Length distributions of albacore catch made by Taiwanese albacore-targeting longline fishery in the Pacific Ocean north of 25°N, 2003-2015[1]

Chiee-Young Chen[1*], Fei-Chi Cheng[1]

[1] Dept Marine Environmental Engineering, National Kaohsiung Marine University, Taiwan
[*]Email: chency@mail.nkmu.edu.tw

Length distributions of albacore catch made by Taiwanese albacore-targeting longline fishery in the Pacific Ocean north of 25°N, 2003-2015[1]

Chiee-Young Chen[1*], Fei-Chi Cheng[1]

[1] Dept Marine Environmental Engineering, National Kaohsiung Marine University, Taiwan
[*]Email: chency@mail.nkmu.edu.tw

Abstract

This working paper is aiming to estimate the length compositions of North Pacific albacore caught by Taiwanese albacore-targeting longline fishery in the waters north of 25°N, 2003-2015. Taiwanese longliners are requested to record fish body length up to 30 individuals (including albacore) on board of their daily operations. These albacore length data, assuming a random sample of albacore catch made by each boat-day operation, were raised by catch in number to obtain the length frequency of each boat-day albacore catch. The length frequency were summed up to estimate albacore length frequency of a given boat operated in each year/quarter/5°X5° stratum, and also to estimate the length frequency of albacore caught by all boats operated in the same year/quarter/5°X5° stratum. The length frequency of each year/quarter/5°X5° stratum was further raised by the albacore catch in number recorded in the Task II data, which was made available by the Overseas Fisheries Development Council (OFDC) of Taiwan. Comparisons between the raised and un-raised percentage length compositions, by year/quarter, were conducted using χ^2 test, and results show no significant differences in almost all the cases.

Introduction

This working paper intend to estimate the albacore length composition of Taiwanese albacore-targeting longline fishery operated in the North Pacific Ocean. Taiwanese longline fleets are requested to record fish body length up to 30 individuals (including albacore) on board of their daily operations. These albacore length data are assumed to be a random sample of albacore catch made by each boat-day operation. Based on these length measurements and albacore catch in number of corresponding boat-day, quarter/5°X5°/boat, quarter/5°X5°/all boats, quarter/5°X5°/Task2, and quarter/north of 25°N /Task2, these onboard measuring length frequencies will be raised step by step to obtain the length compositions of albacore exploited by Taiwanese albacore-targeting fishery in the North Pacific Ocean north of 25°N.

Materials and methods

The albacore length data of each boat-day operation between 2003 and 2015 were kindly made available by the Overseas Fisheries Development Council (OFDC), Taiwan. In addition, daily logbook data of each fishing boat and catch statistics data (Task II), by month and by 5°X5° grid, were also provided by the OFDC.

Methods similar to Chen and Cheng (2013, 2016) were adopted to define the albacore-targeting and non-albacore-targeting data. Owing to that in the stock assessment process, the

---

[1]This working paper was submitted to the ISC Albacore Working Group Intersessional Stock Assessment Workshop, 11-19 April 2017, held at the Southwest Fisheries Science Center, La Jolla, California, USA. Document not to be cited without the author's permission.

Taiwanese albacore-targeting fishery will be treated as a single fishery and it contributed most of the Taiwanese albacore catch, therefor emphasis will be laid on the albacore-targeting fishery in this working paper. Their daily length measurements will be raised to the length compositions of total albacore catch step by step, as shown in the following flow chart,

```
┌─────────────────────────────────────────────────┐
│      1. Length measurements of each boat/day      │
│ (random samples of albacore catch in each boat/day operation) │
└─────────────────────────────────────────────────┘
                        ↓
┌─────────────────────────────────────────────────┐
│      2. Length composition of each boat/day       │
│ (total catch in number of each single boat/day operation) │
└─────────────────────────────────────────────────┘
                        ↓
┌─────────────────────────────────────────────────┐
│   3. Length composition of each boat in a particular │
│           year/quarter/5°X5° stratum              │
└─────────────────────────────────────────────────┘
                        ↓
┌─────────────────────────────────────────────────┐
│   4. Length composition of all boats in a particular │
│           year/quarter/5°X5°stratum               │
└─────────────────────────────────────────────────┘
                        ↓
┌─────────────────────────────────────────────────┐
│  5. Length composition of total albacore catch in a │
│        particular year/quarter/5°X5°stratum       │
│        (raised to the total catch of Task II data)  │
└─────────────────────────────────────────────────┘
                        ↓
┌─────────────────────────────────────────────────┐
│  6. Length compositions of each year/quarter in the │
│              waters north of 25°N                 │
└─────────────────────────────────────────────────┘
```
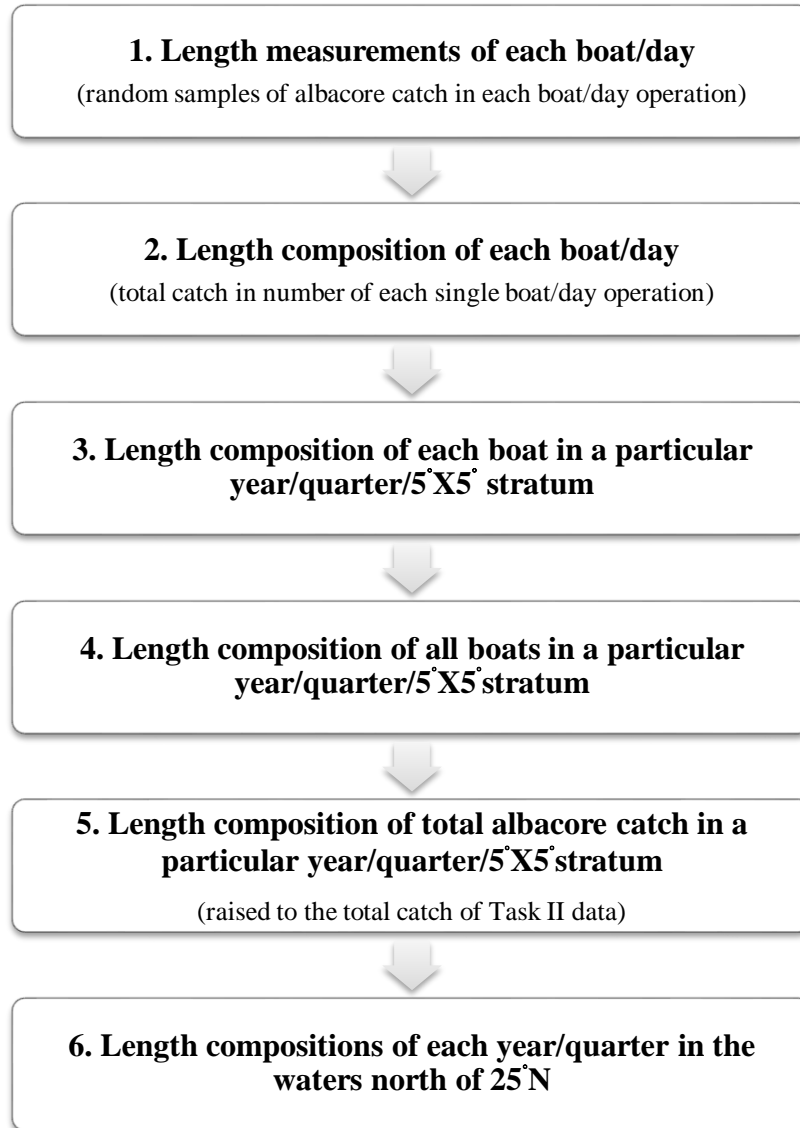
Fig. 1 Procedures of raising albacore length measurements to length compositions of total N. Pacific albacore catch made by Taiwanese albacore-targeting longliners in the waters north of 25°N.

In order to examine the difference between raised and un-raised length compositions, the χ^2 test is applied, and prior to the test, length frequency will be transformed to percentile length frequency.

---

[1]This working paper was submitted to the ISC Albacore Working Group Intersessional Stock Assessment Workshop, 11-19 April 2017, held at the Southwest Fisheries Science Center, La Jolla, California, USA. Document not to be cited without the author's permission.

Results and Discussion

Albacore-targeting fishery was known to contribute most of the Taiwanese albacore catch from the North Pacific (Chen and Cheng, 2013, 2016), and it is also reflected by the number of albacore length measurement taken onboard(Table 1). On average, the albacore-targeting fleets recorded 19.72 length measurement per day whereas the non-albacore-targeting took only 0.50 fish per day. However, in this working paper emphasis will be laid on the albacore-targeting fishery only. In total, length of 381,689 albacore were recorded onboard, 2003-2015, and it comprised 23.04% and 13.87% of albacore catch derived from the daily logbook and Task 2 data, respectively (Table 2). The difference in coverage rate between logbook data and Task2 data is due to the fluctuation in the returning rate of logbook. The albacore-targeting fishery in the North Pacific Ocean showed a seasonal pattern that they mainly fished in the 1st and 4th quarter of the year (Chen and Cheng, 2013, 2016). This seasonal pattern was also shown in the number of length measurement taken onboard (Table 3). Most of the length measurements were made in the 1st and 4th quarter, whereas relatively low number was taken in the 2nd and 3rd quarter. It is noticed that few data is available for the year of 2014 and 2015, particularly in the 2nd and 3rd quarter, and the OFDC responded that these data needed to be updated when the returning of logbook is completed. Table 4 shows that most of the albacore length measurements were made from north of 25°N. It reflects the fact that most of the albacore tuna were caught from north of 25°N, and is also shown by the albacore catch in number of Task2 data shown in Table 4.

Following the procedures given in materials and methods section, the albacore length measurements made onboard were raised step by step to obtain the length composition of total albacore catch made by Taiwanese albacore-targeting longline fishery operated in the north of 25°N. The results show that the raised length frequencies fit very well with the un-raised length frequencies, either on quarterly or yearly basis (Fig. 2, 3). The χ^2-test were applied to test the quarterly length frequencies, and results show no significant difference between the raised and the un-raised for almost all the cases (Table 5).

Reference

Chen, C. Y., and Cheng, F. C. 2013. Taiwanese albacore-targeting longline fisheries in the North Pacific Ocean, 1995-2011. ISC working paper, ISC/13/ALBWG-03/01.

Chen, C. Y., and Cheng, F. C. 2016.The development of Taiwanese longline fishery in the North Pacific Ocean and estimation of albacore CPUE exploited by albacore-targeting fishery, 1995-2015. ISC working paper, ISC/16/ALBWG-02

---

[1]This working paper was submitted to the ISC Albacore Working Group Intersessional Stock Assessment Workshop, 11-19 April 2017, held at the Southwest Fisheries Science Center, La Jolla, California, USA. Document not to be cited without the author's permission.

Table 1. Number of albacore length measurements and corresponding fishing effort (day) of Taiwanese longline fisheries in the North Pacific Ocean.

Year	ALB targeting		Non-ALB targeting		Total	
	Effort (days)	No. of Measurement	Effort (days)	No. of Measurement	Effort (days)	No. of Measurement
2003	543	5152	2360	1659	2903	6811
2004	2473	42509	4600	1476	7073	43985
2005	1902	36132	4221	1795	6123	37927
2006	3128	72464	3089	465	6217	72929
2007	2432	41784	3153	1166	5585	42950
2008	1596	41107	3285	1514	4881	42621
2009	1033	22892	2355	2459	3388	25351
2010	1129	25074	3571	1819	4700	26893
2011	1178	28499	4151	2415	5329	30914
2012	918	24951	3482	1886	4400	26837
2013	1514	21935	2451	2807	3965	24742
2014	802	9032	839	90	1641	9122
2015	709	10158	1880	47	2589	10205
Total	19357	381689	39437	19598	58794	401287
Mean (No./days)		19.72		0.50		6.83

Table 2. Sampling ratio of albacore length measurement to the total catch derived from Logbook and Task2 file of Taiwanese albacore-targeting longline fishsery in the N. Pacific Ocean.

Year	(a) No. of Measurement	(b) Catch No. (LogBook)	(c) Catch No. (Task2)	(a)/(b) %	(a)/(c) %
2003	5152	17922	123868	28.75	4.16
2004	42509	118523	261635	35.87	16.25
2005	36132	114571	288849	31.54	12.51
2006	72464	286019	325083	25.34	22.29
2007	41784	171223	254134	24.40	16.44
2008	41107	182404	211455	22.54	19.44
2009	22892	80130	122291	28.57	18.72
2010	25074	129492	188930	19.36	13.27
2011	28499	153515	212154	18.56	13.43
2012	24951	136729	179299	18.25	13.92
2013	21935	154552	317823	14.19	6.90
2014	9032	55884	99507	16.16	9.08
2015	10158	55631	166290	18.26	6.11
Total	381689	1656595	2751318	23.04	13.87

Table 3. Quarterly sampling ratio of albacore length measurement to the total catch derived from Logbook and Task2 file of Taiwanese albacore-targeting longline fishsery in the N. Pacific Ocean.

Year	Quarter	(a) No. of Measurement	(b) Catch No. (LogBook)	(c) Catch No. (Task2)	(a)/(b) %	(a)/(c) %
2003	1	2278	10589	36069	21.51	6.32
	2					
	3	87	87	204	100.00	42.65
	4	2787	7246	87595	38.46	3.18
2004	1	18808	44135	113121	42.61	16.63
	2	263	267	536	98.50	49.07
	3	230	437	889	52.63	25.87
	4	23208	73684	147089	31.50	15.78
2005	1	12819	40520	97867	31.64	13.10
	2	450	556	556	80.94	80.94
	3	25	68	159	36.76	15.72
	4	22838	73427	190267	31.10	12.00
2006	1	31873	107964	119278	29.52	26.72
	2	11841	63149	64407	18.75	18.38
	3	316	1357	1357	23.29	23.29
	4	28434	113549	140041	25.04	20.30
2007	1	22841	88721	145045	25.74	15.75
	2	7627	23167	34794	32.92	21.92
	3					
	4	11316	59335	74295	19.07	15.23
2008	1	25019	129312	142868	19.35	17.51
	2	8382	32175	35561	26.05	23.57
	3	184	321	355	57.32	51.83
	4	7522	20596	32671	36.52	23.02
2009	1	12787	52885	87482	24.18	14.62
	2	49	49	70	100.00	70.00
	3					
	4	10056	27196	34739	36.98	28.95
2010	1	14620	65452	102426	22.34	14.27
	2	1133	4030	5496	28.11	20.61
	3	186	493	977	37.73	19.04
	4	9135	59517	80031	15.35	11.41
2011	1	12716	83680	122087	15.20	10.42
	2	696	2111	4239	32.97	16.42
	3	350	473	473	74.00	74.00
	4	14737	67251	85355	21.91	17.27
2012	1	10729	57225	63504	18.75	16.89
	2					
	3					
	4	14222	79504	115795	17.89	12.28
2013	1	10294	59941	125541	17.17	8.20
	2					
	3					
	4	11641	94611	192282	12.30	6.05
2014	1	9032	55884	99507	16.16	9.08
	2					
	3					
	4					
2015	1	4159	33193	106458	12.53	3.91
	2					
	3					
	4	5999	22438	59832	26.74	10.03
Total		381689	1656595	2751318	23.04	13.87

Table 4. Quarterly sampling ratio of albacore length measurement to the total catch derived from Task2 file of Taiwanese albacore-targeting longline fishsery in the N. Pacific Ocean north of 25°N (Area N25) and south of 25°N (Area S25).

Year	Quarter	Area N25 (25°-45°N)		Area S25 (0°-25°N)	
		No. of Measurement	Catch No. (Task2)	No. of Measurement	Catch No. (Task2)
2003	1	1902	34442	376	1627
	2				
	3	87	204		
	4	2787	87595		
2004	1	16308	103424	2500	9697
	2			263	536
	3	230	889		
	4	22597	145340	611	1749
2005	1	10398	82111	2421	15756
	2	3	3	447	553
	3	25	159		
	4	22838	190267		
2006	1	30673	117131	1200	2147
	2	11841	64407		
	3	316	1357		
	4	28434	140041		
2007	1	22688	144749	153	296
	2	5812	30331	1815	4463
	3				
	4	11316	74295		
2008	1	24088	140878	931	1990
	2	8374	35552	8	9
	3	184	355		
	4	7522	32671		
2009	1	10895	81697	1892	5785
	2			49	70
	3				
	4	10056	34739		
2010	1	13536	98368	1084	4058
	2	591	3316	542	2180
	3	186	977		
	4	9135	80031		
2011	1	11432	118962	1284	3125
	2	515	4016	181	223
	3	350	473		
	4	14737	85355		
2012	1	10729	63504		
	2				
	3				
	4	14222	115795		
2013	1	10294	125541		
	2				
	3				
	4	11641	192282		
2014	1	9032	99507		
	2				
	3				
	4				
2015	1	4159	106458		
	2				
	3				
	4	5999	59832		
Total		365932	2697054	15757	54264

Table 5. Results of χ^2-test comparison, by year and quarter, between the raised and un-raised length frequencies of albacore caught by Taiwanese albacore-targeting fishery in the north of 25°N.

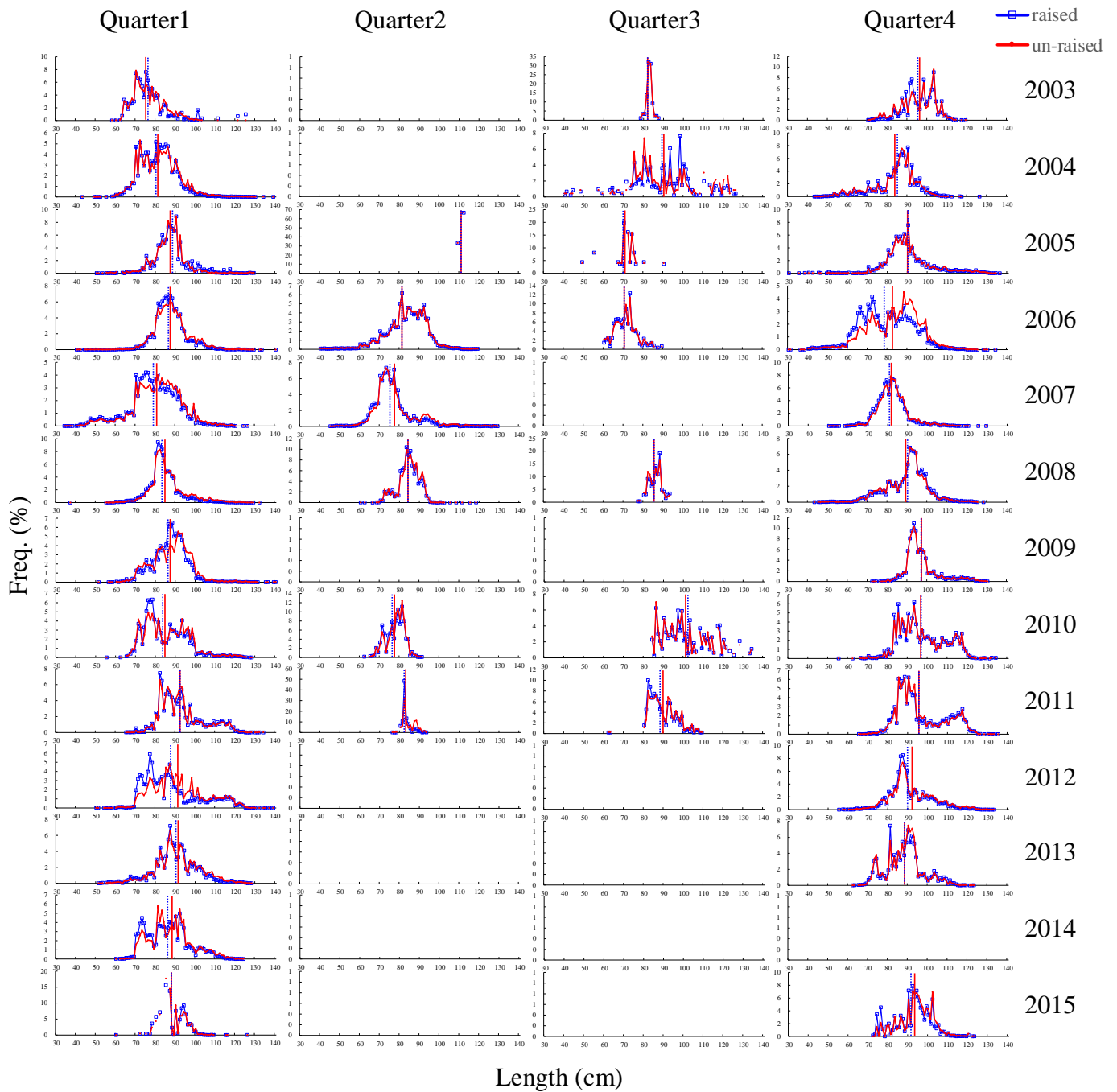| Year	Quarter	No. of Measurement	Catch No. (Task2)	χ^2	d.f.	p	
2003	1	1902	34442	55.76	46	0.153	
	2						
	3	87	204	0.00	9	0.999	
	4	2787	87595	9.10	46	0.999	
2004	1	16308	103424	2.36	80	0.999	
	2						
	3	230	889	30.33	59	0.999	
	4	22597	145340	4.74	71	0.999	
2005	1	10398	82111	18.14	75	0.999	
	2	3	3	0.00	1	0.999	
	3	25	159	0.30	12	0.999	
	4	22838	190267	1.35	92	0.999	
2006	1	30673	117131	2.92	91	0.999	
	2	11841	64407	0.93	79	0.999	
	3	316	1357	1.57	27	0.999	
	4	28434	140041	16.09	94	0.999	
2007	1	22688	144749	4.59	87	0.999	
	2	5812	30331	5.28	84	0.999	
	3						
	4	11316	74295	2.63	69	0.999	
2008	1	24088	140878	4.65	76	0.999	
	2	8374	35552	2.11	42	0.999	
	3	184	355	2.72	15	0.999	
	4	7522	32671	1.17	82	0.999	
2009	1	10895	81697	13.85	79	0.999	
	2						
	3						
	4	10056	34739	0.61	57	0.999	
2010	1	13536	98368	3.90	64	0.999	
	2	591	3316	2.26	27	0.999	
	3	186	977	2.94	40	0.999	
	4	9135	80031	1.08	67	0.999	
2011	1	11432	118962	3.33	67	0.999	
	2	515	4016	36.24	16	0.003	*
	3	350	473	4.48	31	0.999	
	4	14737	85355	1.61	67	0.999	
2012	1	10729	63504	21.00	82	0.999	
	2						
	3						
	4	14222	115795	3.97	76	0.999	
2013	1	10294	125541	3.52	76	0.999	
	2						
	3						
	4	11641	192282	2.40	59	0.999	
2014	1	9032	99507	8.02	63	0.999	
	2						
	3						
	4						
2015	1	4159	106458	4.80	33	0.999	
	2						
	3						
	4	5999	59832	14.67	50	0.999	
Total		365932	2697054				

Fig. 2. Quarterly length frequencies, un-raised (in red) and raised (in blue), of North Pacific albacore caught by Taiwanese albacore-targeting longline fishery in the north of 25°N. (note: Vertical lines indicate quarterly mean length for the un-raised and raised frequency, respectively.)
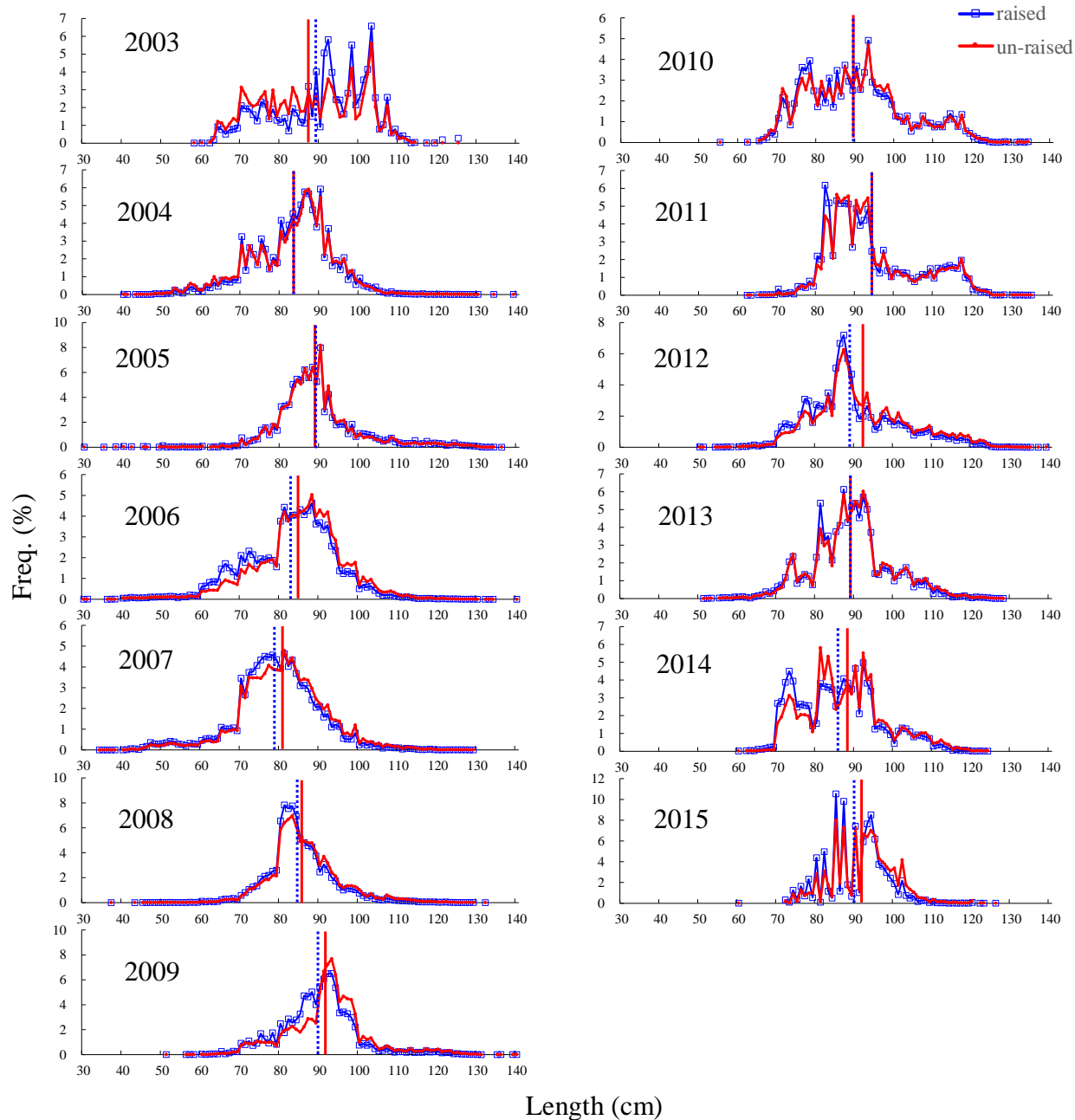
Fig. 3. Yearly length frequencies, un-raised (in red) and raised (in blue), of North Pacific albacore caught by Taiwanese albacore-targeting longline fishery in the north of 25°N. (note: Vertical lines indicate yearly mean length for the un-raised and raised frequency, respectively.)