SHORTFIN MAKO (*ISURUS OXYRINCHUS)* FISHERY IN THE SOUTH OF THE MOROCCAN ATLANTIC WATERS

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SUMMARY

As in other parts of the world, in Morocco, the shortfin mako is caught mainly as by-catch by longliners targeting swordfish in the south of the Moroccan Atlantic waters. The research activities carried out to monitor shortfin mako research program were based on biological sampling missions and onboard surveys on longline vessels targeting this species. A total of four surveys were conducted during the period from April 2018 to April 2019 and 1,366 individuals were sampled. The results of this monitoring are presented in this paper.

RÉSUMÉ

Comme dans d'autres régions du monde, au Maroc, le requin-taupe bleu est principalement capturé en tant que prise accessoire par les palangriers qui ciblent l'espadon dans le Sud des eaux de l'Atlantique marocain. Les activités de recherche menées pour suivre le programme de recherche sur le requin-taupe bleu reposaient sur des missions d'échantillonnage biologique et des prospections à bord de palangriers ciblant cette espèce. Au total, quatre prospections ont été menées d'avril 2018 à avril 2019 et 1.366 spécimens ont été échantillonnés. Les résultats de ce suivi sont présentés dans ce document.

RESUMEN

Como en otras partes del mundo, en Marruecos, el marrajo dientuso se captura principalmente como captura fortuita de los palangreros que se dirigen al pez espada en aguas meridionales del Atlántico marroquí. Las actividades de investigación llevadas a cabo para hacer un seguimiento del programa de investigación del marrajo dientuso se basaban en misiones de muestreo biológico y prospecciones a bordo de los palangreros que se dirigen a esta especie. Durante el periodo de abril de 2018 a abril de 2019 se llevaron a cabo cuatro prospecciones en total y se muestrearon 1.366 ejemplares. Los resultados de este seguimiento se presentan en este documento.

KEYWORDS

Size distribution, catches, Mean length, Mean weight, Longliners, Shortfin mako

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1. Introduction

Located in the region of the Canaries ecosystem, the Moroccan Atlantic waters are considered among the most abounding in fish in the world (Arístegui *et al.*, 2009; Franchimont, 2001). Several hundreds of these fish species are exploited by Moroccan fleets operating in the Moroccan EEZ. Sharks are among the first 70 species caught as target or bycatch species.

As in the rest of the world, the shortfin Mako shark is accidentally caught by fleets targeting large tunas (Campana et al., 2006; Duarte et al., 2018). In fact, in Morocco, this species is mainly caught as bycatch by swordfish longline fleet operating in the south of the Atlantic coast. The vessels have an average overall length of 24 m and an average GRT of 110 tx. These units use exclusively a surface longline as a fishing gear to primarily target swordfish. With their efficient refrigeration system, these longliners are capable of carrying out trips up to 15 days with an average duration of 10 days. For one fishing day, a single fishing operation is carried out by deploying about 1,200 hooks.

Even if Shortfin Mako is associated with the swordfish fishery, landings of this species have increased steadily over the last years: from 420 t in 2011 to 1050t in 2016. According to the surveys conducted with the fishing skippers, the fishing strategy is geared towards this species at the time of non-availability of swordfish

Given the importance of the Shortfin Mako fishery both at the national and regional levels, and to better manage the north Atlantic stock of this species within ICCAT, the National Institute of fisheries research of Morocco (INRH) has set up, in 2018, a research program aiming at monitoring the fishing activity and the biology of this species (maturity, growth…). The results of this study would be of valuable use for stock assessment in 2019.

This paper aims to present the results of the shortfin Mako biology monitoring program.

2. Material and methods

Three sources of data were used to compile results presented in this report.

- Logbooks: for the spatial-temporal distribution of catches.
- Biological sampling program: the biological sampling data collected at landing are size (total and fork length) and weight. A total 1366 SMA were collected, all measurement is made to fork length and also some individuals are measured to total length.
- Observation on board Commercial Fishing Vessels: This information collected on a monthly basis is composed of fishing effort (number of hooks per fishing operation, fishing duration), fishing area (geographical position of the fishing area, depth, discards ...) and the size and maturity data of the captured individuals (**Table 1**).

Size data were tested for normality with Kolmogorov-Smirnov normality tests with the Lilliefors correction (Lilliefors, 1967). To make a comparison with catches at the regional level, data from the ICCAT database (Task 1) are used.

The study area is the southern Moroccan Atlantic, located between Cap Boujdour and Cap Blanc. The monitoring of the shortfin mako fishery occurs from the port of Dakhla, the main harbour of this region (**Figure 1**).

3. Results

3.1. Catch data analysis

The analysis of shortfin mako catches in Morocco shows that more than 91% of catches are made as bycatch in the longline fishery targeting swordfish in the Atlantic. Minor catches occurred in the PS fishery **(Figure 2).**

At the regional level, Morocco ranks second in terms of catches after the EU with 19.21% of catches (**Figure 3 & 4).**

3.2. Biological sampling (Size structure of catches and Mean size)

A total of 1366 individuals were collected during the period from April 2018 to April 2019 (**Table 1**). Along this sampling year, the sizes distribution of the shortfin mako show a dominance of sizes between 130 and 150 cm

witch represent about 61% of total catch. Regarding the first three months of 2019, the catch structure was bi-modal at 140 (25%) and 180 cm (11%) **(Figure 5)**. The monthly distribution of size frequency is represented in **Figure 6**. The monthly evolution of mean size is presented in **Figure 7.** The maximum is observed in july-2018 with 150.8 cm.

3.3. Observer program

3.3.1. Fishing area

The fishing area of the shortfin mako is presented in the **Figure 8.** Longliners activity is focused between latitudes 26°N and 21°N, and at depth levels ranging from 2000 m to 4850 m.

3.3.2. Fishing strategy and gear description

The characteristics of the used gear are:

Name of gear: Surface longline, LL-SWO (American system)
Length of the gear: between 45 and 60 nautical miles (depending on the power of the boat).
Number of GPS buoys: between 18 and 25 (depending on the power of the boat).
Number of floats between two GPS buoys: 10 medium sized floats and a large central float.
Number of hooks between two floats: 5 hooks (a total hook between 800 and 1300 hooks along the entire length of the gear). **(Figure 9)**

Regarding the fishing strategy used by longliners operating in the south Atlantic of Morocco, is as the follow:

To choose the fishing area, the captains are essentially based on their experiences, the mutual assistance between several captains who work on the same segment and the history of their fishing activity.

During the trip, the captain relies on the temperature, an important environmental parameter. Indeed, the boat must be equipped with a probe that measures the temperature in real time, which allows the captain to monitor the distribution of the hot water masses when the longline is being spun.

Longline spinning usually begins in mid-afternoon and lasts between 4 to 6 hours. While the turn begins just after sunrise and lasts between 7 and 12 hours.

3.4. Catch composition

As part of the shortfin mako monitoring program, four onboard surveys were conducted from April 2018 to April 2019 (**Table 2**). During this surveys, 152 shortfin mako were caught corresponding to 3795.3 kg (**Figure 10 & 11).** The most important catches are observed near the coast between latitudes 21°N and 23°N.

3.5. Biological indicators

3.5.1. Size distribution

The descriptive statistics of the size samples are presented in the **Table 3**. Size data was not normally distributed (Lilliefors test: $D = 0.14513$, p-value < 0.001).

The distribution of sizes by sex is presented in **Figure 12.** For female, the distribution is dominated by sizes between 115 and 126 cm with 125 cm as a principal mode (17.8%). Regarding the male, the distribution is almost similar with larger sizes.

Figure 13 presents the monthly distribution of the SMA catch in the south Atlantic of Morocco.

3.5.2. Length weight relationship

The length weight relationship of shortfin mako caught in the port of Dakhla by the longliners fleet is presented in **Table 4** and illustrated **Figure 14**. The result shows a good correlation between length and weight of SMA with $R = 0.9674$.

3.5.3. Sex ratio

From 117 shortfin mako sampled, 56 was female and 61 males. The sex ratio is slightly in favor of males with 52% (**Figure 15)**. From six female exanimated, five were mature with sizes between 135 and 156 cm.

4. Conclusions

Analysis of the exploitation and biological indicators of the shortfin mako caught in the south Atlantic of Morocco, has shown that:

- Almost all catches are made by longliners using LL-SWO as fishing gear.
- An improvement in terms of catch, from 420t in 2011 to 1050t in 2016.
- The size distribution of catches shows a dominance of sizes between 130 and 150 cm FL, which represent 61%.

The on board surveys were very important for the collection of information on the biology of this species. Out of 117 individuals, 48% were females whose sizes range from 110 to 170 FL, with a peak at 125 cm. these operations also made it possible to understand the fishing strategy of the fleet that catches this species and to have an idea on the distribution of catches and structures in the southern Moroccan area.

References

Arístegui J., Barton Eric D., Álvarez-Salgado Xosé A b, A. Miguel P. Santos c , Francisco G. Figueiras b , Souad Kifani d , Santiago Hernández-León a , Evan Mason a , Eric Machú e , Hervé Demarcq f

Campana S., Brazner J. and Marks L, 2006. Assessment of the Recovery Potential of Shortfin Mako Sharks in Atlantic Canada. Research Document 2006/091, ISSN 1499-3848 (Printed / Imprimé). http://www.dfo-mpo.gc.ca/csas/

Casey, J. G. and N. E. Kohler. 1992. Tagging studies on the shortfin mako shark *Isurus oxyrinchus* in the Western North Atlantic. Aust. J. Mar. Freshwater Res., 43:45-60.

Duarte, H., Droguett, E. and Moura, M., 2018. Quantitative ecological risk assessment of shortfin mako shark (*Isurus oxyrinchus*): Proposed model and application example. Applied Ecology and Environmental Research. 16. 10.15666/aeer/1603_36913709.

Franchimont, 2001. National study on biodiversity, synthetisis report. Kingdom of Morocco, legal deposit 2001/1445; 165p.

Francis, M. P. and Duffy, C., 2005. Length at maturity in three pelagic sharks (*Lamna nasus*, *Isurus oxyrinchus* and *Prionace glauca*) from New Zealand. Fishery Bulletin 103, 489–500.

Coelho R. and all, 2017, a revision of the shortfin mako shark catch-at-size in the Atlantic using observer data, Collect. Vol. Sci. Pap. ICCAT, 74(4): 1562-1578 (2017).

Table 1. Onboard surveys conducted by INRH scientific observers.

Month	Number of individuals	Parameters collected
April 2018	4	Size, weight*
July 2018	57	Size, weight and 3 individuals for maturity*
Mars 2019	13	Size , weight* and 3 individuals for maturity*
April 2019	78	Size , weight*

* number of hooks per fishing operation, fishing duration, geographical position of the fishing area, depth, discards…

Table 2. Fishing operations characteristics of the four onboard surveys.

Vessel	Date	Deep	Hooks	BSH	SWO	SMA
A	18/07/2018	3508	1060	8	8	1
	19/07/2018	3300	1043	5	9	1
	20/07/2018	3380	1066	5	4	1
	21/07/2018	3370	1061	10	5	3
	22/07/2018	3100	1058	15	15	4
	23/07/2018	3200	1053	30	3	7
	24/07/2018	3330	1068	12	12	1
	25/07/2018	3000	1040	15	15	5
	26/07/2018	3000	1098	6	3	4
	27/07/2018	3170	1059	10	10	5
	28/07/2018	2890	1051	16	6	7
	29/07/2018	2210	1055	42	2	9
	30/07/2018	2200	1055	30	2	9
B	16/04/2018	1140	823	25	6	0
	17/04/2018	2100	780	22	4	1
	18/04/2018	2200	761	15	3	1
	19/04/2018	2500	802		0	0
	20/04/2018	2050	775	33	1	1
	21/04/2018	2050	562	28	1	1
C	13/03/2019	4850	1200	12	22	1
	14/03/2019	4800	1200	9	15	3
	15/03/2019	4860	1200	9	22	1
	16/03/2019	4780	1200	7	23	1
	17/03/2019	4800	1200	8	20	1
	18/03/2019	4810	1200	11	24	1
	19/03/2019	4750	1200	9	28	1
	20/03/2019	4800	1200	5	22	2
	21/03/2019	4820	1200	3	25	1
	22/03/2019	4790	1200	11	22	1
	23/03/2019	4800	1200	11	14	0
D	12/04/2019	3465	1104	32	23	4
	13/04/2019	3440	1096	15	22	4
	14/04/2019	3350	1102	12	20	9
	15/04/2019	3400	1092	13	28	6
	16/04/2019	3450	1100	15	24	5
	17/04/2019	3380	1100	10	25	5
	18/04/2019	3380	1100	10	27	4
	19/04/2019	3400	1102	10	17	4
	20/04/2019	3100	1102	13	18	16
	21/04/2019	2900	1100	8	17	21

Table 3. Descriptive statistics of length sampling conducted by Scientifics observers.

	Min	Max	1 st Qu	Median	Mean	3rd Qu
FL cm	110	245	125	135	138.4	145

Table 4. Length weight relationship equation of shortfin mako.

Species	Equation	N	R^2
SMA	$Y=7x10^{-6}FL^{3.0789}$	100	0.9674

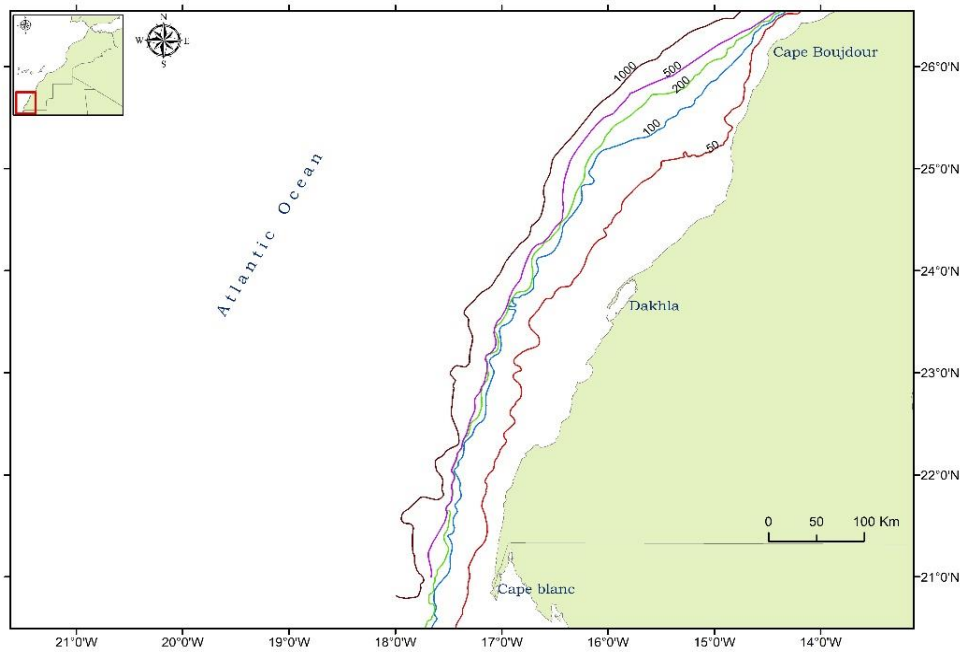

Figure 1. Location of the study area.

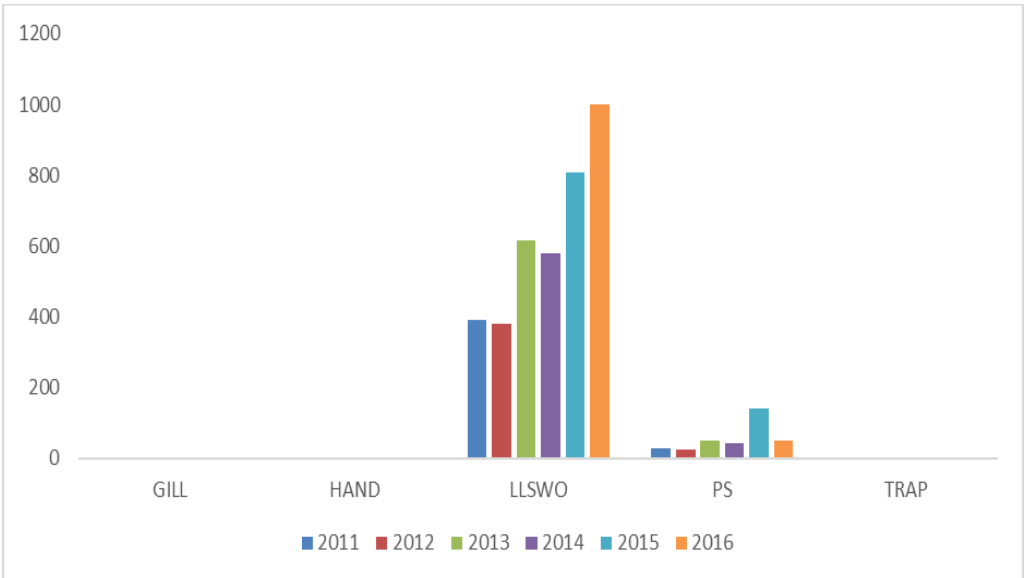

Figure 2. Yearly evolution of SMA catches (TM) made in Moroccan waters during 2011-2016 period (ICCAT data base).

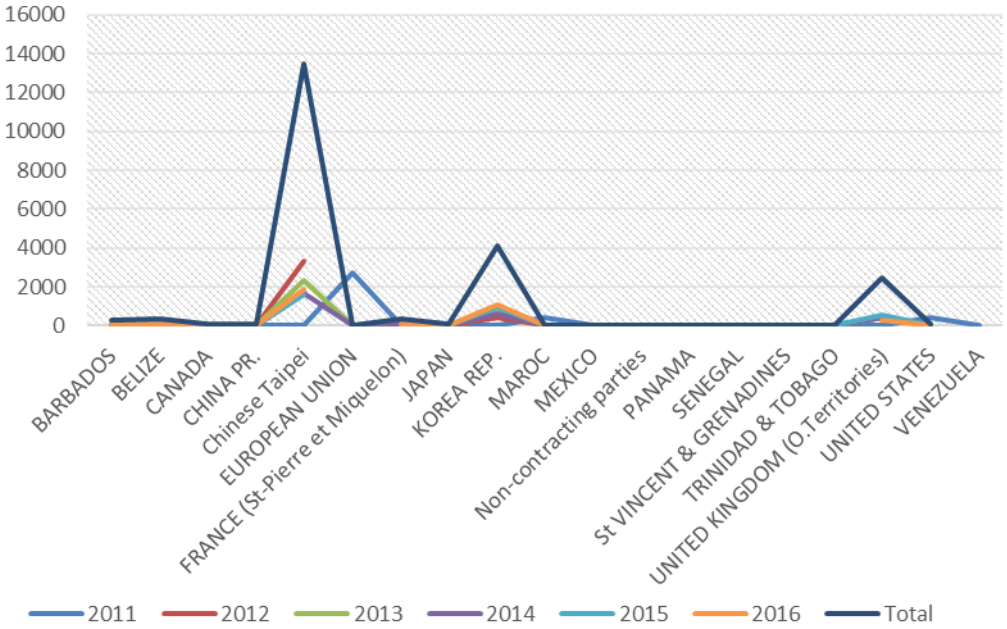

Figure 3. Annual evolution of SMA catches (t) per country during 2011-2016 period (ICCAT data base).

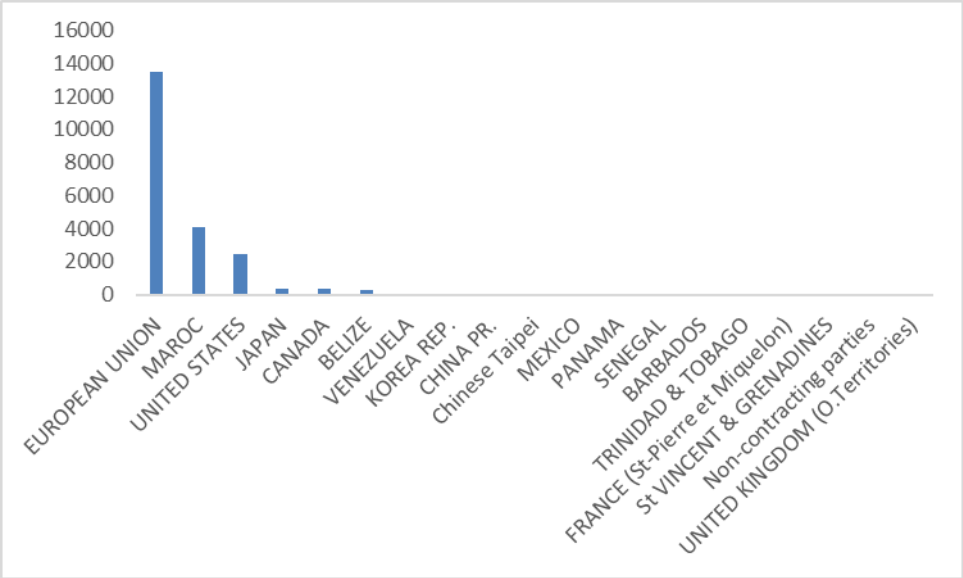

Figure 4. Yearly evolution of SMA catches (T) per country during 2011-2016 period (ICCAT data base).

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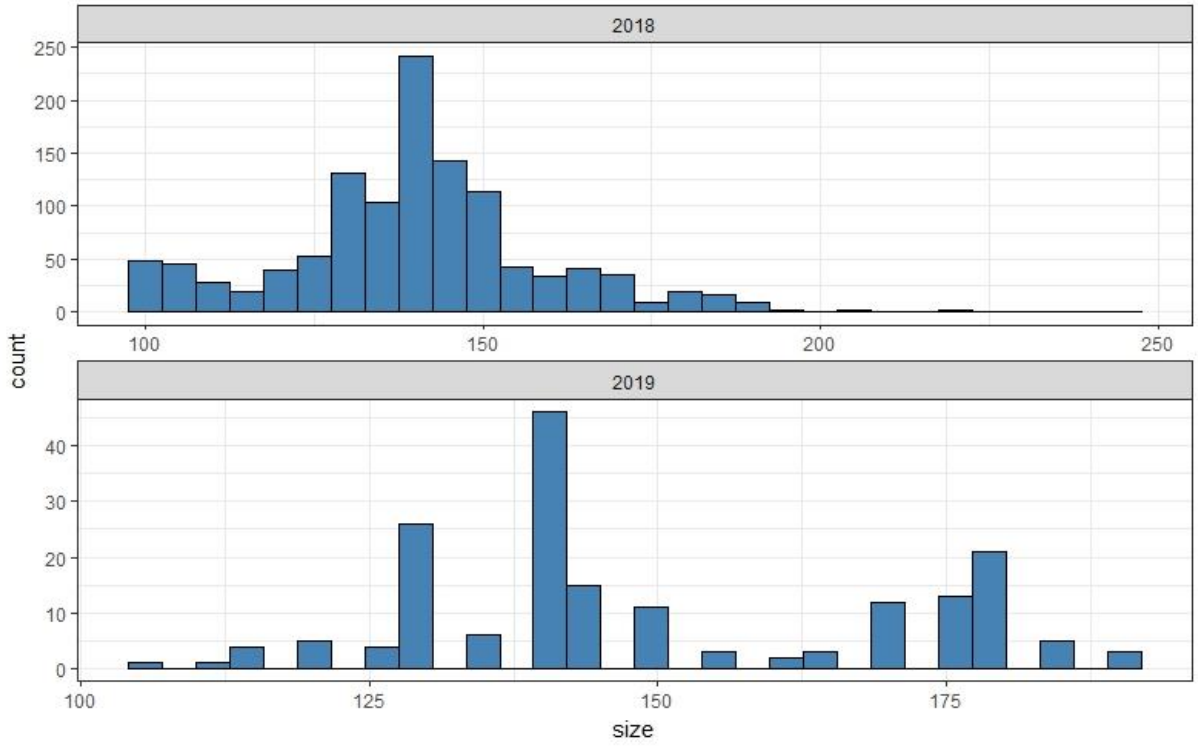

Figure 5. Annual distribution of the size frequencies of the shortfin mako caught by Moroccan swordfish LL fleet.

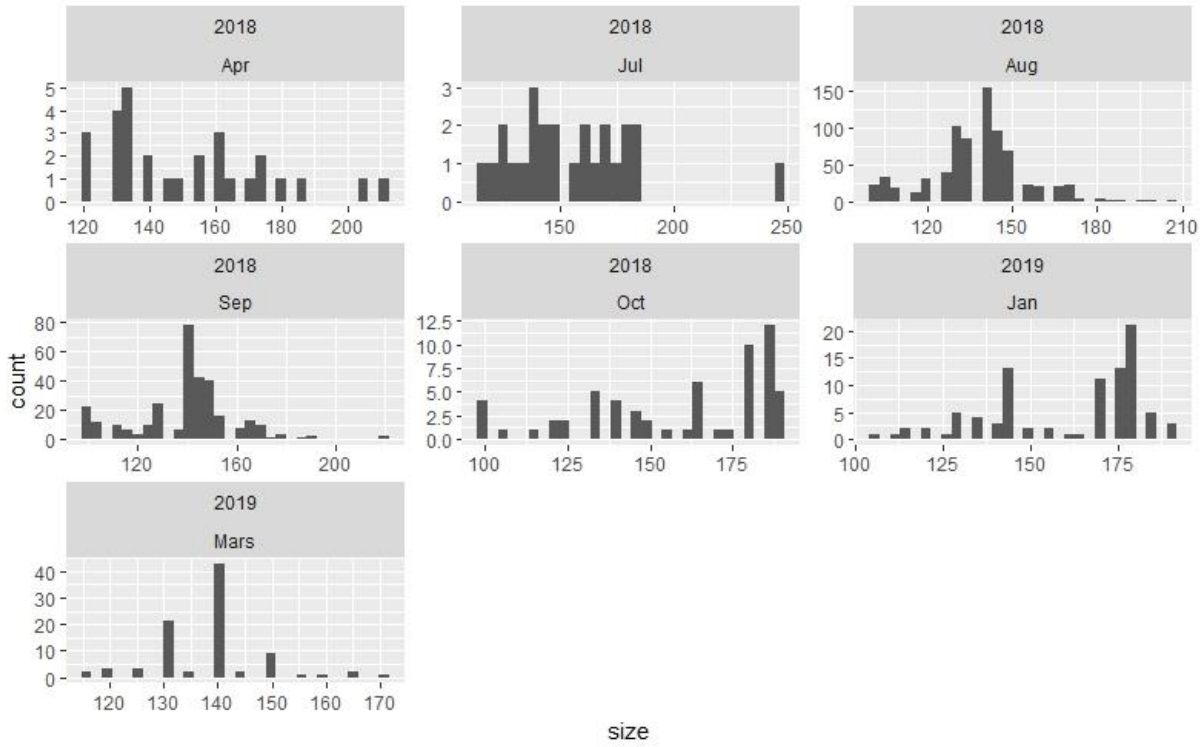

Figure 6. Monthly distribution of the size frequencies of the shortfin mako exploited in south of Moroccan Atlantic waters.

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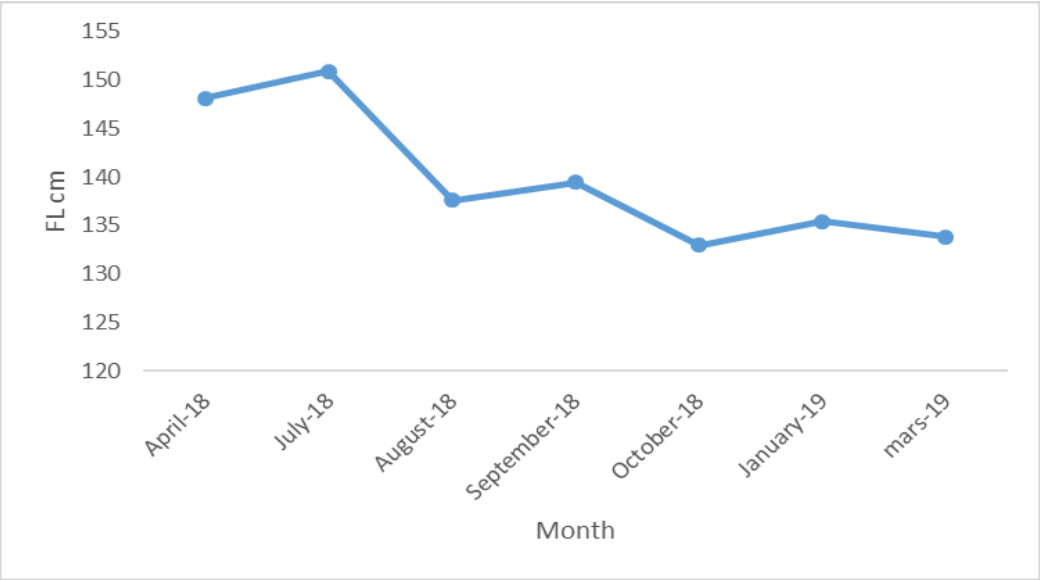

Figure 7. The monthly evolution of the mean size of the shortfin mako caught in the south of Morocco.

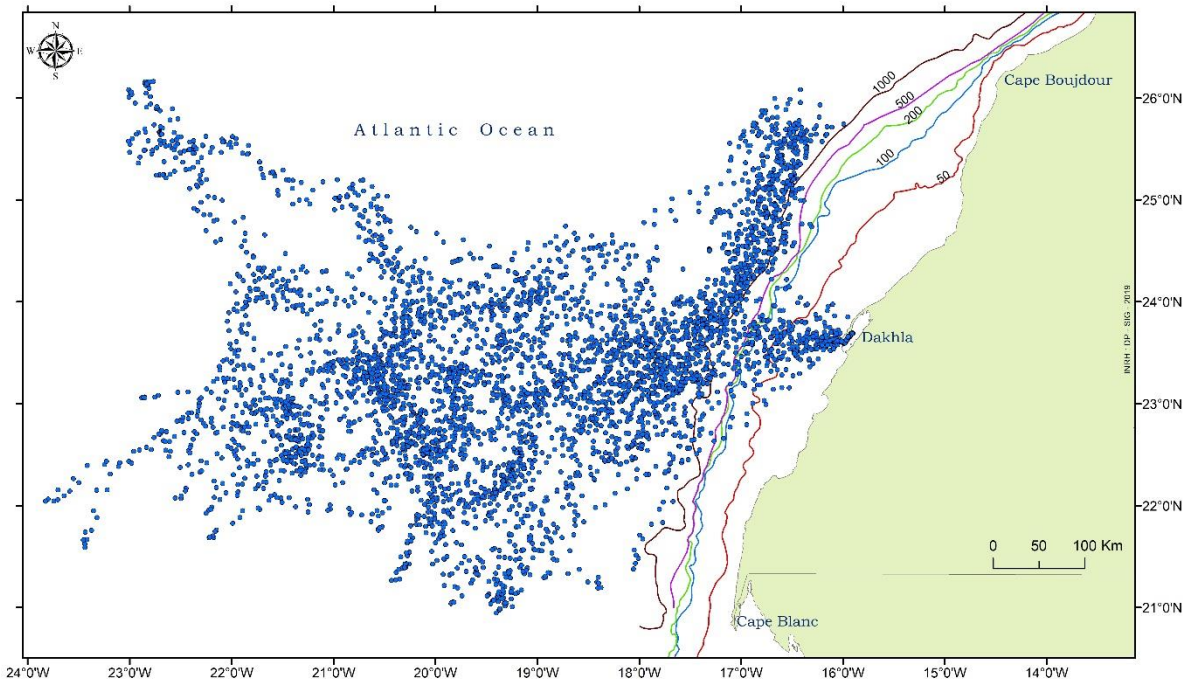

Figure 8. The four longliners Fishing area, subject of the onboard surveys.

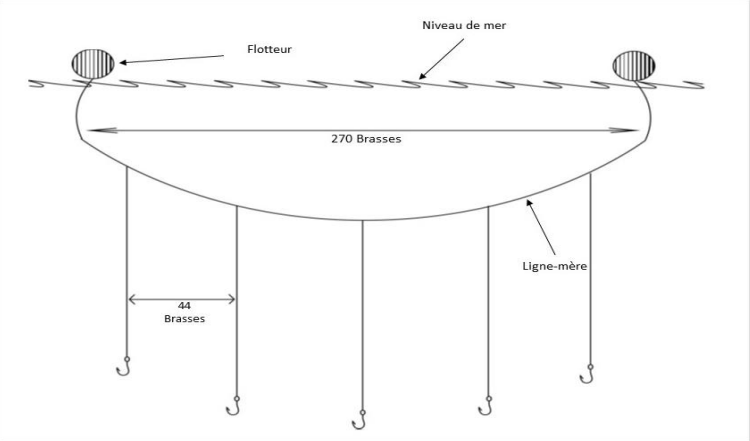

Figure 9. LL-SWO used by longliners operating in the south Atlantic of Morocco.

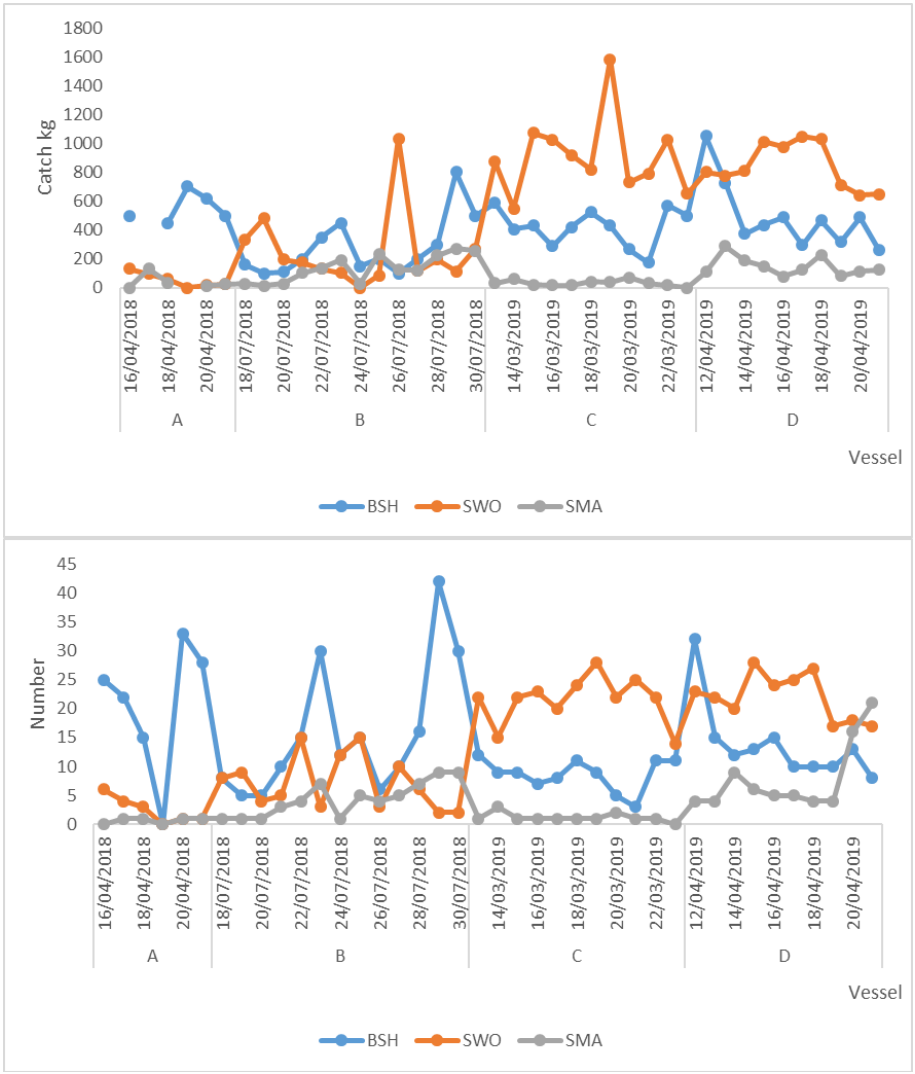

Figure 10. SMA catch Composition in number and weight.

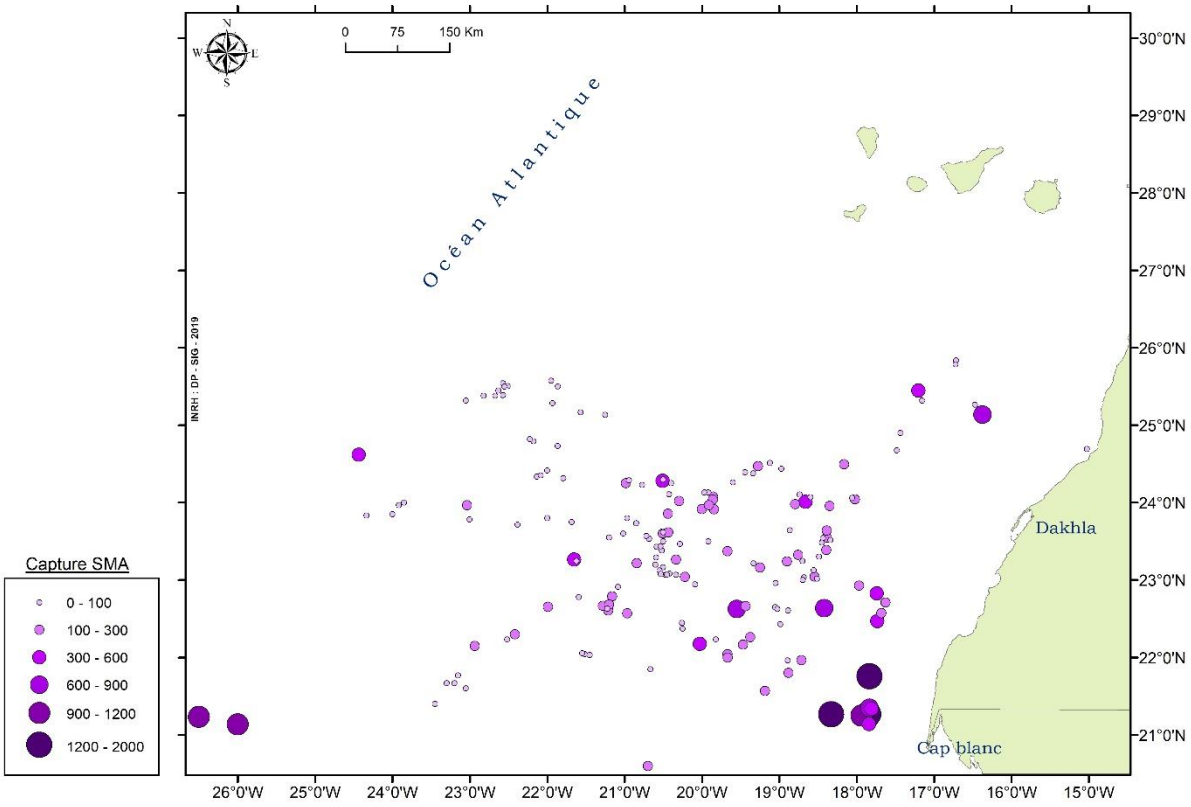

Figure 11. SMA catch distribution in the fishing area of the four longliners subject of the onboard surveys.

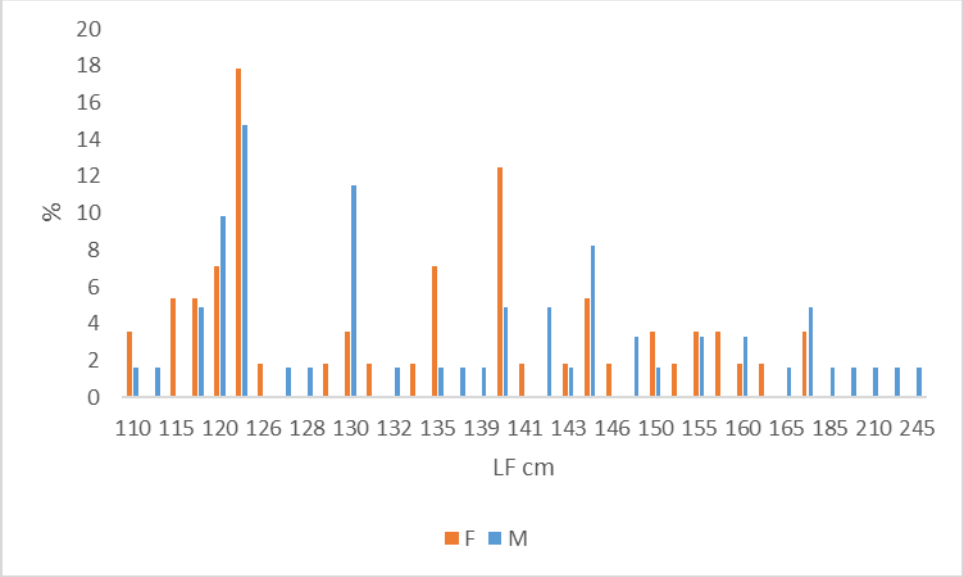

Figure 12. Size frequency distribution by sex of shortfin mako caught in the south of Morocco.

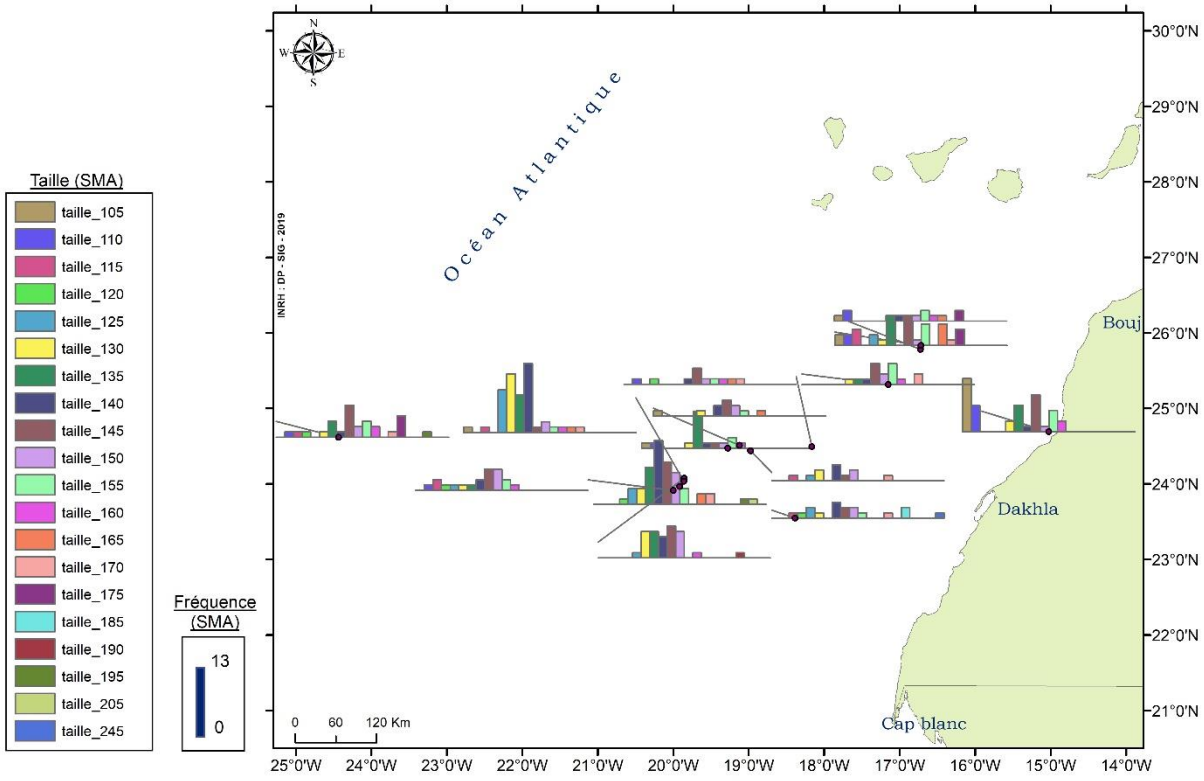

Figure 13. Spatial size frequency distribution of shortfin mako caught in the south Atlantic of Morocco.

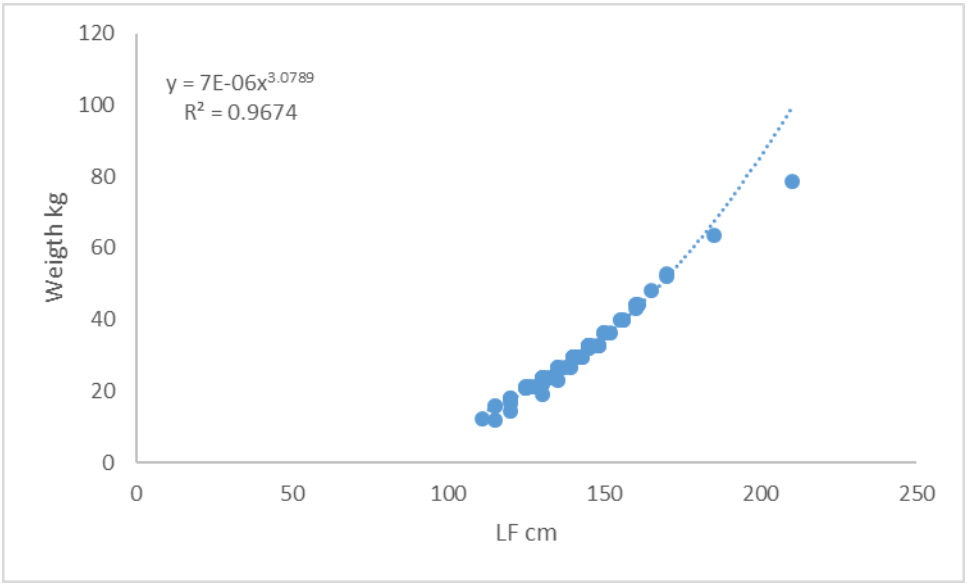

Figure 14. Length weight relationship of shortfin mako caught in the south of Morocco

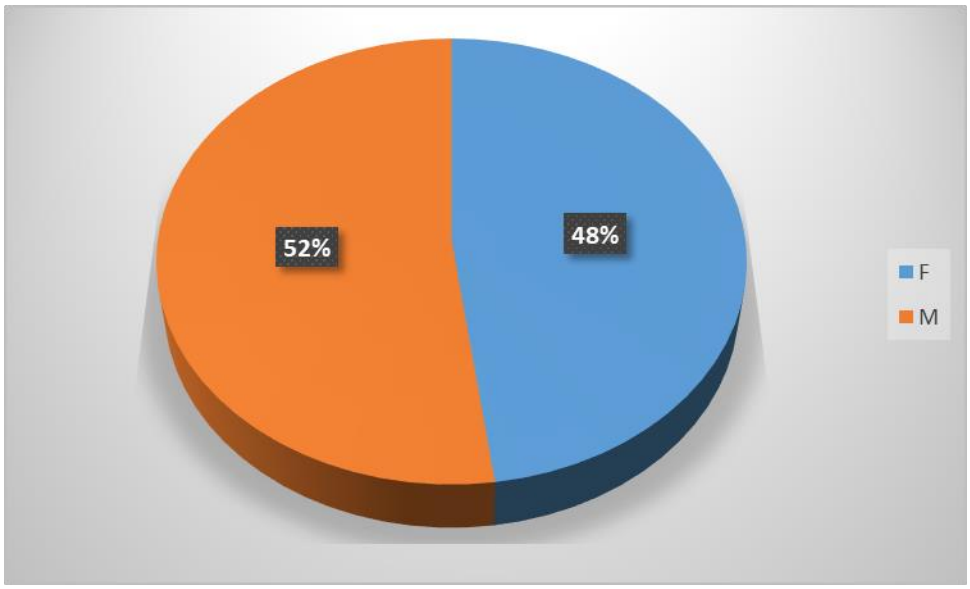

Figure 15. Sex ratio of shortfin mako caught in the south of Morocco.