

**MOON PHASES INFLUENCE ON CPUE: A FIRST ANALYSIS OF SWORDFISH DRIFTNET
CATCH DATA FROM THE ITALIAN FLEET BETWEEN 1990 AND 1991**

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SUMMARY

CPUE data are usually adopted as basic stock abundance indices, but they are often influenced by several factors, some of them environmental, which strongly affect the availability of the target species.

This is particularly important in driftnet catch data, where the use of a passive gear is strictly correlated to the behaviour of the target species.

A first annual analysis of CPUE driftnet data from the Italian fleet confirms the correlation between moon phases and CPUE, on both the target specie and total catches.

RESUME

Les données CPUE sont généralement utilisées en tant qu'indices de base de l'abondance du stock. Toutefois, elles sont souvent influencées par différents facteurs, notamment des facteurs liés à l'environnement qui affectent fortement la disponibilité des espèces visées.

Ce phénomène est particulièrement important dans les données relatives aux captures effectuées à l'aide de filets dérivants, où l'utilisation d'un engin passif est strictement relié au comportement des espèces visées.

Une première analyse des données CPUE de la pêche à l'aide de filets dérivants par la flottille italienne confirme la corrélation entre les phases lunaires et la CPUE, aussi bien en ce qui concerne les espèces visées que les captures totales.

RESUMEN

Usualmente, los datos de CPUE se adoptan como base de los índices de abundancia del stock, pero a menudo están influenciados por varios factores, algunos de ellos ambientales, que afectan mucho la disponibilidad de las especies-objetivo.

Esto tiene importancia sobre todo en los datos de captura de las redes de enmalle a la deriva, donde el uso de un arte pasivo está estrechamente relacionado con el comportamiento de las especies-objetivo.

Un primer análisis anual de los datos de CPUE de las redes de enmalle a la deriva, de la flota italiana, confirma la relación entre las fases de la luna y la CPUE, tanto para las especies-objetivo como para las capturas totales.

INTRODUCTION

Italian swordfish driftnet fishery is one of the most important Mediterranean fishery with this target, both for the number of vessels and total amount of catches, as previously reported (Di Natale *et al.*, 1993, 1993a and 1993b).

CPUE data from this fishery should be used as good stock abundance indices, particularly for the spring/summer fishery activity, because of an improvement of statistical collection by several Italian institutions.

Consequently, driftnet CPUE indices need to be checked and validated, but the influence of some external factors seems to heavily affect them, even if the bias is still undefined.

Italian driftnet fishermen know very well the effects due to different moon phases (and to nocturnal natural light) on commercial catches, after several centuries of experience, but no previous scientific analysis on this subject have been never reported so far, except a recent paper by de la Serna *et al.* (1991), related to Spanish driftnet data.

METHODS

The most reliable source of data has been an observers programme on board, carried out by our Institute for the Ministry of Merchant Marine, from May 1990 to October 1991 in all the Western Italian Basins (Ligurian and Tyrrhenian seas). Catches were reported in detail directly by the observers and a total number of 100 trips were examined (Di Natale *et al.*, 1992).

The observers programme was particularly useful to obtain a true and directly-controlled information about CPUE parameters and by-catch data (CPUE parameters: C = catches in kg; U = single vessel/1-day fishing; E = mean length of net/1 km). CPUE indices related to swordfish (*Xiphias gladius*) catches are reported as "gilled and gutted weight (GGW), while total CPUE is reported as round weight (RW), for the target species, other commercial species and by-catch.

With the purpose to collect a much higher number of data, landings were sampled twice a week in 5 selected ports (2 in the Southern Tyrrhenian sea, 1 in the Central Tyrrhenian sea and 2 in the Ligurian sea), during the whole 1990 and 1991 fishing seasons, on regular basis, and in 3 ports (2 in the Southern Tyrrhenian sea, 1 in the Central Tyrrhenian sea) in 1992.

Landing catch data have been integrated using by-catch correction parameters from the observation on board.

CPUE data from a 5-days period across each moon phase (new moon and full moon) have been used to better define the bias due to this factor.

RESULTS

During 1990, 1991 and 1992 fishing seasons, swordfish daily CPUE data were obtained from 5965 driftnet landings (Di Natale *et al.*, 1993a, 1993b), but only 1893 landings (31,7%) have been selected for this study, following our method for data selection (only CPUE data from 2-days before, during and 2-days after each moon phase were used).

The first evidence from such selection is a reduced fishery activity during full moon days: as a matter of fact, 310 landings have been reported during new moon phases in 1990, against 230 in full moon phases (- 25,8%). 558 landings have been reported during new moon phases in 1991, against 110 in full moon phases (- 80,3%) and 437 landings have been reported during new moon phases in 1992, against 248 in full moon phases (- 43,3%).

In the three-years period examined, 1305 landings have been reported across new moon phases and 588 across full moon phases (-54,9%).

A more detailed analysis is necessary to better define the influence of other external factors (e.g.: environmental conditions, etc.) on the sample selected by us, but certainly other factors affected driftnet fishery activity in 1990 and 1991, as fishermen strikes and several driftnetting bans. In 1992 these "external" factors were strongly reduced.

Anyway, usually full moon phases cause a strong reduction of driftnet fishery activity (due to the predictable low catching rate) and, as a consequence, a large part of the fleet has been reported at moorings inside the harbours, usually from 3 to 5 days.

Daily swordfish CPUE data, reported as gilled and gutted weight (GGW), are plotted on figures 1 (1990), 2 (1991) and 3 (1992); ● indicates new moon phases and ○ full moon phases. The figures are not very clear, due to the high variability of this fishery and to several other factors.

In 1990, driftnet fishing season was very short and interrupted for several times, due to an adverse weather situation at the beginning and to two driftnet bans at the end. Consequently, an uncertain bias could affect these plots.

In 1991, the fishery season was more normal, even if interrupted by a fishermen strike between the end of July and the first part of August. All the highest CPUE peaks are clearly close to each new moon phase (figure 2).

In 1992 the swordfish fishing season could be considered almost as a normal one, because only a few days of interruption due to "external factors" have been reported so far.

A quite more clear evidence of the moon effect on driftnet CPUE is reported on Table I. Daily swordfish (GGW) mean CPUE values per year are here resumed; even in this table, ● indicates new moon phases and ○ full moon phases; L is for number of landings selected across each moon phase.

Table I

MOON PHASE	C P U E (kg/km) SWO							
	1990		1991		1992		1990-92	
●	310	10,155	558	11,046	437	17,492	1305	12,898
○	230	5,515	110	5,516	248	11,634	588	7,555
mean CPUE variation	-45.7%		-50.1%		-33.3%		-41.4%	
total landings	540		668		685		1893	

The results show a clear decrease of the swordfish catches (-48.7%) during full moon phases, both in 1990 and 1991, with a very strong similarity of the mean values. In this case, data are particularly meaningful, because they were collected in the same areas and the majority of the samples came from spawning specimens and, consequently, the bias due to the biological status is reduced to a minimum level.

In 1992 the decrease of catches during the full moon period appears strongly reduced (-33.3%), but data were collected only in some parts of the previous area and they are related to a complete fishing season.

Total CPUE (target species, other commercial species and by-catch, RW) mean data from selected landings in 1990, 1991 and 1992 are showed on table II.

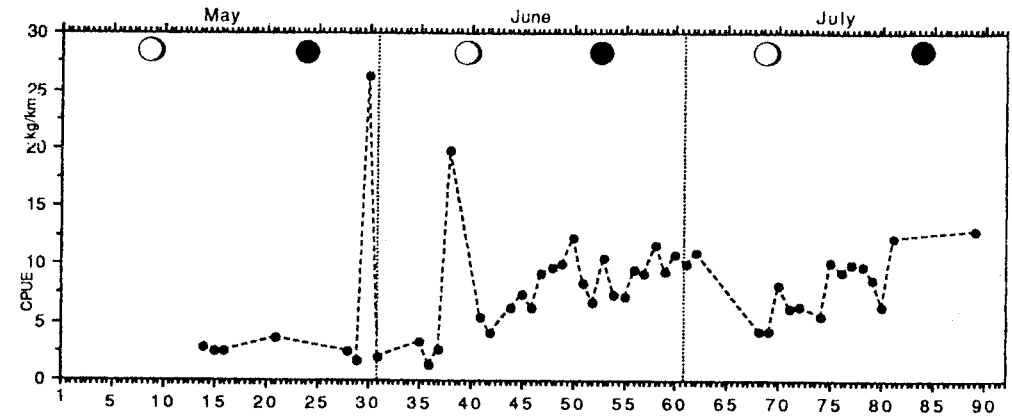


Fig. 1 - Average daily CPUE (kg/km) swordfish data (GWT) from the driftnet fleet in the Western Italian Basins in 1990. Moon phases are showed in the upper part of the graph.

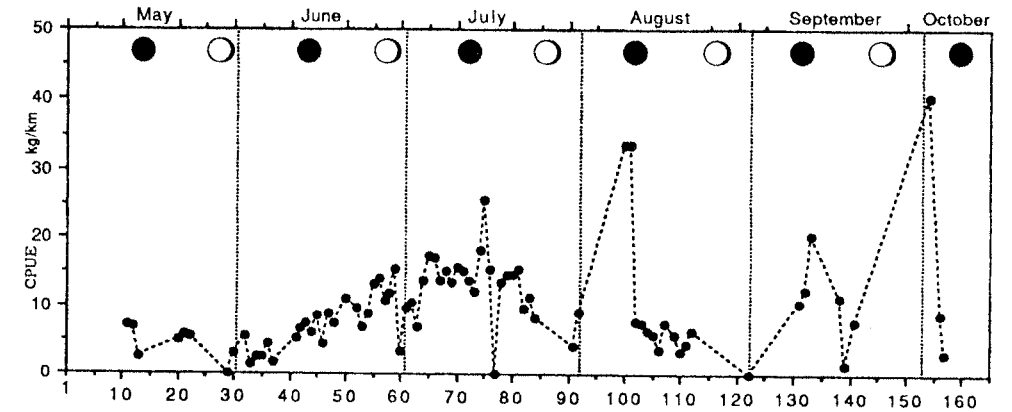


Fig. 2 - Average daily CPUE (kg/km) swordfish data (GWT) from the driftnet fleet in the Western Italian Basins in 1991. Moon phases are showed in the upper part of the graph.

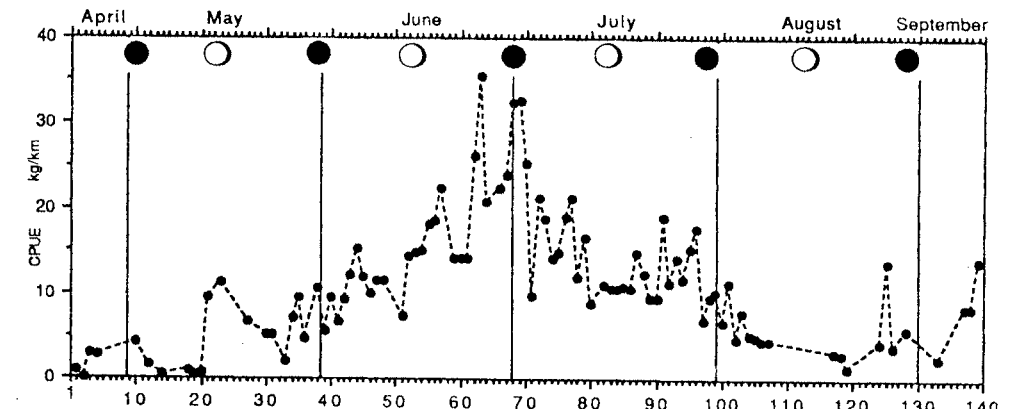


Fig. 3 - Average daily CPUE (kg/km) swordfish data (GWT) from the driftnet fleet in the Tyrrhenian Sea in 1992. Moon phases are showed in the upper part of the graph.

Table II

MOON PHASE	C P U E (kg/km) TOT							
	1990		1991		1992		1990-92	
●	310	16,573	558	20,241	437	25,862	1305	20,892
○	230	10,753	110	16,937	248	17,978	588	15,191
mean CPUE variation	-35.1%		-16.3%		-30.5%		-27.3%	
total landings	540		668		685		1893	

In this case, the effect of full moon phases on total catches is reduced (-27.3%), compared to selected swordfish catches, probably because of the different behaviour of the several species included. The difference between 1990 and 1991 should be possibly due to the longer fishing period considered in the latter year, even if 1992's data are partially in contrast.

The correlation between CPUE data (from selected days across moon phases) and the wind was also roughly checked, but it was meaningless and this other factor is not here considered.

DISCUSSION

This first screening of CPUE data from the Italian driftnet fleet seems very useful to assess the bias due to the moon phases on total catches but, mostly, on swordfish catches.

The reasons for the clear reduction of swordfish driftnet CPUE indices during the full moon phase could be resumed as follow:

- full moon make the driftnet more visible and detectable for the swordfish;
- the behaviour of the swordfish is influenced by the moon (as a consequence of a different environmental lightness);
- the swordfish behaviour could be influenced by changes in vertical distribution of Cephalopods induced by the full moon;
- the combination of these three factors seems to induce a lower catchability of the target species;
- CPUE data should be indefinitely affected by a reduction of the fishing effort during full moon phases.

Of course, a more detailed analysis is necessary to define the influence of other environmental factors (as wind, clouds covering, currents, waves and other oceanographic and environmental components), but it should be necessary to select only observers data (separated per area) and, as a consequence of such splitting, data collection should be not more really representative.

Furthermore, a detailed analysis should consider also the spatial distribution of the species, density per area and correlation between swordfish abundance per area and food availability; but these factors are not available or, sometimes, totally unknown.

The figure seems much more confused adopting total CPUE data, for the highest number of factors involved and, in particular, the different behaviour of the several species included in total catches.

The clear evidence of a decrease of swordfish catches in Italian driftnet fishery during full moon phases in 1990, 1991 and 1992 confirms the previous study carried out by de la Serna *et al.* (1991) on Spanish driftnet catches, both in the Atlantic and the Mediterranean.

As considered by de la Serna *et al.* (1991), swordfish CPUE data from driftnet fishery are not necessarily in contradiction with the observation on swordfish behaviour related to the moon reported by Moreno *et al.*, (1990), because they used long-line data, and the swordfish active predation on the bait makes these data not comparable with CPUE related to a passive gear (as a driftnet is).

Our confirm on full moon influence on swordfish catches is based not only on driftnet CPUE data here reported, but also on unpublished swordfish long-line data from the Italian fleet (Di Natale *et al.*, 1992), showing a contrary CPUE trend related to moon phases.

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