
SIZE DISTRIBUTION OF INDIAN OCEAN YELLOWFIN TUNA (*THUNNUS ALBACARES*) IN CHINA LONGLINE FISHERY

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ABSTRACT

Yellowfin tuna (*Thunnus albacares*) is one of the important tuna species targeted by tuna purse seines and longlines in the Indian Ocean. Size distribution of yellowfin tuna was analyzed based on four trips collected by China's national tuna fisheries observers in the India Ocean between October 2010 and March 2014 (no observer in 2011). In 2010-2014, the fork length distributed from 54 to 180 cm and there were two predominant groups of yellowfin tuna, with the first FL class at 85-105 cm and the second at 125-160 cm. The length distribution from 2010 to 2014 was mostly at 75-170 cm in the first and fourth quarters, and also mainly distributed in the area of 40°-70°E, 13°S-3°N, which suggested that the area is the spawning ground.

INTRODUCTION

The yellowfin tuna, *Thunnus albacares*, is a large pelagic and highly migratory tuna species (Dai *et al.*, 2007). It broadly distributes in temperate and tropical waters of the Indian, Pacific and Atlantic oceans (Collette *et al.*, 1983). In Indian Ocean, it mainly distributes in east coast of India, Madagascar islands, Arabian Sea, coast of India Peninsula and the waters between India and Australia Islands (Meng *et al.*, 2007). Although many studies for yellowfin tuna size frequency have been reported (Tantivala, 2000; Olivier, 2002; Somvanshi, 2002; Xu *et al.*, 2006), no study showed that size frequency of yellowfin tuna varied with the time and areas captured by Chinese tuna fishery in the Indian Ocean. To collect biological characteristics and size composition for tuna fisheries, scientific observers were sent out work onboard Chinese longline fishing vessels in the Indian Ocean in recent years. This report analyzed the fork length (FL) frequency of yellowfin tuna with data collected from these observer trips in 2010-2014 (No observer was sent in 2011).

SOURCE OF DATA

The length data were measured by scientific observer onboard Chinese longline fishing vessels operating in the Indian Ocean from July 2010 to September 2014 (no observer for 2011). There were four trips during the five years. The first trip was from July 2010 to August 2010, and it was four observed sets with eight measured fishes. The second trip was from October 2012 to January 2013. The third trip was from October 2013 to February 2014. The last trip was from August 2014 to September 2014. The original operation set location was processed into 1°×1° spatial grid. Numbers of fish measured for each trip were shown in Table 1 and observed areas

were shown in Fig.1. The size data in 2010 was measured in total length but partial missed, and the processed body weight was all recorded, so it can be used to convert into fork length (FL) (John & Sudarsan, 1993).

RESULT

Distribution of folk lengths by year

Table 2 and 3 showed that a total of 1248 individuals of yellowfin were measured by scientific observers from 2010 to 2014, and the fork length ranged between 54-180 cm and the average was 124.7 cm, with the unimodal peaked at 130-135 cm FL, accounting for 10.9% of the total number. A total of 8, 567, 508 and 165 individuals of yellowfin tuna were collected by observers in 2010, 2012, 2013 and 2014, respectively. The average fork length of yellowfin tuna was the smallest in 2010 (109.0 cm) and the largest in 2013 (135.2 cm) (Table 2).

In 2010, range of fork length distribution was from 87 to 154 cm and the average was 109.0 cm, with the dominant FL class at 110-115 cm, accounting for 37.5% of the total number. In 2012, the size ranged from 65 to 170 cm and the average was 114.9cm, with the dominant FL class at 90-95cm, accounting for 13.4% of the total number. The common size groups were 85-100 cm FL and 125-145 cm FL, with occupying a percentage of 37.0% and 30.2%, respectively. The size composition of yellowfin tuna in 2013 varied from 80 to 180 cm FL, with the dominant FL class at 135-140 cm (14.37%), and the common size group was 125-165 cm FL, with occupying a percentage of 72.44%. In 2014, the fork length ranged from 54 to 177 cm and the average was 126.7cm, with the dominant FL classes at 90-110 cm and 135-160 cm, accounting for 29.7%, 40.6% of the total number, respectively. In general, the FL class at 85-105cm (27.2%) and 125-160 cm (51%) were predominant (Table 3, Figure 3).

Distribution of folk lengths by quarter

From 2010 to 2014, the survey quarters included 1st quarter (January-February), 3rd quarter (July-September) and 4th quarter (October-December) (Table 1). The fork length distribution was mainly at 125-160 cm (51.15%) in the first quarter. While in the third quarter, only 21 individuals were recorded, the mostly FL class was at 110-155 cm (68.97%). In the fourth quarter, there were two main fork length classes at 85-100cm (25.72%) and 125-145 cm (37.91%). Comparing the distribution of folk lengths by quarter, Figure 4 showed that the difference in fish size between 1st and 4th quarters was relatively small. Although a lack of length data in third quarter, the length distribution was uniform, including small and larger fish.

Figure 5 showed that there was little difference in size composition in the first quarter among in 2013 and 2014. However, in the third quarter, more individuals were measured in 2014 than 2010, and most fish were larger than 120 cm in 2014, while in 2010 nearly all fish (87.5%) were in the 85-115 cm. For the 4th quarter, the difference of size composition among years was small, but there was a dominant FL class at 85-100 in 2012.

Length frequency analysis of yellowfin tuna by area

The observed locations were divided into five areas. The first area(A) was in 40°-70°E, 13°S-3°N, the second(B) in 30°-35°E, 30°-40°S, the third(C) in 50°-75°E, 25°-35°S, the fourth(D) in 70°-75°E, 18°-22°S, having five single sets. Only three single sets were observed in Area E

(80°-90°E, 7°S-1°N). Recently size data were mainly collected in Area E, C and D (2014). The size data in 2012-2013 was in Area A, whereas the size data in 2010 was located in Area B (Table 1, Figure 2).

A total of 1219, 8, 12, 6 and 3 individuals of yellowfin tuna were collected by observers in the Area A, Area B, Area C, Area D and Area E, respectively. Area A was the main work area, with the range of size from 54-180 FL cm. There were two dominant FL classes at 85-105 cm (27.6%), 125-160cm (51.2%). In the Areas B, most fish were much smaller than 115 cm; the average fork length was 103cm. In the area C-E, most fish were larger than 115cm; the average fork length was 140.6 cm (Figure 6 and Table 5).

In the Area A, the difference between fish size among quarters (1st /4th quarter) was relatively small. The dominant FL classes of small fish were at 85-110 cm in the first quarter and 85-100 cm in fourth quarter, accounting for 31.6 % and 25.7% of the total number, respectively. The dominant FL classes of larger fish were at 125-160 cm in the first quarter and 125-150 cm in fourth quarter, accounting for 51.1% and 43.2% of the total number, respectively (Figure 7, Table 5). In the Area B-E, the fish was captured all in 3rd quarter, so the fish size difference concentrated in the fork length distribution between Area B and Area C-D (Figure 7).

CONCLUSION

Fork length observation of yellowfin tuna was taken by longline onboard observers in the eastern India Ocean. Somvanshi, 2002 summarized the information on length frequencies of yellowfin tuna obtained from Indian EEZ, and found that the range of size was from 44 to 181 FL in cm (John&Reddy, 1989; John&Sudarsan, 1993; John, 1995; Govinraj *et al*,2000). In our research, the fork length ranged from 54-180cm, so the size of yellowfin tuna in the east India Ocean kept consistent with Indian EEZ. During 2010-2014, there were two predominant groups for the fork length distribution of yellowfin tuna, with the first FL class at 85-105 cm and the second at 125-160cm. There was little difference in size composition in the first quarter or fourth quarter among the years, however, in the third quarter, although the number of length data was limited, most fish were larger than 120 cm in 2014, and in 2010 nearly all fish fork lengths were in the 85-115 cm (87.5%). The area of 50°-70°E, 10°S-0°S is the spawning ground, and November-February are fishing season (Shang, 2005; Zhou *et al*, 2009). In our paper, most of fish (1219 individuals) were captured in first and fourth quarters in Indian Ocean area A with the FL class mainly at 75-170cm (99.2%), and only 29 individuals were measured in Area B-E. The area A is 40°-70°E, 13°S-3°N, which also suggested that that area is a spawning ground.

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Table1 Sampling information of yellowfin tuna for each observer trip

| Trip | Year | Number of Fish measured | Area of observer | | Quarter | Time | Observed sets |
|------|------|-------------------------|------------------|------------------|---------|-------------|---------------|
| 1 | 2010 | 8 | 33°54'S-36°32'S | 30°30'E -32°48'E | 3 | 7.25-8.28 | 4 |
| 2 | 2012 | 567 | 09°12'S-2°05'N | 62°35'E-40°28'E | 4 | 10.30-12.31 | 46 |
| | 2013 | 204 | 12°29'S-06°57'S | 62°17'E -41°31'E | 1 | 1.1-1.22 | 14 |
| 3 | 2013 | 304 | 06°05'S-11°05'S | 47°52'E -66°20'E | 4 | 10.7-12.31 | 70 |
| | 2014 | 144 | 07°56'S-01°58'S | 59°15'E -47°50'E | 1 | 1.4-2.21 | 35 |
| 4 | 2014 | 21 | 32°03'S-00°11'N | 50°45'E -89°54'E | 3 | 8.3-9.17 | 13 |

Table2 Size compositions of yellowfin tuna in each observed year

| Year | 2010-2014 | 2010 | 2012 | 2013 | 2014 |
|------------|-----------|-------|-------|-------|-------|
| Number | 1248 | 8 | 567 | 508 | 165 |
| AVE.FL(cm) | 124.7 | 109.0 | 114.9 | 135.2 | 126.7 |
| Min.FL(cm) | 54 | 87 | 65 | 80 | 54 |
| Max.FL(cm) | 180 | 154 | 170 | 180 | 177 |

Table3 Fork length frequency of yellowfin tuna in the Indian Ocean

| Size class | 2010-2014 | 2010 | 2012 | 2013 | 2014 |
|-------------|-----------|------|------|------|------|
| FL<=55 | 1 | 0 | 0 | 0 | 1 |
| 55<FL<=60 | 0 | 0 | 0 | 0 | 0 |
| 60<FL<=65 | 1 | 0 | 1 | 0 | 0 |
| 65<FL<=70 | 2 | 0 | 0 | 0 | 2 |
| 70<FL<=75 | 2 | 0 | 1 | 0 | 1 |
| 75<FL<=80 | 14 | 0 | 12 | 2 | 0 |
| 80<FL<=85 | 37 | 0 | 27 | 8 | 2 |
| 85<FL<=90 | 86 | 2 | 69 | 8 | 7 |
| 90<FL<=95 | 105 | 1 | 76 | 15 | 13 |
| 95<FL<=100 | 88 | 0 | 65 | 12 | 11 |
| 100<FL<=105 | 61 | 1 | 17 | 29 | 14 |
| 105<FL<=110 | 36 | 0 | 15 | 10 | 11 |
| 110<FL<=115 | 28 | 3 | 14 | 4 | 7 |
| 115<FL<=120 | 36 | 0 | 21 | 12 | 3 |
| 120<FL<=125 | 46 | 0 | 23 | 19 | 4 |
| 125<FL<=130 | 91 | 0 | 44 | 45 | 2 |
| 130<FL<=135 | 136 | 0 | 62 | 68 | 6 |
| 135<FL<=140 | 119 | 0 | 36 | 73 | 10 |
| 140<FL<=145 | 91 | 0 | 29 | 42 | 20 |
| 145<FL<=150 | 76 | 0 | 24 | 39 | 13 |
| 150<FL<=155 | 64 | 1 | 10 | 41 | 12 |
| 155<FL<=160 | 60 | 0 | 14 | 34 | 12 |
| 160<FL<=165 | 39 | 0 | 6 | 26 | 7 |

| | | | | | |
|-------------|----|---|---|----|---|
| 165<FL<=170 | 23 | 0 | 1 | 17 | 5 |
| 170<FL<=175 | 4 | 0 | 0 | 3 | 1 |
| 175<FL<=180 | 2 | 0 | 0 | 1 | 1 |

Table4 Size compositions of yellowfin tuna by year and quarter

| Quarter | 2010 | 2012 | 2013 | | 2014 | |
|------------|------|-------|-------|-------|-------|-------|
| | 3rd | 4th | 1st | 4th | 1st | 3rd |
| Number | 8 | 567 | 204 | 304 | 144 | 21 |
| AVE.FL(cm) | 109 | 114.9 | 128.6 | 139.7 | 126.1 | 130.8 |
| Min.FL(cm) | 90 | 65 | 80 | 80 | 54 | 67 |
| Max.FL(cm) | 154 | 170 | 172 | 180 | 177 | 162 |

Table5 Size compositions of yellowfin tuna by area and quarter

| Quarter | Area A | | Area B | Area C | Area D | Area E |
|------------|--------|-------|--------|--------|--------|--------|
| | 1st | 4th | 3rd | 3rd | 3rd | 3rd |
| Number | 348 | 871 | 8 | 12 | 6 | 3 |
| AVE.FL(cm) | 127.6 | 123.6 | 109 | 143.1 | 113.2 | 117 |
| Min.FL(cm) | 54 | 65 | 87 | 114 | 67 | 107 |
| Max.FL(cm) | 177 | 180 | 154 | 162 | 153 | 123 |

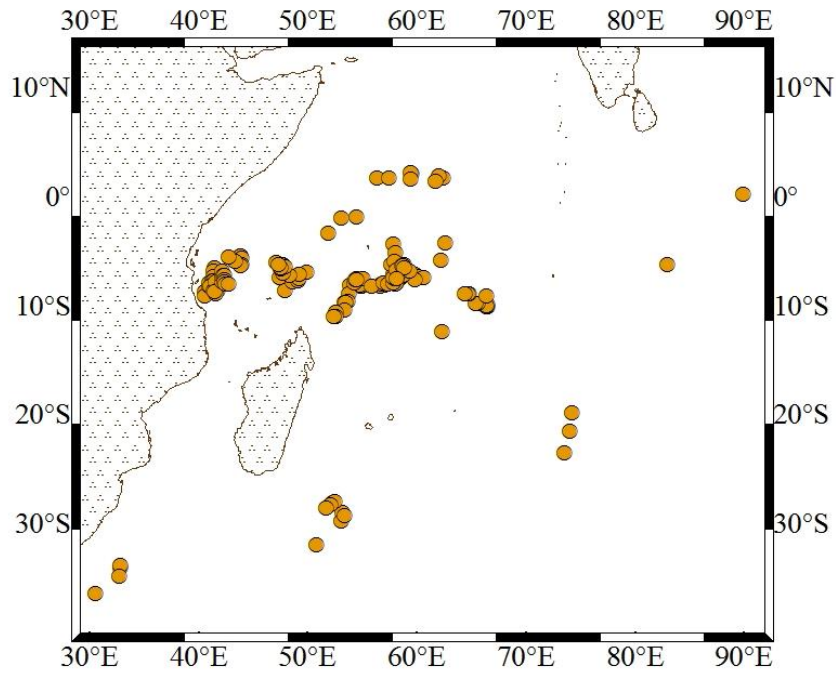


Figure1 1°×1° Area of observers trips (2010-2014)

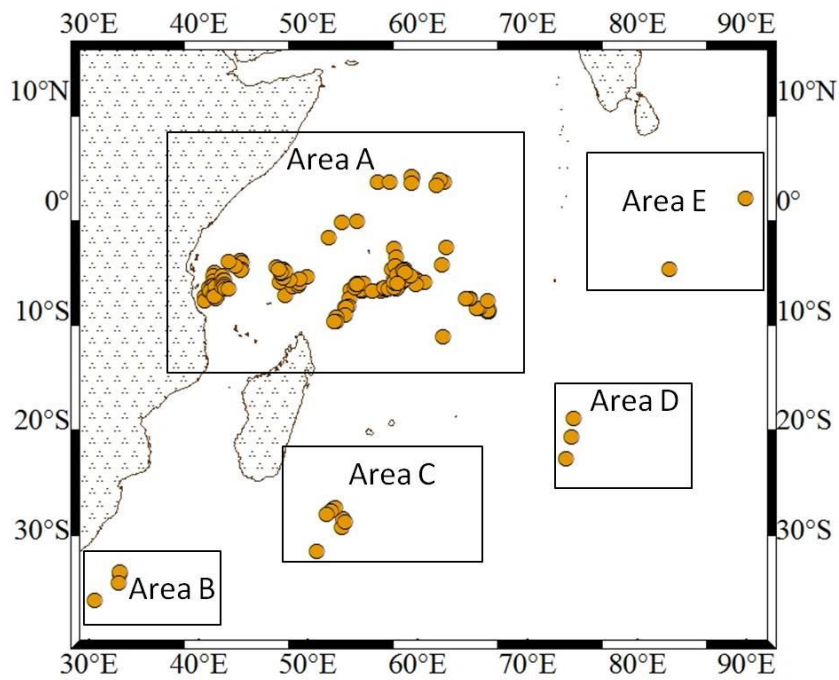


Figure2 Observed locations divide into five areas

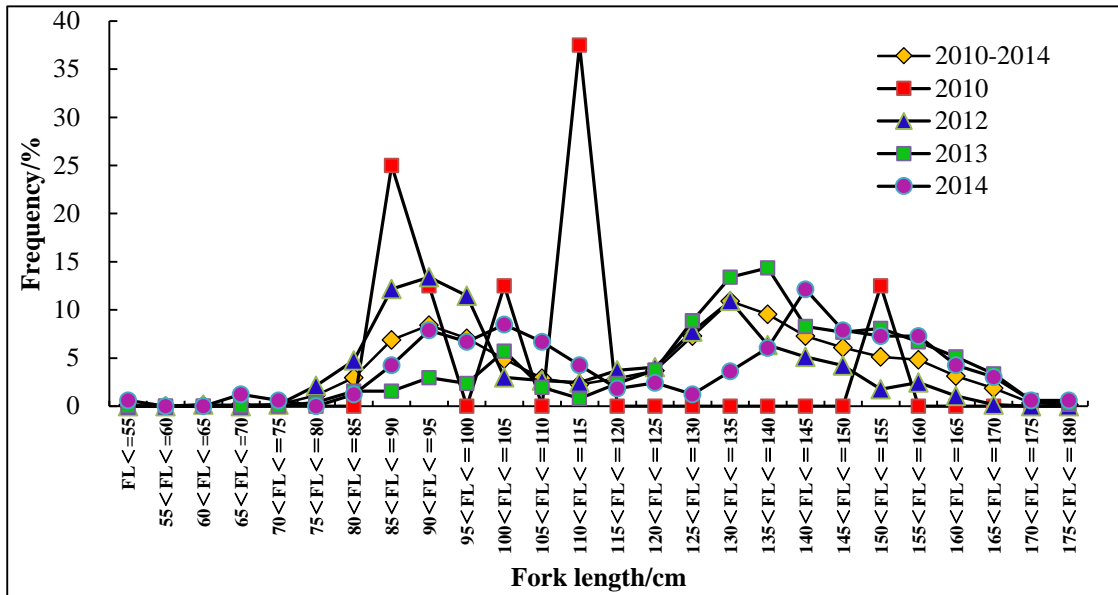


Figure3 Fork length composition of yellowfin tuna in the Indian Ocean

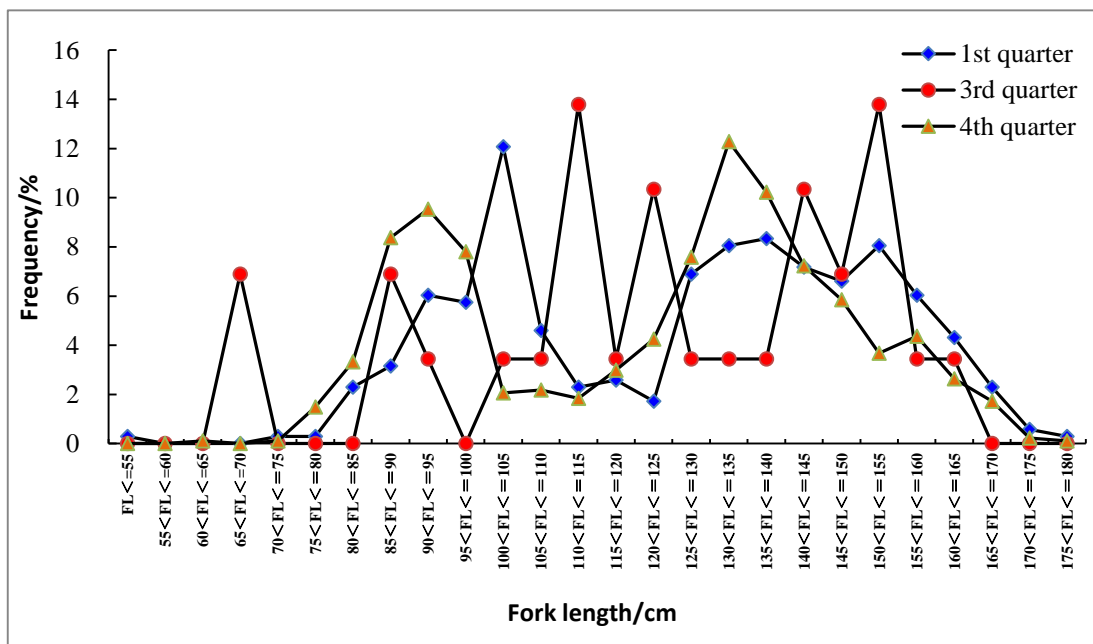
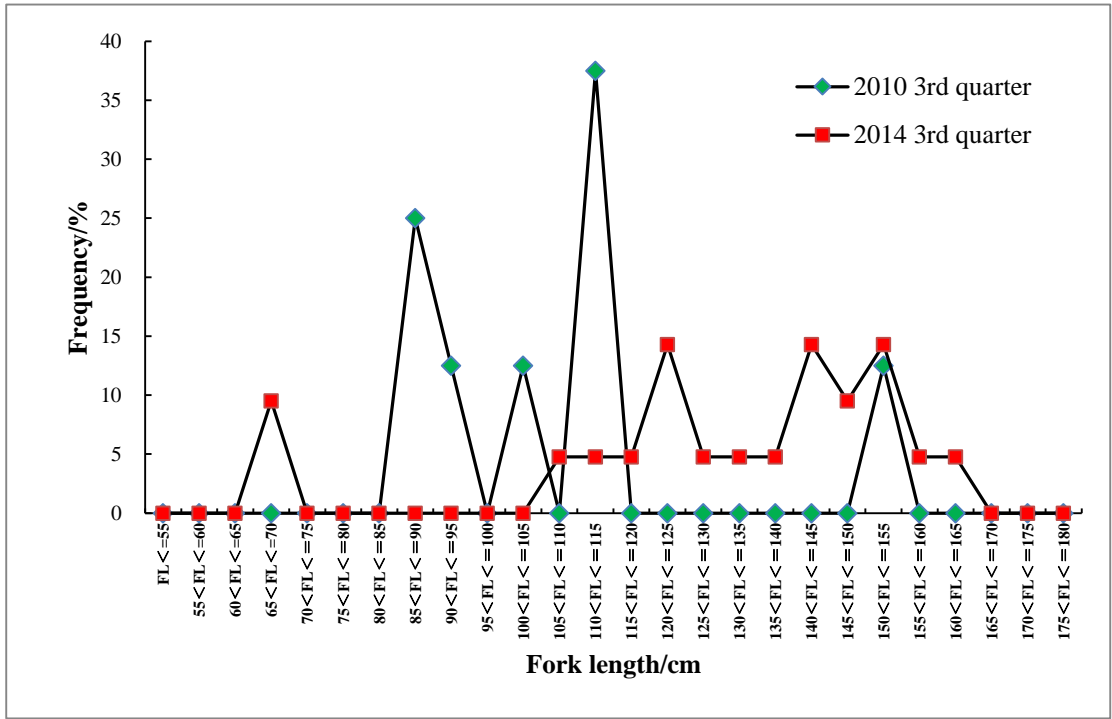
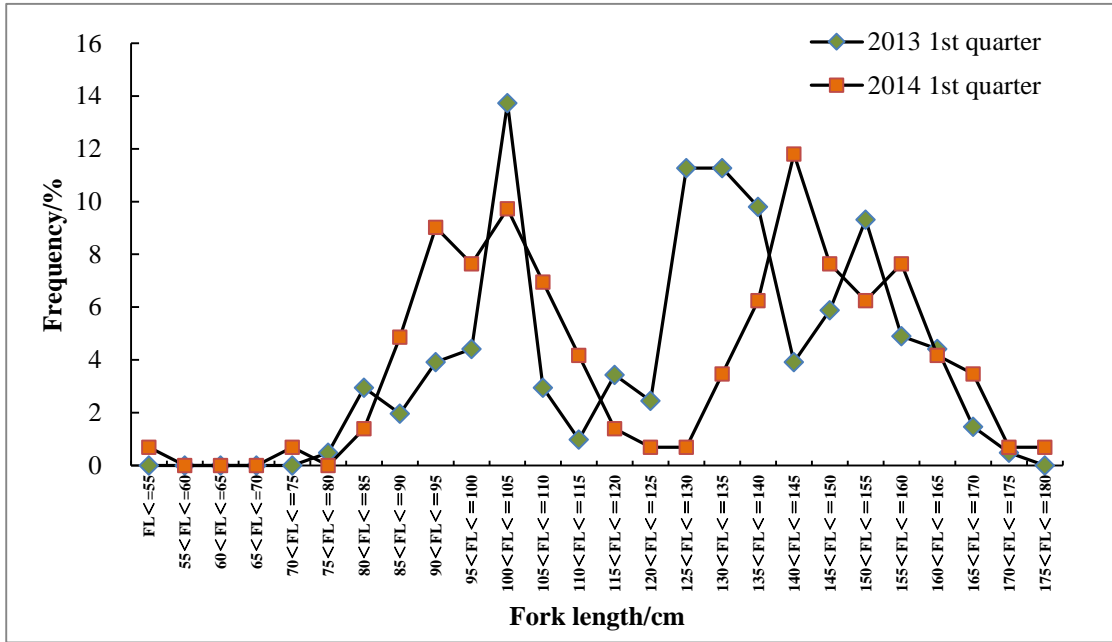


Figure4 Size data distributives of the yellowfin tuna in the Indian Ocean by quarter



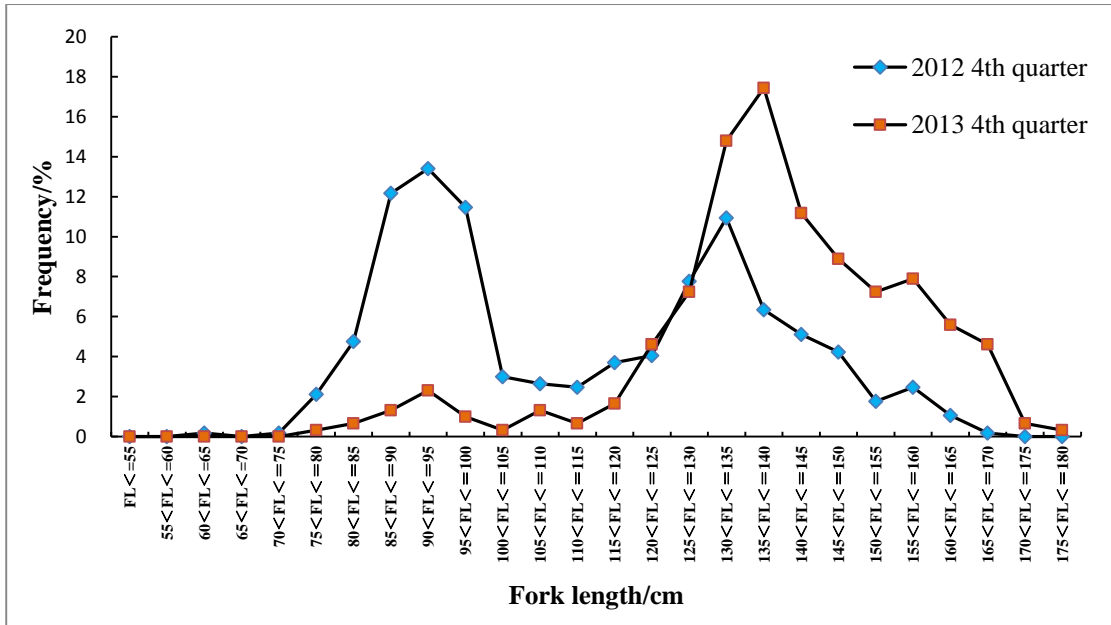


Figure5 Size distributions of yellowfin tuna in the Indian Ocean by quarter and year

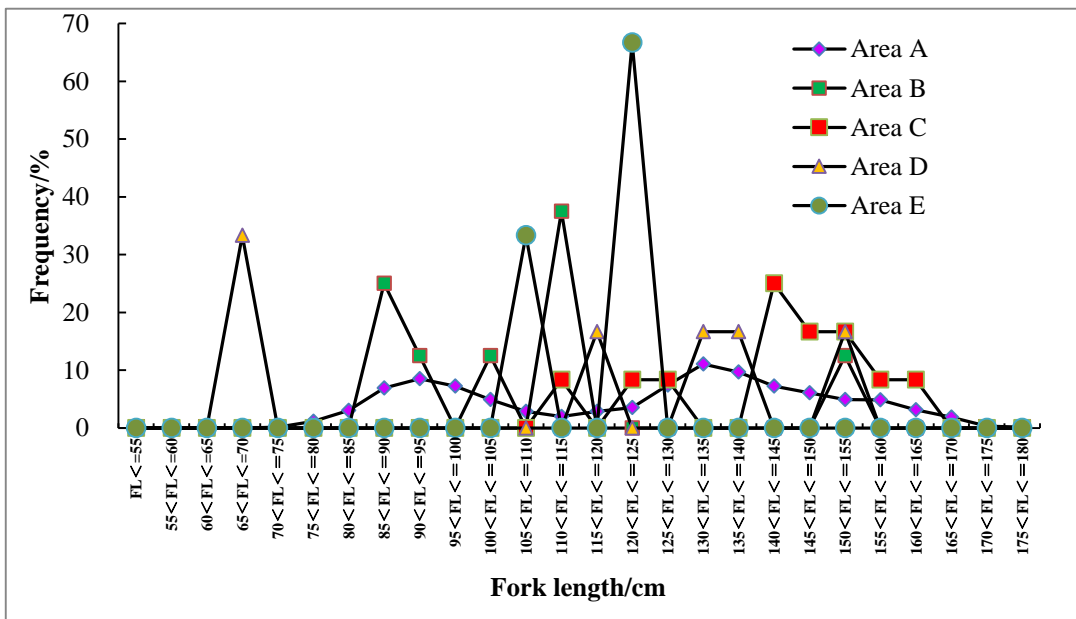


Figure6 Fork length composition by area in the Indian Ocean

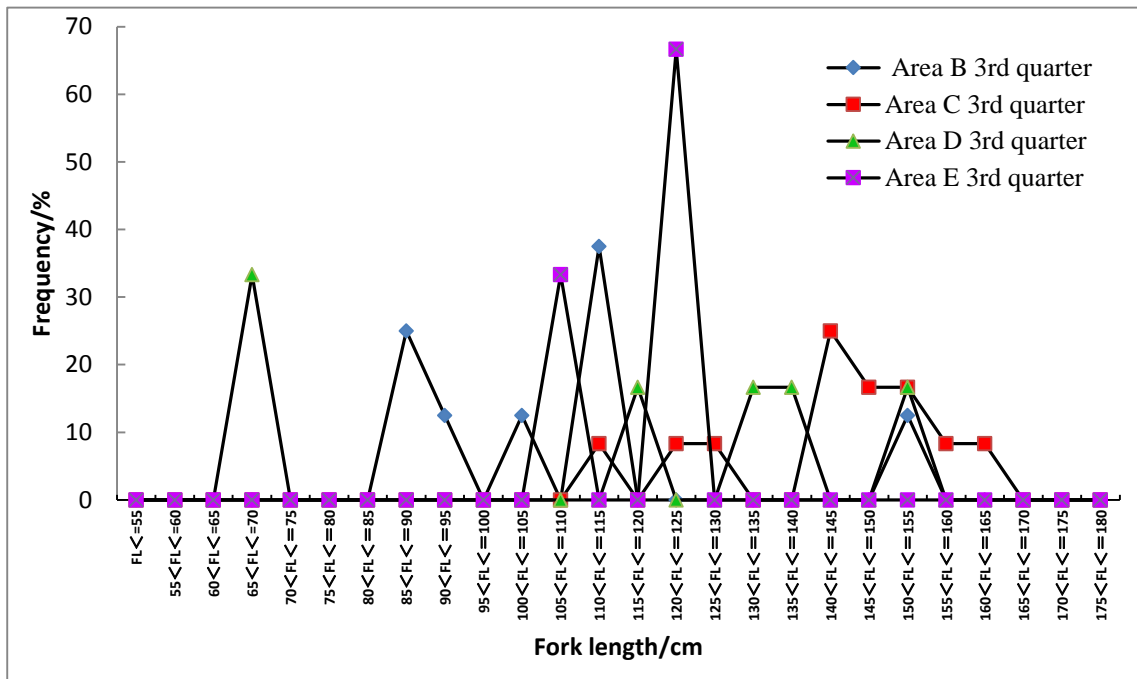
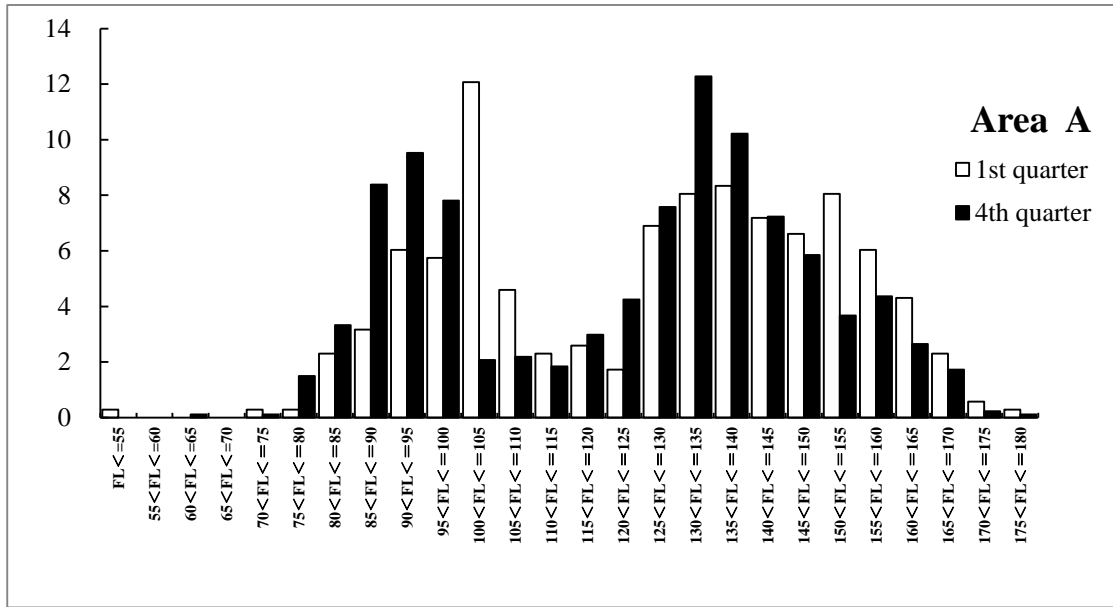


Figure7 Size data distribution of yellowfin tuna in the Indian Ocean by area and quarter