SCRS/2003/015

2003 Mediterranean Swordfish Stock Assessment Session
(*Madrid, Spain – May 26 to 30, 2003*)

1. Opening, adoption of the agenda and meeting arrangements

The meeting was held at the ICCAT Secretariat offices in Madrid. Dr. George Tserpes, meeting Chairman, opened the meeting and welcomed participants ("the Group"). Dr. Jacek Majkowski, on behalf of FAO and GFCM, commented on the excellent cooperation between ICCAT and GFCM and wished the Group a productive session.

The Agenda (**Appendix 1**) was adopted without changes. It was agreed that a draft Executive Summary for this stock would also be developed at this meeting. The list of participants is attached as **Appendix 2** and the list of documents presented at the meeting is attached as **Appendix 3**. The following participants served as rapporteurs:

Agenda Item	Rapporteur
Meeting Report	
1	J. Porter
2	J.Mª. Ortiz de Urbina
3.1	G. Scott
3.2	P. Kebe
3.3	P. Peristeraki
3.4	A. Di Natale
3.5-7	G. Tserpes
4	A. Fenech Farrugia
5	J. Porter & A. Hattour
6.1	J.M. de la Serna & J.Mª. Ortiz de Urbina
6.2	G. Tserpes
7	J. Porter
8	J. Porter
Executive Summary	
1. Biology	A. Di Natale
2. Description of fisheries	J.Mª. Ortiz de Urbina
3. State of stocks	G. Tserpes
4. Outlook	G. Tserpes
5. Effects of current regulations	J. Porter & A. Hattour
6. Management recommendations	G. Tserpes

2. Description of the fisheries

Mediterranean swordfish fisheries are characterized by high catch levels. It should be noted that average annual reported catches (on average about 14,500 t from 1984 to 2001; **Table 1**) are similar to those of the North Atlantic. The Mediterranean is a much smaller body of water compared to the North Atlantic. However, the potential reproductive area in the Mediterranean is probably relatively larger than that in the Atlantic. Further, the productivity of the Mediterranean Sea is thought to be very high.

Swordfish fishing has been carried out in the Mediterranean using harpoons and driftnets (drifting gillnets) at least since Roman times. Currently, swordfish fishing is carried out all over the Mediterranean Sea. The biggest producers of swordfish in the Mediterranean Sea in the recent years (1997-2001) were Italy (44%), Morocco (23%), Greece (10%), and Spain (9%). Also, Algeria, Cyprus, Malta, Tunisia, and Turkey have fisheries targeting swordfish in the Mediterranean. Incidental catches of swordfish have also been reported by Albania, Croatia, France, Japan, Libya, and Portugal. The Group recognized that there may be additional fleets

taking swordfish in the Mediterranean, for example, Israel, Lebanon, Egypt and Monaco, but the data are not reported to ICCAT or FAO.

Mediterranean total swordfish landings showed an upward trend from 1965-72, stabilized between 1973-1977, and then resumed an upward trend reaching a peak in 1988 (20,365 t; **Table 1, Figure 1**). The sharp increase between 1983 and 1988 may be partially attributed to improvement in the national systems for collecting catch statistics. Since 1988, the reported landings of swordfish in the Mediterranean Sea have declined, and since 1990, they have fluctuated between about 12,000 to 16,000 t. In 2001 catches were 15,155 t.

In recent years, the main fishing gears used are surface longline (47% of the total catch) and gillnet. Most of the above-mentioned countries operate longline fisheries, and in 2001 large-scale driftnet fisheries were mostly limited to Italy (>4,000 t) and Morocco (>2,000 t). There are also other countries known to be fishing with driftnets that do not report their catches. Swordfish are also caught with harpoons and traps, but trap gears are not used for targeting swordfish. It should be noted that since the beginning of 2002 driftnet fishing has been banned in EU countries and this will influence the catch data beginning in 2002.

There is a high demand for swordfish for fresh consumption in most Mediterranean countries.

A description follows for fisheries of those nations that attended the meeting (see **Figure 2** for reference to particular locations mentioned below).

EC- Greece

The Greek swordfish fleets exploit mainly the Aegean and Ionian seas but occasionally extend their activities to the Levantine basin.

The swordfish fishing season lasts from February to the end of September, as a closed season is operating from October to January, aiming for the protection of juveniles. About 100 vessels are involved on a regular basis in the swordfish fishery, but there are several boats involved occasionally in the fishery during the summer months. The main activity in the eastern Ionian Sea is usually observed from late spring to September. Swordfish fishing is carried out using drifting longlines. During the last years, the traditional longlines have been gradually replaced by the so-called American-type. Currently, only a few vessels targeting swordfish use the traditional gear.

The swordfish composes the main bulk of large pelagic catches in the areas exploited by the Greek fisheries and its production during the last four years fluctuated from 1,500 to 2,000 t.

EC- Italy

The Italian swordfish fishery has a long historical tradition. Recent catches usually accounts for a total between 6,000 to 7,000 t per year, with a slight variability from year to year, according to various factors. The most relevant fishery, in terms of the fleet, is the longline with about 1200 vessels from 7 to 30 meters in length; it is currently carried out from late February to December, in most of the Mediterranean areas. The most relevant changes of the fishing strategies happened in the last ten years, due to the increasing of tuna longlining in spring, implying a parallel decrease in the swordfish longlining. The swordfish target longline fishery provides the highest catch, while smaller quantities are due to the tuna longline fishery taken as a bycatch. The driftnet fishery was formerly the most important one for swordfish but, according to the EC Regulation, it was banned beginning in January 2002. Gillnet catches now come from set gillnets. The traditional harpoon fishery in the Strait of Messina catches very small quantities of swordfish, while even smaller catches are reported in tuna traps.

The former EC Legislation about the minimum size for the Mediterranean swordfish (120 cm LJFL) was cancelled in 2000 and the previous measure already existing in the Italian regulation (140 cm UJFL) came into force again.

EC- Spain

La pesquería española de pez espada en el Mediterráneo se remonta a principios del siglo XX, iniciándose su expansión en los años 1960- 1970 y estabilizándose a partir de los años 80 (SCRS/2003/042). La pesca se

realiza principalmente con palangre de superficie. También se captura pez espada ocasionalmente con palangre semipelágico (piedri- bola) y como captura accesoria del palangre dirigido al atún rojo y al atún blanco.

La pesquería española de pez espada en el Mediterráneo se caracteriza por la heterogeneidad de la flota y la composición de los aparejos así como por los cambios de estrategia de pesca. La flota puede llegar a estar compuesta por 145 barcos cuyas características medias son 11 m de eslora, 145 HP de potencia y 25 TRB. El área de pesca se extiende desde la Península Ibérica hasta el 06º por el Este y hasta el límite de aguas territoriales de Marruecos y Argelia. La mayor actividad se produce en los meses de verano y otoño.

La captura de pez espada alcanzó las 1484 t, de las que 1315 se capturaron con palangre de superficie, lo que supone en torno al 10% del total de pez espada capturado por todos los países y artes en el Mediterráneo. La estabilidad en la captura, el esfuerzo y los rendimientos es otra característica de esta pesquería.

La pesca de pez espada con palangre de superficie en el Mediterráneo está sometida a regulación mediante Orden de 18 de enero de 1984 (BOE nº.: 51) que limita el esfuerzo y define las características y dimensiones de los aparejos, en particular el número y tipo de anzuelos, longitud máxima del aparejo y número máximo de días de pesca entre otros.

Malta

Maltese fishermen have fished for swordfish for the past half a century. Records kept at the Department of Fisheries Conservation and Control indicate that as early as the 1960´s, Maltese fishermen have targeted swordfish using surface longlines. The fleet is made from about 60 small vessels (less than 10 m) and approximately 15 larger vessels. Swordfish is gilled and gutted at-sea. Most is landed at the central fishmarket, whilst a good percentage is exported directly to neighbouring ports.

In Malta, swordfish is targeted all year round with the highest catches being recorded during the months of June – October. The main fishing area is the central Mediterranean. Bycatch of the swordfish fishery includes mainly little tunny and various shark species. During the months of May and June, swordfish is also caught as a bycatch of the bluefin tuna fishery (SCRS/2003/049).

The historical catches were revised in order to include the swordfish that is exported directly and to convert the gilled and gutted weight into round weight (SCRS/2003/048).

Driftnet fishing is banned from being used by Maltese fishermen.

Morocco

En Méditerranée marocaine (Asilah- Frontière Algero-Marrocaine; **Figure 2**), l'espadon est pêché principalement au filet maillant dérivant (Gill net) par une flottille composée d'environ 370 navires de pêche (SCRS/2003/046). Ces bateaux ont en moyenne un tonnage de jauge brute (TJB) de 8 Tx, une puissance motrice de 80 CV et une longueur hors tout de 10 m.

Cette activité est pratiquée dans toutes les côtes méditerranéennes marocaines, avec une forte concentration dans la zone du détroit de Gibraltar (Cap Spartel- Sebta-). La pêche a lieu entre mars et octobre à des profondeurs allant de 40 à 800 mètres. En mer d'Alboran, cette activité s'étale presque sur toute l'année.

Les prises accessoires de cette pêcherie sont composées de plusieurs espèces notamment des requins, des thonidés mineurs, du billfishes et du thon rouge (*Thunnus thunnus*).

Les captures de l'espadon ont augmenté progressivement cette dernière décennie pour dépasser 5000 T en 1997, puis elles ont montré une tendance à la baisse. Le niveau des captures dépend étroitement de l'effort de pêche déployé par la flottille basée en Méditerranée.

Le filet maillant dérivant contribue en moyenne (5 dernières années) pour 88 % de la capture totale de l'espadon tandis que la palangre et la senne représentent seulement respectivement 10% et 1%.

Les tailles des espadons débarqués varient selon les ports entre 65 et 260 cm. Dans le détroit de Gibraltar, la taille moyenne est de 143 cm. En mer d'Alboran, elle est estimée à 106 cm (SCRS/2003/053).

Au Maroc, la réglementation de la pêche à l'espadon concerne: Fixation d'une taille marchande minimale de 120 cm (25 kg) (Arrêté n°1154-88 du 3 octobre 1988); fixation de la longueur maximale des filets maillants dérivants à 2,5 km; interdiction du maillage inférieur à 400 mm (Circulaire n°1232 du 11 mars 1991); gel de l'effort de pêche par la suspension des investissements en matière de construction navale depuis 1992 (note circulaire 3887 du 18 août 1992).

Tunisia

Les espadons sont parmi les plus importants des grands pélagiques sur la côte tunisienne (SCRS/2003/044). Ils occupent une place importante dans l'économie nationale, car ils sont dotées d'une valeur marchande assez élevée et constituent un matériel préférentiel au marché de l'exportation.

Les engins de pêche utilisés pour sa capture sont essentiellement la palangre de surface, mais sont accessoirement pris aux filets maillant, au feu, aux chaluts pélagiques et à la madrague. Au cours de 2002, plus de 90 palangriers de 10 à 17 m se livrent à la pêche de l'espadon tout au long des côtes tunisiennes. C'est une activité qui se généralise le long de la côte. Plus de 95,5 % des débarquements sont réalisés par les palangres de surface, la proportion restante est réalisée par les petites sennes suivies des chalutiers pélagiques, les prises des madragues, de la pêche au feu et des thoniers sont très faibles.

L'accroissement de l'effort et l'élargissement de l'aire d'activité des palangriers ciblant cette espèce se sont traduits par une augmentation des prises qui ont passé à 1138 t en l'an 2002 accusant ainsi une augmentation de 571 t par rapport à l'année dernière soit une augmentation de plus de 100,7%. Les maximums des débarquements sont réalisés de mai à septembre avec des pics aux mois de juin et juillet ce qui coïncide avec la période de reproduction de l'animal.

Les captures des espadons, à l'image de l'échantillonnage réalisé en 2002 montre que plus de 81,4% des débarquements nationaux sont des poissons de tailles comprises entre 80 et 124 cm, ce qui veut dire que ces poissons n'ont presque pas atteint la taille de leur première maturité sexuelle (SCRS/2003/045).

Les réglementations qui intéressent ces poissons concernent les tailles minimales de capture limitées à 120 cm. Pour ce qui est des techniques de pêche, des mesures ont été prises pour bannir l'emploi des filets dérivants à partir de 2000, même s'ils ne ciblent pas particulièrement l'espadon. Aucune législation particulière ne concerne l'emploi des palangriers mise à part la recommandation de la CICTA, adopté par la Tunisie et qui concerne l'interdiction de la pêche depuis le premier juin au 31 juillet par les palangriers mesurant plus de 24 m.

3. State of the stocks

3.1 Stock structure

Swordfish is a cosmopolitan species found in the Atlantic Ocean and the Mediterranean Sea, as well as in other oceans. Genetic studies suggest that all Mediterranean swordfish form a unique stock that is reproductively isolated from the Atlantic stocks (*e.g.*, SCRS/92/84, SCRS/94/27). Several fisheries and biological studies indicate that there is limited movement from the Mediterranean to areas immediately adjacent in the North Atlantic (*e.g.*, SCRS/92/84; SCRS/98/128). Genetic studies have confirmed this pattern (SCRS/2002/122). Additionally, life history differences between Atlantic and Mediterranean swordfish have been described and support the hypothesis. However, the precise boundary between Mediterranean and Atlantic stocks is uncertain and mixing is expected to be highest in the boundary zone.

3.2 Catch-at-size data

A detailed workplan had been developed by the Rapporteur and distributed together with the meeting announcement. This workplan set the deadlines for the receipt of new or updated data and the tasks to be accomplished before the start of the meeting. In accordance with this plan, the Secretariat created the updated catch-at-size before the start of the meeting. Several countries, however, submitted data on the first day of the meeting. In order to ensure the most complete available data for the assessment, the Group decided to accept the late submissions, and the catch-at-size file was recreated, causing some delay in the work of the Group.

3.2.1 Catch data

The Group reviewed the catch tables prepared by the Secretariat on the basis of available Task I data. Malta presented, in document SCRS/2003/048, a revised series of swordfish data from 1983-2001. As explained in the document, previous data submitted to the Secretariat had not taken export data into account. These revised data were converted from gilled and gutted weight using the conversion factor agreed by the Group of 1.12. It was also clarified that Maltese catches were made by longline, and that the series should be changed from unclassified to longline gear. The Group accepted the revised figures and the ICCAT data base was amended accordingly, as reflected in **Table 1.**

The Group noted that Morocco does not supply Atlantic and Mediterranean data by actual area of fishing. This is of particular concern as the administrative limit for the Mediterranean used by Morocco (**Figure 2**) is west of the ICCAT boundary located at 5º W longitude. The Group therefore recommended that Morocco provide catch, size and effort data by gear and month on as fine a scale as possible (1-degree rectangle for gillnet and 5-degree rectangle for longline), on an annual basis.

Minor changes to the 1999 data for EC-Greece data were also made, as 10 t of longline catch had been misreported as handline. EC-Spain reported an additional 73 t of swordfish caught by unclassified gear for 2001. The Group decided to estimate the Turkish catches for 2001 at 510 t in accordance with document SCRS/2002/039, as no official Task I data had been submitted.

It was also agreed to change the Tunisian data series from unclassified to longline gear, as the majority of the catches were taken by longline, with a very small proportion taken by other gears.

The Group recognized that there may be additional fleets taking swordfish in the Mediterranean, for example, Israel, Lebanon, Egypt and Monaco, but that these catches were unlikely to be very significant and that it would be impossible to make reliable estimates of such catches.

3.2.2 Size data

The Secretariat presented document SCRS/2003/050 which showed that data availability at the start of the meeting, together with the substitution, raising and re-raising carried out to create catch at size. On review, additional size data were made available from EC-Italy (longline and gillnet 1995-1997) and Morocco (gillnet 1998-2001). It was agreed that these data would be incorporated and that the substitutions would be amended accordingly.

The Group revised the substitutions made by the Secretariat and made some amendments. In particular, it was agreed that using EC-Greece data for substituting Malta and Tunisia was inappropriate, as these fisheries took different size classes. Italian data were therefore used in general for these fisheries, as the nature of the fishery had changed, resulting in the taking of smaller fish. Spanish longline data were therefore used to substitute Tunisia for these years. The Cypriote fishery, however, was considered to be similar to the Greek fishery, and it was decided that Cyprus should be substituted by Greek data.

Some doubts were raised regarding the substitutions for Algerian data, but as there were considerable uncertainties associated with the catch levels and the nature of the fisheries, it was agreed that Spanish longline (LLHB) data would continue to be used for substitution.

The catch-at-size was calculated and appears in **Table 2**. The catch-at-age (**Table 3**) was estimated by applying the slicing procedure (inverse Von-Bertalanffy equation: $T_i = T_i - \frac{1}{K}.\ln(1 - \frac{L_i}{L_\infty})$) to the catch-at-size matrix grouped by year. The birth date was considered July 1st.

Two documents were presented by Spanish scientists in relation to this topic: SCRS/2003/051 and SCRS/2003/052. The former presented a study of sex-at-size in the Moroccan gillnet fishery, and showed patterns similar to those found by other authors, in that females were predominant in the larger size classes but were found in very low proportions in the smaller classes. Assuming that the criterion for identification bewteen sexes in the small size classes is consistent among the various studies, the lower percentage of females in small size classes could be explained by a greater local abundance, or greater catchability, of males in certain time-area strata of the Mediterranean due to the diverse migration of the sexes and their geographical segregation

resulting from their respective migratroy, feeding and reproductive habits. This behaviour, which has been described in the Atlantic, Indian and Pacific Oceans, may also be possible in some areas and at certain times in the Mediterranean.

Document SCRS/2003/052 outlined a comparative study between the sex-at-size ratios of the Moroccan gillnet fishery and the Spanish longline fishery. The differences found in these ratios were attributed to a) possible mixing of Atlantic and Mediterranean swordfish in the Moroccan catches, given the proximity of the harvest to the Mediterranean / Atlantic stock boundary; b) the seasonal variations in the catches, Moroccan gillnet catches being made mainly in the second quarter, while Spanish longline fishery operates throughout the year; and c) the reduction in catchability by longline of females during the spawning period.

3.3 Catch rate (CPUE) data

Four papers concerning catch rate data were presented.

SCRS/2003/041 presented an analysis of commercial CPUE data series by means of Generalized Linear Modeling techniques, to examine the catchability differences between the two longline types used in the Greek swordfish fishery. The analysis revealed that the newly introduced American-type longline has an overall 36% higher performance, in terms of CPUE expressed in kg/1000hooks, than the traditional longline. It was commented that the reported difference was smaller than that previously observed in the Atlantic. This may be attributed to the fact that the Mediterranean fishery targets smaller fish than the Atlantic one and to modifications in fishing strategy of the traditional longlines, during the recent years.

SCRS/2003/040 presented standardized catch rates from the Italian and Greek fisheries operating in the central-eastern Mediterranean. Indices were estimated by means of GLM techniques and included the Greek longline fisheries operating in the eastern Mediterranean and the Sicilian longline and driftnet fisheries operating in the Tyrrhenian Sea and Straits of Sicily for the period 1987-2001. A combined index has been also estimated. Results did not demonstrate the presence of any particular trend over time.

SCRS/2003/043 presented the updated standardized catch rates for swordfish from the Spanish longline fleet in the Mediterranean Sea, for the years 1988-2001. Data included 15810 observations from the Spanish surface (traditional) longline fleet and were analyzed by means of GLM techniques. The effects of year, area and quarter were considered. Annual standardized CPUEs did not show any trend, a finding consistent with the results of the SCRS/2003/040. The CPUE series of the Spanish fishery represents a localized and limited area in the Mediterranean and may not reflect the general situation.

SCRS/2003/047 presented an analysis of the catch rates of the Moroccan driftnet fishery from the Mediterranean. Catch data, by month and boat, from 1990 to 2000 were analyzed by General Linear Modeling techniques. Standardized catch rates showed a general increasing trend throughout the years. However, the bimodal pattern of the model residuals indicated that estimates may be biased and suggested that other factors (*e.g.* changes in the exploitation pattern) should be also taken into account in the analysis of the data. It was recommended that the analysis should take into account geographic location on as fine a scale as possible in the future. It was also recommended that future analyses should examine the different gears separately and use the relevant standard measures of effort for them.

3.4 Biological population parameters

According to the available information (SCRS 1995), in recent years, only a few swordfish from the Mediterranean are reported to exceed 200 kg. The majority of the Mediterranean catch is comprised of individual of less than 3 years old and the average size is much lower than in the Atlantic. The fact that the fishery is based on 2-3 young year classes makes it vulnerable to recruitment changes.

Growth studies of swordfish in the Mediterranean, carried out by several teams, using both anal fin spines and length frequency data, all show a similar pattern of growth. It is also well known that the Mediterranean swordfish have sexually dimorphic growth, with males having a lower length-at-age, and achieving a smaller asymptotic size than do females. The growth equations adopted by the GFCM/ICCAT Working Group in 1995 are those published by Tserpes and Tsimenides (1995) and still used as follows:

$$L_{inf} = 238.60\ (1 - e^{-0.185\ (t + 1.404)})\ \text{for sexes combined}$$
$$L_{inf} = 203.08\ (1 - e^{-0.241\ (t + 1.205)})\ \text{for males}$$

$L_{inf} = 226.53\ (1 - e^{-0.210\ (t + 1.165)})$ for females.

Spawning generally occurs in spring and summer, with peaks in June and July, and variations in timing may be due to a variety of environmental and oceanographic influences. The most important spawning areas in the Mediterranean, according to the current knowledge, are around the Balearic Islands, the southern and central Tyrrhenian Sea, the Ionian Sea and the Strait of Messina. Juveniles are found throughout the Mediterranean but often tend to concentrate close to the coast.

According to the most recent review of the biological information available for the Mediterranean swordfish (SCRS/2001/050), major differences with the Atlantic stock have been noticed. Mature females as small as 110 cm LJFL have been observed and the estimated size at which 50% of the female population is mature occurs at 142 cm (SCRS/95/045). According to the growth curves used by SCRS in the past for the Mediterranean swordfish, these two sizes correspond to 2 and 3.5 year-old fish respectively. At 125 cm about 20% of the females in the Mediterranean would be mature. Males reach sexual maturity at smaller sizes.

3.5 Stock assessment model results

The Group noted that the absence of reliable historical data prior to 1968 (both catch and CPUE) has resulted in a situation where the stock cannot be described in relation to the unexploited population. Unless these historical data are recovered, it is unlikely that this problem will be resolved, and this will be a major constraint to future stock assessments for the Mediterranean.

3.5.1 Production models

The non-equilibrium surplus production model (ASPIC, cataloged version 3.82) was applied to catch and effort data for Mediterranean swordfish. The input data used in these analyses are presented in **Table 4**. For these analyses, a composite CPUE pattern was developed as the catch-weighted average of the Italian longline, Greek longline, Italian gillnet (SCRS/2003/40) and Spanish longline (SCRS/03/43) catch rate time series. Catch weighting was used in this case, due to concerns that the Spanish longline catch rate time series represented a relatively small area of fishing and typically represented about 10% of the total Mediterranean catch of swordfish. The resulting CPUE pattern is shown in **Figure 4**.

The production model was first fit to catch and effort for the period 1987-2001 (the period for which both catch and effort data exist). In this case, there was insufficient information in the data with which to freely estimate all model parameters (model convergence could be achieved by fixing both *r* and the initial biomass ratio; see **Appendix 4**). The fit of the production model to the CPUE series indicates that on average, the catches taken over the time period (average about 15,000 MT) resulted in a relatively stable population biomass over the period for which both catch and effort data exists (**Figure 5**). The results of model application to this short time series was considered unreliable from the standpoint of estimating population productivity and status parameters (MSY, B/B_{MSY} and F/F_{MSY}.)

The production model was then fit to catch data since 1968 and catch and effort data since 1987. In this case, the inclusion of more historic catch data allowed estimation of an additional model parameter, compared to the short (1987-2001) time-series of catch and effort. In these cases, initial biomass ratios had to be fixed to achieve model convergence, but the other model parameters were freely estimable. The model estimated *r* at about 0.55, close to that estimated for the North Atlantic swordfish stock. The fits to the CPUE data over a range of initial biomass ratios (0.5, 1, 2) were as shown in **Figure 5**. The model estimates of population status indicated a stock that was relatively stable over the 1987-2001 period, as with the short time-series, but the estimate of MSY (28,500 MT, which was insensitive to initial biomass ratio assumptions) was far in excess of the observed catches over time. This result, and hence the resulting stock status indicators with respect to MSY levels were considered unreliable. Application of a catch rate time series that extended back to 1984 (Tserpes *et al.* 2001) and thus provided information about change in relative abundance while the fishery was quickly expanding in the mid to late 1980s, resulted in a more plausible estimates of population productivity and status; similar to those estimated in Tserpes *et al.* 2001. However, the updated CPUE standardization analyses considered the data prior to 1987 to be too sparse for use in analysis.

3.5.2 Age-structured models

The Lowestoft VPA suite was used for the analysis. A separable VPA model (Pope and Shepherd 1982) was fitted to the estimates of the total Mediterranean catch numbers at age for the years 1985-2001 and ages 1-10 (**Table 3**). Input weight-at-age is presented in **Table 5**. Data for age 0 were too sparse to apply to the model. The same was true for ages older than 10, thus the latter was considered as a plus group. The input and output files from the analysis are available from the Secretariat.

The final SVPA run was made assuming M=0.2 and a reference age of 3. Fishing mortality in the reference age was set to 0.5 and selectivity at the oldest age in the final year was considered to be equal to that of age 3. The method calculates all the other fishing mortalities subject to these constraints. Based on information from SCRS/95/45 it was assumed a 50% maturity at age 3 and full maturity from age 4 onwards.

External specification of the level of fishing mortality at all ages, in the final year, requires that the level of mortality be estimated externally to the fitted model. This was achieved by maximizing the correlation between the model estimates of fishing mortality or population abundance with an additional information series via the Laurec-Shepherd method. The CPUE series from the Greekand Italian, and Spanish fleets estimated in SCRS/2003/040 and SCRS/2003/043 were applied in tuning. Both series were considered to represent relative biomass abundances of 2-9 age groups (**Table 6**). The combined Greek-Italian index covered the period 1990-2001 and included data from longline and drifnet fisheries. The Spanish CPUE series covered the period 1988-2001 and was estimated from the longline fisheries.

Figure 6 illustrates the residuals for the two CPUE series used for tuning. Overall, the Spanish series had smaller residuals, probably due to the lower inter-annual variability in the index.

Tables 7 and 8 present the estimates of fishing mortality and population numbers-at-age, respectively. Recent recruitment estimates (2000 and 2001) are considered to be unreliable due to the limited number of observations available for obtaining those estimates. Recruitment appears to be extremely consistent; there have been no strong or weak year classes.

Both, total and spawning stock biomass estimates remain stable during the last decade (**Figure 7**). **Figure 8** plots the estimated selection at age. Selection at age is estimated to be constant after age 3. Yearly mean fishing mortality rates reached their maximum values in late 80s, since then being mostly between 0.46-0.63 (**Figure 9**).

In general, findings are in-line with those previously reported from an assessment based on Greek and Italian fisheries data (SCRS/2002/034).

3.5.3 Stock status summary

Both production modeling and age-based VPA indicated the presence of a stable situation in terms of recruitment, total and spawning biomass (**Figures 5, 7**). These findings suggest that the current exploitation pattern and level of exploitation are sustainable, in the short-term. However, the lack of sufficient historical data did not allow the determination of stock status relative to MSY benchmarks. The VPA analysis suggested that recent F estimates were higher than the calculated Y/R and SPR benchmarks.

The Committee noted the large catches of small size swordfish (many of which have probably never spawned and the relatively low number of large individuals in the catches (**Figure 3**).

3.6 Yield- and spawner-per-recruit

Yield- and spawner-per-recruit analysis was conducted using input parameters derived from the VPA. The result of this analysis is shown in **Figure 10**. The VPA analysis suggested recent F's were on the order of 0.6, while Y/R and SPR benchmarks calculated were at lower values. **Table 9** shows the estimates of current F relative to these benchmarks. Under the current fishing mortality pattern, spawning stock biomass would be expected to equilibrate at about 10% of the unfished condition.

3.7 Projections

Assessment results indicated the presence of a stable recruitment pattern and suggested that the current exploitation pattern and level of exploitation are sustainable, at least in the short-term. Average catch over the past decade has been about 15,000 t per year (**Table 1, Figure 1**). The Committee expects that annual catches of about this magnitude will keep the stock at about the present level, at least over the short-term.

4. Environmental factors

It is well known that swordfish catches are highly affected by prevailing environmental factors. For example, the catches of swordfish are affected mainly by the presence of a stable thermocline during late spring and summer. In fact, when using driftnets, all catches are done just above the thermocline. Swordfish catches are also affected by the moon phase. In the presence of a full moon, higher catches are recorded for traditional longlines, whilst lower catches are recorded for driftnets (SCRS/94/86, SCRS/91/65). Areas characterized by higher turbulence also seem important for swordfish. Higher catches are recorded in the Tyrrhenian and Alboran seas.

During this meeting, no new data concerning environmental factors were presented. It was recommended that more work should be carried out in order to identify better the effects of the environment on swordfish.

5. Effects of current regulations

Although ICCAT has no specific regulatory measures for Mediterranean swordfish fisheries, several countries have imposed technical measures, such as closed areas and seasons, minimum landing size regulations and license control systems. The EU introduced a driftnet ban in 2002. National regulations are mentioned in Section 2. The Group reviewed the various measures taken by member countries and noted the difficulties in implementing some of the management measures, particularly that of minimum size.

6. Recommendations

6.1 Statistics and research

1) *Data submission.* Data must be reported by the ICCAT deadlines, even when no analytical stock assessment is scheduled. Historical catch, effort and CPUE data, if revised or when requested by the Secretariat, should also be provided, if possible. If the catch and size data are provided to the Secretariat by the specified deadlines, then the Secretariat will provide the catch-at-size and the adopted substitution table to the relevant scientists for review in advance of the meeting. This will then allow the stock assessment session to proceed immediately with analyses, without the delay associated with recalculating the catch-at-size during the meeting due the late submission of new data on the first day of the meeting.

2) *Sampling schemes.* The Group noted that the COPEMED Program, which has greatly improved the collection of data on statistics and biology, is coming to an end. The Group recommended that national or regional sampling schemes should be set-up in order to fill this void and to maintain at least the current level of sampling and research.

3) *Catch*. All countries catching swordfish (directed or by-catch) should report catch, catch-at-size (by sex) and effort statistics by as small an area as possible (5-degree rectangles for longline, and 1-degree rectangles for other gears), and by month. It is recommended that at least the order of magnitude of unreported catches be estimated.

4) *Size sampling.* All countries and fishing entities should carry out an adequate level of size sampling, and when possible sampling by sex, preferably by month and on as fine a scale as possible. If standard units of measure are not reported to ICCAT, then National Scientists should also provide appropriate conversion factors. In the absence of research to define adequate sampling levels, the Group recommended at least a large sampling fraction as proposed for the Atlantic, perhaps as much as 20% (see SCRS/1999/019). The Group noted that it is important to collect size data together with the catch and effort data to provide meaningful CPUEs.

5) *Stock structure.* The Group supported the 2002 SCRS recommendation for a comprehensive workshop on the topic of swordfish stock structure to be held in 2004.

6) *CPUE.* CPUE series should be developed to take into account the geographic stratification of the catch by gear and month using standard measures of effort for each gear (*e.g.*, # hooks for longline, length of nets for gillnet), on as fine a scale as possible (5-degree rectangles for longline, and 1-degree rectangles for other gears). Although CPUE by age is the usual input for the age-structured analyses, the Group recognized that this must be based on an increased level of sampling, not merely substitution of the current data. Therefore it is recommended that increased sampling take place so that CPUEs can be developed by age. To achieve this goal, the Group noted that it is important to collect size data together with the catch and effort data to provide meaningful CPUEs.

7) *Environment.* The Group recommended that more work should be carried out in order to identify better the effects of the environment on swordfish. Future CPUE analyses should focus on developing additional methods to explicitly incorporate environmental variability into the model.

8) *Next Mediterranean swordfish stock assessment.* It is recommended that Mediterranean catch and effort be monitored bi-annually, and that the next swordfish stock assessment be conducted not sooner than 2008 so long as there is no signal from the stock indicating a dramatic decline. This allows time to increase the time series of catch and effort data, and to advance basic research and assessment methods. It should be noted that the data required for that session should be up to and including the year prior to the meeting.

6.2 ***Management***

Assessment results indicated the presence of a stable recruitment pattern and suggested that the current exploitation pattern and level of exploitation are sustainable, as long as the stock does not decline. Mostly because of the lack of historical data, the Group cannot determine stock status relative to MSY benchmarks. Given the uncertainties in the assessment, the Group recommends that the current levels of exploitation not be exceeded, under the current exploitation patterns.

The percentage of juveniles in the catches is relatively high (**Figure 3**), as happens with several Mediterranean fisheries, and a reduction of their catches would improve the yield and spawning biomass per recruit. In the past, adoption of a minimum landing size regulation of 120 cm may have resulted in under-reporting of juvenile catches and appeared not to be practical in all situations, considering the low size-selectivity of the fishing gears used. Alternative methods for reducing juvenile catches are mentioned in the 2001 SCRS Report (Section 15.4) and their applicability should be further investigated.

In addition, given the uncertainty of the location of the boundary between the Mediterranean and North Atlantic stocks, it is important to identify the biological origin of those catches reported at or near the boundary so that the resulting knowledge can be considered in the management of the North Atlantic and/or Mediterranean stocks. The Group continues to recommend that the Commission ensure that reliable data be provided on catch effort and size for Mediterranean swordfish. Improvements to these basic inputs to the stock assessment are essential to improve future estimates.

7. Other matters

The Group drafted the Executive Summary in preparation for the 2003 SCRS Plenary.

8. Report adoption and closure

The report was adopted by consensus. The Group complimented the Chairman on his excellent leadership so that the meeting could be concluded in just 4 days. The Chairman thanked the participants for their hard work, and the meeting was closed.

Table 1. Nominal catches (t) of swordfish in the Mediterranean Sea by fleet and gear, 1950-2001 (26 May 2003).

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Total	586	580	337	0	452	340	393	0	914	200	112	206	300	318	394	1760	1752	1317	3440	3723	3341	4975	5958	4807	5034	4301	4637	5280
Longline	*586*	*580*	*337*	*0*	*452*	*340*	*393*	*0*	*414*	*0*	*0*	*94*	*188*	*94*	*282*	*1423*	*1192*	*869*	*1196*	*1350*	*1114*	*1426*	*1529*	*1388*	*1094*	*715*	*4143*	*4606*
Other and Uncl. Gears	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*500*	*200*	*112*	*112*	*112*	*224*	*112*	*337*	*560*	*448*	*2244*	*2373*	*2227*	*3549*	*4429*	*3419*	*3940*	*3586*	*494*	*674*
Longline																												
ALGERIE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	196	500	368	370
CHINESE TAIPEI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CROATIA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CYPRUS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	59	95
EC-ESPAÑA	586	580	337	0	452	340	393	0	414	0	0	0	0	0	0	1200	1000	700	1000	1100	900	1100	1300	1105	700	89	89	667
EC-GREECE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EC-ITALY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3435	3330
EC-PORTUGAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
JAPAN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
LIBYA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MALTA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MAROC	0	0	0	0	0	0	0	0	0	0	0	94	188	94	282	223	192	169	196	250	214	326	229	183	193	118	186	144
NEI-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TUNISIE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	3	5	0
Other and Uncl.																												
ALBANIA	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ALGERIE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EC-ESPAÑA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EC-FRANCE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EC-ITALY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1568	2240	2016	3248	4144	3136	3730	3362	312	417
LIBYA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	224	224	336	560	0	0	0	0	0	0	0	0	0
MALTA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	112	224	224	224	192	214	175	223
MAROC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	1	1	0	3	0	0	0
NEI-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TURKEY	0	0	0	0	0	0	0	0	500	200	112	112	112	224	112	112	336	111	115	133	99	76	60	59	15	10	7	34

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Total	5958	5547	6579	6813	6343	6896	13666	15292	16765	18320	20365	17762	12441	11997	14726	13265	16082	12430	12053	14693	14369	13700	15570	15155
Longline	*5046*	*4877*	*5115*	*5418*	*5770*	*6313*	*6749*	*6493*	*7505*	*8007*	*9476*	*7065*	*7184*	*7393*	*7648*	*7377*	*8985*	*6084*	*5884*	*5389*	*6496*	*6098*	*6961*	*7179*
Other and Uncl. Gears	*912*	*670*	*1464*	*1395*	*573*	*583*	*6917*	*8799*	*9260*	*10313*	*10889*	*10697*	*5257*	*4604*	*7078*	*5888*	*7097*	*6346*	*6169*	*9304*	*7873*	*7602*	*8609*	*7976*
Longline																								
ALGERIE	320	521	650	760	870	877	884	890	847	1820	2621	590	173	173	6	173	185	247	247	247	0	0	0	133
CHINESE TAIPEI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	3	0	0	0	0
CROATIA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	20	0	0
CYPRUS	82	98	72	78	103	28	63	71	154	84	121	139	173	162	73	116	159	89	40	51	61	92	82	135
EC-ESPAÑA	720	800	750	1120	900	1321	1243	1219	1337	1134	1760	1250	1438	1132	790	1293	1402	1351	1040	1184	1409	867	1396	1402
EC-GREECE	0	0	0	91	773	772	1081	1036	1714	1303	1008	1120	1344	1904	1456	1568	2520	974	1237	750	1650	1520	1960	1730
EC-ITALY	3750	3455	3642	3362	2583	2660	2759	2493	2622	2831	2989	2989	2454	2470	3518	3260	3844	2800	2617	2458	2458	2680	2639	2236
EC-PORTUGAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	115
JAPAN	2	3	1	0	5	6	19	14	7	3	4	1	2	1	2	4	2	4	5	5	7	5	0	0
LIBYA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	8	6
MALTA	0	0	0	0	0	59	94	172	144	163	233	122	135	129	85	91	47	72	72	100	153	187	175	102
MAROC	172	0	0	0	0	43	39	38	92	40	62	97	371	508	807	517	527	169	273	245	323	259	205	754
NEI-2	0	0	0	0	517	532	552	499	524	566	598	598	918	733	733	0	0	0	0	0	0	0	0	0
TUNISIE	0	0	0	7	19	15	15	61	64	63	80	159	176	181	178	354	298	378	352	346	414	468	483	567
Other and Uncl.																								
ALBANIA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	13	13	13	0	0
ALGERIE	0	0	0	0	0	0	0	0	0	0	0	0	539	389	389	389	415	560	560	560	825	709	816	948
EC-ESPAÑA	0	0	0	0	0	1	2	8	0	0	2	87	85	39	32	65	101	28	146	80	34	39	41	82
EC-FRANCE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
EC-ITALY	756	475	501	461	356	366	6601	8370	8791	9494	10021	10020	3070	2319	4077	3070	3921	3925	2669	3646	3646	3632	4876	4152
LIBYA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MALTA	136	151	222	192	177	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MAROC	0	0	0	0	0	0	0	0	0	0	0	0	878	1198	1885	2072	2127	1527	2461	4655	2905	2979	2503	2272
NEI-2	0	0	728	672	0	0	219	231	243	262	277	381	442	559	559	0	0	0	0	0	0	0	0	0
TURKEY	20	44	13	70	40	216	95	190	226	557	589	209	243	100	136	292	533	306	320	350	450	230	373	510

Table 2. Catch-at size matrix (5 cm length classes) for Mediterranean swordfish, 1985-2001.

Length classes	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
10															41		
30											46						
35											772						
40	49		807		3490	82		55		173	971	1	1				153
45	495	326		440	1996	82		158			187						307
50	1268	1688		754	3715	174	215	1335	672	519	130			679	275		1325
55	732	1448	2259	1633	5249	204	443	2468	1265	828	1152	133	44	5950	52	86	2643
60	1039	2969	1567	2084	8461	497	1671	6089	3413	3502	5405	210	1032	7289	510	401	8665
65	2569	2958	6052	4790	6532	2340	2906	10566	6552	8850	5596	1387	1985	3327	2437	1221	14605
70	4000	3949	9840	17395	12701	4357	8459	12273	10978	19588	9281	12286	8954	10004	11963	3843	35248
75	7330	4269	15544	20701	16228	8062	10797	12600	17542	21720	14797	10465	9893	16843	11535	5369	21736
80	14175	6833	22895	36790	22968	15062	12815	16969	22762	16426	21899	14524	13687	23804	12925	13156	22880
85	15095	11265	21139	33908	22510	29100	19222	17976	28524	11401	31420	19746	17651	47539	18805	23656	27160
90	22876	15916	34086	53472	36628	43669	25407	17821	33679	23076	38555	32765	26167	53251	32163	39456	32014
95	22566	19688	29203	51621	36987	39491	32140	26835	40503	31961	49045	39212	31493	46525	38527	42257	48304
100	34041	21493	34476	61995	48659	48402	39055	48126	56375	65692	55234	39652	38909	43977	42892	51176	65435
105	28706	19345	19918	45000	47274	43774	38785	60422	63913	59022	44427	37649	32642	37139	47254	42469	55398
110	30121	32988	24144	36729	39556	50872	34255	65578	72272	73126	39287	34490	34439	39861	40766	44702	47372
115	26908	34731	33362	40660	40870	47606	33592	56001	46449	62361	33814	32068	41396	38572	40684	40791	51259
120	29786	42142	23747	35998	37939	50303	33984	43710	35396	50928	36324	38290	43432	32689	33564	42859	46427
125	29378	39727	29155	32238	37535	37352	26129	31806	28720	37151	26504	32510	45167	27857	28569	34365	33778
130	24929	32254	26869	27226	23872	26683	23858	25741	22596	29762	29287	28908	38824	24333	22103	33344	28698
135	25160	24490	28574	25704	26484	19139	23292	19960	14881	25873	21019	22359	31330	17825	21503	24648	23565
140	20164	21973	20702	18711	25656	16454	17140	15995	13693	17942	16508	19094	25039	16370	17134	20842	19986
145	20542	14845	16712	25891	22041	10349	12849	13654	9971	13066	9956	12268	14484	12715	14496	15999	18103
150	16294	20423	23819	24523	17900	9849	11059	13428	9247	10971	7792	11787	17263	11458	13610	15730	12997
155	14226	11579	17706	23543	18769	6605	10133	9364	8034	8815	8606	8867	10172	11590	13696	12191	8292
160	14686	14586	19533	16289	16832	7130	7299	10122	7494	9723	7965	6246	17504	9967	9228	11939	7549
165	9939	15081	19199	20548	15233	4046	6298	7548	6518	7056	5067	5420	7547	9678	8644	9323	8346
170	12393	14753	15075	12353	9935	4133	6674	7581	5911	6989	5302	4884	5180	8750	7488	9030	5806
175	9356	9463	13774	13117	7857	3589	4236	5159	4075	6401	4140	3949	4337	6183	4990	5289	5220
180	11098	10077	11417	7471	5966	3038	2739	4719	3772	4625	3242	2606	4609	5925	5676	5212	3751
185	3438	4962	4998	4940	2840	1392	2576	2966	2381	3821	3217	2547	2915	3601	3615	3523	3298
190	2889	4340	3138	2949	3879	1045	1660	2088	2351	2924	1300	1602	839	2959	2836	3390	2229
195	1463	686	1412	2437	3335	993	1316	2423	1696	2302	1234	1277	729	2304	958	1643	1774
200	1213	1187	1739	2472	1188	565	1186	2359	1383	1417	1024	920	915	1186	895	1098	540
205	838	2399	1250	666	662	177	1019	938	718	729	827	666	467	801	414	1056	495
210	393	2185	658	1974	1141	346	512	215	519	962	481	501	230	603	518	471	699
215	612	363	1808	1060	644	258	146	96	104	389	403	181	143	426	235	207	616
220	571	110	451	451	10	66	125	98	161	196	170	266	99	175	154	331	197
225		5	8	13	511	74	125	133	173	292	64	8	58	181	38		144
230		5	807	442	2		197	184	34	166	16	2	86	143	17	44	83
235							55	36	15	62	51	4		36	7	83	130
240	3	4						29	2	61	12	1	1	28	7	36	
245									44	7	28			23	96	4	
250	3				3						12			0		56	
255									21		12	1	1		48		21
260											12	1	1	62	41		
265														0			
270												1	1		17		
280												1	1	0			
285		1	0													4	
295																4	
Total	**461340**	**467502**	**537842**	**708984**	**634047**	**537360**	**454370**	**575623**	**584809**	**640875**	**542591**	**479749**	**529665**	**582627**	**511426**	**561301**	**667251**

Table 3. Catch-at-age (in numbers) for Mediterranean swordfish, 1985-2001.

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0	6950	10177	12651	13179	31982	4205	6927	23124	14098	17789	16584	4943	5447	19237	5708	2566	34589
1	85241	61130	130737	210407	145479	138916	107148	102020	151792	120255	162672	125783	105459	195973	123526	126878	180451
2	137648	133842	126149	205982	199122	221020	166078	256353	260247	292444	195046	166173	168715	179463	191959	205270	247748
3	103474	126508	106517	110793	118458	112983	97158	104588	88572	122251	101468	112733	150081	92675	96000	121634	116279
4	56288	53324	62979	76733	65218	32064	38870	40972	31124	38009	30457	37534	50494	39999	45714	49957	45835
5	34911	40839	51320	48959	41778	15021	19627	24089	19160	23234	18278	16215	32686	27374	25040	29098	21017
6	23189	23423	28937	24034	16604	7624	9096	11965	9451	12609	8599	7673	9954	14276	12543	12902	10388
7	7383	9579	9163	8203	6359	2631	4121	5167	4556	6531	4664	4210	3713	6479	6518	6664	5418
8	2866	2661	3016	4111	5123	1523	2216	3730	2911	3753	2065	2122	1310	3739	2224	3259	2753
9	1303	1910	1892	2242	1215	522	1356	2263	1394	1435	1158	1132	890	1324	796	1187	573
10+	2087	4110	4481	4341	2707	849	1772	1352	1503	2566	1600	1232	916	2088	1398	1887	2200
Total	461340	467502	537842	708984	634047	537360	454370	575623	584809	640875	542591	479749	529665	582627	511426	561301	667251

Table 4. Input data used for non-equilibrium production modelling. The short time series model application used data from 1987-2001 (Obs 20-34). The long time-series model application used data from 1968-2001. CPUE values indicated by a dash are missing values. Yields are in MT. CPUE is in relative values.

Obs	Year	Observed CPUE	Observed yield	Obs	Year	Observed CPUE	Observed yield
1	1968	--	3.44E+03	20	1987	0.90860	1.83E+04
2	1969	--	3.72E+03	21	1988	0.98890	2.04E+04
3	1970	--	3.34E+03	22	1989	1.09500	1.78E+04
4	1971	--	4.98E+03	23	1990	0.81820	1.24E+04
5	1972	--	5.96E+03	24	1991	1.00000	1.20E+04
6	1973	--	4.81E+03	25	1992	0.83560	1.47E+04
7	1974	--	5.03E+03	26	1993	0.99710	1.33E+04
8	1975	--	4.30E+03	27	1994	1.12700	1.61E+04
9	1976	--	4.64E+03	28	1995	1.12500	1.24E+04
10	1977	--	5.28E+03	29	1996	0.74710	1.21E+04
11	1978	--	5.96E+03	30	1997	1.09200	1.47E+04
12	1979	--	5.55E+03	31	1998	1.23400	1.44E+04
13	1980	--	6.58E+03	32	1999	1.17600	1.37E+04
14	1981	--	6.81E+03	33	2000	0.92720	1.56E+04
15	1982	--	6.34E+03	34	2001	1.00400	1.50E+04
16	1983	--	6.90E+03				
17	1984	--	1.37E+04				
18	1985	--	1.53E+04				
19	1986	--	1.68E+04				

Table 5. Input weight-at-age for the VPA.

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	7.9	8.1	7.6	7.6	7.7	8.2	7.9	7.4	7.7	7.3	8.0	8.0	7.9	7.8	7.9	8.4	7.3
2	17.0	18.1	17.1	16.5	16.8	17.2	16.9	17.1	16.7	17.0	16.6	17.0	17.2	16.9	16.9	16.9	16.8
3	31.3	30.8	31.6	31.0	31.1	30.2	31.1	30.5	30.3	30.6	30.9	30.8	30.6	30.8	31.0	30.9	30.7
4	49.0	49.2	49.9	49.9	49.2	48.5	49.0	49.0	49.0	48.6	48.8	49.0	47.9	49.3	49.5	49.1	48.3
5	69.0	69.8	69.2	69.1	68.6	68.3	69.1	68.9	69.0	68.8	68.4	68.8	66.7	69.2	68.9	69.0	69.3
6	90.0	89.4	89.4	88.9	89.0	89.5	88.3	89.2	89.2	89.2	89.2	88.4	90.7	89.5	89.6	89.2	89.2
7	107.2	108.1	107.3	107.8	109.0	107.7	108.3	108.0	108.6	108.5	107.6	107.9	105.9	108.2	108.4	108.7	108.4
8	126.2	124.2	126.3	127.4	126.7	127.1	127.2	127.9	126.9	126.8	127.9	127.0	127.8	126.5	126.0	126.2	126.7
9	143.9	145.8	144.0	142.9	143.6	143.0	144.3	143.2	143.5	143.7	145.2	144.9	142.8	143.9	143.8	144.6	145.2
10+	177.1	165.6	185.5	179.2	177.8	176.3	179.3	183.0	181.5	183.5	183.2	173.7	178.7	187.4	195.3	182.3	183.7

Table 6. Tuning CPUE (relative biomass) series (Greek-Italian=GR-IT, and Spanish) used in the VPA assessment.

Year	GR-IT	SPAIN*
1988		4.94
1989		4.61
1990	0.78	4.62
1991	1.06	4.33
1992	0.86	4.31
1993	1.02	4.55
1994	1.15	4.69
1995	1.16	4.63
1996	0.73	4.48
1997	1.14	4.53
1998	1.31	4.54
1999	1.24	4.42
2000	0.94	4.54
2001	1.06	4.37

* log scale

Table 7. VPA estimated fishing mortality estimates by age and year.

Year	Age									
	1	2	3	4	5	6	7	8	9	10+
1985	0.13	0.29	0.39	0.37	0.50	0.71	0.55	0.34	0.34	0.34
1986	0.11	0.31	0.48	0.35	0.50	0.75	0.73	0.39	0.39	0.39
1987	0.20	0.34	0.43	0.47	0.68	0.83	0.77	0.53	0.54	0.54
1988	0.30	0.53	0.56	0.64	0.82	0.82	0.60	1.00	1.00	1.00
1989	0.22	0.51	0.68	0.77	0.89	0.75	0.54	0.98	0.98	0.98
1990	0.24	0.59	0.62	0.39	0.40	0.39	0.25	0.23	0.23	0.23
1991	0.16	0.50	0.57	0.45	0.45	0.45	0.37	0.34	0.34	0.34
1992	0.15	0.72	0.68	0.51	0.57	0.54	0.51	0.69	0.69	0.69
1993	0.19	0.66	0.59	0.44	0.47	0.46	0.40	0.61	0.61	0.61
1994	0.17	0.67	0.77	0.54	0.69	0.66	0.68	0.69	0.69	0.69
1995	0.23	0.47	0.52	0.43	0.55	0.59	0.55	0.48	0.48	0.48
1996	0.20	0.39	0.54	0.37	0.44	0.47	0.65	0.52	0.52	0.52
1997	0.17	0.46	0.74	0.50	0.65	0.53	0.43	0.43	0.43	0.43
1998	0.28	0.48	0.49	0.44	0.57	0.67	0.80	1.09	1.09	1.09
1999	0.19	0.48	0.52	0.48	0.55	0.56	0.76	0.72	0.72	0.72
2000		0.53	0.65	0.57	0.66	0.62	0.66	1.16	1.16	1.16
2001			0.66	0.54	0.50	0.53	0.57	0.64	0.64	0.64

Table 8. VPA estimated numbers at age by year.

Year	Age									
	1	2	3	4	5	6	7	8	9	10+
1985	771976.40	596545.70	353328.00	199460.80	97107.73	49966.86	19067.54	11036.82	5017.78	8036.92
1986	657404.20	555205.90	364670.30	196407.40	112769.20	48228.59	20203.92	9002.27	6461.61	13904.28
1987	808958.20	483115.60	334275.90	185188.00	112917.20	55743.11	18587.96	7991.51	4982.23	11799.85
1988	893311.10	544603.80	282223.80	178143.80	95165.16	46609.83	19853.31	7045.39	3842.32	7439.56
1989	819141.90	542256.00	261448.50	131905.10	77258.94	34280.16	16741.69	8917.54	2114.94	4712.04
1990	720756.40	539714.60	265610.20	108244.30	49825.34	26058.82	13251.24	8013.39	2746.55	4467.08
1991	785035.10	465113.70	244172.00	116448.10	59846.45	27314.51	14492.18	8482.23	5190.38	6782.71
1992	830355.10	546203.90	232004.30	112968.60	60490.66	31398.64	14208.01	8165.56	4954.07	2959.75
1993	963453.30	587901.90	218338.40	96519.34	55787.80	27969.59	14994.54	7004.03	3354.03	3616.28
1994	831385.30	652123.60	248786.80	99520.45	51110.28	28501.94	14427.23	8188.45	3130.94	5598.61
1995	869397.60	572363.30	272649.00	94638.55	47451.16	21093.05	12068.40	5978.17	3352.40	4631.98
1996	752694.10	565417.10	293777.00	132355.60	50168.13	22487.14	9577.02	5705.68	3043.74	3312.62
1997	741640.70	503013.10	313779.80	139600.40	74666.78	26532.32	11533.11	4078.72	2771.03	2851.98
1998	887808.50	512208.80	260577.40	122961.40	69060.88	31920.24	12809.24	6112.52	2164.48	3413.46
1999	800239.60	550662.10	258539.00	130306.50	64802.59	32045.30	13379.62	4711.02	1686.14	2961.33
2000	821231.50	543940.60	278815.00	125698.10	65720.83	30640.73	15010.03	5139.19	1871.81	2975.65
2001			261538.40	119563.70	58207.91	27806.89	13549.56	6334.75	1318.49	5062.24
2002				110233.90	56856.37	28828.49	13463.69	6245.41	2725.81	2745.59

Table 9. Estimates of YPR and SPR benchmarks and corresponding estimates of current F with respect to the benchmarks.

$F_{20\%SPR}$	0.29	$F/F_{20\%SPR}$	2.3
$F_{30\%SPR}$	0.20	$F/ F_{30\%SPR}$	3.3
$F_{40\%SPR}$	0.14	$F/ F_{40\%SPR}$	4.7
F_{2001}	0.66	$F/ F_{0.1}$	4.7
F_{MAX}	0.24	F/ F_{MAX}	2.7
$F_{0.1}$	0.14		

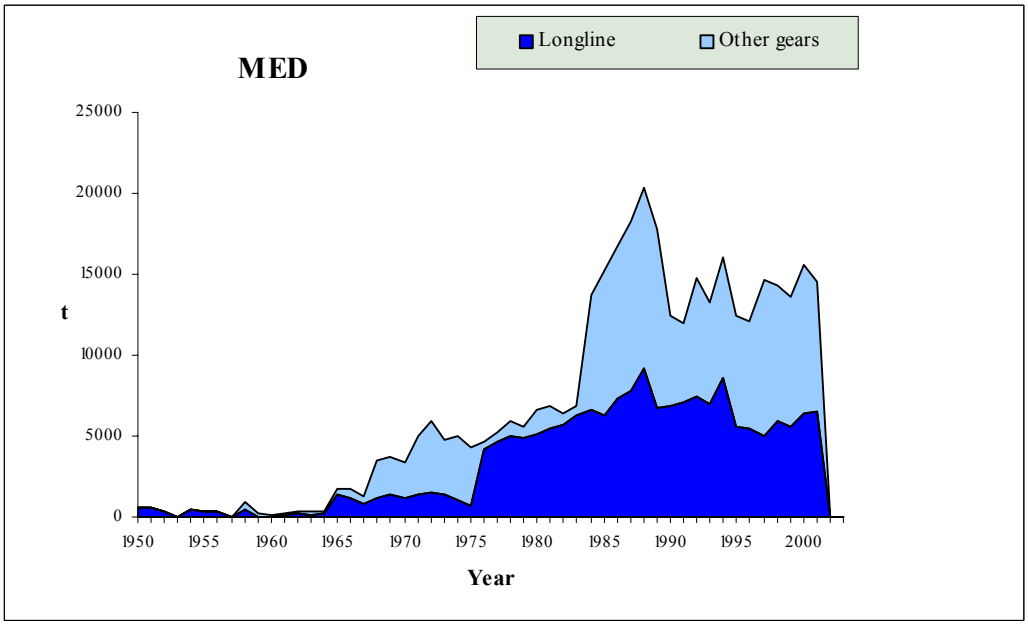


Figure 1. Cumulative estimates of swordfish catches (t) in the Mediterranean by major gear type, 1950-2001.

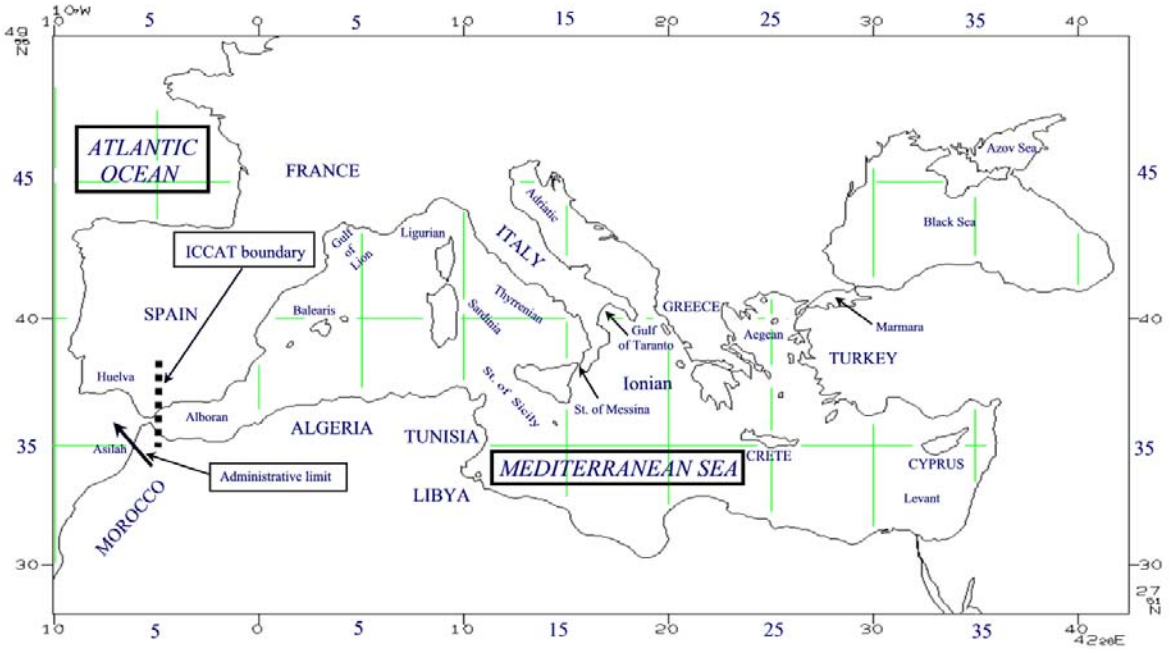


Figure 2. Map of the Mediterranean Sea with the locations referred to in the Report. The Mediterranean/Atlantic boundary used by ICCAT is at 5º W longitude. The approximate provincial administrative limit for the Mediterranean used by Morocco (is also shown (see section 3.2.1).

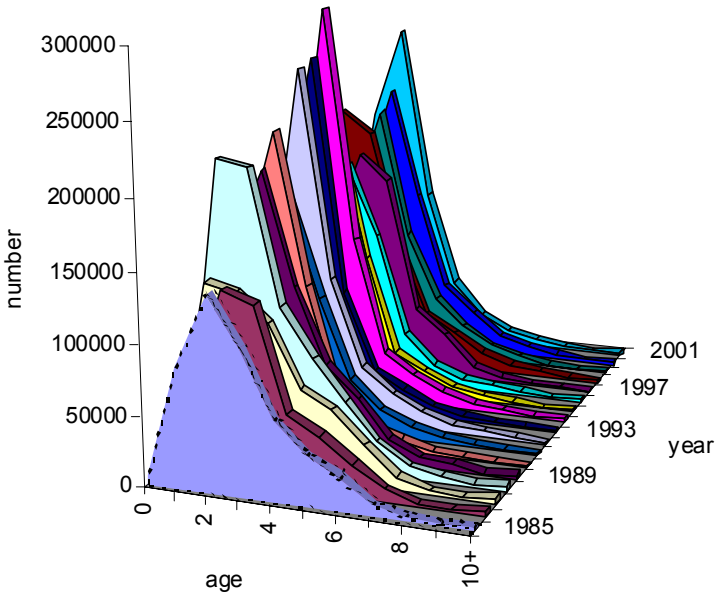


Figure 3. Age distribution of catches in the Mediterranean by year (1985-2001).

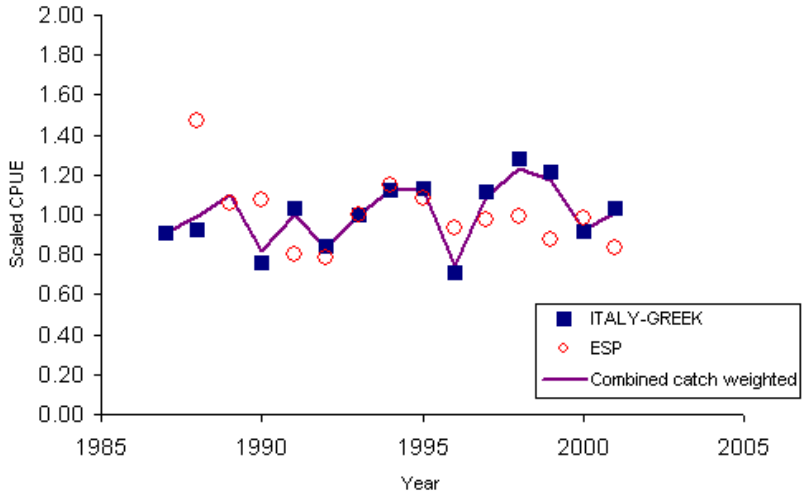


Figure 4. The CPUE pattern (Combined) used in production model tuning was a catch-weighted average of the Italian, Greek (SCRS/03/40), and Spanish (SCRS/03/43) CPUE time-series. Because the Italian and Greek catches were considerably larger than the Spanish longline catches, the resulting weighted average pattern more closely resembles the Italian-Greek CPUE series.

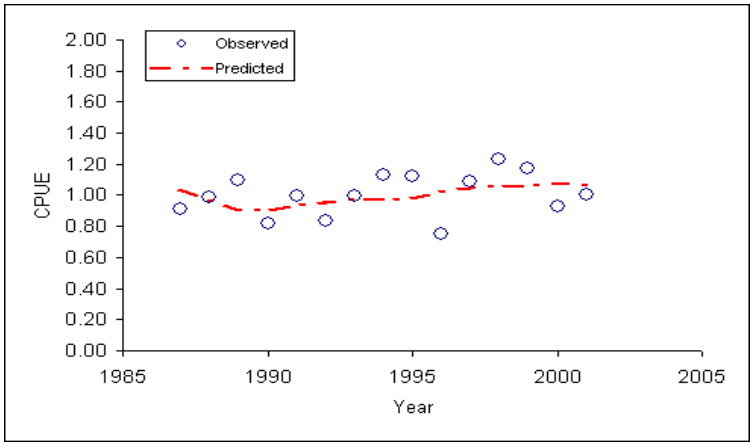


Figure 5. Fit of the non-equilibrium production model to catch and effort since 1987. The predicted CPUE indicates a relatively stable population biomass over the time-period from 1987-2001.

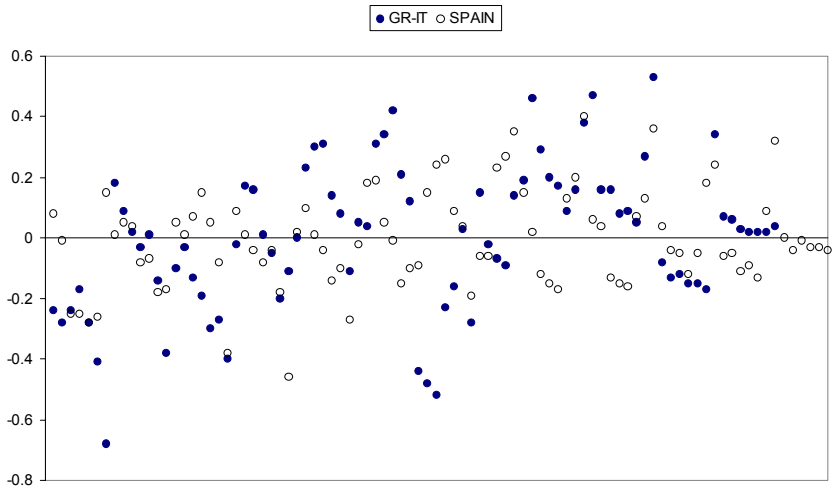


Figure 6. Residuals by CPUE series (Greek-Italian=GR-IT, and Spanish) from the tuned VPA.

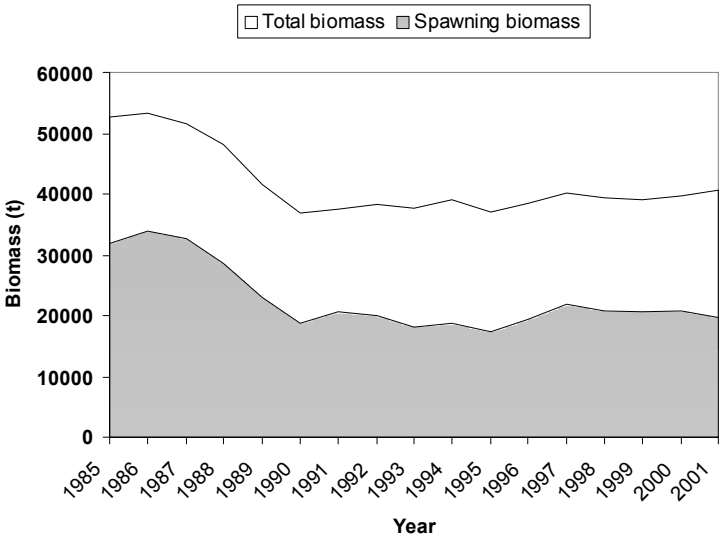


Figure 7. Total and spawning biomass estimates by year as estimated from the VPA.

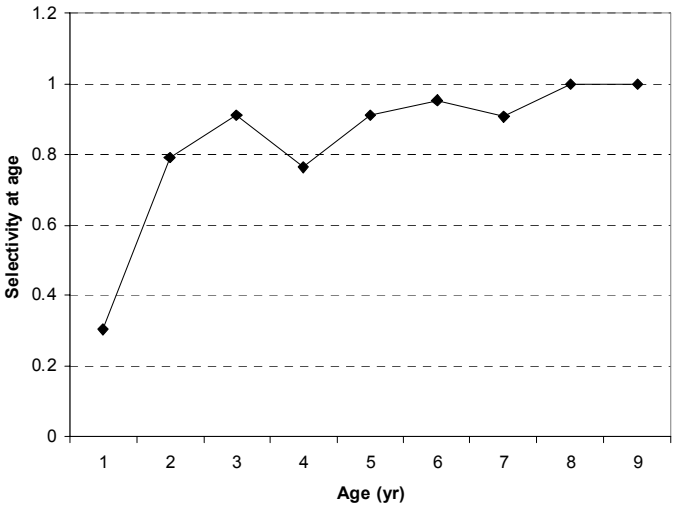


Figure 8. Estimated selectivity at age.

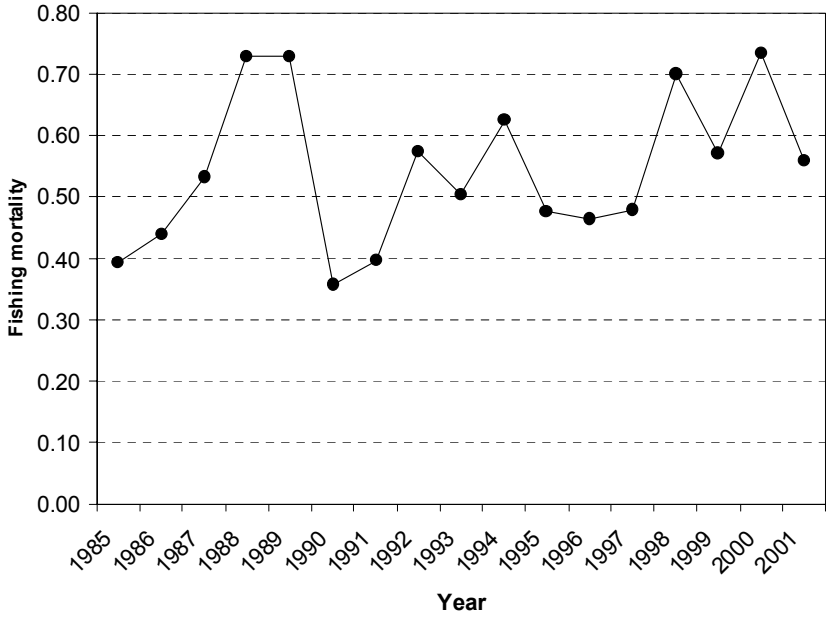
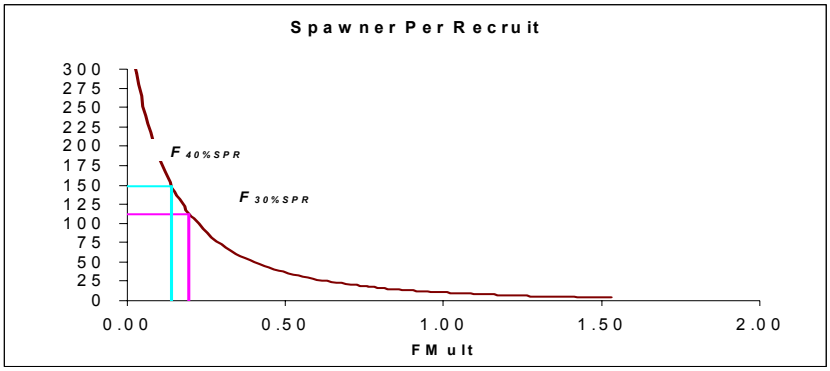


Figure 9. Mean fishing mortality by year.



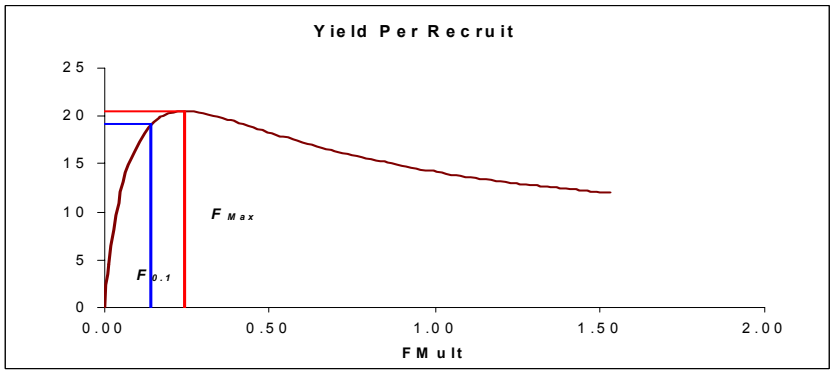


Figure 10. Spawner-per-recruit (kg, upper) and yield-per-recruit (kg, lower) for Mediterranean swordfish based on VPA results. Corresponding benchmarks, relative to current F levels (FMult=1.0) are shown.

Appendix 1

Agenda

1. Opening, adoption of the agenda and meeting arrangements
2. Description of the fisheries
3. State of the stocks
   - 3.1 Stock structure
   - 3.2 Catch-at-size data
   - 3.3 Catch rate (CPUE) data
   - 3.4 Biological population parameters (growth, natural mortality, maturity)
   - 3.5 Stock assessment model results
   - 3.6 Yield- and spawner-per-recruit
   - 3.7 Projections
4. Environmental factors
5. Effects of current regulations
6. Recommendations
   - 6.1 Statistics and research
   - 6.2 Management
7. Other matters
8. Report adoption and closure

Appendix 2

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Appendix 3

List of Documents

SCRS/2003/040 Standardised catch rates for swordfish (*Xiphias Gladius*) from the Italian and Greek fisheries operating in the central-eastern Mediterranean. TSERPES, G., P. Peristeraki, and A. Di Natale.

SCRS/2003/041 Catchability differences among the long-lines used in the Greek swordfish fishery. TSERPES, G., and P. Peristeraki.

SCRS/2003/042 Análisis de la pesquería española de pez espada (*Xiphias gladius*) en el Mediterráneo DE LA SERNA, J.M , D. Macías, J.Mª. Ortiz de Urbina, E.Alot, P.Rioja.

SCRS/2003/043 Updated stansardized catch rates in number and weight for swordfish (*Xiphias gladius* L.) from the Spanish longline fleet in the Mediterranean Sea. ORTIZ DE URBINA, J. Mª., J.M. de la Serna, J. Mejuto, P. Rioja, and D. Macías.

SCRS/2003/044 La pêche de l'espadon dans les eaux tunisiennes au cours de 2002. HATTOUR, A.

SCRS/2003/045 Relation taille-poids éviscéré des espadons débarques dans les principaux ports tunisiens en 2002. HATTOUR, A.

SCRS/2003/046 Situation de la pêcherie de l'espadon (*Xiphias gladius*) des côtes marocaines. SROUR, A. et N. Abid.

SCRS/2003/047 Analyse préliminaire des indices d'abondance de l'espadon des côtes marocaines. SROUR, A. et N. Abid, J.Mª. Ortiz de Urbina, et J.M. de la Serna.

SCRS/2003/048 Revision of historical catches of swordfish made by Maltese longliners. FENECH FARRUGIA, A.

SCRS/2003/049 Description of swordfish bycatches made with bluefin tuna longlines near Malta during 2002. FENECH FARRUGIA, A., J.M. de la Serna and J. Mª. Ortiz de Urbina.

SCRS/2003/050 Update of the Mediterranean swordfish catch-at-size data base. Statistics Department, ICCAT Secretariat.

SCRS/2003/051 Preliminary analysis of the spatial and temporal variability in the sex ratio at size of the swordfish (*Xiphias gladius* L.) caught by the Moroccan drift net fishery. SROUR, A., N. Abid, J. M. de la Serna, and J. Mª. Ortiz de Urbina.

SCRS/2003/052 A comparison of swordfish (*Xiphias gladius* L.) sex ratio at size between the Moroccan drift net fishery and the Spanish longline fishery. DE LA SERNA, J.M., N. Abid, A. Srour, J. Mª. Ortiz de Urbina, D. Macías, and P. Rioja.

SCRS/2003/053 Preliminary analysis of the temporal and spatial variability in the length-weight relationship of the swordfish (*Xiphias gladius* L.) caught by the Moroccan drift net fishery. SROUR, A., N. Abid, J. Mª. Ortiz de Urbina, and D. Macías.

Other references (not in SCRS volumes)

ANON. 1996. Report of the Second Meeting of the Ad Hoc GFCM/ICCAT Working Group on Stock of Large Pelagic Fishes in the Mediterranean Sea. Coll. Vol. Sci. Pap. 45: 1-151.

POPE, J.G., and J.G, Shepherd. 1982. A simple method for the consistent interpretation of catch-at-age data. J. Cons. Int. Explor. Mer 40: 176-184.

TSERPES, G., P. Peristeraki, A. De Natale, and C. Darby. 2001. Analysis of swordfish fisheries data series in the central and eastern Mediterranean Sea. Final report of EC Study Project 98/034, 97 pp.

TSERPES, G., and N. Tsimenides. 1995. Determination of age and growth of swordfish, *Xiphias gladius* L. 1758, in the eastern Mediterranean using anal-fin spines. Fish. Bull. 93: 594-602.

Appendix 4

Details of Production Modeling for Mediterranean Stock Assessment

Mediterranean SWO 2003; B1 fixed at 1; catches since 1987, r fixed (27 May 2003 at 02:34.22)

ASPIC -- A Surplus-Production Model Including Covariates (Ver. 3.82) FIT Mode

Ref: Prager, M. H. 1994. A suite of extensions to a nonequilibrium surplus-production model. Fishery Bulletin 92: 374-389.

CONTROL PARAMETERS USED (FROM INPUT FILE)

Number of years analyzed:	15	Number of bootstrap trials:	0
Number of data series:	1	Lower bound on MSY:	1.000E+03
Objective function computed:	in effort	Upper bound on MSY:	6.000E+05
Relative conv. criterion (simplex):	1.000E-08	Lower bound on r:	5.000E-02
Relative conv. criterion (restart):	3.000E-08	Upper bound on r:	5.000E+00
Relative conv. criterion (effort):	1.000E-05	Random number seed:	922738
Maximum F allowed in fitting:	8.000	Monte Carlo search mode, trials:	1 1000

PROGRAM STATUS INFORMATION (NON-BOOTSTRAPPED ANALYSIS) code 0

Normal convergence.

GOODNESS-OF-FIT AND WEIGHTING FOR NON-BOOTSTRAPPED ANALYSIS

Loss component number and title	Weighted SSE	N	Weighted MSE	Current weight	Suggested weight	R-squared weight in CPUE
Loss(-1) SSE in yield	0.000E+00					
Loss(0) Penalty for B1R > 2	0.000E+00	1	N/A	0.000E+00	N/A	
Loss(1) Combined Index	2.869E-01	15	2.207E-02	1.000E+00	1.000E+00	0.005
TOTAL OBJECTIVE FUNCTION:	2.86875366E-01					

Number of restarts required for convergence: 2
Est. B-ratio coverage index (0 worst, 2 best): 0.1817 < These two measures are defined in Prager
Est. B-ratio nearness index (0 worst, 1 best): 1.0000 < et al. (1996), Trans. A.F.S. 125:729

MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Starting guess	Estimated	User guess
B1R	Starting biomass ratio, year 1987	1.000E+00	1.000E+00	0	1
MSY	Maximum sustainable yield	1.496E+04	1.300E+04	1	1
r	Intrinsic rate of increase	4.250E-01	4.250E-01	0	1
.....	Catchability coefficients by fishery:				
q(1)	Combined Index	1.512E-05	3.000E-03	1	1

MANAGEMENT PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Formula	Related quantity
MSY	Maximum sustainable yield	1.496E+04	Kr/4	
K	Maximum stock biomass	1.408E+05		
Bmsy	Stock biomass at MSY	7.042E+04	K/2	
Fmsy	Fishing mortality at MSY	2.125E-01	r/2	
F(0.1)	Management benchmark	1.913E-01	0.9*Fmsy	
Y(0.1)	Equilibrium yield at F(0.1)	1.481E+04	0.99*MSY	
B-ratio	Ratio of B(2002) to Bmsy	1.001E+00		
F-ratio	Ratio of F(2001) to Fmsy	1.002E+00		
F01-mult	Ratio of F(0.1) to F(2001)	8.983E-01		
Y-ratio	Proportion of MSY avail in 2002	1.000E+00	2*Br-Br^2	Ye(2002) = 1.496E+04
.....	Fishing effort at MSY in units of each fishery:			
fmsy(1)	Combined Index	1.405E+04	r/2q(1)	f(0.1) = 1.265E+04

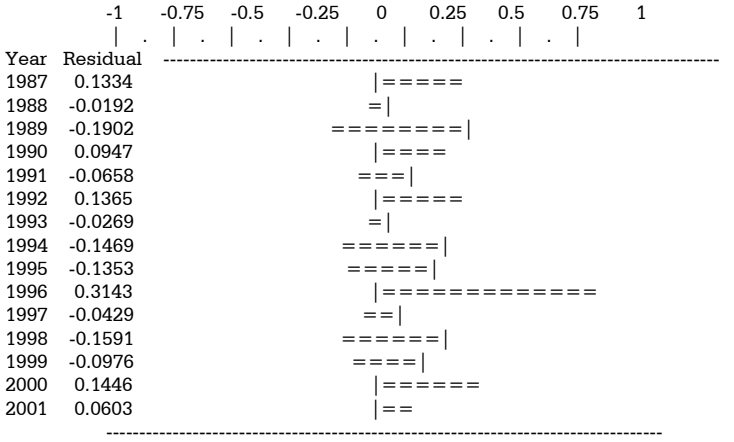
RESULTS FOR DATA SERIES # 1 (NON-BOOTSTRAPPED) Combined Index

Data type CC: CPUE-catch series Series weight: 1.000

Obs	Year	Observed CPUE	Estimated CPUE	Estim F	Observed yield	Model yield	Resid in log scale	Resid in yield
1	1987	9.086E-01	1.038E+00	0.2668	1.832E+04	1.832E+04	0.13336	0.000E+00
2	1988	9.889E-01	9.701E-01	0.3174	2.037E+04	2.037E+04	-0.01921	0.000E+00
3	1989	1.095E+00	9.056E-01	0.2966	1.776E+04	1.776E+04	-0.19016	0.000E+00
4	1990	8.182E-01	8.995E-01	0.2091	1.244E+04	1.244E+04	0.09474	0.000E+00
5	1991	1.000E+00	9.368E-01	0.1937	1.200E+04	1.200E+04	-0.06580	0.000E+00

6	1992	8.356E-01	9.577E-01	0.2325	1.473E+04	1.473E+04	0.13646	0.000E+00
7	1993	9.971E-01	9.706E-01	0.2066	1.327E+04	1.327E+04	-0.02692	0.000E+00
8	1994	1.127E+00	9.726E-01	0.2500	1.608E+04	1.608E+04	-0.14690	0.000E+00
9	1995	1.125E+00	9.826E-01	0.1913	1.243E+04	1.243E+04	-0.13533	0.000E+00
10	1996	7.471E-01	1.023E+00	0.1782	1.205E+04	1.205E+04	0.31430	0.000E+00
11	1997	1.092E+00	1.046E+00	0.2123	1.469E+04	1.469E+04	-0.04291	0.000E+00
12	1998	1.234E+00	1.053E+00	0.2064	1.437E+04	1.437E+04	-0.15908	0.000E+00
13	1999	1.176E+00	1.067E+00	0.1941	1.370E+04	1.370E+04	-0.09759	0.000E+00
14	2000	9.272E-01	1.072E+00	0.2197	1.557E+04	1.557E+04	0.14464	0.000E+00
15	2001	1.004E+00	1.067E+00	0.2129	1.502E+04	1.502E+04	0.06029	0.000E+00

UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 1



Mediterranean SWO 2003; B1 fixed at 2.0 (26 May 2003 at 12:07.12)

ASPIC -- A Surplus-Production Model Including Covariates (Ver. 3.82) FIT Mode

CONTROL PARAMETERS USED (FROM INPUT FILE)

Number of years analyzed:	34	Number of bootstrap trials:	0
Number of data series:	1	Lower bound on MSY:	1.000E+03
Objective function computed:	in effort	Upper bound on MSY:	6.000E+05
Relative conv. criterion (simplex):	1.000E-08	Lower bound on r:	5.000E-02
Relative conv. criterion (restart):	3.000E-08	Upper bound on r:	5.000E+00
Relative conv. criterion (effort):	1.000E-05	Random number seed:	922738
Maximum F allowed in fitting:	8.000	Monte Carlo search mode, trials:	1 1000

PROGRAM STATUS INFORMATION (NON-BOOTSTRAPPED ANALYSIS) code 0

Normal convergence.

GOODNESS-OF-FIT AND WEIGHTING FOR NON-BOOTSTRAPPED ANALYSIS

Loss component number and title	Weighted SSE	N	Weighted MSE	Current weight	Suggested weight	R-squared in CPUE
Loss(-1) SSE in yield	0.000E+00					
Loss(0) Penalty for B1R > 2	0.000E+00	1	N/A	0.000E+00	N/A	
Loss(1) Combined Index	2.855E-01	15	2.196E-02	1.000E+00	1.000E+00	0.006

TOTAL OBJECTIVE FUNCTION: 2.85466854E-01

Number of restarts required for convergence: 3

Est. B-ratio coverage index (0 worst, 2 best): 0.3579 < These two measures are defined in Prager

Est. B-ratio nearness index (0 worst, 1 best): 0.3579 < et al. (1996), Trans. A.F.S. 125:729

MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Starting guess	Estimated	User guess
B1R	Starting biomass ratio, year 1968	2.000E+00	2.000E+00	0	1
MSY	Maximum sustainable yield	2.882E+04	1.300E+04	1	1
r	Intrinsic rate of increase	5.600E-01	4.250E-01	1	1
.....	Catchability coefficients by fishery:				
q(1)	Combined Index	5.687E-06	3.000E-03	1	1

MANAGEMENT PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Formula	Related quantity
MSY	Maximum sustainable yield	2.882E+04	Kr/4	
K	Maximum stock biomass	2.059E+05		

Bmsy	Stock biomass at MSY	1.029E+05	K/2	
Fmsy	Fishing mortality at MSY	2.800E-01	r/2	
F(0.1)	Management benchmark	2.520E-01	0.9*Fmsy	
Y(0.1)	Equilibrium yield at F(0.1)	2.853E+04	0.99*MSY	
B-ratio	Ratio of B(2002) to Bmsy	1.702E+00		
F-ratio	Ratio of F(2001) to Fmsy	3.057E-01		
F01-mult	Ratio of F(0.1) to F(2001)	2.944E+00		
Y-ratio	Proportion of MSY avail in 2002	5.066E-01	2*Br-Br ^ 2	Ye(2002) = 1.460E+04
.....	Fishing effort at MSY in units of each fishery:			
fmsy(1)	Combined Index	4.924E+04	r/2q(1)	f(0.1) = 4.432E+04

RESULTS FOR DATA SERIES # 1 (NON-BOOTSTRAPPED) Combined Index

Data type CC: CPUE-catch series Series weight: 1.000

Obs	Year	Observed CPUE	Estimated CPUE	Estim F	Observed yield	Model yield	Resid in log scale	Resid in yield
1	1968	*	1.162E+00	0.0168	3.440E+03	3.440E+03	0.00000	0.000E+00
2	1969	*	1.150E+00	0.0184	3.723E+03	3.723E+03	0.00000	0.000E+00
3	1970	*	1.143E+00	0.0166	3.341E+03	3.341E+03	0.00000	0.000E+00
4	1971	*	1.136E+00	0.0249	4.975E+03	4.975E+03	0.00000	0.000E+00
5	1972	*	1.126E+00	0.0301	5.958E+03	5.958E+03	0.00000	0.000E+00
6	1973	*	1.121E+00	0.0244	4.807E+03	4.807E+03	0.00000	0.000E+00
7	1974	*	1.120E+00	0.0255	5.034E+03	5.034E+03	0.00000	0.000E+00
8	1975	*	1.121E+00	0.0218	4.301E+03	4.301E+03	0.00000	0.000E+00
9	1976	*	1.122E+00	0.0235	4.637E+03	4.637E+03	0.00000	0.000E+00
10	1977	*	1.120E+00	0.0268	5.280E+03	5.280E+03	0.00000	0.000E+00
11	1978	*	1.116E+00	0.0303	5.958E+03	5.958E+03	0.00000	0.000E+00
12	1979	*	1.113E+00	0.0283	5.547E+03	5.547E+03	0.00000	0.000E+00
13	1980	*	1.110E+00	0.0337	6.579E+03	6.579E+03	0.00000	0.000E+00
14	1981	*	1.105E+00	0.0350	6.813E+03	6.813E+03	0.00000	0.000E+00
15	1982	*	1.103E+00	0.0327	6.343E+03	6.343E+03	0.00000	0.000E+00
16	1983	*	1.101E+00	0.0356	6.896E+03	6.896E+03	0.00000	0.000E+00
17	1984	*	1.083E+00	0.0718	1.367E+04	1.367E+04	0.00000	0.000E+00
18	1985	*	1.053E+00	0.0826	1.529E+04	1.529E+04	0.00000	0.000E+00
19	1986	*	1.027E+00	0.0928	1.677E+04	1.677E+04	0.00000	0.000E+00
20	1987	9.086E-01	1.003E+00	0.1039	1.832E+04	1.832E+04	0.09859	0.000E+00
21	1988	9.889E-01	9.780E-01	0.1184	2.037E+04	2.037E+04	-0.01109	0.000E+00
22	1989	1.095E+00	9.632E-01	0.1048	1.776E+04	1.776E+04	-0.12845	0.000E+00
23	1990	8.182E-01	9.723E-01	0.0727	1.244E+04	1.244E+04	0.17249	0.000E+00
24	1991	1.000E+00	9.913E-01	0.0688	1.200E+04	1.200E+04	-0.00925	0.000E+00
25	1992	8.356E-01	9.983E-01	0.0839	1.473E+04	1.473E+04	0.17792	0.000E+00
26	1993	9.971E-01	1.001E+00	0.0753	1.327E+04	1.327E+04	0.00365	0.000E+00
27	1994	1.127E+00	9.985E-01	0.0916	1.608E+04	1.608E+04	-0.12065	0.000E+00
28	1995	1.125E+00	1.000E+00	0.0706	1.243E+04	1.243E+04	-0.11766	0.000E+00
29	1996	7.471E-01	1.010E+00	0.0678	1.205E+04	1.205E+04	0.30155	0.000E+00
30	1997	1.092E+00	1.011E+00	0.0826	1.469E+04	1.469E+04	-0.07742	0.000E+00
31	1998	1.234E+00	1.006E+00	0.0812	1.437E+04	1.437E+04	-0.20413	0.000E+00
32	1999	1.176E+00	1.006E+00	0.0774	1.370E+04	1.370E+04	-0.15654	0.000E+00
33	2000	9.272E-01	1.002E+00	0.0883	1.557E+04	1.557E+04	0.07789	0.000E+00
34	2001	1.004E+00	9.973E-01	0.0856	1.502E+04	1.502E+04	-0.00698	0.000E+00

* Asterisk indicates missing value(s).

UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 1