

Progress in analysis of historical fishery data for Taiwanese southern bluefin tuna fleet

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要約

台湾のミナミマグロ漁業データを、漁業及びデータの特徴を理解するために解析した。漁獲と努力量、並びにサイズデータは、特に 2002 年以降に多くの量が蓄積されてきた。インド洋南東部における台湾ミナミマグロ漁業は独特であり、日本延縄漁場とのオーバーラップは小さかった。漁場は CCSBT 統計海区で区分することは不適當であった。漁獲されたミナミマグロは主に 3 歳、4 歳、5 歳であり、若齢期に加入レベルを提供するデータとして期待される。我々は、台湾漁業データはさらに解析するに値するものであると結論付ける。

Abstract

Taiwanese fishery data for southern bluefin tuna (SBT) were explored to better understand characteristics of the fishery and data. Substantial amount of data in catch and effort, as well as size, have been accumulated from Taiwanese longline fishery, especially since 2002. Taiwanese SBT fishery in south eastern Indian Ocean is unique such that there were little overlaps to Japanese longline fishing ground. The fishing grounds are not suitable to be classified according to CCSBT statistical areas. The SBT caught was mainly age 3, 4, and 5 so that the data is expected to provide information of recruitment levels in their young stage. We concluded that it is worthwhile to do further analysis on Taiwanese fishery data.

1. Introduction

Taiwanese deep sea longline fleet has historically exploited the southern bluefin tuna (*Thunnus maccoyii* SBT) in three oceans. The fishery indicators, such as temporal and spatial patterns of size of catch and historical trend of CPUE, based on Taiwanese longline fleet would be informative inputs for SBT assessment. However, the understanding for historical fishery characteristics of Taiwanese SBT fishery should be important issue prior to analyze the fishery indicators and to be applied to the assessment. In this paper, therefore, we attempt to analyze the data of Taiwanese SBT fishery for exploring the historical characteristics of Taiwanese SBT fishery and also make preliminary comparison with the data of Japanese longline fishery. The results of this report may be informative for further relevant analyses.

2. Analysis on the data submitted to CCSBT

Taiwanese fishery data for SBT were explored to better understand characteristics of the fishery and data. This understanding may further improve statistical modeling of its CPUE standardization. Data were extracted from the database distributed from CCST Secretariat in January 2013, which included data up to 2011. Three datasets, including catch and effort, size and age, were extracted.

Outline of data used was summarized as shown in Appendix A.

2-1 Data treatment

Catch and Effort data

Data existed between 1981 and 2011 (Fig. 1). Efforts in the number of hooks were recorded substantially starting from 1981. An extremely high effort was recorded in 1986. In most years, efforts were less than 200,000 thousands hooks. Catch in the number of SBT caught were small between 1981 and 1986, and then increased up to 1989 when exceeded 30,000 individuals (Fig. 2). SBT catch of between about 23,000 and 53,000 were maintained during the period between 1989 and 2010.

Latitude and longitude were recorded in multiples of 5 degree except several records. There were some data which were recorded as the middle point of 5 degree (e.g. -42.5 in latitude or 157.5 in longitude). Those records were observed only in 2003 around New Zealand area and these records were excluded in the following analysis.

Size data

Size data exist between 1993 and 2011 (Fig. 3). All data were for length (fork length).

No weight data were included in the size data. Bin of length was 2 cm for all records. Number of SBT measured were small between 1993 and 2001 with a maximum of 5,341 in 1996, and increased drastically to more than 29,000 individuals in 2002 and 2003. The length data file contained raw data between 1993 and 2003, but after 2002 the file included data which were raised to all catch. Both raw and raised data exist for 2002 and 2003.

Age data

Age data converted from length data exist between 2002 and 2011 (Fig. 4). There were two types of dataset in age data, named "TW_A" and "COMPARE". "COMPARE" was used because it was based on the length cut points used at present.

2-2 Temporal and spatial distribution of Taiwanese longline fishery for SBT

Catch and Effort

Figure 5 shows sum of the number of SBT caught by 5x5 degrees square all years between 1981 and 2011 combined. It is recognized that the main place of Taiwanese longline SBT catch occurred around 70E-80E, 30S (30.0S-34.9S). There is almost no overlap of this area with Japanese longline catch, except for little overlaps in margins around 90-100E, 30-35S.

The second major place of Taiwanese catch is found in off Cape waters around 40E, 35S. There are some overlaps occurred between the Taiwanese and Japanese fisheries, 20-50E and 35S and 30-45E and 40S.

In Figure 6 which illustrate the similar figure but separated by year, it is confirmed that there are little overlaps with a few exceptions. It was also observed that these two major areas of Taiwanese longliners have been fished since the first year of 1981.

For these Taiwanese fishing grounds, the classification according to CCSBT statistical areas is not suitable. Figure 7 shows mapping of effort in hooks, number of SBT caught and nominal CPUE in all years between 1981 and 2011 combined. In the south-eastern Indian Ocean, say east of 60E, the western boundary of CCSBT Area 2 (80E) divides the catch area in the middle. The southern boundary of CCSBT Area 2 (35S) also cuts through the continuity of the fishing ground. The northern boundary of CCSBT Area 9 (35S) cut through the continuity of fishing ground around 20-40E ranged from 25S to 40S.

Based on this inspection on spatial patterns of the catch and effort, we propose two new areas, named "TArea", specialized for Taiwanese fishery. TArea 1 is for a fishing

ground centered around 80E and 30S. Tentatively, TArea 1 was defined as between 25S and 40S (not including 40S boundary line) and between 60E and 110E (not including 110E boundary line). The boundaries should be determined after careful examination in the future. It would be better to have sensitivity analyses on CPUE standardization by applying different boundary definitions, especially for the northern and western boundaries.

TArea 2 is for fishing ground centered around 30E and 35S. Tentatively, TArea 2 was defined as between 20S and 44.9S and between 20E and 59.9E. The boundaries in west, north and east should be explored further with sensitivity analyses.

Size

Figures 8 and 9 show length frequencies by year. In the raw length data, the length frequencies were distributed widely between 1993 and 2001. In this period, because the shape of length frequency is not smooth, considering that the number of samples before 2002 was smaller than that after 2002 and very small-sized fish occurred in 1994. The verification with the length records from logbook data would be useful to make further clarification. .

In 2002 and 2003, length data in both raw and raised to all catch were obtained. Raw data were 98% in 2002 and 94% in 2003 of all the catch. Presumably proportion of size data obtained against catch is high after 2004, but this could not be confirmed in the dataset in CCSBT.

In raised to catch length data between 2002 and 2011, most fish caught by Taiwanese longline ranged between 90 and 150 cmFL in all years. Length frequencies in TArea 1 were different from those in TArea 2 in many years, although they were similar in 2010 and 2011.

Age

Figures 10 show age frequency by year after 2002. It had raised to all catch. Ages with non-trivial catch ranged between 1 and 8. Ages 3, 4 and 5 were dominant in each year.

Age difference within TArea 1 was investigated in longitude, latitude and month. No tendency of change along with longitude was observed (Fig. 11). In latitude, the catch was much larger in 30S than in 25S or 35S, but there was no tendency of change along with latitude (Fig. 12).

In month, the catch was large in July and August (Fig. 13). There was no obvious tendency of change along with month, though age 3 was highest in September in some

years that age 4 was the highest in other months (i.e. 2003, 2006, 2007 and 2008).

3. Discussion

Our analysis showed that substantial amount of data have been accumulated from Taiwanese longline fishery, especially since 2002. Large amount of size data have been accompanied.

Taiwanese SBT fishery in south eastern Indian Ocean is unique such that there were little overlaps to Japanese longline fishing ground. Therefore, Taiwanese longline fishery data provide unique information on the stock status of SBT to CCSBT.

The SBT caught was mainly age 3, 4, and 5. It is the age range of the same as or one year older than those seen in aerial survey and one year younger than those of Japanese longline CPUE which truncated at age 4. Taiwanese longline data is expected to provide information of recruitment levels in their young stage.

As far as we analyzed, annual changes in fishing area, and size difference in longitude, latitude and month were not large, thus it is expected that stock status is reflected in CPUE without strong masking from these effect.

In conclusion at this stage, it is worthwhile to do further analysis on Taiwanese data.

To go further, we need to understand more about the fishery and data. For example, its nature of targeting albacore is unique and unfamiliar in the past CCSBT analysis of longline CPUE. Obtaining appropriate information of operation, which may be difficult to reflect on the data submitted to CCSBT in regular data exchanges, from fishermen through Taiwanese scientists is essential on this matter.

There are several points identified relating data to be considered.

- Unify catch and effort in 5x5 square (e.g. there was representation such as -42.5 in latitude in 2003).
- Check whether it was appropriate to have the extremely high effort in 1986.
- Provide size data both in raw and raised form since 2004.
- Examine size data between 1993 and 2001 based on the knowledge from sufficient amount of data after 2002.

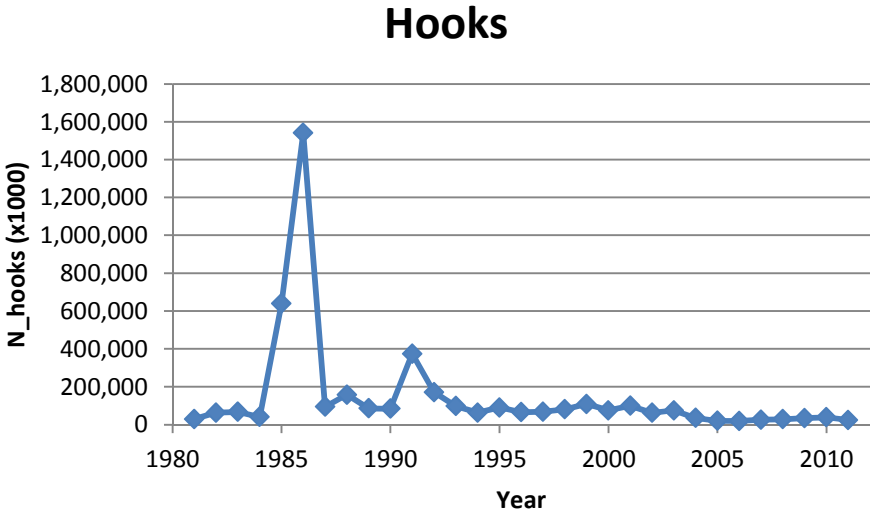


Fig 1. Number of hooks in the data by year.

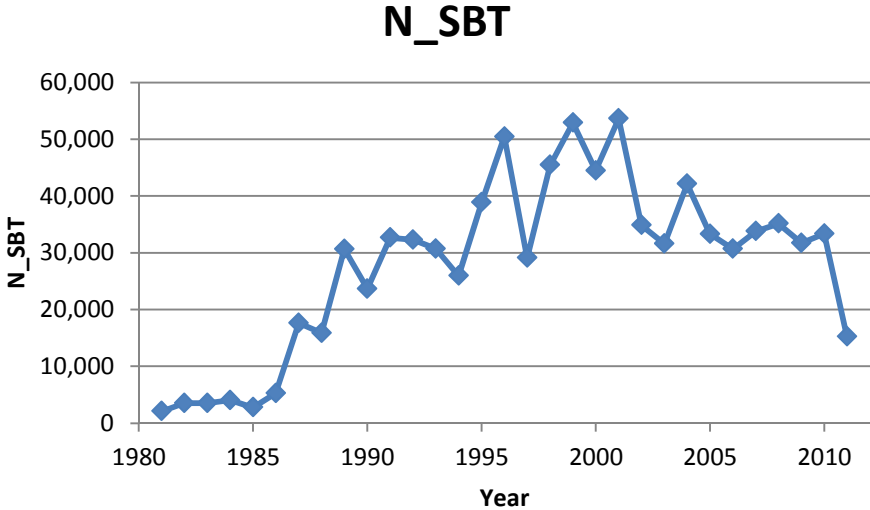


Fig 2. Number of SBT caught in the data by year.

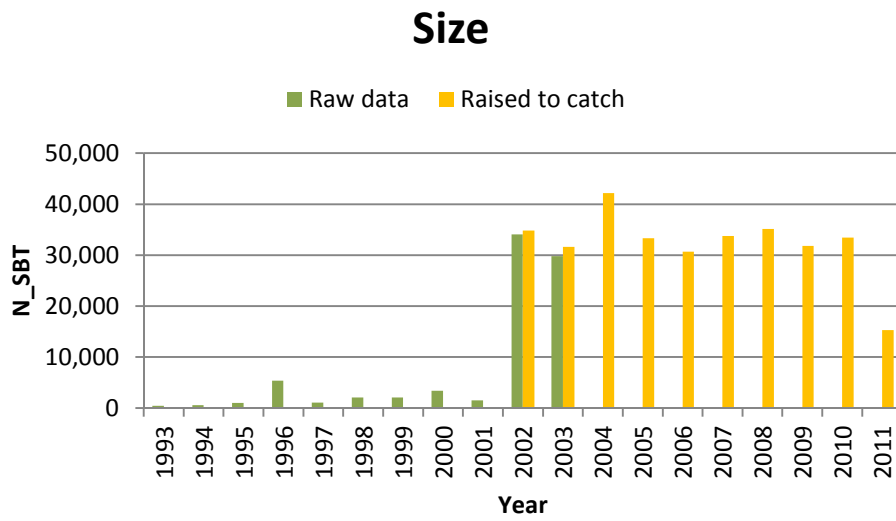


Fig 3. Number of SBT size in the data by year.

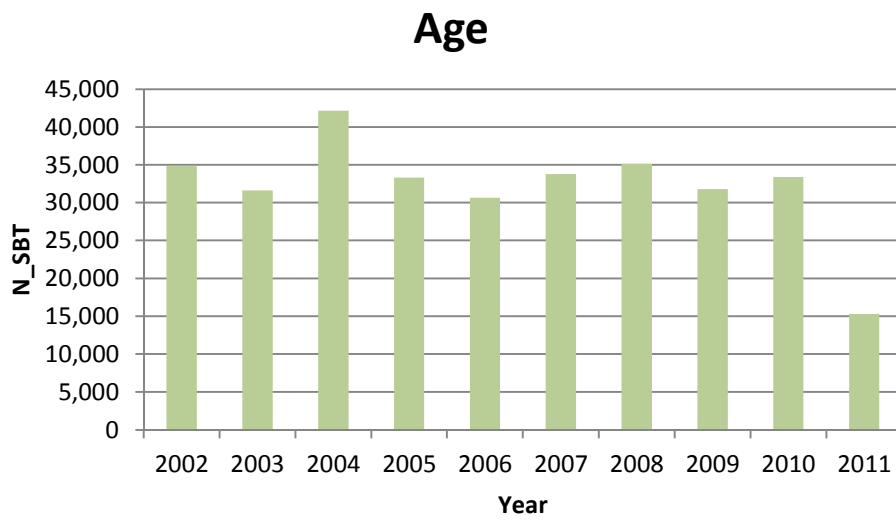


Fig 4. Number of SBT in the catch-at-age data by year.

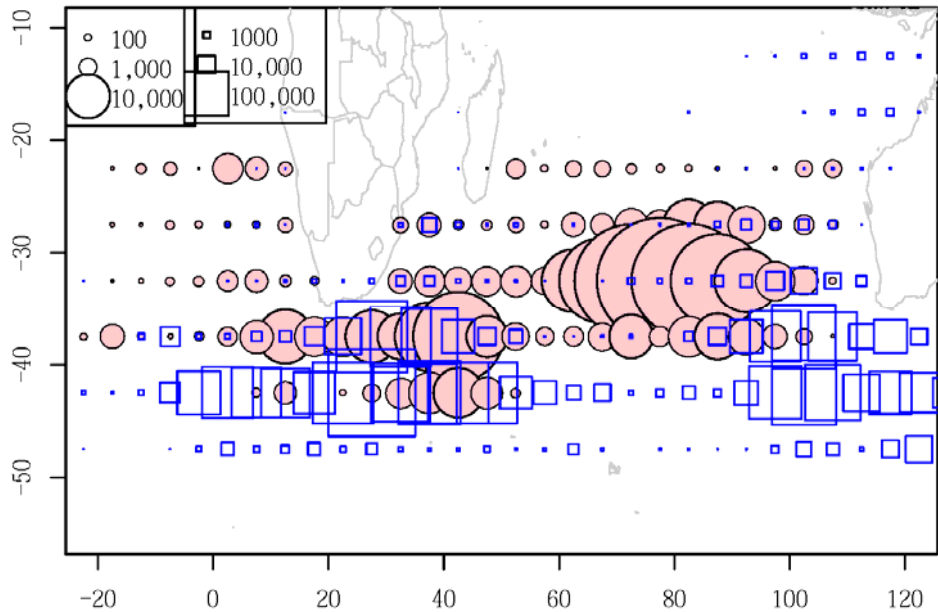


Fig 5. Sum of the number of SBT caught by 5x5 degrees square all years combined between 1981 and 2011. Circle is for Taiwanese longline and square is for Japanese longline in the same period. Note the difference of unit in the legend.

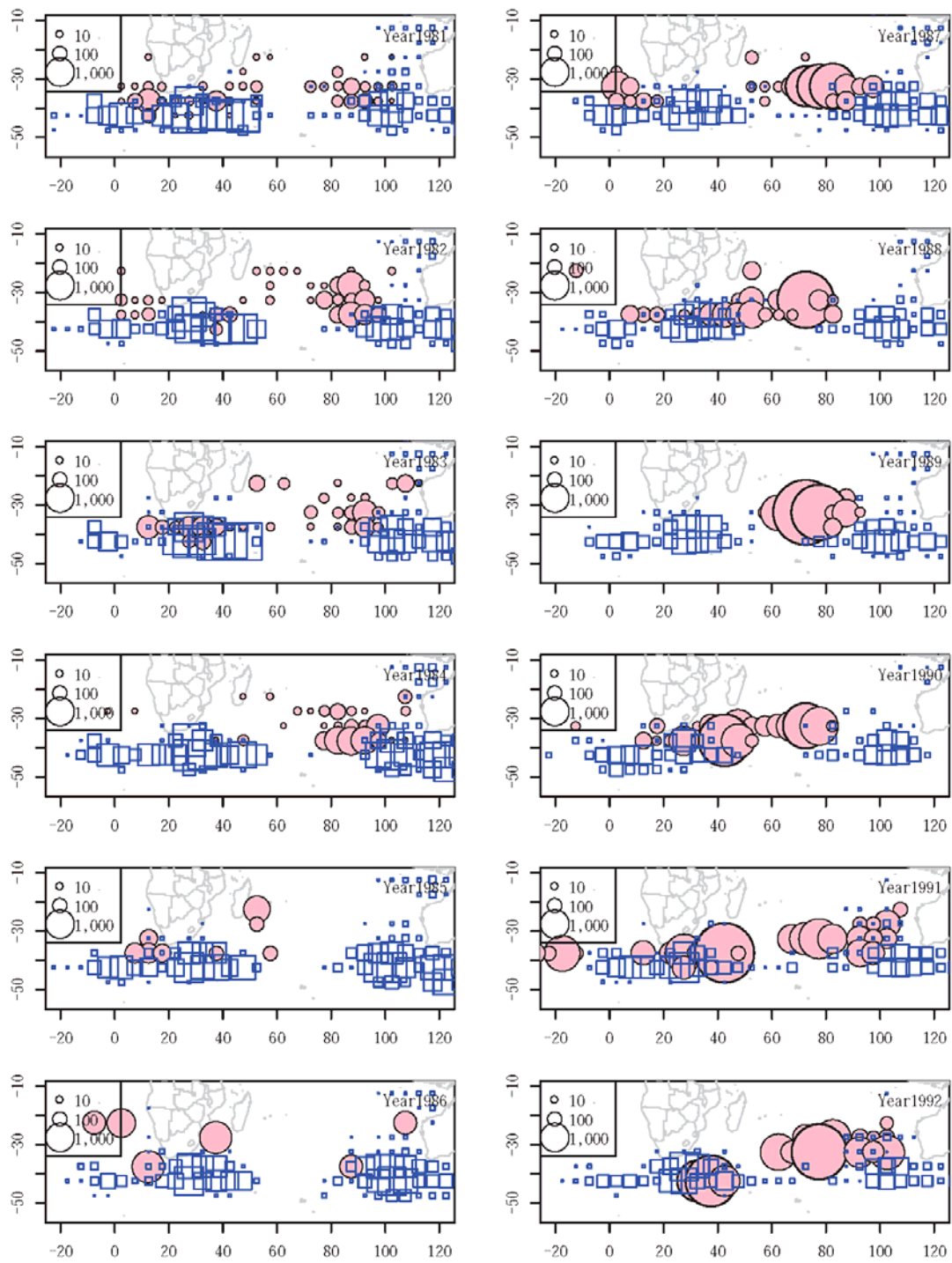


Fig 6. Sum of the number of SBT caught by 5x5 degrees square by year. Circle is for Taiwanese longline and square is for Japanese longline.

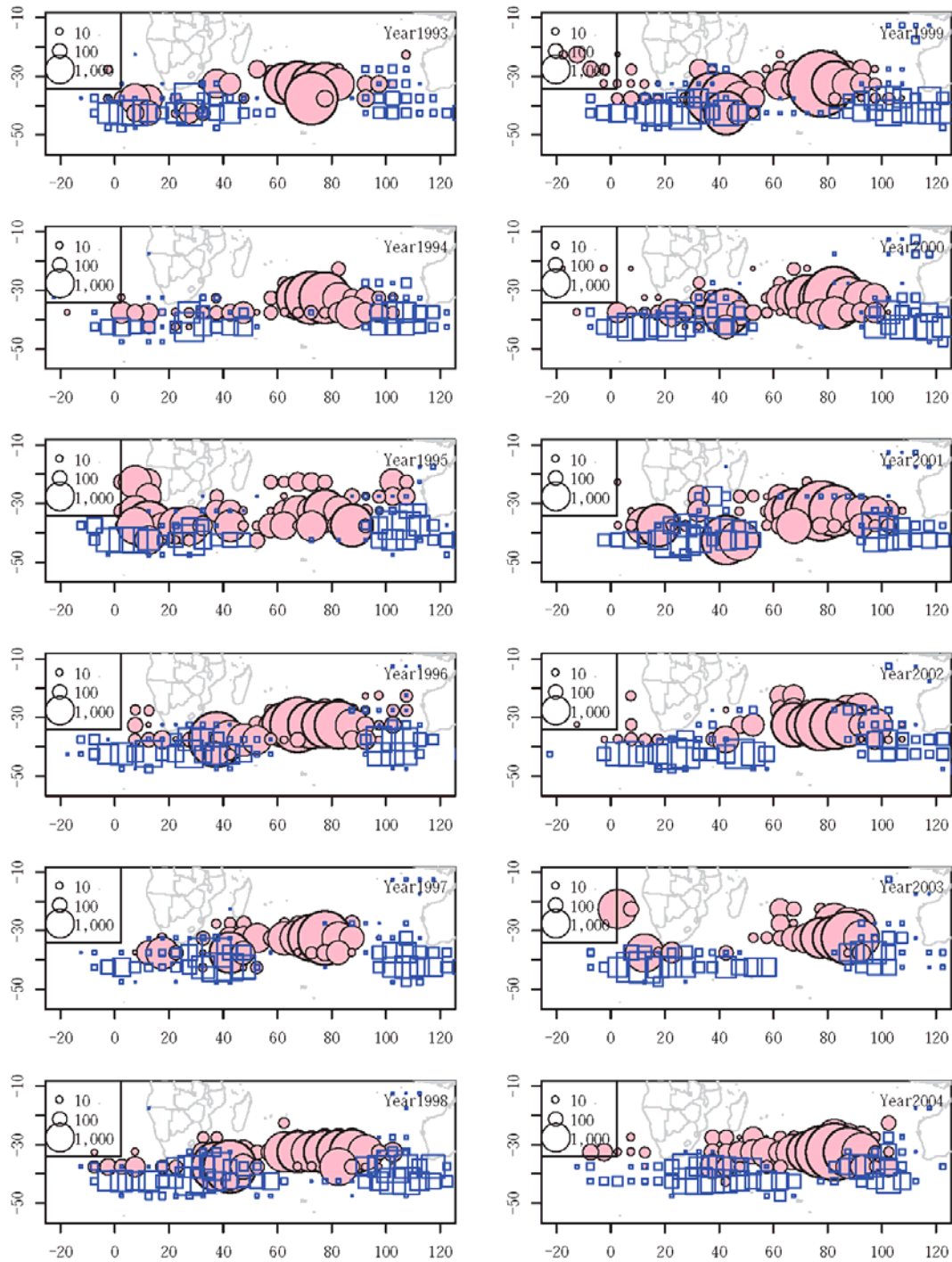


Fig 6. (cont'd)

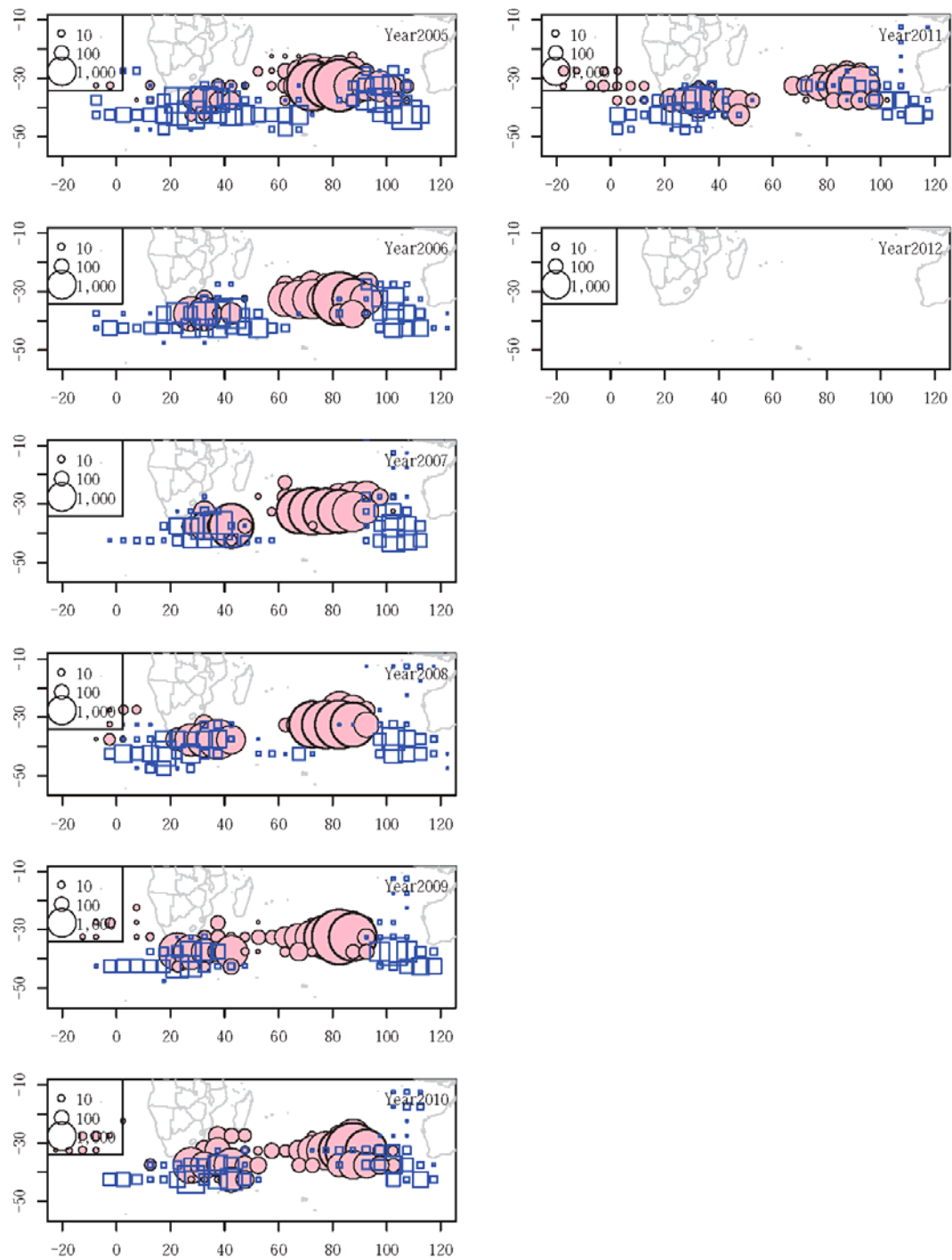


Fig 6. (cont'd)

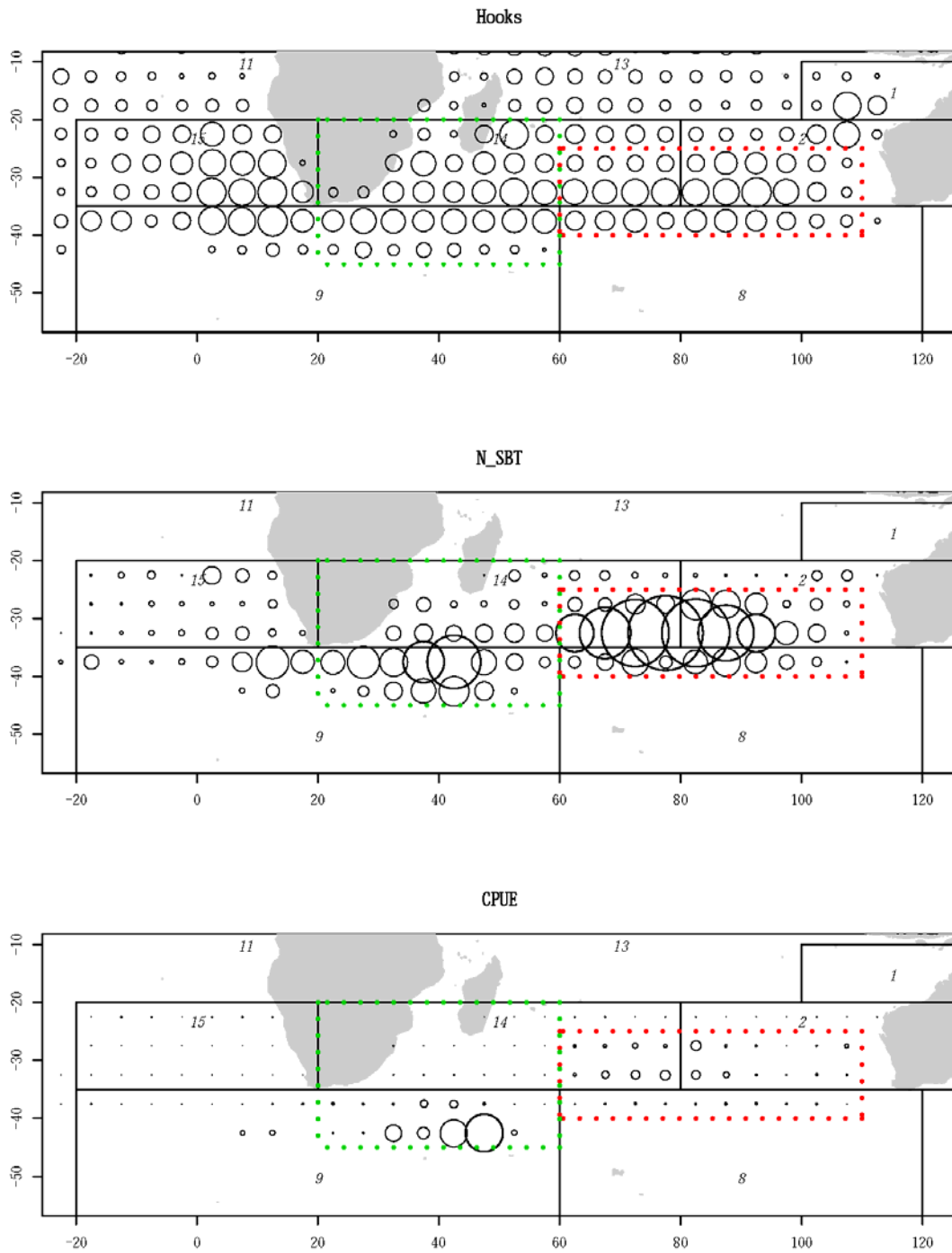


Fig 7. Hooks, number of SBT caught and nominal CPUE of SBT of Taiwanese longline by 5x5 degree square for all the years combined between 1981 and 2011. Areas enclosed with dotted line in red and green is proposed areas, TArea 1 and TArea 2, respectively. Areas enclosed with black line and the number denotes CCSBT statistical areas.

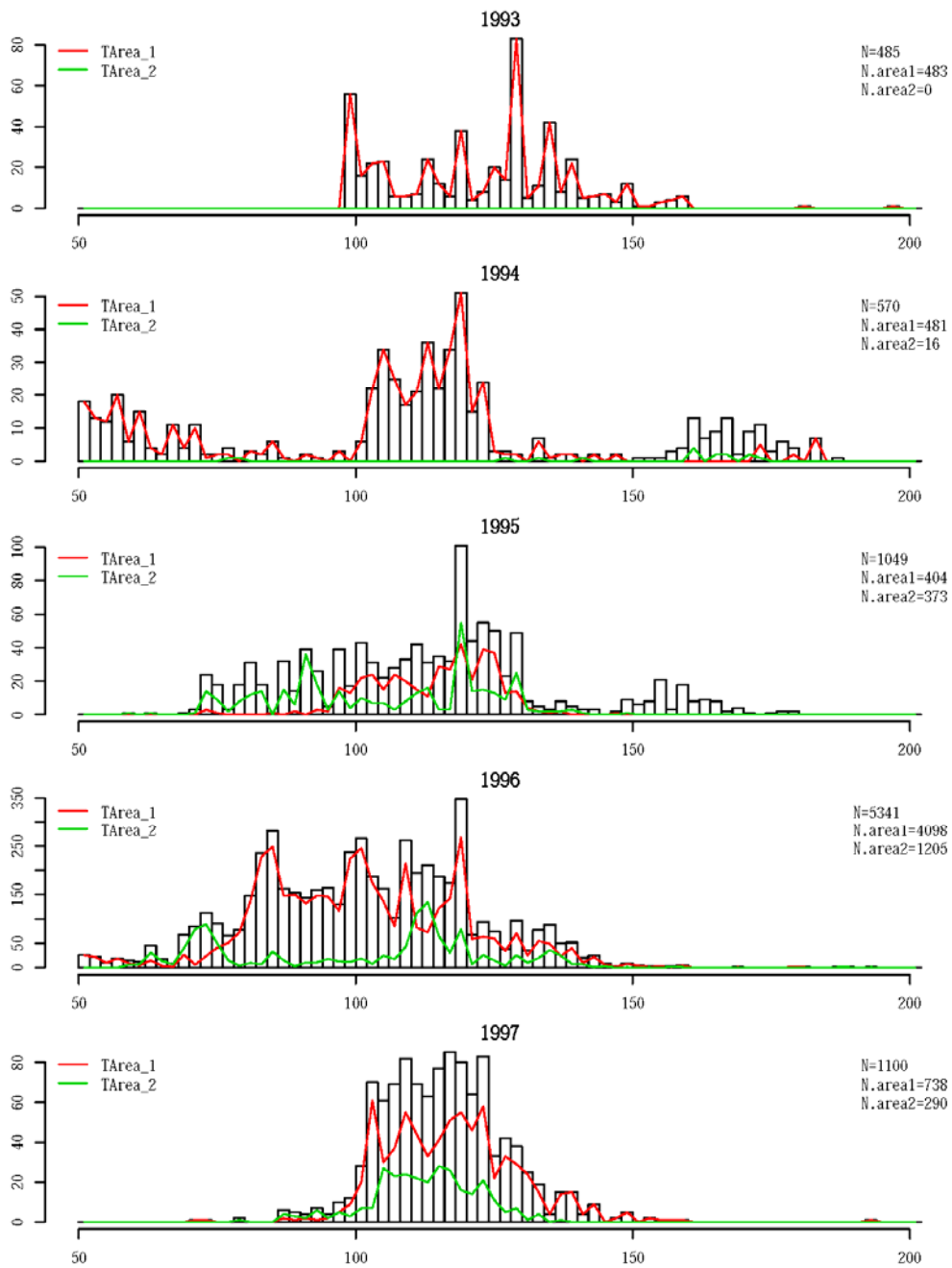


Fig 8. Length frequency of SBT caught by in all areas (bar), TArea 1 (red line) and TArea 2 (green line) for raw size data.

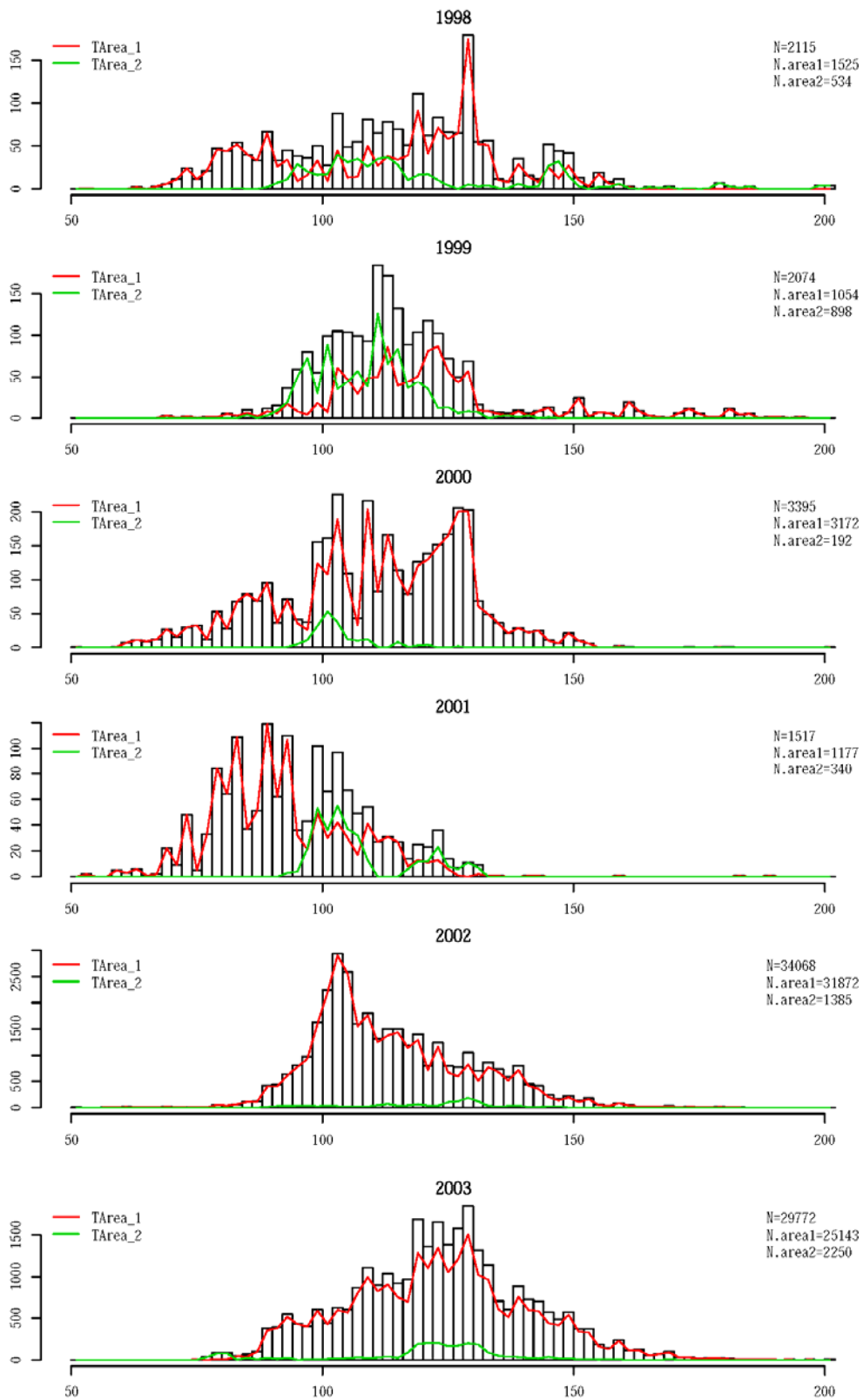


Fig 8 (cont'd)

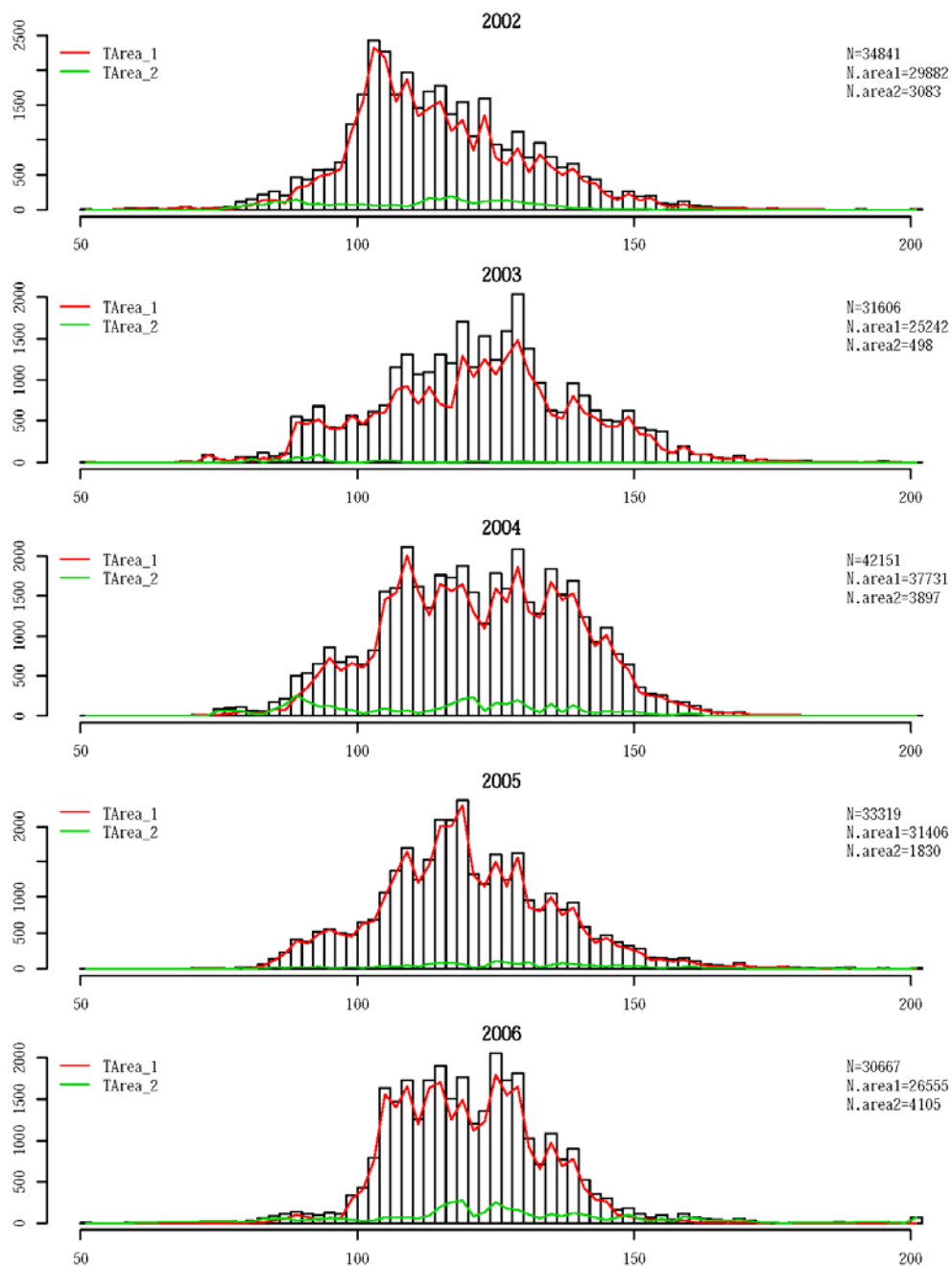


Fig 9. Length frequency of SBT caught by year in all areas (bar), TArea 1 (red line) and TArea 2 (green line) for raised to catch.

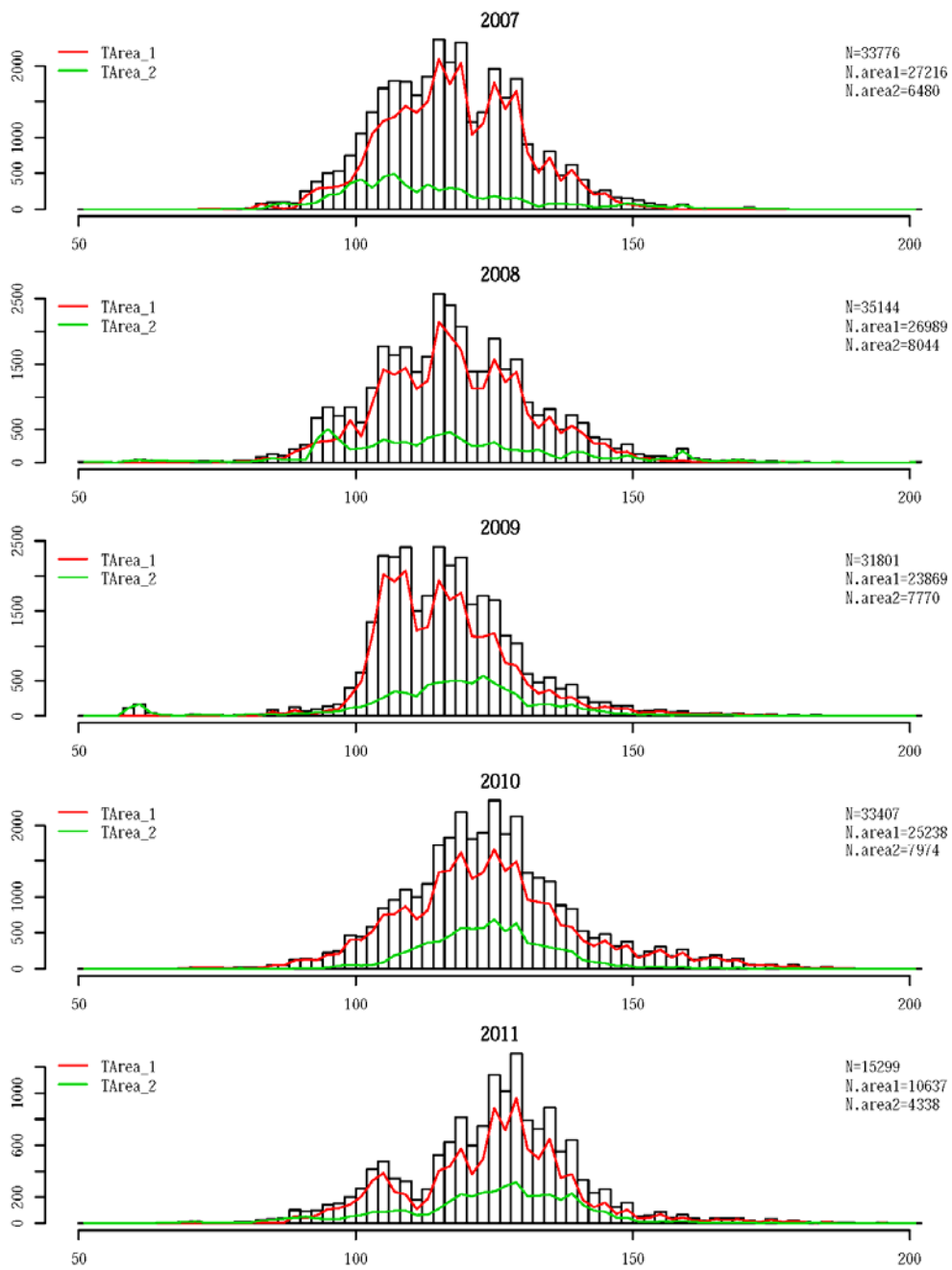


Fig 9 (cont'd)

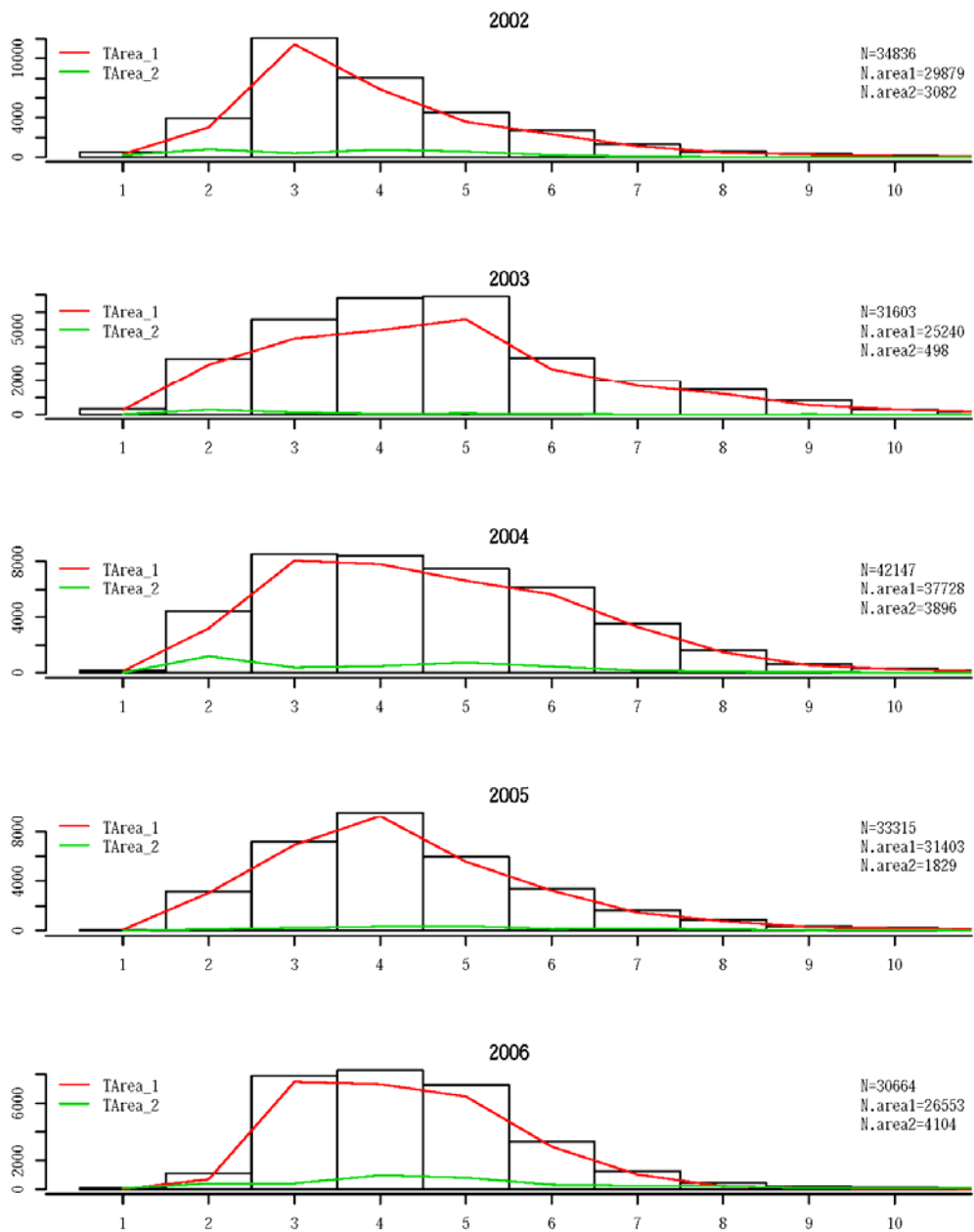


Fig 10 Age frequency of SBT caught by year in all areas (bar), TArea 1 (red line) and TArea 2 (green line).

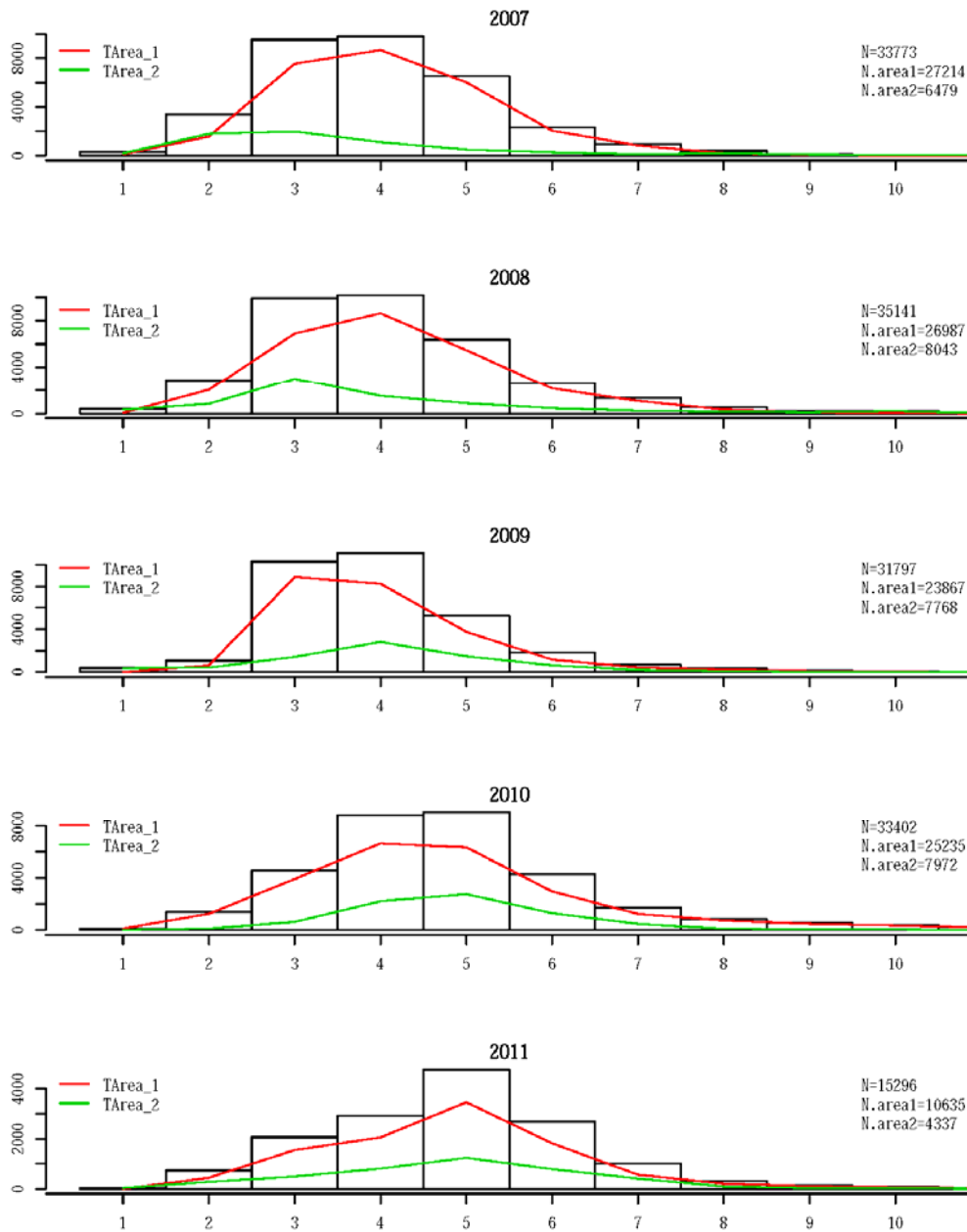


Fig 10 (cont'd)

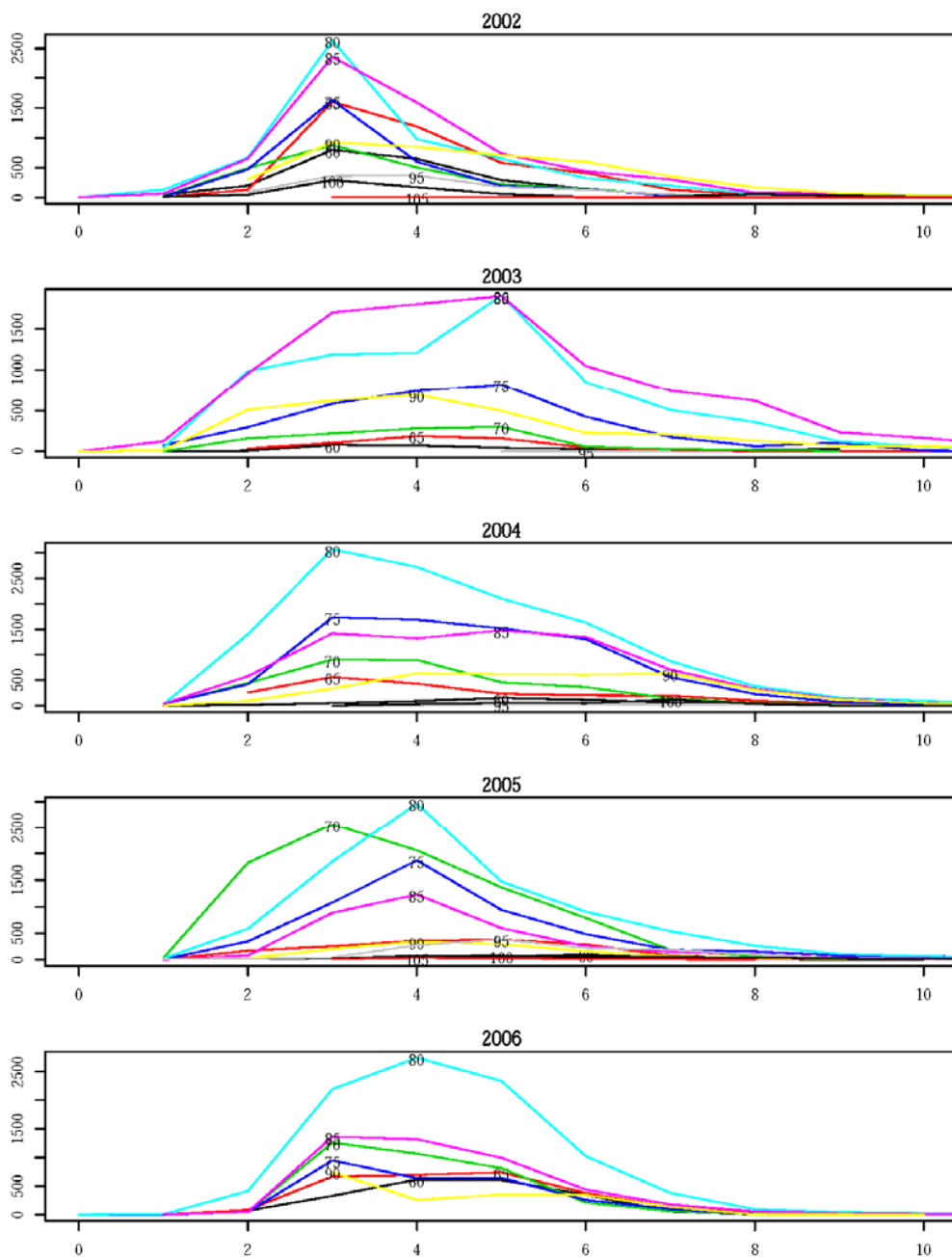


Fig 11 Age frequency of SBT caught by year and longitude. Numerical denotes its longitude and placed at the highest frequency.

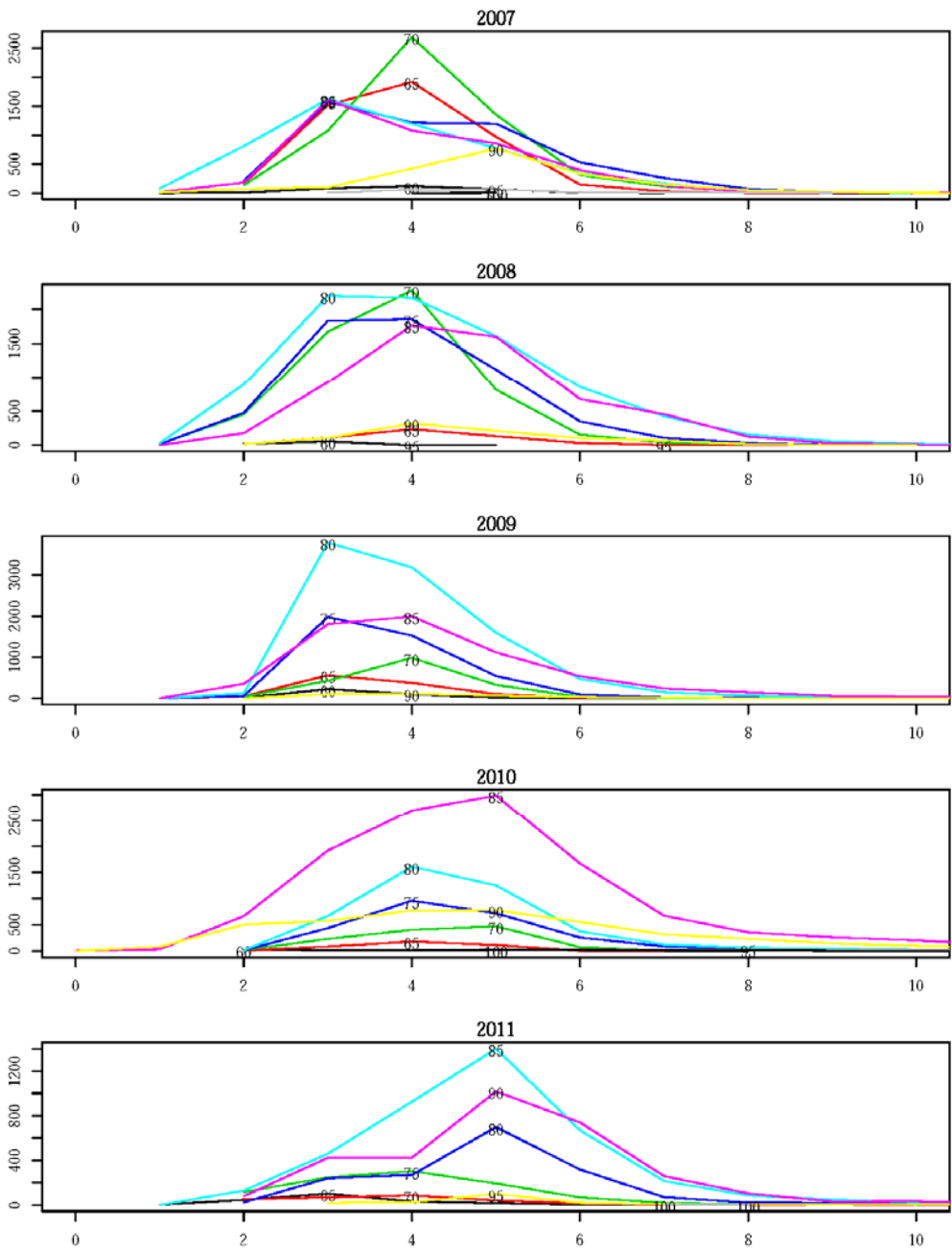


Fig 11 (cont'd)

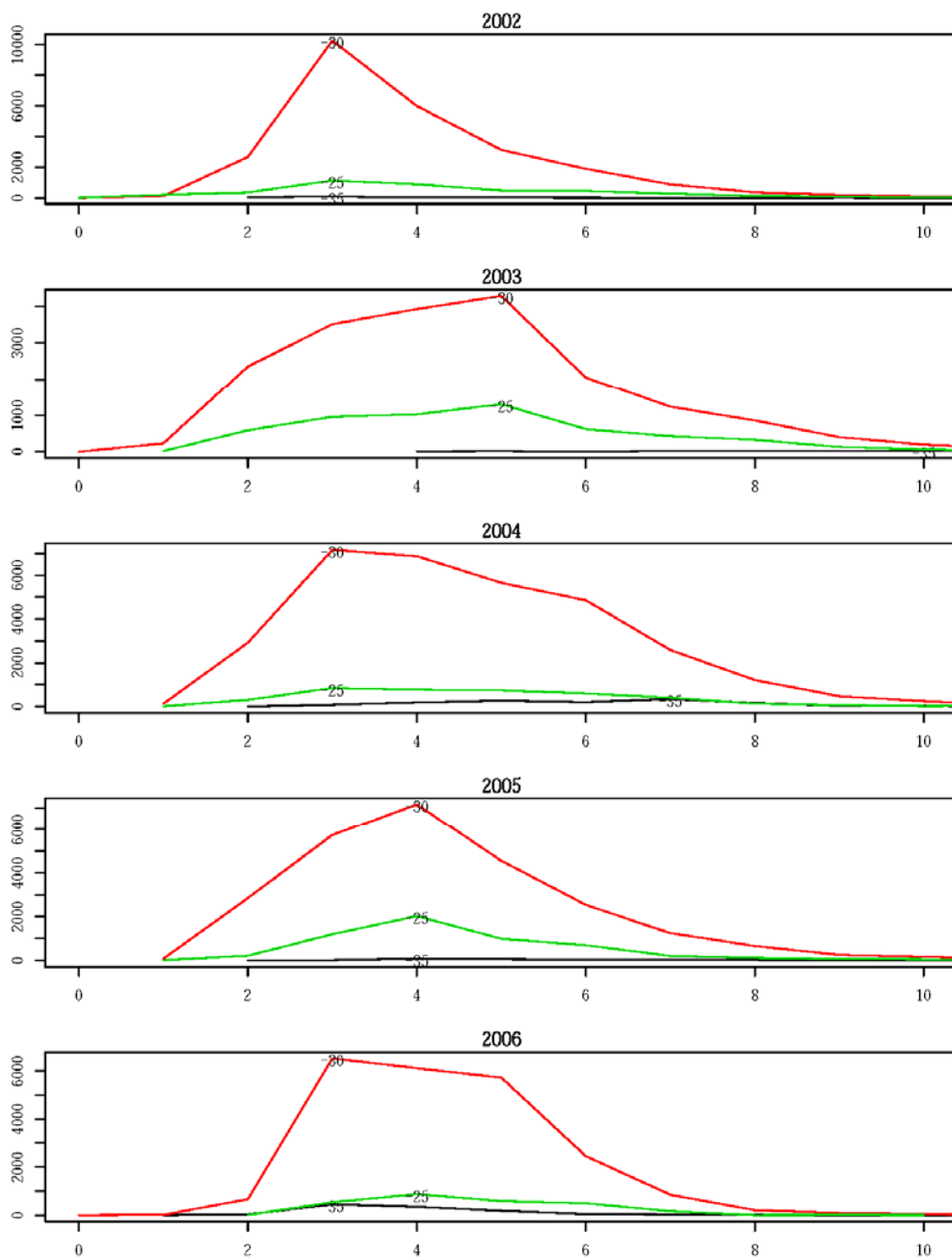


Fig 12 Age frequency of SBT caught by year and latitude.
 Numerical denotes its latitude in south and placed at the highest frequency.

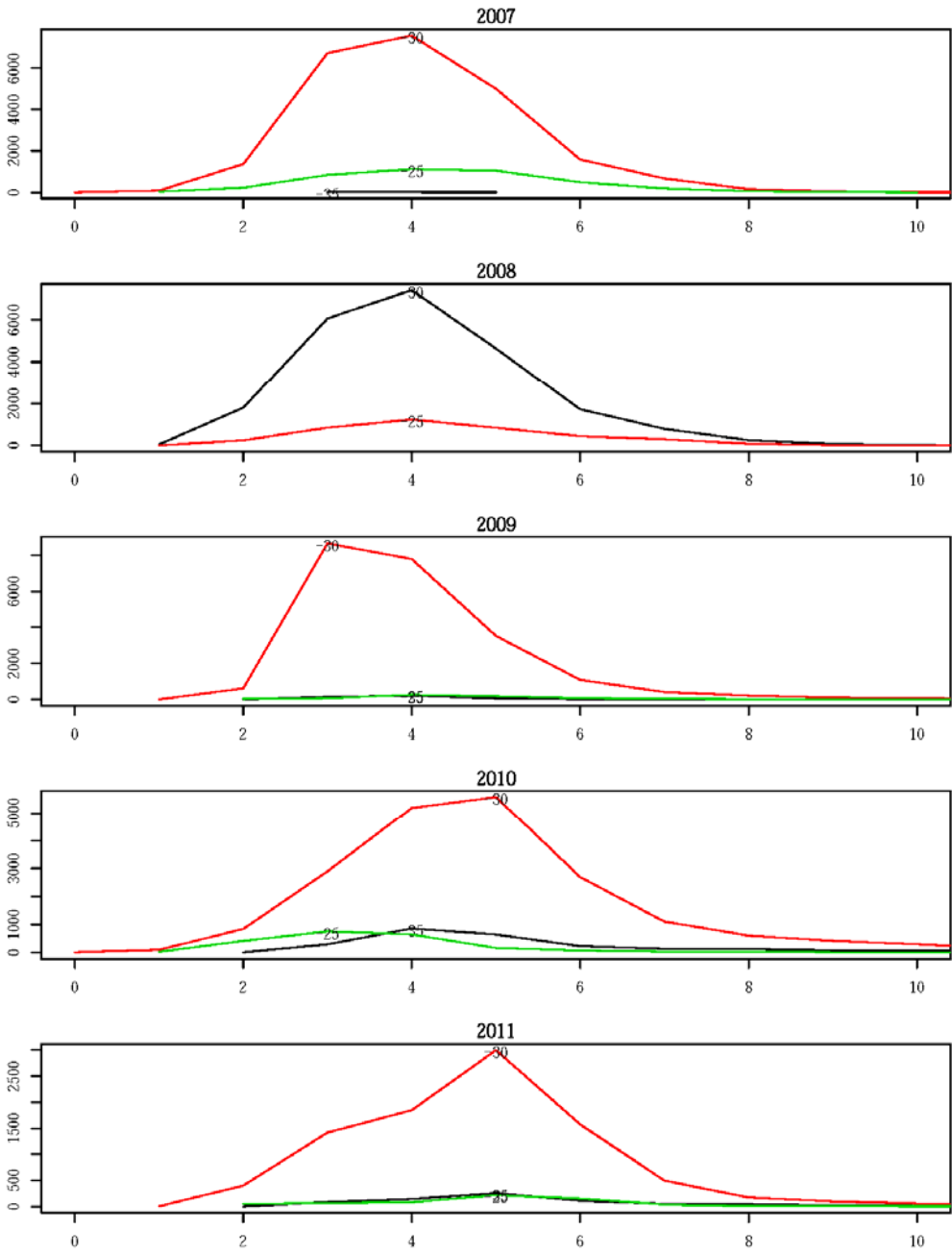


Fig 12 (cont'd)

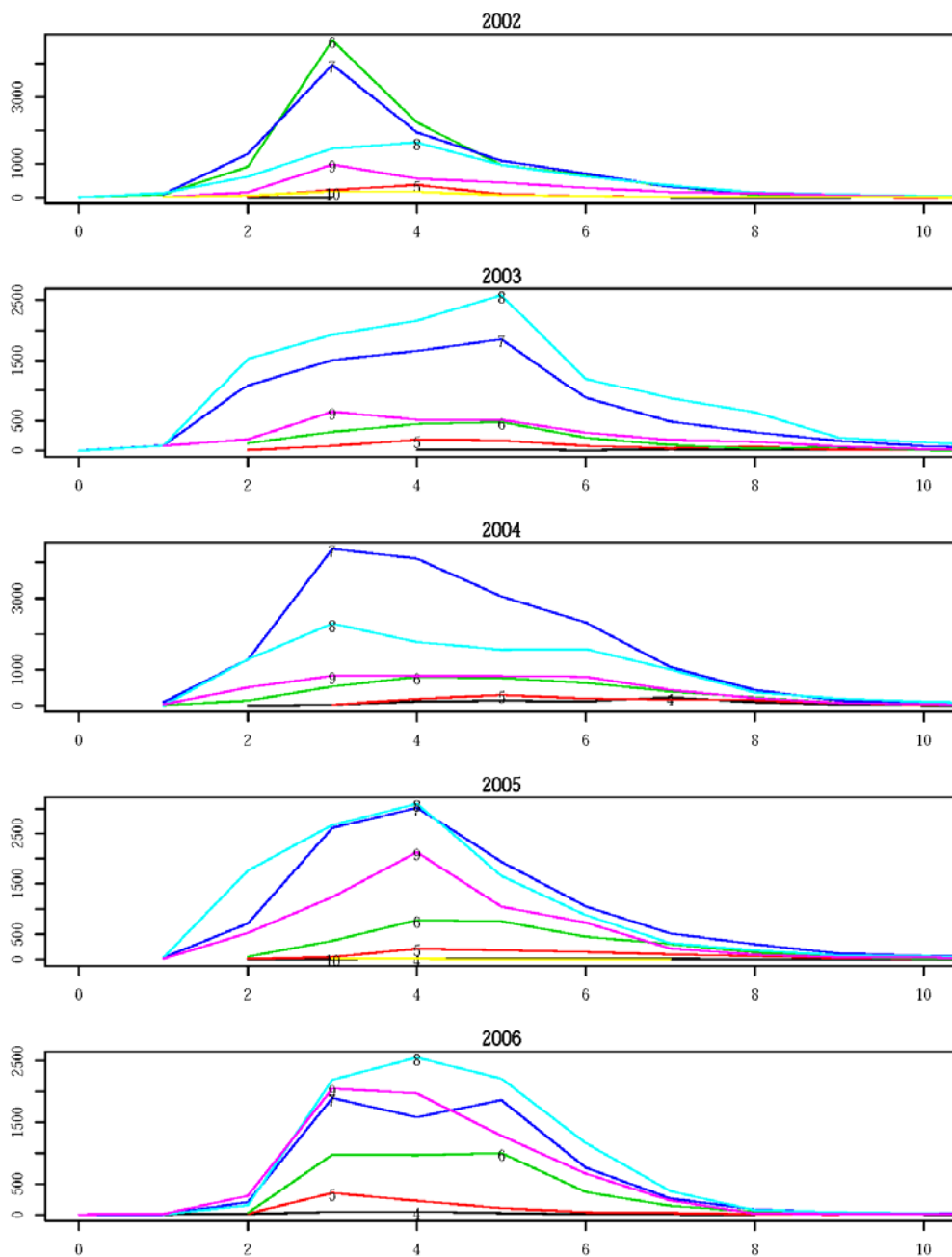


Fig 13 Age frequency of SBT caught by year and month.
 Numerical denotes its month and placed at the highest frequency.

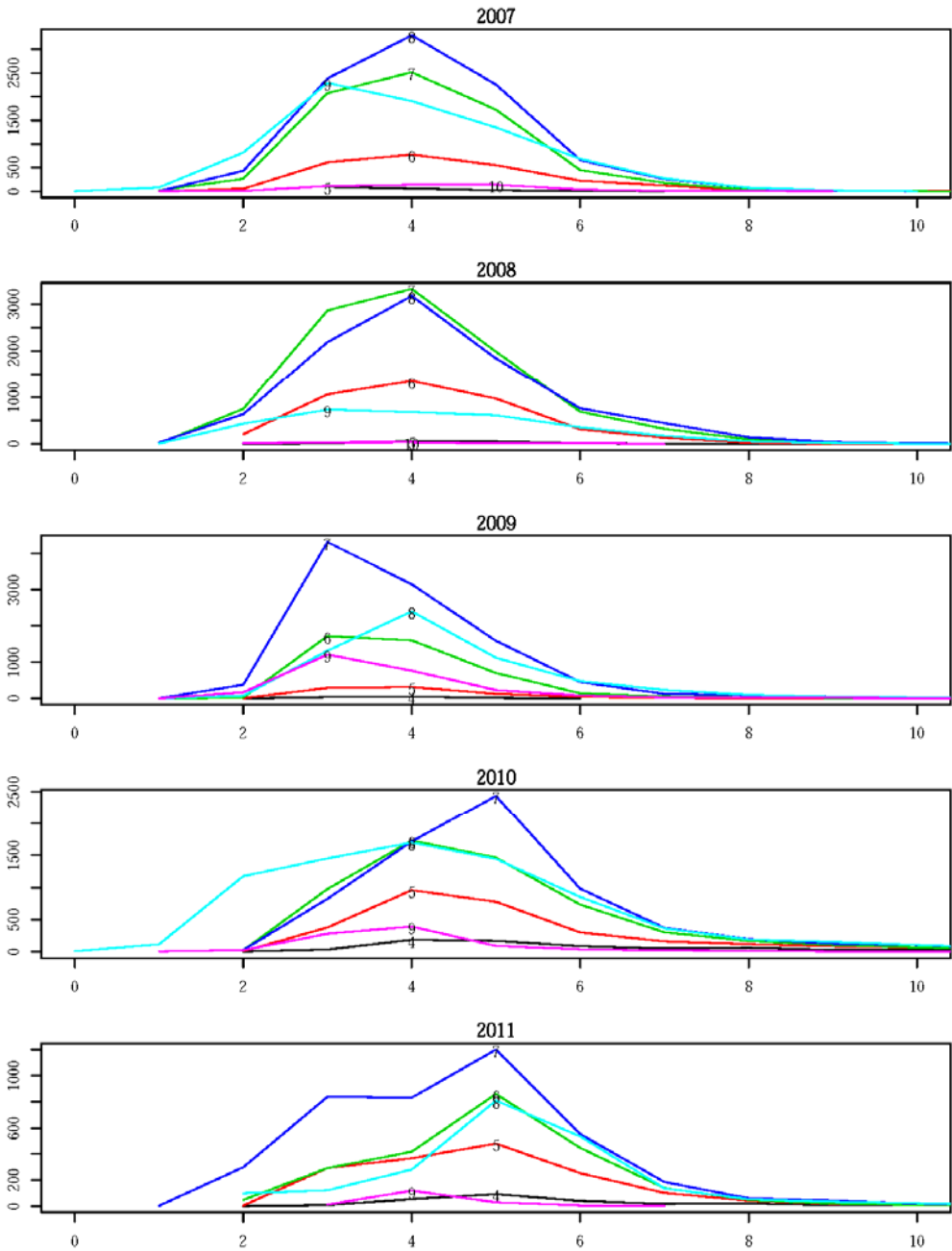


Fig 13 (cont'd)

Appendix A Summary table of Taiwanese data used.

Table A-1. Number of records of catch and effort by year and month.

Year	1	2	3	4	5	6	7	8	9	10	11	12	total
1981	11	21	28	28	25	33	23	19	28	19	2	4	241
1982	7	20	32	32	29	35	29	23	29	11	5	9	261
1983	15	16	26	23	23	21	16	14	16	9	7	8	194
1984	15	13	10	19	16	16	14	17	19	10	9	7	165
1985	13	16	20	18	19	16	15	12	14	3	1	1	148
1986	4	6	10	13	11	12	12	10	16	7	8	8	117
1987	5	5	17	21	25	25	24	19	18	9	1	7	176
1988	7	10	14	12	17	15	9	14	13	1	3	4	119
1989	3	3	8	14	9	10	8	8	5				68
1990	1		2	6	9	19	22	15	13	5	1	3	96
1991	7	9	14	20	16	13	19	14	10	4	3	3	132
1992		4	5	7	7	11	14	12	8	1			69
1993	2	7	15	17	24	23	22	13	24	21	14	13	195
1994	12	16	28	29	34	30	33	33	31	13	8	6	273
1995	13	13	26	36	32	38	37	44	32	10	9	8	298
1996	36	38	31	30	29	30	33	37	42	54	32	41	433
1997	50	36	35	37	38	28	28	42	39	38	32	21	424
1998	33	23	23	35	40	39	34	47	46	35	35	37	427
1999	45	39	40	45	42	36	36	47	55	49	42	40	516
2000	38	42	33	47	45	46	41	47	62	54	49	43	547
2001	44	39	31	33	41	33	26	36	37	28	23	22	393
2002	29	24	26	38	39	35	33	43	39	19	13	18	356
2003	39	41	22	17	19	11	18	31	24	11	19	11	263
2004	13	18	18	17	23	21	21	29	36	16	14	16	242
2005	15	15	22	21	26	20	20	29	18	8	12	8	214
2006	16	11	14	11	14	12	14	20	19	8	6	7	152
2007	14	11	10	11	13	13	14	15	24	15	16	8	164
2008	8	13	15	25	31	23	21	21	25	11	10	19	222
2009	15	24	28	19	34	37	29	30	32	11	12	16	287
2010	23	23	32	35	32	30	29	31	30	13	10	16	304
2011	20	22	23	21	27	23	30	25	16	5	4	3	219
total	553	578	658	737	789	754	724	797	820	498	400	407	7715

Table A-2. Number of hooks (x1000) by year and month.

Year	1	2	3	4	5	6	7	8	9	10	11	12	total
1981	887	1,997	4,052	3,867	4,565	3,779	3,459	2,619	2,100	1,005	348	448	29,125
1982	658	2,916	6,720	8,147	9,277	8,651	9,300	7,956	4,436	1,668	1,398	2,175	63,302
1983	4,129	4,656	8,766	11,955	9,800	7,431	5,378	4,415	3,665	2,881	2,487	1,461	67,025
1984	2,643	4,557	6,152	4,828	4,980	4,057	3,978	3,166	2,839	1,164	1,004	797	40,165
1985	25,784	37,420	69,569	87,532	99,242	85,881	96,019	68,568	38,765	7,826	9,306	13,707	639,617
1986	35,141	77,766	87,481	149,861	205,397	205,732	140,840	166,108	135,145	136,973	125,976	74,751	1,541,170
1987	3,103	3,319	5,815	10,995	12,073	15,916	16,278	13,367	8,886	2,034	298	2,338	94,422
1988	6,087	8,355	11,975	16,868	22,310	23,083	25,634	27,674	7,729	467	2,555	5,207	157,942
1989	1,383	1,818	2,723	5,573	13,195	17,691	23,083	17,077	3,298				85,842
1990	726		246	2,960	9,055	20,297	23,565	17,714	5,101	2,802	349	1,644	84,458
1991	27,820	26,452	40,787	55,788	55,611	47,273	46,923	41,977	17,932	3,797	8,255	1,390	374,006
1992		2,930	4,612	15,428	30,590	29,621	39,394	34,774	11,157	2,785			171,291
1993	1,160	2,636	5,401	9,666	10,393	11,458	12,767	11,911	12,060	8,033	6,775	5,398	97,658
1994	1,920	2,487	6,592	8,445	8,286	9,414	10,060	9,438	3,524	1,140	852	905	63,062
1995	3,603	3,408	5,236	10,901	11,782	11,354	12,780	13,328	9,822	3,213	2,035	2,286	89,747
1996	5,465	4,428	2,408	3,235	6,046	7,134	9,376	9,104	5,285	3,975	4,458	5,017	65,931
1997	5,690	3,804	2,716	6,445	6,712	7,067	9,955	9,317	5,149	3,770	3,886	3,473	67,985
1998	3,757	2,431	3,651	6,285	7,204	10,804	12,779	10,776	5,778	5,238	6,734	5,498	80,934
1999	8,004	3,587	5,269	8,460	11,065	14,337	12,274	12,414	9,631	7,205	8,360	8,568	109,176
2000	3,555	2,591	2,530	3,918	7,168	10,607	12,447	12,235	6,899	3,712	4,945	4,488	75,094
2001	6,748	6,882	5,702	7,017	8,450	11,114	14,104	12,465	7,732	6,510	6,450	5,906	99,079
2002	8,236	3,907	3,023	4,276	6,762	8,260	8,238	8,623	5,622	1,875	1,679	1,950	62,452
2003	16,225	8,432	6,541	4,590	4,700	5,086	9,289	8,855	4,954	1,635	1,962	2,345	74,614
2004	356	700	1,260	1,799	2,293	4,306	8,719	7,422	2,969	1,356	2,294	2,075	35,549
2005	701	627	1,202	1,389	1,705	2,633	4,530	4,215	1,989	170	210	256	19,626
2006	755	756	1,021	1,648	1,882	2,479	3,092	2,992	2,041	604	886	763	18,919
2007	1,732	1,501	2,286	2,417	1,970	2,343	3,329	3,024	2,721	1,360	1,320	1,529	25,532
2008	937	965	1,704	2,727	3,624	3,439	4,511	4,277	2,441	1,160	1,166	1,275	28,226
2009	935	1,032	1,681	3,008	4,055	5,085	6,339	5,348	2,786	1,523	1,290	1,076	34,158
2010	1,485	1,175	1,934	3,470	5,371	7,073	7,794	6,628	1,826	629	566	726	38,677
2011	1,184	857	1,185	2,717	4,076	4,381	4,928	3,607	997	305	213	67	24,518
total	180,810	224,394	310,241	466,214	589,638	607,786	601,160	561,392	335,280	216,815	208,057	157,517	4,459,303

Table A-3. Number of SBT retained by year and month.

Year	1	2	3	4	5	6	7	8	9	10	11	12	total
1981	178	227	738	280	306	113	123	17	66	6	0	7	2,061
1982	146	354	330	111	382	604	417	853	168	6	36	116	3,523
1983	687	630	187	1,205	310	169	9	65	18	122	56	47	3,505
1984	134	907	2,072	312	81	77	51	231	40	113	5	10	4,033
1985	296	493	198	99	592	296	0	0	0	0	592	197	2,763
1986	957	0	479	479	0	0	0	0	2,394	958	0	0	5,267
1987	110	221	277	2,098	981	2,721	4,888	5,288	690	276	0	69	17,619
1988	156	739	428	584	467	1,478	4,043	7,542	234	0	39	156	15,866
1989	0	61	245	0	154	5,693	14,965	8,967	550				30,635
1990	45		0	22	157	7,371	8,177	6,204	1,188	0	0	492	23,656
1991	2,993	774	2,802	1,159	774	12,939	7,532	966	97	0	2,125	484	32,645
1992		0	11,674	435	73	1,742	6,746	9,935	1,669	0			32,274
1993	127	830	1,179	1,945	4,463	6,790	7,698	3,521	3,872	96	64	112	30,697
1994	488	354	914	1,707	1,754	4,329	10,039	5,285	913	81	9	57	25,930
1995	3,189	2,345	3,064	6,127	4,574	5,820	5,666	4,153	2,009	623	960	308	38,838
1996	3,129	1,435	171	214	1,066	6,122	17,047	9,296	1,052	98	3,047	7,745	50,422
1997	2,626	649	240	198	166	1,160	8,403	10,756	1,874	0	0	3,028	29,100
1998	5,944	333	169	542	658	4,954	12,668	9,749	1,409	453	1,389	7,166	45,434
1999	6,019	691	213	202	496	4,283	13,359	9,626	1,762	72	5,156	11,016	52,895
2000	6,210	1,677	21	620	1,264	5,849	13,386	10,304	4,649	481	0	2	44,463
2001	10,583	1,690	974	2,585	284	5,079	18,350	11,730	1,228	1,056	33	39	53,631
2002	0	134	228	28	638	10,900	15,063	4,762	2,245	0	0	843	34,841
2003	44	582	1,972	607	715	1,800	8,291	11,727	5,837	0	0	0	31,575
2004	1,032	0	47	773	1,241	4,477	17,960	11,622	4,895	0	16	62	42,125
2005	582	209	0	57	859	3,028	10,484	11,197	6,856	27	0	0	33,299
2006	580	1,410	17	139	769	3,553	7,076	9,632	7,473	0	0	11	30,660
2007	0	0	0	0	234	2,456	7,628	9,904	7,963	549	1,251	3,787	33,772
2008	1,627	157	0	49	187	4,148	10,536	10,100	3,293	349	1,503	3,182	35,131
2009	2,866	214	0	102	839	4,537	10,821	6,328	3,642	162	512	1,681	31,704
2010	2,966	325	0	785	3,426	6,030	8,317	9,976	1,243	2	56	213	33,339
2011	599	757	0	361	1,667	2,577	4,991	3,315	460	91	275	133	15,226
total	54,313	18,198	28,639	23,825	29,577	121,095	254,734	203,051	69,789	5,621	17,124	40,963	866,929

Table A-4. Number of records of catch and effort by latitude and longitude.

	-55	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	135 total		
-45				1																																	1
-40		7	30	23	18	6	3					1	3	15	7	12	33	23	13	22	10	3	1														230
-35	6	48	117	79	44	28	18	39	21	21	48	98	96	112	91	99	118	141	109	108	81	67	75	70	59	60	36	84	85	79	60	30	13	1		2241	
-30		5	16	8	4	5	7	11	21	21	25	74	72	86	66	7	12	82	117	94	89	98	112	114	114	129	135	142	149	140	91	40	7		2093		
-25			1	10	13	6	3	6	12	19	31	67	68	62	1			14	65	65	81	86	72	52	48	57	60	63	91	72	27	15	8		1175		
-20					20	24	13	19	13	13	25	64	49	17			7	14	6	41	91	85	79	78	55	47	25	27	21	12	22	33	4		904		
-15					2	23	19	18	15	11	6	16	12				13	5	1	15	41	34	31	23	12	8	6	9	4	7	15	4			350		
-10					3	21	21	10	6	6	1	2	1					8	6	35	40	33	30	26	14	15	22	18	1	4	5	1			329		
-5							1	17	9	10	6							1	10	24	36	41	57	51	12	26	24	28	20	9	1				9	392	
total	6	60	164	121	104	113	85	103	105	91	145	332	307	292	165	118	163	267	332	318	333	431	467	439	411	362	330	361	408	359	204	119	81	10	9	7715	

Table A-5. Number of hooks (x1000) by latitude and longitude.

	-55	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	135 total		
-45				21																																	21
-40		285	58,133	14,044	2,315	378	362					101	320	2,806	605	779	7,835	1,489	5,085	2,947	581	370	5														98,436
-35	208	19,804	222,341	62,798	38,523	13,939	3,285	23,039	22,326	1,642	11,220	115,052	110,148	164,083	43,559	31,920	80,066	55,245	34,020	62,381	34,313	56,383	54,467	18,058	19,344	44,661	8,588	37,831	43,165	27,381	13,563	3,975	1,606	42		1,478,955	
-30		118	875	550	141	103	175	844	5,560	4,932	17,542	137,797	94,268	135,672	30,582	522	1,372	26,938	31,436	26,625	51,564	123,456	63,772	77,297	58,952	94,850	107,432	94,617	91,147	156,322	77,234	15,356	669		1,528,721		
-25			40	593	564	714	281	637	13,101	10,907	39,291	98,746	61,683	110,608	35			8,505	63,198	9,344	34,826	23,260	13,994	6,986	5,349	7,830	10,045	10,616	42,570	32,244	17,247	10,043	567		633,824		
-20					959	2,739	1,567	2,602	2,041	9,489	10,384	61,348	16,688	10,627			106	1,701	94	13,280	134,792	11,313	18,398	9,460	16,399	6,178	3,753	3,317	1,327	3,521	17,013	83,846	461		443,399		
-15					304	3,571	2,689	2,414	1,335	957	998	2,452	1,777					1,837	214	9	1,752	5,328	7,599	3,590	3,739	938	949	245	796	386	438	110,997	15,836		171,151		
-10					620	5,858	6,393	1,268	461	265	19	85	16						521	130	5,262	10,722	4,617	3,149	3,031	1,340	1,819	1,545	1,394	8	152	315	13		49,003		
-5							105	1,866			1,211	388	695						51	2,275	4,791	7,668	8,617	8,941	6,051	1,099	1,855	1,741	3,951	2,802	433	9			1,162	55,792	
total	208	20,207	281,369	78,006	43,426	27,303	14,836	30,804	46,791	28,192	80,666	415,949	285,597	423,796	74,780	33,221	89,273	92,283	137,327	104,400	139,495	352,941	168,219	141,896	###	171,608	136,377	151,326	185,939	222,265	112,392	46,886	198,000	16,351	1,162	4,459,303	

Table A-6. Number SBT retained by latitude and longitude.

	-55	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	135 total		
-45				0																																	0
-40		0	381	0	6	0	0					0	175	1,689	0	85	1,005	3,736	8,062	13,330	4,081	210	0														32,830
-35	0	104	2,347	886	448	304	97	2,130	106	53	224	1,229	4,796	16,744	6,960	7,346	15,551	11,137	30,816	59,464	8,457	2,905	1,038	1,260	2,991	9,748	1,498	7,707	11,144	5,847	2,155	781	18	0	216,291		
-30			0	3	0	0	1	12	43	169	252	1,416	1,840	380	177	0	0	2,228	3,742	2,901	3,499	3,965	2,972	24,866	53,315	105,478	137,978	108,314	65,754	24,988	7,021	3,299	104		554,717		
-25			0	0	6	28	0	33	23	157	110	78	110	653	0			741	2,061	272	247	687	109	1,998	1,858	4,633	3,619	14,057	11,396	5,970	438	1,277	258		50,819		
-20					0	0	0	19	235	479	7	3,807	1,779	564				0	0	0	5	1,206	114	827	804	255	147	104	34	13	18	858	988	9		12,272	
-15					0	0	0	0	0	0	0	0	0	0				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
-10					0	0	0	0	0	0	0	0	0	0				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
-5							0	0	0	0	0	0	0	0				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
total	0	104	2,731	956	460	332	98	2,194	407	858	593	6,530	8,700	20,030	7,137	7,431	16,556	17,842	44,681	75,967	16,289	8,973	4,233	28,951	58,968	120,114	143,242	130,182	88,328	36,818	9,632	6,215	1,368	9	0	866,929	

Table A-7 Number of size records by year and month.

It is for raw data (not raised to catch).

Year	1	2	3	4	5	6	7	8	9	10	11	12	total
1993						32	46	18	43	4			143
1994	5	5	12	9	10	23	84	38	18		2	2	208
1995	52	37	57	52	28	39	51	29	1	7	13	9	375
1996	28	13	4	1	24	116	236	206	63	3	53	47	794
1997	99	39	8		1	30	73	29	48				327
1998			2	1	18	72	166	145	52	35		71	562
1999	56	6	1	6	10	81	81	77	38		24	32	412
2000	46		1	17	28	150	233	204	132				811
2001	34					90	104	53	50	24			355
2002		8	30	14	59	282	294	347	193			49	1276
2003	83	52	34	35	209	418	592	523	716	32		12	2706
2004													0
2005													0
2006													0
2007													0
2008													0
2009													0
2010													0
2011													0
total	403	160	149	135	387	1333	1960	1669	1354	105	92	222	7969

Table A-8 Number of size measured SBT by year and month.

It is for raw data (not raised to catch).

Year	1	2	3	4	5	6	7	8	9	10	11	12	total
1993						81	120	69	208	7			485
1994	9	6	19	10	10	70	232	156	54		2	2	570
1995	189	121	111	143	116	140	110	48	1	8	50	12	1,049
1996	152	39	13	1	34	607	2,209	1,125	236	4	489	432	5,341
1997	244	98	19		1	79	358	224	77				1,100
1998			2	1	34	185	710	489	125	76		493	2,115
1999	568	10	1	6	21	200	458	359	131		197	123	2,074
2000	195		1	26	99	453	1,229	1,006	386				3,395
2001	339					255	435	182	179	127			1,517
2002		131	194	19	592	10,692	14,894	4,582	2,153			811	34,068
2003	616	223	293	103	867	2,637	8,304	8,703	7,636	85		305	29,772
2004													0
2005													0
2006													0
2007													0
2008													0
2009													0
2010													0
2011													0
total	2,312	628	653	309	1,774	15,399	29,059	16,943	11,186	307	738	2,178	81,486

Table A-9 Mean length of size measured SBT by year and month.

It is for raw data (not raised to catch).

Year	1	2	3	4	5	6	7	8	9	10	11	12	total
1993						124.0	120.5	125.3	124.0	140.0			123.6
1994	167.1	166.0	157.3	154.0	121.2	92.5	111.2	105.7	118.8		86.0	79.0	111.8
1995	104.1	109.0	116.5	116.4	122.9	124.3	124.7	114.9	132.0	83.0	82.1	101.8	113.9
1996	121.2	98.8	107.5	114.0	112.5	109.7	104.7	94.9	92.8	138.5	92.8	108.2	102.4
1997	113.3	114.6	117.4		138.0	119.2	117.8	118.2	118.7				116.8
1998			139.0	170.0	107.7	118.6	120.3	109.9	93.7	109.6		119.4	115.4
1999	108.1	104.2	130.0	124.7	111.5	122.3	120.0	121.8	123.7		110.8	114.4	116.2
2000	105.4		88.0	129.2	126.8	112.5	108.5	109.7	119.2				111.1
2001	108.6					99.3	93.2	95.3	85.7	87.2			96.5
2002		156.6	150.9	155.9	118.2	112.1	111.9	120.9	126.8			127.1	115.0
2003	124.0	104.4	125.8	132.6	127.3	127.1	123.7	123.2	125.9	114.3		103.5	124.2
2004													
2005													
2006													
2007													
2008													
2009													
2010													
2011													
total	113.5	118.0	132.0	126.8	123.1	114.7	114.8	118.9	124.0	102.0	96.8	117.4	117.1

Table A-10 Number of size records by year and month.

It is for data raised to catch.

Year	1	2	3	4	5	6	7	8	9	10	11	12	total
1993													0
1994													0
1995													0
1996													0
1997													0
1998													0
1999													0
2000													0
2001													0
2002	31	5	15	81	168	376	557	690	530	242	67	52	2814
2003	12	33	28	45	111	151	390	438	209				1417
2004	50		19	97	251	427	541	635	400		4	17	2441
2005	204	95		40	216	282	356	512	364	12			2081
2006	178	134	13	29	74	207	270	396	386			11	1698
2007					56	199	324	370	359	107	87	133	1635
2008	118	23		28	61	193	315	436	293	82	159	138	1846
2009	137	27		38	190	325	367	431	258	49	100	139	2061
2010	150	51		169	426	296	373	546	222	2	27	46	2308
2011	59	101		121	278	273	335	337	68	25	52	19	1668
total	939	469	75	648	1831	2729	3828	4791	3089	519	496	555	19969

Table A-11 Number of size measured SBT by year and month.

It is for data raised to catch.

Year	1	2	3	4	5	6	7	8	9	10	11	12	total
1993													0
1994													0
1995													0
1996													0
1997													0
1998													0
1999													0
2000													0
2001													0
2002	342	5	15	246	961	10,359	10,744	7,234	4,092	594	145	104	34,841
2003	44	582	1,970	617	734	1,802	8,296	11,728	5,833				31,606
2004	1,032		47	773	1,241	4,487	17,974	11,624	4,895		16	62	42,151
2005	582	209		61	865	3,037	10,485	11,197	6,856	27			33,319
2006	580	1,410	17	139	769	3,555	7,076	9,633	7,477			11	30,667
2007					234	2,456	7,628	9,908	7,963	549	1,251	3,787	33,776
2008	1,627	157		49	196	4,151	10,536	10,101	3,293	349	1,503	3,182	35,144
2009	2,866	214		102	914	4,547	10,823	6,331	3,649	162	512	1,681	31,801
2010	2,966	325		803	3,476	6,030	8,317	9,976	1,243	2	56	213	33,407
2011	599	757		361	1,732	2,585	4,991	3,315	460	91	275	133	15,299
total	10,638	3,659	2,049	3,151	11,122	43,009	96,870	91,047	45,761	1,774	3,758	9,173	322,011

Table A-12 Mean length of size measured SBT by year and month.

It is for data raised to catch.

Year	1	2	3	4	5	6	7	8	9	10	11	12	total
1993													
1994													
1995													
1996													
1997													
1998													
1999													
2000													
2001													
2002	116.7	154.8	152.4	122.4	121.5	112.5	113.7	118.8	123.2	117.6	113.4	119.2	115.9
2003	104.2	107.5	125.0	131.6	129.3	123.0	121.3	123.6	124.5				123.2
2004	103.7		141.5	134.7	134.4	126.9	121.2	122.1	125.1		127.1	129.4	122.7
2005	125.6	143.8		132.1	131.9	127.4	120.8	117.9	122.2	115.0			121.2
2006	122.0	120.6	163.3	114.3	114.6	120.8	121.9	123.3	121.3			119.3	121.8
2007					115.1	119.8	119.2	119.8	118.1	124.6	117.0	112.0	118.3
2008	106.3	100.5		139.8	124.3	118.4	118.0	121.0	121.2	119.1	119.6	116.2	118.6
2009	109.6	116.0		114.9	118.8	116.5	116.6	121.7	116.9	118.4	125.8	124.0	117.6
2010	124.4	117.9		134.9	128.8	125.4	127.4	122.6	121.1	141.0	139.3	133.5	125.4
2011	129.5	106.6		140.3	125.9	126.9	123.5	129.3	125.7	128.2	131.0	130.5	125.7
total	115.5	115.6	125.9	132.3	126.5	120.3	120.0	121.5	121.5	120.7	120.5	116.6	120.8

Table A-13. Number of size records by latitude and longitude.

It is for raw data (not raised to catch).

	-170	-165	-50	-45	-40	-30	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	155	160 total		
-40			1	1								24					19	34	33	5													3	120	
-35		1	2	1	1				1	1	60	167	54	58	52	54	232	171	29	21		20	36	120	64	48	83	75	53	51	17		5	1478	
-30	2	7			11		32	33	37	54	64	73	11				29	26	58	108	102	274	636	713	839	701	573	368	183	41	7		4982		
-25	1									4	10						41	1	11		21	125	116	98	136	133	255	176	29	6			1163		
-20									3		17										25	46	51	25	30	1								198	
-5																								17											17
0																								11											11
total	3	8	3	2	12	1	32	33	41	55	128	291	65	58	52	54	321	232	131	134	168	481	934	917	1053	918	903	597	263	64	7	5	3	7969	

Table A-14. Number of size measured SBT by latitude and longitude.

It is for raw data (not raised to catch).

	-170	-165	-50	-45	-40	-30	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	155	160 total		
-40			1	1								51					42	218	249	7														3	572
-35		1	2	1	4	1			1	1	287	831	147	226	216	254	2,398	1,514	138	57		36	77	289	226	146	301	328	151	284	31		5	7,953	
-30	2	7			34		194	194	76	225	274	464	18				41	70	254	754	791	1,277	7,318	7,404	12,514	12,070	13,238	4,379	2,276	130	8		64,012		
-25	1										5	35					99	4	16		37	497	648	329	361	993	2,478	2,309	76	9			7,897		
-20									3			33									62	324	408	35	67	2								934	
-5																																			94
0																								24											24
total	3	8	3	2	38	1	194	194	80	226	566	1,414	165	226	216	254	2,580	1,806	657	818	926	2,175	8,687	8,088	13,088	13,366	16,044	6,839	2,636	170	8	5	3	81,486	

Table A-15. Mean length of size measured SBT by latitude and longitude.

It is for raw data (not raised to catch).

	-170	-165	-50	-45	-40	-30	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	155	160 total		
-40			162.0	182.0								115.9					116.7	110.0	112.9	124.0														133.3	112.8
-35		172.0	179.0	80.0	166.0	74.0			84.0	130.0	134.5	128.4	117.2	106.2	108.4	106.7	111.2	115.5	121.3	108.6	118.4	115.6	108.8	109.1	101.0	105.8	112.3	116.2	154.7	148.2		140.8	116.0		
-30	191.0	120.0			120.1		127.9	126.2	129.2	129.7	129.9	130.3	119.3				131.2	110.5	121.3	116.9	125.2	107.2	114.0	110.9	112.7	115.0	121.9	122.7	119.1	128.4	135.8		116.4		
-25	100.0										139.2	86.8					126.3	128.0	112.9		120.3	118.5	123.1	114.9	119.8	124.8	122.7	124.5	121.0	112.4			122.6		
-20									172.7			84.2									132.8	131.4	131.0	147.3	140.8	140.0							131.1		
-5																																			111.5
0																								110.9											110.9
total	160.7	126.5	173.3	131.0	124.9	74.0	127.9	126.2	130.3	129.7	132.3	126.5	117.5	106.2	108.4	106.7	112.2	114.7	117.9	116.4	125.2	113.7	115.3	111.1	112.9	115.5	121.8	123.2	123.0	131.2	135.8	140.8	133.3	117.1	

Table A-19 Number of records in catch-at-age data by year and month.

Year	1	2	3	4	5	6	7	8	9	10	11	12	total
2002	12	4	14	65	114	126	223	260	196	89	29	18	1150
2003	6	14	13	29	68	52	138	185	89				594
2004	16		12	46	119	156	216	249	144		2	16	976
2005	92	50		29	99	118	138	188	125	6			845
2006	86	44	13	15	24	82	95	139	156			9	663
2007					18	67	109	119	106	39	40	62	560
2008	38	8		20	27	72	124	174	124	26	45	48	706
2009	42	7		16	87	143	159	179	108	25	45	51	862
2010	53	22		102	209	144	166	219	103	3	15	29	1065
2011	26	25		73	144	128	133	163	29	7	18	7	753
total	371	174	52	395	909	1088	1501	1875	1180	195	194	240	8174

Table A-20 Number of SBT in catch-at-age data by year and month.

Year	1	2	3	4	5	6	7	8	9	10	11	12	total
2002	342	5	15	246	960	10,358	10,743	7,233	4,091	594	145	104	34,836
2003	44	582	1,970	617	734	1,802	8,295	11,727	5,833				31,603
2004	1,032		47	773	1,241	4,486	17,973	11,623	4,894		16	62	42,147
2005	582	209		61	865	3,037	10,484	11,196	6,855	27			33,315
2006	580	1,410	17	139	769	3,555	7,076	9,632	7,476			11	30,664
2007					234	2,456	7,627	9,907	7,963	549	1,251	3,787	33,773
2008	1,627	157		49	196	4,151	10,535	10,100	3,292	349	1,503	3,182	35,141
2009	2,866	214		102	914	4,546	10,822	6,330	3,649	162	512	1,681	31,797
2010	2,966	325		803	3,475	6,029	8,316	9,975	1,243	2	56	213	33,402
2011	599	757		361	1,731	2,584	4,990	3,314	460	91	275	133	15,296
total	10,636	3,658	2,049	3,149	11,118	43,004	96,863	91,039	45,756	1,773	3,757	9,172	321,975

Table A-21 Mean age of SBT by year and month.

Year	1	2	3	4	5	6	7	8	9	10	11	12	total
2002	4.3	9.5	10.1	5.7	4.7	3.8	3.8	4.3	4.6	3.9	3.3	3.8	4.0
2003	3.5	3.7	5.0	6.2	5.7	4.7	4.6	4.7	4.8				4.8
2004	3.5		7.2	6.2	6.1	5.2	4.5	4.6	4.8		4.7	4.8	4.7
2005	6.3	8.7		6.1	6.0	5.2	4.4	4.1	4.5	3.5			4.5
2006	6.1	5.4	13.3	4.1	3.9	4.4	4.5	4.6	4.3			3.9	4.5
2007					3.9	4.3	4.2	4.2	4.0	4.5	3.8	3.2	4.0
2008	3.8	3.2		7.5	5.1	4.2	4.1	4.4	4.4	4.0	4.1	3.6	4.2
2009	4.0	4.2		4.0	4.4	4.0	4.0	4.4	3.9	4.0	4.5	4.3	4.1
2010	5.2	4.5		6.7	5.7	5.0	5.2	4.7	4.4	7.8	6.3	5.3	5.1
2011	5.7	3.6		8.0	5.2	5.1	4.7	5.3	4.7	5.0	5.1	4.9	5.0
total	4.6	4.7	5.2	6.3	5.3	4.5	4.4	4.5	4.4	4.1	4.1	3.6	4.5

Table A-22 Number of records in catch-at-age data by latitude and longitude.

	-175	-170	-165	-160	-155	-150	-145	-135	-50	-45	-40	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	155	160	165	170	175 total				
-40	54								1										4		4		6	26	38	3	54	30															30	10			202	
-35		1							2	1									1	13	19	29	77	17	30	18										69	179	152	93	59	3	89	3				2349	
-30	5	21	5	4	9	5	2	5				1	9	8	33	51	17							176	85	31	55	54	113	190	292	390	443	609	704	500	113	81	31			17	2	18		4144		
-25	2				2						7			8	9	9	21	8						1	44	30	14	35	28	53	69	80	120	203	265	200	25							1		9	1288	
-20												4		9						16	13	5														10	4	15	6									181
total	7	22	5	4	11	5	2	5	1	2	8	4	1	20	17	43	85	80	78	124	23	160	371	726	315	329	149	109	188	294	406	498	573	885	1163	858	231	174	38	119	31	2	19	9	8174			

Table A-23 Number of SBT in catch-at-age data by latitude and longitude.

	-175	-170	-165	-160	-155	-150	-145	-135	-50	-45	-40	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	155	160	165	170	175 total						
-40									2											21		37	61	77	5	497	588																			44	13			1,734
-35		1								2	2					1	43	37	133	2,664	32	3,770	8,437	8,826	4,835	10,457	752	309	142	138	319	147		918	2,915	1,733	483	529	6	225	2						47,847			
-30	3	4	4	22	56	14	9	19					1	12	18	163	242	28	38	102	2			1,146	1,090	300	563	1,194	1,726	4,946	16,482	30,456	38,786	60,557	51,932	17,640	2,619	556	106			29	1	1		230,864				
-25	1				5						21			33	23	31	52	40	33					1	475	286	201	607	397	1,085	1,299	3,217	1,999	11,302	8,822	5,099	207	447						1	10	35,731				
-20												11		4						2,781	129	4																49	35	394	232								5,890	
total	4	5	4	22	61	14	9	19	2	2	23	11	1	49	41	195	337	2,863	340	2,813	34	3,807	8,498	10,050	6,405	12,116	2,227	2,110	2,793	6,808	18,531	33,820	40,834	72,812	84,083	24,704	3,308	1,760	152	288	45	1	2	10	321,975					

Table A-24 Mean age of SBT by latitude and longitude.

	-175	-170	-165	-160	-155	-150	-145	-135	-50	-45	-40	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	155	160	165	170	175 total					
-40									3.0											3.3		4.5	5.4	5.0	5.9	5.0	4.5																						4.9
-35		14.0									3.0	12.0								5.0	6.8	8.4	6.1	5.1	5.7	4.1	4.7	5.3	3.7	4.2	4.1	4.3	5.8	5.7	3.9	4.3	4.2	4.5	5.0	7.0	8.7	7.3	4.2	8.0	7.5				4.7
-30	17.7	13.8	6.5	7.4	6.3	6.0	2.4	4.4					8.0	5.8	5.4	4.6	6.2	5.9	4.8	6.6	10.6			6.0	4.9	4.2	4.2	4.2	4.3	4.3	4.1	3.9	4.2	4.3	4.7	4.9	4.9	5.6	5.0			7.4	16.2	10.6			4.4		
-25	2.4				8.4						4.9			4.8	5.2	3.0	4.9	4.6	4.5	3.4				20.0	5.4	3.2	4.1	4.4	4.3	4.4	4.3	4.3	5.5	4.5	4.3	5.0	5.4	3.9						20.0			7.0	7.5	4.5
-20												3.7		9.3						4.6	4.5	7.8				1.9	2.3			3.5	5.0	6.6			5.6	7.5	4.0	4.5						6.4	9.7			4.6	
total	13.9	13.8	6.5	7.4	6.5	6.0	2.4	4.4	3.0	3.0	5.5	3.7	8.0	5.4	5.3	4.4	6.1	4.7	5.4	5.1	6.0	4.1	4.7	5.4	4.0	4.2	4.0	4.2	4.3	4.4	4.2	3.9	4.3	4.3	4.7	5.1	5.5	5.8	6.2	8.2	7.9	16.2	8.7	7.5			4.5		