

Size composition of Indian Ocean albacore based on Chinese longline fishery

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Abstract

Albacore (*Thunnus alalunga*) is a highly migratory tuna species. This paper presents the current information on length frequency of Albacore (*Thunnus alalunga*) caught in the Indian Ocean based Chinese longline fishery scientific observer program from 2008 – 2013 (no observer for 2011) with five trips in all. The average fork length of albacore is the shortest in 2010. In the five years, length of albacore caught distributed from 71-120 cm and the dominant FL class mostly at 102-104 cm. The length distribution from 2008 to 2013 was mainly at 98-116 cm (98.4%) in the first quarter, which suggested that larger fish tends to appear in the north part of Indian Ocean, while smaller fish were likely limited in the area south of Lat. 36° S. Details on length frequency by year, by quarter and by area were also presented.

1. Introduction

Albacore (*Thunnus alalunga*) is typically a temperate and highly migratory tuna species (Fonteneau, 2004). In the Indian Ocean, albacore distributes between 15°N and 40°S, and is more abundant between 15°S and 35°S (Collette and Nauen, 1983; Nishid and Tanaka, 2008; Wang *et al.*, 2011). Although many studies were reported for albacore size frequency (Lee *et al.*, 2004; Dhurmeea *et al.*, 2012; Matsumoto and Uosaki, 2011; Setyadji *et al.*, 2012), no study has been reported for size frequency of albacore 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 albacore with data collected from these observer trips in 2008-2013 (No observer was sent in 2011).

2. Data source

In this report, length data were measured by scientific observers onboard Chinese longline fishing vessels operating in the Indian Ocean from September 2008 to December 2013 (no observer for 2011). There were five trips during the five years. The first trip was from September 2008 to October 2008. The second trip was from March 2009 to April 2009. The third trip was from July 2010 to September 2010. The fourth trip was from November 2012 to January 2013. And the last were two observed sets with two measured fishes. 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, so it was converted into fork length (FL) (Li *et al.*, 2010).

3. Result

3.1 Length frequency by year

A total number of 313 individuals of albacore were measured by observers from 2008 to 2013 (Tables 1 and 2). The fork length range was 71-120 cm and the average was 102.7 cm (Fig.2), with the dominant FL class at 102-104 cm, accounting for 23.3% of the total number. The average fork length of albacore was the smallest in 2010 (85.6 cm) and the largest in 2009 (108.0 cm) (Fig.3).

A total number of 36, 147, 52, 52 and 26 individuals of albacore were collected by observers in 2008, 2009, 2010, 2012 and 2013 respectively (Table 2).

In 2008, the fork length ranged from 74 to 115 cm and the average was 103.7cm, with the dominant FL class at 102-104 cm, accounting for 30.6% of the total number (Table 3). The fork length ranged from 106 to 108 cm with the percentage of 13.9%, and 98-102cm made up 22.2%. Fig.3 shows that there were three parts of FL class in 2008. The size mostly ranged from 98 to 114 cm (83.3%). Another two parts were 86-96cm (13.9%) and 70-72cm (2.8%).

In 2009, the fish mostly ranged from 102 to 110 cm and the average was 108.0cm, with the dominant FL class at 102 -104cm, accounting for 21.1% of the total number. The fish in range of 102-110 cm occupied a percentage of 76.2% (Fig.3).

In 2010, the size composition of albacore was somewhat different from that of other years. The fork length ranged from 71 to 99 cm and the average was 108.0 cm, with the dominant FL class at 80-82 cm (28.8%). (Fig.3).

In 2012, the fork length ranged from 95 to 115 cm and the average was 103.1cm, with the dominant FL class at 102-104 cm, accounting for 40.4% of the total number. The FL class at 96-106cm was predominant (90.4%) (Fig. 3).

In 2013, the most fork lengths were between 100 and 104 cm and the average was 104.4 cm, with the dominant FL class at 102-104 cm, accounting for 38.5% of the total number (Fig.3).

3.2 Length frequency by quarter

Fork length distribution from 2008 to 2013 was mainly at 98-116 cm (98.4%) in the first quarter (January-March). While in the second quarter (April-June), the mostly FL classes were at 104-112 cm (80.9%). In the third quarter (July-September), the size composition was much smaller (almost smaller than 100 cm). Some larger fish were mainly caught in the fourth quarter (October-December). The difference in fish size between 1st and 2nd quarters was relatively small. During the 3rd quarter, much smaller fishes were caught (Fig.4).

There was little disparity in size composition in the first quarter among the years. But in the third quarter, most fish were larger than 100 cm in 2008, while in 2010 nearly all fish (98.1%) were in the 70-96 cm range, with the mean of 85.6 cm. For the 4th quarter, the difference of size composition among years was small, but more small fish were caught in 2012 (Fig.5).

3.3 Length frequency analysis of albacore tuna by area

The observed locations were divided into four areas. The first area was in 40°-45°E, 7°-15°S, the second in 55°-80°E, 15°-35°S, the third in 30°-40°E, 30°-40°S. Only two single sets were observed in Area 4. Recently size data were mainly collected in Area 1 (2012 and 2013). The size data in 2008-2009 was in Area 2, whereas the size data in 2010 was located in Area 3 (Fig.6).

A total number of 75, 183, 52 and 3 individuals of albacore were collected by observers in the Area 1, Area 2, Area 3 and Area 4, respectively. In the Areas 1, 2 and 4, most fish were larger than 100cm. However, in the Area 3, fish size was much smaller (<100cm), the average fork length was 85.6 cm with the range from 78-88 cm (56.6%) in majority (Fig.7 and Table 4).

In the Area 1, the difference between fish size among quarters was relatively small, the dominant FL class was at 104-106 cm in the first and fourth quarter, accounting for 41.7% and 41.2% of the total number, respectively (Fig.8).

In the Area 2, the differences of fish size was small among the 1st, 2nd and 3rd quarters, but with more large fishes at 104-106 cm were caught in the 4th quarter (46.7%) (Fig.8).

There was only one observer trip in Area 4. The fork length distribution was at 98-100 cm (33.3%) (Fig.8).

4. Discussion

From what has been analyzed above, we can draw the conclusion that the average fork length of albacore is the shortest in 2010 and the differences of fish size among the five years were relatively small except in 2010. During the five trips, the fork length distribution of albacore was almost larger than 100 cm, but was a little smaller in 2010 with the dominant FL class at 80-82cm. In the third quarter (2010), the fork length distribution tends to have more small fish compared with the same quarter in 2008 (September to October). This may have something to do with its distribution pattern. In 2010, the observed area is 30°-40°E, 30°-40°S, which is located in the feeding areas of albacore (Nishida and Tanaka, 2004), while the area of 0°-45°E, 7°-15°S is the spawning ground. The length distribution suggested that larger fish tends to appear in the north part of Indian Ocean, while smaller fish were likely limited in the area south of Lat. 36° S, consistent with the species' life history (Chen, 2004).

Acknowledgements

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Table 1 Sampling information of albacore for each observer trip

Trip	Year	Number of fish measured	Area of observer trip		Quarter	Time	Observed sets
1	2008	21	19°20'S -32°00'S	73°01'E -78°08'E	3	9.16-9.30	10
	2008	15	17°01'S -25°08'S	69°52'E -71°57'E	4	10.2-10.11	7
2	2009	100	18°32'S-26°59'S	58°38'E-67°58'E	1	3.10-3.31	21
	2009	47	22°59'S -25°16'S	60°46'E -65°43'E	2	4.1-4.12	9
3	2010	52	31°47'S-36°43'S	30°03'E-34°32'E	3	7.25-9.21	24
4	2012	52	04°23'S-08°40'S	40°53'E-62°35'E	4	11.18-12.31	18
	2013	24	07°22'S-09°00'S	41°24'E-42°25'E	1	1.1-1.14	8
5	2013	2	11°05'S-11°05'S	52°20'E -52°30'E	4	12.25-12.26	2

Table 2 Size compositions of albacore in each observed year (2008-2013)

Year	2008-2013	2008	2009	2010	2012	2013
Number	313	36	147	52	52	26
Ave.FL(cm)	102.7	103.7	108.0	85.6	103.1	104.4
Max.FL(cm)	120	115	120	99	115	110
Min.FL(cm)	71	74	97	71	95	98

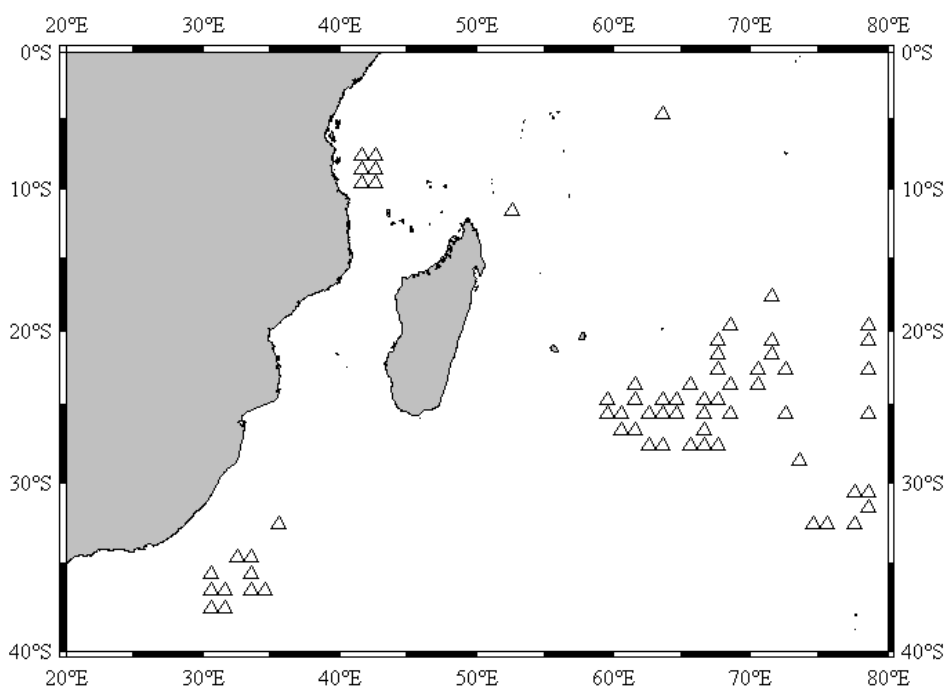
Table 3 Fork length frequency of albacore in the Indian Ocean from Chinese longline observer trip

Size class (cm)	2008-2014	2008	2009	2010	2012	2013
FL<=70	0.6	0.0	0.0	3.8	0.0	0.0
70<FL<=72	0.3	2.8	0.0	0.0	0.0	0.0
72<FL<=74	0.0	0.0	0.0	0.0	0.0	0.0
74<FL<=76	1.3	0.0	0.0	7.7	0.0	0.0
76<FL<=78	0.3	0.0	0.0	1.9	0.0	0.0
78<FL<=80	1.6	0.0	0.0	9.6	0.0	0.0
80<FL<=82	4.8	0.0	0.0	28.8	0.0	0.0
82<FL<=84	1.9	0.0	0.0	11.5	0.0	0.0
84<FL<=86	1.0	0.0	0.0	5.8	0.0	0.0
86<FL<=88	1.0	2.8	0.0	3.8	0.0	0.0
88<FL<=90	1.6	2.8	0.0	7.7	0.0	0.0
90<FL<=92	1.3	2.8	0.0	5.8	0.0	0.0
92<FL<=94	1.9	2.8	0.0	1.9	7.7	0.0
94<FL<=96	2.9	2.8	1.4	9.6	0.0	3.8
96<FL<=98	4.5	0.0	1.4	1.9	19.2	3.8
98<FL<=100	3.8	11.1	2.7	0.0	5.8	3.8
100<FL<=102	11.2	11.1	9.5	0.0	17.3	30.8
102<FL<=104	23.3	30.6	21.1	0.0	40.4	38.5

104<FL<=106	12.5	8.3	19.7	0.0	7.7	11.5
106<FL<=108	9.3	13.9	15.0	0.0	0.0	7.7
108<FL<=110	9.9	2.8	20.4	0.0	0.0	0.0
110<FL<=112	3.2	2.8	6.1	0.0	0.0	0.0
112<FL<=114	1.6	2.8	2.0	0.0	1.9	0.0
114<FL<=116	0.0	0.0	0.0	0.0	0.0	0.0
116<FL<=118	0.3	0.0	0.7	0.0	0.0	0.0
118<FL<=120	0.0	0.0	0.0	0.0	0.0	0.0

Table 4 Size compositions of albacore by area and quarter

Quarter	AREA 1		AREA 2			AREA 3	AREA 4	
	1 st	4 th	1 st	2 nd	3 rd	4 th	3 rd	4 th
Number	24	51	100	47	21	15	52	3
Ave.FL(cm)	104.5	103.2	108.2	107.7	101.1	107.3	85.6	102.7
Max.FL(cm)	110	115	120	115	113	115	99	110
Min.FL(cm)	100	95	97	97	74	102	71	98

**Fig.1** 1°×1° Area of observer trips (2008-2013)

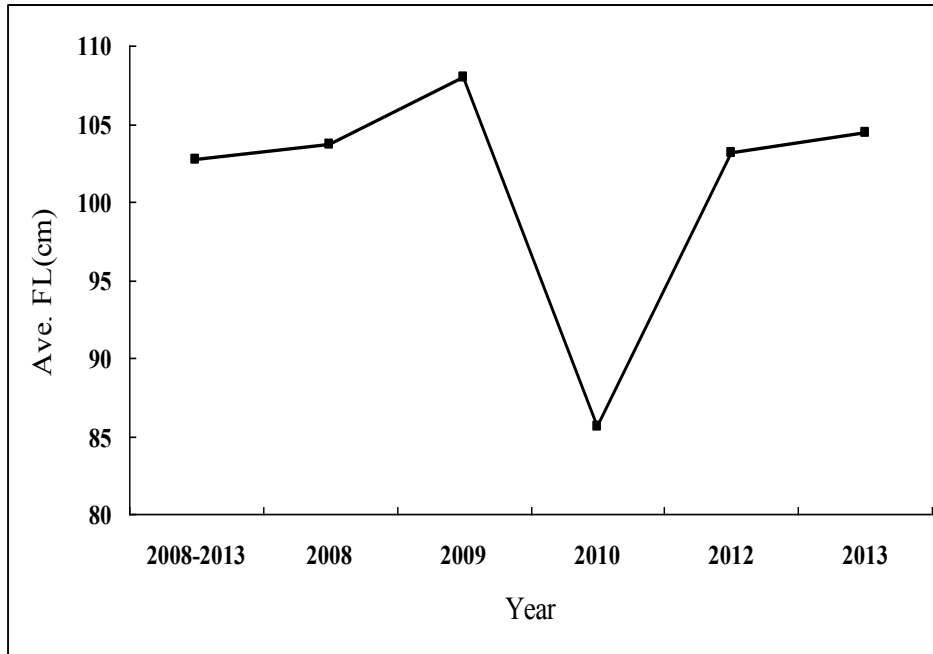


Fig.2 Average fork length of albacore in the Indian Ocean from Chinese longline observer trips

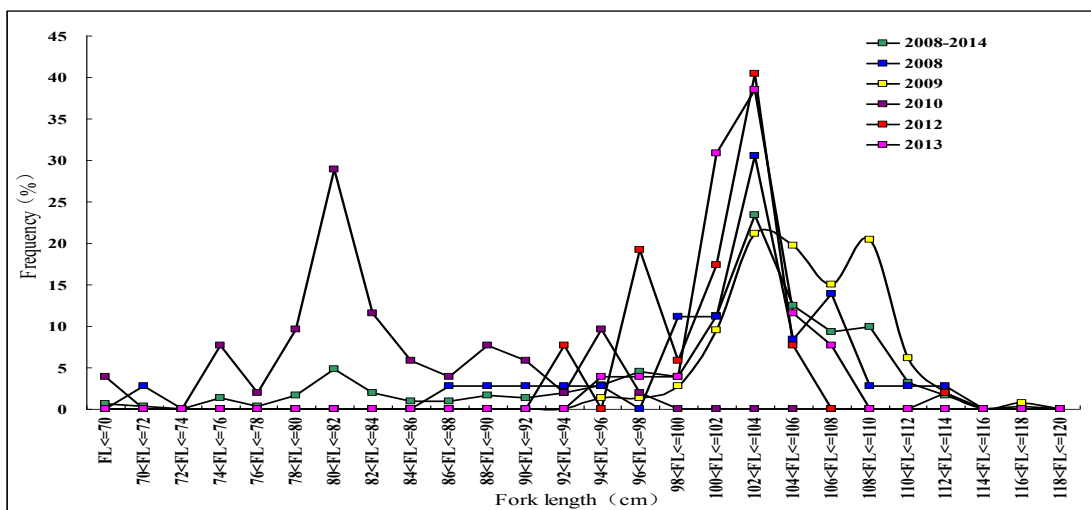


Fig.3 Fork length composition of albacore in the Indian Ocean from Chinese longline observer trips

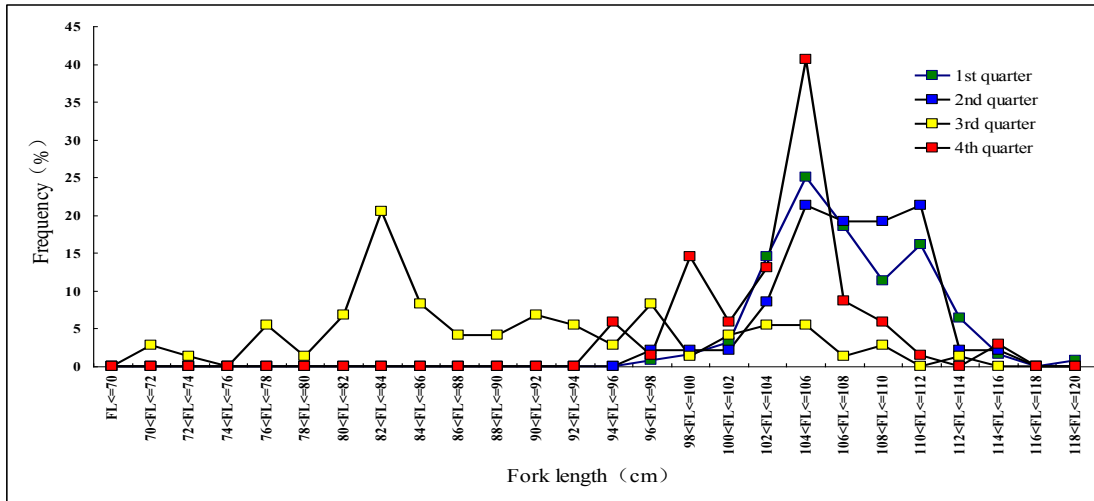
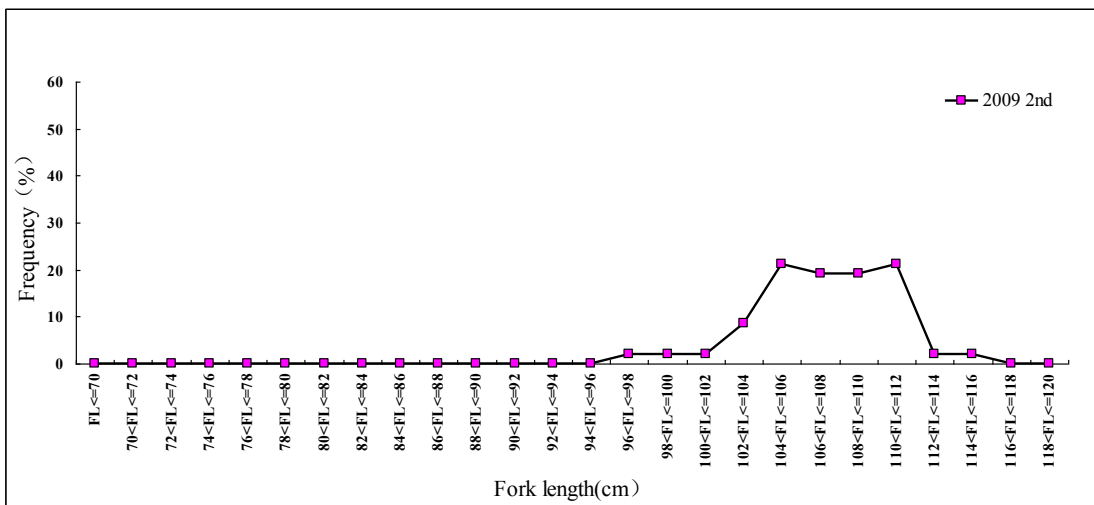
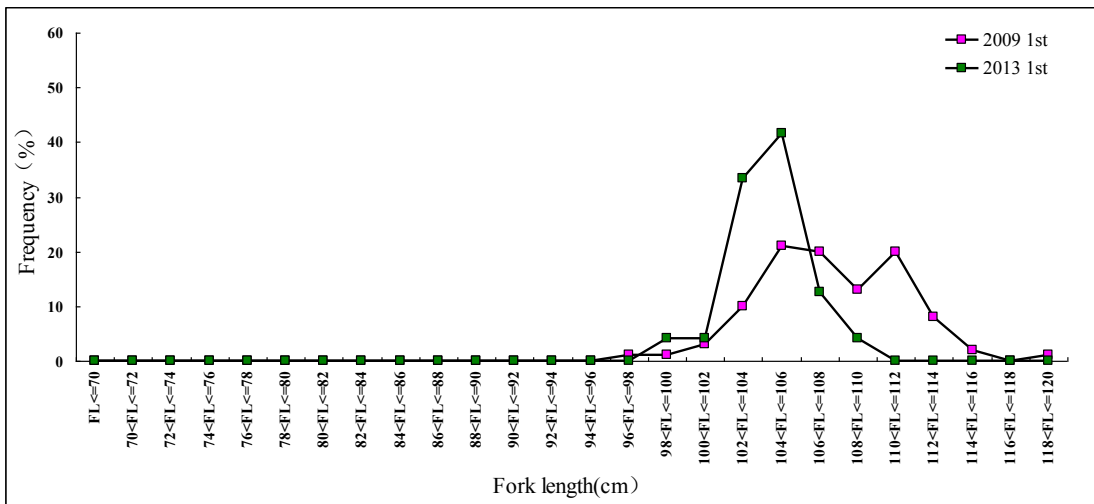


Fig.4 Size data distributes of albacore in the Indian Ocean by quarter (2008-2013)



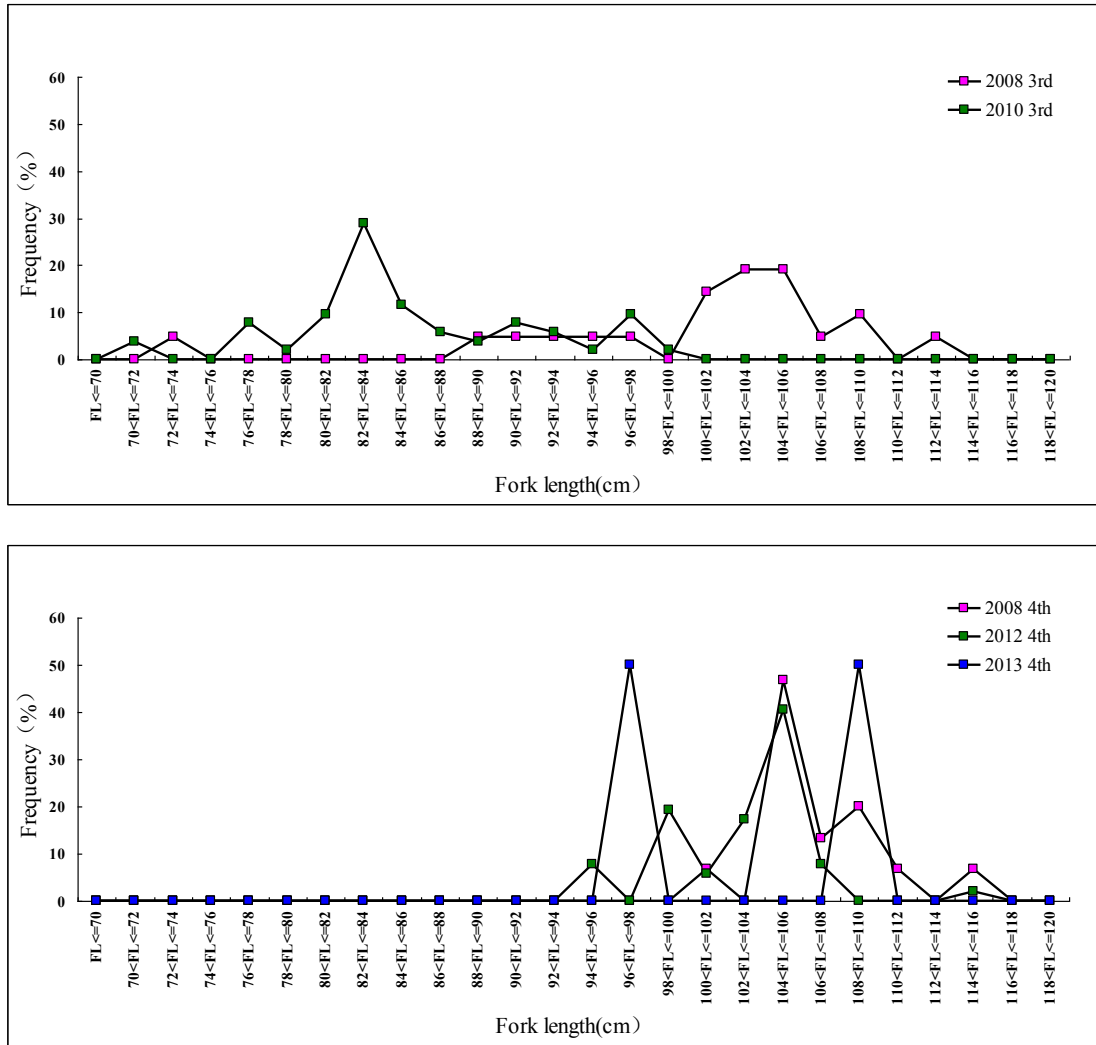


Fig.5 Size distribution of albacore in the Indian Ocean by quarter and year

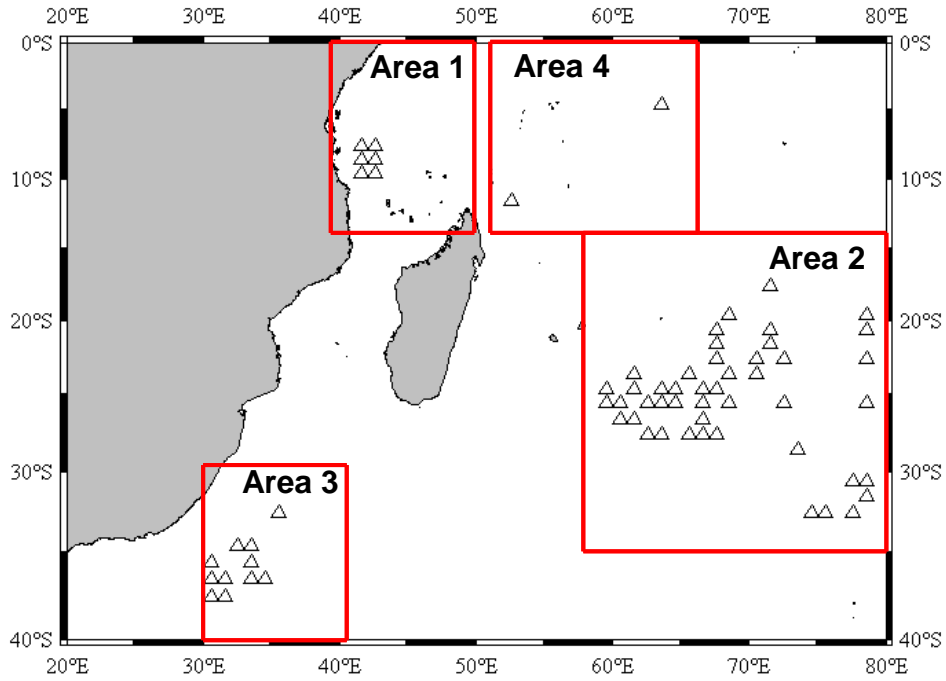


Fig.6 1°×1° observed area (2008-2013)

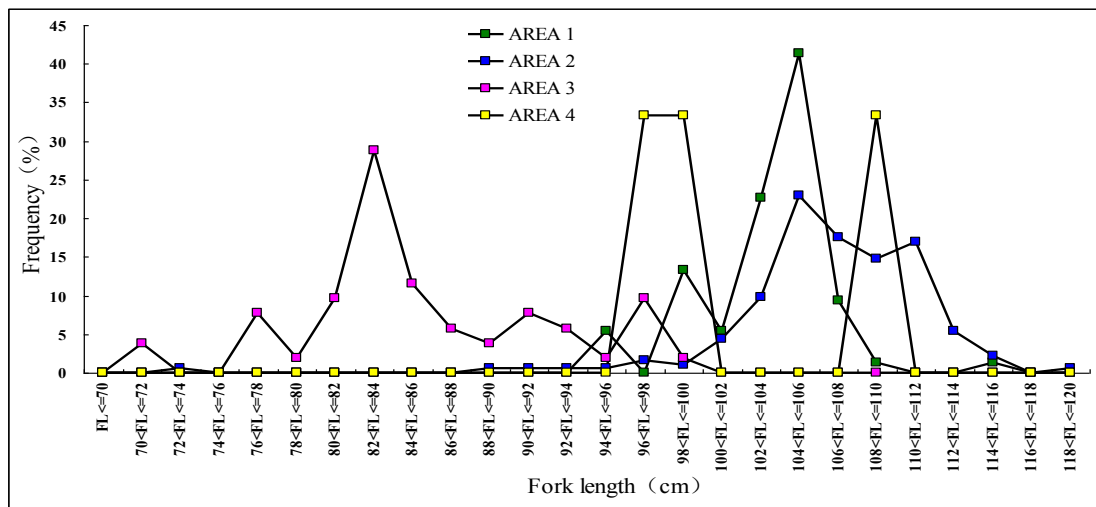
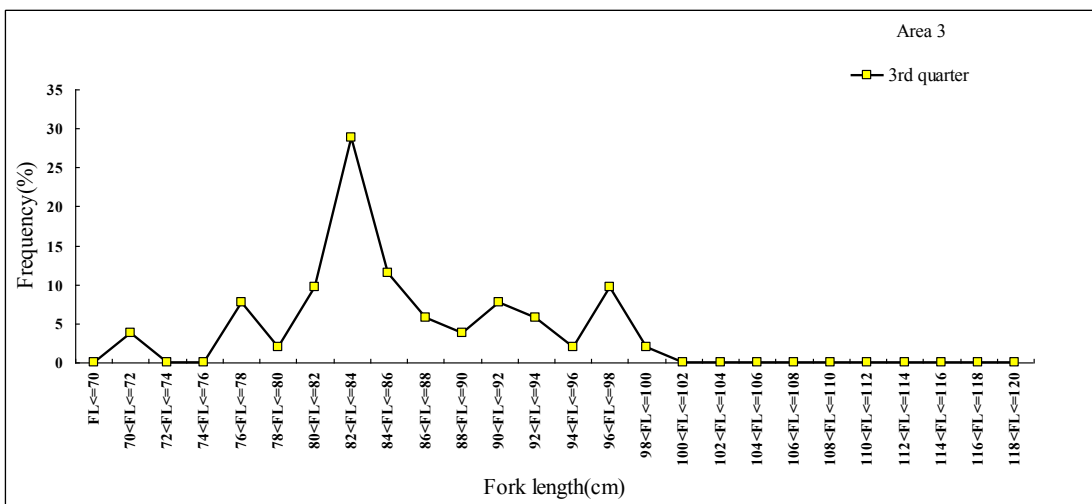
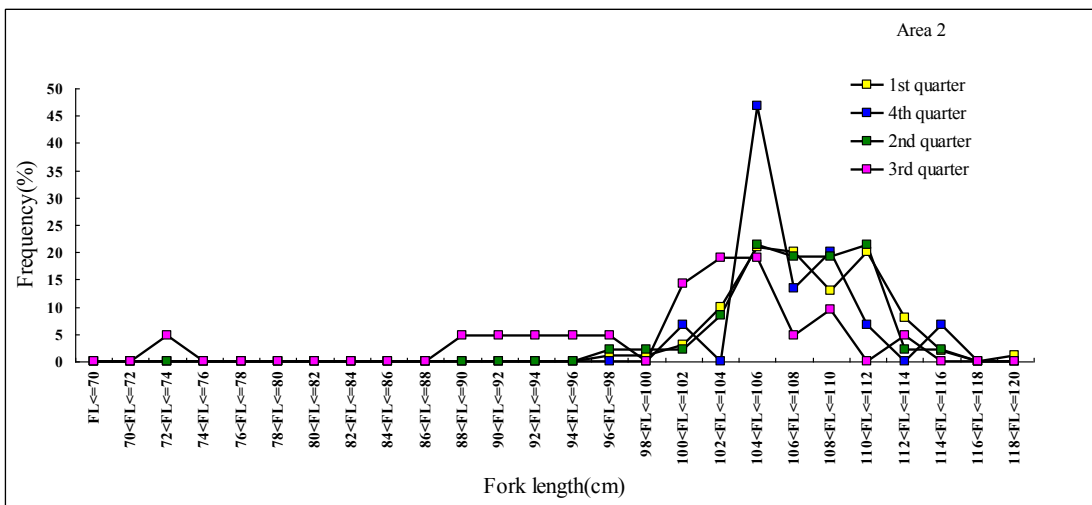
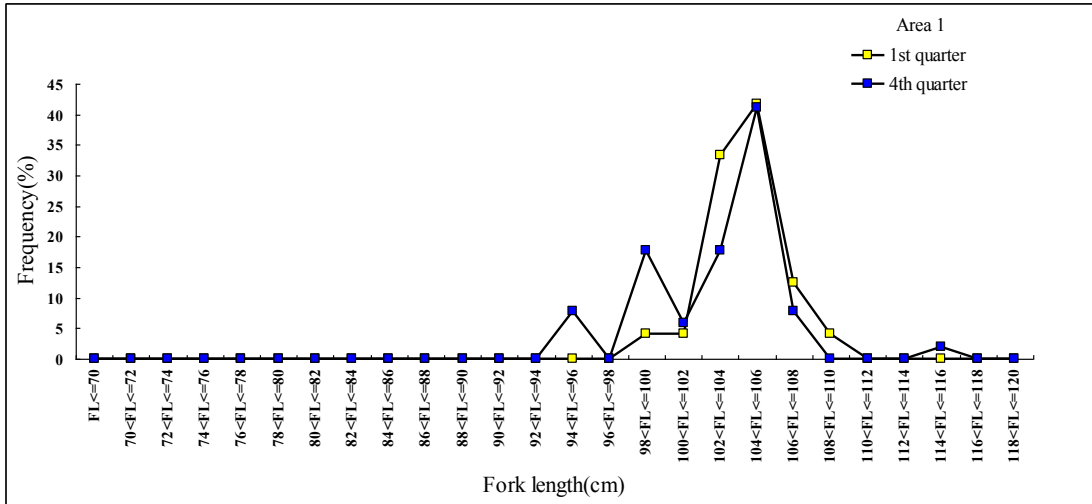


Fig.7 Fork length composition of albacore by area in the Indian Ocean from Chinese longline observer trips (2008-2013)



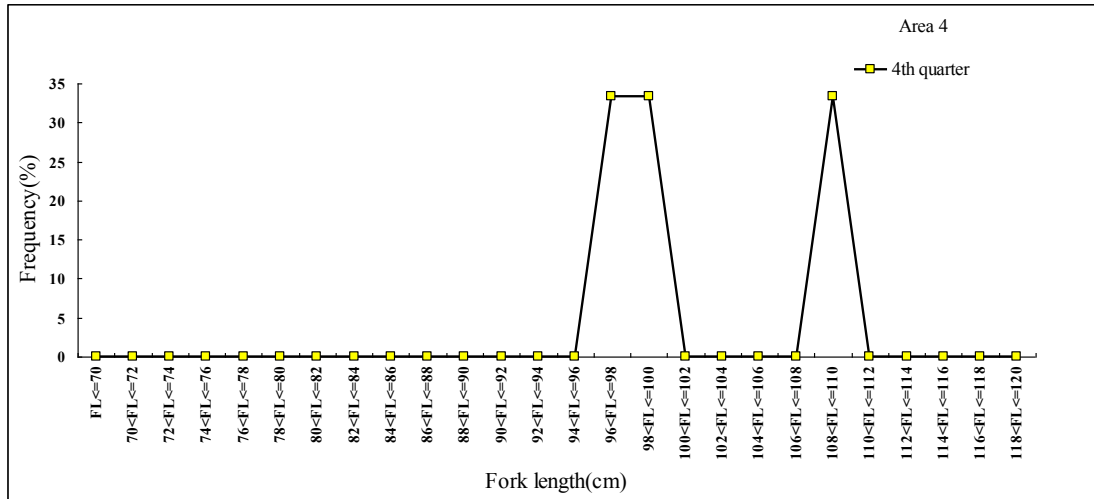


Fig.8 Size data distribution of albacore in the Indian Ocean by area and quarter