EFFECTS OF THE INTRODUCTION OF THE MESOPELAGIC LONGLINE ON CATCHES AND SIZE STRUCTURE OF SWORDFISH IN THE LIGURIAN SEA (WESTERN MEDITERRANEAN)

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SUMMARY

In 2010 the new mesopelagic long line was introduced in the Ligurian Sea swordfish fishery, substituting the traditional surface long line. In 2010 e 2011 fishing seasons the main effects were: a) significant increasing of swordfish mean size, both for males and females b) great increasing of catches and CPUE values c) decreasing of by-catch. During the third year (2012) a great decline, both of mean size and CPUE, was recorded, followed by a small recovery in 2013. The introduction of this new gear revealed the presence of a fraction of the swordfish population, made up of large spawners, so far only partially exploited by commercial fishing, suggesting that swordfish SSB could be larger than previously expected. Effects of heavy exploitation on this fraction of the stock are discussed.

RÉSUMÉ

En 2010, la nouvelle palangre mésopélagique a été introduite dans la pêcherie d'espadon de la mer de Ligure, remplaçant la palangre de surface traditionnelle. Pendant les saisons de pêche 2010 et 2011, les principaux effets étaient: a) augmentation considérable de la taille moyenne de l'espadon mâle et femelle, b) forte augmentation des captures et des valeurs de CPUE et c) diminution des prises accessoires. Au cours de la troisième année (2012), une forte chute, à la fois de la taille moyenne et de la CPUE, a été enregistrée, suivie d'un faible rétablissement en 2013. L'introduction de ce nouvel engin a révélé la présence d'une fraction de la population d'espadon, composée de gros spécimens reproducteurs, jusqu'alors partiellement exploités par la pêche commerciale, ce qui donne à penser que la SSB de l'espadon pourrait être plus grande que ce qu'on avait antérieurement prévu. Les effets de la forte exploitation sur cette fraction du stock sont discutés.

RESUMEN

En 2010, se introdujo el nuevo palangre mesopelágico en la pesquería de pez espada del mar de Liguria, sustituyendo al tradicional palangre de superficie. En las temporadas de pesca de 2010 y 2011 los principales efectos fueron: a) un aumento significativo en la talla media del pez espada, tanto para las hembras como para los machos, b) un gran aumento en las capturas y los valores de la CPUE y c) un descenso en la captura fortuita. Durante el tercer año (2012) se consignó un descenso sustancial, tanto de la talla media como de la CPUE, seguido de una pequeña recuperación en 2013. La introducción de este nuevo arte reveló la presencia de una parte de la población de pez espada, compuesta por grandes reproductores, hasta ahora solo parcialmente explotada por la pesca comercial, lo que sugiere que la SSB del pez espada podría ser mayor de lo anteriormente previsto. Se discutieron los efectos de la gran explotación de esta parte del stock.

KEYWORDS

Swordfish, Catch/effort, Size distribution, Mediterranean

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1. Introduction

Total Ligurian swordfish fishery landings represent about 2.5 - 3% of total Italian swordfish fishery production (IREPA, 2011), depending on the year and is an important fraction of the professional fishing and constitutes a good income for the Ligurian local economy. The main fishing ground is located in the Central Western Ligurian Sea, where there are concentrated about 40 boats, that, before the two months closure imposed by ICCAT in October and November, were engaged in this activity consecutively from May to January.

Since 1990 swordfish fishery in the Ligurian Sea have been monitored by the Genoa University within the framework of national (MiPAAF, MIUR) and international (EU, ICCAT) programs; in the last years research have been sustained mainly by regional funds. Several studies are being conducted on many aspects, not only of fishery itself, such as exploitation and fishery trends, by-catch, possible interactions with protected and endangered species, possible influence of climate change, but also on the biology of the main pelagic species, such as reproduction, growth, feeding and tagging (Orsi Relini *et al*., 1993, 1995, 1999a, 1999b, 2003, 2008, 2010; Garibaldi *et al*., 1999; Palandri *et al*., 2006; Canese *et al*., 2008).

Aim of this note is to describe changes that occurred in recent years in the fishing activities, mainly due to the introduction of a different long line, which greatly affected the total amount and the size structure of the swordfish catches in the area.

2. Material and methods

2.1 Description of the fishery and gears

Since 1990 we have been monitoring the fishing activities addressed to large pelagic fish: considering this 25 years period, the surface drifting swordfish longline (LLSWO) was the main gear used, even if in the past some activities with driftnet were present. In fact the first ban of driftnet in 1990, regarded foreign vessels only and later (1992) the small resident fleet using driftnets (a maximum of 17 units along the total Ligurian coast. The creation of such an area of biological protection for cetaceans and other pelagic species led to the actually enforced Pelagos Cetacean Sanctuary. At the end of nineties, only for some years, French (thonaille) and Italian (ferrettara) driftnets were introduced in the area: build up with smaller mesh size than 'spadara' nets, they were mainly addressed to bluefin tuna, but of course they catch also swordfish.

The Ligurian swordfish long line fishery has artisanal characteristics: the boats involved are about 40, of which more than 30% have a small size (less than 10 m LOA, the largest one is less than 15m LOA), crew are made of 2–3 men and the fishing operations have a daily rhythm.

Up to 2009, the main gear was the traditional drifting LLSWO, displaced strictly at surface (max depth 15m) during the afternoon and hauled during the night: the main line was a monofilament nylon, 1.4 mm ø, the branchlines of monofilament nylon 1.3 mm ø, with hooks of 7cm in length, maintained at surface by floating devices (bottles and balls): the number of hooks per haul is usually 600 – 1500, with an average of 750. The gear maintained the same characteristics in its general scheme (hook size, bait, number of average hooks per boat and depth of set) all throughout the period of observation, since 1990; in this way comparison among different years was more reliable.

Starting in 2010 quite all boats have introduced a new gear, borrowed from some vessels that have come to fish from southern Italian areas, where this long line was already in use for a few years. Only a residual activity was carried out with LLSWO in 2010 and 2011 by a limited number of boat. The newly introduced gear has a general scheme which is completely different; the main differences are referred to depth of displacement and timing of fishing operations. The main line is made of a monofilament nylon 2.0 mm ø, the branchlines are composed by two different parts; the first one is a monofilament nylon made of 1.3mm ø, while the second terminal part, bringing the hook, made of monofilament nylon 1.17 ø "double strength". The first hook is displaced at about 100m depth and is followed by other 40 hooks, the deepest reaching the depth of about 600 m. Considering that 75% of the hooks are set in mesopelagic waters, we called this long line as Mesopelagic Swordfish Long line (MESOLLSWO). The gear is set during the day, left 1.5-2 days at sea and then hauled; all boats are equipped with radio buoy system for the constant monitoring of the drift and to facilitate the recovery of the gear. In **Table 1** the main characteristics of the two gears are compared.

Moreover starting from 2011 all boats introduced also the American Type swordfish longline (AM-LLSWO), equipped with lights as attraction devices, which is used exclusively during the winter season (December-January), after the two months period of closure stop imposed by ICCAT in October-November and only occasionally and irregularly during summer.

2.2 Monitoring and sampling activities

Also for the new gear, data from the swordfish fishery have always been collected in the same way used in previous studies, in order to continue the historical series obtained till now. The main harbours where landing controls were carried out are Sanremo and Imperia, which produce about 80% of the landings of the Ligurian coast, from a minimum of 6 to a maximum of 20 boats per day. Observations were carried out weekly at Imperia and on a daily basis at Sanremo. During each day of observation at landings, information about total catches and effort were recorded and all the catches were measured, as lower jaw fork length (LJFL) and weighted (gutted weight, GW). Activities were also carried out directly onboard the fishing vessels: the new MESOLLSWO was equipped with Time Depth Recorder (TDR) to obtain more precise data about its depth of displacement and biological samples were collected.

2.3 Data analysis

Nominal CPUE values, length-frequency distributions and length-weight relationships were obtained from data collected. Considering that MESOLLSWO is only used during the period May-September, in order to better compare the two gears, also for data collected in the past deriving for surface LLSWO only the data sets collected in the past form May to September were considered. Due to this fact data collected from Am.Type LLSWO collected in winter are not presented here.

3. Results

3.1 Long line CPUE time series

The long line CPUE time series covers 21 consecutive fishing seasons for the Surface LLSWO and the last 4 years for the MESOLLSWO, both in weight (**Figure 1a**) and numbers (**Figure 1b**). After 1992, an increasing trend appeared, although with some fluctuations, up to the great large peak in 2007 (296,4 kg/1000 hooks), followed by a clear decline in the following years, until 2010, when it introduced the new tool and nominal CPUE reached the highest level ever observed. After the high value reached in the first year of activity (344,1 kg/1000 hooks), there is an abrupt drop in the next two years (2011 and 2012), followed by only a slight recovery in 2013. Comparing the two graphs, in weight and numbers, it can be considered that this high value in weight is probably not due to a high number of individuals, but especially to their larger size.

3.2 Swordfish average size

Considering the average size of the fish caught by the two long lines, differences are clear. In **Figure 2** the time series of the mean size values of swordfish is presented: while the highest value for the LLSWO was achieved in 2006, with 131.7cm LJFL, in the first year of use of the MESOLLSWO it was 143.87cm LJFL.

3.3 Swordfish size-frequency distributions

In fact, if we consider the size frequency distributions of swordfish caught by MESOLLSWO, they are completely different from those recorded before with LLSWO. In **Figure 3** are shown the size distributions recorded for MESOLLSWO separately for the 4 years of activity. The trends over the four years shows that in 2010 individuals of large size were more abundant in the catches than in the following years. Moreover, in 2012 it appears the recruitment of the cohort 2011, which can also followed in 2013. If we compare these size/ frequency distributions with those of the previous year derived from data sets of the LLSWO, the difference is clearly evident (**Figure 4**).

3.4 Size frequency distributions by sex and sex ratio

It is well known that swordfish females attain larger sizes than males. The average size for females recorded in these 4 years has been 144.88 cm LJFL (maximum recorded size 235cm LJFL) and 130.6 cm LJFL for males (maximum recorded size 196 cm LJFL). Taking into account of the size distributions recorded for the new gear (**Figure 5**), we could hypothesize that the increase in the average size was mainly related to an increase of the number of females in the catch. The sex-ratio showed a slight overall predominance for females, representing the 55.4% of the catches (sex ratio 1.24:1 in favour of female); males are dominant for the smaller sizes, as shown in the **Figure 6.**

3.5 By-catch

The by-catch is greatly reduced in comparison to the traditional surface longline: a detailed description is reported in Garibaldi (2015, *In press*).

4. Discussion

The last session of the Mediterranean swordfish Stock Assessment held in 2010, led to the conclusion that the Mediterranean swordfish stock is overexploited and in conditions of light overfishing. (Anon., 2011). Probably the main problem in the exploitation of this resource is that most of the catches are made of individuals less than 3 years old, as shown in the overall size/frequency distribution derived from ICCAT database and used for the analysis. So, all the technical measures taken for the recovery of the stock were addressed to the protection of juveniles, such as the introduction of the two periods of fishery closure, in October-November and February-March. The dilemma that always divides fisheries biologists is whether it is better to protect juveniles or spawners.

The changes in the habits of the different fishing fleets not only in the Mediterranean are often very fast and it is extremely difficult to follow each developments in the fishing activities. The comparison between surface long line and the newly introduced American type long lines made in Eastern Mediterranean some years ago did not show major differences in the size structure of the fished stock, even if the latter gear seems to catch less juveniles (Tserpes e Peristeraki, 2010).

This is not the case of the Mesopelagic long line. In recent years, this new gear, which was introduced some years ago in the Italian fleets, is very similar to the long line described by Barcelona-Garcia *et al.* (2010), and called Semipelagic longline (SPLL), which was introduced by Spanish fishermen since 2006. This gear was thought to go to undermine the swordfish during their diel vertical migrations.

The introduction of the new gear, not only in the Ligurian Sea, as well as but in all Italian seas has revealed the unexpected presence of a bulk of large spawners, that found their refuge in the deep. Even more, the mean sizes of individuals caught with this gear are larger than those recorded with driftnets in the 90s (Di Natale *et al*., 1995). What in the past we thought it was the real structure of the swordfish stock, as shown by surface gears, both LLSWO and gillnets, represented indeed only a part of the population. Of course, the data collected in these four years in the Ligurian Sea maybe could be not yet sufficient to draw definite conclusions, but we can make some considerations.

a) the actual size structure of the Mediterranean swordfish stock is probably the one obtained merging the two distributions in **Figure 4**. If we consider this true, it is evident that the real SSB at sea is (was) larger than previously expected.

b) With this gear juveniles catches are lower, but the rapid decline in nominal CPUE values and average sizes after a few years, the fact that the vast majority of the catch is made of large spawners, especially females, raises some concern.

c) It is evident the great reduction of the commercial by-catch and discards, both in number and weight, and the discards and the complete avoidance of catches of protected species, such as sea turtles.

d) Last but not least, the evidence of the presence of a strong cohort constituted of swordfish born in 2011, whose abundance is easy to follow also in subsequent years.

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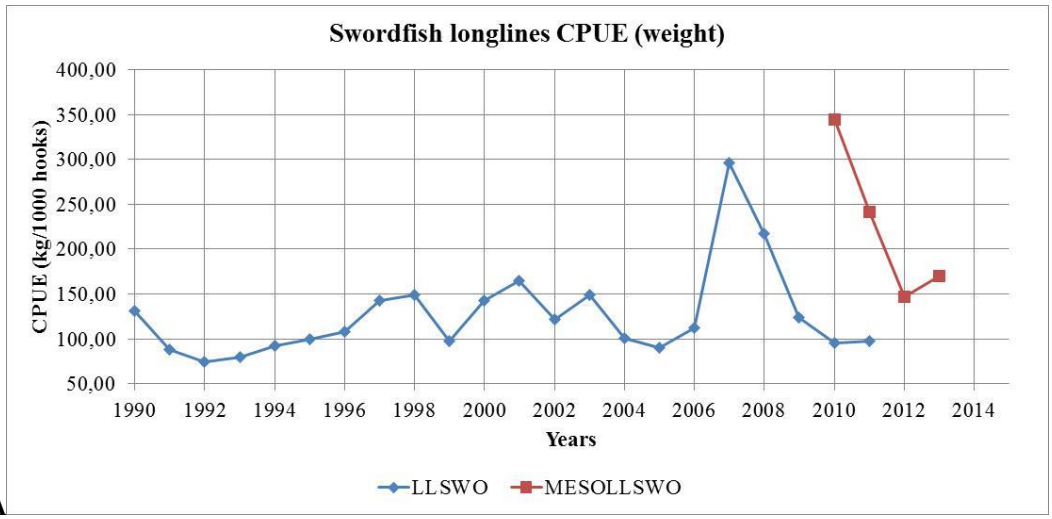
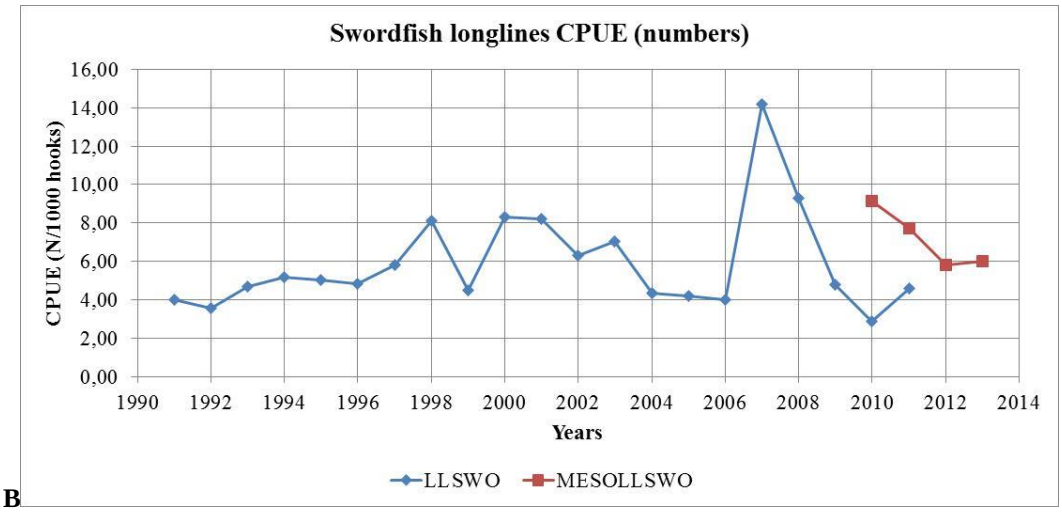
Table 1. Comparison of the main characteristics and timing of the SWOLL and MESOSWOLL used in the Ligurian Sea.

	SWO LL – AM SWO LL	MESO SWO LL
Displacement	Afternoon	Early afternoon
End of displacement	Sunset	Afternoon
Waiting time	2 - 4 hours	36 hours
Hauling	Early morning	Early mnorning
N° hooks	Variable (500 a 1500)	Variable da 500 a 1800
N° of set	1	1 or 2
Depth range	10m - 20ma	100m – 600m or more



A



B

Figure 1. Nominal CPUE time series for the two different type of longlines. A) CPUE in weight B) CPUE in numbers.

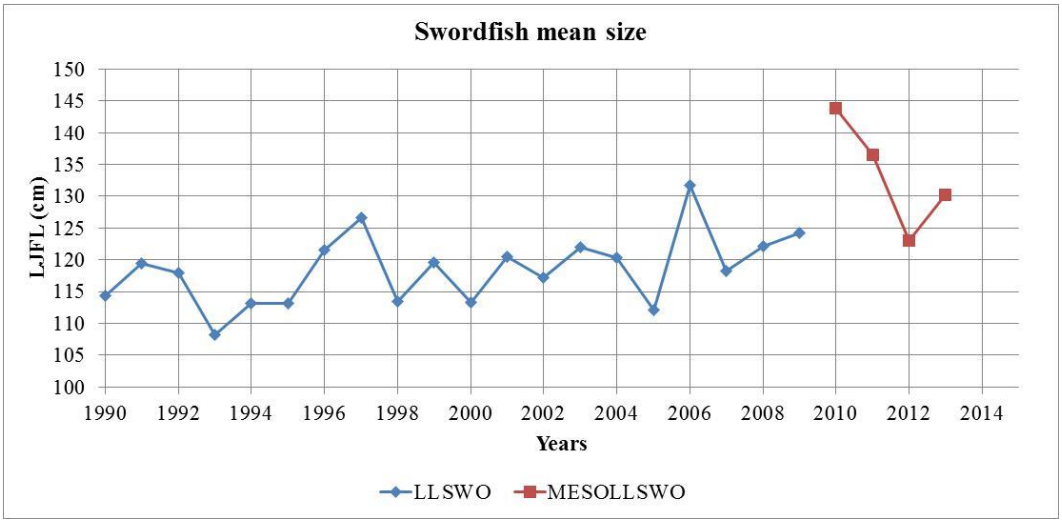
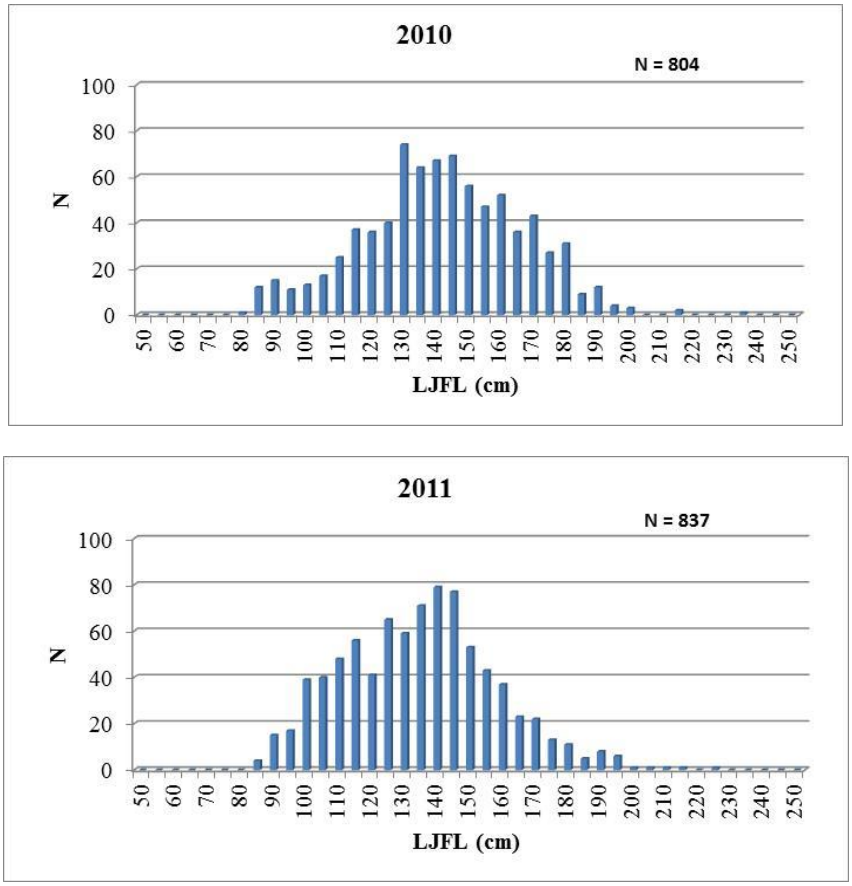


Figure 2. Evolution of the mean size of the swordfish caught with the two different long lines.



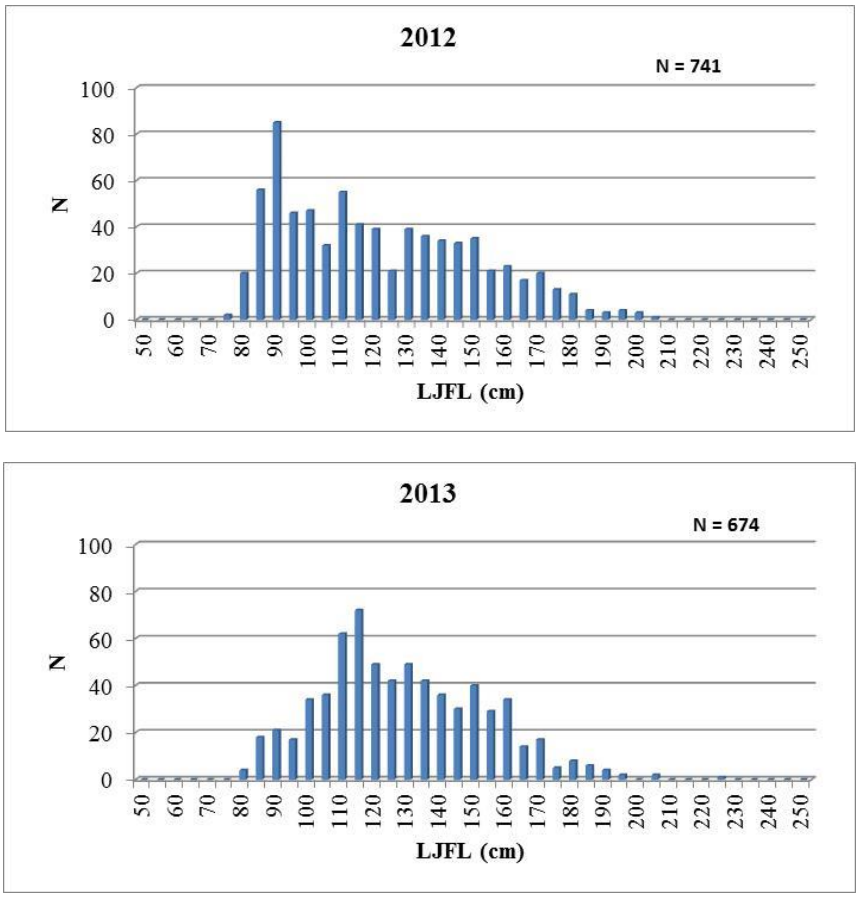


Figure 3. Size distribution of swordfish caught by MESOLLSWO.

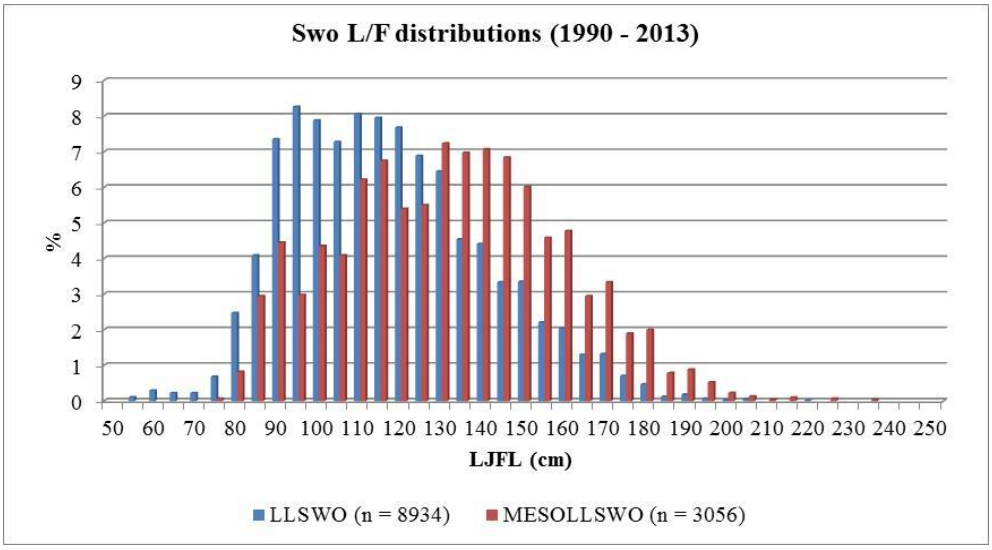


Figure 4. Size/frequency distributions of swordfish caught by the two different long lines over the entire period.

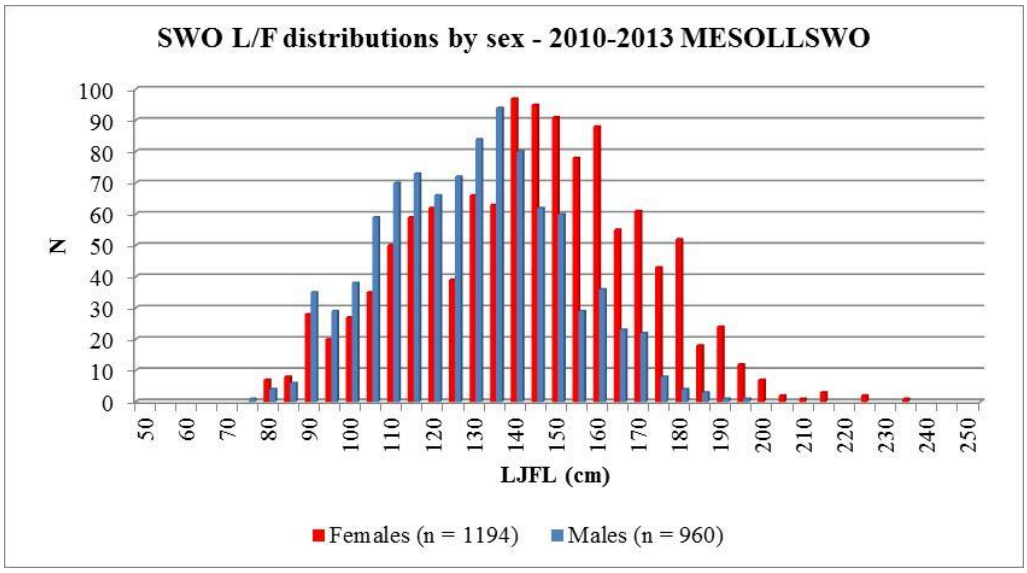


Figure 5. Size distributions of males and females derived from swordfish caught with MESOSWOLL 2010-2013.

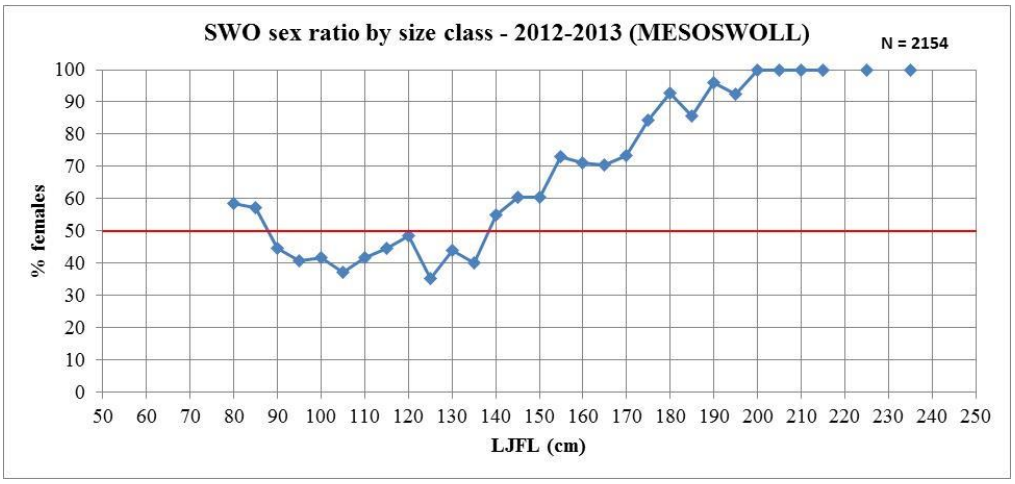


Figure 6. Sex-ratio by size derived from swordfish caught with MESOSWOLL 2010-2013.