Review of Japanese longline fishery and its albacore catch in the Indian Ocean

by

Takayuki Matsumoto and Koji Uosaki

National Research Institute of Far Seas Fisheries,
7-1, Orido 5-chome, Shimizu, Shizuoka, 424-8633, Japan

1. Introduction

There are two kinds of Japanese tuna fishery in the Indian Ocean, i.e. longline and purse seine fisheries. In those fisheries only the longline fishery has caught albacore. The longline fishery commenced in 1952 in the eastern equatorial waters in the Indian Ocean. The fishing effort of the longline first expanded westward, and then southward. In the late 1960s, the effort covered entire fishing ground of the longline in the Indian Ocean. The annual amount of the effort has changed since the late 1960s. And also annual albacore catch have considerably changed, ranging from 400 t to 18,000 t (Table 1), as well as catches of other tunas. Those changes were mainly due to the change of targeting as seen in the other Oceans.

In this document, historical and spatial changes of albacore catch and the fishing effort were described in conjunction with the catches of the other tunas and tuna-like species. In addition, the size data of albacore caught by the longline are shown to see general information of fish size and to seek the possibility of the application of the age-structured stock assessment for Indian albacore stock.

2. Data source

In order to count number of hooks and catches in number of tunas and billfish, basic data used here is the logbook data that have been compiled at National Research Institute of Far Seas Fisheries (NRIFSF) based on the logbook mandatory submitted by the fishermen of the longline vessels larger than 20 gross ton (GRT). The data are so-called “raised” data, which is aggregated by month and 5˚x5° block, and then expanded with coverage rate of the logbook. The basic data is available for 1952-2010. The geographical range as the "Indian Ocean" to count the amount of the effort and the catches from the basic data is shown in Fig. 1a. As for albacore catch in weight by area, IOTC database was used.

There were a few sources of the size data for the albacore, i.e. onboard measurement by training vessels and commercial vessels, and port sampling at Yaizu and Tokyo. The data were collected and compiled at NRIFSF and are available for 1965-2009. Data for 2009 are preliminary. Area stratification to compute the area-specific sample number of the measurement is shown in Fig. 1b.

3. Trend of catch and effort

Table 2 and Fig. 2a show that after the beginning of the exploitation by longline fishery in the Indian Ocean, annual fishing effort increased until 1967 and then fluctuated ranging from 40% to 99% of the peak year until 2009. However, fishing effort has been decreasing since 2007, and in 2010 (preliminary) it decreased to about 30% of the peak value. It is probably because of the effects of pirates in the western Indian Ocean (around Somalia). The albacore catch (in number) peaked (1,010 thousands fish) in 1962 and 1964, then sharply decreased to 32 thousands fish in 1978 and 1979, corresponding to 3% of the level in peaked year, and then increased with fluctuation. The catch in 2006 was 481 thousands fish, which corresponds to 48% of peak value and was highest since 1970. After that the catch decreased again, but slightly increased in 2010. Following is the description for the temporal and spatial changes of the catch and the effort including detailed description in recent years.

Fig. 3 shows geographical distribution of effort (number of hooks), albacore catch and CPUE by each decade. In the 1950s, when the effort increased (Fig. 2a), the effort was deployed mainly in the region north of 15˚S. The main component of the catch was yellowfin tuna in this fishing ground (Fig. 2b).

Following this period, the effort continued to increase up to 130 million hooks until the late 1960s (Fig. 2a). In this period, the total catch of four species of tunas, i.e., yellowfin, albacore, southern bluefin and bigeye tunas was historical highest, and species-specific catches were also the highest for yellowfin, albacore and bluefin tunas (Fig. 2b). Of the four species, yellowfin tuna was the most dominant catch in this period, to the lesser extent, albacore and southern bluefin tuna. Also the catch of bigeye tuna in this period increased compared to the 1950s. In this period, fishing ground of this fishery expanded to southward, in the west side and the east side of the Indian Ocean, excluding the southern central of the Indian Ocean. Albacore catch was high in the region between 10˚S and 35˚S, which corresponds to the region of South Equatorial Current (Sub-tropical waters). The CPUE of albacore was also high in the west side of the region, eventually increasing overall CPUE of entire Indian Ocean (Fig. 2c), but in the east side the CPUE was lower compared with west side. In the west side of this region, main component of the catch was albacore (Fig. 4), on the other hand, southern bluefin tuna was the largest component in the east area.

In the period from the late 1960s to the late 1970s, the effort decreased to about 60 million hooks, about 50% of the peak year (Fig. 2a). In this period, each catch of yellowfin and albacore drastically decreased compared to that in the previous period (Fig. 2b). This decrease was due to withdrawing in the effort from the fishing ground ranging from 10˚S to 35˚S.

In the period from the late 1970s to the mid 1980s, the effort increased again and reached to 130 million hooks (Fig. 2a), the same level as the previous peak in the 1960s. This increase was seen in the regions off Somalia and the south of 35˚S, targeting bigeye tuna and high quality (=oily) southern bluefin tuna, respectively.

In the period from the mid 1980s to the early 1990s, the effort decreased again (Fig. 2a). This decrease was due to the decrease of the effort in the region south of 35˚S, corresponding to the fishing ground for southern bluefin tuna, by introduction of the TAC for southern bluefin tuna in 1986.

In the period from the early 1990s to the late1990s the effort increased (Fig. 2a). The increase was seen in the regions off west coast of Australia probably targeting bigeye tuna, and south of Madagascar Island where yellowfin, albacore and bigeye were mainly caught (Fig. 4). In those region albacore was substantially caught, and this contributes to the increase of total catch in the period (Fig. 2a).

In the period of 2000s the effort kept high until 2007, and sharply decreased after that (Fig. 2a). The decrease was seen especially in the regions off Somalia in 2010 (**Fig. 5**, **Fig. 6**). This is probably due to the effect of pirates in this area as mentioned above. As a result, the proportion of catch and effort in the area south of 25˚S increased, where catch rate of albacore is higher. Also, increase of CPUE in the area west off Australia is observed during 2005-2007 (**Fig. 5**). These may have caused increase of albacore CPUE (Fig. 2c). In the area west off Australia, the proportion of albacore in the entire catch also increased during 2005-2007, and kept high thereafter (**Fig. 6**). As mentioned above, since the late 1960s, the longline fishery had been running without targeting albacore, and the effort had not been deployed in the region where albacore is abundant in general. Eventually, albacore had been caught only as a bycatch with southern bluefin tuna and bigeye tuna, to lesser extent yellowfin tuna. However, it seems that albacore is at least partly targeted by Japanese longline vessels in recent years. Also, recent situation of the change in the proportion of effort by area due to pirates seems to be unusual.

4. Size data

Table 3 shows the number of measurement for albacore caught by the longline vessel by type of vessels. The annual number of samples is roughly more than five thousand individuals in the period from 1965 to 1990, but then decreased to five thousand or less individuals after that. Table 4 and Table 5 show the sample number by year, quarter and area. The area classification used here is divided into four with 80˚E in longitude and 30˚S in latitude as shown in Fig. 1b. The size data tended to be distributed in Area 2, but in recent years mainly distributes in Area3 (Table 4). Size data distribute in each quarter (Table 5).

Fig. 7 shows length distribution of albacore for 1965-2009 stratified by decade, area and quarter. The fish mostly ranged between 80cm and 110cm until 1990s, but most of the fish were between 70cm and 90cm in the 2000s. This is probably because the proportion of Area 2, in which larger fish dominate, decreased. The length were distributed between roughly 80 cm 120 cm in the northern area (Areas 1 and 2), but the length between roughly 60 cm and 110 cm in the southern area (Areas 3 and 4). The difference of fish size among quarters was small, but some smaller fish (75-85cm) were also caught in the third quarter.

Fig. 8 shows length distribution of albacore for 1965-2009 stratified by quarter and area. In area 1 (northwest area), most fish were larger than 85cm in the first, second and fourth quarter. However, substantial fish between 55cm and 85cm were caught in the third quarter. In area 2 (northeast area), most fish were larger than 90cm in the second and third quarter, but some fish between 75cm and 90cm and substantial fish between 60cm and 90cm were caught in the first and fourth quarter, respectively. In area 3 (southwest area), the difference of fish size among quarters was comparatively small, but some large fish (larger than 100cm) were mainly caught in the first quarter. In area 4 (southeast area), the difference of fish size among quarters was small, but some small fish were caught in the second and third quarters.

Table 1. Albacore catch in weight (t) caught by Japanese longline fishery. Western: FAO area No. 51 (mostly west of 80°E), eastern: FAO area No. 57 (mostly east of 80°E). Data source: IOTC database.

Year	Western	Eastern	Total
1952	0	61	61
1953	0	1,094	1,094
1954	75	2,659	2,734
1955	1,192	1,867	3,059
1956	1,609	3,466	5,075
1957	1,483	3,179	4,662
1958	3,667	2,618	6,285
1959	5,246	5,164	10,410
1960	5,872	5,190	11,062
1961	11,393	3,848	15,241
1962	13,694	3,955	17,649
1963	7,565	4,994	12,559
1964	13,249	4,565	17,814
1965	6,496	4,870	11,366
1966	9,746	3,312	13,058
1967	9,702	4,400	14,102
1968	6,857	3,196	10,053
1969	7,708	859	8,567
1970	2,897	2,029	4,926
1971	1,934	1,384	3,318
1972	904	505	1,409
1973	1,143	839	1,982
1974	1,141	1,652	2,793
1975	412	849	1,261
1976	700	473	1,173
1977	217	187	404
1978	184	234	418
1979	234	159	393
1980	331	290	621
1981	602	584	1,186
1982	1,033	259	1,292
1983	1,094	575	1,669
1984	923	907	1,830
1985	1,013	1,268	2,281
1986	1,789	712	2,501
1987	1,496	772	2,268
1988	970	342	1,312
1989	612	278	890
1990	504	450	954
1991	590	392	982
1992	1,570	208	1,778
1993	788	493	1,281
1994	1,141	646	1,787
1995	871	1,168	2,039
1996	1,280	1,133	2,413
1997	2,049	1,184	3,233
1998	2,546	668	3,214
1999	1,377	905	2,282
2000	1,484	1,083	2,567
2001	1,878	1,155	3,033
2002	1,912	1,304	3,216
2003	1,707	543	2,250
2004	3,028	577	3,605
2005	3,646	433	4,079
2006	5,404	795	6,198
2007	3,993	1,270	5,263
2008	2,740	2,074	4,814
2009	1,615	1,953	3,568
2010	1,201	2,740	3,941

Table 2. Annual fishing effort (number of hooks) for the Japanese longline fishery and its catch in number by species.

	#of hook	Catch in number (thousand)							
	(thousand)	SBT	ALB	BET	YFT	SWO	STM	BUM	BKM
1952	2,021	6	3	21	131	0	3	9	6
1953	7,071	50	57	53	240	2	7	27	17
1954	12,557	31	142	137	472	4	21	47	25
1955	16,109	24	157	173	972	5	19	51	24
1956	30,064	119	258	281	1,245	10	45	74	41
1957	26,609	193	232	215	728	8	50	57	36
1958	23,269	120	301	191	556	12	46	62	30
1959	34,021	693	524	169	598	12	56	64	28
1960	52,554	1,072	574	314	962	15	52	56	41
1961	59,807	910	777	270	869	17	65	49	35
1962	65,755	432	1,010	419	1,331	22	48	46	45
1963	56,453	649	722	264	655	17	34	27	26
1964	68,342	490	1,010	334	594	21	38	43	34
1965	80,372	459	630	386	767	25	81	50	30
1966	93,511	428	752	479	1,156	29	105	50	31
1967	129,496	787	850	517	903	40	114	51	35
1968	124,438	689	623	541	1,714	30	63	34	44
1969	108,171	674	589	378	771	31	59	26	35
1970	89,731	454	304	342	375	27	45	17	25
1971	96,596	411	228	290	480	24	28	14	16
1972	80,158	467	100	212	294	21	21	14	6
1973	82,768	442	145	138	148	17	15	8	5
1974	88,397	476	182	190	200	18	38	13	10
1975	90,236	322	79	179	249	19	25	10	11
1976	80,284	452	99	61	95	9	14	4	4
1977	62,583	365	33	98	85	6	13	4	2
1978	69,281	259	32	312	170	23	44	13	7
1979	67,728	254	32	122	133	12	25	6	3
1980	91,661	357	47	161	106	13	24	8	4
1981	88,407	294	87	191	159	16	21	10	4
1982	88,257	238	105	283	228	22	15	15	4
1983	116,631	367	141	428	239	26	16	22	6
1984	118,289	296	136	346	245	28	25	19	11
1985	128,438	250	176	410	281	47	25	20	8
1986	123,252	181	204	382	311	30	24	17	5
1987	109,888	152	160	382	238	30	16	13	4
1988	93,254	141	99	295	266	33	6	10	3
1989	82,513	143	68	182	129	21	3	5	2
1990	52,576	86	68	199	175	23	2	4	1
1991	62,434	98	61	208	122	20	4	3	1
1992	59,284	102	127	133	142	25	3	3	1
1993	52,337	80	96	214	172	24	2	4	1
1994	81,657	90	141	393	253	39	5	8	1
1995	92,232	69	148	395	222	27	5	5	1
1996	107,875	79	179	384	326	33	6	7	1
1997	126,309	97	275	433	382	46	7	15	1
1998	124,226	136	237	407	443	39	6	16	2
1999	107,647	119	157	348	410	26	6	11	2
2000	103,463	65	200	336	433	26	7	12	1
2001	109,752	92	226	321	400	21	3	6	1
2002	105,990	62	221	328	397	23	3	6	1
2003	78,269	35	152	246	535	18	1	5	1
2004	98,237	91	281	260	497	20	2	6	1
2005	113,861	104	364	296	666	26	2	6	1
2006	118,365	71	481	342	708	33	3	10	2
2007	117,675	51	399	456	596	45	2	11	2
2008	89,373	22	362	336	332	33	4	8	2
2009	64,951	37	240	233	160	22	1	6	1
2010	37,587	32	290	116	128	12	5	3	1

Table 3. Number of fish measured on the albacore length by type of measurement. 2009 data are preliminary.

Year	Commercial vessel	Training vessel	Total
1965	5,324	21,944	27,268
1966	5,817	17,344	23,161
1967	3,927	5,697	9,624
1968	1,870	4,206	6,076
1969	2,817	5,487	8,304
1970	781	6,375	7,156
1971	350	7,981	8,331
1972	0	4,819	4,819
1973	0	7,398	7,398
1974	240	7,369	7,609
1975	0	4,157	4,157
1976	0	8,644	8,644
1977	0	5,582	5,582
1978	0	5,076	5,076
1979	0	4,831	4,831
1980	0	5,801	5,801
1981	0	13,694	13,694
1982	0	10,554	10,554
1983	0	9,265	9,265
1984	0	9,299	9,299
1985	0	14,006	14,006
1986	266	14,047	14,313
1987	60	12,848	12,908
1988	79	7,121	7,200
1989	1,261	6,873	8,134
1990	1,147	6,982	8,129
1991	624	2,368	2,992
1992	2,064	1,582	3,646
1993	848	742	1,590
1994	753	103	856
1995	654	266	920
1996	68	291	359
1997	2,279	570	2,849
1998	379	969	1,348
1999	549	171	720
2000	4,172	476	4,648
2001	2,394	51	2,445
2002	2,426	27	2,453
2003	1,390	5	1,395
2004	1,180	0	1,180
2005	316	0	316
2006	7	0	7
2007	250	0	250
2008	59	0	59
2009	0	0	0

Table 4. Number of fish measured on the albacore length data for Japanese longline fishery by area. Area classification was shown in Fig. 1b. Only the resolution of month 5˚x5˚ block was indicated.

Year	Area1	Area2	Area3	Area4	Total
1965	3,487	10,856	12,798	127	27,268
1966	7,694	9,053	6,414	0	23,161
1967	260	6,525	702	2,137	9,624
1968	470	5,016	0	590	6,076
1969	372	4,136	3,596	200	8,304
1970	106	6,255	795	0	7,156
1971	19	7,036	0	1,276	8,331
1972	22	4,797	0	0	4,819
1973	1,036	6,351	0	11	7,398
1974	0	7,353	256	0	7,609
1975	245	3,895	17	0	4,157
1976	44	8,600	0	0	8,644
1977	4	5,578	0	0	5,582
1978	0	4,781	295	0	5,076
1979	97	4,237	495	2	4,831
1980	6	5,748	47	0	5,801
1981	20	13,436	238	0	13,694
1982	841	9,343	360	10	10,554
1983	173	7,915	1,087	90	9,265
1984	297	8,557	445	0	9,299
1985	243	12,984	779	0	14,006
1986	25	14,022	266	0	14,313
1987	92	12,759	57	0	12,908
1988	36	7,118	43	3	7,200
1989	342	6,848	919	25	8,134
1990	707	6,982	440	0	8,129
1991	19	2,465	508	0	2,992
1992	0	1,582	1,401	663	3,646
1993	92	749	749	0	1,590
1994	507	103	246	0	856
1995	48	266	606	0	920
1996	0	267	68	24	359
1997	40	595	2,214	0	2,849
1998	46	966	333	3	1,348
1999	161	171	388	0	720
2000	304	494	3,850	0	4,648
2001	1,237	108	1,100	0	2,445
2002	2,078	59	316	0	2,453
2003	92	13	1,290	0	1,395
2004	112	15	1,053	0	1,180
2005	208	30	78	0	316
2006	7	0	0	0	7
2007	0	0	250	0	250
2008	59	0	0	0	59
2009	0	0	0	0	0

Table 5. Number of fish measured on the albacore length data for Japanese longline fishery by area and quarter. Area classification is shown in Fig. 1b. Only the resolution of month 5˚x5˚ block was indicated.

Year	Qt	Area1	Area2	Area3	Area4	Total
1965	1	799	3,502	0	100	4,401
1965	2	1,943	3,816	2,567	0	8,326
1965	3	604	1,142	9,319	0	11,065
1965	4	141	2,396	912	27	3,476
1966	1	0	4,341	0	0	4,341
1966	2	127	881	1,162	0	2,170
1966	3	2,503	1,388	5,252	0	9,143
1966	4	5,064	2,443	0	0	7,507
1967	1	0	3,270	0	205	3,475
1967	2	0	1,308	100	1,126	2,534
1967	3	10	1,606	571	128	2,315
1967	4	250	341	31	678	1,300
1968	1	163	3,280	0	1	3,444
1968	2	19	331	0	582	932
1968	3	0	475	0	0	475
1968	4	288	930	0	7	1,225
1969	1	67	1,448	370	0	1,885
1969	2	305	313	1,504	200	2,322
1969	3	0	1,621	1,204	0	2,825
1969	4	0	754	518	0	1,272
1970	1	15	650	241	0	906
1970	2	91	3,336	0	0	3,427
1970	3	0	1,163	540	0	1,703
1970	4	0	1,106	14	0	1,120
1971	1	2	2,179	0	1,126	3,307
1971	2	3	2,330	0	150	2,483
1971	3	4	1,753	0	0	1,757
1971	4	10	774	0	0	784
1972	1	0	2,439	0	0	2,439
1972	2	0	852	0	0	852
1972	3	0	703	0	0	703
1972	4	22	803	0	0	825
1973	1	1,036	3,018	0	0	4,054
1973	2	0	1,385	0	0	1,385
1973	3	0	394	0	0	394
1973	4	0	1,554	0	11	1,565
1974	1	0	3,262	0	0	3,262
1974	2	0	1,200	16	0	1,216
1974	3	0	1,476	240	0	1,716
1974	4	0	1,415	0	0	1,415
1975	1	164	1,427	17	0	1,608
1975	2	0	725	0	0	725
1975	3	3	594	0	0	597
1975	4	78	1,149	0	0	1,227
1976	1	44	3,802	0	0	3,846
1976	2	0	1,306	0	0	1,306
1976	3	0	1,471	0	0	1,471
1976	4	0	2,021	0	0	2,021
1977	1	4	2,875	0	0	2,879
1977	2	0	342	0	0	342
1977	3	0	241	0	0	241
1977	4	0	2,120	0	0	2,120
1978	1	0	2,784	24	0	2,808
1978	2	0	340	31	0	371
1978	3	0	404	238	0	642
1978	4	0	1,253	2	0	1,255
1979	1	0	1,263	5	2	1,270
1979	2	2	76	59	0	137
1979	3	47	1,559	420	0	2,026
1979	4	48	1,339	11	0	1,398
1980	1	6	307	0	0	313
1980	2	0	2,260	37	0	2,297
1980	3	0	1,448	10	0	1,458
1980	4	0	1,733	0	0	1,733
1981	1	13	2,052	0	0	2,065
1981	2	0	5,678	150	0	5,828
1981	3	0	3,184	86	0	3,270
1981	4	7	2,522	2	0	2,531
1982	1	478	1,153	117	0	1,748
1982	2	0	2,848	198	0	3,046
1982	3	1	2,593	45	10	2,649
1982	4	362	2,749	0	0	3,111
1983	1	38	1,396	19	0	1,453
1983	2	8	2,629	760	0	3,397
1983	3	47	1,472	308	72	1,899
1983	4	80	2,418	0	18	2,516
1984	1	99	332	0	0	431
1984	2	0	972	222	0	1,194
1984	3	192	3,552	159	0	3,903
1984	4	6	3,701	64	0	3,771
1985	1	62	760	5	0	827
1985	2	26	3,824	454	0	4,304
1985	3	155	2,921	320	0	3,396
1985	4	0	5,479	0	0	5,479
1986	1	25	1,351	0	0	1,376
1986	2	0	1,575	265	0	1,840
1986	3	0	4,033	1	0	4,034
1986	4	0	7,063	0	0	7,063
1987	1	81	2,074	0	0	2,155
1987	2	0	2,556	8	0	2,564
1987	3	0	3,193	49	0	3,242
1987	4	11	4,936	0	0	4,947
1988	1	0	867	0	0	867
1988	2	0	1303	0	0	1303
1988	3	36	2170	43	0	2249
1988	4	0	2778	0	3	2781
1989	1	0	804	0	0	804
1989	2	95	814	325	0	1234
1989	3	247	1531	579	13	2370
1989	4	0	3699	15	12	3726
1990	1	0	195	0	0	195
1990	2	60	407	238	0	705
1990	3	646	2330	202	0	3178
1990	4	1	4050	0	0	4051
1991	1	0	174	0	0	174
1991	2	18	303	93	0	414
1991	3	1	580	363	0	944
1991	4	0	1,408	52	0	1,460
1992	1	0	132	0	161	293
1992	2	0	176	899	502	1,577
1992	3	0	174	467	0	641
1992	4	0	1,100	35	0	1,135
1993	1	0	385	42	0	427
1993	2	7	353	357	0	717
1993	3	80	0	311	0	391
1993	4	5	11	39	0	55
1994	1	0	0	0	0	0
1994	2	76	103	113	0	292
1994	3	405	0	45	0	450
1994	4	26	0	88	0	114
1995	1	0	0	333	0	333
1995	2	10	27	187	0	224
1995	3	38	67	78	0	183
1995	4	0	172	8	0	180
1996	1	0	0	10	0	10
1996	2	0	267	58	24	349
1996	3	0	0	0	0	0
1996	4	0	0	0	0	0
1997	1	3	281	1	0	285
1997	2	16	197	549	0	762
1997	3	19	46	1,554	0	1,619
1997	4	2	71	110	0	183
1998	1	15	0	1	0	16
1998	2	31	209	184	0	424
1998	3	0	740	148	0	888
1998	4	0	17	0	3	20
1999	1	9	0	17	0	26
1999	2	24	171	70	0	265
1999	3	128	0	220	0	348
1999	4	0	0	81	0	81
2000	1	0	0	0	0	0
2000	2	246	476	314	0	1,036
2000	3	58	0	2,530	0	2,588
2000	4	0	18	1,006	0	1,024
2001	1	0	2	0	0	2
2001	2	17	51	9	0	77
2001	3	1,096	0	415	0	1,511
2001	4	124	55	676	0	855
2002	1	33	59	68	0	160
2002	2	0	0	41	0	41
2002	3	2,007	0	9	0	2,016
2002	4	38	0	198	0	236
2003	1	92	8	0	0	100
2003	2	0	5	0	0	5
2003	3	0	0	0	0	0
2003	4	0	0	1,290	0	1,290
2004	1	0	15	0	0	15
2004	2	46	0	558	0	604
2004	3	66	0	495	0	561
2004	4	0	0	0	0	0
2005	1	157	0	0	0	157
2005	2	11	0	78	0	89
2005	3	0	30	0	0	30
2005	4	40	0	0	0	40
2006	1	0	0	0	0	0
2006	2	7	0	0	0	7
2006	3	0	0	0	0	0
2006	4	0	0	0	0	0
2007	1	0	0	0	0	0
2007	2	0	0	56	0	56
2007	3	0	0	179	0	179
2007	4	0	0	15	0	15
2008	1	59	0	0	0	59
2008	2	0	0	0	0	0
2008	3	0	0	0	0	0
2008	4	0	0	0	0	0
2009	1	0	0	0	0	0
2009	2	0	0	0	0	0
2009	3	0	0	0	0	0
2009	4	0	0	0	0	0

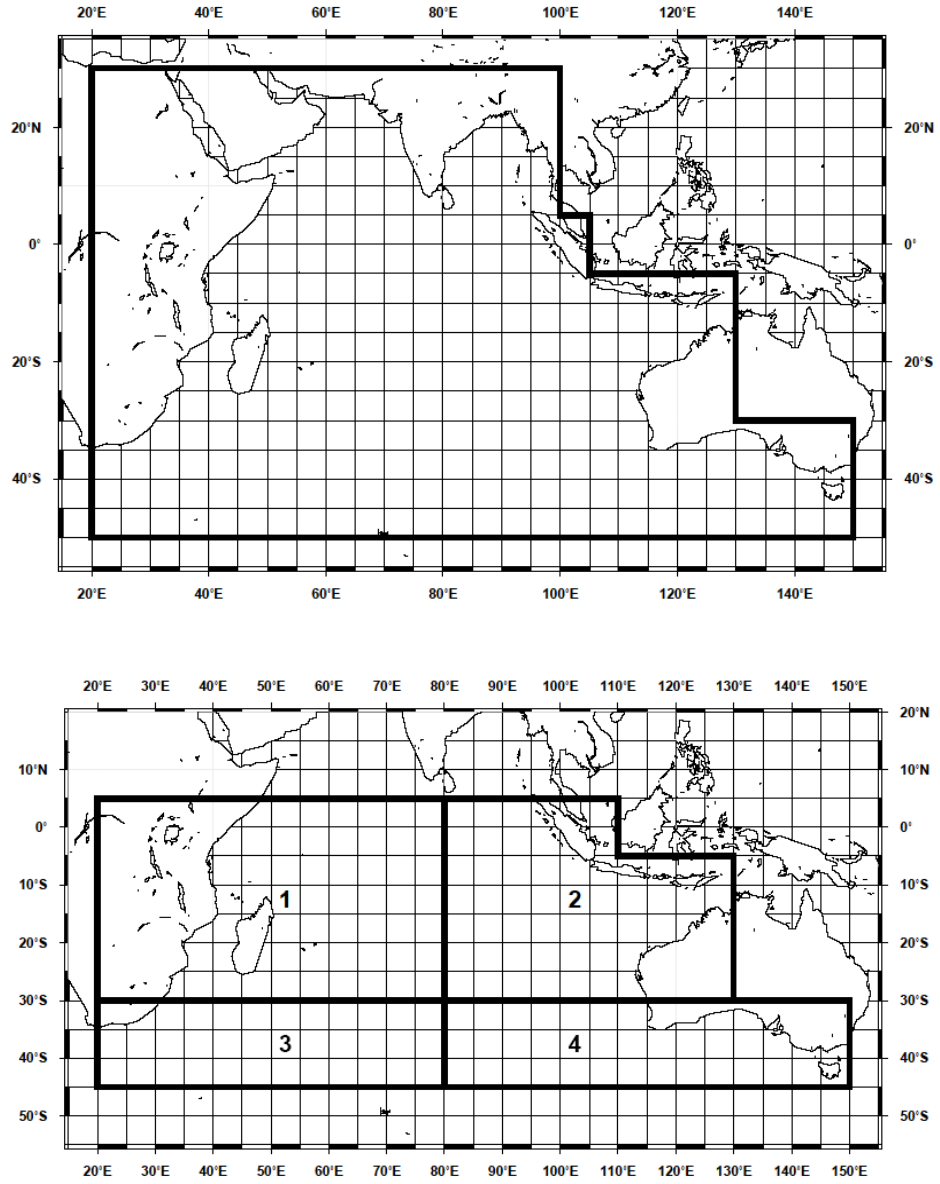

Fig. 1. The geographical range to count the amount of the effort and the catches (top) and area definition to count the number of sample of albacore length data (bottom).

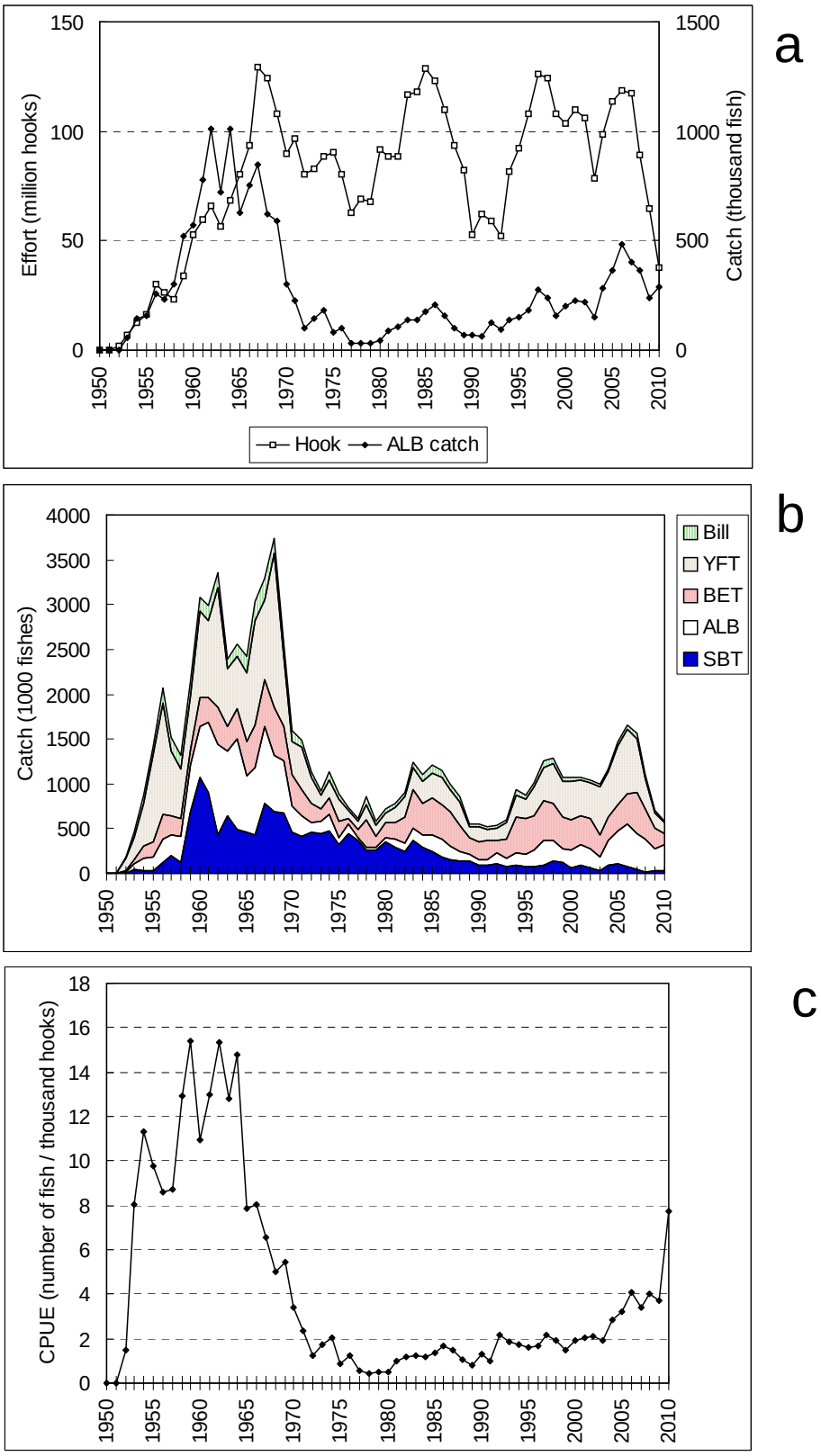

Fig. 2. The number of hooks employed and albacore catch (a), species composition (b), and nominal CPUE of albacore (c) caught by Japanese longline fishery.

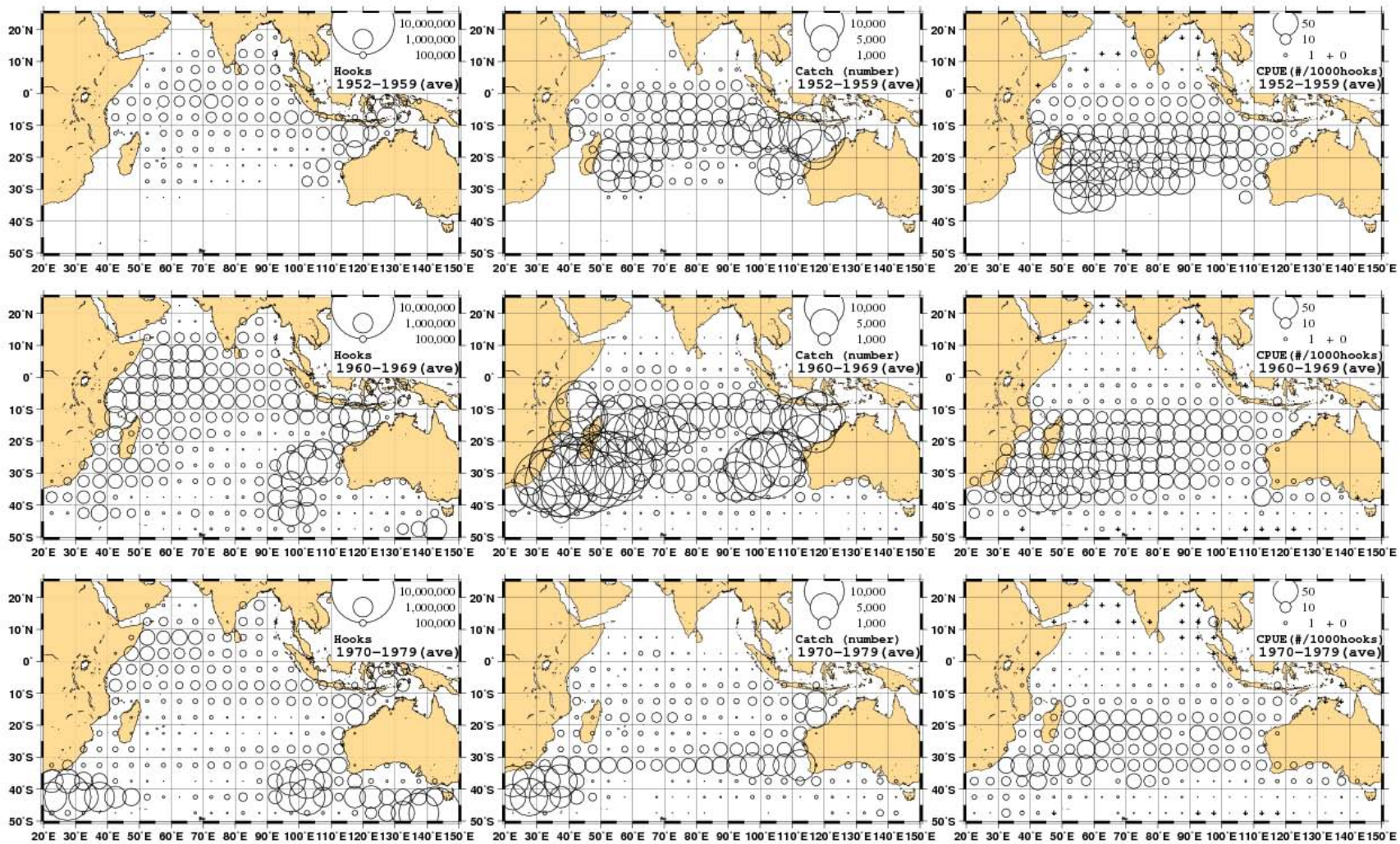

Fig. 3. The average distribution of the effort (number of hooks), albacore catch (number of fish) and CPUE (number of fish/1000hooks) for each decadal period.

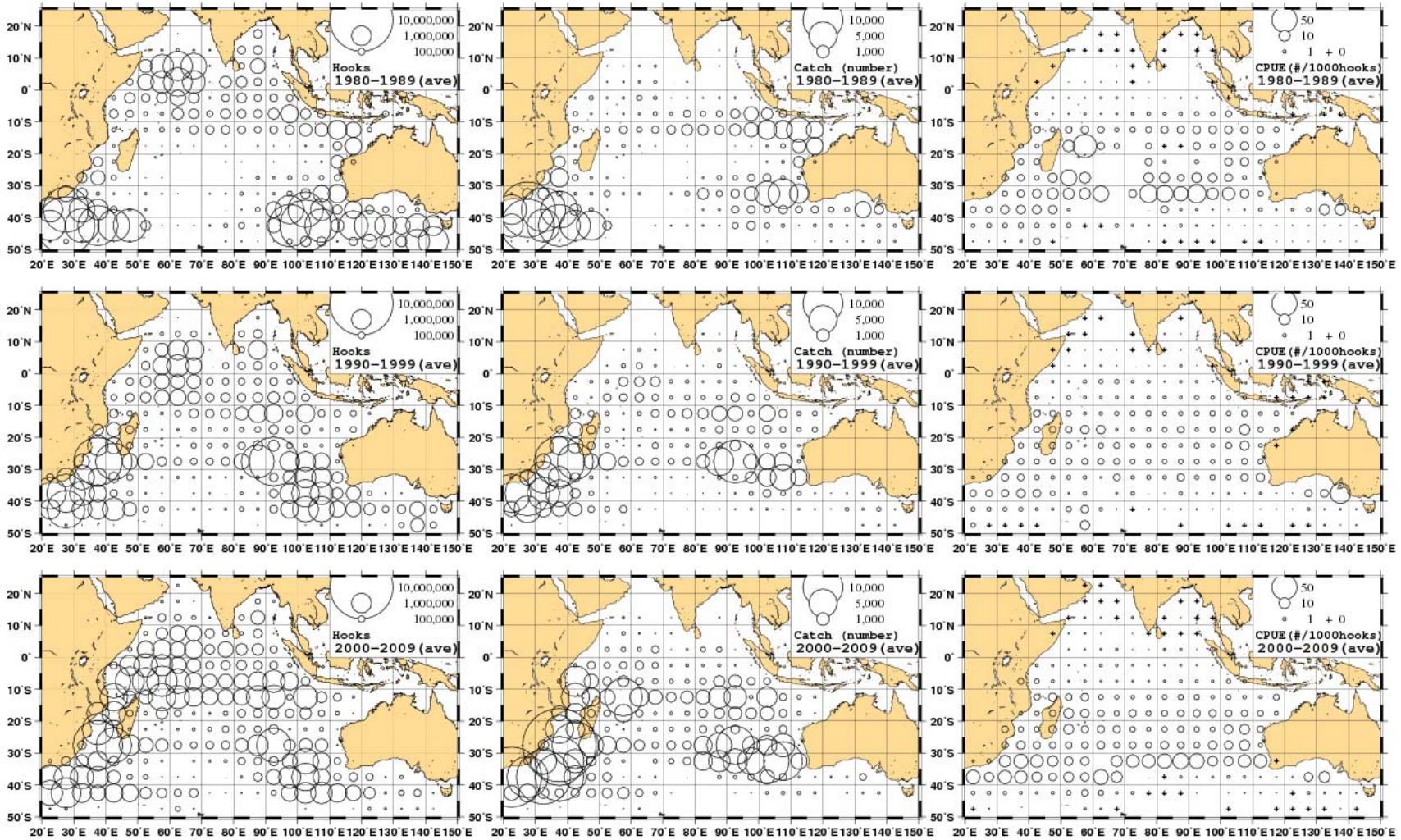

Fig. 3. The average distribution of the effort (number of hooks), albacore catch (number of fish) and CPUE (number of fish/1000hooks) for each decadal period.(continued)

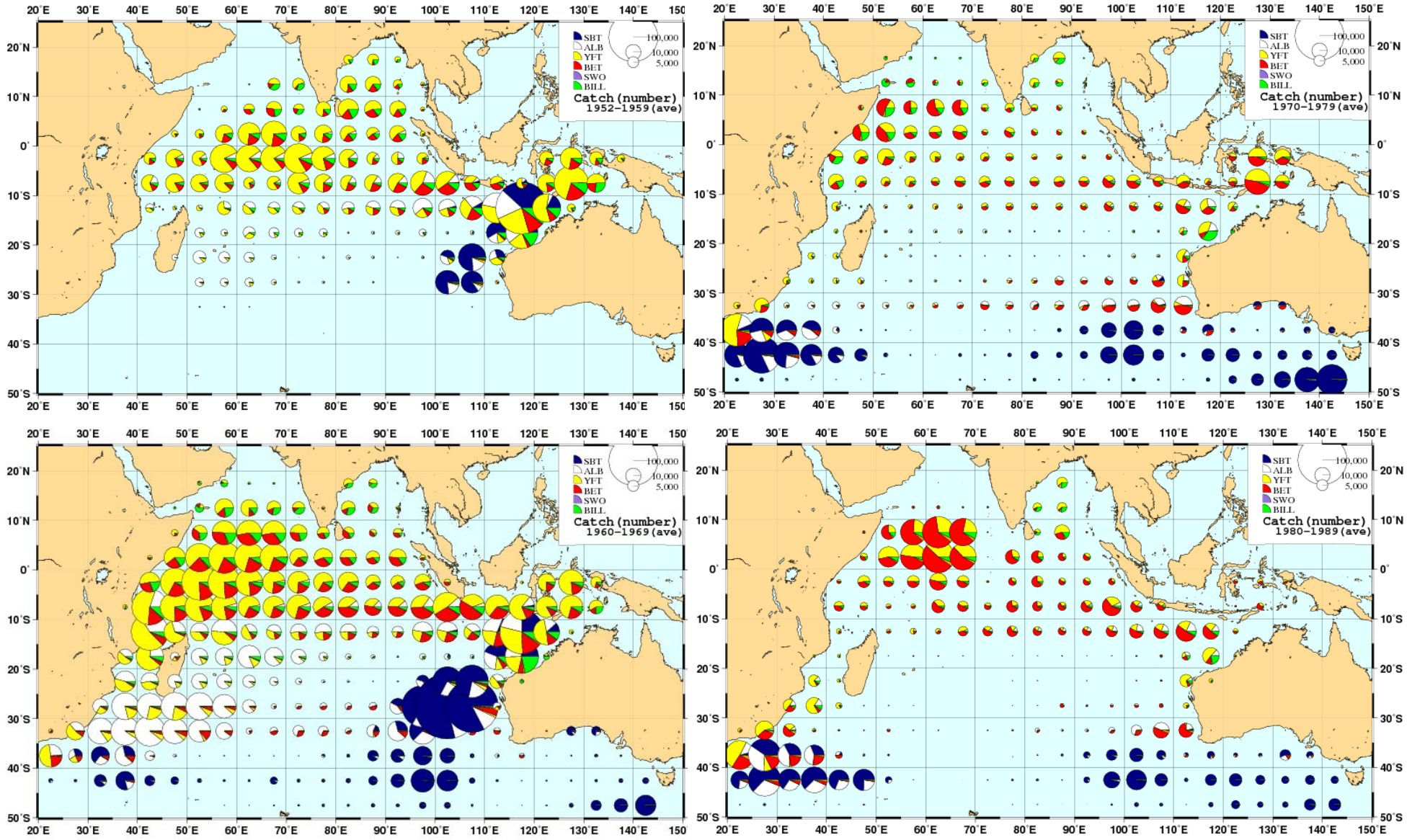

Fig. 4. The averaged distribution of amount of catch in number by species for each decade. Size of circle shows amount of total of catches i.e. southern bluefin tuna (SBT), albacore (ALB), bigeye tuna (BET), yellowfin tuna (YFT), swordfish (SWO) and billfishes (Bill).

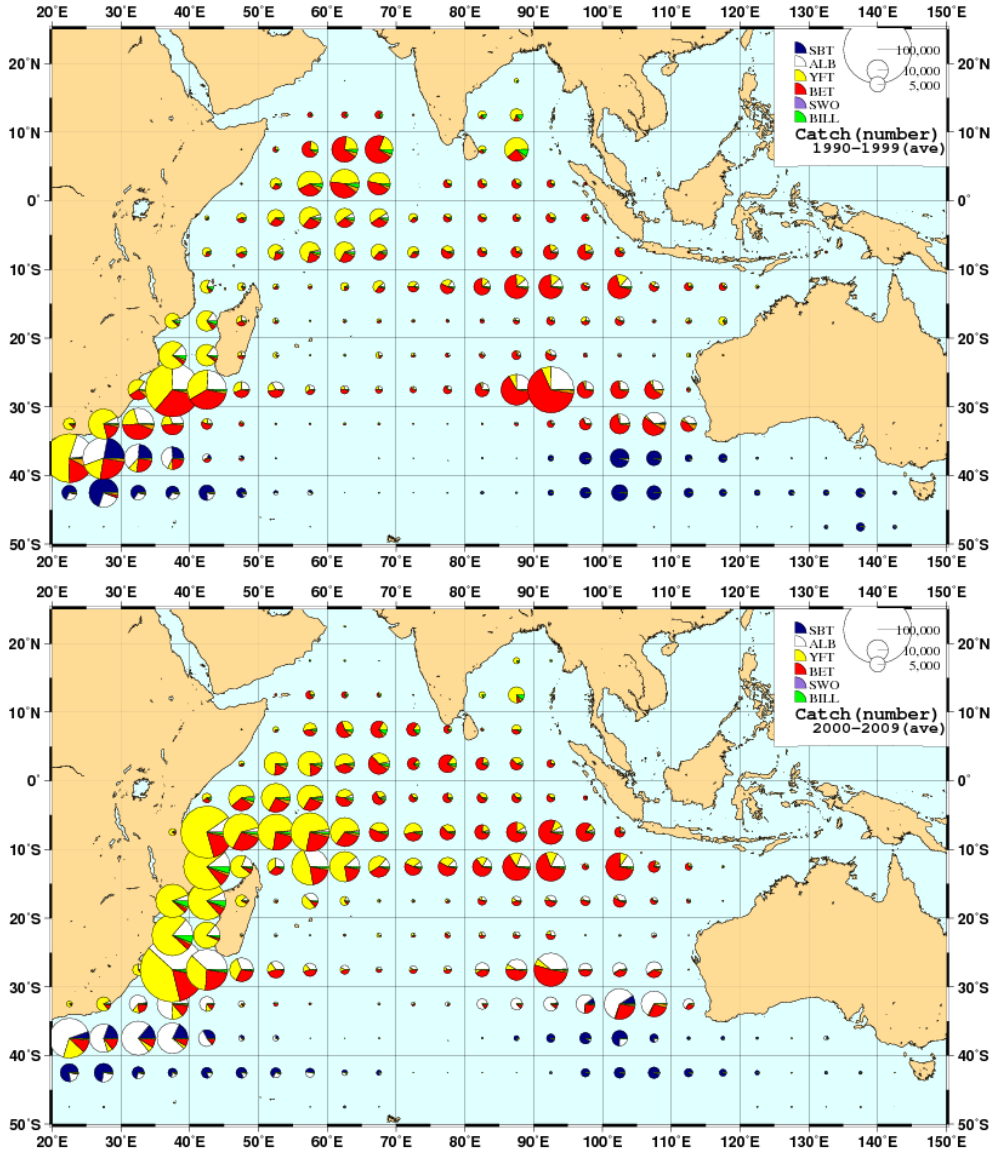

Fig. 4. The averaged distribution of amount of catch in number by species for each decade. Size of circle shows amount of total of catches i.e. southern bluefin tuna (SBT), albacore (ALB), bigeye tuna (BET), yellowfin tuna (YFT), swordfish (SWO) and billfishes (Bill). (continued)

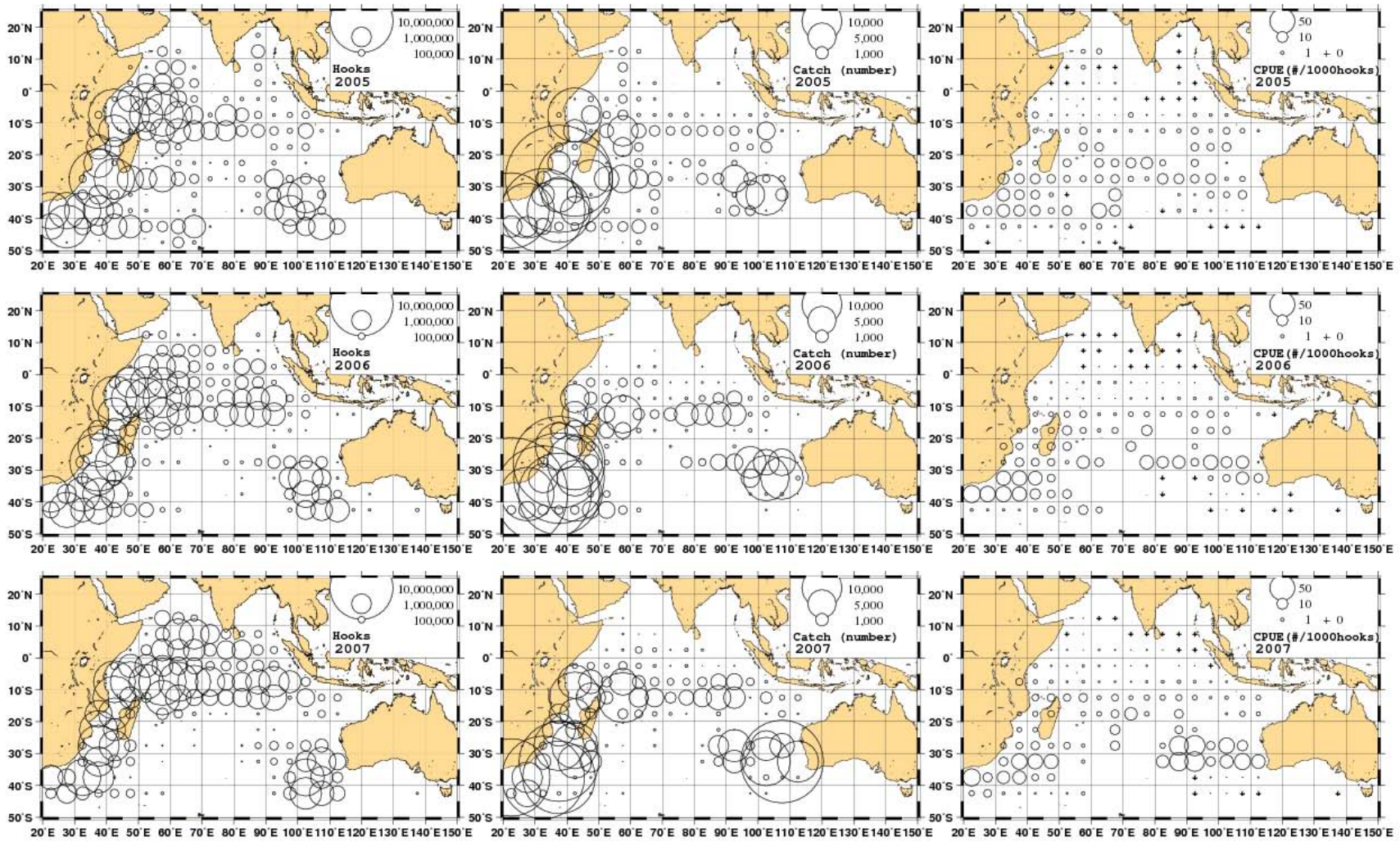

Fig. 5. The geographical distribution of the effort (number of hooks), albacore catch (number of fish) and CPUE (number of fish/1000hooks) in recent years.

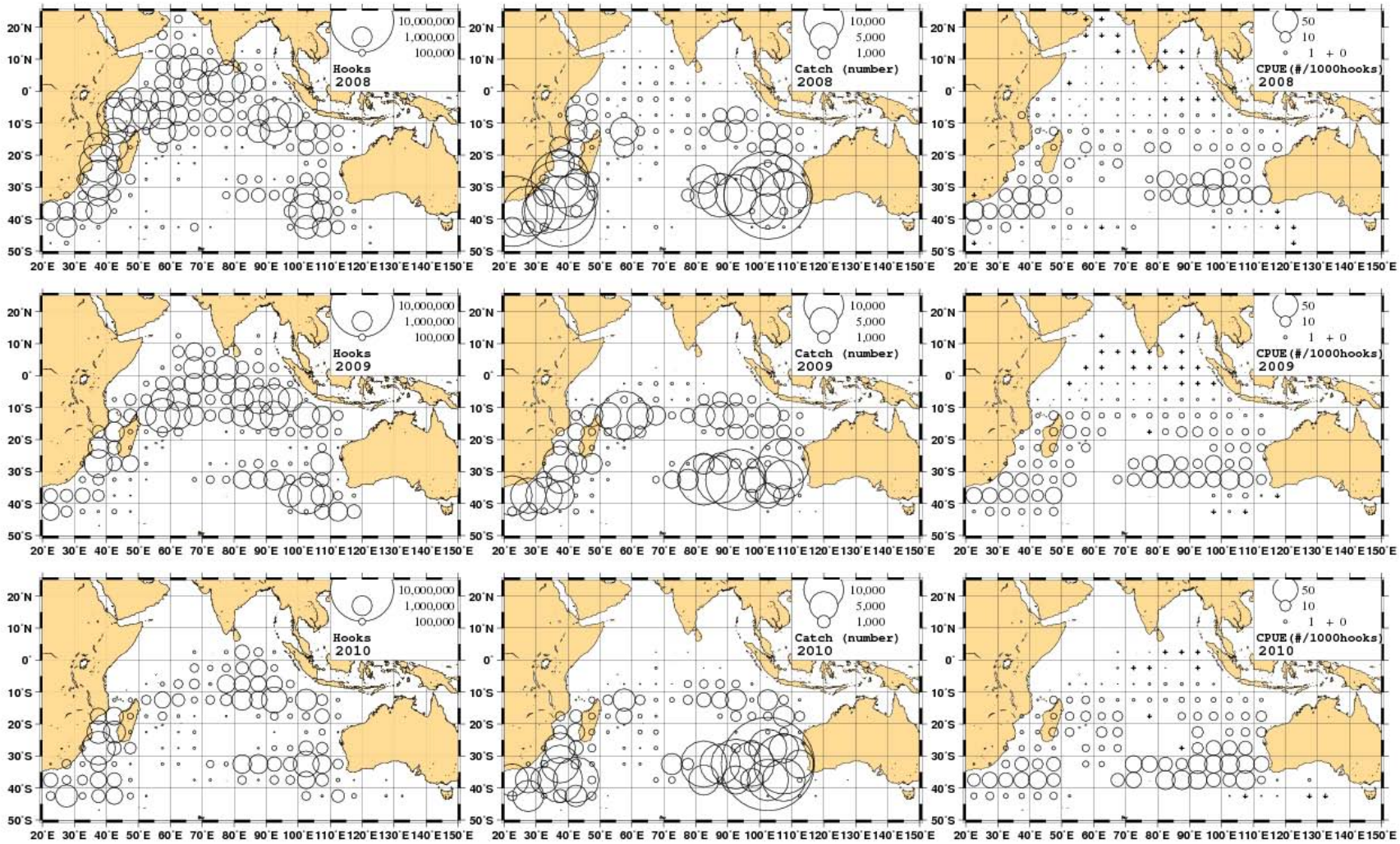

Fig. 5. The geographical distribution of the effort (number of hooks), albacore catch (number of fish) and CPUE (number of fish/1000hooks) in recent years. (continued)

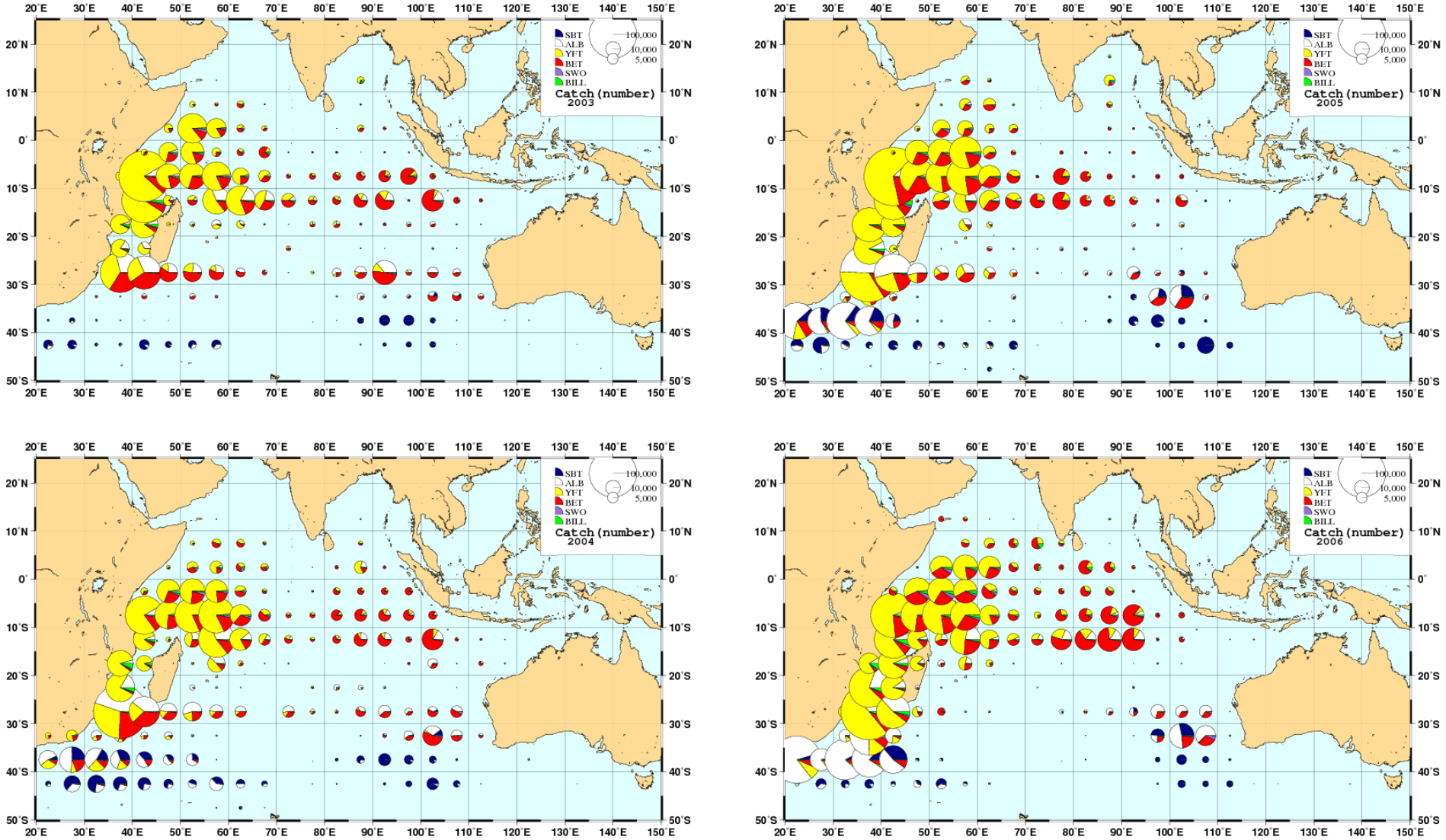

Fig. 6. Annual recent distribution of amount of catch in number by species. Size of circle shows amount of total of catches i.e. southern bluefin tuna (SBT), albacore (ALB), bigeye tuna (BET), yellowfin tuna (YFT), swordfish (SWO) and billfishes (Bill).

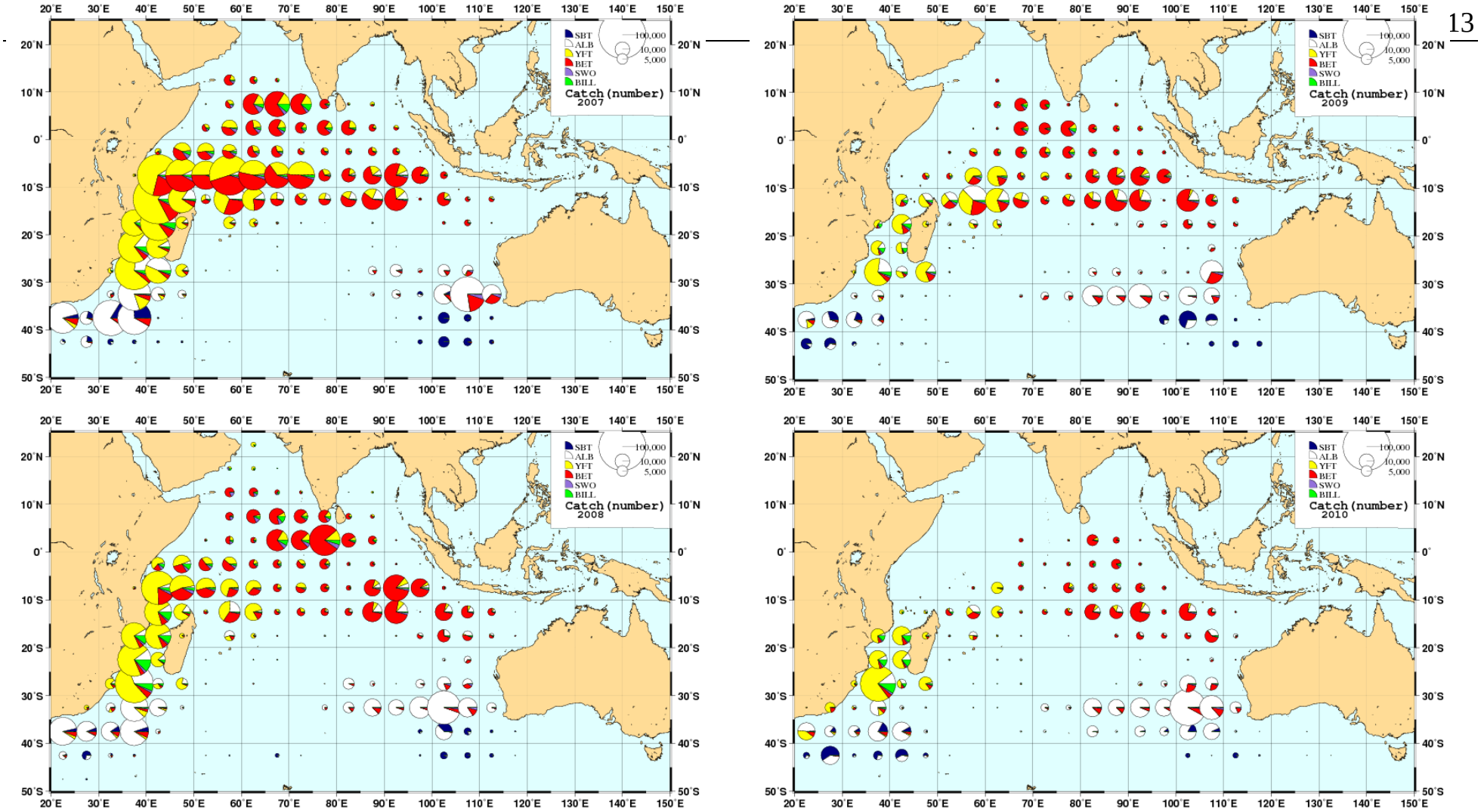

Fig. 6. Annual recent distribution of amount of catch in number by species. Size of circle shows amount of total of catches i.e. southern bluefin tuna (SBT), albacore (ALB), bigeye tuna (BET), yellowfin tuna (YFT), swordfish (SWO) and billfishes (Bill).(continued)

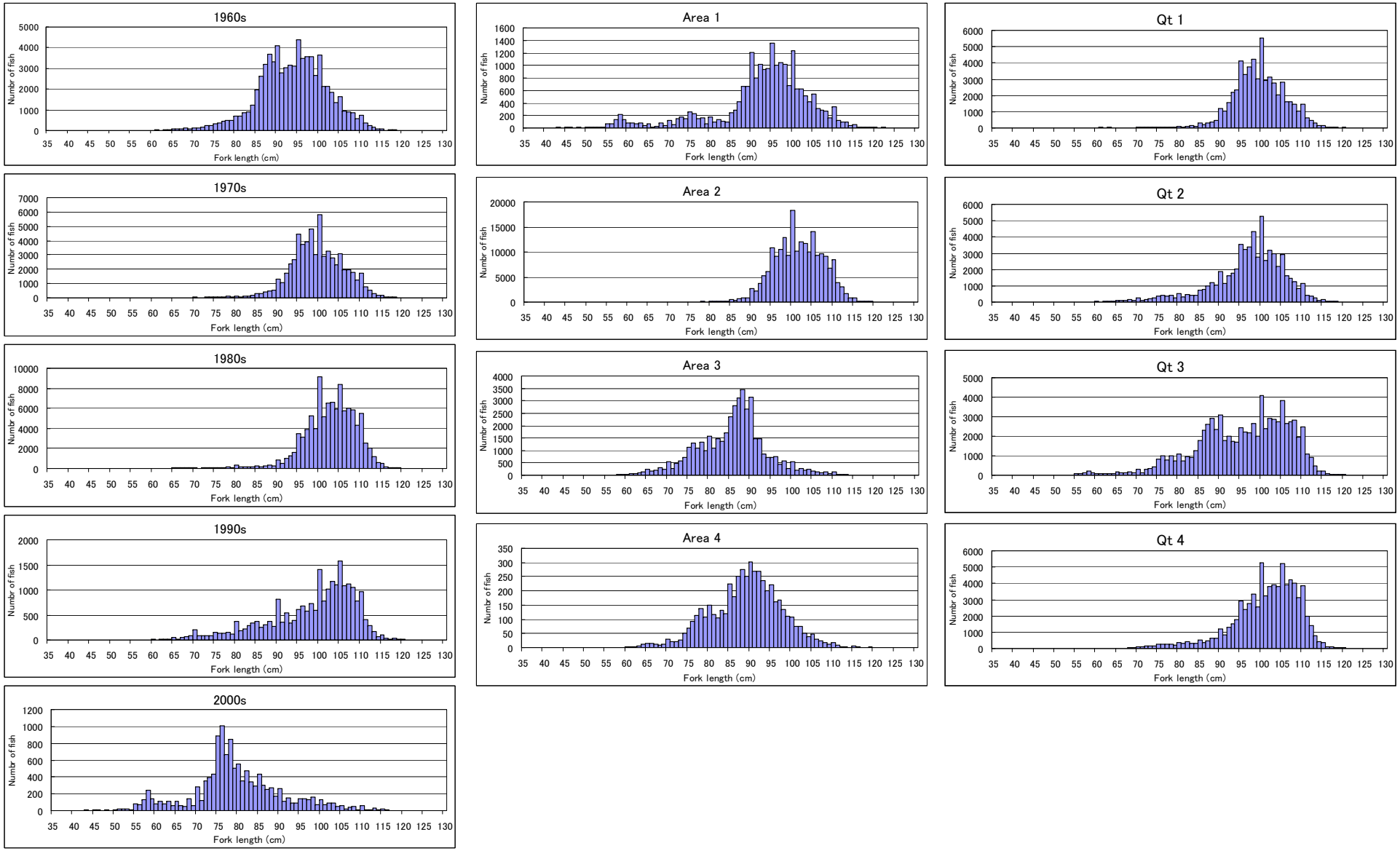

Fig. 7. Length frequency of albacore in the Indian Ocean caught by Japanese longline by decade (left), area (middle) and quarter (right) shown in Fig. 1 (right).

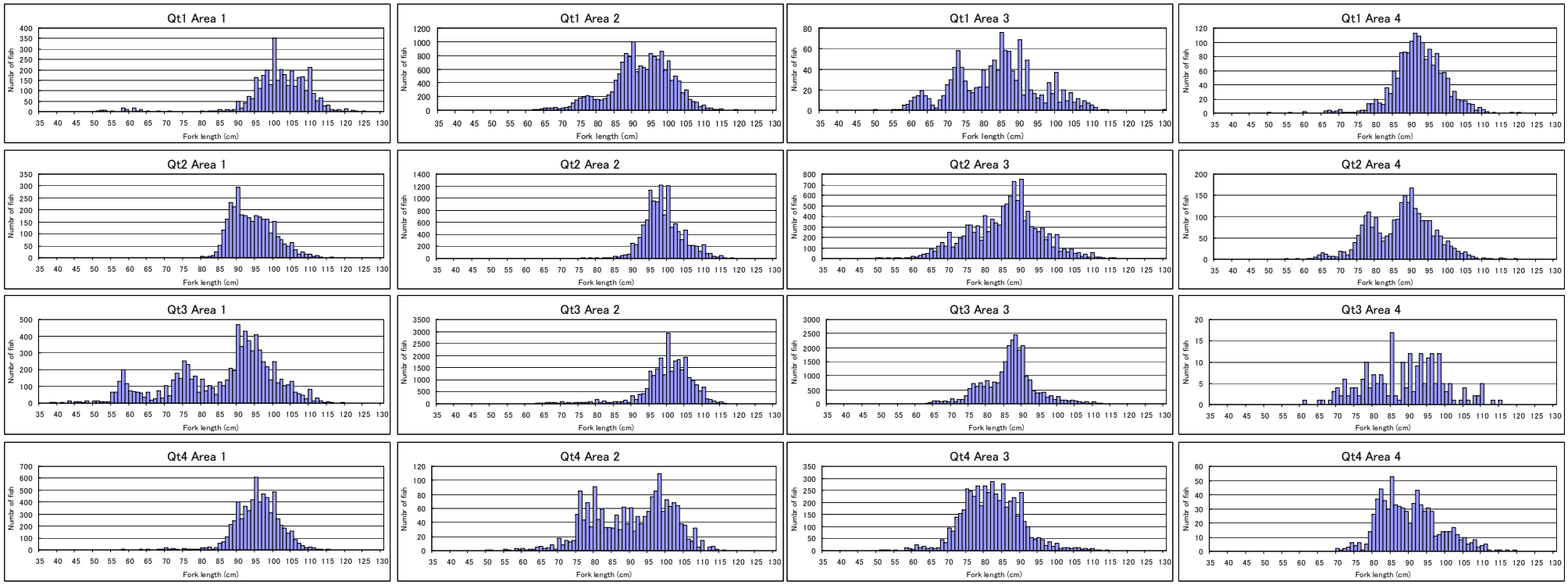

Fig. 8. Length frequency of albacore in the Indian Ocean caught by Japanese longline by quarter and area.