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

by
Takayuki Matsumoto

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

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 had been targeting albacore until late 1960s, albacore became non-target after that, but it has become one of target species in recent years. Fishing effort fluctuated and it sharply decreased in recent years 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 recently main component in the southern part including west off Australia and around Madagascar. Size data of albacore has been almost constantly collected from on-board measurement, observer program and so on, although sample size was usually not large. Changes in fish size by season, area and period were observed, for example, the fish south of 30°S was smaller than those in the north of 30°S.

1. Introduction

There are two kinds of Japanese tuna fishery in the Indian Ocean, i.e. longline and purse seine fisheries. Of 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, CPUE and the fishing effort were described in conjunction with the catches of the other tunas and tuna-like species. These will be useful for considering CPUE standardization for albacore caught by Japanese longline fishery. In addition, the size data of albacore caught by the longline are shown to see general information of fish size and to provide information for considering selectivity and area definition for age-structured or multi area stock assessment model for Indian Ocean albacore.

2. Data source

In order to count number of hooks and catches in number of tunas and billfishes, 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 1952-2013. Data for 2013 are preliminary. 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 as of May 2014 was used.

There are several 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. Data for 1965-2012 were used. Area stratification to compute the area-specific sample number of the measurement is shown in Fig. 1b.

Data for the fish whose size was measured at 1cm, 2cm or 1kg interval were used for analyses. Fish size in weight was converted to length using the following equation.

$W=1.3718*10^{-5}*L^{3.0793}$

where L is fork length in cm, and W is body weight in kg.

Fish size in length converted from weight was aggregated with length data and was used to create length frequency of the fish in each stratum.

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 2013 (preliminary) it decreased to about 23% of the peak value. Main reason of the decrease in recent years is the effects of piracy activities 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 thousand fish, which corresponds to 48% of peak value and was highest since 1970. After that the catch decreased again with fluctuation. 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 historical change in the proportion of fishing effort (number of hooks) by each category of number of hooks per basket (HPB). In the all Indian Ocean, 4-7 HPB was dominant until early 1990s, but it sharply decreased around mid-1990s. The effort for 8-11 HPB was main component during early 2000s, but the proportion of 12-15 and 16-21 increased after that. In the tropical area, 16-21 HPB has been main component since mid-1990s, but 8-11 and/or 12-15 HPB are dominant in the temperate area.

Fig. 4-Fig. 6 show geographical distribution of fishing effort (number of hooks), albacore catch and CPUE by each decade, respectively. 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. 7), 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. 7). 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. 8, Fig. 11). This is due to the effect of piracy activities 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. 8). These may have caused increase in 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. 11). 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 especially in the west off Australia. Also, recent situation of the change in the proportion of effort by area due to piracy activities seems to be unusual.

Historically, albacore was mainly caught in the southeastern and southwestern part (temperate and subtropical areas) of Indian Ocean. It seems that albacore was consistently caught in the southwestern part (around and south of Madagascar), and the catch became higher in the southwestern part (east off Australia) in recent years.

4. Size data

Table 3 shows the number of measurement for albacore caught by the longline vessel by type of vessels or measurement. 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 until 1990. After that, data

from these vessels decreased, but data from on-board observers has been obtained and it has become main data source.

Fig. 12 shows length distribution of albacore stratified by decade and area. The length were distributed between roughly 80 cm 120 cm in the northern area (Areas 1-4), but the length between roughly 60 cm and 110 cm in the southern area (Areas 5 and 6). The difference of fish size among quarters was small in the Areas 1-2, but comparatively large difference was observed in the Areas 3-4. The fish caught in the first quarter and in the third to fourth quarters were larger in the Area 3 and Area 4, respectively. The fish mostly ranged between 80cm and 110cm until 1990s, but a certain proportion of the fish were between 70cm and 90cm after 2000s. This is probably because the proportion of the samples in the southern area, in which smaller fish dominate, increased due to measurement by scientific observers which is mainly conducted in the SBT fishing ground.

Fig. 13 shows length distribution of albacore for each decade stratified by quarter and area. Some decadal changes were observed. For example, in Area 1, most fish were larger than 90cm until 1990s, but smaller fish (<90cm) was also observed in 2000s. Possibly these are at least partly because of small sample size in recent years.

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.

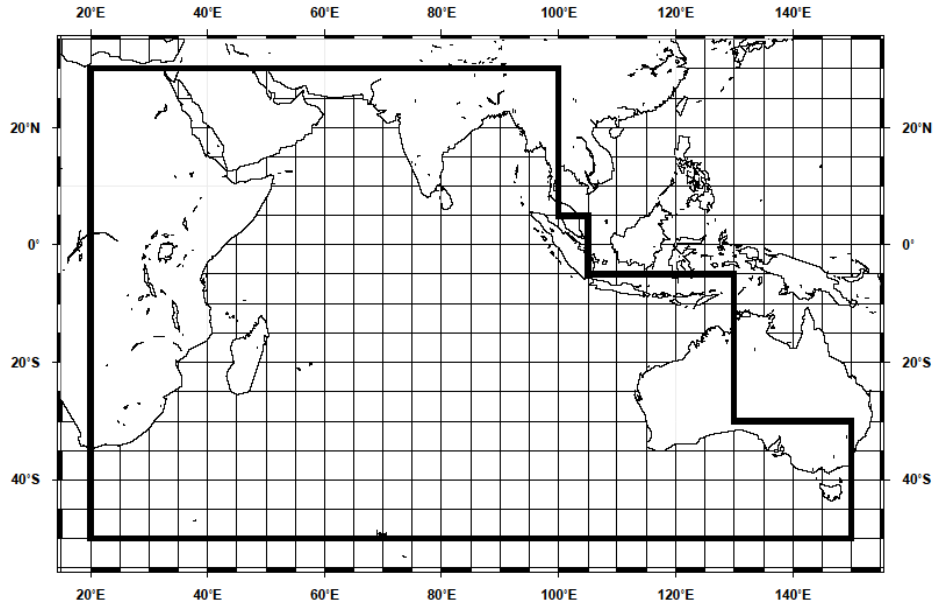
Year	Western	Eastern	Total
1952	0	61	61
1953	0	1,094	1,094
1954	75	2,659	2,734
1955	1,192	1,867	3,059
1956	1,609	3,466	5,075
1957	1,483	3,179	4,662
1958	3,667	2,618	6,285
1959	5,246	5,164	10,410
1960	5,872	5,190	11,062
1961	11,393	3,848	15,241
1962	13,694	3,955	17,649
1963	7,565	4,994	12,559
1964	13,249	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	1,112	2,734	3,846
2011	1,374	1,068	2,442
2012	1,277	1,641	2,918

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

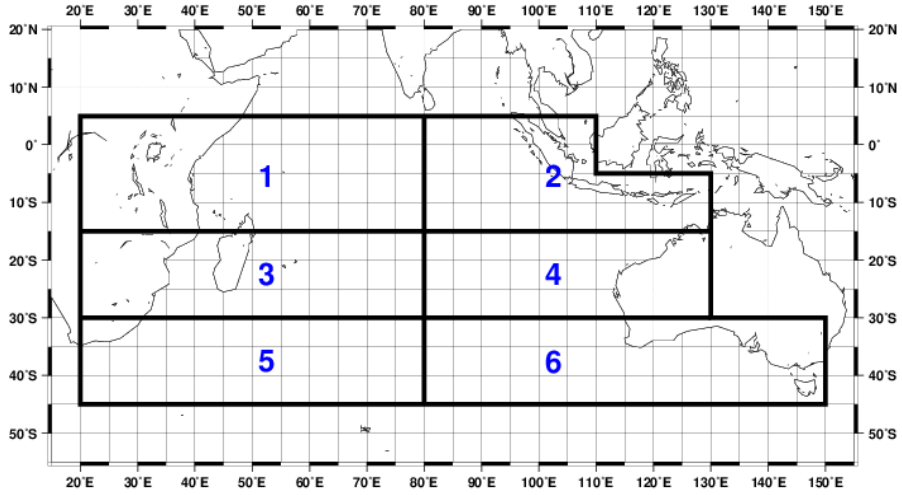
	#of hook	Catch in number (thousand)							
	(thousand)	SBT	ALB	BET	YFT	SWO	STM	BUM	BKM
1952	2,021	6	3	21	131	0	3	9	6
1953	7,071	50	57	53	240	2	7	27	17
1954	12,557	31	142	137	472	4	21	47	25
1955	16,109	24	157	173	972	5	19	51	24
1956	30,064	119	258	281	1,245	10	45	74	41
1957	26,609	193	232	215	728	8	50	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	89,357	22	362	336	332	33	4	8	2
2009	64,951	37	240	233	160	22	1	6	1
2010	36,570	31	282	120	114	11	5	3	1
2011	28,454	37	183	105	140	10	7	3	1
2012	31,466	28	257	139	112	11	3	3	1
2013	29,516	17	191	138	139	11	2	2	1

Table 3. Number of fish measured on the albacore size by type of measurement.

Year	Commercial vessel	Training Vessel	Observer	Total
1965	5,324	21,944	0	27,268
1966	5,817	17,344	0	23,161
1967	3,927	5,697	0	9,624
1968	1,870	4,206	0	6,076
1969	2,817	5,487	0	8,304
1970	781	6,375	0	7,156
1971	350	7,981	0	8,331
1972	0	4,819	0	4,819
1973	0	7,398	0	7,398
1974	240	7,369	0	7,609
1975	0	4,157	0	4,157
1976	0	8,644	0	8,644
1977	0	5,582	0	5,582
1978	0	5,076	0	5,076
1979	0	4,831	0	4,831
1980	232	5,801	0	6,033
1981	2	13,694	0	13,696
1982	2,325	10,554	0	12,879
1983	1,403	9,265	0	10,668
1984	2,465	9,299	0	11,764
1985	4,314	14,006	0	18,320
1986	1,293	14,047	0	15,340
1987	417	12,848	0	13,265
1988	323	7,121	0	7,444
1989	2,146	6,873	0	9,019
1990	1,675	6,982	0	8,657
1991	788	2,368	0	3,156
1992	3,628	1,582	1,862	7,072
1993	1,222	742	251	2,215
1994	753	103	91	947
1995	661	266	303	1,230
1996	282	291	667	1,240
1997	2,279	570	1,855	4,704
1998	1,510	969	955	3,434
1999	1,405	171	1,467	3,043
2000	4,154	586	2,932	7,672
2001	2,116	66	1,986	4,168
2002	1,399	27	407	1,833
2003	41	5	1,572	1,618
2004	1,265	0	2,224	3,489
2005	40	0	6,359	6,399
2006	171	0	9,689	9,860
2007	364	0	6,573	6,937
2008	132	0	384	516
2009	0	0	2,228	2,228
2010	0	0	1,933	1,933
2011	0	0	3,720	3,720
2012	0	0	1,882	1,882



a



b

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

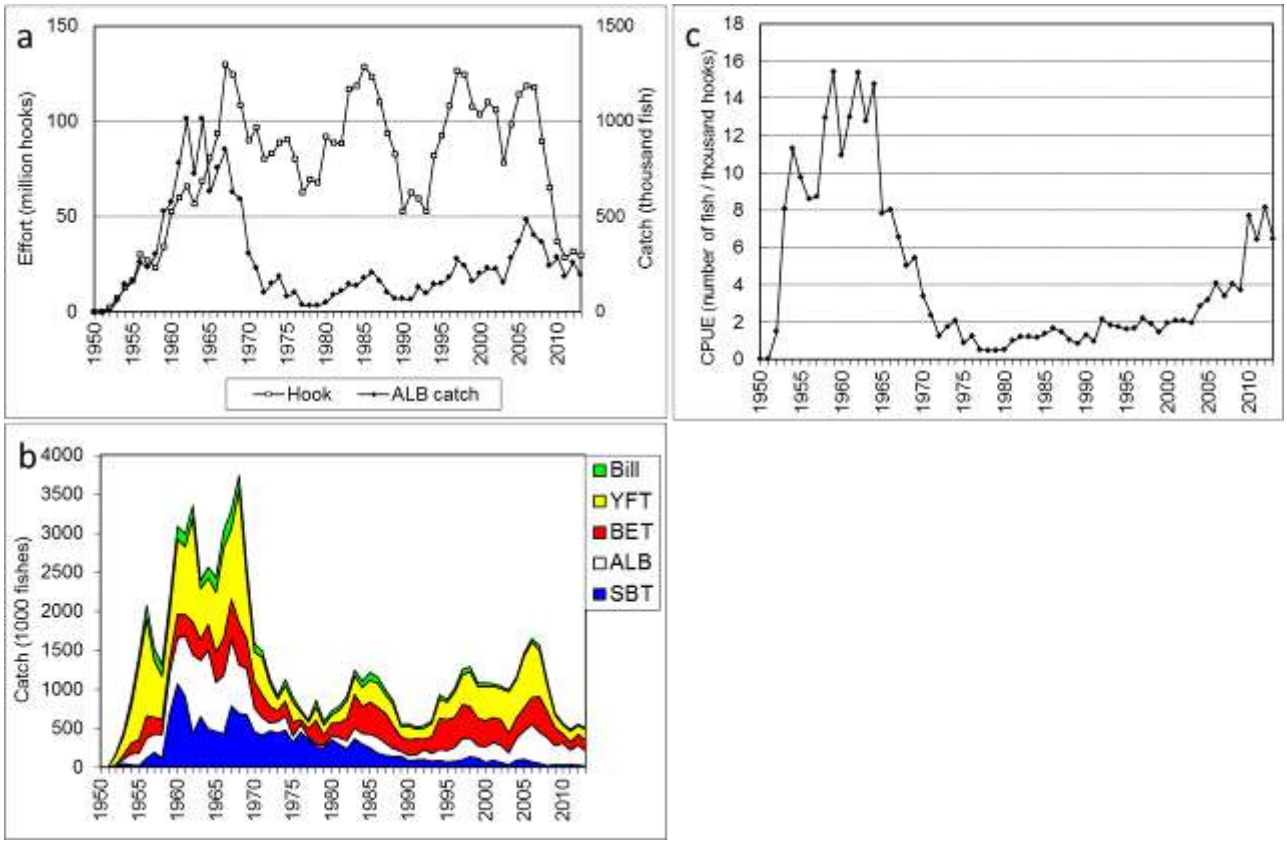


Fig. 2. The number of hooks employed and albacore catch in number (a), species composition (b), and nominal CPUE of albacore (c) caught by Japanese longline fishery.

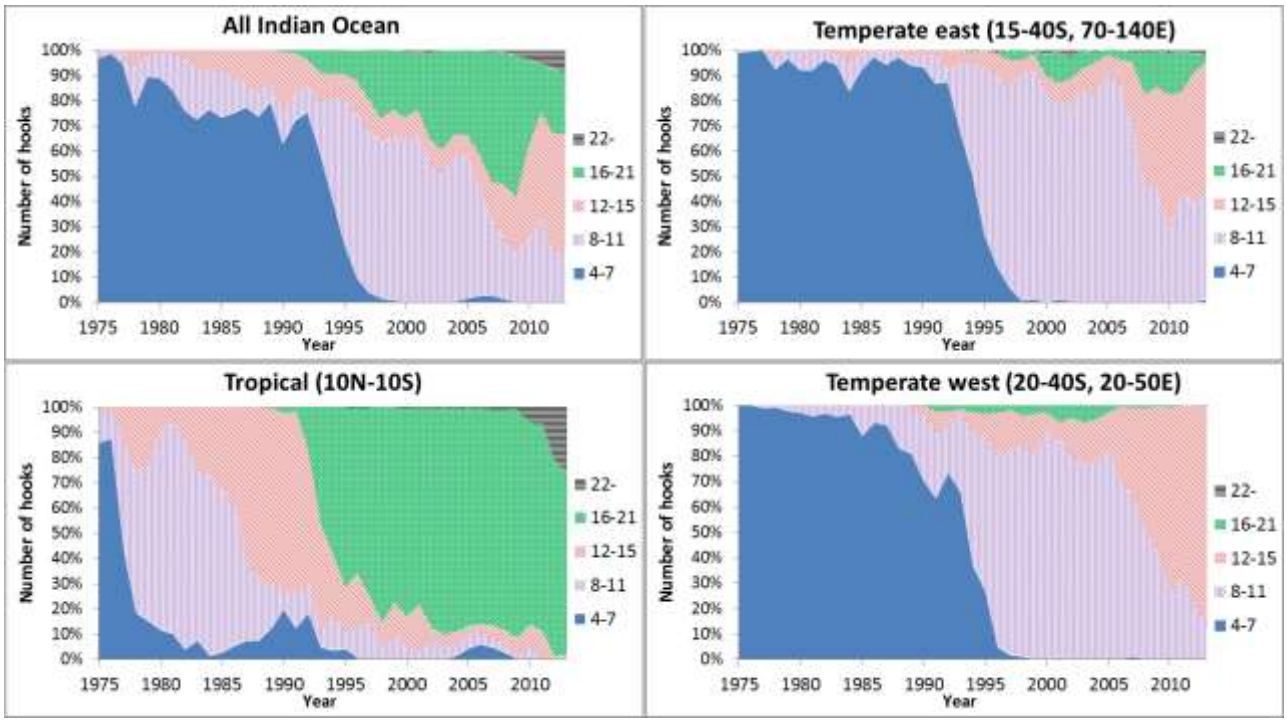


Fig. 3. Change in the proportion of fishing effort (number of hooks) by each category of number of hooks per basket.

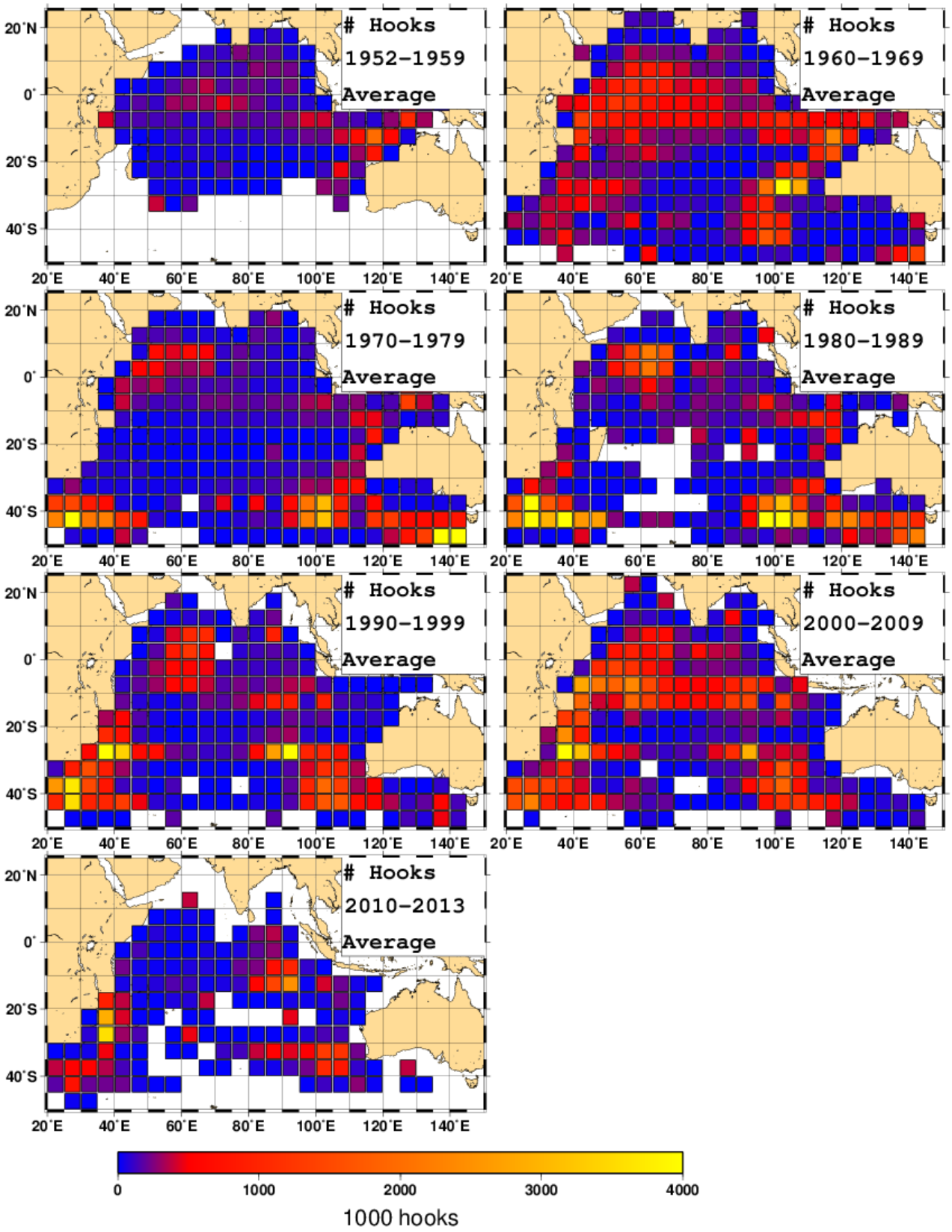


Fig. 4. The average distribution of the effort (number of hooks) for each decadal period by Japanese longline fishery.

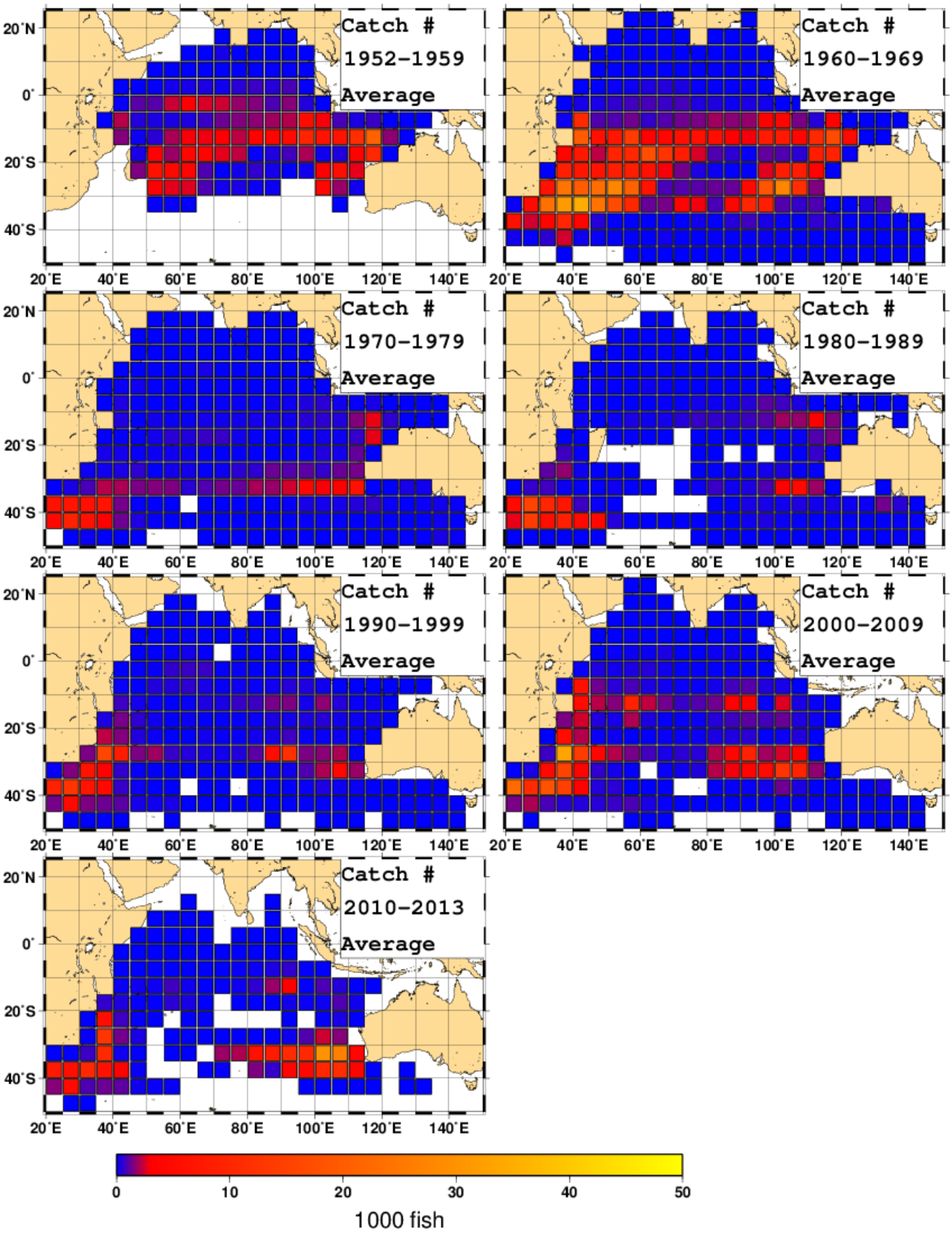


Fig. 5. The average distribution of albacore catch (number of fish) for each decadal period by Japanese longline fishery.

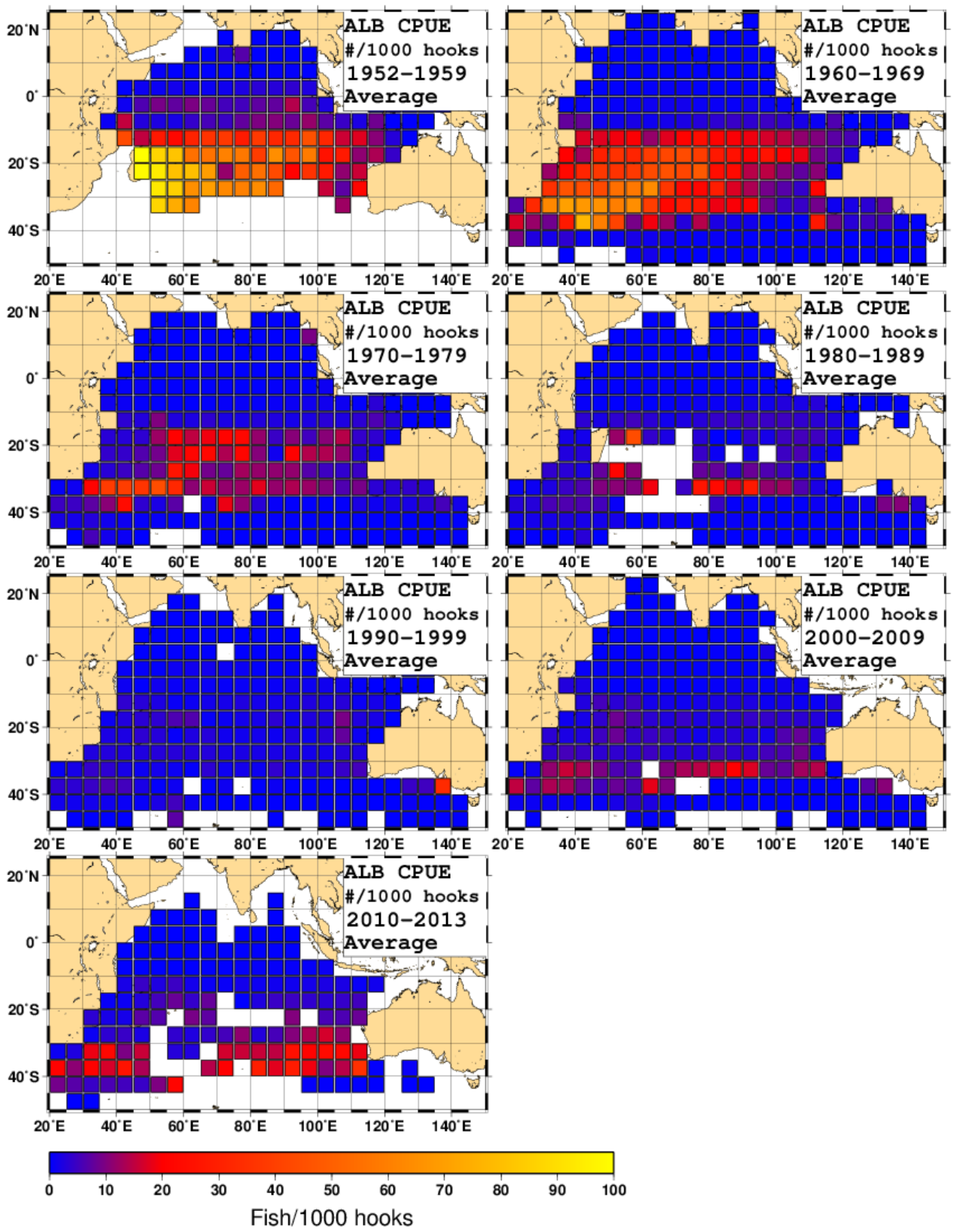


Fig. 6. The average distribution of albacore CPUE (number of fish/1000hooks) for each decadal period by Japanese longline fishery.

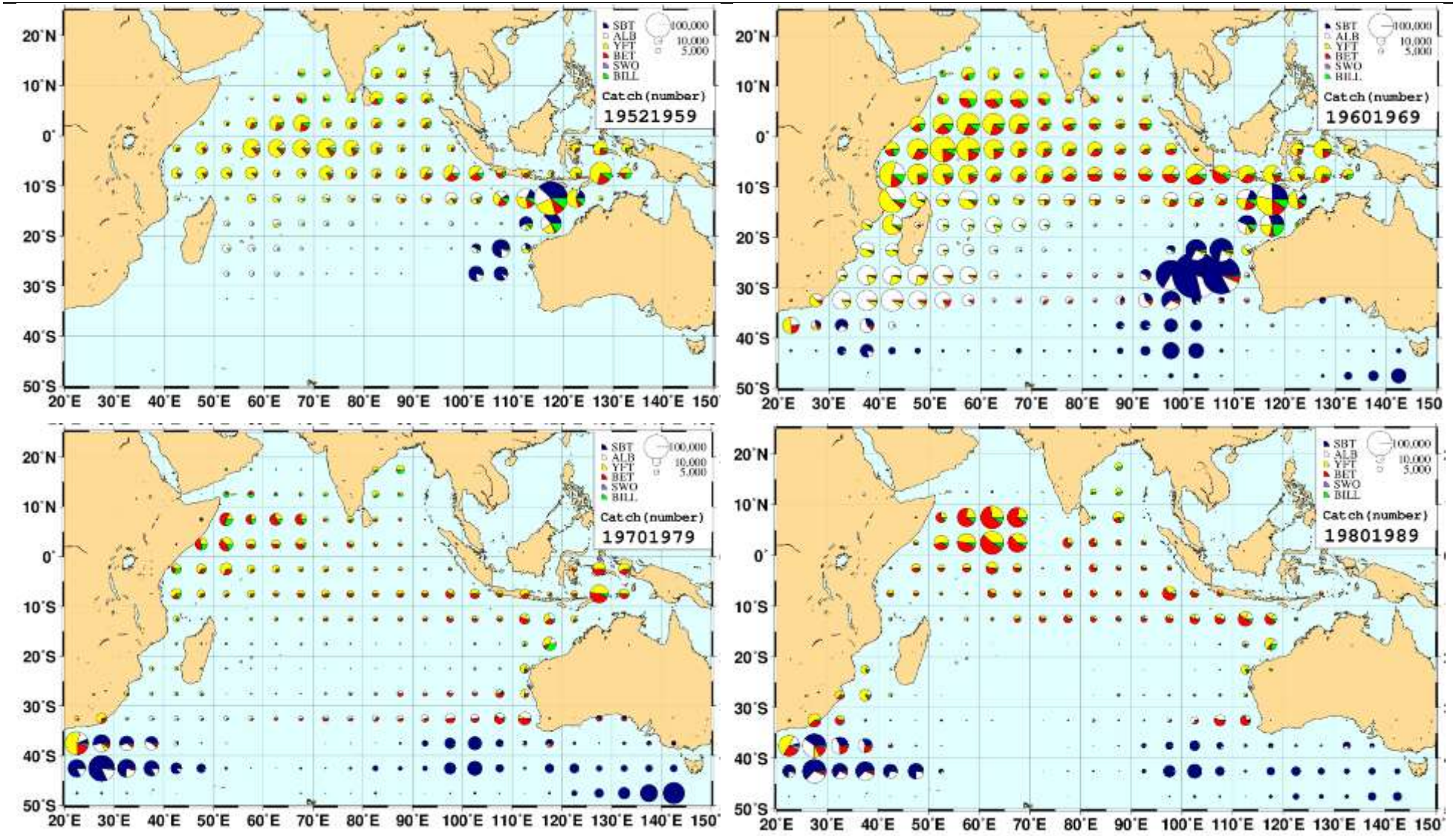


Fig. 7. The averaged distribution of amount of catch in number by species for each decade. Size of circle shows amount of total of catches i.e. southern bluefin tuna (SBT), albacore (ALB), bigeye tuna (BET), yellowfin tuna (YFT), swordfish (SWO) and billfishes (Bill).

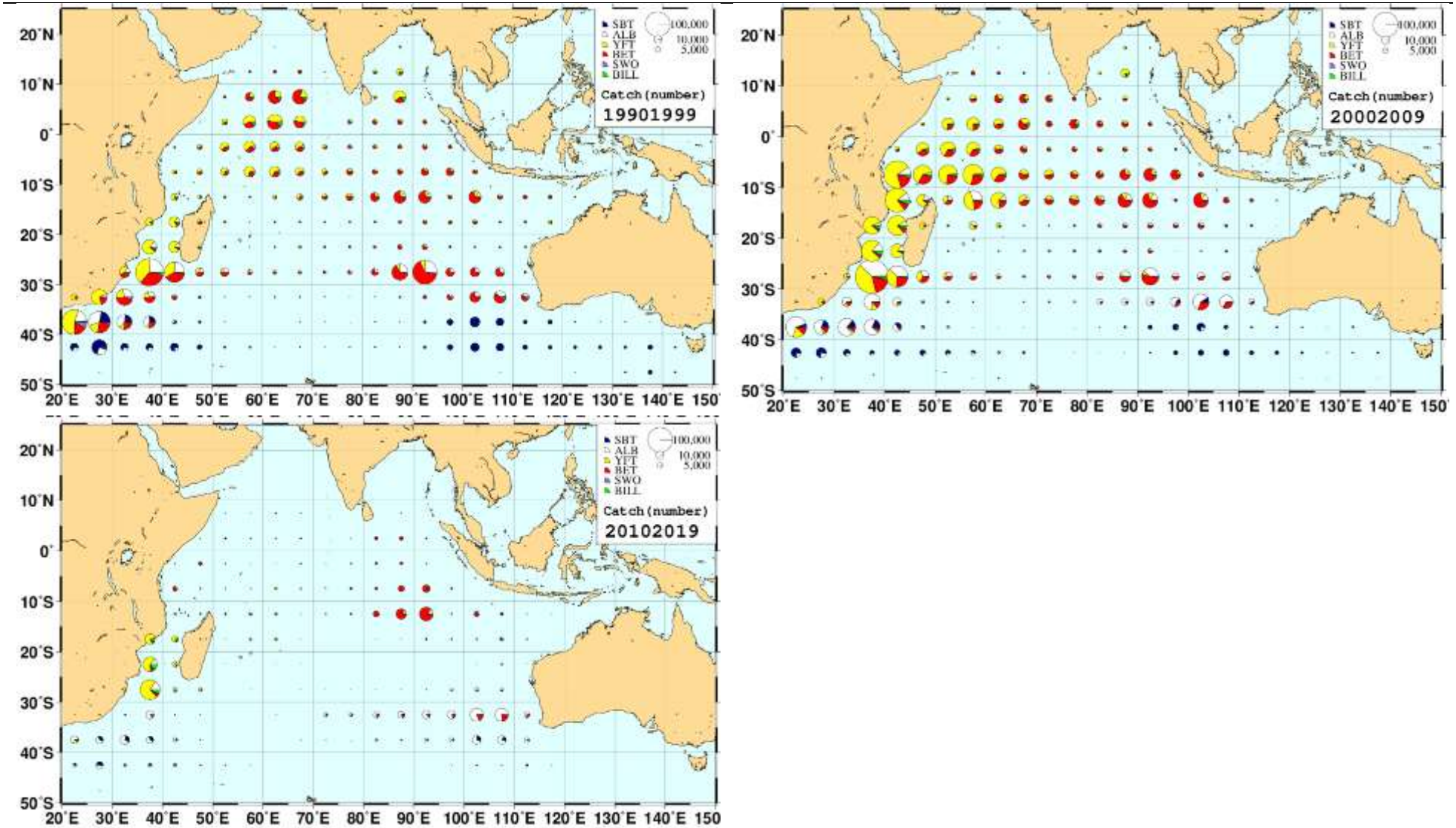


Fig. 7. The averaged distribution of amount of catch in number by species for each decade. Size of circle shows amount of total of catches i.e. southern bluefin tuna (SBT), albacore (ALB), bigeye tuna (BET), yellowfin tuna (YFT), swordfish (SWO) and billfishes (Bill). (continued)

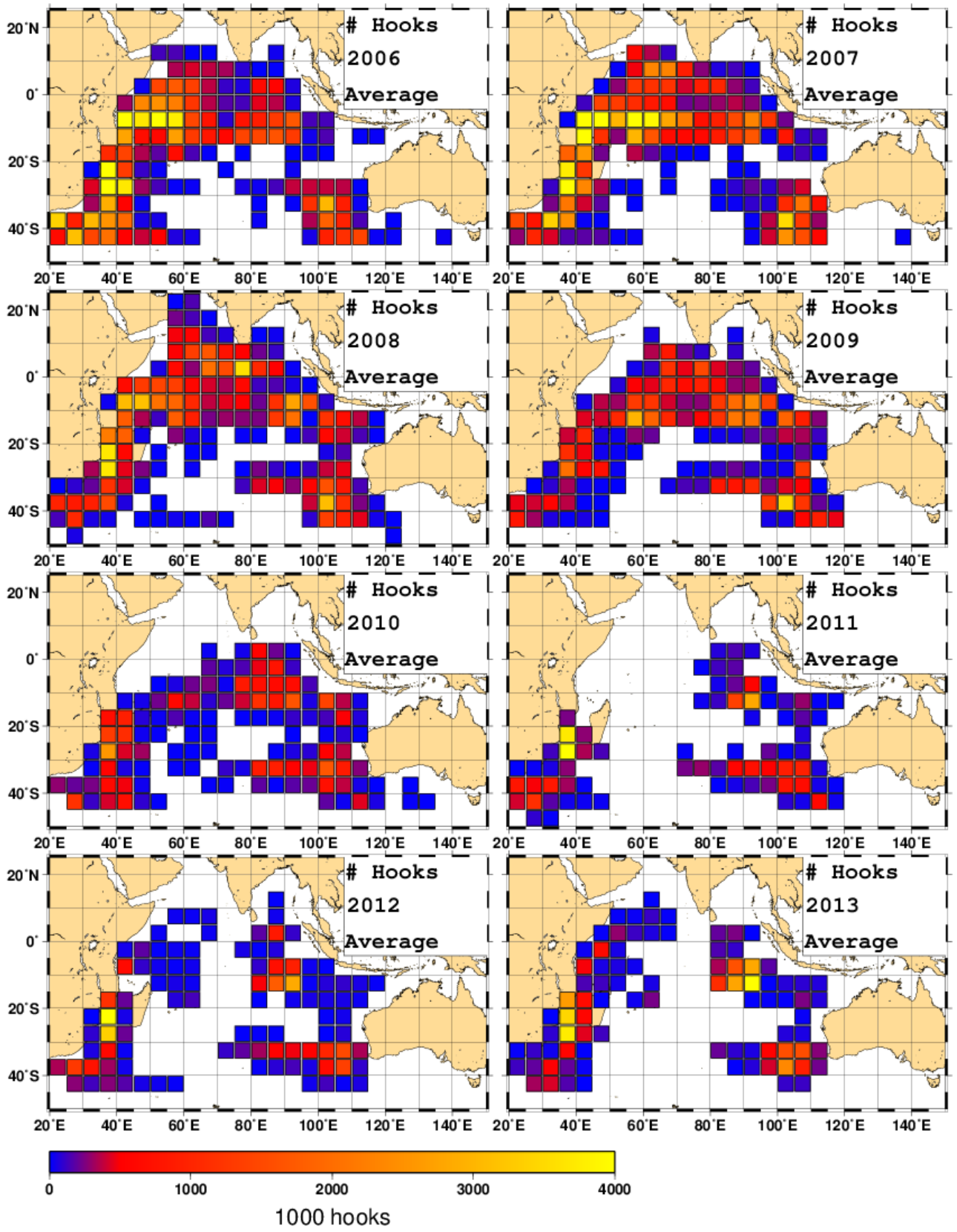


Fig. 8. The geographical distribution of the effort (number of hooks) in recent years by Japanese longline fishery.

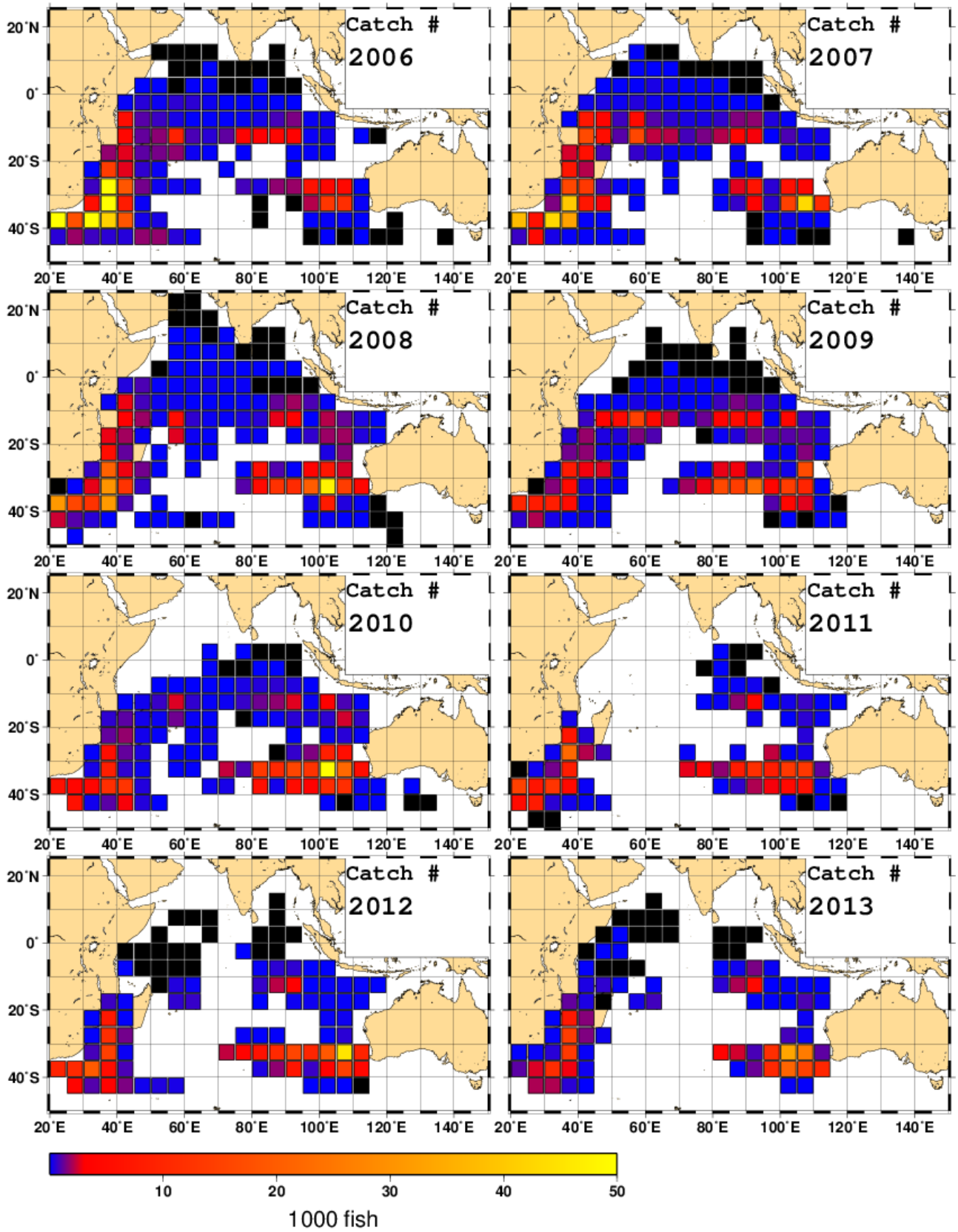


Fig. 9. The geographical distribution of albacore catch (number of fish) in recent years by Japanese longline fishery.

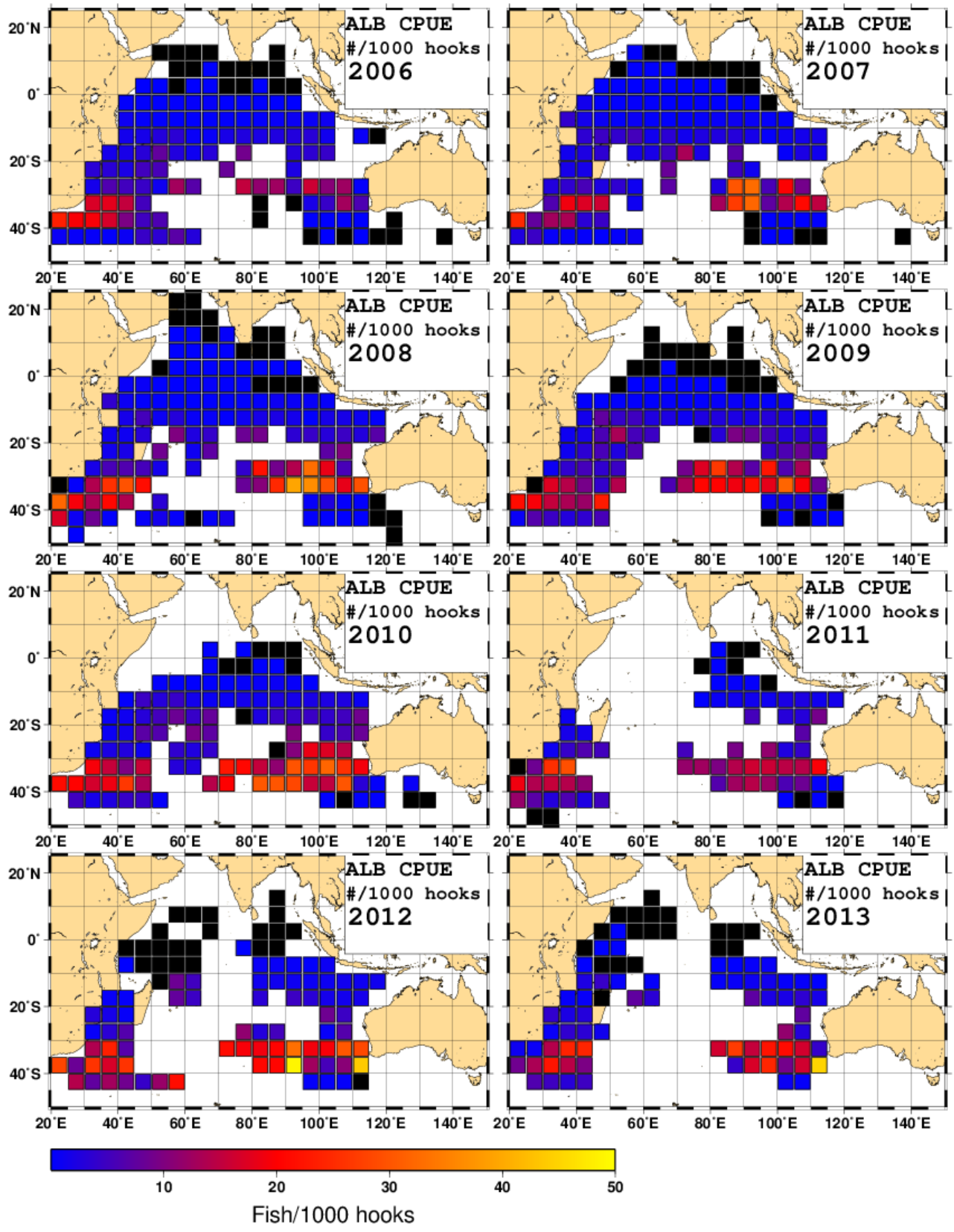


Fig. 10. The geographical distribution of albacore CPUE (number of fish/1000hooks) in recent years by Japanese longline fishery.

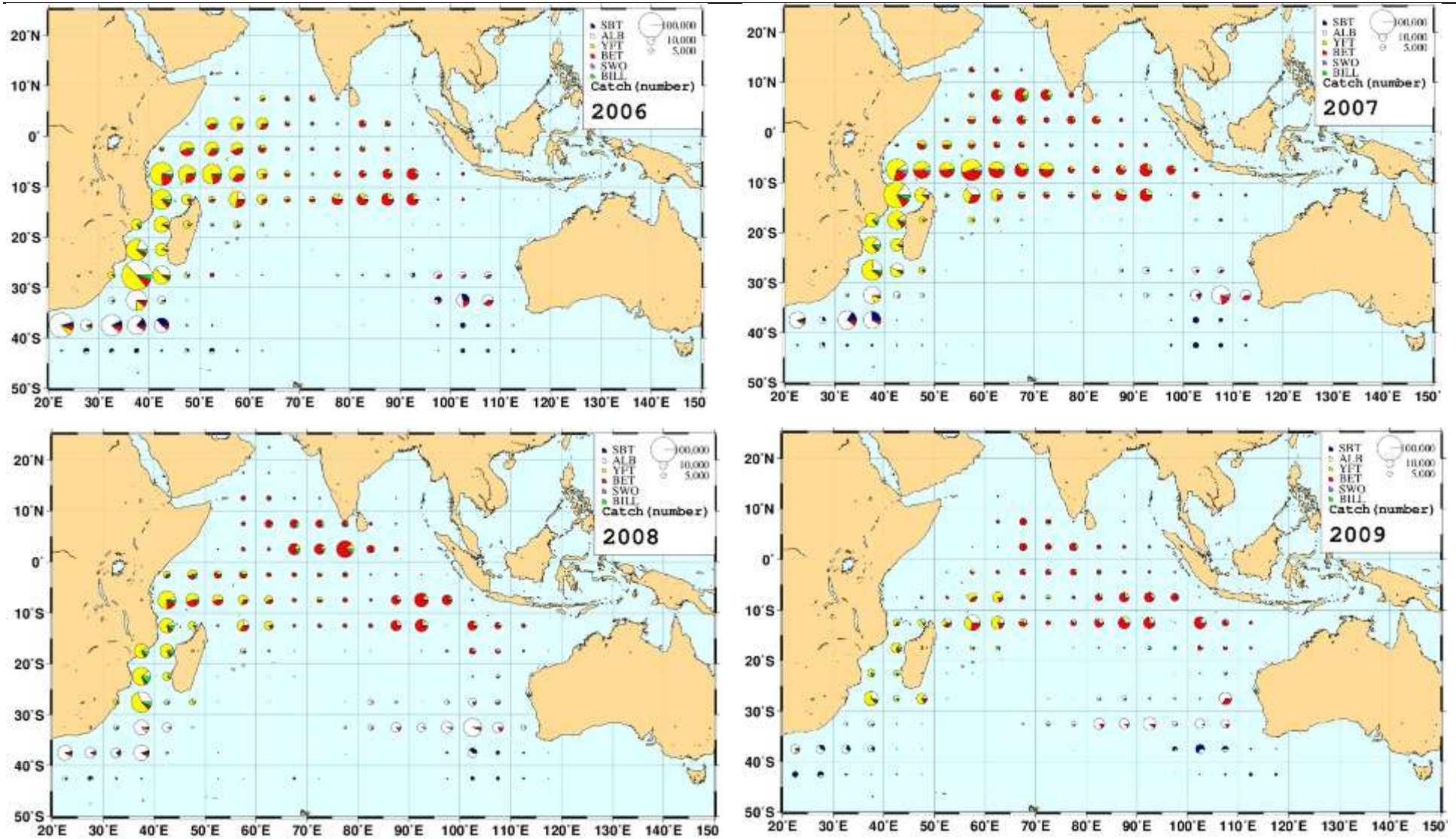


Fig. 11. Annual recent distribution of amount of catch in number by species. Size of circle shows amount of total of catches i.e. southern bluefin tuna (SBT), albacore (ALB), bigeye tuna (BET), yellowfin tuna (YFT), swordfish (SWO) and billfishes (Bill).

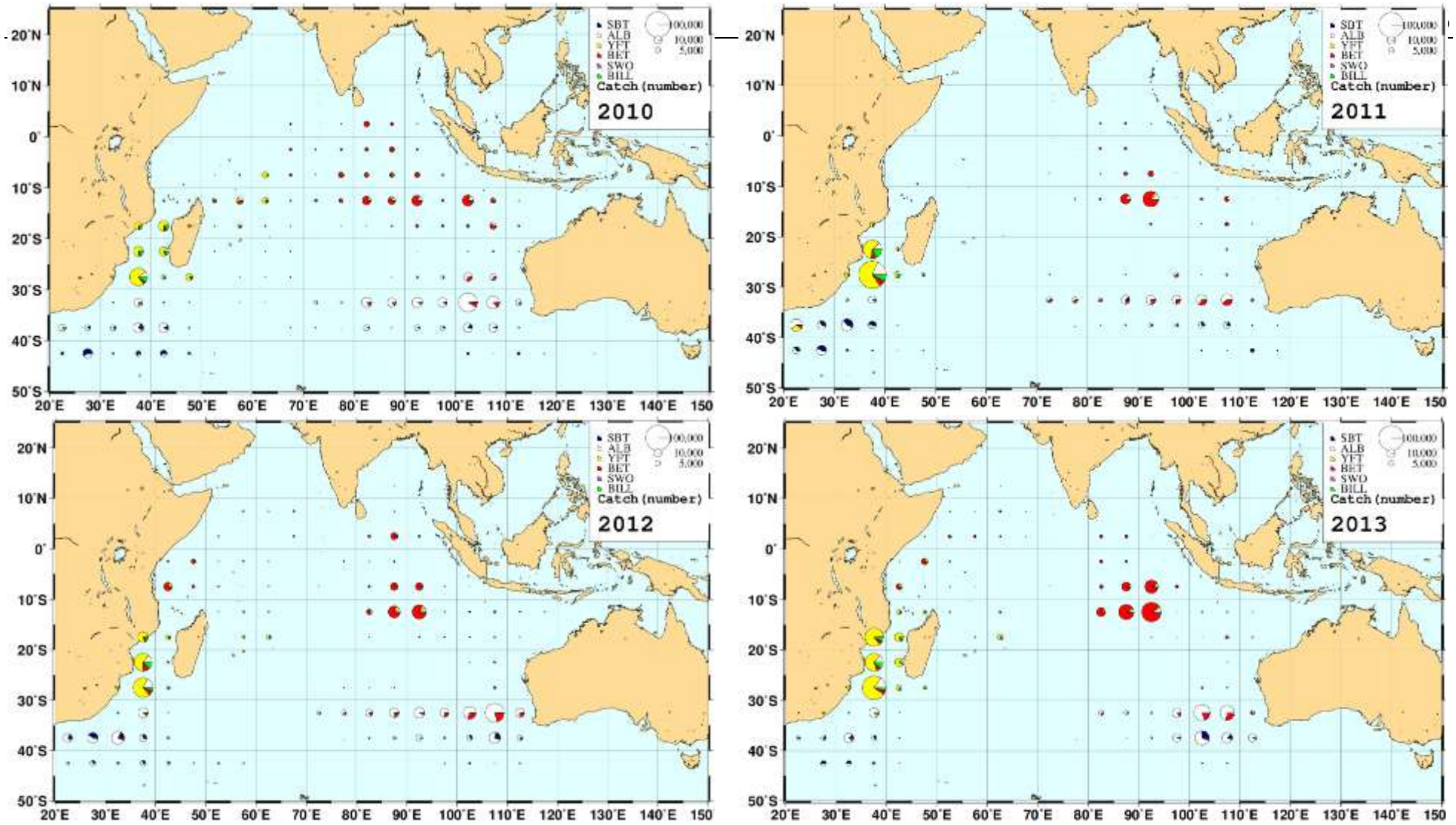


Fig. 11. Annual recent distribution of amount of catch in number by species. Size of circle shows amount of total of catches i.e. southern bluefin tuna (SBT), albacore (ALB), bigeye tuna (BET), yellowfin tuna (YFT), swordfish (SWO) and billfishes (Bill).(continued)

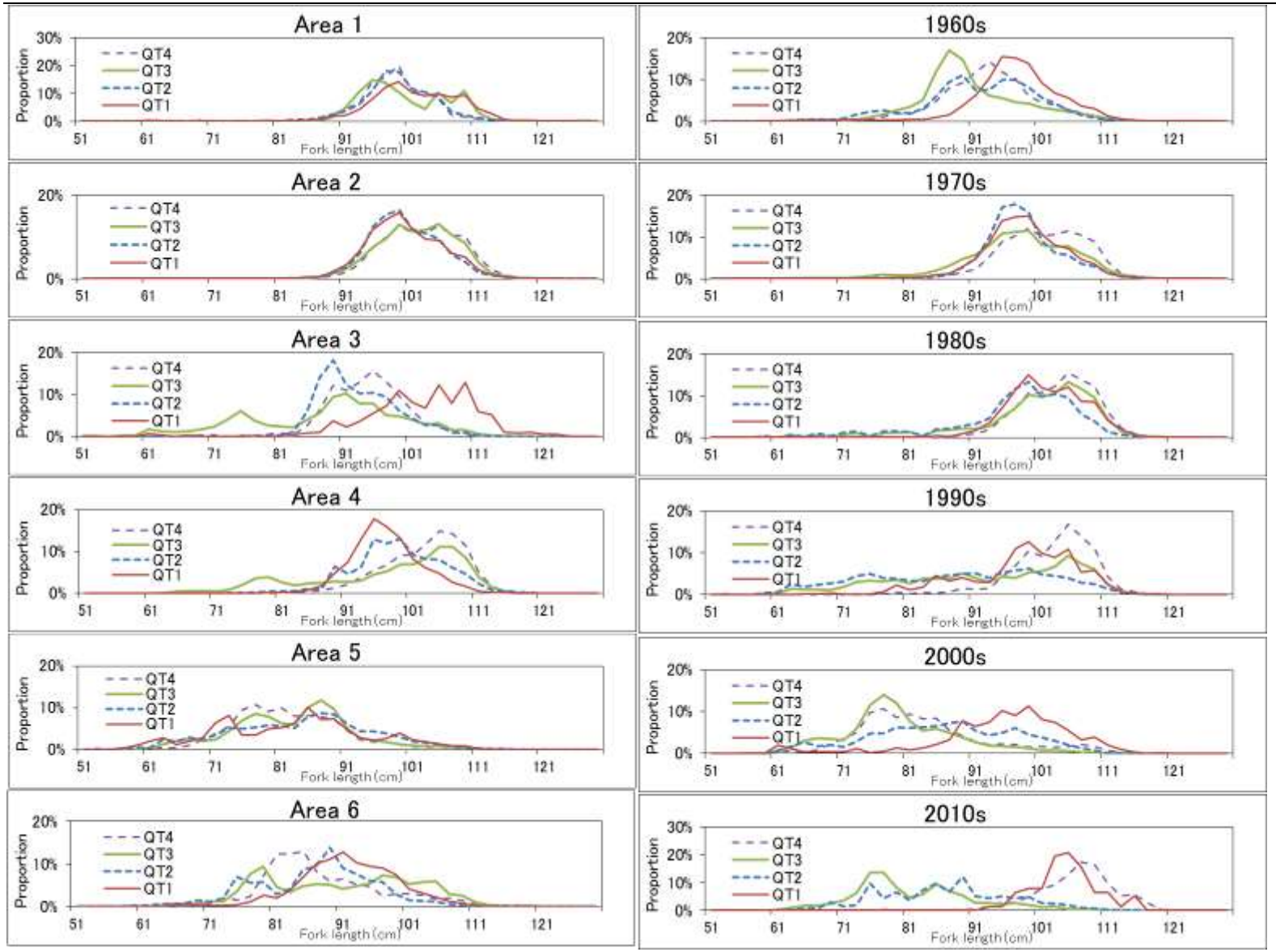


Fig. 12. Length frequency of albacore in the Indian Ocean caught by Japanese longline by decade (left), area (middle) and quarter (right) shown in Fig. 1 (right).

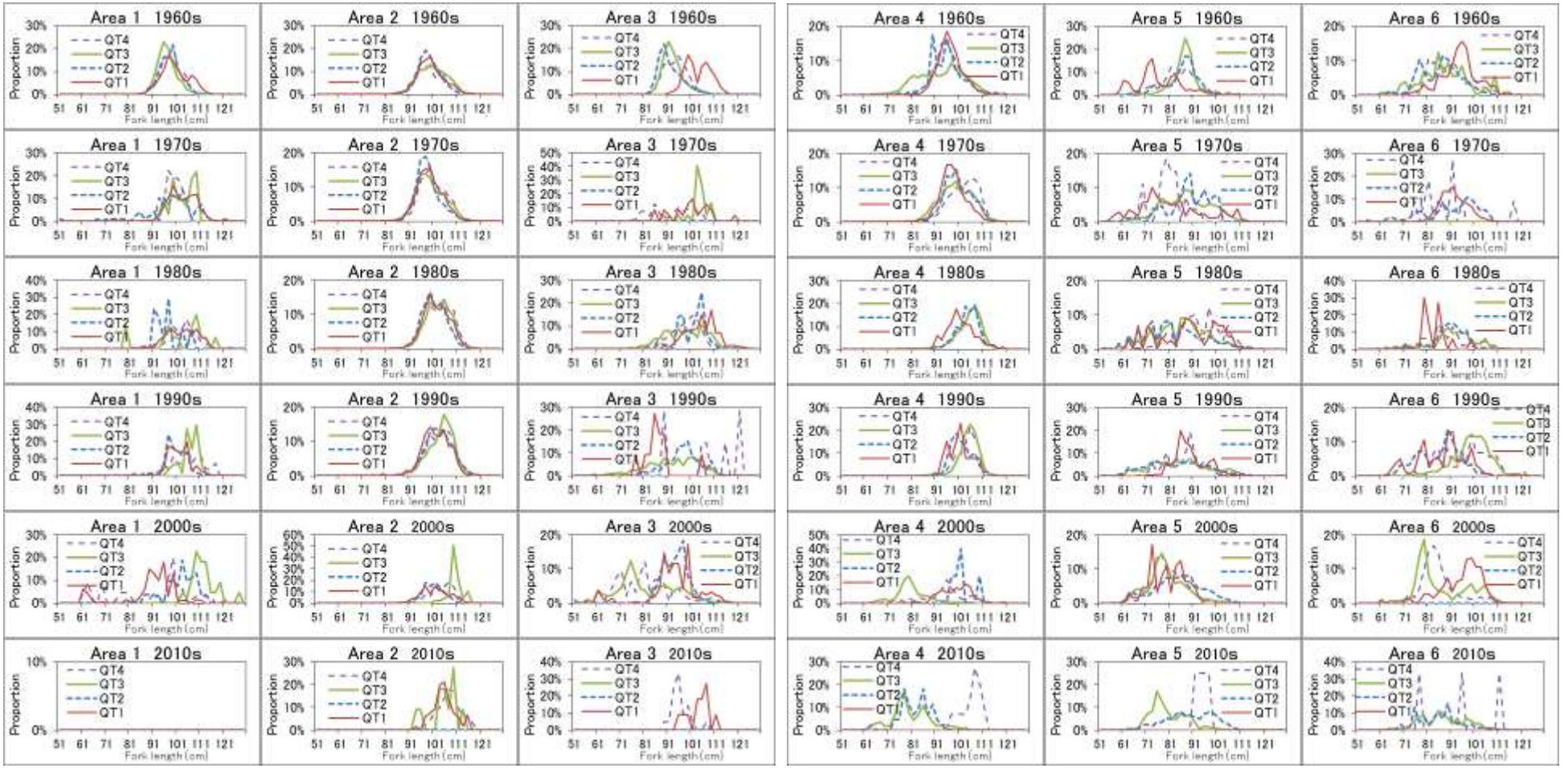


Fig. 13. Length frequency of albacore in the Indian Ocean caught by Japanese longline by quarter and area.