

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

by

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### **Summary**

Status of effort, albacore catch, CPUE and body size was summarized for Japanese longline fishery operating in the Indian Ocean including recent trends. Japanese longline vessels were targeting albacore since late 1960s, albacore became non-target after that, but it has become one of target species in recent years. Fishing effort fluctuated and it is sharply decreasing in recent years probably due to the effects of pirates. Albacore catch was high in 1960s, sharply decreased in 1970s, and then gradually increased with fluctuation. In the early period, the effort was deployed mainly in the tropical area, and then expanded to the south. Fishing effort in the northwestern part (around Somalia) sharply decreased after 2009 due to pirates. During 1960s albacore was main component of the catch in the western part between 10°S and 35°S, and is also main component in the southern part including west off Australia. Size data of albacore has been almost constantly collected from on-board measurement, observer program and so on. Changes in fish size by season and area were observed.

### **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 1952-2011. 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 1965-2011. Data for 2011 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 indicate 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 2011 (preliminary) it decreased to about 20% of the peak value. Main reason of the decrease in recent years 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 gradually 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 with slight increase 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 late 1990s 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 has been seen especially in the regions off Somalia since 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 was observed during 2006-2007 (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. In recent years, however, due to decreased quota of southern bluefin tuna and enhanced market value of albacore for sashimi products, more Japanese longline vessels are targeting albacore in the west off Australia. 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 except for a part of year. On-board measurements by training and commercial longline vessels had been main data source since 1990. After that, data from these vessels decreased, but data from on-board observers (mostly in the fishing ground for southern bluefin tuna) has been obtained and it has become main data source. Table 4 and Table 5 show the sample number by year or decade, 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 1965-2011 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 100cm after 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 1965-2011 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.

Fig. 9 shows length distribution of albacore for 1965-2011 stratified by decade and quarter. Fish size was

comparatively constant (mostly between 85 and 115cm) for quarter 1. In quarter 2 and 3, most fish were larger than 80cm until 1980s, but smaller fish (60-80cm) were also included after that. This is probably because of the fish were mainly sampled in Area 2 until 1980s and main component changed to Area 3 after that (Table 4), where smaller fish are dominant (Fig. 7). Similar change was observed for quarter 4 in 2000s. It is also because of shift of area sampled (from Area 2 to Area 3). Apart from the changes of area sampled, historical changes in fish size seem to be small. The results indicate that fish size measured by different methods including on-board measurement for commercial vessels were similar size.

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 hooks (thousand)	Catch in number (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	37,037	31	283	122	121	12	5	3	1
2011	26,314	36	185	92	136	9	6	2	1

Table 3. Number of fish measured on the albacore length by type of measurement. 2009 data are preliminary. SBT related survey: observer program.

Year	On-board			Port sampling		Total
	Training Vessel	Commercial vessel	SBT related survey	Training Vessel	Commercial vessel	
1965	0	0	0	21,944	7,237	29,181
1966	0	0	0	17,344	7,188	24,532
1967	5,697	0	0	0	4,388	10,085
1968	4,206	0	0	0	2,718	6,924
1969	5,487	0	0	0	3,017	8,504
1970	6,375	0	0	0	881	7,256
1971	7,981	0	0	0	1,010	8,991
1972	4,819	0	0	0	0	4,819
1973	7,398	0	0	0	150	7,548
1974	7,369	0	0	0	240	7,609
1975	4,157	0	0	0	0	4,157
1976	8,644	0	0	0	0	8,644
1977	5,582	0	0	0	0	5,582
1978	5,076	0	0	0	0	5,076
1979	4,831	0	0	0	0	4,831
1980	5,801	0	0	0	0	5,801
1981	13,694	0	0	0	0	13,694
1982	10,554	0	0	0	0	10,554
1983	9,265	0	0	0	0	9,265
1984	9,299	0	0	0	0	9,299
1985	14,006	0	0	0	0	14,006
1986	14,047	266	0	0	0	14,313
1987	12,848	60	0	0	0	12,908
1988	7,121	79	0	0	0	7,200
1989	6,873	1,261	0	0	0	8,134
1990	6,982	1,147	0	0	0	8,129
1991	2,368	624	0	0	0	2,992
1992	1,582	2,064	2,127	0	0	5,773
1993	742	848	278	0	0	1,868
1994	103	753	88	0	0	944
1995	266	654	293	0	0	1,213
1996	291	68	777	0	0	1,136
1997	570	2,279	2,464	0	0	5,313
1998	969	379	957	0	0	2,305
1999	171	549	1,521	0	0	2,241
2000	476	4,172	1,190	0	0	5,838
2001	51	2,394	2,012	0	0	4,457
2002	27	2,426	440	0	0	2,893
2003	5	1,390	310	0	0	1,705
2004	0	1,180	2,115	0	0	3,295
2005	0	246	5,876	0	0	6,122
2006	0	171	9,680	0	0	9,851
2007	0	364	4,830	0	0	5,194
2008	0	0	386	0	0	386
2009	0	0	2,236	0	0	2,236
2010	0	0	1,804	0	0	1,804
2011	0	0	3,728	0	0	3,728

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

Year	Area1	Area2	Area3	Area4	Total	Decade	Qt	Total	Area1	Area2	Area3	Area4
1965	3,487	10,856	12,798	127	27,268	1960	1	17,546	1,029	15,841	370	306
1966	7,694	9,053	6,414	0	23,161	1960	2	16,284	2,394	6,649	5,333	1,908
1967	260	6,525	702	2,137	9,624	1960	3	25,823	3,117	6,232	16,346	128
1968	470	5,016	0	590	6,076	1960	4	14,780	5,743	6,864	1,461	712
1969	372	4,136	3,596	200	8,304	1970	1	26,379	1,265	23,699	287	1,128
1970	106	6,255	795	0	7,156	1970	2	12,244	96	11,892	106	150
1971	19	7,036	0	1,276	8,331	1970	3	11,250	54	9,758	1,438	0
1972	22	4,797	0	0	4,819	1970	4	13,730	158	13,534	27	11
1973	1,036	6,351	0	11	7,398	1980	1	12,039	802	11,096	141	0
1974	0	7,353	256	0	7,609	1980	2	27,007	129	24,459	2,419	0
1975	245	3,895	17	0	4,157	1980	3	28,470	678	26,097	1,600	95
1976	44	8,600	0	0	8,644	1980	4	37,658	466	37,078	81	33
1977	4	5,578	0	0	5,582	1990	1	1,759	27	1,167	404	161
1978	0	4,781	295	0	5,076	1990	2	10,264	248	2,213	6,834	969
1979	97	4,237	495	2	4,831	1990	3	12,430	1,317	3,989	6,488	636
1980	6	5,748	47	0	5,801	1990	4	7,460	34	6,937	413	76
1981	20	13,436	238	0	13,694	2000	1	1,212	492	472	137	111
1982	841	9,343	360	10	10,554	2000	2	6,307	342	532	5,433	0
1983	173	7,915	1,087	90	9,265	2000	3	28,600	3,408	149	23,113	1,930
1984	297	8,557	445	0	9,299	2000	4	5,858	230	640	4,407	581
1985	243	12,984	779	0	14,006	2010	1	77	11	66	0	0
1986	25	14,022	266	0	14,313	2010	2	3,348	0	1	1,899	1,448
1987	92	12,759	57	0	12,908	2010	3	1,851	0	76	641	1,134
1988	36	7,118	43	3	7,200	2010	4	256	25	223	6	2
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	3,227	964	5,773							
1993	92	754	1,015	7	1,868							
1994	507	103	317	16	943							
1995	48	266	759	140	1,213							
1996	0	267	790	79	1,136							
1997	40	595	4,626	52	5,313							
1998	52	966	1,155	132	2,305							
1999	161	326	1,302	452	2,241							
2000	304	596	4,728	210	5,838							
2001	1,237	169	3,035	16	4,457							
2002	2,078	96	719	0	2,893							
2003	92	130	1,427	56	1,705							
2004	112	81	3,087	15	3,295							
2005	168	103	5,363	488	6,122							
2006	224	169	7,914	1,544	9,851							
2007	257	180	4,702	55	5,194							
2008	0	219	1	166	386							
2009	0	50	2,114	72	2,236							
2010	25	197	1,197	385	1,804							
2011	11	169	1,349	2,199	3,728							



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	Year	Qt	Area1	Area2	Area3	Area4	Total
1965	1	799	3,502	0	100	4,401	1977	1	4	2,875	0	0	2,879
1965	2	1,943	3,816	2,567	0	8,326	1977	2	0	342	0	0	342
1965	3	604	1,142	9,319	0	11,065	1977	3	0	241	0	0	241
1965	4	141	2,396	912	27	3,476	1977	4	0	2,120	0	0	2,120
1966	1	0	4,341	0	0	4,341	1978	1	0	2,784	24	0	2,808
1966	2	127	881	1,162	0	2,170	1978	2	0	340	31	0	371
1966	3	2,503	1,388	5,252	0	9,143	1978	3	0	404	238	0	642
1966	4	5,064	2,443	0	0	7,507	1978	4	0	1,253	2	0	1,255
1967	1	0	3,270	0	205	3,475	1979	1	0	1,263	5	2	1,270
1967	2	0	1,308	100	1,126	2,534	1979	2	2	76	59	0	137
1967	3	10	1,606	571	128	2,315	1979	3	47	1,559	420	0	2,026
1967	4	250	341	31	678	1,300	1979	4	48	1,339	11	0	1,398
1968	1	163	3,280	0	1	3,444	1980	1	6	307	0	0	313
1968	2	19	331	0	582	932	1980	2	0	2,260	37	0	2,297
1968	3	0	475	0	0	475	1980	3	0	1,448	10	0	1,458
1968	4	288	930	0	7	1,225	1980	4	0	1,733	0	0	1,733
1969	1	67	1,448	370	0	1,885	1981	1	13	2052	0	0	2065
1969	2	305	313	1,504	200	2,322	1981	2	0	5678	150	0	5828
1969	3	0	1,621	1,204	0	2,825	1981	3	0	3184	86	0	3270
1969	4	0	754	518	0	1,272	1981	4	7	2522	2	0	2531
1970	1	15	650	241	0	906	1982	1	478	1153	117	0	1748
1970	2	91	3,336	0	0	3,427	1982	2	0	2848	198	0	3046
1970	3	0	1,163	540	0	1,703	1982	3	1	2593	45	10	2649
1970	4	0	1,106	14	0	1,120	1982	4	362	2749	0	0	3111
1971	1	2	2,179	0	1,126	3,307	1983	1	38	1396	19	0	1453
1971	2	3	2,330	0	150	2,483	1983	2	8	2629	760	0	3397
1971	3	4	1,753	0	0	1,757	1983	3	47	1472	308	72	1899
1971	4	10	774	0	0	784	1983	4	80	2418	0	18	2516
1972	1	0	2,439	0	0	2,439	1984	1	99	332	0	0	431
1972	2	0	852	0	0	852	1984	2	0	972	222	0	1194
1972	3	0	703	0	0	703	1984	3	192	3552	159	0	3903
1972	4	22	803	0	0	825	1984	4	6	3701	64	0	3771
1973	1	1,036	3,018	0	0	4,054	1985	1	62	760	5	0	827
1973	2	0	1,385	0	0	1,385	1985	2	26	3824	454	0	4304
1973	3	0	394	0	0	394	1985	3	155	2921	320	0	3396
1973	4	0	1,554	0	11	1,565	1985	4	0	5479	0	0	5479
1974	1	0	3,262	0	0	3,262	1986	1	25	1351	0	0	1376
1974	2	0	1,200	16	0	1,216	1986	2	0	1575	265	0	1840
1974	3	0	1,476	240	0	1,716	1986	3	0	4033	1	0	4034
1974	4	0	1,415	0	0	1,415	1986	4	0	7063	0	0	7063
1975	1	164	1,427	17	0	1,608	1987	1	81	2074	0	0	2155
1975	2	0	725	0	0	725	1987	2	0	2556	8	0	2564
1975	3	3	594	0	0	597	1987	3	0	3193	49	0	3242
1975	4	78	1,149	0	0	1,227	1987	4	11	4936	0	0	4947
1976	1	44	3,802	0	0	3,846	1988	1	0	867	0	0	867
1976	2	0	1,306	0	0	1,306	1988	2	0	1303	0	0	1303
1976	3	0	1,471	0	0	1,471	1988	3	36	2170	43	0	2249
1976	4	0	2,021	0	0	2,021	1988	4	0	2778	0	3	2781

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. (continued)

Year	Qt	Area1	Area2	Area3	Area4	Total	Year	Qt	Area1	Area2	Area3	Area4	Total
1989	1	0	804	0	0	804	2001	1	0	8	0	0	8
1989	2	95	814	325	0	1234	2001	2	17	51	260	0	328
1989	3	247	1531	579	13	2370	2001	3	1096	0	1813	0	2909
1989	4	0	3699	15	12	3726	2001	4	124	110	962	16	1212
1990	1	0	195	0	0	195	2002	1	33	96	137	0	266
1990	2	60	407	238	0	705	2002	2	0	0	147	0	147
1990	3	646	2330	202	0	3178	2002	3	2007	0	35	0	2042
1990	4	1	4050	0	0	4051	2002	4	38	0	400	0	438
1991	1	0	174	0	0	174	2003	1	92	18	0	0	110
1991	2	18	303	93	0	414	2003	2	0	5	105	0	110
1991	3	1	580	363	0	944	2003	3	0	50	32	47	129
1991	4	0	1408	52	0	1460	2003	4	0	57	1290	9	1356
1992	1	0	132	0	161	293	2004	1	0	34	0	0	34
1992	2	0	176	2378	771	3325	2004	2	46	0	874	0	920
1992	3	0	174	814	32	1020	2004	3	66	0	2213	0	2279
1992	4	0	1100	35	0	1135	2004	4	0	47	0	15	62
1993	1	0	385	42	0	427	2005	1	157	0	0	0	157
1993	2	7	353	591	0	951	2005	2	11	0	753	0	764
1993	3	80	0	343	7	430	2005	3	0	0	4610	0	4610
1993	4	5	16	39	0	60	2005	4	0	103	0	488	591
1994	1	0	0	0	0	0	2006	1	118	0	0	56	174
1994	2	76	103	168	0	347	2006	2	22	0	2641	0	2663
1994	3	405	0	61	14	480	2006	3	53	99	5273	1438	6863
1994	4	26	0	88	2	116	2006	4	31	70	0	50	151
1995	1	0	0	333	0	333	2007	1	92	47	0	55	194
1995	2	10	27	275	0	312	2007	2	0	0	67	0	67
1995	3	38	67	143	134	382	2007	3	128	0	4131	0	4259
1995	4	0	172	8	6	186	2007	4	37	133	504	0	674
1996	1	0	0	10	0	10	2008	1	0	219	0	0	219
1996	2	0	267	573	24	864	2008	2	0	0	0	0	0
1996	3	0	0	207	52	259	2008	3	0	0	1	166	167
1996	4	0	0	0	3	3	2008	4	0	0	0	0	0
1997	1	3	281	1	0	285	2009	1	0	50	0	0	50
1997	2	16	197	1459	1	1673	2009	2	0	0	0	0	0
1997	3	19	46	3056	1	3122	2009	3	0	0	1869	71	1940
1997	4	2	71	110	50	233	2009	4	0	0	245	1	246
1998	1	15	0	1	0	16	2010	1	0	0	0	0	0
1998	2	37	209	621	0	867	2010	2	0	0	1191	385	1576
1998	3	0	740	533	118	1391	2010	3	0	3	0	0	3
1998	4	0	17	0	14	31	2010	4	25	194	6	0	225
1999	1	9	0	17	0	26	2011	1	11	66	0	0	77
1999	2	24	171	438	173	806	2011	2	0	1	708	1063	1772
1999	3	128	52	766	278	1224	2011	3	0	73	641	1134	1848
1999	4	0	103	81	1	185	2011	4	0	29	0	2	31
2000	1	0	0	0	0	0							
2000	2	246	476	586	0	1308							
2000	3	58	0	3136	208	3402							
2000	4	0	120	1006	2	1128							

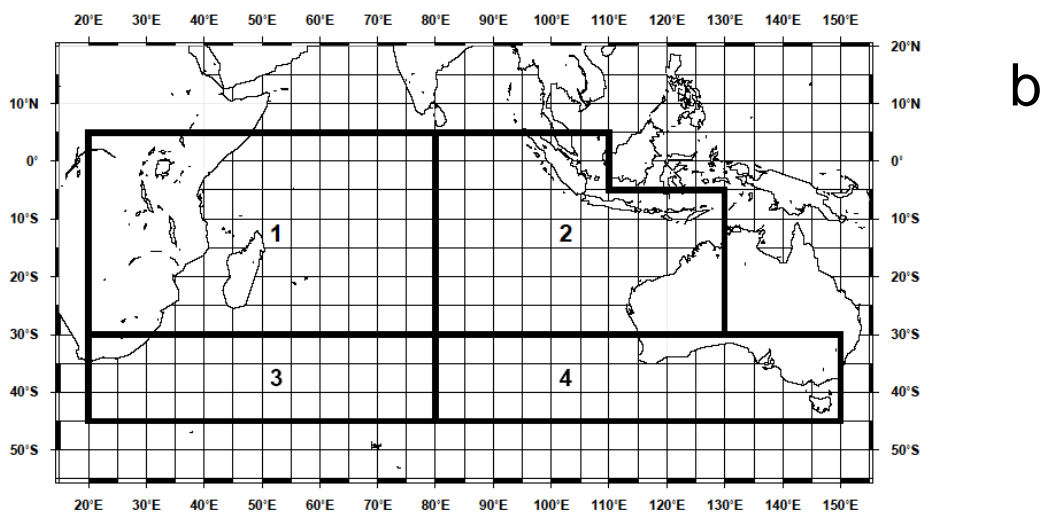
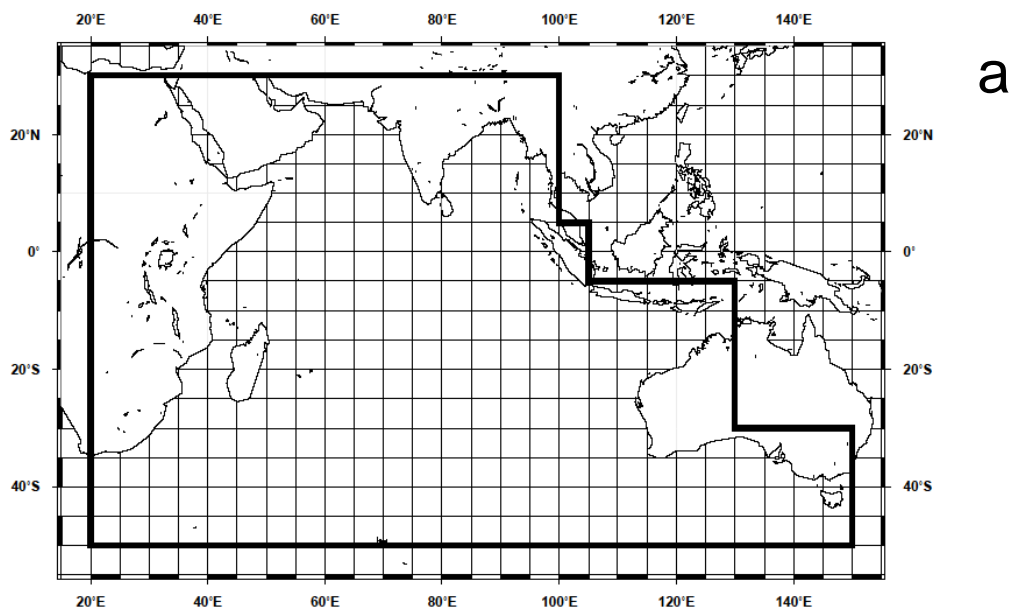


Fig. 1. The geographical range to count the amount of the effort and the catches (top) and area definition to count the number of sample of albacore length data (bottom).

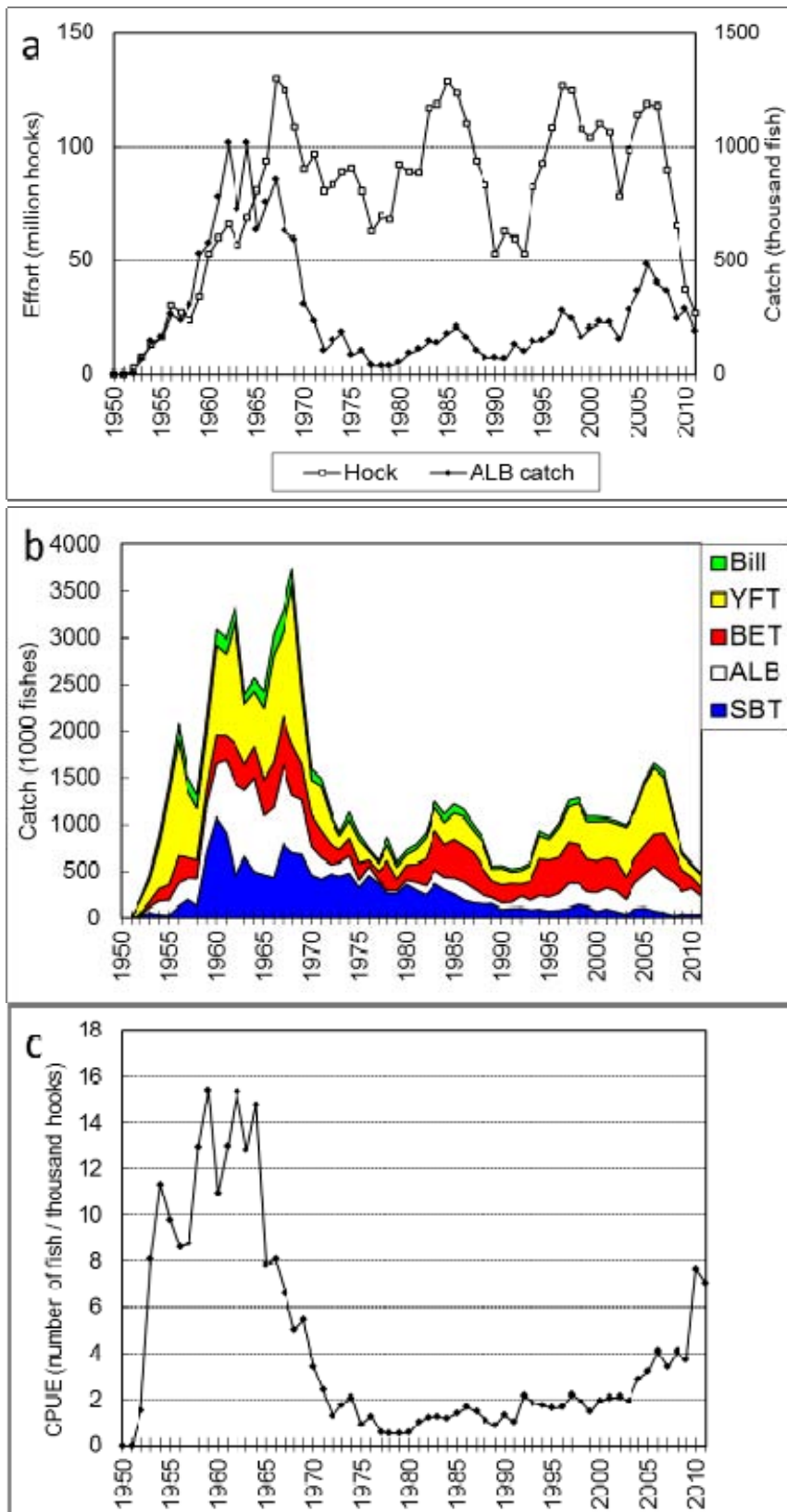


Fig. 2. The number of hooks employed and albacore catch (a), species composition (b), and nominal CPUE of albacore (c) caught by Japanese longline fishery.

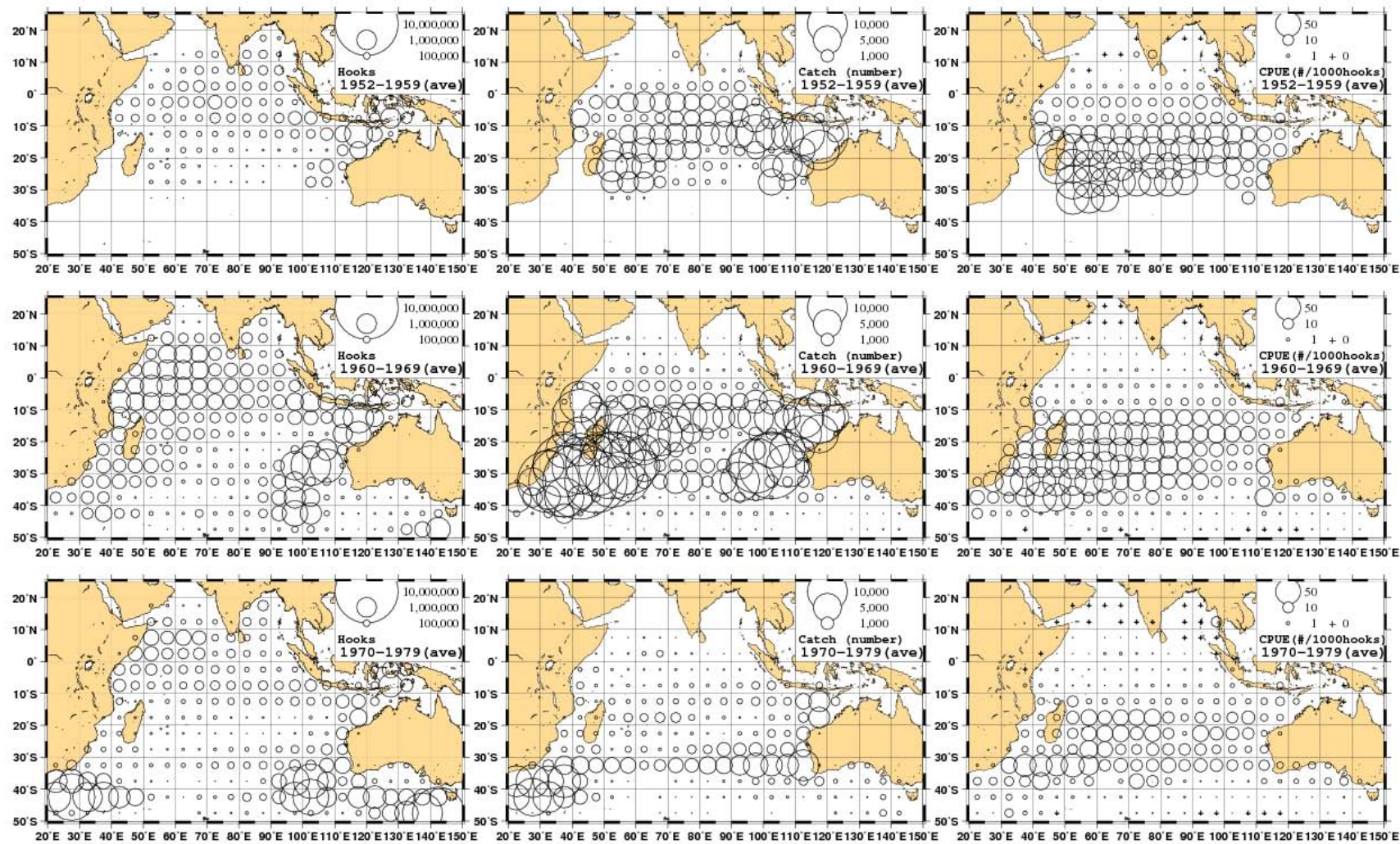


Fig. 3. The average distribution of the effort (number of hooks), albacore catch (number of fish) and CPUE (number of fish/1000hooks) for each decadal period.



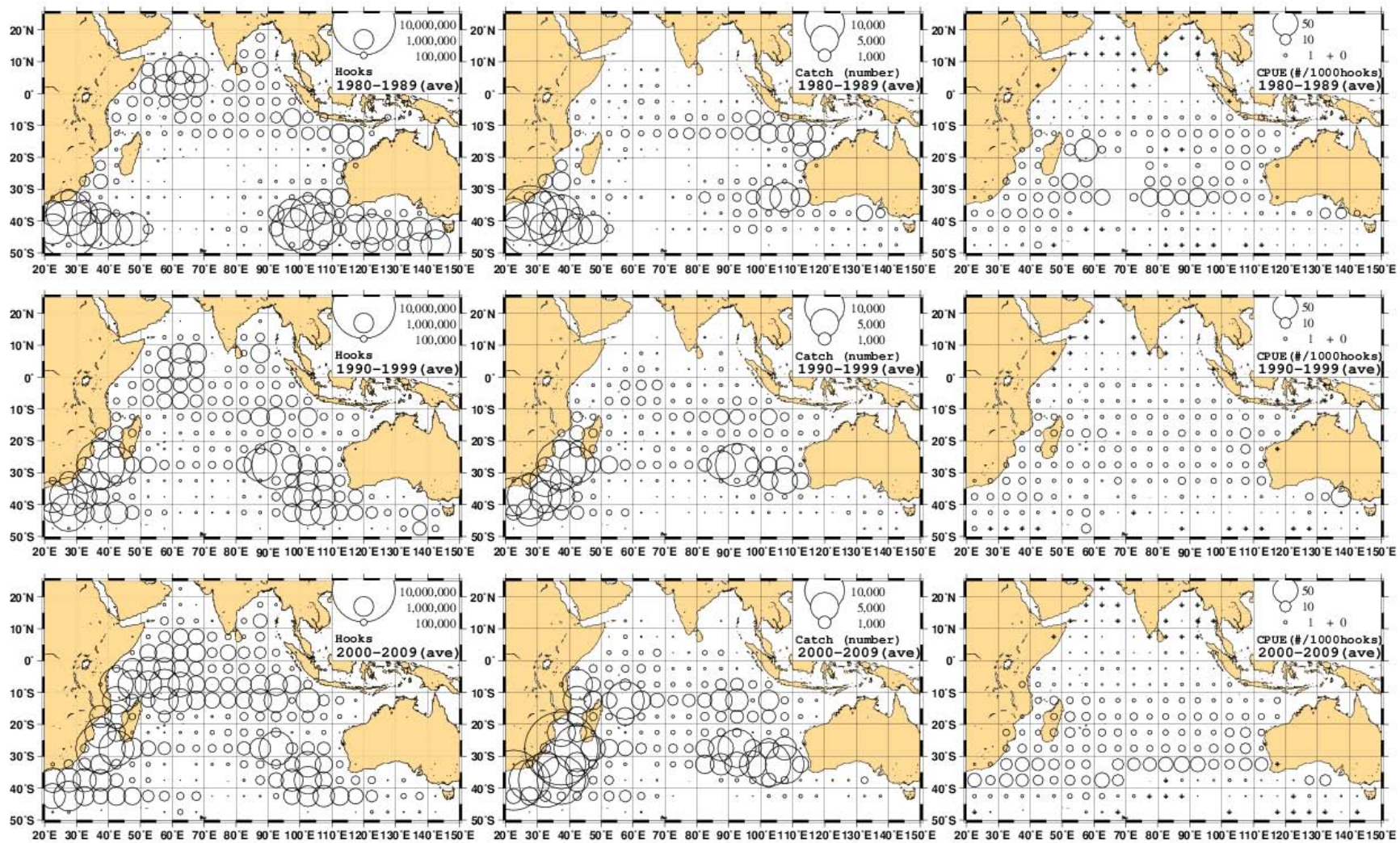


Fig. 3. The average distribution of the effort (number of hooks), albacore catch (number of fish) and CPUE (number of fish/1000hooks) for each decadal period.(continued)



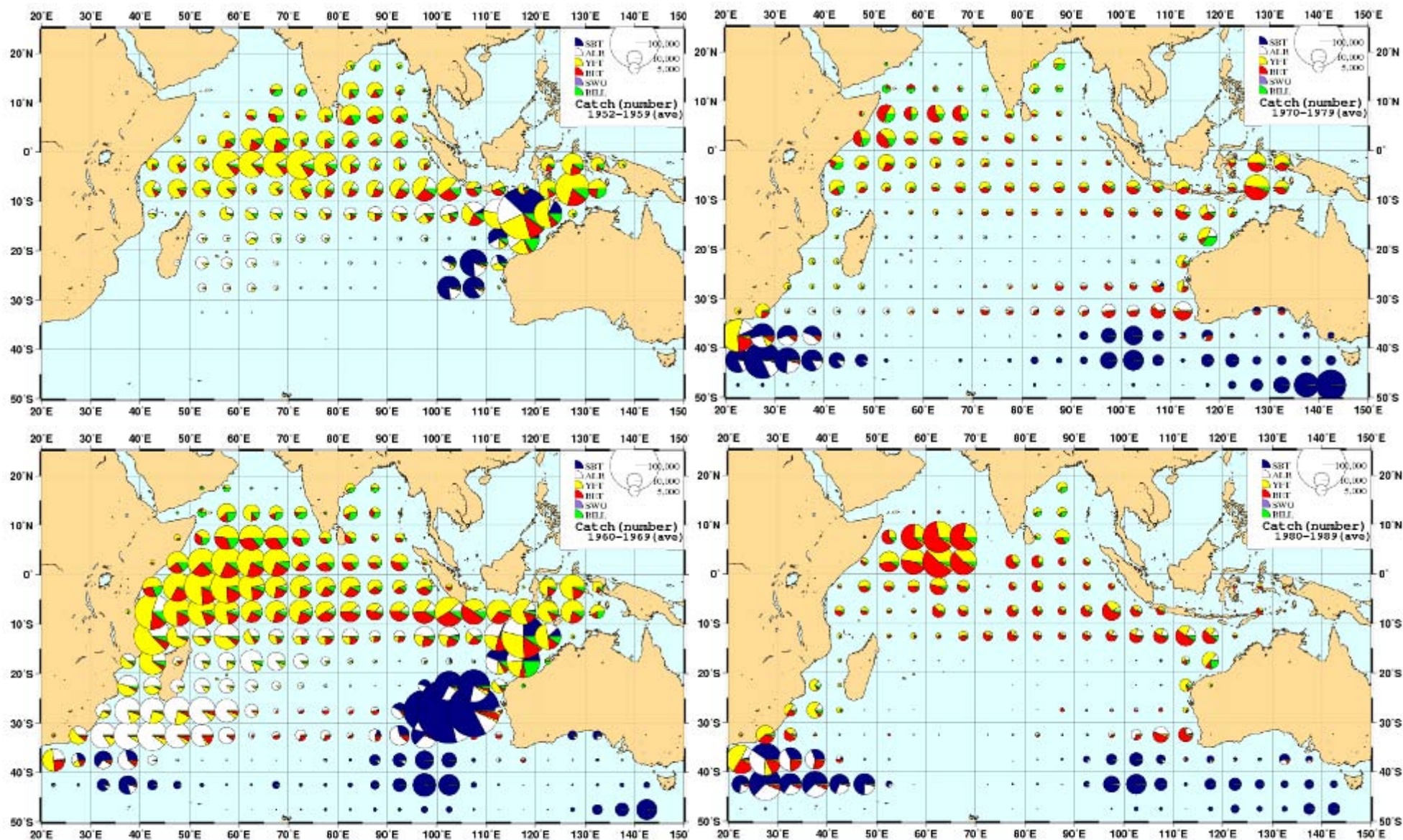


Fig. 4. The averaged distribution of amount of catch in number by species for each decade. Size of circle shows amount of total of catches i.e. southern bluefin tuna (SBT), albacore (ALB), bigeye tuna (BET), yellowfin tuna (YFT), swordfish (SWO) and billfishes (Bill).



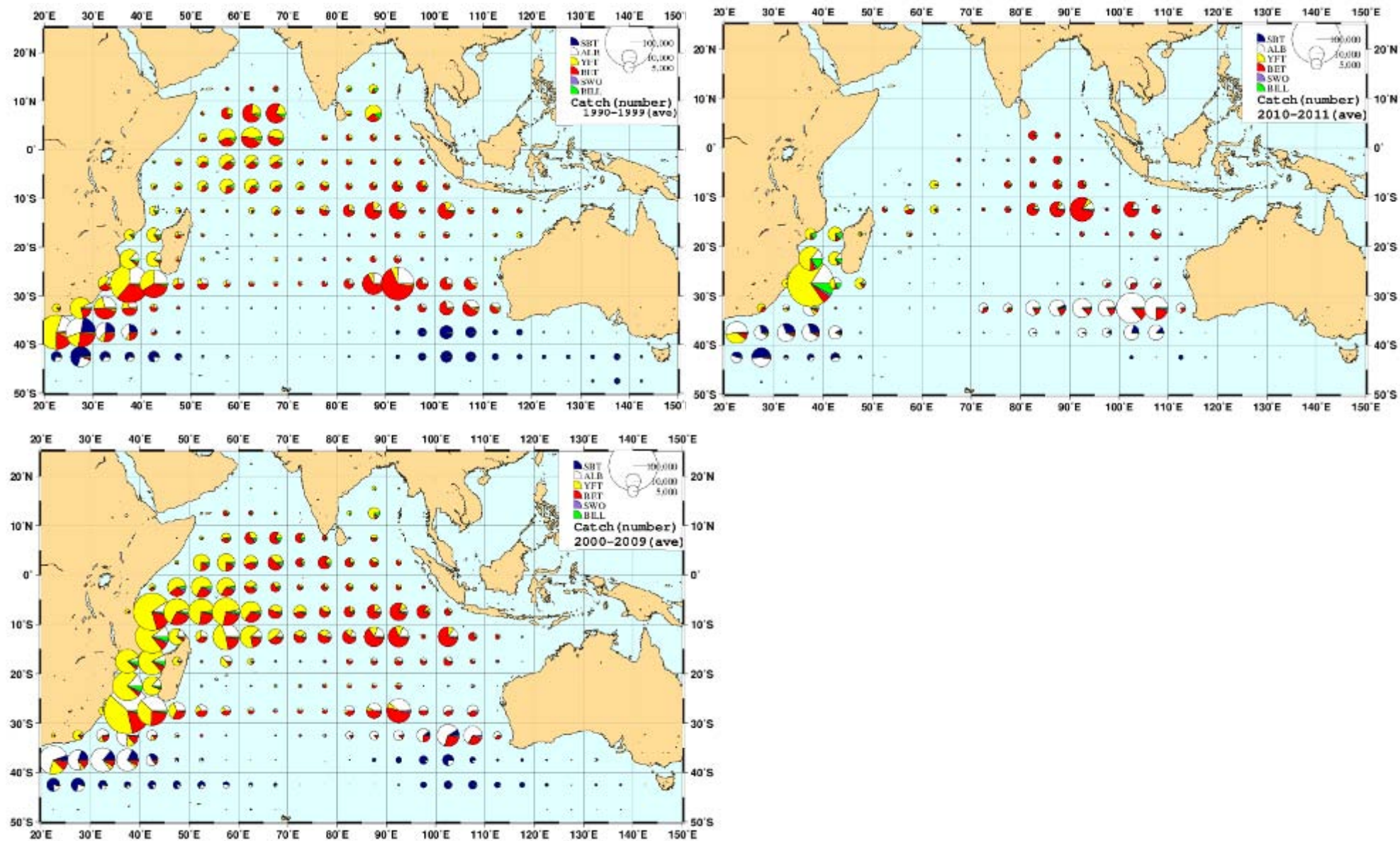


Fig. 4. The averaged distribution of amount of catch in number by species for each decade. Size of circle shows amount of total of catches i.e. southern bluefin tuna (SBT), albacore (ALB), bigeye tuna (BET), yellowfin tuna (YFT), swordfish (SWO) and billfishes (Bill). (continued)



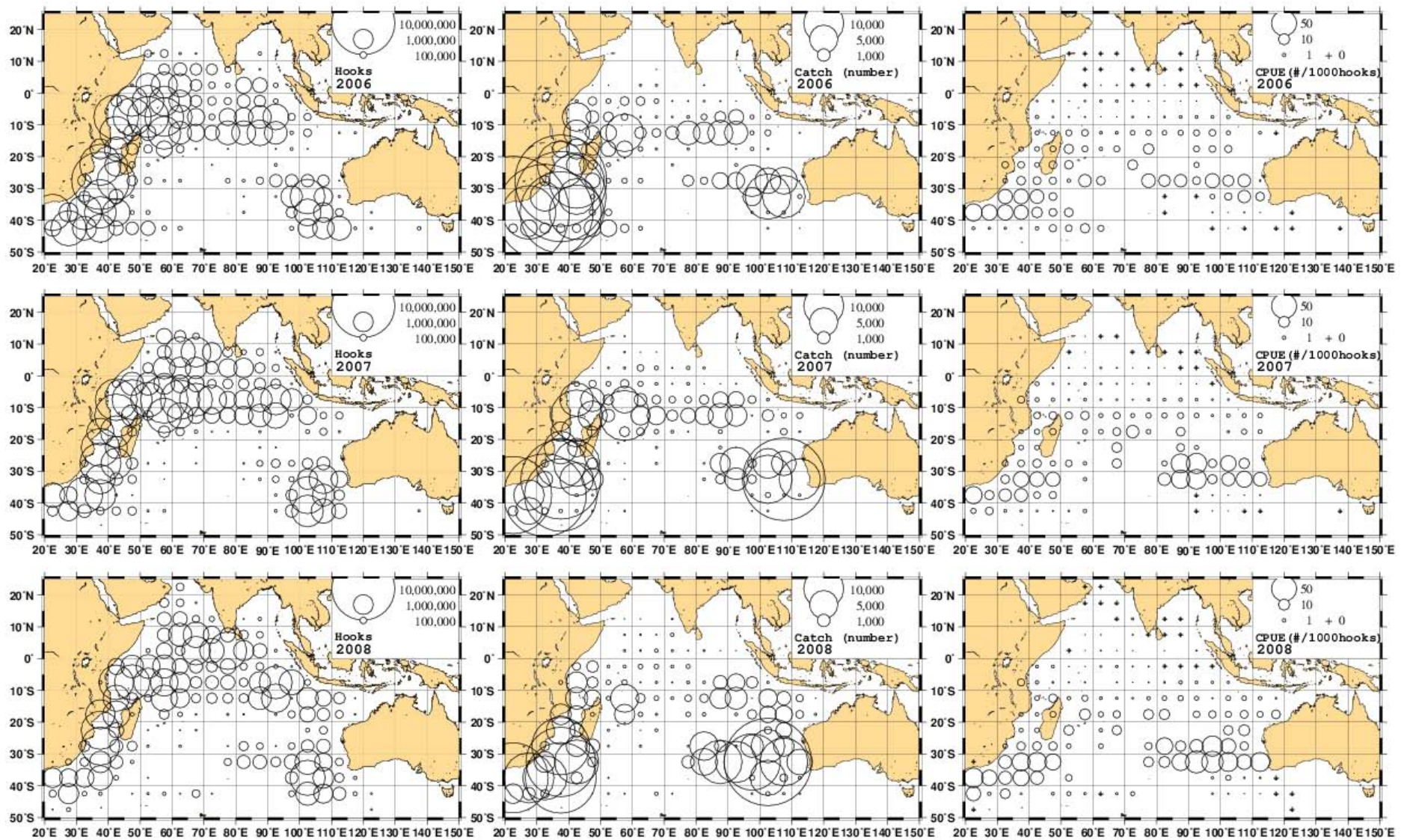


Fig. 5. The geographical distribution of the effort (number of hooks), albacore catch (number of fish) and CPUE (number of fish/1000hooks) in recent years.



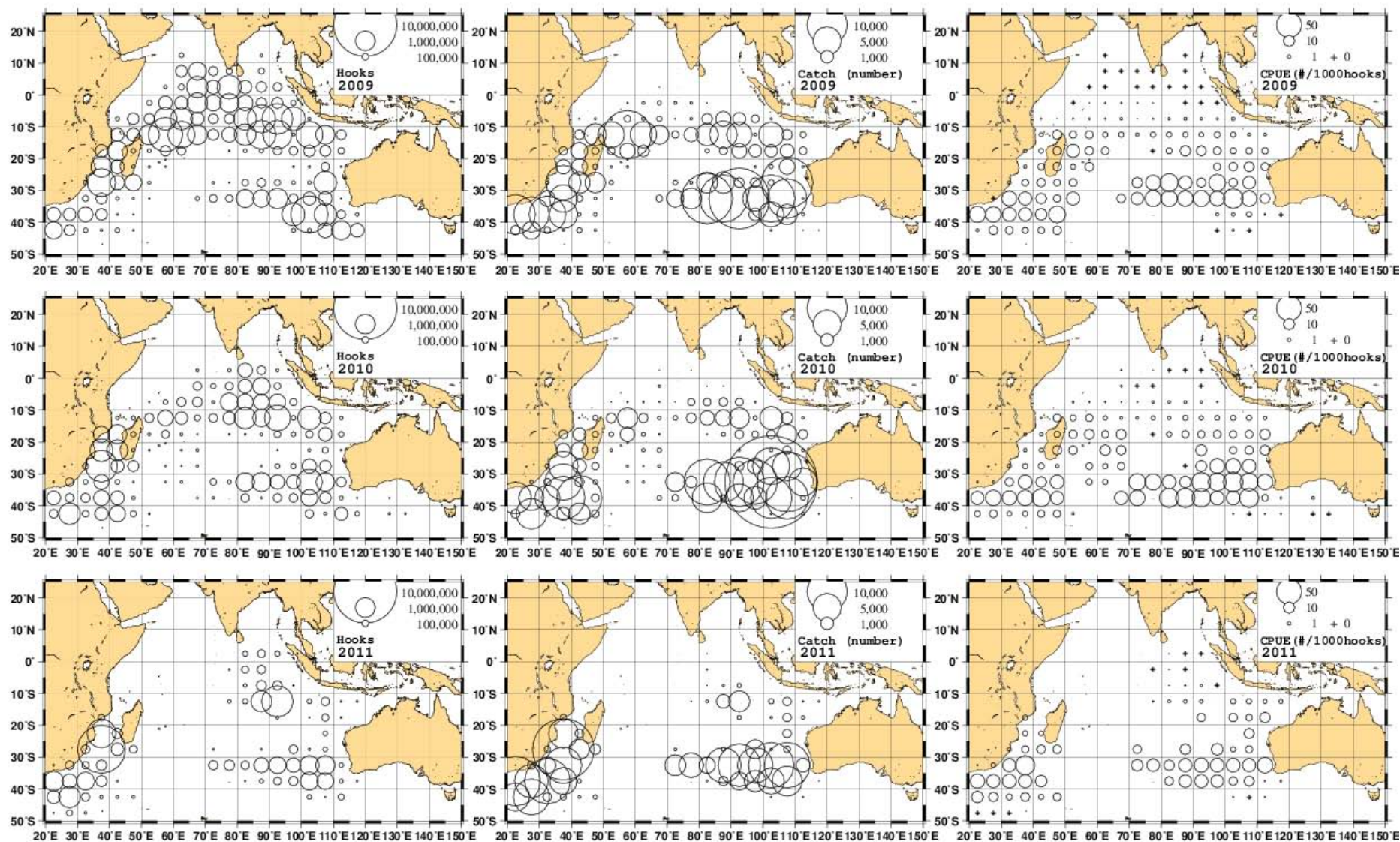


Fig. 5. The geographical distribution of the effort (number of hooks), albacore catch (number of fish) and CPUE (number of fish/1000hooks) in recent years. (continued)



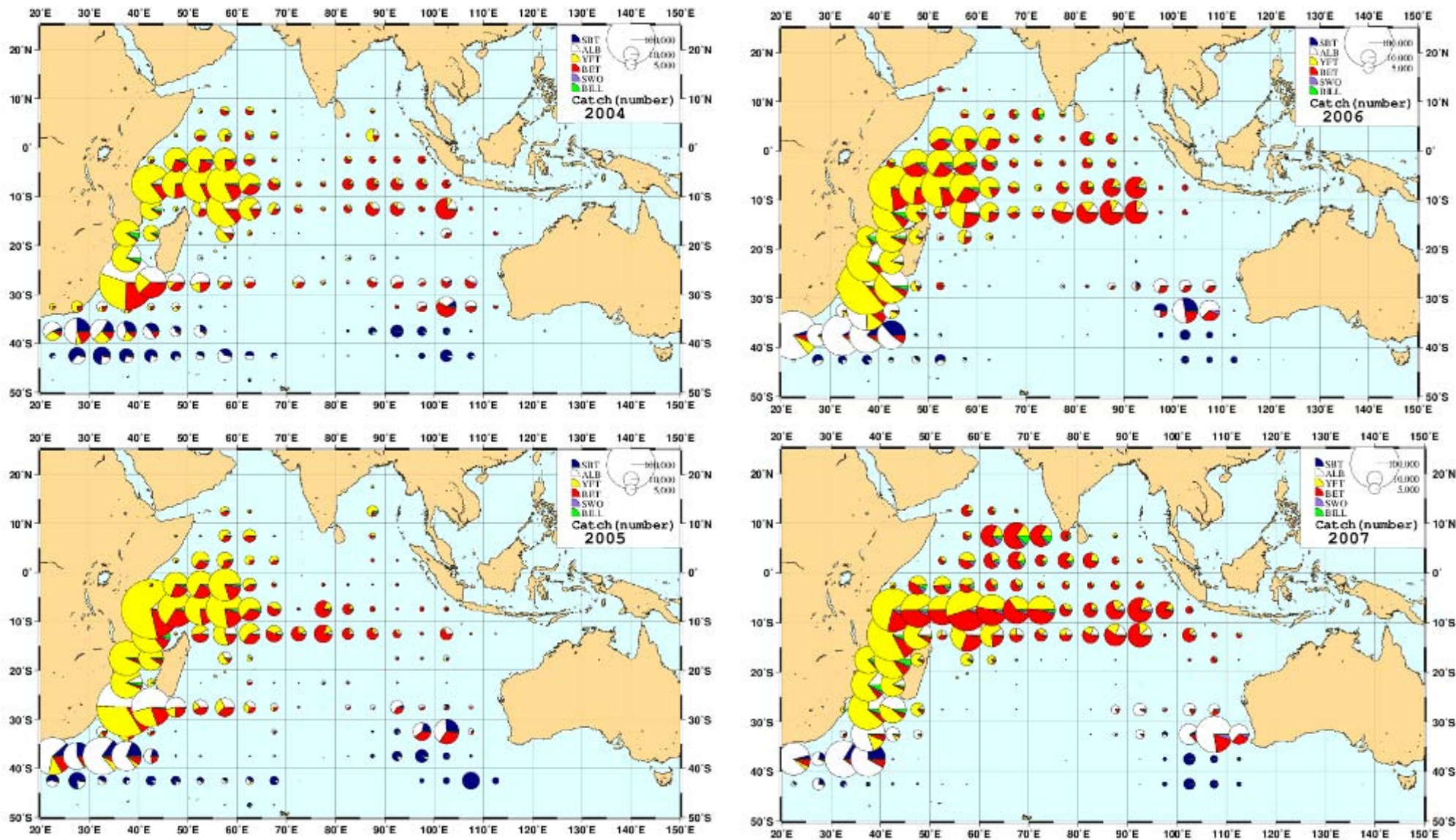


Fig. 6. Annual recent distribution of amount of catch in number by species. Size of circle shows amount of total of catches i.e. southern bluefin tuna (SBT), albacore (ALB), bigeye tuna (BET), yellowfin tuna (YFT), swordfish (SWO) and billfishes (Bill).



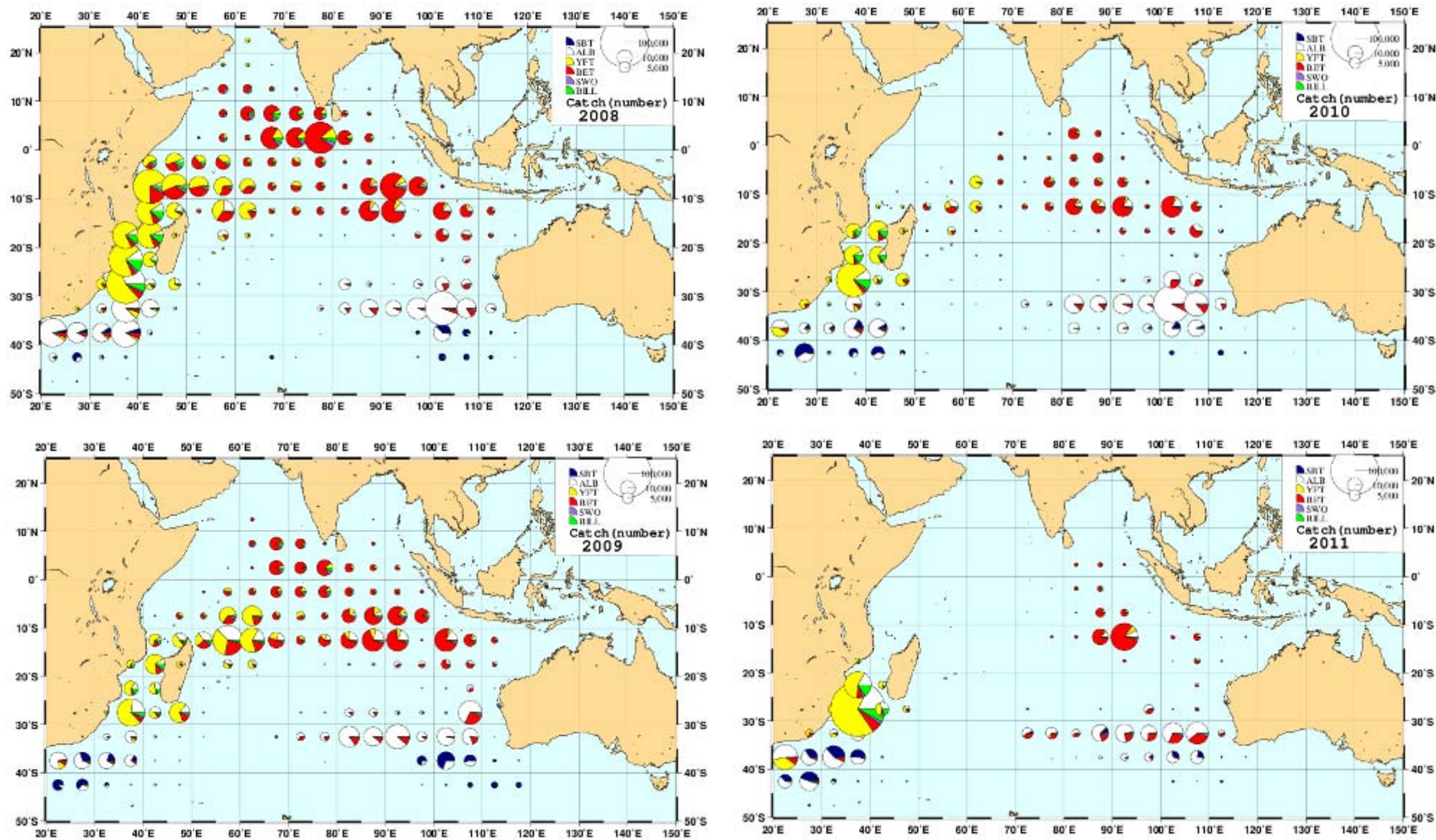


Fig. 6. Annual recent distribution of amount of catch in number by species. Size of circle shows amount of total of catches i.e. southern bluefin tuna (SBT), albacore (ALB), bigeye tuna (BET), yellowfin tuna (YFT), swordfish (SWO) and billfishes (Bill).(continued)

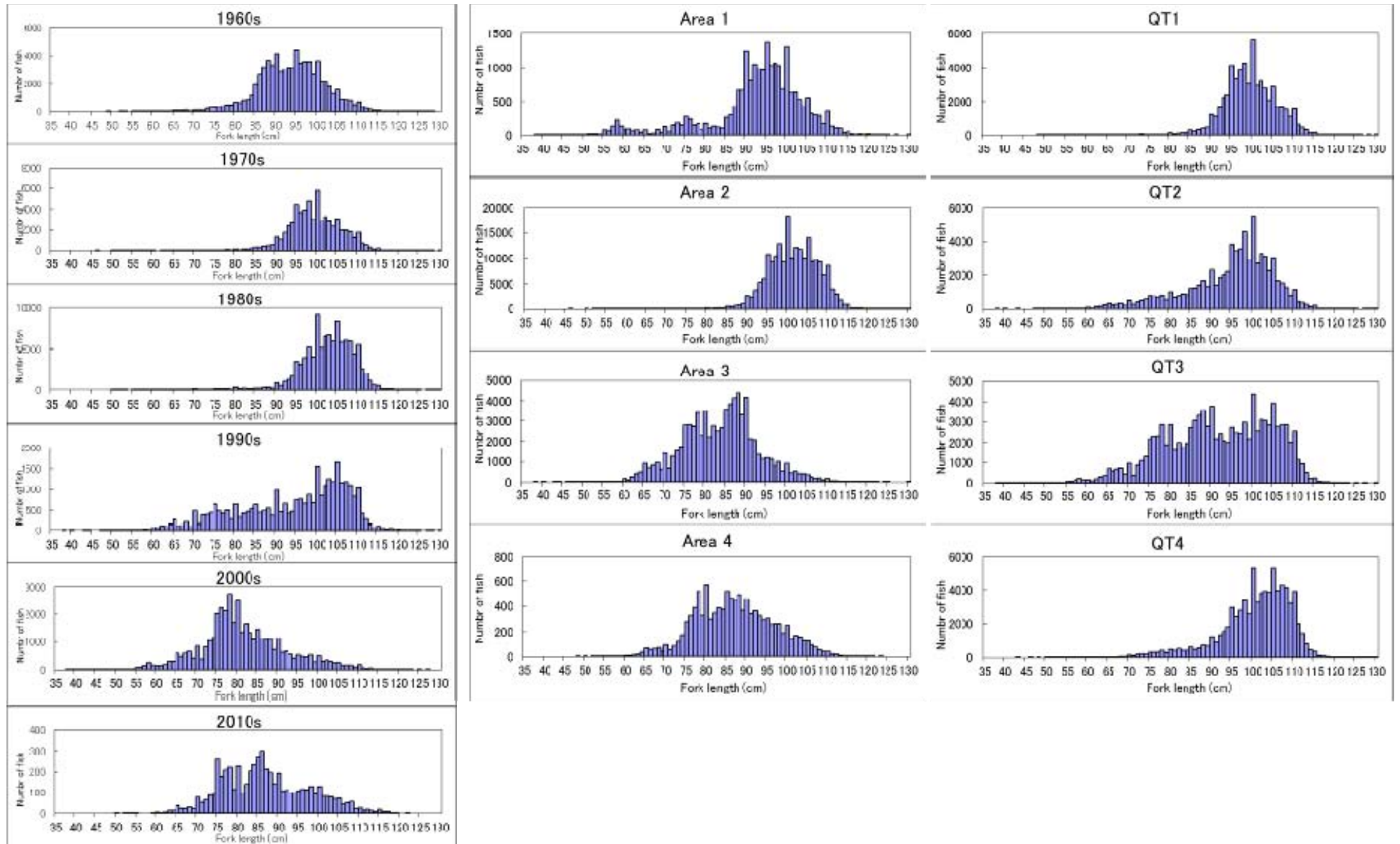


Fig. 7. Length frequency of albacore in the Indian Ocean caught by Japanese longline by decade (left), area (middle) and quarter (right) shown in Fig. 1 (right).



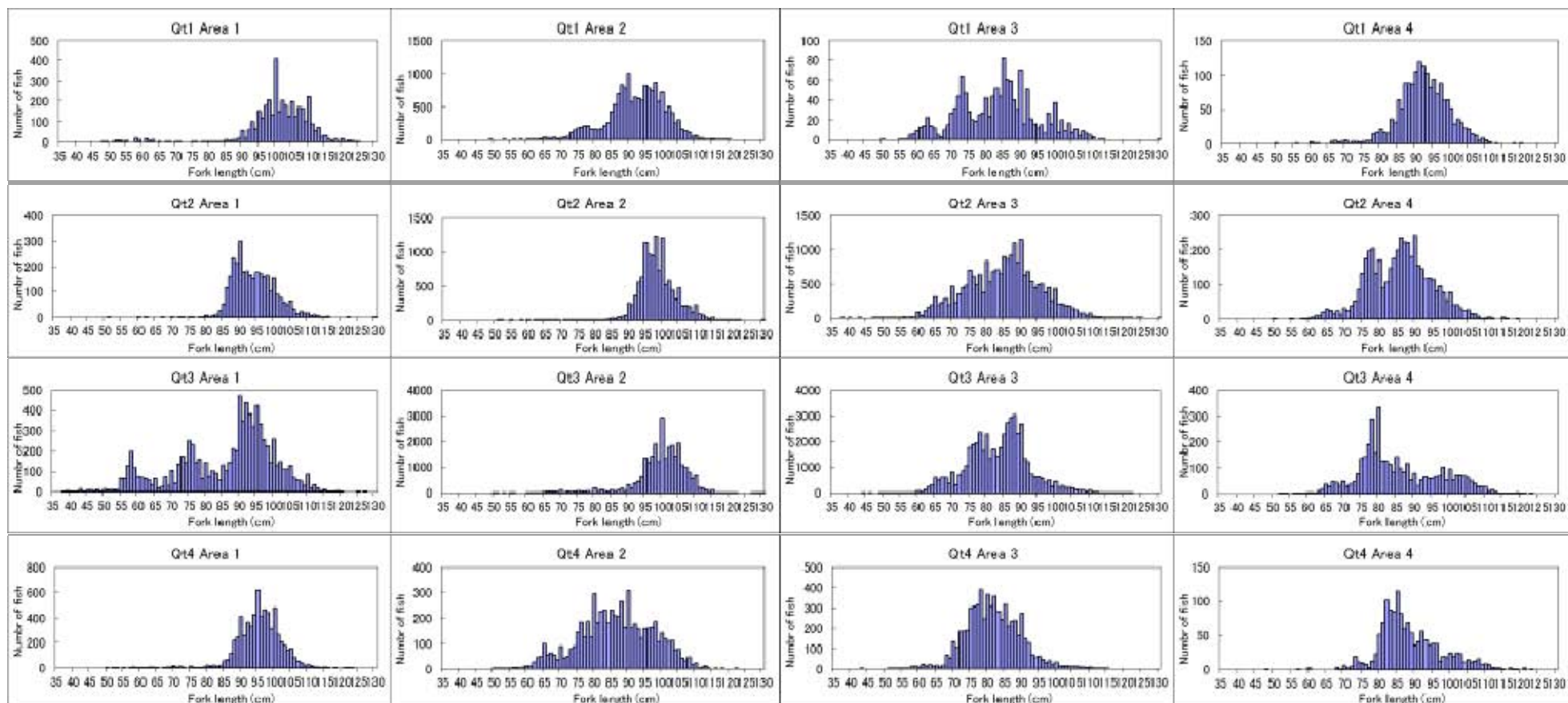


Fig. 8. Length frequency of albacore in the Indian Ocean caught by Japanese longline by quarter and area.

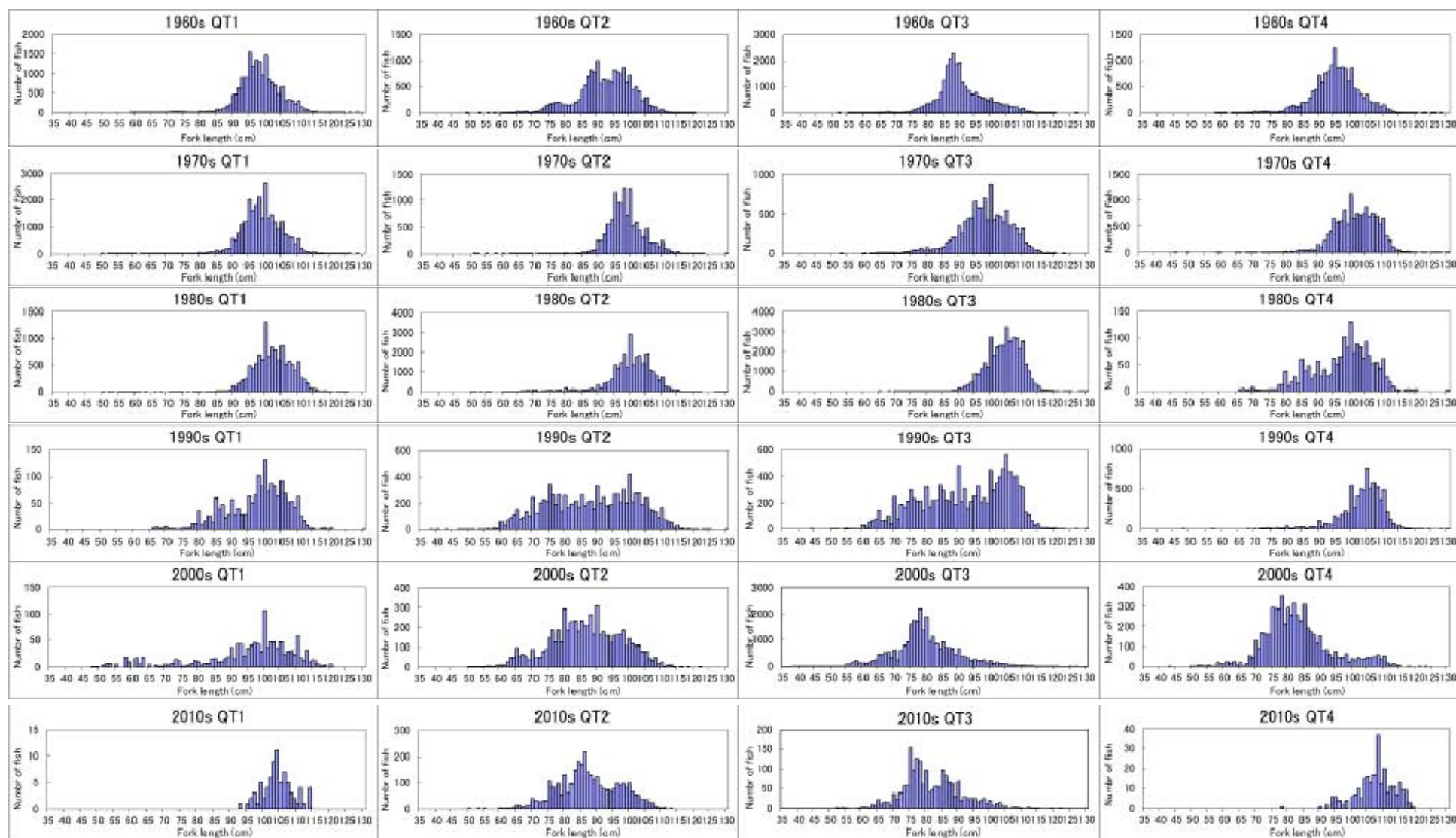


Fig. 9. Length frequency of albacore in the Indian Ocean caught by Japanese longline by decade and quarter.