

8.9 SWO-MED-MEDITERRANEAN SWORDFISH

The most recent assessment was conducted in 2007 (SCRS/2007/016), making use of catch and effort information through 2005. The present report summarizes assessment results and readers interested in more detailed information on the state of the stock should consult the Report of the 2007 Stock Assessment Session. The impact of different management measures on stock levels and fisheries was examined during an inter-session meeting held in February 2008 and the main findings are presented in the current report. More details can be found in the "Report of the 2008 Analysis of Mediterranean Swordfish Management Measures" (SCRS/2008/011).

SWO-MED-1. Biology

Research results have demonstrated that Mediterranean swordfish compose a unique stock separated from the Atlantic stocks, although there is incomplete information on stock mixing and boundaries. However, mixing between stocks is believed to be low and generally limited to the region around the Straits of Gibraltar.

According to previous knowledge, the Mediterranean swordfish have different biological characteristics compared to the Atlantic stock. The growth parameters are different, and the sexual maturity is reached at younger ages as compared to the Atlantic, although more recent information for the Atlantic indicates that these differences may be smaller than was previously thought. In the Mediterranean, 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 about 140cm. According to the growth curves used by the SCRS in the past for Mediterranean swordfish, these two sizes correspond to 2 and 3.5 year-old fish, respectively. Males reach sexual maturity at smaller sizes and mature specimens have been found at about 90 cm LJFL. Based on the fish growth pattern and the assumed natural mortality rate of 0.2, the maximum yield would be obtained through immediate fishing at age 6, while current catches are dominated by fish less than 4 years-old.

SWO-MED-2. Fishery indicators

Annual catch levels do not show any particular trend in the last decade, fluctuating between 13,000-16,000 t. Those levels are relatively high and similar to those of bigger areas such as the North Atlantic. This could be related to higher recruitment levels in the Mediterranean as compared to the North Atlantic, different reproduction strategies (larger spawning areas in relation to the area of distribution of the stock) and the lower abundance of large pelagic predators (e.g. sharks) in the Mediterranean. Updated information on Mediterranean swordfish catch by gear type is provided in **SWO-MED-Table 1** and **SWO-MED-Figure 1**. The total 2007 catch is estimated to be around to 14,000 t, while 2008 catch data are incomplete. The biggest producers of swordfish in the Mediterranean Sea in recent years are EC-Greece, EC-Italy, EC-Spain and Morocco. Furthermore, Algeria, EC-Cyprus, EC-Malta, EC-Portugal, Tunisia and Turkey have fisheries targeting swordfish in the Mediterranean. Minor catches of swordfish have also been reported by Albania, Croatia, EC-France, Japan, and Libya. The Committee recognized that there may be additional fleets taking swordfish in the Mediterranean, for example, Egypt, Israel, Lebanon, Monaco and Syria; however, the data are not reported to ICCAT or FAO.

Mediterranean swordfish landings showed an upward trend from 1965-1972, stabilized between 1973-1977, and then resumed an upward trend reaching a peak in 1988 (20,365 t; **SWO-MED-Table 1**, **SWO-MED-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 in the last decade, they remain mostly around to 14,000-15,000 t.

The main fishing gears used are surface longline and gillnets. Minor catches are also reported from harpoon, trap and recreational fisheries. Surface longlines are used all over the Mediterranean, while gillnets are still used in some areas and there are also countries known to be fishing with gillnets but not reporting their catches. However, following ICCAT recommendations for a general ban of driftnets in the Mediterranean, the gillnet fleet has been decreasing, although the total number of vessels cannot be determined from ICCAT statistics.

Preliminary results of experimental fishing surveys presented during the 2006 SCRS meeting indicated that selectivity of the surface longline targeting swordfish was more affected by the type and size of the bait, the

depth of the set and the distance between branch lines rather than the type (circular vs. J-shaped) and the size of the hook. In general, American-style longlines capture less juvenile fish than the traditional Mediterranean longline gear, while a significant reduction of swordfish catches was found when using circle hooks.

A study based on fisheries data from the eastern Mediterranean (SCRS/2009/144) suggested that there are no major differences in the age selection pattern among American and traditional longlines and confirmed previous findings regarding the higher catch efficiency of the American gear. It has been noted, however, that further studies in other Mediterranean areas are needed to verify that the estimated selection curves are independent of the stock distribution pattern.

A working paper (SCRS/2009/177) that presented an updated analysis of size data from the Moroccan driftnet fishery indicated that the mean size of fish has shown an increasing trend during the last decade owing to the implementation of a national minimum landing size regulation. In addition, the proportion of juveniles (less than 125 cm) in the catches has substantially decreased.

As observed in the 2007 assessment, the combined CPUE series from the main longline and gillnet fisheries targeting swordfish did not show any trend over time (**SWO-MED-Figure 2**).

SWO-MED-3. State of the stock

Two forms of assessment gave a consistent view of the declining stock abundance, but differed in the extent of the decline, in the sense that some models suggested relatively modest changes in the last decade. Estimates of population status from production modeling using a longer time-series of catch and effort (a series for which we have less confidence) showed a 2005 stock level that was most likely about 13% below the amount necessary to achieve the ICCAT Convention objective, while recent fishing mortality was about 25% above the level that would permit the stock to attain MSY levels. The results of the production model assessment indicate that the fishery underwent a rapid expansion in the 1980s resulting in F 's likely at or above F_{MSY} and a slow declining stock biomass which has recently most likely fallen below the level which can support MSY. Estimates of stock status from virtual population analysis using a shorter time series of catch and effort data, for which we have more confidence, indicated about a 40% reduction in spawning stock level yet stable recruitment over the past 20 years. This spawning stock level is less than half that necessary to achieve the ICCAT Convention objective and estimates of recent fishing mortality rates from this form of assessment are more than twice that amount, which if continued without abatement, is expected to drive the spawning biomass to a very low level (about 10% SPR) within a generation. These low levels are considered to give rise to non-negligible risks of rapid declines in the stock although this indicator has not yet been observed in the Mediterranean swordfish fisheries (**SWO-MED-Figures 3 and 4**).

Furthermore, the Committee noted the large catches of small size swordfish, i.e., less than 3 years old (many of which have probably never spawned) and the relatively low number of large individuals in the catches. Fish less than 3 years-old usually represent 50-70% of the total yearly catches in terms of numbers and 20-35% in terms of weight (**SWO-MED-Figure 5**). A reduction of the volume of juvenile catches would improve yield per recruit and spawning biomass per recruit levels.

SWO-MED-4. Outlook

The assessment of Mediterranean swordfish indicates that the stock is below the level which can support MSY and that current fishing mortality exceeds F_{MSY} . The degree to which biomass is below B_{MSY} and F is above F_{MSY} differs between assessment models. Overall results indicate fishing mortality (and near-term catches) needs to be reduced to move the stock toward the Convention objective of biomass levels which could support MSY and away from levels which are considered to result in non-negligible risks of rapid stock decline. While one modeling approach indicates that the current stock status is only about 13% below B_{MSY} , it also indicates that future catches exceeding 12,000 t will not result in the improvement of the stock status. In contrast, the modeling approach that provides a more pessimistic view of the current status, at less than half B_{MSY} , indicates that future catches, that allow rebuilding, are somewhat higher, up to about 14,000 t, assuming that the current high selectivity for juvenile fish continues, and that recruitment does not improve (**SWO-MED-Figure 6**).

Simulations projected the levels of landings and spawning stock biomass (SSB) for a period of 25 years under different management schemes including fishery closures of different duration in the East, central and West Mediterranean. Considering the estimated statistical uncertainty, gains in terms of landings and SSB from short fishery closures (e.g. one month) will be negligible. In contrast, relatively long (over three months) Mediterranean-wide closures in the last two quarters of the year would result in important long term gains, which are more profound in the case of SSB. The ICCAT convention objectives concerning SSB, however, can only be met with Mediterranean-wide drastic closures in the last two quarters of the year (i.e. six months). Such closures would result in short term decreases in landings (**SWO-MED-Figure 7**).

SWO-MED-5. Effects of current regulations

ICCAT imposed a Mediterranean-wide one month fishery closure for all gears targeting swordfish in 2008, followed by a two-month closure in 2009. As already mentioned (see Section 4), it is unlikely that such short closures would result in any detectable increase either in SSB or landing levels. Several countries have imposed technical measures, such as closed areas and seasons, minimum landing size regulations and license control systems. The EC introduced a driftnet ban in 2002 and in 2003 ICCAT adopted a recommendation for a general ban of this gear in the Mediterranean [Rec. 03-04]. Rec. 04-12 forbids the use of various types of nets and longlines for sport and recreational fishing for tuna and tuna-like species in the Mediterranean.

In the past meetings, the Committee has reviewed the various measures taken by member countries and noted the difficulties in implementing some of the management measures, particularly that of minimum landing size.

SWO-MED-6. Management recommendations

The Commission should adopt a Mediterranean swordfish fishery management plan with the goal of rebuilding the stock to levels that are consistent with the ICCAT Convention objective. Until now, the Committee has evaluated the technical measure for time-area fishing closures, which could initiate rebuilding, depending on the duration and timing of these closures. The Committee recommends the Commission to continue and strengthen the adoption of such measures which will move the stock condition to the level which will support MSY.

Following the results from recent studies (de la Serna *et al.* 2006), technical modifications of the longline fishing gears, as well as the way they are operated, can be considered an additional technical measure to reduce the catch of juveniles. The Committee recommends that future work should consider a broader set of scenarios including such modifications of the fishing gears, as well as fishing capacity reductions, minimum landing size regulations (MLS) and quota scenarios. However, the Group considers that MLS and quota might be difficult to implement in the Mediterranean swordfish fisheries. In addition, future analyses of management measures should include economic aspects.

MEDITERRANEAN SWORDFISH SUMMARY	
Maximum Sustainable Yield	14,250-15,500 ¹
2005 Yield during the assessment	14,600 t
Current (2007) Yield ²	14,227 t
Current (2007) Replacement Yield	~12,000-14,000 t ¹
Relative Biomass (B ₂₀₀₅ /B _{MSY})	0.26-0.87 ¹
Relative Fishing Mortality	
F ₂₀₀₅ /F _{MSY}	1.3 (0.6-2.5) ³
F ₂₀₀₅ /F _{max}	2.9 (2.4->5) ⁴
F ₂₀₀₅ /F _{0.1}	4.6 (3.7->5) ⁴
F ₂₀₀₅ /F _{20%SPR}	3.0 (2.6->5) ⁴
F ₂₀₀₅ /F _{30%SPR}	4.2 (3.6->5) ⁴
Management measures in effect	Driftnet ban [Rec. 03-04] One month fishery closure in 2008 [Rec. 07-01] ⁵

¹ Range indicated is average estimates from production models and age-structured models. The uncertainty in the estimates is broader than indicated.

² The 2008 reported catch is considered incomplete and too provisional to use in this table.

³ Based on production model analysis using a long time series of catch effort data for which we have less confidence, range represents approximately 80% confidence region for the model assumptions.

⁴ Based on age-structured analysis using a shorter times-series of catch effort data for which we have greater confidence, range represents approximately 80% confidence region for the model assumptions.

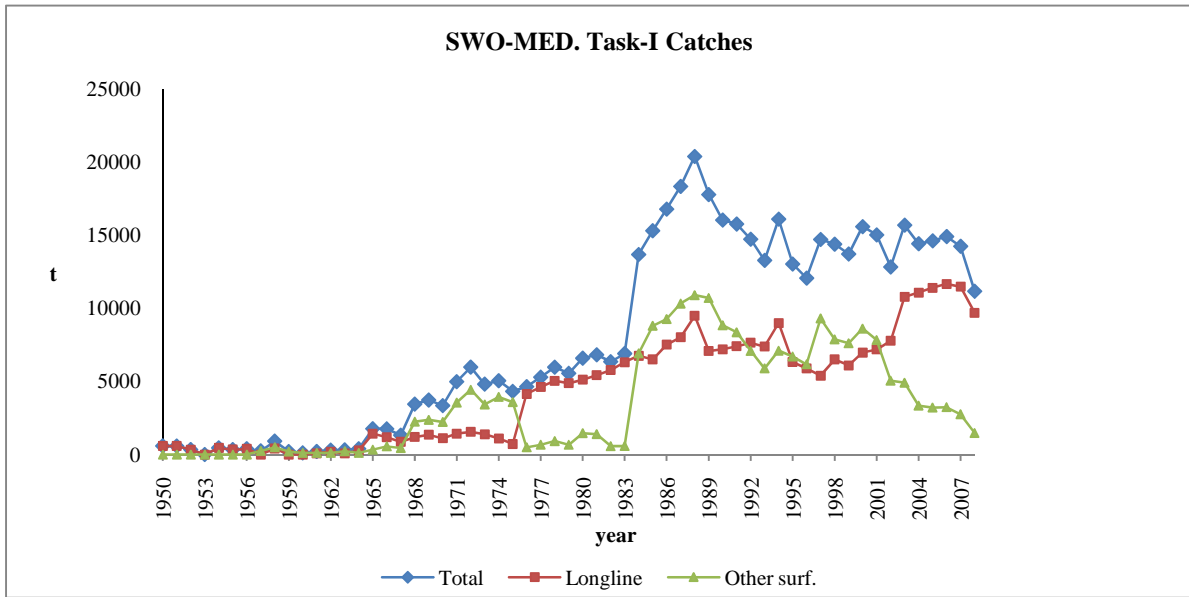
⁵ Various technical measures, such as closed areas, minimum size regulations and effort controls are implemented at the national level.

SWO-MED-Table 1. Estimated Catches (t) of Swordfish (*Xiphias gladius*) in Mediterranean sea by gear and flag.

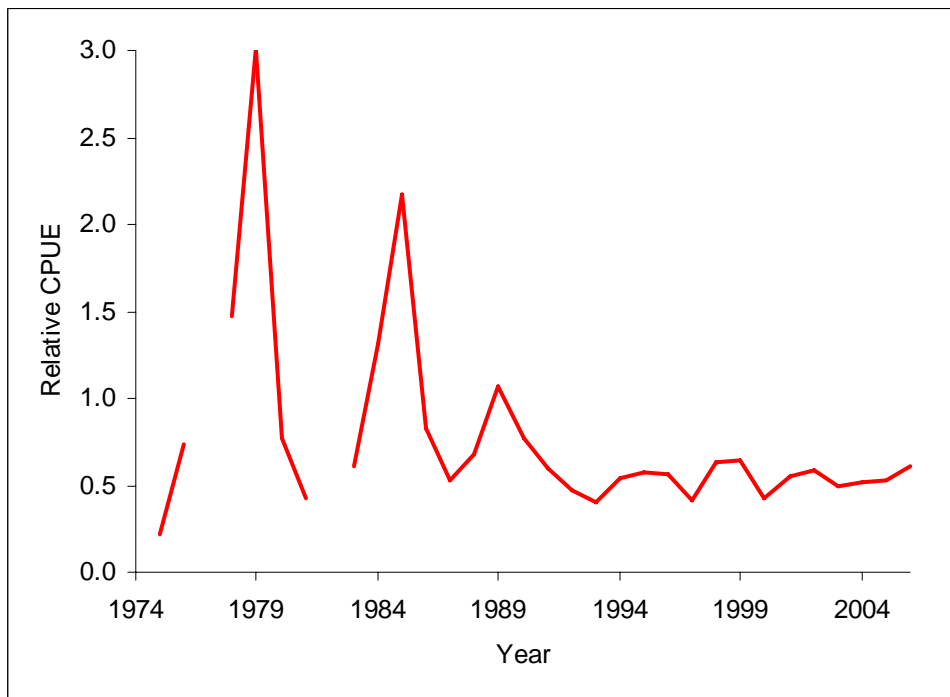
		1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	
TOTAL	MED	13666	15292	16765	18320	20365	17762	16018	15746	14709	13265	16082	13015	12053	14693	14369	13699	15569	15006	12814	15674	14405	14600	14893	14227	11153	
Landings	MED	6749	6493	7505	8007	9476	7065	7184	7393	7631	7377	8985	6319	5884	5389	6496	6097	6963	7180	7767	10765	11053	11273	11638	11451	9651	
	Other surf.	6917	8799	9260	10313	10889	10697	8834	8353	7078	5888	7097	6696	6169	9304	7873	7602	8606	7826	5047	4909	3343	3214	3239	2756	1474	
Discards	Longline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	113	16	19	27	
Landings	MED	Albania	0	0	0	0	0	0	0	0	0	0	0	13	13	13	13	0	0	0	0	0	0	0	0	0	
		Algeria	884	890	847	1820	2621	590	712	562	395	562	600	807	807	807	825	709	816	1081	814	665	564	635	702	601	802
		Chinese Taipei	0	0	0	0	0	0	0	0	0	1	1	0	1	3	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	10	20	0	0	0	0	0	0	0	0	4
		EC.Cyprus	63	71	154	84	121	139	173	162	56	116	159	89	40	51	61	92	82	135	104	47	49	53	43	67	67
		EC.España	1245	1227	1337	1134	1762	1337	1523	1171	822	1358	1503	1379	1186	1264	1443	906	1436	1484	1498	1226	951	910	1462	1697	2095
		EC.France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	27	0	19	0	0	14	14
		EC.Greece	1081	1036	1714	1303	1008	1120	1344	1904	1456	1568	2520	974	1237	750	1650	1520	1960	1730	1680	1230	1120	1311	1358	1887	962
		EC.Italy	9360	10863	11413	12325	13010	13009	9101	8538	7595	6330	7765	7310	5286	6104	6104	6312	7515	6388	3539	8395	6942	7460	7626	6518	4549
		EC.Malta	94	172	144	163	233	122	135	129	85	91	47	72	72	100	153	187	175	102	257	163	195	362	239	213	260
		EC.Portugal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	115	8	1	120	14	16	0	0
		Japan	19	14	7	3	4	1	2	1	2	4	2	4	5	5	7	4	2	1	1	0	2	4	0	3	1
		Libya	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	8	6	0	10	2	0	14	0	0	0
		Maroc	39	38	92	40	62	97	1249	1706	2692	2589	2654	1696	2734	4900	3228	3238	2708	3026	3379	3300	3253	2523	2058	1722	1957
		NEI (MED)	771	730	767	828	875	979	1360	1292	1292	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Syria Rep.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37
	Tunisie	15	61	64	63	80	159	176	181	178	354	298	378	352	346	414	468	483	567	1138	288	791	791	949	1024	386	
	Turkey	95	190	226	557	589	209	243	100	136	292	533	306	320	350	450	230	370	360	370	350	386	425	410	423	386	
Discards	EC.Greece	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	113	16	19	27	

Notes

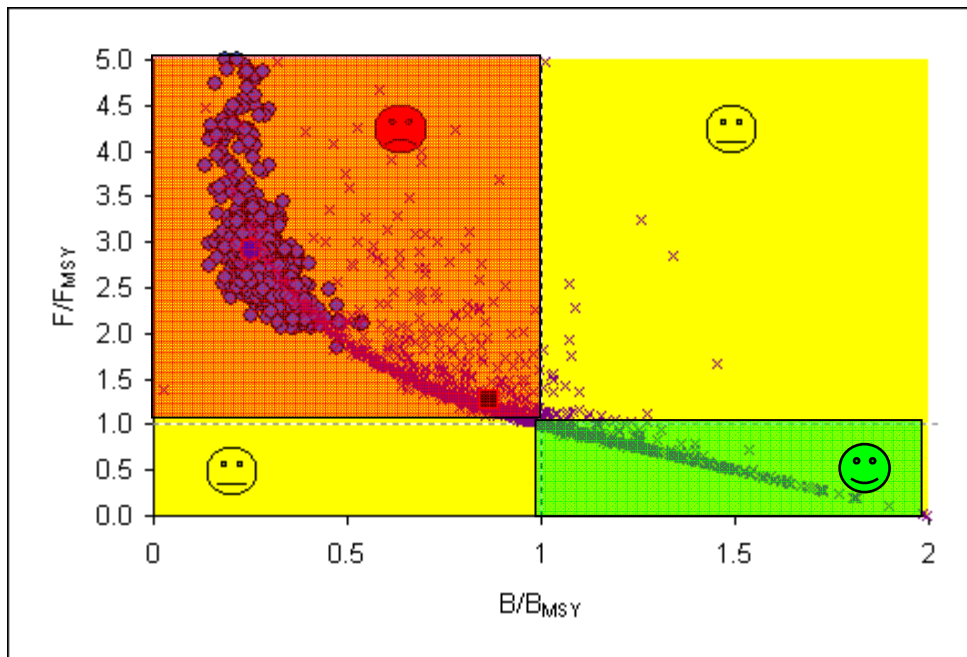
Task-1 catches (new figures) not included in the table Japan update for 2007 (3 t) and 2008 (2 t)



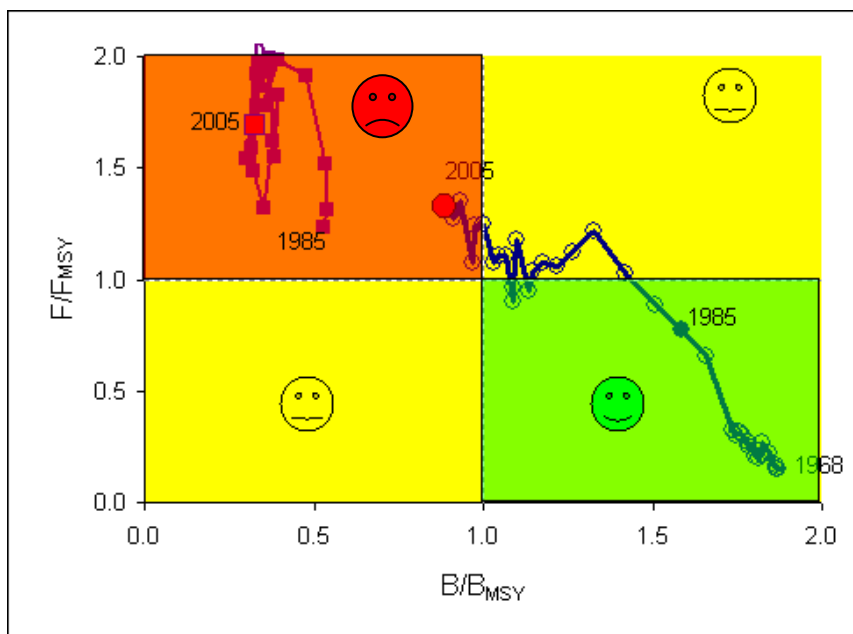
SWO-MED-Figure 1. Cumulative estimates of swordfish catches (t) in the Mediterranean by major gear type, for the 1950-2007 period (catch data for 2008 are incomplete).



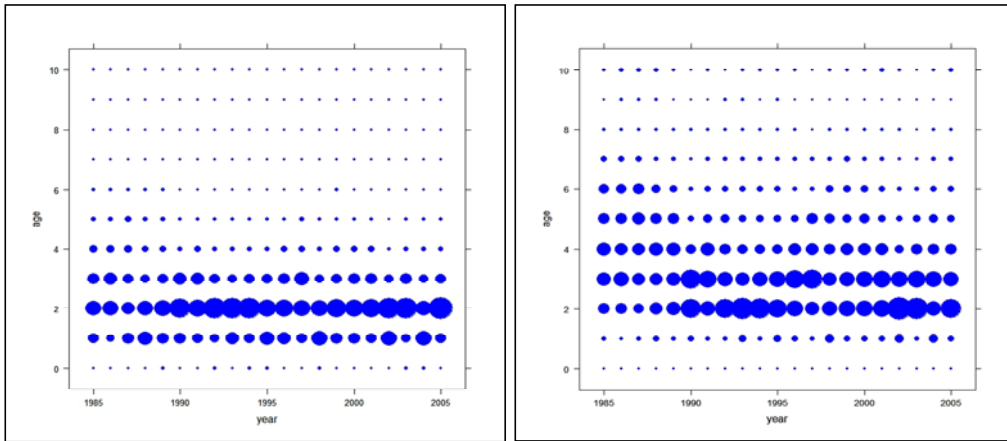
SWO-MED-Figure 2. The relative CPUE time series which results from the combined information in the Italian longline, Greek longline, Spanish longline, Japanese longline, Moroccan gillnet, and Italian gillnet time series.



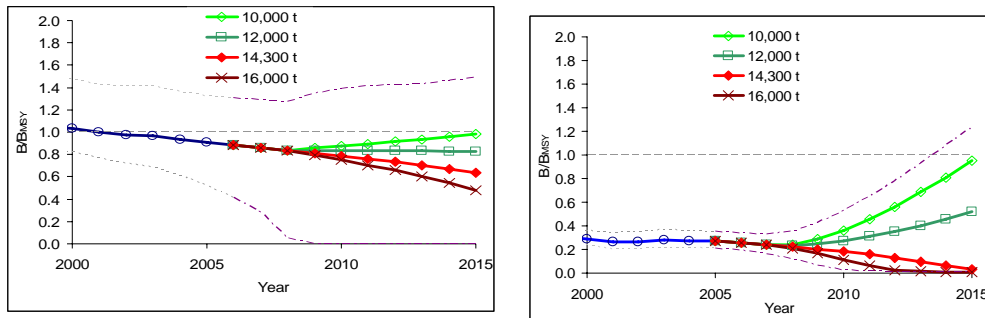
SWO-MED-Figure 3. Current (2005) stock status (B/B_{MSY} and F/F_{MSY}) outcomes from production model analysis (crosses) of a long time-series of catch and effort data for which we have less confidence and from age - structured analysis (solid circles) of a shorter time-series of catch-effort data for which we have more confidence. The median outcome from the production model analysis is shown as a large solid square and that of the age-structured analysis, a large solid circle.



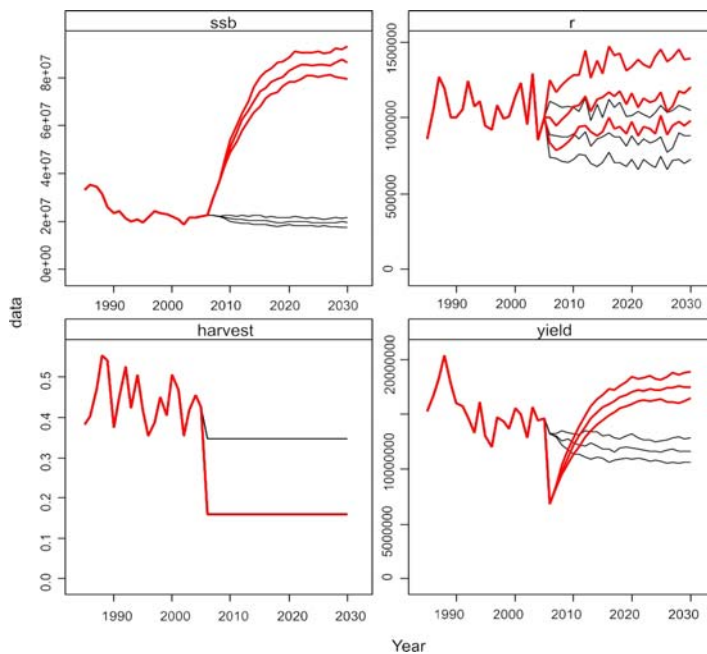
SWO-MED-Figure 4. Time trend for stock status (B/B_{MSY} and F/F_{MSY}) outcomes from production model analysis (circles) of a long time-series of catch and effort data for which we have less confidence and from age structured analysis (squares) of a shorter time-series of catch-effort data for which we have more confidence. The 2005 outcome from the production model analysis is shown as a large solid circle and that of the age-structured analysis, a large solid square. The beginning and ending years for the time-series shown are indicated for each form of analysis.



SWO-MED-Figure 5. Proportion of catch numbers (left) and catch weight (right) at age by year.



SWO-MED-Figure 6. Median forecasts of stock status from production model analysis (left) and age-structured analysis (right) for different levels of future constant catch, as indicated, starting in year 2008. The dashed horizontal line at a biomass ratio of 1 represents the ICCAT Convention objective of B_{MSY} . Confidence bounds (80%) for the projections are also indicated as broken, irregular lines.



SWO-MED-Figure 7. Time series with the 25th, 50th and 75th percentiles for SSB, r , fishing mortality (harvest) and yield for the scenario assuming a Mediterranean-wide fishing closure in the third and fourth quarter of the year (i.e. six months). A Beverton-Holt stock recruitment relationship was assumed.