# 13TH WORKING PARTY ON BILLFISH (WPB13)

Olhão, Portugal

1st – 5th September 2015

## Billfish by-catches of the Seychelles Industrial Longline Fishery

*Abstract*

Billfishes are incidental catches of Seychelles industrial longline fishery primarily targeting bigeye tuna. On average billfishes comprising of swordfish, marlins and sailfish accounted for 14% of the total catch of that fishery per year, over the last 11 years. The Seychelles industrial longline fleet started operating in the Indian Ocean in 1999 and in 2014, the fleet comprised of 36 vessels with an average capacity of 542.3 GT. The total billfish catches exhibited same trend in catches as bigeye tuna with a progressive drop in the total billfish catches (swordfish, marlins and sailfish) from 2004 to 2011 followed by a sharp increased in catches in 2012 where catches of both swordfish and marlins increased from less than 400 Mt to around a 1000 Mt amounting to a record catch of 2,144 Mt of billfishes since the beginning of the fishery. Similarly, the catch rate for billfish followed a decreasing trend from 2004 to 2011 and increased sharply in 2012 to 0.11 Mt/1000 hooks and has stabilized to around 0.07 Mt/1000 hooks over the last two years.
A total of 30,000 swordfish and 13,500 marlins measurements, have been collected on board Seychelles Industrial longliners from 2007 to 2014. The annual size distributions of swordfish and marlins appear rather consistent, with 50% of the swordfish and marlins comprised in the *LMFL* intervals of 136-165 cm and 155-184 cm, respectively. Maps of fishing ground show that billfishes are mostly caught in the Indian Ocean Monsoon gyre relative to bigeye catches.

# 1. Introduction

Billfishes are incidental catches of Seychelles (SYC) industrial longline fishery primarily targeting bigeye tuna. The Seychelles registered distant-water tuna longline fishing fleet started operating in 1999 with 6 vessels registered. Major target species of this fleet is bigeye tuna in Indian Ocean Monsoon gyre but billfishes and species reported as 'Others' are also caught between 30°S and 40°S of the Indian Ocean.

This paper review available statistics on billfishes in the Seychelles industrial Longline fleet and presents an analysis and evaluation of billfish catches, catches rate and geographical catches distribution.

# 2. Fleet Composition

In 2014, the Seychelles industrial longline fleet consisted of 36 registered vessels, with an average capacity of 542.3 Gross Tonnage, an average length overall (LOA) of 52m and a mean vessel age of 19 years (Table 1). The fleet started operation in 1999 and the fleet sizes increased sharply to reach a record of 48 vessels registered in 2003, but has since then remained more or less stable averaging to around 30 vessels registered per year. The mean LOA and GT of the vessels have remained consistent since the beginning of the fishery whilst the average age of the vessels in the fleet shows an increasing trend.

**Table 1: Main characteristics of the Seychelles industrial longline fleet, years 2000 - 2014.**

| Year | Vessel (Number) | Average LOA (m) | Average GT (Mt) | Average Age (years) |
|---|---|---|---|---|
| 2000 | 19 | 47.6 | 527.0 | 14 |
| 2001 | 47 | 50.2 | 552.0 | 11 |
| 2002 | 42 | 50.7 | 556.8 | 11 |
| 2003 | 48 | 51.0 | 544.9 | 10 |
| 2004 | 33 | 50.8 | 533.7 | 10 |
| 2005 | 27 | 51.9 | 518.7 | 10 |
| 2006 | 28 | 51.9 | 521.3 | 11 |
| 2007 | 27 | 51.6 | 521.3 | 12 |
| 2008 | 27 | 52.9 | 524.2 | 12 |
| 2009 | 27 | 53.2 | 527.9 | 13 |
| 2010 | 27 | 52.8 | 535.7 | 15 |
| 2011 | 24 | 52.9 | 540.2 | 16 |
| 2012 | 32 | 53.6 | 552.3 | 17 |
| 2013 | 32 | 53.2 | 551.2 | 18 |
| 2014 | 36 | 52.2 | 542.3 | 19 |

# 3. Fishing Gears

Longline gear consists of three basic components: the mainline, the branch line, and the baited hook (figure 1). All of these parts are adaptable for targeting specific species through changes in materials, lengths, and deployment strategies. Using small buoys and float lines to suspend the gear below the surface results in a pelagic longline set. Squid is generally used as bait in addition to a light stick (Cyalume1). The gear is very effective at capturing large pelagic fishes, such as bluefin tuna, bigeye (Thunnus obesus), yellowfin (Thunnus albacares), and albacore (Thunnus alalunga) but also broadbill swordfish (Xiphias gladius), and the istiophorid billfishes.

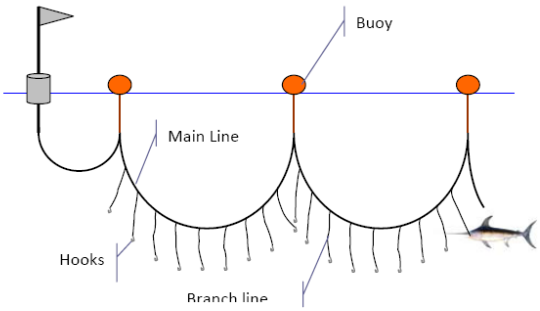



**Figure 1. The Longline Gear**

# 4. Data

## 4.1. Data Collection

The main data sources of the Seychelles industrial longline fleet are logbook, length frequency data, landing and transshipment forms and Vessel Monitoring System (VMS) data.

*Logbooks*

All Seychelles registered vessels are under obligation to submit a logbook to the Seychelles Fishing Authority. The logbook details the vessel's daily catch and effort wherever they operate throughout the validity of their registration period. Logbooks are distributed to all Seychelles flagged longliners to collect information on trip, gear configuration, fishing position, fishing effort, number of fish caught by species, and their estimated weights. The logbook is updated by SFA whenever required, to ensure compliance with IOTC resolutions.

*Length Frequency*

A sampling protocol was set up by SFA in collaboration with Deep-Sea Fisheries of Taiwan in June 2007. The aim of the sampling program is to collect information on the size distribution of the different species (tuna, billfish and sharks) caught by the Seychelles Longline fleet, so as to monitor the stock structure relative to time and strata. The sampling is carried out on Seychelles registered industrial longliners by crew members where they measure the first 20 fish per each set hauls and record on a sampling form which is then submitted to SFA via email.The data recorded are: vessel details, date, position, and the measurement for the first 20 fish by species. The tuna species are measured using Dorsal Fork Length (DFL), the Lower Maxillary Fork length (LMFL) is used for swordfish and the total length of sharks are measured.

*Vessel Monitoring System*

Since 2003, one of the prerequisite for any Seychelles registered vessel to be authorized to target tuna and tuna-like species in the WIO is to have an operational Vessel Monitoring System. VMS reports are being automatically transmitted to the Fisheries Monitoring Centre (FMC) at SFAMC on an hourly basis. VMS information collected are use to validate logbook data.

*Landing and Transshipment*

The distant water industrial longliners rarely land or transship in port Victoria, making monitoring of transshipments/ landing difficult. However SFA do receive information on landing in foreign ports and Seychelles is also participating in the IOTC regional observer scheme to monitor transshipment at sea on carrier vessels.

## 4.2. Data Coverage

In order to provide reliable and prompt estimate of catch and effort data for longliners, the Statistics section monitor the proportion of logbook received from the registered vessels. Since all vessels licensed are under obligation to submit a logbook for the duration of their registration period, for each month covered a logbook is required. The reporting rate is calculated based the number of logbooks submitted to SFA per each month of the period of registration.

Figure 2 shows the level of logbook returned between the year 2000 and 2014 by the Seychelles industrial longline fleet. This figure suggests that there has been a serious issue with under-reporting prior to the year 2003 which seems to have produced an impact on total catch declarations given the high number of vessels in the Seychelles industrial longline fleet during that period. Hence, only data from 2004 to 2014 is analyzed in this report which is based on over 70% reporting rate.

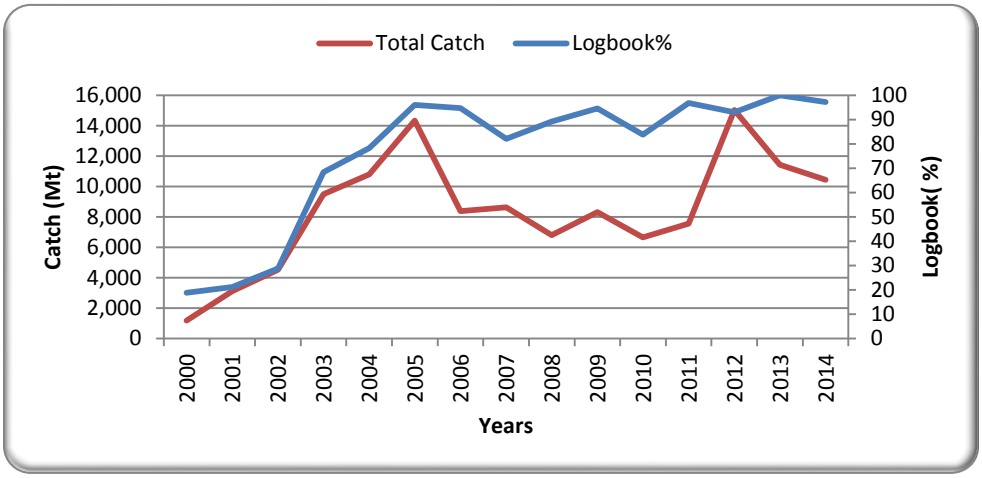



**Figure 2: Proportion of logbook returned to SFA by Seychelles industrial longliners, years 2000 - 2014**

## 5. Fishing Efforts

The reported fishing effort has fluctuated between 15 million hooks and 21 million hooks between 2004 and 2012. In 2013, fishing effort increased to reach a peak of 23 million hooks, the highest effort recorded since the beginning of the fishery (table 2 and figure 3). An increase of 8 vessel registered in 2012 resulted in an increase of 16% in fishing effort. However despite a significant 54% increase in number of sets , the mean number of hooks per set dropped to a record low of 3,026 hooks compared to an average of 3,211 hooks per set for the over years.

**Table 2: Yearly fishing effort ('000 hooks) of the Seychelles industrial longliners, years 2004 - 2014**

| Year | Vessel (number) | Effort ( 1000 hooks) | Sets (Number) | Average Hooks per Set |
|---|---|---|---|---|
| 2004 | 33 | 18,983 | 406 | 3,282 |
| 2005 | 27 | 20,724 | 472 | 3,285 |
| 2006 | 28 | 17,396 | 381 | 3,125 |
| 2007 | 27 | 18,867 | 365 | 3,256 |
| 2008 | 27 | 14,850 | 268 | 3,178 |
| 2009 | 27 | 19,884 | 392 | 3,290 |
| 2010 | 27 | 17,629 | 311 | 3,311 |
| 2011 | 24 | 16,334 | 288 | 3,177 |
| 2012 | 32 | 18,974 | 443 | 3,026 |
| 2013 | 32 | 23,477 | 468 | 3,204 |
| 2014 | 36 | 21,248 | 469 | 3,188 |

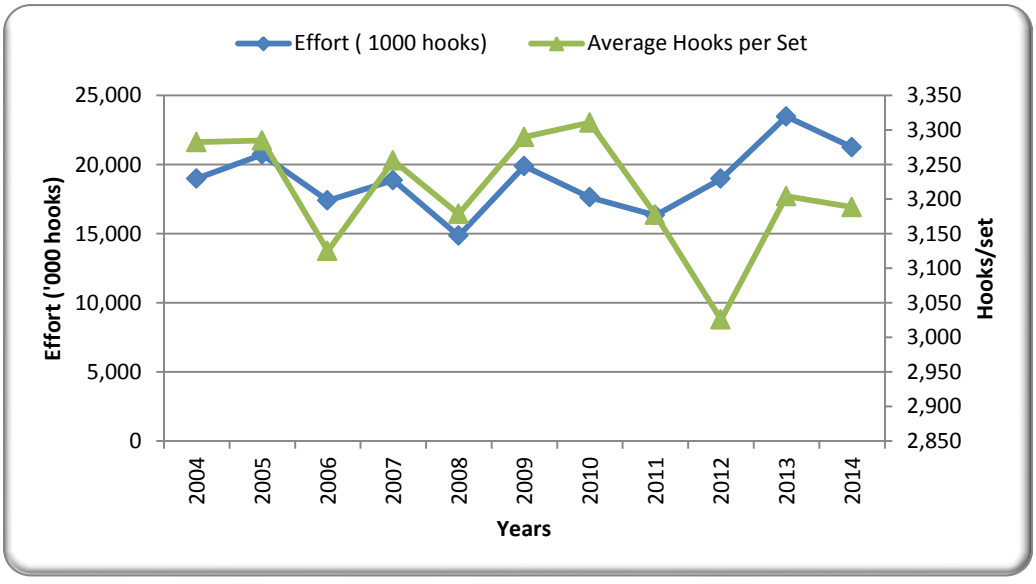



**Figure 3. Fishing effort of the Seychelles industrial longliners, years 2004 – 2014**

# 6. Nominal Catch

Catches of the Seychelles industrial longliners were characterized by a sharp drop of 42% from 14,350 Mt in 2005 to 8,374 Mt in 2006 corresponding to a 16% drop in fishing effort. This was followed by slight fluctuations in catches until the year 2011 (table 3 and figure 4) with lower caches reported during the years of piracy threat in the Indian Ocean (2008-2011). In 2012 the total catch of the fleet increased sharply by 99% reaching a record high of 14,695 Mt which corresponds to the period where the threat of piracy threat in the Indian Ocean had been contained, an increased in both number of vessels registered and fishing effort reported. Over the last two years, catches of the Seychelles industrial longline fleet has remained fairly constant averaging to 10,944 Mt per year.

**Table 3: Yearly catch (Mt) of the Seychelles industrial longliners, years 2004 - 2014**

| Year | BET | YFT | ALB | BIL | SHK | OTH | Total |
|---|---|---|---|---|---|---|---|
| 2004 | 5,624 | 3,322 | 62 | 1,499 | 170 | 122 | 10,799 |
| 2005 | 5,375 | 7,369 | 139 | 1,192 | 190 | 86 | 14,350 |
| 2006 | 3,834 | 2,763 | 92 | 873 | 139 | 674 | 8,374 |
| 2007 | 4,511 | 1,775 | 303 | 825 | 137 | 1,091 | 8,642 |
| 2008 | 4,009 | 580 | 765 | 764 | 57 | 620 | 6,795 |
| 2009 | 4,119 | 468 | 339 | 755 | 257 | 2,390 | 8,329 |
| 2010 | 3,384 | 527 | 669 | 635 | 282 | 1,161 | 6,659 |
| 2011 | 4,082 | 1,184 | 492 | 700 | 283 | 826 | 7,566 |
| 2012 | 10,435 | 1,173 | 36 | 2,144 | 388 | 520 | 14,695 |
| 2013 | 6,193 | 1,177 | 283 | 1,519 | 392 | 1,867 | 11,431 |
| 2014 | 5,125 | 1,601 | 127 | 1,616 | 576 | 1,413 | 10,457 |

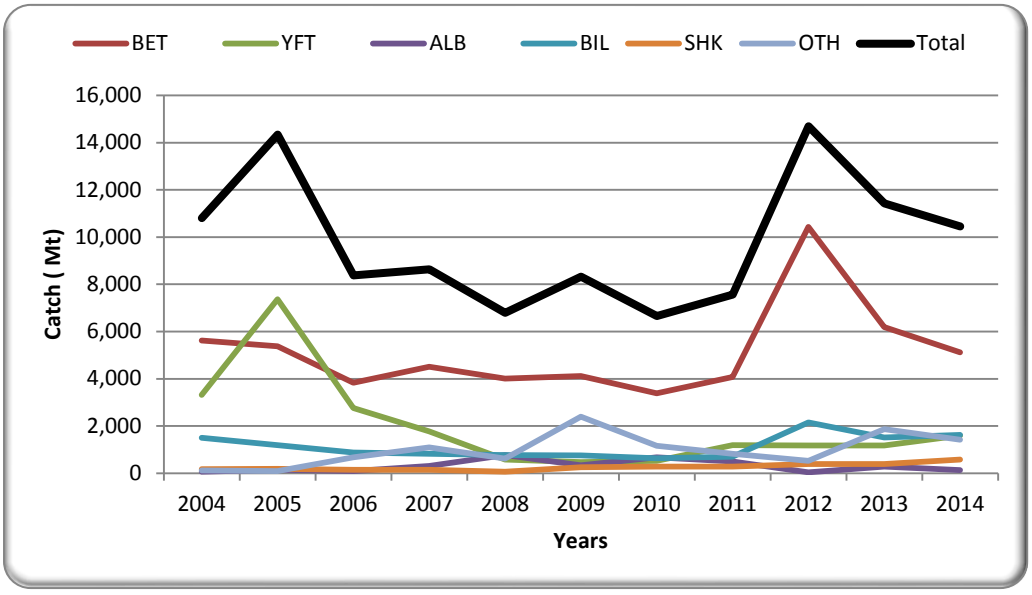



**Figure 4: Yearly catches by species of the Seychelles industrial longliners, years 2004 – 2014**

# 7. Species Composition

The Seychelles fleet pursued Bigeye tuna since 2004 to date accounting on average for around 50% of the total catch per year. However in 2005 yellowfin tuna replaced bigeye tuna as the dominant species caught by the Seychelles industrial longliners accounting for 51% of the total catch. The yellowfin tuna catches drastically decreased from the year 2005 to 2010 similar to the billfish catches. Since 2011 catches of both yellowfin tuna and billfish has been on an increasing trend ( figure 5).

Over the last 3 years billfish has replaced yellowfin as the second dominant species caught by the Seychelles Industrial Longline fleet accounting for on average 14% of the total catch followed by yellowfin tuna (11%) and catches grouped as others (11%). It is also worth noting that the group of species declared on logbooks as 'others' has since 2009 accounted for a fairly significant proportion of the total catch averaging to 15% of the total catch per year over the last 6 years. It has been reported that this group comprise of mostly ***Ruvettus pretiosus***. During the years of piracy threat in the Indian Ocean an increase in albacore catches by the Seychelles industrial longliners was also be observed.

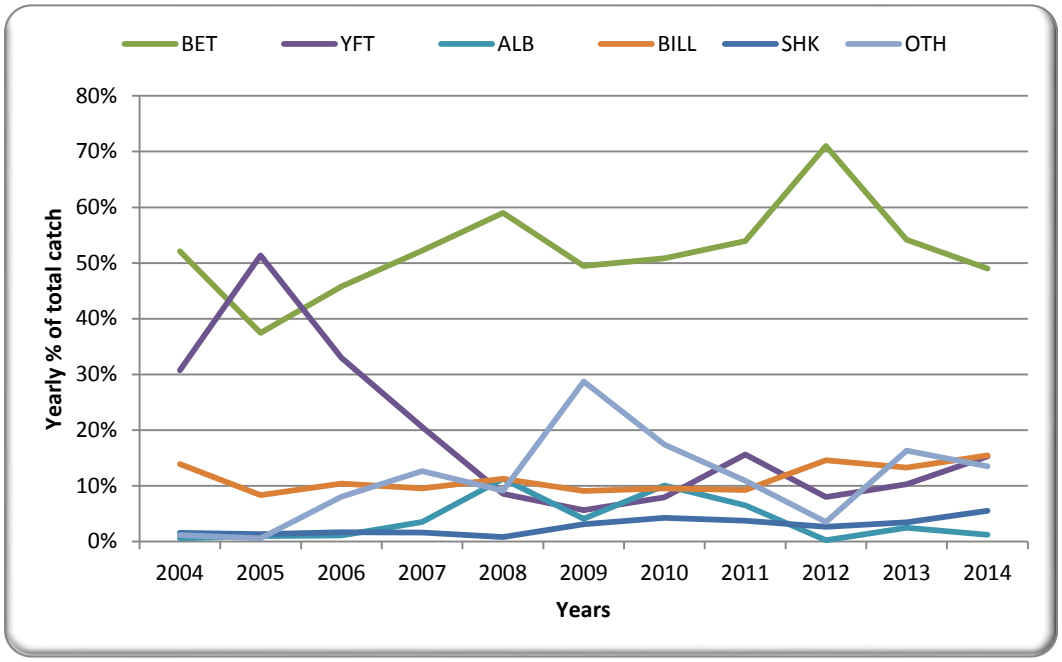



**Figure 5:Yearly percentage of main species caught by SYC industrial longliners, 2004 -2014.**

### 7.1. Billfish Catches

Table 4 shows the billfish catches by species for the years 2004 to 2014. It must be noted that since 2009, the logbook used by the Seychelles industrial longline fleet was amended to include disaggregated billfish species. Hence prior to 2009 most marlin species were grouped as marlins nei.

Figure 6 reveals a progressive drop in the total catch of billfishes (swordfish, marlins and sailfish) from 2004 to 2011 followed by a sharp increased in catches in 2012 where catches of both swordfish and marlins increased from less than 400 Mt to around a 1000 Mt amounting to a record catch of 2,144 Mt of billfishes since the beginning of the fishery.

It is worth noting that in 2012, marlin catches was the highest of billfish catches replacing swordfish as the dominant billfish catch of the Seychelles industrial longliners with a record catch of 1,079 Mt. The main marlin species reported were black marlin, blue marlin and striped marlins. Over the last two years, swordfish catches has remained more or less stable, around 945 Mt per year whilst marlin catches has dropped to an average of 615 Mt per year.

The annual catches of billfishes by species shown in figure 7, indicates that swordfish has been the dominant species of billfishes accounting for on average 71% of the total billfish catches per year since 2004 followed by marlins representing on average 27% of the total billfish catches per year with the exception of the year 2012 where marlin and swordfish accounted for 50% and 49% of the total billfish catches respectively.

**Table 4. Yearly catches (Mt) of Billfish by the SYC industrial longliners, 2004 - 2014.**

| Year | Swordfish | Shortbill spearfish | Indo-Pacific sailfish | Striped marlin | Black marlin | Blue marlin | Marlins nei | *Marlins Total* | Grand Total |
|---|---|---|---|---|---|---|---|---|---|
| **2004** | 1,234 | | 6 | | 10 | | 250 | *260* | **1,499** |
| **2005** | 982 | | 2 | 1 | | | 208 | *209* | **1,192** |
| **2006** | 722 | | 0 | | | | 150 | *150* | **873** |
| **2007** | 690 | | 0 | | | | 134 | *134* | **825** |
| **2008** | 559 | | | | | | 205 | *205* | **764** |
| **2009** | 581 | 1 | 13 | 11 | 43 | 4 | 102 | *160* | **755** |
| **2010** | 409 | 1 | 11 | 70 | 130 | 15 | | *214* | **635** |
| **2011** | 396 | 1 | 18 | 66 | 178 | 41 | | *285* | **700** |
| **2012** | 1,057 | 1 | 7 | 468 | 556 | 55 | | *1,079* | **2,144** |
| **2013** | 945 | 0 | 10 | 178 | 357 | 29 | | *564* | **1,519** |
| **2014** | 947 | | 4 | 84 | 552 | 28 | | *665* | **1,616** |

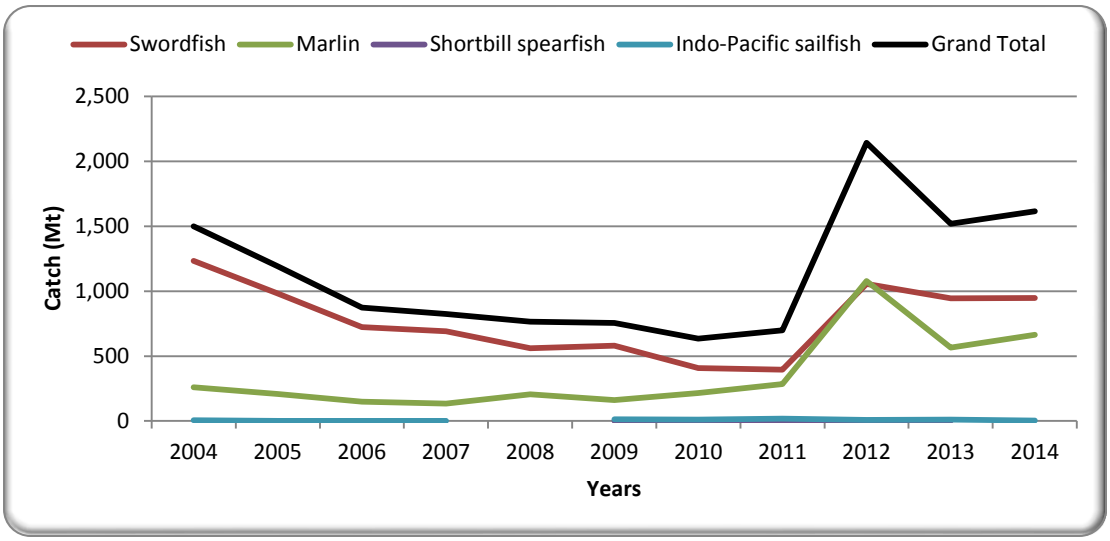



Figure 6: Billfish catches (Mt) of the SYC industrial longliners, 2004 - 2014

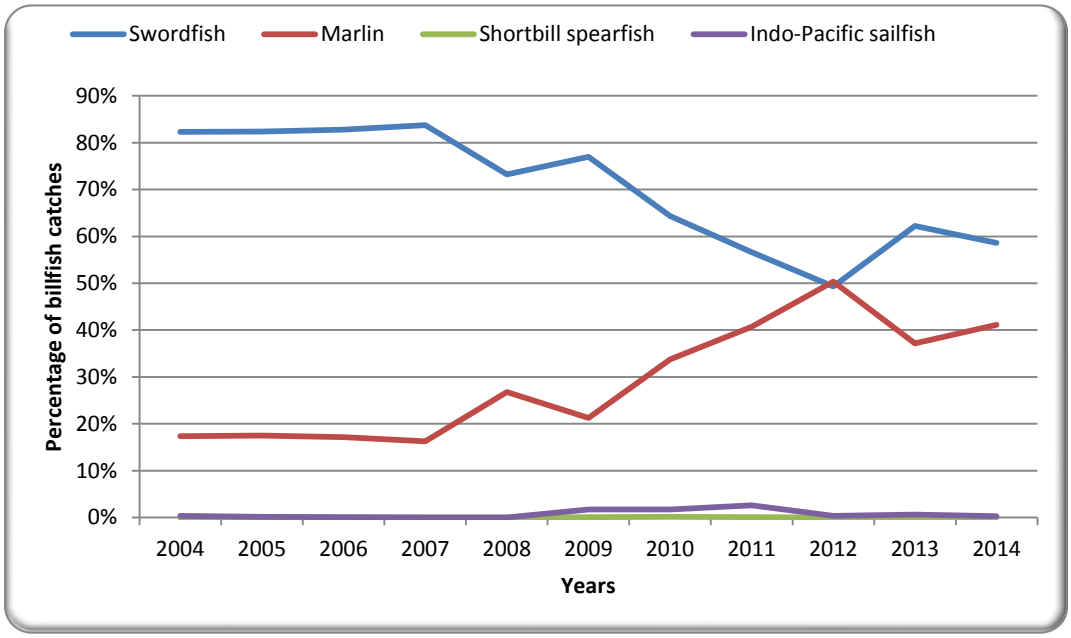



Figure 7: Percentage of main species of billfish catches by SYC industrial longliners, 2004 – 2014

## 7.2. Length Frequency data

A total of about 30,000 length-frequency samples have been collected onboard the SYC industrial longliners during 2007-2014 (Table 6). Data entry and checking of all samples collected for the year 2010 is ongoing and should be completed by the end of 2015. The number of fishes collected by haul is consistent with the sampling protocol as about 60% of the samples are composed of 20 fishes and more than 75% of the samples include 14 fishes or more.

**Table 6. Total number of length-frequency samples (n) collected onboard SYC industrial longliners during 2007-2014**

| Year | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|
| n | 2863 | 4533 | 3142 | 647 | 3478 | 5185 | 5723 | 3789 |

The total number of fishes measured during 2007-2014 and currently recorded in the SFA database is about 480,000 fishes, among which swordfishes and marlins nei represent about 30,000 and 13,500 measurements, respectively (Table 7).

**Table 7. Total number of billfishes measured onboard SYC industrial longliners during 2007-2014**

| **Species** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** |
|---|---|---|---|---|---|---|---|---|
| Marlins nei | 604 | 1477 | 704 | 173 | 862 | 3253 | 3680 | 2749 |
| Swordfish | 2602 | 5067 | 3052 | 590 | 1329 | 4687 | 6570 | 5460 |
| **TOTAL** | **3206** | **6544** | **3756** | **763** | **2191** | **7940** | **10250** | **8209** |

The annual size distributions of swordfish and marlins appear rather consistent over 2007-2014, with 50% of the swordfish and marlins comprised in the *LMFL* intervals of 136-165 cm and 155-184 cm, respectively (Figure 8). Notwithstanding the year 2010 for which samples are not yet fully available, length frequency data suggest an increase in the size of swordfish caught by SYC longliners between 2007-2009 and 2011-2014, accompanied by a concurrent contraction of the size range. The mean *LMFL* of swordfish caught increased from 148 cm (SD = 29 cm) during 2007-2009 to 151 cm (SD = 21 cm) during 2011-2014. Such a change could be due to the changes in fishing grounds that occurred in relation with the piracy threat off the Somalian coasts (see below) and should be further explored.

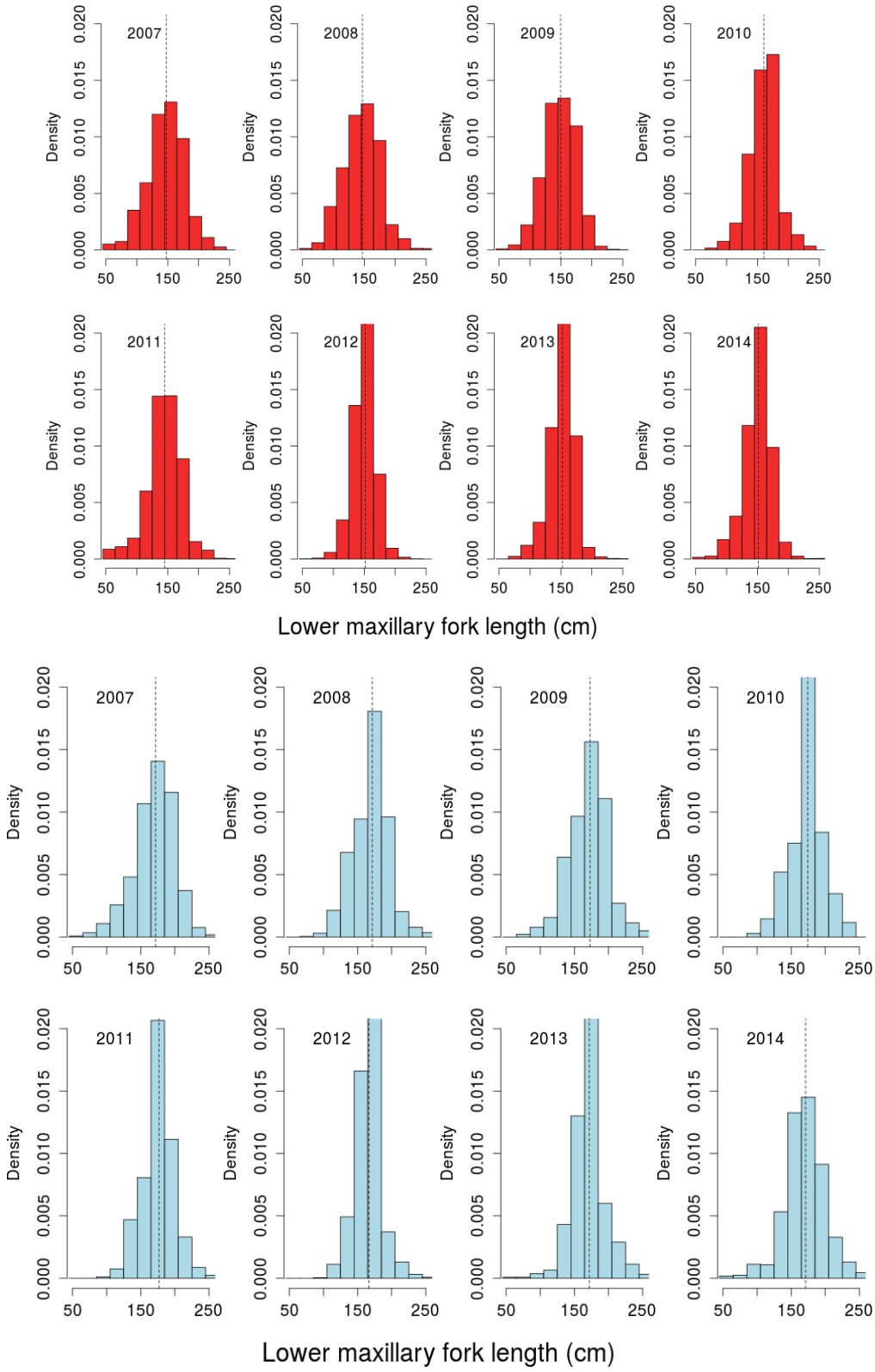



**Figure 8. Annual length-frequency histograms of (Top panel) Swordfish (*Xiphias gladius*) and (bottom panel) Marlins nei (Makaira spp.) caught by the SYC industrial longliners during 2007-2014**

## 8. Catch Rate

The overall catch rates for the Seychelles industrial longliners stood at 0.69 Mt/1000 hooks in 2005 followed by a gradual decline to a mere 0.38 Mt/1000 hooks in 2010 (figure 8). The total catch rate then increased sharply to a record of 0.77 Mt/1000 hooks in 2012 and has level off to 0.49 Mt/1000 hooks over the last two years.

The catch rate for billfish followed similar patterns to the total catch rate with a decreasing trend from 0.08Mt/1000 hooks in 2004 to a mere 0.04 Mt/1000 hooks in 2009-2011. In 2012 the billfish catch rate increased sharply to 0.11 Mt/1000 hooks and has stabilized to around 0.07 Mt/1000 hooks over the last two years.

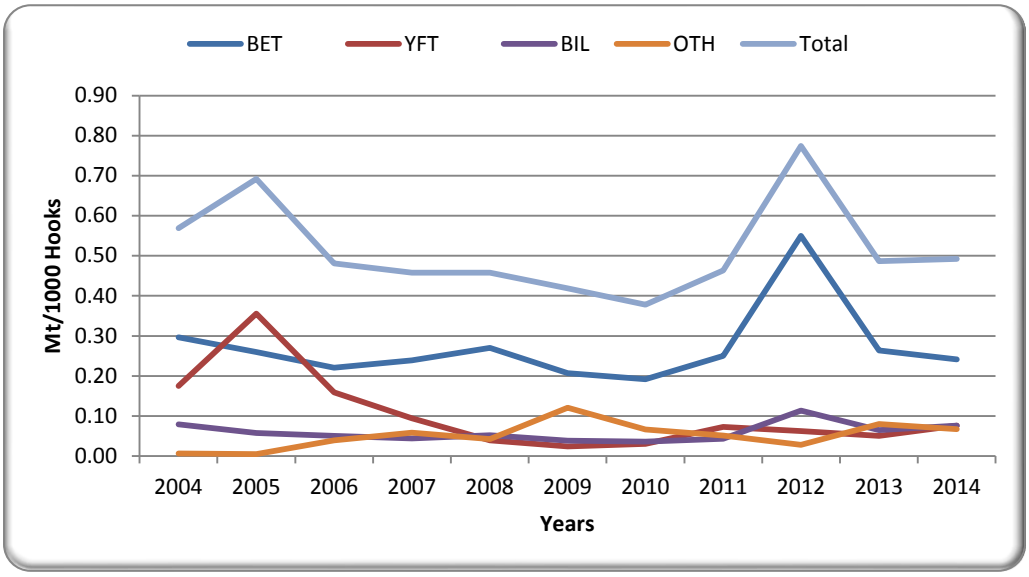



Figure 8: Catch rate (Mt/1000 hooks) of the SYC industrial longliners, 2004-2014.

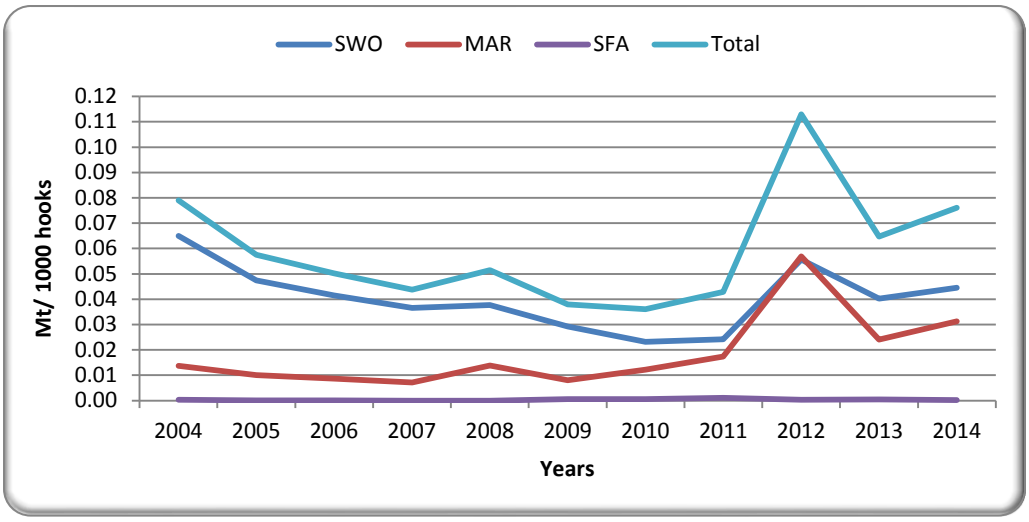



**Figure 9: Catch rate (Mt/1000 hooks) of billfish catches of the SYC industrial longliners, 2004 - 2014.**

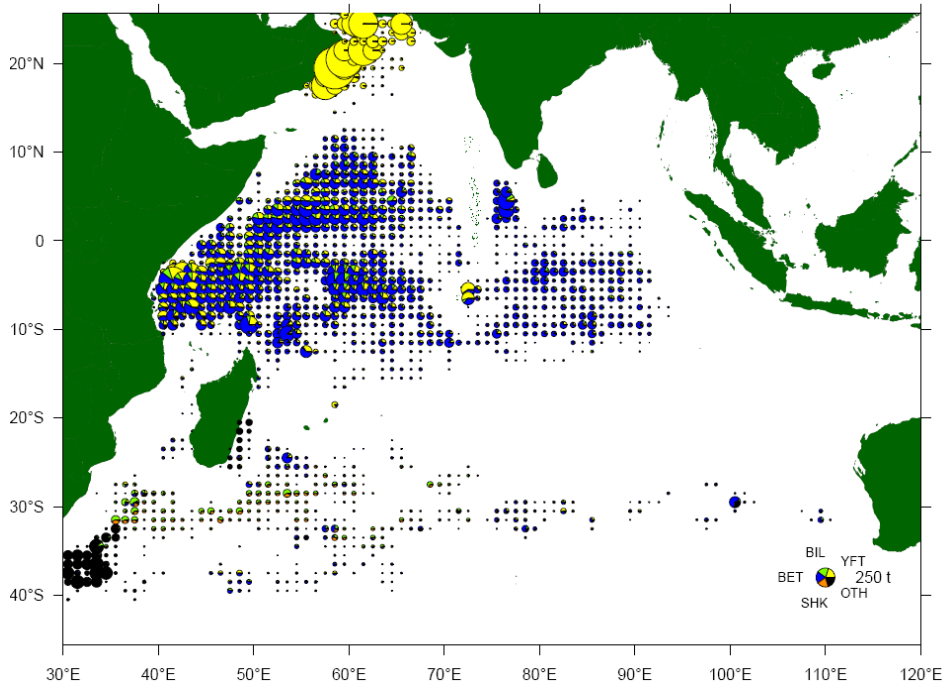
# 9. Fishing Ground

Maps 1a and 1b shows the total catch distribution and billfish and bycatches distribution respectively of the Seychelles industrial longliners for the period 2004 -2007. Maps 2a and 2b shows the same catches distribution for the period of piracy threat in the Indian Ocean ( years 2008 - 2011) and maps 3a and 3b shows the same catches distribution for the post piracy threat period ( years 2012 -2014).

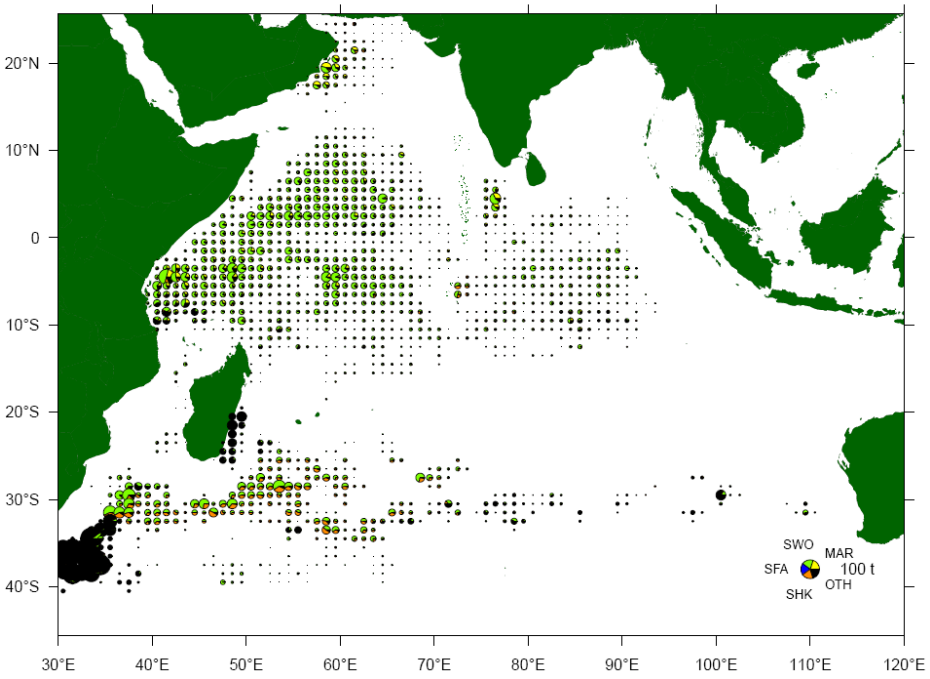
Maps 1a shows three distinct fishing area where bigeye tuna were mainly targeted in the Indian Ocean Monsoon Gyre (map4), yellowfin tuna were targeted in the Arabian Sea, both with bycatches of billfishes (map 1b). The fleet also reported significant catches of billfish and 'Other' species between 30°S and 40°S.

Map 2a shows that during the period of piracy threat in the Indian Ocean the fleet activities sharply decreased in the north western Indian Ocean (off the coast of Africa) and almost no fishing took place in the Arabian Sea where yellowfin tuna were previously being targeted. Billfishes were mostly caught in the Indian Ocean Monsoon gyre. An increase in bycatches between 30°S and 40°S (map 2b) and an increase in activity between 80° E to 90°E by the fleet could also be observed.

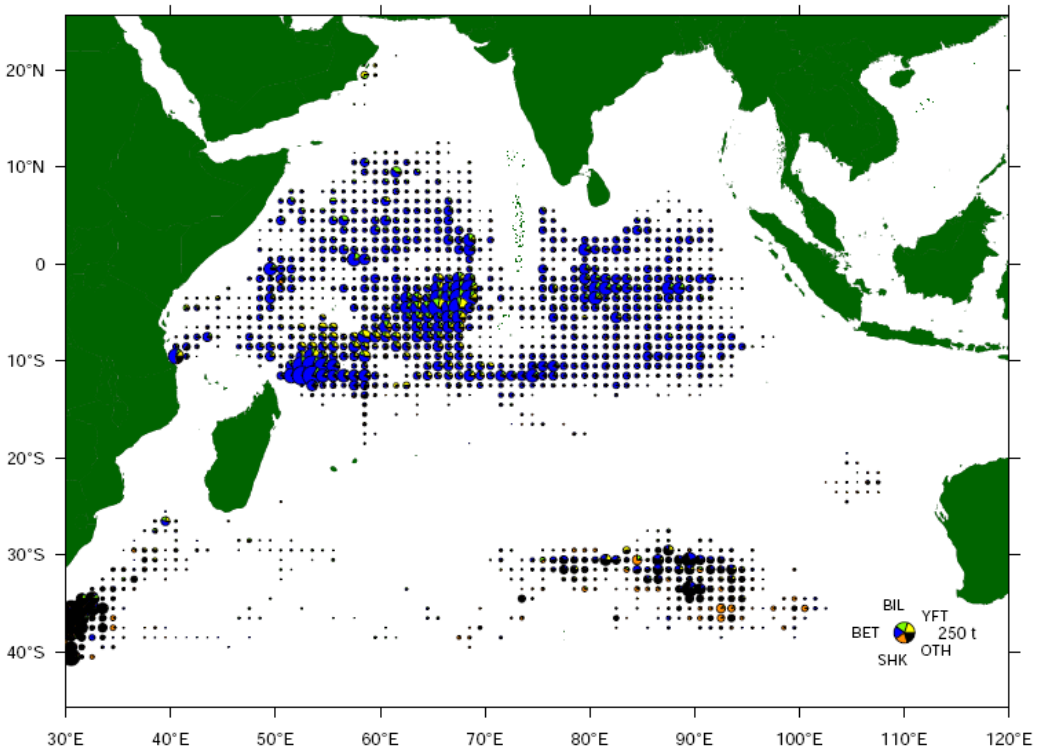
Map 3a shows that with the significant decrease in piracy activities in the Indian Ocean since 2012, the fleet resumed their pre-2008 fishing ground with increased targeting of bigeye tuna in the Indian Ocean Monsoon gyre but still keeping off the coast of Africa. Increases in billfish catches corresponding to increasing catches of bigeye can be observed in map 3b and significant catches of 'Other' species between 30°S and 40°S can also be observed.



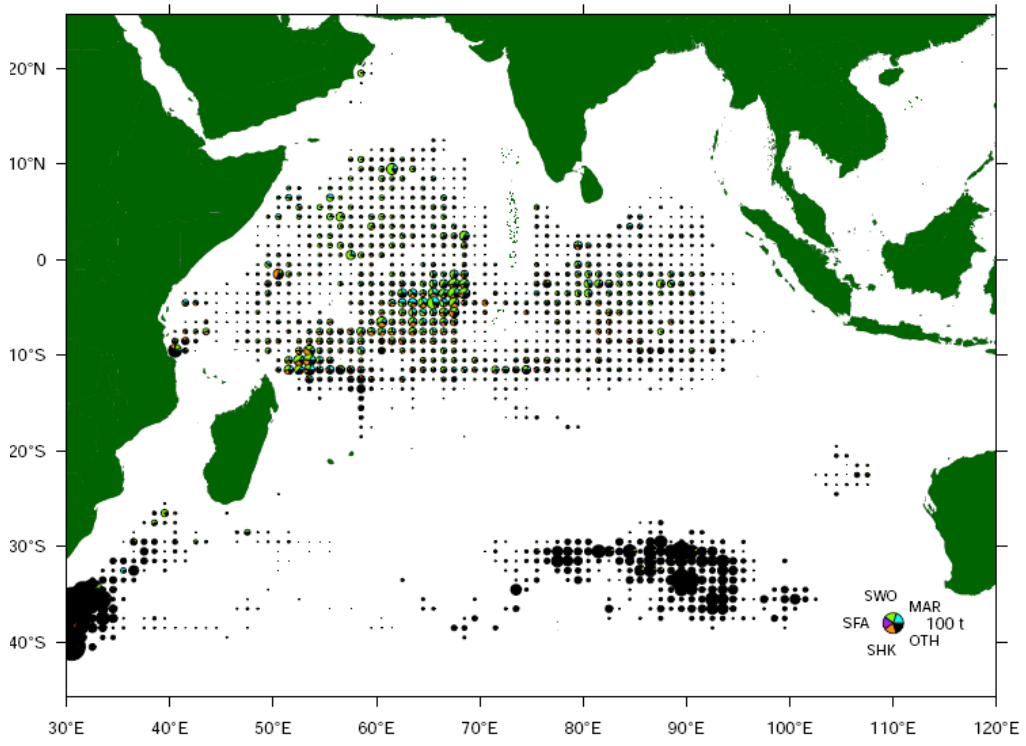

Map 1a. Fishing ground of SYC industrial longliners, years 2004 - 2007.



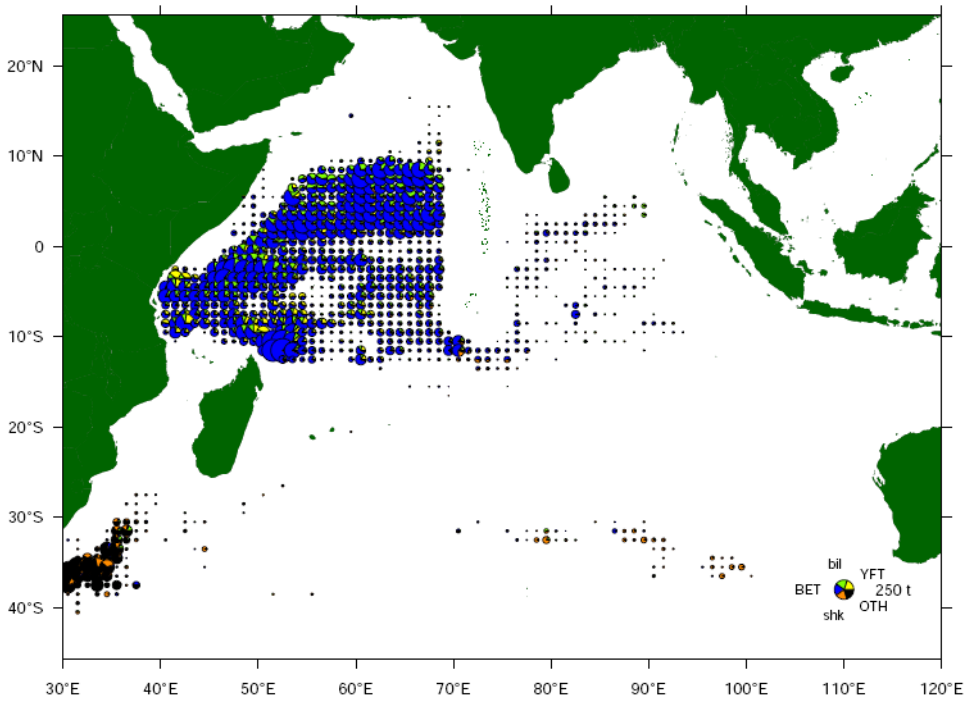

Map 1b. Fishing area of billfish catches of SYC industrial longliners, years 2004 - 2007.



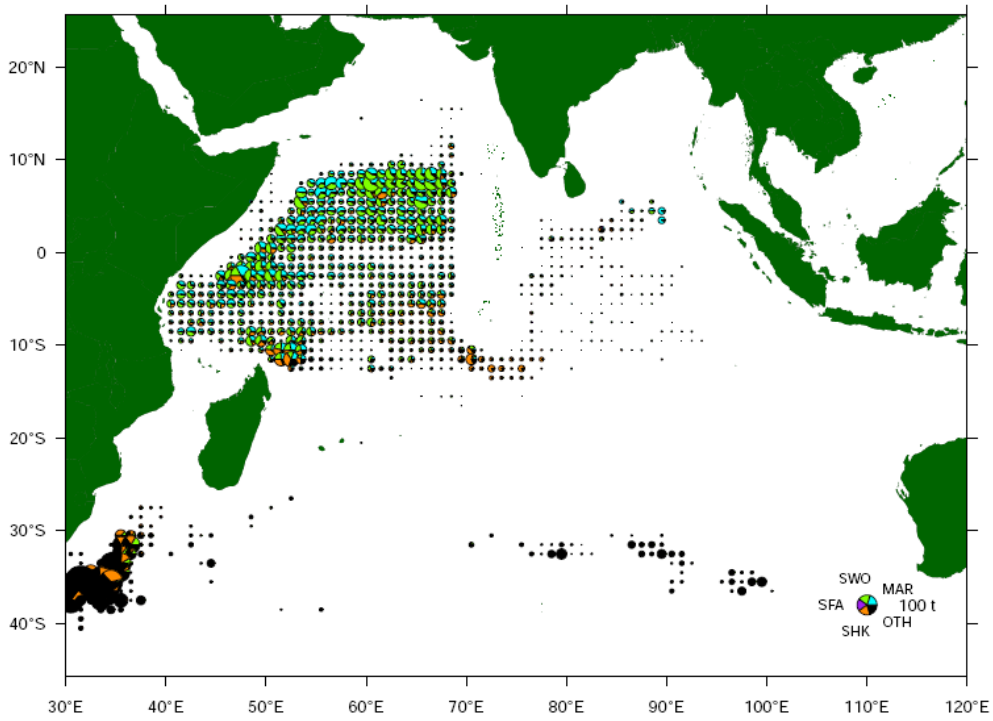

Map 2a. Fishing ground of the SYC industrial longliners, years 2008 - 2011



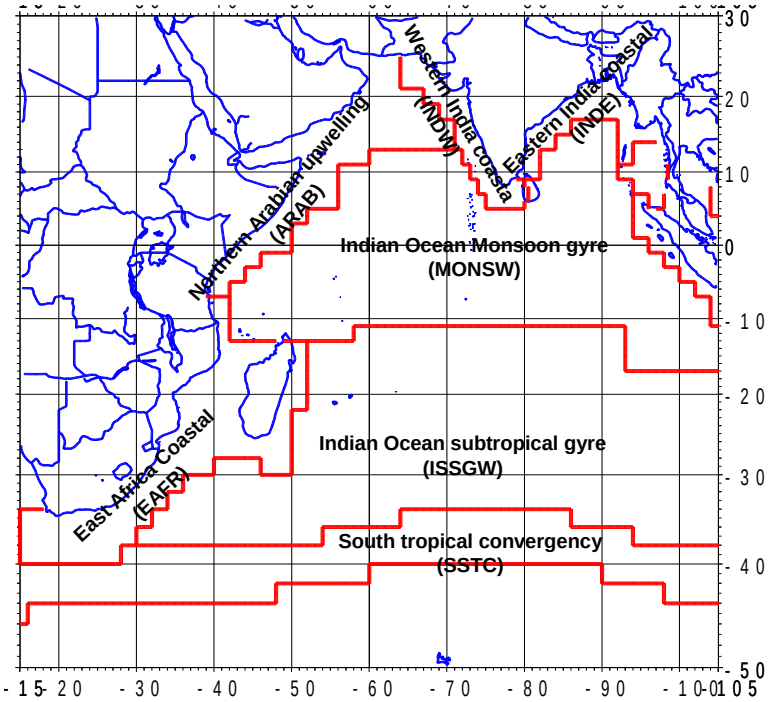

Map 2b. Fishing area of billfish catches of SYC industrial longliners, years 2008 - 2011.




Map 3a: Fishing ground of the SYC industrial longliners, years 2012 - 2014




Map 3b. Fishing area of billfish catches of SYC industrial longliners, years 2012 - 2014.




Longhurst areas

**Map 4. Map showing the zones of Indian Ocean for longline fishery.**

# 10.References


OKAMOTO, H. (2011). Preliminary analysis of the effect of the Piracy activity in the northwestern Indian Ocean on the CPUE trend of bigeye and yellowfin. *IOTC -2011-WPTT13-44.* IOTC.

SC CHAIR and IOTC SECRETARIAT. (2012). Examination of the Effect of Piracy on fleet operations and subsequent catch and effort trends. *IOTC-2012-SC15-07[E].*