

EFFECTS OF A SEASONAL CLOSURE OF THE MEDITERRANEAN SWORDFISH FISHERIES ON THE STOCK PRODUCTION LEVELS

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SUMMARY

The effects of a seasonal closure of the Mediterranean swordfish fisheries on the production levels of the stock were evaluated through simulations assuming annual recruitment rates varying randomly around the mean 1985-1999 value. The analysis indicated that a four-month closure during the recruitment period would result in an increase of the total annual catch of about 6% in terms of weight, and in reduction of the number of juvenile fish in the catch by 18-23%.

RÉSUMÉ

Les effets d'une fermeture saisonnière des pêcheries d'espadon de la Méditerranée sur les niveaux de production du stock ont été évalués par des simulations postulant des taux de recrutement annuel variant aléatoirement autour de la valeur moyenne de 1985-1999. L'analyse a indiqué qu'une fermeture de quatre mois pendant la période de recrutement donnerait lieu à une augmentation de la prise annuelle totale d'environ 6% en termes de poids, et à une réduction du nombre de poissons juvéniles dans la capture de l'ordre de 18-23%.

RESUMEN

Se han evaluado los efectos en los niveles de producción del stock de una veda estacional de las pesquerías de pez espada del Mediterráneo mediante simulaciones que asumen tasas de reclutamiento anual que oscilan aleatoriamente en torno al valor medio de 1985-1999. Los análisis indicaban que una veda de cuatro meses durante el periodo de reclutamiento se traduciría en un incremento de la captura total anual de aproximadamente un 6% en términos de peso, así como en una reducción del número de juveniles capturados de aproximadamente el 18-23%.

KEYWORDS

Swordfish, management, yield prediction, Mediterranean, season regulations

1. Introduction

The Mediterranean swordfish stock is heavily exploited by several countries which have fisheries targeting swordfish by means of surface longlines and/or gillnets. Swordfish fishing is carried out throughout the year, but for most fisheries is more intensive from late spring to middle autumn (Anon. 2004). Overall catch levels are rather stable in the last decade and the latest ICCAT assessment suggested that the stock is in rather stable position in terms of fishing mortality and recruitment (Anon. 2006). However, it has been noted that a large proportion of the catches (50-70%) is composed of juvenile fish that have never spawned and it has been pointed out that a reduction of the volume of juvenile catches would improve the stock exploitation pattern.

Based on the species biology and fisheries, different technical measures including seasonal closures during the recruitment period and minimum landing size regulations have been adopted on a national basis aiming to the protection of juvenile fish. The applicability of analogous technical measures on a global basis has been extensively discussed, but the potential effects of those measures on the exploitation pattern of the stock have not been quantitatively evaluated (Di Natale *et al.* 2002).

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In the present work we attempt to evaluate the effects of a seasonal closure of the Mediterranean swordfish fisheries, on the catch composition and stock production levels. The analysis is based on the catch-at-age data used during the latest ICCAT assessment and the estimated recruitment and mortality rates.

2. Materials and methods

2.1 Stock assessment

The latest ICCAT assessment of the Mediterranean swordfish stock was conducted in 2003 using fisheries data from 1985 to 2001 that were available in the ICCAT database. The assessment was based on a VPA approach that was tuned using CPUE series from the Italian, Greek and Spanish long-line fleets. The catch-at-age matrix included the 1 to 10 age groups (see Anon. 2004 for details) and was obtained through slicing the length composition of the catch according to a previously estimated von-Bertalanffy growth model (Tserpes and Tsimenides 1995). Fish with an estimated age of less than 0.5 years were considered as 0-age and were not included in the analysis due to their relatively low number in the landings. In order to evaluate the technical measures aiming to the protection of the entire juvenile component of the stock (0-2 age groups) the assessment was re-run, with the same adjustments, including the 0-age fish. In this way, fishing mortality and stock estimates for the 0-age group were also obtained.

2.2 Population model and exploitation scenarios

Based on the mean stock abundance by age estimates for the 1985-1999 period, a population model was assumed with annual recruitment rates obtained randomly from a normal distribution with mean and coefficient of variation (CV) equal to those estimated for the above period. The natural mortality was assumed to be equal to 0.2 for all age groups and years, as it was considered in the VPA assessment.

Two different projection scenarios were examined:

- 1) Continuation of the same exploitation pattern, i.e. no change in fishing effort and fishing mortality (base-case scenario).
- 2) A four-month closure during the recruitment period (October to January). The Mediterranean swordfish spawns from May-July (Rey 1988, Cavalaro *et al.* 1991, Tserpes *et al.* 2001); hence it was assumed that such a closure would practically eliminate fishing mortality for the 0-age fish. Additionally, based on information from the Greek fishery (unpublished data) and taking into account that all over the Mediterranean much more fishing pressure is exerted on the stock from late spring to middle autumn (Anon. 2004), it was assumed that this closure will reduce global fishing effort by 20%. Assuming that fishing effort is proportional to fishing mortality, infers that a similar reduction in fishing mortality is expected for the rest age classes.

Each projection scenario was simulated 1000 times for a period of 20 years starting with year 2000. Simulations were conducted using the FLR framework developed in the frames of the EFIMAS project (<http://www.flr-project.org/doku.php?id=team:paperflcore>, <http://www.efimas.org>).

3. Results

Similar to the previous ICCAT assessment, results revealed a stable situation, in terms of fishing mortality and recruitment, over the examined period. Fishing mortality was increasing with age, being stable from age 3 onwards with an average $F=0.57$. Hence full selection ($S=1$) was assumed in the population model for ages > 2 . Based on the assessment results, selection for ages 0, 1 and 2 was assumed to be equal to 0.02, 0.36 and 0.91 respectively. The annual recruitment was assumed to be 1023523 individuals with a coefficient of variation (CV) equal to 10%. These were the mean assessment estimates for the 1985-1999 time period.

The base case scenario indicated a stable production pattern with annual catches being mostly (probability $>50\%$) around to 13500-14500 t throughout the projection period (**Figure 1**). Catch variation is increasing with year as the influence of the random recruitment value on the total population size is increasing. Reported catches for the years 2000-2004 were generally consistent with those predicted by the model. Simulations revealed that

the average annual catch for the examined period will be 13929 MT and 4583 of them (32.90%) will be juvenile fish (ages 0, 1 and 2).

The seasonal closure scenario indicated the stabilization of the production, at the level of 14500-15500 t (probability >50%) after 5-6 years from the closure (**Figure 2**). The average annual catch for the examined period will be 14702 MT and the corresponding volume of juvenile fish will be 3954 MT (26.89%).

4. Discussion

As it was expected, the assumption of small recruitment variations revealed a stable production pattern in both scenarios. Our results showed that the seasonal closure will result in an about 6% increase of the total catch and similar reduction of juvenile catches (about 630 t). Assuming that the average weight of the juvenile fish in the catch is around to 8-10 kg it is roughly concluded that the seasonal closure will result in an annual reduction of the juvenile catches by 63000-78000 fish. The catch-at-age data used in the latest assessment session (Anon. 2004) indicated that on average about 344000 juvenile fish were caught annually during the 1985-2001 period; hence the aforementioned catch reduction corresponds to 18-23% of the total catch number of juvenile fish.

The above estimates were based on the reported landed data and did not include discards due to lack of relevant systematic studies. Unpublished data from the Greek longline fisheries which exploit a large part of the eastern Mediterranean indicate that in 2005 discards were up to 8% of the total catch in terms of weight. It is difficult to estimate the total volume of discards from local studies, as minimum landing size regulations and compliance with them vary among countries. In addition, discard rates vary among gears. However, based on the above information it is normal to expect that adoption of such a seasonal closure would, in reality, result in higher reduction of juvenile catches than the one currently estimated.

As at the moment there is not available any stock-recruitment relationship for the Mediterranean swordfish, all scenarios were based in the assumption that recruitment is independent of spawning stock size; thus they were unable to predict any stock collapse due to intensive fishing. Inclusion of such a relationship in future scenarios would certainly provide more rational predictions.

5. Acknowledgements

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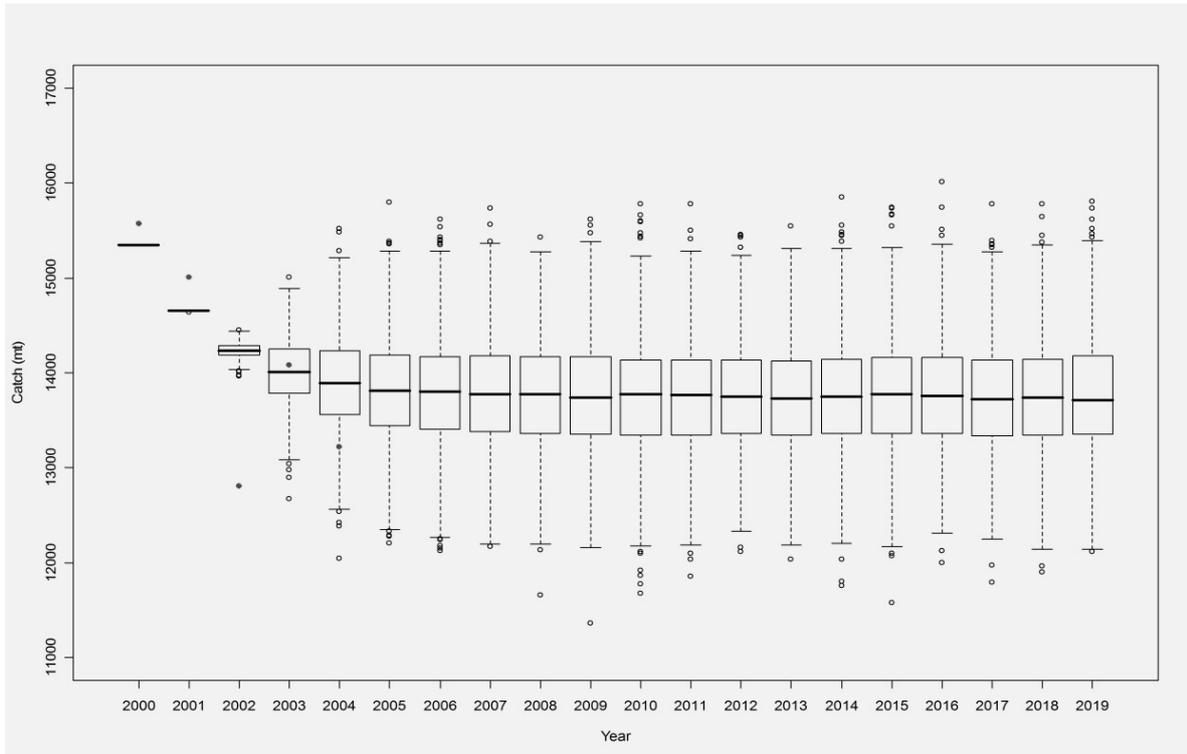


Figure 1. Box-whisker plots by year, for the production estimates obtained from the simulations of the base-case scenario. Solid circles indicate the reported production rates for the years 2000-2004.

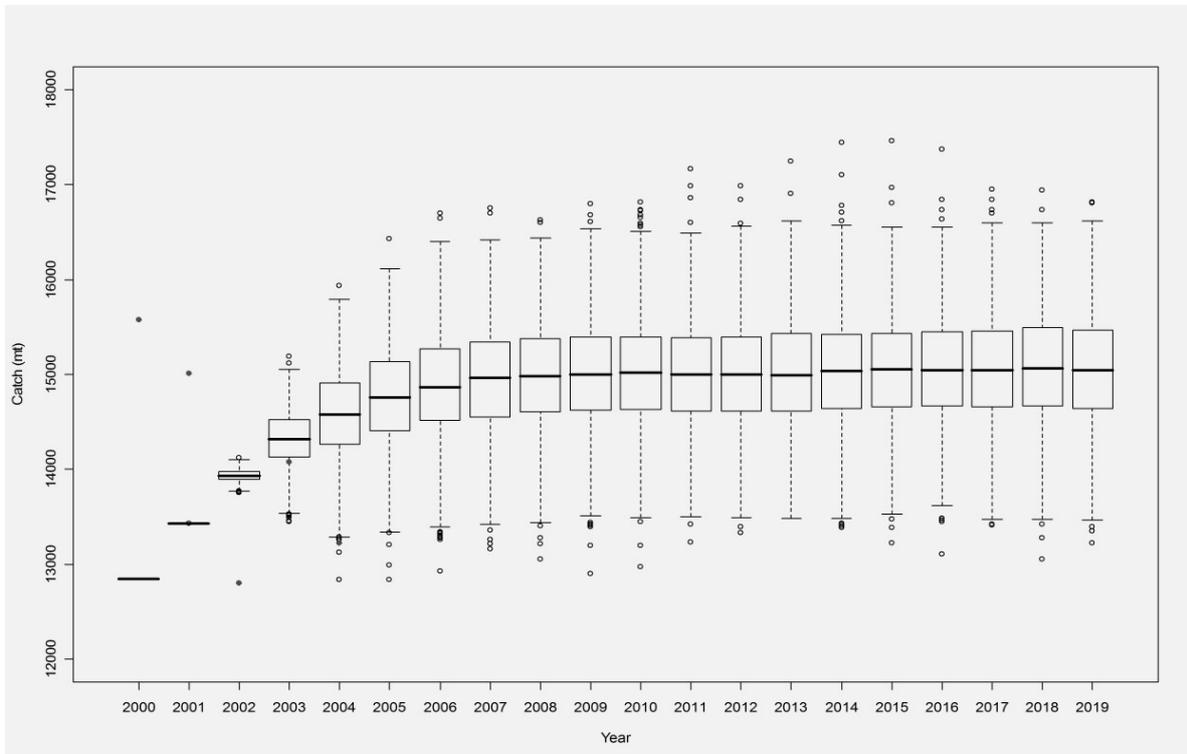


Figure 2. Box-whisker plots by year, for the production estimates obtained from the simulations of the seasonal closure scenario. Solid circles indicate the reported production rates for the years 2000-2004.