landings data is confused by the reporting of both live weight and livers by Member States. This potentially can lead to duplication of data and an over estimation of landings. Detailed CPUE series for stock assessment purposes are not very long for either of these species but the CPUE of both species has shown a strong decline in northern areas (ICES sub-areas V, VI, VII and XII). In Subarea IX, the CPUE trend appears to be stable, and there is a relatively stable pattern over the entire history of the Portuguese fishery, since 1989.

Reference points have been set for both these species along the guidelines used n common with other deep-water stocks that based on their life-history parameters, are typically slow-growing and late maturing, and ICES has set Ulim is set at 0.2* virgin biomass and Upa is set at 0.5* virgin biomass (ICES, 1998). These two species are considered highly vulnerable to exploitation. The leafscale gulper shark is listed on the CITES Red List as "Vulnerable

(VU)", and the Portuguese dogfish is listed as "Near Threatened (NT)". IUU fishing is known to take place in international waters, and this may be continuing.

Existing specific management measures

In 2007, the TAC for deepwater sharks in Sub-areas V, VI, VII, VIII and IX is 2,472 t. In 2008, the TAC for these species in these areas will be reduced to 1 646 t. In 2007 and 2008, the TAC for deepwater sharks is set at 20 t annually in Sub-area X, and 99 t in Sub-area XII. These TACs apply to the following list of species: Portuguese dogfish (*Centroscymnus coelolepis*), leafscale gulper shark (*Centrophorus squamosus*), birdbeak dogfish (*Deania calceus*), kitefin shark (*Dalatias licha*), greater lanternshark (*Etmopterus princeps*), velvet belly (*Etmopterus spinax*), black dogfish (*Centroscyllium fabricii*), gulper shark (*Centrophorus granulosus*), blackmouth dogfish (*Galeus melastomus*), mouse catshark (*Galeus murinus*), Iceland catshark (*Apristurus* spp.). In Subarea X, *Deania hystricosum* and *Deania profundorum* are also on this list.

ICES' WGEF has found it difficult to quantify landings data when MS report data for both live weight and for livers. This potentially can lead to duplication of data and over estimation of landings. WGEF has asked all MS to explain how landings of livers are raised to total live weight, and to report if duplication could be happening.

Recent management advice

According to the STECF 2008 report, there is insufficient information to separate the landings of Portuguese dogfish Centroscymnus coelolepis and leafscale gulper shark Centrophorus squamosus. Total international landings of the combined species have steadily increased to around 11 000 t in 2003 and have rapidly declined after 2003 to the lowest levels since the fishery started. Substantial declines in cpue series for the two species in Subareas V, VI, and VII suggest that both species are severely depleted and that they have been exploited at unsustainable levels. In Division IXa, lpue series are stable for leafscale gulper shark and declining for Portuguese dogfish.

Due to its very low productivity, Portuguese dogfish and leafscale gulper shark can only sustain very low rates of exploitation. The rates of exploitation and stock sizes of deepwater sharks cannot be quantified. However, based on the cpue information, Portuguese dogfish and leafscale gulper shark are considered to be depleted. Given their very poor state, ICES recommends a zero catch of Portuguese dogfish and leafscale gulper shark.

Kitefin Shark (Dalatias licha)

Kitefin shark ***Dalatias licha***		
Order:	Squaliformes	
Family:	Dalatiidae	
English:	Kitefin shark, black shark, darkie charlie and seal shark	
French:	Squale liche	
Spanish:	Carocho	

Overview

Kitefin sharks, like all elasmobranchs, are susceptible to exploitation due to their life history characteristics. The life history of Kitefin sharks is not well known, although it is believed that juveniles are located in deep non-exploited waters. Whilst, they aren't recruited to the stock until they are 5 years old (100 cm) for males, and 6 years old (120 cm) for females (ICES, 2007).

The fishery

The directed fishery on the Azores stopped at the end of 1990s because it was not profitable. Kitefin shark in the North Atlantic is currently a bycatch in other fisheries. A detailed description of the fisheries can be found in Heessen (2003) and ICES (2003).

EC directed catch trends and characteristics: EC MS Landings over the past six years have been variable, peaking at 738 t in 2003 and dropping to 62 in 2006. In 2003 the main landings were by the UK (518 t), mainly from VIIk[1]. Historically, landings from the Azores began in the early seventies and increased rapidly to over 947 tonnes in 1981. Since 1981 to 1991 landings fluctuated considerably, following the market fluctuations, peaking at 937 tonnes in 1984 and 896 tonnes in 1991. Since 1991 the reported landings have declined linearly, possibly as a result of economic problems related to markets. Since 1988 a bycatch has been reported from mainland Portugal with 282 tonnes in 2000 and 119 tonnes in 2003.

Incidental catch characteristics: Kitefin from the Azores is now a bycatch from different deep-water fisheries, with landings in 2004–2006 less than about 15 t per annum. Otherwise three individuals were recorded as bycatch in Irish horse mackerel fisheries in ICES Subarea VIIc at 300m depth.

Existing specific management measures

Deepwater sharks are subject to management in Community waters and in certain non-Community waters for stocks of deep-sea species (EC no 2270/2004 article 1). Fishing opportunities (TAC) for stocks of deep-sea shark species for Community vessels were presented in an Annex (EC no 2270/2004 and EC no 2015/2006 annex part 2). A list of species was given to be considered in the group of 'deep sea sharks'.

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[1] While the UK (E&W), France and Ireland have official reported landings of kitefin shark in these areas, it is considered by WGEF (ICES, 2007) that these have been misidentified, and are more likely to be either Portuguese dogfish or leafscale gulper shark.

Data quality issues: Data from observers or fishing logbooks are not available. Species misidentification is a problem with deepwater sharks. Official landings come exclusively from the commercial first sale of fresh fish on the auctions. Landings that are not sold on the auctions, as frozen or processed fish, are not taken in account on the statistics provided to ICES. In some areas it is known that some additional Azorean catches are not contained in the reported data. Therefore, data are likely to be an underestimate of total landings.

Status of the stocks

Atlantic Ocean: historically the Kitefin stock has had highly variable catches and landings (ICES, 2007). The NE Atlantic Kitefin shark fishery has been dominated since 1988 to present by Portuguese vessels, predominantly from the Azores, with landings varying between 40 tonnes in 2002 up to 908 tones in 1991 (ICES, 2007). Since 2004 the landings of Kitefin shark have remained low even in the light of other European countries such as France, the UK and Germany beginning to land Kitefin since 2003. However, reported landings from other European countries excluding Portugal have been questioned, as it's believed these are in fact misidentifications of Gulper sharks or Portuguese dogfish. Catches and landings have remained low due to the directed fishery ceasing to exist at the end of the 1990s and as such all landings are now through bycatches from other deepwater fisheries (ICES, 2007).

The last stock assessment carried out on Kitefin shark in the 1980s considered the stock to be depleted. Supported by the fact that the shark was intensively exploited as the observed average catches were 809 tonnes which was only 124 tonnes lower than the maximum sustainable yield for the stock (ICES, 2007). However, there have been no stock assessments since then, as no new data has been available and the current status of the Northeast Atlantic Kitefin shark stock is unknown.

Although, no official stock assessment has been carried out, there have been indications of the Kitefin stock showing that the Kitefin is most abundant in the south area of the Mid Atlantic Ridge. (ICES, 2007). Indications for the rest of the Northeast Atlantic show that records of Kitefin catches have been infrequent.

Recent management advice

According to ICES advice 2008, the new information available for kitefin shark (*Dalatias licha*) in the North Atlantic is too sparse to revise the advice from 2006. The advice for 2009 and 2010 is therefore the same as the advice given in 2006: *"This stock is managed as part of the deep-sea shark fisheries. No targeted fisheries should be permitted unless there are reliable estimates of current exploitation rates and sufficient data to assess productivity".*

Other deepwater sharks

The stock assessments of deepwater sharks other than Portuguese dogfish, leafscale gulper shark and kitefin shark are considered in this section. These species are of a lower commercial value and are not the targets of fisheries themselves but a minor component of the bycatch of other trawl, longline and gillnet fisheries. Other than the landings data, little is known about these species and that landings data apart from more recent years many of these species would have not been detailed in catch statistics.

The species that could be considered deepwater sharks are as follows;

Gulper shark (*Centrophorus granulosus*)
Birdbeak dogfish (*Deania calceus*),
Longnose velvet dogfish (*Centroscymnus crepidater*),
Black dogfish (*Centroscyllium fabricii*),
Velvet belly (*Etmopterus spinax*),
Blackmouth catshark (*Galeus melastomus*),
Greenland shark (*Somniosus microcephalus*),
Lantern sharks "nei" (*Etmopterus spp*.),
'Aiguillat noir' (may include *Centroscyllium fabricii*, *Centroscymnus crepidater* and *Etmopterus spp*).

ICES advice on deepwater sharks mainly relates to the other species mentioned in other sections of this report. No species specific stock assessment advice has been given for the shark and skate species considered here. In EC waters, a combined TAC is set for a group of deep-water sharks. These include; Portuguese dogfish (*Centroscymnus coelolepis*), Leafscale gulper shark (*Centrophorus squamosus*)), Kitefin shark (*Dalatias licha*), and the species listed here birdbeak dogfish (*Deania calceus*), greater lanternshark (*Etmopterus princeps*), velvet belly (*Etmopterus spinax*), black dogfish (*Centroscyllium fabricii*), gulper shark (*Centrophorus granulosus*), blackmouth dogfish (*Galeus melastomus*), mouse catshark (*Galeus murinus*), Iceland catshark (*Apristurus spp*.). Specifically in ICES subarea XII, *Deania hysticosum* and *Deania profundorum* have been added to this list.

As for many other shark species large quantities of deepwater species are landed in the grouped categories such as "Sharks nei" and "Dogfish nei". Therefore all catches and landings information are probably greatly underestimated.

The most reliable estimates of abundance for these deepwater shark species within the ICES area are those obtained from the deepwater surveys (depth range 300–1900 m) by ICES Members. Since 1998, these surveys have been reasonably consistent in terms of survey design, gear and area covered which provides a good time series of CPUE (abundance) and species composition data. The most abundant shark species in terms of catch rate in kg hr^{-1} are the longnose velvet dogfish (*C. crepidator)* and the birdbeak dogfish (*D. calceus)*.

In response to a request from NEAFC in 2007 and building on the response given to an EC request in 2006, WGDEEP made recommendations for the coordination of deep-water surveys in the NEAFC Convention Area (ICES, 2007). These surveys will it is hoped provide better information for the assessment of the deepwater shark stocks present.

In summary due to the lack of good reliable data no assessments have been undertaken for any of the deepwater shark species listed here, although no reference points have been proposed for any of these species a precautionary TAC for a number of species combined has been allocated.

D. DEMERSAL ELASMOBRANCHS

Overview: this group of species includes a large number of skate and ray species, as well as a number of demersal shark species. The catches of demersal elasmobranchs by EC Member States in ICES waters over the period 2001 – 2006 are provided in the table overleaf, with the following six species being subjected to particular fishing pressure:

Cuckoo ray *Raja naevus*

Common skate *Raja batis*

Thornback ray *Raja clavata*

Spotted ray *Raja montagui*

Longnose skate *Raja (Dipturus) oxyrinchus*

Small-spotted dogfish *Scyliorhinus canicula*

It is important to note that the majority of EU vessels only report to genus level e.g. *Raja* spp., which complicates stock management efforts for the more vulnerable species.

Fishing methods, directed catch trends and incidental catch characteristics for demersal elasmobranchs in the NE Atlantic will be described on an area by area basis.

North Sea, Skagerrak, Kattegat and the Eastern Channel fisheries: The thornback ray *Raja clavata*, is probably the most important ray in longline, gillnet and trawl fisheries, with the spotted ray *R. montagui* and *R. brachyura* of secondary importance. Demersal elasmobranchs are caught as a bycatch in the mixed demersal fisheries for roundfish and flatfish. A few inshore vessels target skates and rays with tangle nets and long-line. Due to effort restrictions, and high fuel prices, effort may divert to small inshore fisheries that may target skates and rays. For a description of the demersal fisheries see the Report of the North Sea Demersal Working Group (ICES, 2006b) and the report of the DELASS project (Heessen, 2003). Whilst France and Sweden provide species-specific data, even these are considered unreliable and ICES is of the opinion that only direct market sampling over different regions, gears and seasons would be adequate, together with more robust protocols for species identification (ICES, 2007a). Fisheries independent surveys in the North sea have mainly been based around the International Bottom Trawl Survey IBITS (in winter and summer) and from different beam trawl surveys (in summer). An overview of North Sea elasmobranchs based on survey data was presented in Daan *et al*. (2005). The abundance of the four main skate species – *R. clavata*, *R. montagui*, *Leucoraja naevus* and *Amblyraja radiatia* – appears to have been maintained or even increased since 1980. However the area occupied by *R. clavata* is only 44% of the extent of the species in the 1980's.

Since a TAC was introduced for North Sea skates and rays in 1999 it has always been higher than the landings. This TAC, however, has gradually been reduced, for example from 2005 to 2006 by 15% and from 2006 to 2007 by 20%. In 2008 the TAC is 1 643 t, mostly to the UK[2]. The TAC for rays and skates should only apply to areas IIIa, IV and VIId and not to IIa since this only a part of IIa belongs to the present North Sea eco-region. ICES report that demersal elasmobranchs may be subject to area misreporting in order to permit the landing of high quantities of *R. clavata* (rays and skates may comprise no more than 25% by live weight of

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[2] The catches of cuckoo ray (*Leucoraja naevus*), thornback ray (*Raja clavata*), blonde ray (*Raja brachyuran*), spotted ray (*Raja montagui*), starry ray (*Amblyraja radiate*) and the common skate (*Dipturus batis*) must be reported separately.

the catch retained on board). These fish may then be dumped when they have served their purpose. Additionally, if skates and rays are retained at the start of a fishing trip, but subsequent fishing does not comprise large quantities of other commercial species that can be landed; this can result in discarding of dead fish.

Table 1: EU fleet catches of demersal elasmobranches in ICES waters

Species	Country	2001	2002	2003	2004	2005	2006
Angular roughshark	Portugal	63	86	144	79	38	53
Birdbeak dogfish	Portugal	50	90	75	160	154	80
	Spain	.	12	43	81	63	30
	UK	1	0	22	84	47	21
Black dogfish	France	278	27	53	56	4	2
Blackmouth catshark	Portugal	34	50	30	64	50	31
	Spain	.	230	184	86	119	190
Blonde ray	Portugal	.	.	.	<0.5	120	378
Blue skate	France	664	449	443	472	304	259
Bluntnose six-gill shark	Portugal	1	7	2	30	12	15
Catsharks etc. nei	Ireland	.	.	299	134	122	40
	Spain	.	.	.	557	392	-
	UK	22	11	4	10	3	4
Catsharks nursehounds nei	France	26	15	21	49	65	105
	Portugal	776	713	782	750	460	260
	Spain	.	.	.	121	111	146
	UK	34	38	32	42	66	-
Common eagle ray	France	<0.5	<0.5	2	1	2	2
	Portugal	.	.	15	10	16	24
Common stingray	France	8	10	11	14	20	13
Crest-tail catsharks nei	Ireland	.	.	5	7	5	7
Cuckoo ray	France	2 882	2 742	2 843	2 759	3 056	2 527
Deep-water catsharks	Spain	.	.	.	.	8	1
Dogfish sharks nei	France	3 476	1 992	860	700	845	598
	Germany	431	518	642	634	54	-
	Ireland	30	14	2 211	1 686	1 140	967
	Lithuania	14	40	22	56	6	6
	Spain	365	171	338	532	118	308
	UK	478	752	158	230	32	27
Dogfishes and hounds	UK	1 388	1 747	153	198	215	311

Species	Country	2001	2002	2003	2004	2005	2006
Dogfishes nei	Belgium	398	447	446	466	488	503
Eagle rays	Portugal	9	12	-	-	-	-
	Spain	.	.	.	4	5	2
Electric rays nei	Spain	.	.	.	14	13	21
Guitarfishes nei	Portugal	1	1	2	1	1	-
Hammerhead sharks	Portugal	4	5	7	19	2	12
Houndsharks smoothhounds nei	Portugal	81	77	45	-	-	-
	UK	76	56	86	75	171	130
Knifetooth dogfish	Spain	.	.	-	9	9	125
	UK	.	.	<0.5	-	39	-
Lanternsharks nei	Spain	.	99	76	64	60	-
Longnose velvet dogfish	France	-	12	6	7	6	3
	Portugal	3	4	2	1	3	8
	UK	0	0	503	294	152	412
Longnosed skate	France	92	210	198	43	50	48
Nursehound	France	183	168	171	178	195	158
	Portugal	.	.	33	30	210	421
	UK	85	39	62	-	9	-
Species	**Country**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Raja rays nei	Belgium	1 527	1 734	1 849	2 013	2 031	1 859
	Denmark	122	59	69	156	90	54
	France	3 152	3 153	3 430	3 021	3 095	2 680
	Germany	28	26	42	66	68	26
	Ireland	2 140	2 501	2 643	2 447	1 781	1 467
	Lithuania	-	-	-	2	12	8
	Netherlands	749	792	677	558	565	606
	Portugal	1 685	1 636	1 804	1 861	1 426	921
	Spain	9 198	3 692	2 267	2 369	2 931	3 166
	Sweden	12	8	13	20	8	16
	UK	6 394	6 061	6 545	5 197	3 475	3 369
Rays and skates nei	Estonia	56	6	-	-	4	-
	France	76	43	32	38	33	32
	Ireland	-	-	110	84	46	22
	Spain	.	<0.5	12	529	737	816
Rays stingrays mantas nei	Ireland	.	.	126	173	287	256

Species	Country	2001	2002	2003	2004	2005	2006
	Spain	.	.	.	12	1 709	999
Sailfin roughshark	UK	<0.5	-	-	-	-	-
Sandy ray	France	328	302	281	258	295	222
	Portugal	.	.	18	24	56	80
Shagreen ray	France	67	70	46	33	32	25
Small-eyed ray	France	-	-	13	16	23	19
Small-spotted catshark	France	6 320	5 714	5 477	5 574	5 792	5 465
	Ireland	633	564	.	.	.	.
	Spain	.	6	8	69	90	112
	UK	156	163	103	103	218	141
Smooth-hound	Portugal	2	2	1	7	11	25
	Spain	.	.	.	63	29	32
Smooth-hounds nei	France	1 272	1 590	1 882	2 197	2 360	2 416
	Portugal	40	38	49	36	25	12
	Spain	.	.	.	26	24	41
Spiny butterfly ray	Portugal	2	4	6	4	6	9
Spotted ray	France	1 563	1 451	1 434	1 312	1 155	1 017
	Portugal	.	.	.	.	64	81
Starry smooth-hound	Portugal	<0.5	2	5	8	10	22
Stingrays butterfly rays	Portugal	2	2	5	2	1	3
Thornback ray	France	1 215	1 163	1 329	1 081	958	827
	Portugal	<0.5	2	48	87	220	363
Torpedo rays	France	42	34	31	33	22	23
	Portugal	35	34	45	45	47	60
Velvet belly	UK	0	0	5	10	51	0
TOTAL		**48 779**	**41 702**	**41 459**	**40 353**	**38 868**	**35 573**

Source: Eurostat/ICES database on catch statistics - ICES 2007 Copenhagen

Barents Sea: the starry ray (or thorny skate) *Amblyraja radiate* comprises 96% by total number and about 92% by weight of skates caught in surveys or as bycatch. The next most abundant species are arctic (*A. hyperborean*) and round (*Rajella fyllae*) skates (3% and 2% by number respectively). The rest of the species are scarce (Dolgov *et al*., 2004; Drevetnyak *et al*., 2005). Much of this is bycatch from the bottom trawl and longline fisheries which is largely discarded and not landed. Catch data from any EC fleet activity in the area appears to be extremely limited.

Norwegian Sea: like the Barents Sea, the starry ray *Amblyraja radiate* is the most abundant skate species. Long-nosed skate *Dipturus oxyrinchus* is mainly distributed in the southern section of coastline south of below latitude 65°N. There is no directed fishery on skates and rays in the Norwegian Sea, though they are caught in mixed fisheries targeting teleost species. Overall landings throughout time have been low and total around 200–300 t per year, with Russia and Norway the main countries landing skates and rays from the Norwegian Sea. Again catch data from any EC fleet activity in the area appears to be extremely limited.

Faroe Islands: The elasmobranch fauna off the Faroe Islands is little studied in the scientific literature, though it is likely to be somewhat similar to that occurring in the northern North Sea and off Iceland. *Dipturus batis*, *Dipturus oxyrinchus*, *Leucoraja fullonica*, *Raja clavata* and *Amblyraja radiata* have all been recorded. Since 1973, nine countries (Denmark, Faroes, France, Germany (and Fed. Rep Germany), Netherlands, Norway, Poland, UK and Russia) have reported catches of demersal elasmobranchs from Division Vb. UK vessels include a small number of large Scottish trawlers which are occasionally able to obtain quotas to fish in Faroese waters targeting gadoids and deepwater species. French vessels fishing in this area are probably from the same fleet that prosecute the mixed deep-water and shelf fishery west of the UK. In all cases, it is likely that demersal elasmobranchs represent a minor to moderate bycatch in fisheries targeting other species.

Celtic Seas[3]: Whilst the spurdog *Squalus acanthias* (see above) and lesser-spotted dogfish *Scyliorhinus canicula*, are widespread throughout this region, there are some important regional differences in the distributions of other species. These include the tope, smooth-hounds *Mustelus* spp. and greater-spotted dogfish *Scyliorhinus stellaris*. Sixteen species of skate and ray are recorded in the area, the most abundant skates being *Raja clavata*, cuckoo ray *Leucoraja. naevus*, blonde ray *R. brachyura*, spotted ray *R. montagui*, undulate ray *R. undulata*, common skate *Dipturus batis*, shagreen ray *L. fullonica* and small-eyed ray, *R. microocellata*. Other batoids (stingray *Dasyatis pastinaca*, marbled electric ray *Torpedo marmorata* and electric ray *T. nobiliana*) may be observed in this region, although they are more common in more southerly waters. These are generally discarded if caught in commercial fisheries.

Most skate and ray species in the Celtic Seas are taken as a bycatch in mixed demersal fisheries, which are either directed at flatfish or gadoids. The main countries involved in these fisheries are Ireland, UK, France, Spain, with smaller catches by Belgium and Germany. The main gears used are otter trawls and bottom-set gillnets, with the Belgian fishery carried out by a beam-trawl fleet. There are also beam trawls from Ireland, the UK and the Netherlands in this area.

There are also some localised fisheries that target *R. clavata* using longline and tangle nets. There is a small fishery off south-east Ireland targeting various skate species in the southern Irish Sea (Area VIIa), using rockhopper otter trawls and beam trawls, and some UK trawlers may target skates in the Bristol Channel (VIIf) at some times of year. Most coastal dogfishes (e.g. tope, smooth-hounds and catsharks) are taken as a bycatch in various trawl and gillnet fisheries. Due to the low market value of these species, they tend to be discarded by some nations, though some of marketable sizes are sometimes retained. A largely unknown quantity is retained for use as bait in the Irish Sea and Bristol Channel whelk fishery, and the northwest Ireland crab fishery, and these may not routinely be declared in the landings.

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[3] The Celtic Seas eco-region covers west of Scotland (VIa), Rockall (VIb), Irish Sea (VIIa), Bristol Channel (VIIf), the western English Channel (VIIe), and the Celtic Sea and west of Ireland (VIIb-c, g-k), although the south-western sector of ICES Division VIIk is contained in the oceanic northeast Atlantic eco-region.

There are Nephrops fisheries in the Irish Sea (VIIa), Celtic Sea (VIIg), Porcupine Seabight (VIIj) and at the Aran Islands, (VIIb) which may catch various elasmobranchs as a bycatch. In the deep waters of Area VI and VII there is a skate bycatch in fisheries for anglerfish, megrim, and hake, and these species include *L. fullonica*, *L. circularis* and *Dipturus* spp.. There is also a large recreational fishery for skates, rays and dogfishes, particularly for those species close to shore, with some ports having locally important charter boat fisheries.

There are no TACs for any of the relevant species in this region. Landings have been highly variable over the past ten years and between the different areas in this region, but the overall trend is downward. Reported landings from divisions VIIb,c,j,k increased dramatically in the late 1990s, to more than 4 000 t, but have subsequently declined to approximately 1 000 t per year. The lack of species-specific landings data for the demersal sharks – and the many categories under which these are reported – is a particular issue in improving fisheries management.

Discard levels from elasmobranch fisheries in this area are also variable. Irish discard observer records show that most lesser-spotted dogfish caught are discarded, with discard rates generally over 60%. These species are known to have a high survivorship (Revill *et al*, 2005). UK discard surveys indicate that skates below a certain size tend to be discarded, regardless of species. While this size varies from vessel to vessel, in general, it is around 47 cm, though UK demersal fisheries land *R. clavata* of a smaller size (UK (E&W) Discard Surveys).

Bay of Biscay and Iberian Waters: three species in this area are considered by ICES for detailed assessment, including *Scyliorhinus canicula*, *Leucoraja naevus* and *Raja clavata*. Most landings come from the bycatch of fisheries targeting teleost demersals such as hake, anglerfish and megrim. The main gear in subarea VIIIc is the bottom trawl fleet that targets a mixture of gadoids and flatfish at depths of 100–300 m over the continental shelf and catches skates (R. clavata, *L. naevus*, *R. montagui*, *R. brachyura*, *R. undulata* and *R. microocellata*) and dogfish. In 1994, a total of 7 089 t of elasmobranchs were caught by trawl fleet in the Cantabrian Sea, of which 87% were discarded (Perez *et al*., 1996). *S. canicula* is usually discarded in the Spanish fishery in the Cantabrian Sea (VIIIc) and only 10–25% is actually landed (ICES, 2002). In the case of skates, the highest landings are those from bottom trawls (75%) followed by longline (21%) and gillnet (3%). Occasionally there have been landings from purse seine or traps (Fernández *et al*., 2002).

The main fishing gear taking demersal elasmobranchs in sub-areas VIIIa,b,d is the Basque otter trawlers targeting hake, anglerfish and megrim. The most important elasmobranch species landed by this fleet is *Scyliorhinus canicula*, on average 299 t/year since 1996. The most abundant skates are *L. naevus* and *R. clavata*, which accounted for 77% and 17% respectively of the skate catch composition in the period 2000–2006. In these subdivisions small quantities of other skates (including *L. fullonica*, *R. montagui*, *D. batis*, and *D. oxyrinchuis*) are also landed.

Off mainland Portugal (IXa), lesser-spotted dogfish *Scyliorhinus canicula* is caught mainly by coastal trawlers and by the artisanal fishing fleet. This species, along with greater-spotted dogfish *S. stellaris*, are landed in the major ports of Division IXa under the generic name of *Scyliorhinus* spp. Skates and rays are captured mainly by the artisanal polyvalent fleet, which uses primarily trammel nets. The artisanal fleet also use different types of fishing gear, such as longline and gillnet, and account for the highest landing records (75% of the annual skate and ray landings).

Landings of skates since 1973 show no clear pattern, although there was a remarkable peak in landings in the earlier years (1973–1974) and from 1982–1991. The reduction in observed landings from 1992–1995 coincides with a misreporting period of Spanish landings, but since 1996 the landings seem to have stabilized between 4 000 and 5 000 t/year.

Mediterranean: The commercial value of demersal elasmobranchs is low in the Mediterranean, with catches of under 5 000 t reported by EC vessels in 2005 (GFCM FishStat database, 2007). There are no Mediterranean pelagic fisheries that target migratory oceanic sharks (Cavanagh and Gibson, 2007). However, longline fisheries targeting swordfish and tunas (which have increased in effort over the past three decades) pose a great threat to susceptible chondrichthyans taken as bycatch in this fishery (ICCAT, 2001). Bycatch is poorly documented and data are rarely incorporated into national and international (FAO) statistics, therefore numbers of sharks caught as bycatch can only be crudely estimated (Camhi *et al*. 1998). IUCN state that bycatch in nets (gillnets, purse seines and driftnets) is considered a possible threat to 67 (94%) of Mediterranean chondrichthyans and bycatch in longlines fisheries is a potential threat to 48 (67%) of species (Cavanagh and Gibson, 2007).

Unfortunately, data collected are incomplete and some of the most important landings are not recorded due to several species being reported under one group. For example, only thornback ray *Raja clavata* has separate records data among the Rajids. Additionally, FAO data only report official landings and therefore bycatch returned to the sea is not included (Walker *et al*. 2005).

Table 2: EC fleet catches of demersal elasmobranchs in the Mediterranean (2000 – 2005)

Fleet	Species	2000	2001	2002	2003	2004	2005
Cyprus	Sharks, rays, skates, etc. nei	22	28	22	13	13	21
France	Dogfish sharks nei	12	17	14	6	5	1
	Rays, stingrays, mantas nei	70	64	75	71	78	65
	Small-spotted catshark	30	31	33	32	37	28
	Thornback ray	29	17	19	27	25	15
	Sub-total	**163**	**157**	**163**	**149**	**158**	**130**
Greece	Dogfish sharks nei	270	224	143	171	169	140
	Guitarfishes, etc.nei	94	89	52	32	41	24
	Raja rays nei	746	579	536	150	162	165
	Smooth-hounds nei	578	351	383	281	241	205
	Thornback ray	-	-	-	351	298	315
	Sub-total	**1 688**	**1 243**	**1 114**	**985**	**911**	**849**
Italy	Dogfish sharks nei	-	-	-	-	-	157
	Rays, stingrays, mantas nei	507	543	498	541	577	1 481

	Sharks, rays, skates, etc. nei	-	-	-	-	-	432
	Smooth-hounds nei	462	369	325	423	483	882
	Sub-total	**969**	**912**	**823**	**964**	**1 060**	**2 952**
Malta	Angelsharks, sand devils nei	<0.5	<0.5	-	-	-	-
	Dogfish sharks nei	2	3	2	<0.5	<0.5	1
	Rays, stingrays, mantas nei	7	<0.5	-	5	6	7
	Sub-total	**9**	**3**	**2**	**5**	**6**	**8**
Portugal	Sharks, rays, skates, etc. nei	3	1	1	-	4	3
Romania	Rays, stingrays, mantas nei	-	-	-	-	-	-
Slovenia	Common eagle ray	-	-	-	-	-	<0.5
	Smoth-hounds nei	2	4	2	5	4	2
	Sub-total	**2**	**4**	**2**	**5**	**5**	**2**
Spain	Catsharks, nursehounds nei	331	379	185	274	316	240
	Dogfish sharks nei	11	20	19	16	12	10
	Eagle rays nei	-	-	-	-	9	45
	Rays, stingrays, mantas nei	536	375	835	206	315	287
	Sharks, rays, skates, etc. nei	397	369	28	28	29	21
	Smoth-hounds nei	15	19	12	21	18	22
	Stingrays, butterfly rays nei	-	-	-	-	2	2
	Sub-total	**1 290**	**1 162**	**1 079**	**545**	**701**	**627**
TOTAL		**4 146**	**3 510**	**3 206**	**2 666**	**2 858**	**4 592**

Source: GFCM catch database (via FAO FishStat metadatabase)

Azores and Mid-Atlantic Ridge: The main species of demersal elasmobranchs observed in this eco-region are deepwater elasmobranch species (*Centrophorus* spp., *Centroscymnus spp.*, *Deania* spp., *Etmopterus* spp., *Hexanchus griseus*, *Galeus marinus*, *Somniosus microcephalus*, *Pseudotriakis microdon*, *Scymnodon obscurus*, *Centroscyllium fabricii*. *Raja* spp. etc.), particularly whenever the gear fishes deeper than 600 m, yet most of these may be discarded due to their low commercial value (ICES, 2005). In the Azores area the kitefin shark (*Dalatias licha*) and tope (*G. galeus*) are the most important commercial demersal elasmobranchs (see earlier sections).

Of the skates, the most abundant species in sub-area X are thornback ray *Raja clavata*. Other species also observed include *Dipturus batis*, *D. oxyrinchus*, *Leucoraja fullonica*, *Rajella bathyphila*, *Raja brachyura*, *Raja maderensis* and *Rostroraja alba* (Pinho, 2005, 2006). Other species of batoid, like stingray *Dasyatis pastinaca*, marbled electric ray *Torpedo marmorata* and electric ray *T. nobiliana*, are also observed in this eco-region. These species are generally discarded if caught in commercial fisheries.

Demersal elasmobranches are caught in the Azores EEZ by a multispecies demersal fishery, using hand-lines and bottom longlines, and by the black scabbard fish fishery using bottom longlines (ICES, 2005). The most commercially important elasmobranchs caught and landed from these fisheries are *Raja clavata* and *G. galeus* (Pinho, 2005, 2006; ICES, 2005).

Table 3: Demersal elasmobranchs in the Azores and Mid-Atlantic Ridge.

Landings of demersal elasmobranchs (t) from ICES Subarea X

Fleet	**Species**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Azores	Rajidae	103	83	68	70	89	72	50	62
France	Rajidae			2	-	-	-	-	-
Spain	Rajidae		24	29				-	-
Azores	Bluntnose	n.a.	n.a.	n.a.	7	2	1	1	n.a.
Azores	Sharks	6	18	22	n.a.	n.a.	n.a.	3	n.a.
TOTAL		**109**	**125**	**121**	**77**	**91**	**73**	**53**	**62**

Status of the stocks

Ray species are an important component of mixed demersal fisheries for most European countries such as Portugal. The main ray species are the Cuckoo ray (*Raja naevus*), Common skate (*Raja batis*), Thornback ray (*Raja clavata*), Spotted ray (*Raja montagui*), and the Longnose skate Raja (*Dipturus rhina*) (ICES, 2005).

Atlantic Ocean: historically ray catches in the North Atlantic have shown temporal variability in both the relative status of the species and its vulnerability. Trawls in the Northwest Atlantic have indicated that since 1971 the biomass and abundance of mature rays have declined (ICES, 2005). Although, a trend has been identified for immature rays suggesting that there has been an increase in biomass and abundance from the mid 1980s to the mid 1990s.

Currently there are few directed fishery for ray species in the Atlantic Ocean, with all catches through bycatch from commercial groundfish fisheries. Ray bycatch has decreased since the early 1990s which is associated with the decline in groundfish fisheries in the Atlantic (Government of Canada, 2007). Historically rays have been viewed as commercially undesirable, however more recently Rays have been harvested for their wings, which are used in food preparation (Government of Canada, 2007). The recreational landings of Rays are negligible.

Misidentification of ray species is common due to the difficulty in identifying between species because of their similar morphology. As a result, records of bycatch for Ray species are commonly reported under the generic classification of rays, apart from those common species that can be readily identified.

As a consequence of a lack of bycatch data and the misidentification of ray species there have been no stock assessments carried out on ray species in the Atlantic. To enable stock assessments to be carried out there needs to be increased levels of training on less common species, in addition to identification cards for these species (Government of Canada, 2007).

Recent management advice

Skates (Rajidae)

According to ICES advice 2008, reported landings of skates (the groups as a whole) in the area seem stable or slightly declining in recent years.

Analyses of lpue from the Basque trawl fleet since 1996 indicate that there has been a decrease in skate abundance (mainly cuckoo ray *Leucoraja naevus* and thornback ray *Raja clavata*) in Divisions VIIIa,b,d since the 1998 peak. Landings have also decreased since 1996, but have been more stable in recent years.

In Division VIIIc, results obtained from groundfish surveys indicate an increase in thornback ray biomass since 1996. Survey data for the cuckoo ray seems to indicate an increasing trend in biomass although there is considerable year-to-year variability.

Surveys in Subarea IX were judged to be inadequate for estimating abundance trends. In this subarea, skate landings have been stable since 1996, averaging 1800 t year.

The status of the less common skate species is unknown due to the lack of species information in landings and their low frequencies in surveys.

Lesser-spotted dogfish (Scyliorhinus canicula)

According to ICES advice 2008, reported landings of lesser-spotted dogfish in the area seem stable or slightly decreasing in recent years.

Analyses of lpue from the Basque trawler fleet indicate that the lpue of lesser-spotted dogfish in Divisions VIIIa,b,d has increased from 1994 to 2006. In 2007 a slight decrease in lpue was observed (Table 9.4.12.2). Estimates from ground-fish surveys indicate an increase in the biomass of this species in Division VIIIc since 2002. Overall the population of lesser-spotted dogfish in Subarea VIII appears to be stable or slightly increasing.

Landings from Subarea IX decreased since 2004 by more than a factor of two. However, in this area lesser-spotted dog-fish is essentially a bycatch from other fisheries, so the decrease in landings during the last few years may be related to changes in the effort distribution targeting different species, and/or better species identification at Portuguese landing ports.

Other demersal elasmobranch species

According to ICES advice 2008, the state of other elasmobranch species (e.g. smooth hounds *Mustelus* spp.) is unknown due to a lack of species differ-entiation in landings and the short and discontinous nature of relative abundance indices.

The available landing data of smoothhounds showed that landings in Subarea VIII have increased sharply since 1996, from 151 t to a peak of 500 t in 2006. In Subarea IX *Mustelus* spp. landings have declined since 1999.

ICES advises that landings of demersal elasmobranchs in 2009 should not exceed recent average landings (2002–2006), treating skates and rays, and lesser-spotted dogfish separately. Species-specific landings data should be collected for the major skate species (including cuckoo ray, blonde ray, thornback ray, spotted ray, undulate ray, and smalleyed ray).

Longnose skate (Raja rhina)

Overview: the Longnose skate is primarily caught in trawl and hook-and-line fisheries and mainly as bycatch from groundfish directed fisheries. The average annual catches of Longnose skate from the trawl fleet are between 300-400 tonnes, 54 per cent of which is retained (Government of Canada, 2007). There is limited information on the hook and line fleets bycatch and discard mortality, however it has been estimated that over 300 tonnes per year are caught in the halibut directed fishery (Government of Canada, 2007).

Atlantic Ocean stocks: the longnose skate distribution extends across the entire Canadian Pacific coast, southward to the Gulf of California and northward to the Bering Sea (Government of Canada, 2007). However, little is still known about the longnose skate's population and whether this population actually constitutes a distinguishable unit. Management of the longnose skate is in the form of a TAC in place for trawlers in the Hecate Strait off the Canadian coast, which was set to 47 tonnes in 2002. There are no restrictions identified in other areas (Government of Canada, 2007).

Although, there is data on the catches of longnose skate there is no stock assessment identified although the Hecate Trawl Survey and West Coast Triennial Survey indicate that the abundance of longnose skates within the survey area is stable and perhaps increasing (Government of Canada, 2007).

Pacific Ocean stocks: Pacific catches of rays were first recorded in 1954 under a generic code and in the 1990s they began to be recorded according to species (Government of Canada, 2007). Ray species in the Pacific are caught as bycatch with the exception of the Longnose skate (*Raja rhina*) which is caught by a directed fishery (Government of Canada, 2007).

Rays are managed through the Pacific Region Integrated Fisheries Management Plan Groundfish, which under consultation, annually sets TACs for ray catches and specifically the longnose skate within designated areas (Government of Canada, 2007). Since 2006 there has been full coverage of the hook and line vessels by sea and video monitoring, with monitoring of landings and discards considered to be accurate as there is 100 per cent coverage on trawl vessels (Government of Canada, 2007).

References

Aasen, O. (1964). The exploitation of the spiny dogfish (*Squalus acanthias* L.) in European waters. *Fiskeridir. Skr. Ser. Havunders*., 13(7): 5–16.

Anon (2003). Report of the subgroup on resource status (SGRST) of the Scientific, Technical and Economic for Fisheries (STECF): Elasmobranch Fisheries. Brussels 22–25 July 2003.

Baum, J.K., R.A. Myers, D.G. Kehler, B. Worm, S.J. Harley, and P.A. Doherty (2003). **Collapse and conservation of shark** populations **in the Northwest Atlantic. *Science* 299:389–392.**

Baum, J. K., Kehler, D. and Myers, R. A. (2005). Robust estimates of decline for pelagic shark populations in the Northwest Atlantic and Gulf of Mexico. *Fisheries*, 30: 27–30.

Biseau, A. (2006). Chapter Taupe Catch data of porbeagle in French artisanal fishery on porbeagle. *WGEF Working Document*.

Bonfil, R. (1994). Overview of world elasmobranch fisheries. *FAO Fisheries Technical Paper*, No. 341. FAO, Rome, 119 pp.

Buencuerpo V., Rios S., and Moron J. (1998). Pelagic sharks associated with the swordfish, *Xiphias gladius*, fishery in the eastern North Atlantic Ocean and the Strait of Gibraltar. *Fishery Bulletin*, 96(4): 667–685.

Burgess, G. H., Beerkircher, L. R., Cailliet, G. M., Carlson, J. K., Cortes, E., Goldman, K. J.; Grubbs, R. D., Musick, J. A., Musyl, M. K. and Simpfendorfer, C. A. (2005a). Is the collapse of shark populations in the Northwest Atlantic Ocean and Gulf of Mexico real? *Fisheries*, 30: 19–26.

Burgess, G. H., Beerkircher, L. R., Cailliet, G. M., Carlson, J. K., Cortes, E., Goldman, K. J.; Grubbs, R. D., Musick, J. A., Musyl, M. K. and Simpfendorfer, C. A. (2005b). Reply to “Robust estimates of decline for pelagic shark populations in the Northwest Atlantic and Gulf of Mexico”. *Fisheries*, 30: 30–31.

Cailliet G.M., Martin L.K., Harvey J.T., Kusher, D. and Welden B.A. (1983). Preliminary studies on the age and growth of blue *Prionace glauca*, common thresher *Alopias vulpinus* and shortfin mako *Isurus oxyrinchus* sharks from California waters. In: Proceedings of the International workshop on age determination of oceanic pelagic fishes: Tunas, billfishes and sharks (E.D.Prince & L.M.Pulos, eds.) *NOAA Technical Report NMFS*, 8: 179–188.

Camhi, M., Fowler, S.L., Musick, J.A., Bräutigam, A. and Fordham, S.V. (1998). Sharks and their Relatives – Ecology and Conservation. IUCN/SSC Shark Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. iv + 39 pp.

Campana, S. E., Joyce, W., Marks, L. and Harley, S. (2001). Analytical Assessment of the porbeagle shark (*Lamna nasus*) population in the Northwest Atlantic, with estimates of long-term sustainable yield. Canadian Stock Assessment, *Research Document*, 2001/067, Ottawa.

Campana, S. E., Marks, L., Joyce, W. Kohler, N. (2005). Catch, by-catch, and indices of population status of blue shark (*Prionace glauca*) in the Canadian Atlantic. International Commission for the Conservation of Atlantic Tunas, *Collective Volume of Scientific Papers. ICCAT* 58(3): 891–934.

Campana, S. E., Marks, L., Joyce, W., Hurley, P., Showell, M., and Kulka, D. (1999). An analytical assessment of the porbeagle shark (*Lamna nasus*) population in the Northwest Atlantic. Canadian Stock Assessment, *Research Document* 1999/158, Ottawa.

Cavanagh, R. D. and C. Gibson (2007). Overview of the Conservation Status of Cartilaginous Fishes (Chondrichthyans) in the Mediterranean Sea. IUCN, Gland, Switzerland and Malaga, Spain. vi + 42 pp.

CEC (2006). Proposal for a Council Regulation fixing for 2007 the fishing opportunities and associated conditions for certain fish stocks and groups of fish stocks, applicable in Community waters and, for Community vessels, in waters where catch limitations are required. Brussels, 5.12.2006 *COM(2006*) *774* final, 212 pp.

CITES (2007a). Consideration of Proposals for Amendment of Appendices I and II (Proposal for the inclusion of *Squalus acanthias* Linnaeus, 1758 in Appendix II in accordance with Article II 2(a). Fourteenth meeting of the Conference of the Parties. CoP14 Prop. 16. The Hague (Netherlands), 3-15 June 2007.

CITES (2007b). Consideration of Proposals for Amendment of Appendices I and II (Proposal for the inclusion of *Lamna nasus* (Bonnaterre, 1788) in Appendix II in accordance with Article II 2(a). Fourteenth meeting of the Conference of the Parties. CoP14 Prop. 15. The Hague (Netherlands), 3-15 June 2007.

Compagno, L.J.V. (1984). FAO Species Catalogue. Sharks of the World: an annotated and illustrated catalogue of shark species known to date. Part 2: Carcharhiniformes. *FAO Fisheries Synopsis* No. 125, Vol. 4(2): 251–655.

Daan, N., Heessen, H.J.L., and ter Hofstede, R. (2005). North Sea Elasmobranchs: distribution, abundance and biodiversity. *ICES CM 2005*/N:06.

DFO Atlantic Fisheries (1996). Shortfin Mako Shark. Maritimes Region DFO Atlantic Fisheries, Stock Status Report 96/32 E. pp 2.

DFO (2006). Recovery Potential Assessment Report on White Sharks in Atlantic Canada. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2006/052.

Diez, G., Santurtún, M., Ruiz, J., Iriondo, A., Gonzalez, I. and Artetxe, I. (2007). The longline Basque Fishery on blue shark (*Prionace glauca*) in the Bay of Biscay (1998–2006) Working Document for ICES Working Group on Elasmobranch Fishes, Galway 22–28 June 2007.

Dolgov, A.V., Drevetnyak, K.V. and Gusev, E.V. (2004). Skate Stocks in Barents Sea. *Journal of Northwest Atlantic Fisheries Science* 35, 249–260.

Drevetnyak, K. V. Dolgov, A. V., Sokolov, K. M., Gusev, E. V. and Grekov, A. A. (2005). Skates in the Barents Sea: stock status and catch by fishing fleet. *ICES CM* 2005/ N:11, 14 pp.

FAO (2007). Second FAO *ad hoc* expert advisory panel for the assessment of proposals to amend appendices I and II of CITES concerning commercially-exploited aquatic species *FAO Fisheries Report* No. 833. Rome. 140 pp.

Fernández, A., Rodriguez-Cabello, C., Gancedo, R., Punzón, A., Olaso, I., and Cendrero, O. (2002). Overview of continental shelf elasmobranch fisheries in the Cantabrian Sea. NAFO Symposium on Elasmobranch Fisheries. Santiago de Compostela (Spain), 11–13 September 2002. NAFO, SCR Doc. 02/115.

Figueiredo, I. and Machado, P. (2006). Standardized CPUE for deep-water sharks captured in the Portuguese continental slope. WGEF Working document.

Fishery Agency of Japan (2004). Salmon Shark *Lamna ditropis*; Porbeagle Shark *Lamna nasus*, Pacific, Atlantic and Indian Oceans. In: The current status of international fishery stocks (summarised edition). Pp. 82–83. Fishery Agency, Japan.

Fitzmaurice, P, Green, P., Keirse, G., Kenny, M. and Clarke, M. (2005). Stock discrimination of blue shark, based on Irish tagging data SCRS/2004/124 *Col. Vol. Sci. Pap. ICCAT,* 58(3): 1171–1178.

Gauld J. A. (1989). Records of porbeagles landed in Scotland, with observations on the biology, distribution and exploitation of the species, *Scottish Fisheries Research Report* 45. Dept. Ag., Edinburgh, Scotland: 1–15.

Government of Canada (2007). National Plan of Action for the conservation and Management of Sharks. Government of Canada, Communications Branch, Fisheries and Oceans Canada, Ottawa, Ontario, K1A 0E6. pp 31.

Green, P. (2007). Central Fisheries Board marine sportfish tagging programme 1970 to 2006. *Working document to WGEF*, 2007.

Hanan D.A., Holts D.B., and Coan A.L. Jr. (1993). The California drift gillnet fishery for sharks and swordfish, 1981–1982 through 1990–91. California Department of Fish Game, *Fishery Bulletin*, 175: 95 pp.

Hareide, N-.R., Rihan, D., Mulligan, M., McMullen, P., Garnes, G., Clark, M., Connolly, P., Tyndall, P., Misund, R., Furevik, D., Newton, A., Høydal, K., Blasdale, T. and Humborstad, O-.B. (2005). A preliminary investigation on shelf edge and deepwater fixed net fisheries to the west and north of Great Britain, Ireland, around Rockall and Hatton bank. ICES CM 2005/N:07.

Heessen, H.J.L. (2003). Development of elasmobranch assessments DELASS. Final report of DG Fish Study Contract 99/055, 605 p.

Henderson, A.C., Flannery, K., Dunne, J. (2001). Growth and reproduction in spiny dogfish *Squalus acanthias* L. (Elasmobranchii: Squalidae), from the west coast of Ireland. Sarsia, 87(5): 350–261.

Holden, M. J. and Meadows, P. S. (1962). The structure of the spine of the spurdog fish (*Squalus acanthias* L.) and its use for age determination. Journal of the Marine Biological Association of the United Kingdom, 42: 179–197.

Holden, M. J. (1968). The rational exploitation of the Scottish-Norwegian stock of spurdogs (*Squalus acanthias* L.). Fishery Investigations, Series II, 25(8), MAFF, London, 27 pp.

ICCAT (2005a). Report on the 2004 Inter-Sessional Meeting of the ICCAT Sub-Committee on By-Catches Shark Stock Assessment. *Col. Vol. Sci. Pap. ICCAT*, 58(3): 799 – 890.

ICCAT (2005b). Report of the 2004 inter-sessional meeting of the ICCAT sub-committee on bycatches: shark stock assessment. *Col. Vol. Sci. Pap. ICCAT*, 58: 891-934.

ICCAT (2006a). Recommandation supplémentaire de l'ICCAT concernant la conservation des requins capturés en association avec les pêcheries gérées par l'ICCAT.- Rec. 06-10 BYC, 1 p.

ICCAT (2006b). Chapter 8.12 SHK-Sharks Report of the Standing Committee on Research and Statistics (SCRS) ICCAT. PLE-014/2006 Madrid, Spain, October 2-6, 2006 106–113.

ICES (2006a). Report of the Working Group on Elasmobranch Fishes (WGEF), 14–21 June 2006, ICES Headquarters. *ICES CM* 2006/ACFM:31. 291 pp.

ICES (2006b). Working Group on the assessment of demersal stocks in the North Sea and Skagerrak (WGNSSK). 6–15 September 2005, ICES Headquarters Copenhagen. *ICES CM* 2006/ACFM:09.

ICES (2007a). Report of the Working Group on Elasmobranch Fishes (WGEF). 22-28 June 2007, Galway Ireland. *ICES Advisory Committee on Fishery Management* ICES CM 2007/ACFM:27 318 pp

ICES (2007b). Report of the ICES-FAO Working Group on Fish Technology and Fish Behaviour (WGFTFB), 23–27 April 2007, Dublin, Ireland. ICES CM 2007/FTC:06, 197 pp.

IOTC (2005). WPBy-06 Incidental mortality of seabirds, turtles and sharks: A review of data collected east of 20 degrees by South African observers Compiled by Samantha Petersen First Meeting of the IOTC Bycatch working party Phuket, 20 July 2005

IOTC (2007). Report of the Third Session of the IOTC Working Party on Ecosystems and Bycatch. *Indian Ocean Tuna Commission*. Seychelles, 11 – 13 July. pp 39.

Johnston, G., Clarke, M., Blasdale, T., Ellis, J., Figueiredo, I., Hareide, N. R., and Machado, P. (2005). Separation of Species Data from National Landings Figures. ICES CM 2005/N:22, 16 pp.

Jones, E., Clarke, M., Dobby, H., Beare, D., Trinkler, N., Burns, F., Neat, F., Fernandes, P. and Peach, K. (2005). The potential impact of commercial fishing activity on the ecology of deepwater chondrichthyans from the west of Scotland. ICES CM 2005 /N:16.

Liu K.-M., Chang Y.-T., Ni I.-H., and Jin C.-B. (2006). Spawning per recruit analysis of the pelagic thresher shark, *Alopias pelagicus*, in the eastern Taiwan waters. *Fisheries Research*, 82: 56–64.

Macias D., Gomez-Vives M.J., and de la Serna J.M. (2003). Desembarcos de especies asociadas a la pesqueria de palangre de superficie dirigido al pez espada (*Xiphias gladius*) en el Mediterraneao durante 2001 y 2002. ICCAT SCRS/2003/137. In: *Collection ICCAT Scientific Papers* 56(3): 981–986 (2004).

Mandelman, J. W., and Farrington, M. A. (2006). The estimated short-term discard mortality of a trawled elasmobranch, the spiny dogfish (*Squalus acanthias*). *Fisheries Research* 83: 238–245.

McEachran, J.D. and Branstetter, S. (1986). Squalidae. In Fishes of the North-eastern Atlantic and the Mediterranean Volume 1 (P.J.P.Whitehead, M.-L.Bauchot, J.-C.Hureau, J.Nielsen and E.Tortonese, Eds.), UNESCO, Paris, 128–147.

Mejuto J., Garcias-Cortes B. and de la Serna J.M. (2001). Preliminary scientific estimations of by-catches landed by the Spanish surface longline fleet in 1999 in the Atlantic Ocean and Mediterranean Sea. ICCAT SCRS/2001/049. In: *Collection ICCAT Scientific Papers* 54(4): 1150–1163 (2002).

Mejuto, J. (1985). Associated catches of sharks, Prionace glauca, Isurus oxyrinchus and *Lamna nasus*, with NW and N Spanish swordfish fishery in 1984. *ICES C.M*. 1985/H:42, 16 pp.

Morato, T., Sola, E., Gros, M. P. and Menezes, G. (2003). Diets of thornback ray (*Raja clavata*) and tope (*Galeorhinus galeus*) in the bottom longline fishery of the Azores, northeastern Atlantic. *Fishery Bulletin*, 101: 590–602.

MRAG (2004). Report of the 2003 / 2004 British Indian Ocean Territory Observer Progarmme. MRAG Ltd, 50pp.

NAFO (2007). Recovery Potential Assessment Report of Shortfin Mako Sharks in Atlantic Canada. Canadian Science Advisory Secretariat, *Science Advisory Report* 2006. pp 9.

NFSC (2006). 43rd Northeast Regional Stock Assessment Workshop (SAW). 2006. U.S. Dept of Commerce, *Northeast Fish. Sci. Cent. Ref. Doc*. 06-14: 46p.

NMFS (2006). Final Consolidated Atlantic Highly Migratory Species Fishery Management Plan. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Sustainable Fisheries, Highly Migratory Species Management Division, Silver Spring, MD. Public Document. pp. 1600.

Pérez, N., Pereda, P., Uriarte, A., Trujillo, V., Olaso, I., and Lens, S. (1996). Descartes de la flota española en el área del ICES. Datos y Resúmenes. *Inst. Esp. de Oceanogr*., 2: 142 pp.

Pinho, M. R. (2005). Elasmobranches of the Azores (ICES Area X). ICES WGEF 2005 Working Document, 20 pp.

Pinho, M. R. (2006). Elasmobranch statistics from the Azores (ICES Area X).Working Document (*WGEF*, 2006).

Revill, A., Dulvy, N. K. and Holst, R. (2005). The survival of discarded lesser-spotted dogfish (*Scyliorhinus canicula*) in the western English Channel beam trawl fishery. *Fisheries Research*, 71: 121–124.

Shark Alliance (2007). Fact sheet: spurdog. Pp 2

Sibert, J., Hampton, J., Kleiber, P., and Maunder, M. (2006). Biomass, size, and trophic status of top predators in the Pacific Ocean. *Science* **314**: 1773-76.

Sosinski, J. (1977). Polish investigations on the Scottish Norwegian spurdog (*Squalus acanthias*) in 1974. Ann. Biol., Copenhagen, 32: 178–179.

STECF (2006a). 22nd Report of the Scientific, Technical and Economic Committee for Fisheries. Brussels, 3–7 April, 50pp.

Tudela, S., Kai, A., Maynou, F., El Andalossi, M. and Guglielmi, P. (2005). Driftnet fishing and biodiversity conservation: the case study of the large-scale Moroccan driftnet fleet operating in the Alboran Sea (SW Mediterranean). *Biological Conservation*, 121: 65–78.

Walker, P., Cavanagh, R.D., Ducrocq, M. and Fowler, S.L. (2005). Chapter 7 – Regional Overviews: Northeast Atlantic (including Mediterranean and Black Sea). P86. In: Fowler, S.L., Cavanagh, R.D., Camhi, M., Burgess, G.H., Cailliet, G.M., Fordham, S.V., Simpfendorfer, C.A. and Musick, J.A. (comp. and ed.). (2005). Sharks, Rays and Chimaeras: The Status of the Chondrichthyan Fishes. IUCN SSC Shark Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK.