

THE SWORDFISH CPUE POSES SEVERAL QUESTIONS AND ENIGMAS. A DISCUSSION PAPER

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SUMMARY

The CPUE is the most commonly used index for showing commercial fish abundance. In recent decades, fishers have been very innovative, often proposing technologically advanced fishing gear that could only be scientifically evaluated 'a posteriori'. In swordfish fishing, this has perhaps happened most frequently. Recently, a new fishing gear, which does not fit into any previously known category, has been identified: it is here called 'trap-line' and it has supposedly been in use since at least 2021. This gear poses a number of new challenges to researchers, including how to define the CPUE of the last three years. The data collection, management, and regulation of this new gear should pose also new challenges.

RÉSUMÉ

La CPUE est l'indice le plus fréquemment utilisé pour indiquer l'abondance des poissons commerciaux. Au cours des dernières décennies, les pêcheurs se sont montrés très inventifs, proposant souvent des engins de pêche technologiquement avancés qui ne pouvaient être évalués scientifiquement qu'« a posteriori ». C'est probablement dans le domaine de la pêche à l'espadon que ce phénomène s'est produit le plus fréquemment. Récemment, un nouvel engin de pêche, qui n'entre dans aucune catégorie connue auparavant, a été identifié : il est appelé ici « piège » (trap-line), il est supposé être utilisé depuis au moins 2021. Cet engin pose un certain nombre de nouveaux défis aux chercheurs, notamment en ce qui concerne la définition de la CPUE des trois dernières années. La collecte de données, la gestion et la réglementation de ce nouvel engin devraient également poser de nouveaux défis.

RESUMEN

La CPUE es el índice más utilizado para mostrar la abundancia de peces comerciales. En las últimas décadas, los pescadores se han mostrado muy innovadores, proponiendo a menudo artes de pesca tecnológicamente avanzados que sólo podían evaluarse científicamente "a posteriori". En la pesca del pez espada, esto ha ocurrido quizá con mayor frecuencia. Recientemente se ha identificado un nuevo arte de pesca que no encaja en ninguna categoría conocida hasta ahora: aquí se denomina "trampilla" (trap-line) y que se lleva utilizando desde al menos 2021. Este arte plantea una serie de nuevos retos a los investigadores, entre ellos cómo definir la CPUE de los últimos tres años. La recopilación de datos, la ordenación y la regulación de este nuevo arte de pesca deberían plantear también nuevos retos.

KEYWORDS

Swordfish; longline; innovative fishing gear; trap-line; entangling gear; CPUE; by-catch; pelagic fishery; management; monitoring; data collection; regulation

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1. Foreword

The swordfish (*Xiphias gladius*) is a peculiar species since ever and from many points of views. It belongs to a separate sub-order (Xiphioidi) of the Perciformes, family (Xiphiidae, Rafinesque, 1815), having a single species (*Xiphias gladius*, Linnaeus, 1758)⁶. Collette *et al.* (2006) clearly defined the phylogenetic of the species, showing also a full agreement with a separation of all billfish (Xiphioida and Istiophoridae) from the Scombroidea.

The Xiphiidae appeared for the first time in the early Eocene (about 53 My), but the swordfish appeared in middle Miocene (15 My) (Fierstine, 2006), a geological period characterised by important climate changes.

This phylogenetic isolation, along with the widespread distribution in all parts of the ocean, excluding the polar and circumpolar areas, possibly induced several adaptive strategy to this species, including the behavioural ones. The literature has many detailed reports on several behavioural aspects of the swordfish (diving capacity, speed, etc.), mostly summarised in the comprehensive book by Ellis (2013), but many aspects are still unknown.

2. The spatial distribution and the behavioural aspects

All studies never focused on the spatial distribution of the swordfish in a given area, even if it is sure that this is not a schooling species. As it was reported in previous studies (Di Natale, 1985; Di Natale *et al.*, 1992, 1996, 2002), this species shows temporary aggregations only when it is at a juvenile stage, when the right trophic chain is a common need for many individuals having the same living and feeding necessity. In those cases, as it was noticed when the longline fishery targeting juvenile swordfish was still practised in several Mediterranean areas, it was possible to find thousands of juvenile swordfish in small areas, but never really schooling.

This observation provides the background information for imagining how adult swordfish can move in a spatial plan. When they are still small juveniles, they can move not so distant one from the other but when they become adults, the strategy is different and it is showed by the distribution of catches along a longline or a driftnet, when some specific studies were carried out in the past (Di Natale *et al.*, 1992, 1995).

When they are in the spawning season, it is possible finding one female followed by one or more males (up to five) close to the surface, swimming closely (Reina, 1658; Di Natale, 2005).

Besides these observations, nothing is available for the largest part of the year, when swordfish is freely moving around in the ocean for feeding purposes (and, in this specific case, often for “hunting”). It seems that several (many) individuals can distribute themselves over a large area, horizontally but also with a vertical distribution. It seems that, in this way, swordfish can explore a certain water mass, taking advantage of the food distribution as much as they can. Surely, the bill is used as an important tool, possibly also a sort of antenna for receiving or even emitting sounds or for both, but this was never proved so far.

3. Is the swordfish able to communicate?

Like all other living organisms, vegetal or animal, it is supposed that swordfish can communicate with the conspecifics at least. This was never proved so far, but it is logical that swordfish has ways to do so. The swordfish has another peculiar characteristic that can be important for the communication, but that represents a further enigma: the lateral line is present only in juveniles, up to a LJFL of about 1 m (Nakamura, 1985). Then, it suddenly disappear. Therefore, the basic functions of the lateral line should be covered in other ways, which unfortunately we still do not know, even if there is the suspect that the “sword” should have some role.

Communication in fish is still a very obscure chapter of the marine life, but it is already proved that many fish species can communicate. According to Looby *et al.* (2022), 989 fish species have been showing to produce voluntary sounds. Allen and Demer (2003) demonstrated that *Thunnus thynnus* and *Thunnus albacares* emits sounds (low-frequency pulses varying from 20 to 130 Hz). However, possibly due to the practical difficulties in dealing with a fish known for having a difficult temperament, the swordfish is not included in any study. Therefore, as any behavioural study on this species is very challenging, we can only speculate.

⁶ https://inpn.mnhn.fr/espece/cd_nom/70422/tab/taxo?lg=en

According to the previous behavioural assumptions in paragraph 2, it would be logical that various swordfish individuals distributed over a large marine area should stay in contact among them. How and what they communicate is a question without any answer, but we can suppose that basic information on food availability is the minimum they can exchange. In addition, it would be logical that they can interchange information about any potential danger. Is this hypothetical communication including the knowledge of longlines? It was never proved so far, but we strongly suspect that this possibility cannot be entirely excluded.

4. Is the CPUE representative of the abundance?

The CPUE is used since many decades as an essential parameter for all halieutic studies for fishery management purposes (Leslie and Davis 1939; DeLury 1947, 1951; Ricker 1958), and it is now used also by the newest MSE approaches. It is based on the assumption that a given species has the same possibilities to be caught in a specific fishing gear in a given area under a known effort. Since years, there are doubts about the CPUE capacity of representing the abundance of a species (Harley *et al.*, 2001), but so far it is the system in place for marine species.

There are few cases where it was possible to compare CPUE from different gear types in the same area. One of the few examples are the CPUE obtained from driftnets and longlines, standardised from the same area and showing different trends, confirmed in different years (Tserpes *et al.*, 2003, 2004, 2011).

Usually, in many cases and with few exceptions (those particularly in very large fishing areas), the graphs show high CPUE for the first years (often from 3 to 4 years) and then a sudden decreasing trend, with various attitudes after a low period (i.e. the CPUE graphs showed by Anonymous, 2020 and Abid and Idrissi, 2020).

This is commonly interpreted as the impact on the swordfish abundance in the first years of the fishery (and the initial peak is considered as a sort of pristine reference abundance), while the variables CPUEs in the following periods are usually interpreted as various levels of abundance indices, always at a lower level compared to the initial years, due to the impact of the fishery on the fish population.

5. The doubt posed by a new gear: the trap-line

In 2024, there was the opportunity to find and describe a new fishing gear used both in the Mediterranean Sea and in the Atlantic: the trap-line (Garibaldi *et al.*, 2024). Some fleets have used this gear obscurely and silently so far, at least in the last 2 or 3 years, and this has caused a number of problems with the reliability of the LL CPUE data for swordfish from the fleets concerned, which remain unclear to the present time.

Usually, it is not always possible to compare CPUE from different gears. For example, the swordfish CPUE was at least the double in driftnets compared to the longlines used in the same area in the same period (Di Natale *et al.*, 1996) but, even if the depth range was the same, there was never the possibility to compare the different abundance due to the very different characteristics of the gears and the fact that they were never used together.

This is the first time that a new gear is used by some vessels along the same main line of another gear (partly or entirely). According to the very preliminary information available so far (still informal), the CPUE obtained by the trap-lines is at least the double (sometimes much more) of the CPUE obtained by the LL hooks in the same day on the same main line.

Of course, we should consider the possible different efficiency of the new gear, but the catchability of the species in the same day, in the same area and at the same depth should be the same.

This is a difficult discussion, but does it have a clear logic? Apparently, it is not so obvious.

Why a different gear is able to catch more in the same situation? Is it a matter of efficiency or there is something else?

6. The doubts and the hypotheses

This is mostly a sort of open mind discussion, trying to find explanations that might help in improving our understanding.

The first point is concerning the swordfish capability to “learn” the dangerousness of a fishing gear (whenever it is able to escape at the first experience or when he notice a bad experience happened to another swordfish individual) and pass this information to the co-specifics. We do not have any scientific observation or evidence on this hypothesis, but the “learning” behaviour of the bluefin tuna is able to reinforce the hypothesis. Prof. Arena (1989, 1990), using the aerial observation, noticed in the southern Tyrrhenian Sea that a school headed by large tunas, were able to escape from a purse seine going deeper before the closure of the seine; in the same day, the same school was seen successfully using the same technique to escape from the seine of another fishing vessel. Is it possible that a “learned” swordfish can detect in some way a metal hook? Is this knowledge able to select swordfish individuals having this “culture” and, therefore, slowly inducing a sort of behavioural evolution, particularly evident in semi-closed geographical areas as the Mediterranean Sea? Is it possible that the swordfish can communicate to others the potential dangerousness of a longline? If this is possible (and we do not know in what manner so far, being the communication system of the swordfish fully unknown), then the lower values of a CPUE after the first years in a given area might be explained in a different way.

The second one is linked to the first point: is the high CPUE of the trap-line induced by the fact that the swordfish is facing an unknown and new gear, and therefore it is going to the lure because it is not able to detect any metal hook? Is this the motivation for having a much higher CPUE in the same day along the same main line but only in the part equipped with the new gear? Is it also a matter of catchability? If this hypothesis is true and if the swordfish is able to communicate with co-specific, then the individuals that were able to escape from the trap-line or those entangled in the trap-line could possibly inform the others. Therefore, if the hypotheses are true, the CPUE in trap-lines should decrease in a considerable manner in the next years.

The third point is a consequent conclusion taking into account the first two: apparently and using the CPUE from the trap-lines, the abundance of the swordfish in the area seems much higher than the abundance obtained using the LL CPUE in the same area. This poses a serious problem: which one is representative of the apparent abundance? Of course, we can discuss about the different efficiency of the gear and the related catchability but, surely, there is a problem that we, as scientists, should discuss.

7. Conclusions

Our fully lack of knowledge about the communication features used by swordfish to communicate is a key point to be always considered and that should be scientifically studied for improving our understanding of this peculiar pelagic species. This is an extremely important research line.

At the same time, our knowledge about the ethology of this species is still very poor and it is limited only to the individuals tagged with PSATs or to the historical observations made by the harpoon fishers in the Strait of Messina. We do not have any scientific knowledge about the behaviour of the swordfish when several individuals are in the same area at the same time, but just the hypotheses reported in this paper.

The problem posed by the new gear (the trap-lines) has many aspects, but those concerning our perception of the abundance of the swordfish is possibly the most relevant from a management point of view for this species. Again, now, we have just hypotheses.

These are the reasons why it should be important having a scientific discussion at the ICCAT SCRS SWO Species Group, also in future, for finding the ways for improving our knowledge and understanding, and at least trying to smooth the biases that might occur in the assessment.

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