Review of Japanese fisheries and tropical tuna catch in the Indian Ocean

by

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Summary

Japanese longline vessels have been targeting bigeye and yellowfin tunas along with albacore and southern bluefin tuna. The fishing effort for longline fishery fluctuated and sharply decreased in recent years, which is mainly by the decrease in the northwestern part due to piracy activities. Both bigeye and yellowfin tuna catch peaked during 1960s, sharply decreased in the 1970s, fluctuated after that, and sharply decreased around late 2000s. High CPUE for bigeye and yellowfin tuna was observed mainly in the eastern and western Indian Ocean, respectively. Japanese purse seine vessels have been targeting skipjack, yellowfin and bigeye tuna since 1970s. Fishing effort of purse seine peaked in 1992, and then decreased until 2000, after that it kept low level. The annual catch of tropical tuna coincided with the trend of effort. The vessels mainly operated in the eastern part after 2000s. Set for logs or natural objects was main component before mid-1980s, and then FAD associated schools become dominant. Size data for bigeye and yellowfin tuna were collected by several methods. Fish size does not largely differ by decade, area and quarter.

1. Introduction

There are two kinds of Japanese tuna fisheries in the Indian Ocean, i.e. longline and purse seine fisheries. Both fisheries catch tropical tunas. 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. Also, annual catch of bigeye and yellowfin tuna have considerably changed especially as for yellowfin, which varied from 2,100 t to 59,000 t, as well as catches of other tunas.

The purse seine fishery commenced in 1950s. In the early period, as far as data exist, operations were conducted in the eastern equatorial waters in the Indian Ocean. After 1978 the fishery in the Indian Ocean gradually developed and from the late 1980s to the middle 1990s the effort covered entire the Indian Ocean. After that the fishery was considerably contracted and stable but low level in effort after 2000. The annual catch of the tropical tuna were coincided with the trend of effort.

In this document, historical and spatial changes of tropical tuna catch and the fishing effort by longline and purse seine fisheries, including recent situation, are described in conjunction with the catches of the other tunas and tuna-like species. Overview of size data and fish size caught by Japanese longline fishery is also described.

2. Data source

2.1. Catch and effort data

In order to count the effort (number of hooks for longline and number of sets and fishing days for purse seine) and catches (in number by longline and in weight by purse seine), basic data used here is the logbook data that have been compiled at Fisheries Resources Institute (former National Research Institute of Far Seas Fisheries

(NRIFSF)) based on the logbooks mandatory submitted by the fishermen of the longline and purse seine vessels larger than 20 gross ton (GRT). The data for longline fishery are so-called “raised” data, which is aggregated by month and 5˚x5° block, and then expanded with coverage rate of the logbook. Operational (set by set) data for longline fishery was also used to calculate fishing effort by number of hooks between floats because the information is not available in the raised data before 1975. As for purse seine fishery, logbook coverage is 100%. The basic data is available for 1952-2020 for longline and 1967-2019 for purse seine. Data for 2020 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. 1.

2.2. Size data

There are a few sources of the size data for the bigeye and yellowfin tuna caught by longline fishery, i.e. onboard measurement on training and commercial vessels including measurement by scientific observers, with small proportion port sampling. The data are collected and compiled at Fisheries Resources Institute and are available for 1965-2019. Area stratification to compute the area-specific sample number of the measurement is shown in Fig. 1. For compiling length frequency of the fish, data for the fish whose size was measured at length were used.

3. Trend of catch and effort

3.1. Longline fishery

Fig. 2 shows annual trend of fishing effort (hooks) and bigeye and yellowfin than catch in number. Fig. 3 shows the trend of nominal CPUE of bigeye and yellowfin tuna by longline fishery. Fig. 4 shows species composition of the catch by longline fishery. Fig. 2 indicates 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 is decreasing trend since 2007. Main reason of the decrease in recent years is the effects of piracy activities in the western Indian Ocean (around Somalia), and Japanese longline vessels still almost don’t operate in the northwest area. Fishing effort after 2014 shows gradual decrease. Yellowfin tuna catch (in number) peaked (1,714 thousands fish) in 1968, then sharply decreased to 85 thousands fish in 1977, corresponding to 5% of the level in peaked year, and then gradually increased with fluctuation. The catch in 2006 was 708 thousand fish, which corresponds to 41% of peak value and was highest since 1970. After that the catch decreased again and kept in a low level since 2010. Bigeye tuna catch (in number) peaked (541 thousands fish) in 1968, then sharply decreased to 61 thousands fish in 1976, corresponding to 11% of the level in peaked year, and then fluctuated between about 100 and 400 thousands fish. Bigeye tuna catch also decreased recently (after 2007) and kept in a low level since 2010. Following is the description for the temporal and spatial changes of the catch and the effort including detailed description in recent years.

CPUEs for both species decreased during 1950s and 1960s especially for yellowfin tuna, and those show constant or slight increasing trend after that (Fig. 3).

Fig. 5 shows geographical distribution of fishing effort (number of hooks), bigeye and yellowfin tuna CPUE by each decade. In the 1950s, when the effort increased (Fig. 2), 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. 3).

Following this period, the effort continued to increase up to 130 million hooks until the late 1960s (Fig. 2). 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. 4). Of the four species, yellowfin tuna was the most dominant catch in this period, followed by albacore and southern bluefin tuna. Also the catch of bigeye tuna in this period increased compared to the catch in 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. Bigeye CPUE was high in the tropical area and in the region between 25˚S and 35˚S. The CPUE of yellowfin tuna was also high in the tropical area especially in the western part. In the west side of this region, main component of the catch was yellowfin tuna (Fig. 6), on the other hand, yellowfin and bigeye tunas were caught comparatively equally in the eastern equatorial 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. 2). In this period, catch of yellowfin and bigeye drastically decreased compared to that in the previous period. This decrease was due to withdrawing in the effort from the fishing ground in the tropical area as well as decrease in CPUE.

In the period from the late 1970s to the mid 1980s, the effort increased again and reached to 130 million hooks (Fig. 2), 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. 2). 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 to late 1990s the effort increased (Fig. 2). 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. 6). During 1980s - 1990s effort in the tropical area is higher in the western part than in the eastern part.

In the period of 2000s the effort kept high until 2007, and sharply decreased during 2008-2010 (Fig. 2). The decrease has been seen especially in the regions off Somalia (Fig. 7, Fig. 8). This is due to the effect of piracy activities in this area as mentioned above. There is almost no fishing effort in this area in the 2010s (Fig. 5). However, high CPUE for bigeye and yellowfin tunas was seen in the eastern tropical area and in the area around Madagascar, respectively (Fig. 5). Recent situation of the distribution of effort by area due to piracy activities seems to be unusual. In recent years, the proportion of albacore is higher (Fig. 4). This is due to higher proportion of fishing effort in the temperate area as well as increased market demand and commercial value for this species, which increased targeting this species.

Historical changes in the proportion of effort by fishing gear (number of hooks between floats, NHF for the area of yellowfin tuna and gear material) are shown in Fig. 9. NHF of 5-7 was dominant in each area in the early period. NHF increased with time and sudden increase occurred during early 1990s in each area. In recent years, NHF 11-13 is dominant in Area 3 and 4, and NHF 17-19 and/or 20 or more in Area 2 and 5, and the increase is very slight. Nylon material for both main and branch lines developed rapidly around mid-1990s, which almost coincided with the change in NHF.

3.2. Purse seine fishery

Fig. 10 indicate effort and catch by species caught by Japanese purse seine fishery in the Indian Ocean. Annual fishing effort (number of set) increased in 1990s and marked historical highest value (1,372 sets) in 1992, and then decreased rapidly to 171 sets in 2000, after that it kept in a low level with fluctuation. The annual catch of the tropical tuna coincided with the trend of effort, which reached to 45,000 mt in 1992 and then decreased to 3,000 mt in 2001. After that it ranged between about 1,000 and 6,000 mt. Fishing effort (number of set) and catch of the tropical tuna in 2019 sharply decreased to 9 and 235 mt, respectively because the fishing conditions were extremely poor thus fishing operations ended very quickly in a very short time then purse seine vessels shifted to the Pacific Ocean (Matsumoto et al., 2020). Usually 60 to 70% of the catch (excluding species other than tropical tuna) is skipjack tuna. In recent years, increasing and decreasing trend for the proportion of skipjack and bigeye tuna, respectively, is seen (Fig. 10).

The number of Japanese purse seine vessels in the Indian Ocean from 1991 to 1992 was 11, and then sharply decreased to 2 in 2000, and then ranged from 1 to 3 after 2001.

Fig. 11 shows the proportion of the number of set by school type. Associated schools with natural objects were dominant until mid-1980s, and then FAD associated schools became dominant. The proportion of free swimming school was low (mostly less than 10%) over the entire period. Fig. 12 shows the proportion of the number of days by activity. The information of searching day was not available during the early period. About 40% of the days was searching and the proportion is increasing in recent years. Fig. 13 shows historical trend of nominal CPUE for tropical tunas. Increasing trend with fluctuation is observed for skipjack and bigeye tuna until early 2010s, and then it decreased. The CPUE was comparatively stable for yellowfin tuna especially after early 1990s but is decreasing in recent years. In recent years, CPUE for tropical tunas combined is around 10-20 mt per set, which is lower than that in 2000s and early 2010s.

Fig. 14 and Fig. 15 show geographical distribution of catch by species for each decade and annual change in recent years, respectively. From late 1980s to mid-1990s, when the effort increased (Fig. 10), the effort was deployed in the whole equatorial area of the Indian Ocean, and then the effort mainly distributed in the eastern area of the Indian Ocean. The proportion of bigeye tuna was usually higher in the east side of the Indian Ocean. The change in fishing ground, along with the spread of FADs, may be the reason for increasing proportion and CPUE for bigeye tuna.

4. Size data

4.1. Longline fishery

Fig. 16 shows the number of measurement for bigeye and yellowfin tunas caught by the longline vessel by sampling category and unit of measurement. The number of samples for bigeye tuna peaked in 1985 (over 60,000 individuals), but then decreased to less than 3,000 individuals per year, and increased after that. On-board measurements by training longline vessels had been main data source until early 1990s, but recently almost no training longline vessels are operating in the Indian Ocean. Several fish were measured by scientific observers in recent years, which is almost only data source in recent years. As for yellowfin tuna, the annual number of samples had been usually over 20,000 until mid-1980s, but it decreased after that. In recent years around 5,000 or less fish were measured per year. Regarding the unit of measurement, main component was length at 1 or 2cm interval.

Fig. 17 shows length frequency of bigeye and yellowfin tuna (all fish). Fig. 18-Fig. 20 show length frequency of bigeye and yellowfin tuna stratified by decade, area and quarter, respectively. The mode of the length was about 130 cm FL for both species. There was almost no change among decades, but in 2010s smaller fish were included. As for bigeye tuna, the fish size in the Areas 4 (southeastern part) was a bit smaller than those in the other areas.

5.4. References

Matsumoto, T., Inoue, Y., Nishida, T., Semba, Y., and Fisheries Agency, Government of Japan (FAJ). 2020. Japan National Report to the Scientific Committee of the Indian Ocean Tuna Commission, 2020. IOTC–2020–SC23–NR08. 27 pp.

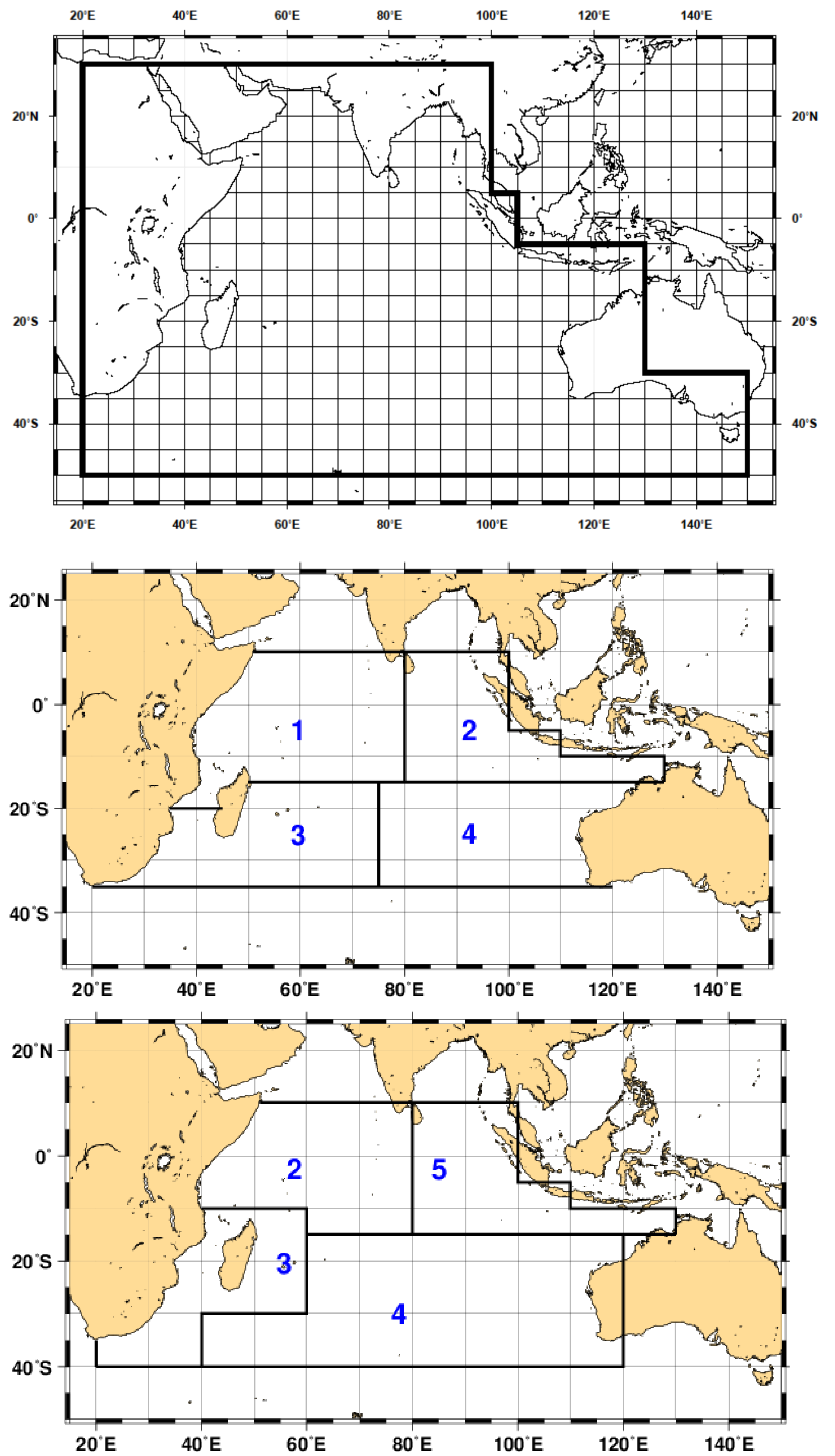

Fig. 1. The geographical range to count the amount of the effort and the catches (upper), area definition to compile size data for bigeye (middle) and yellowfin tuna (bottom) by the Japanese longline fishery.

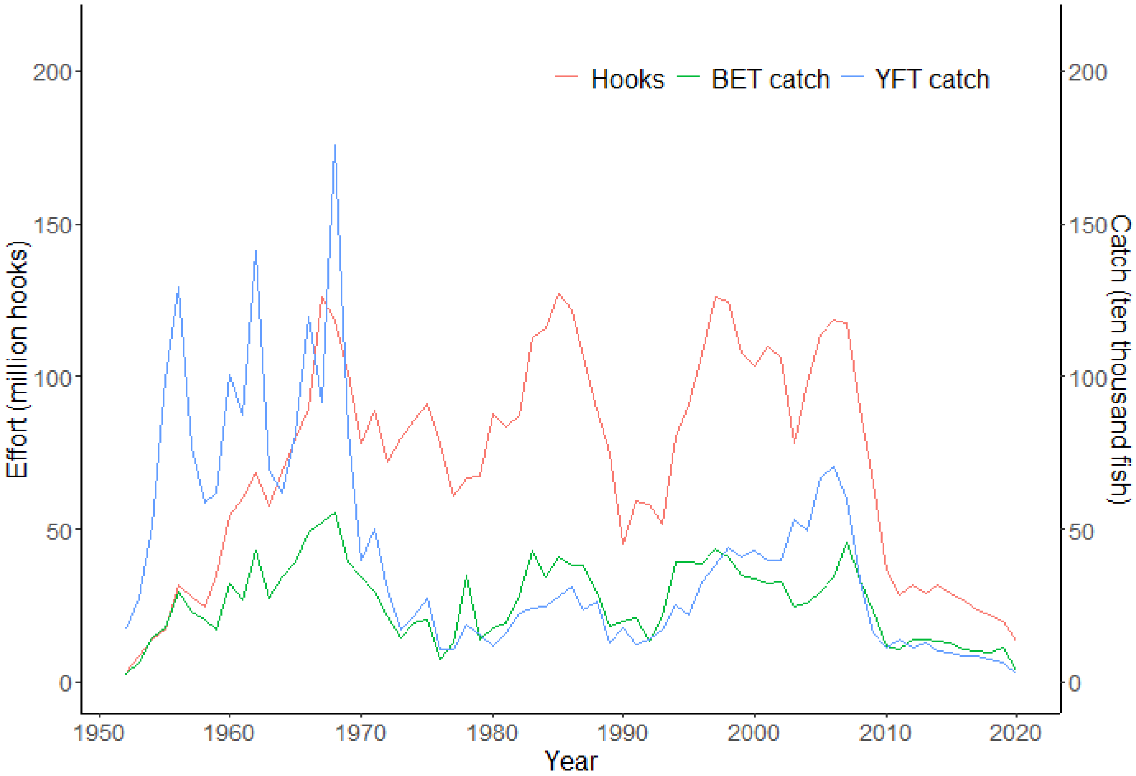

Fig. 2. The number of hooks employed and catch in number of bigeye and yellowfin tuna in the Indian Ocean by the Japanese longline fishery.

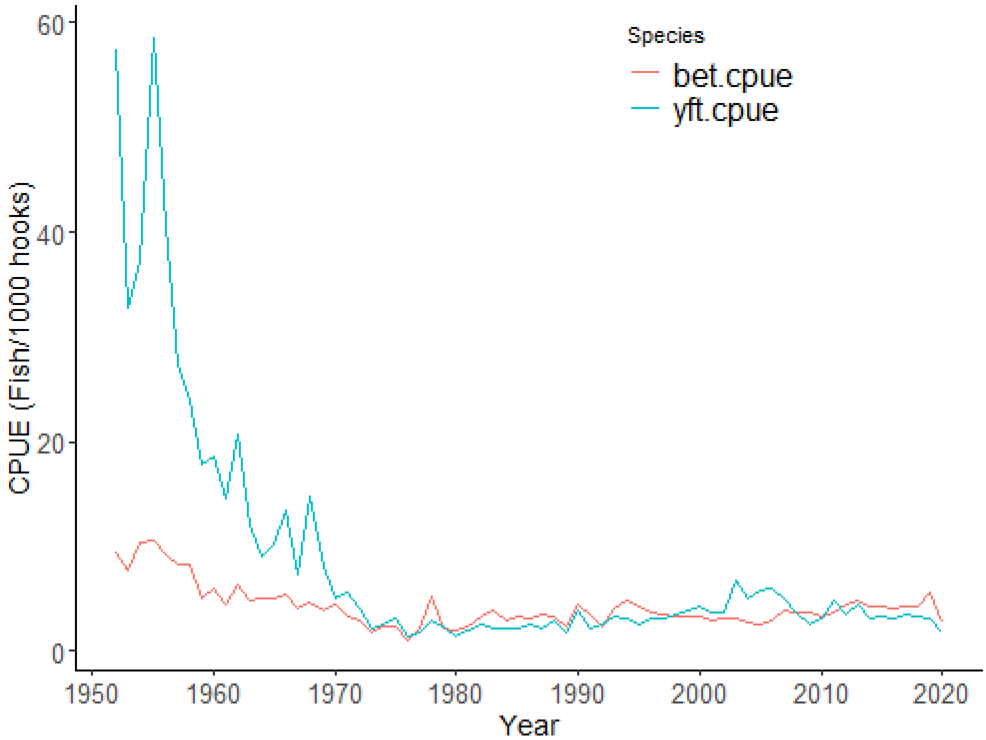

Fig. 3. Trend of nominal CPUE of bigeye and yellowfin tuna caught by Japanese longline fishery.

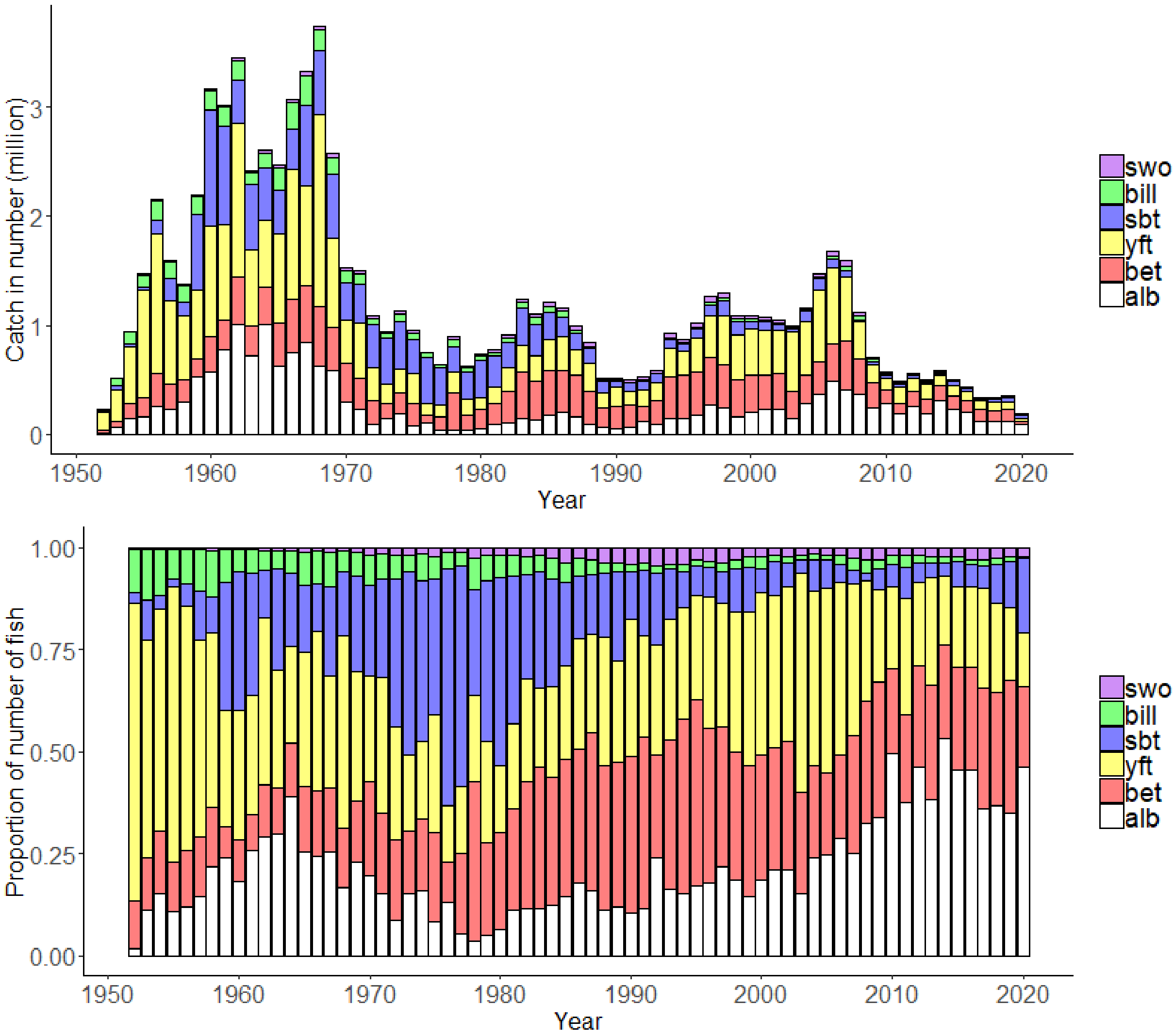

Fig. 4. Species composition of catch in number in the Indian Ocean by the Japanese longline fishery.

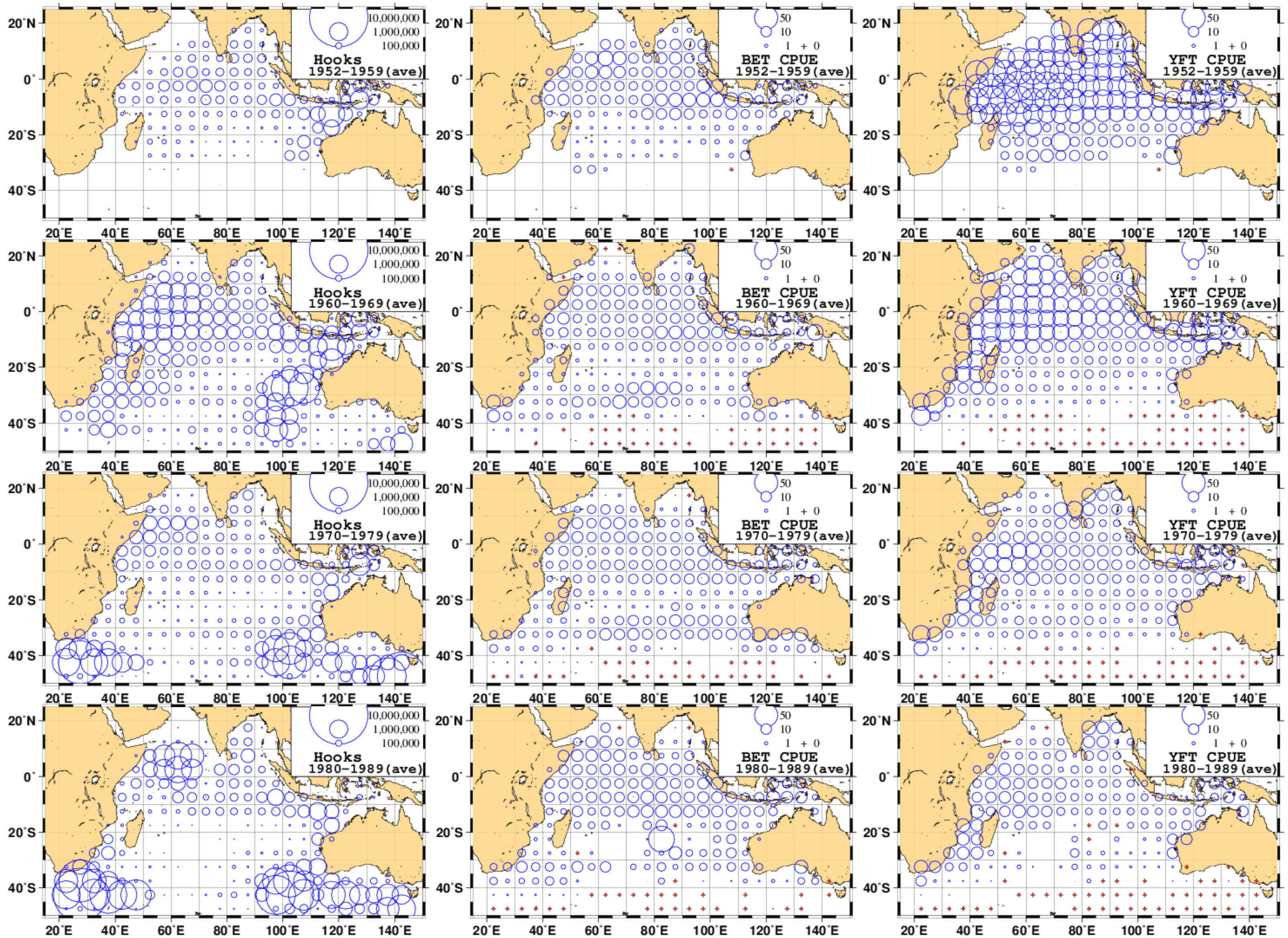

Fig. 5. The average distribution of the effort (number of hooks) and bigeye and yellowfin tuna CPUE (number of fish/1000hooks) for each decadal period by Japanese longline fishery.

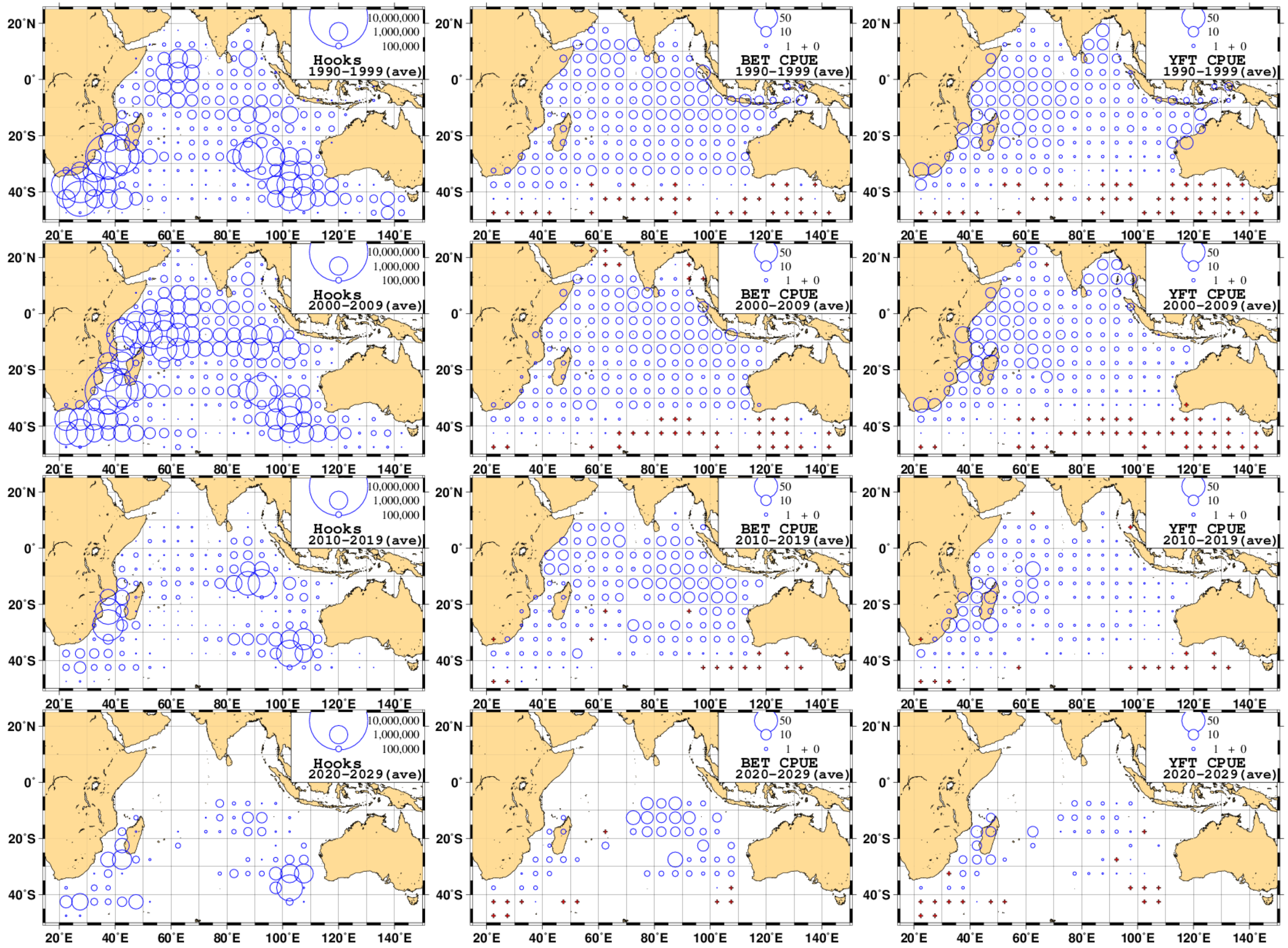

Fig. 5. The average distribution of the effort (number of hooks) and bigeye and yellowfin tuna CPUE (number of fish/1000hooks) for each decadal period by Japanese longline fishery.(continued)

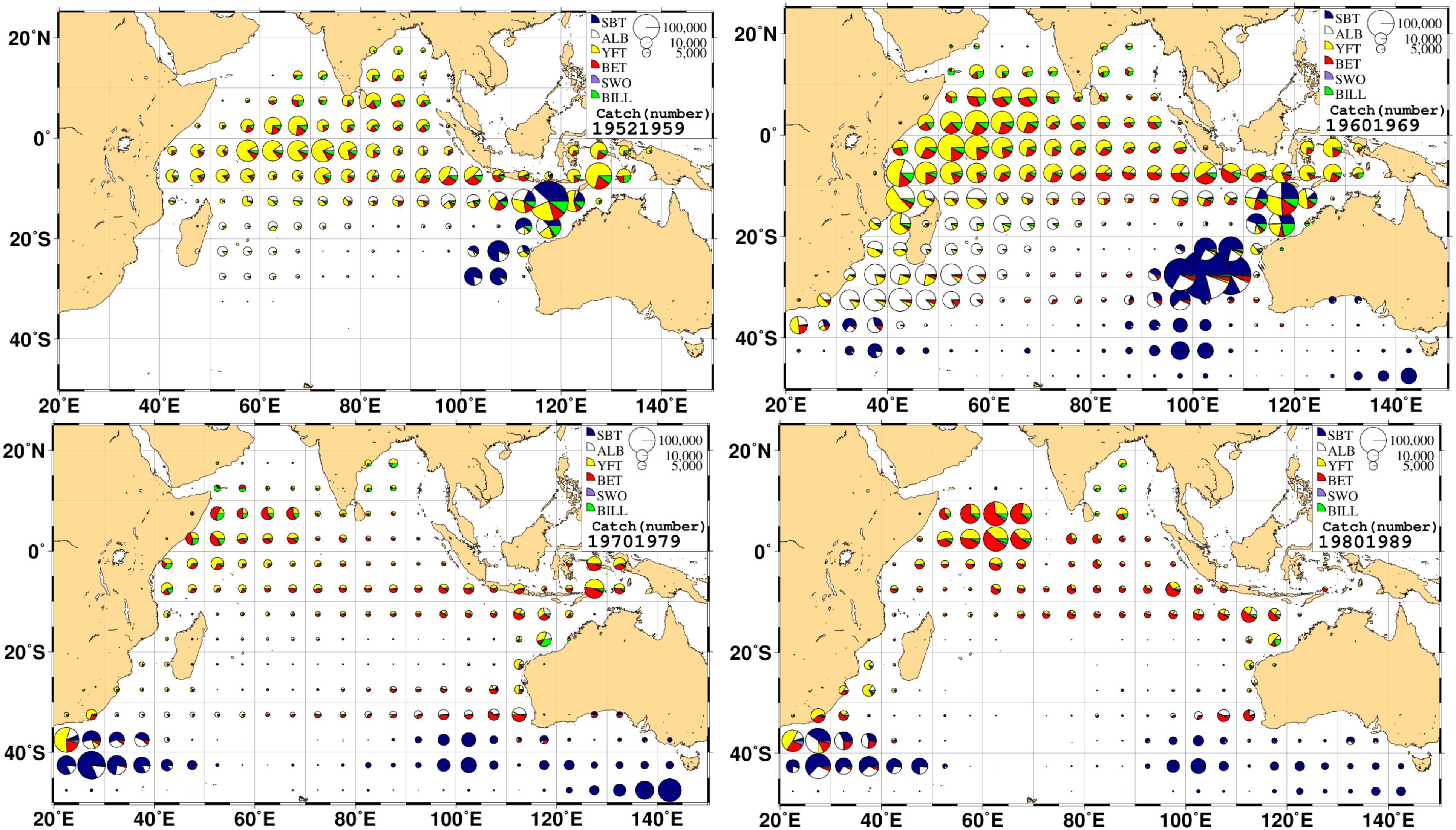

Fig. 6. The distribution of amount of catch in number by species for each decade by Japanese longline fishery. Size of circle shows amount of total of catches i.e. southern bluefin tuna (SBT), albacore (ALB), bigeye tuna (BET), yellowfin tuna (YFT), swordfish (SWO) and billfishes (BILL).

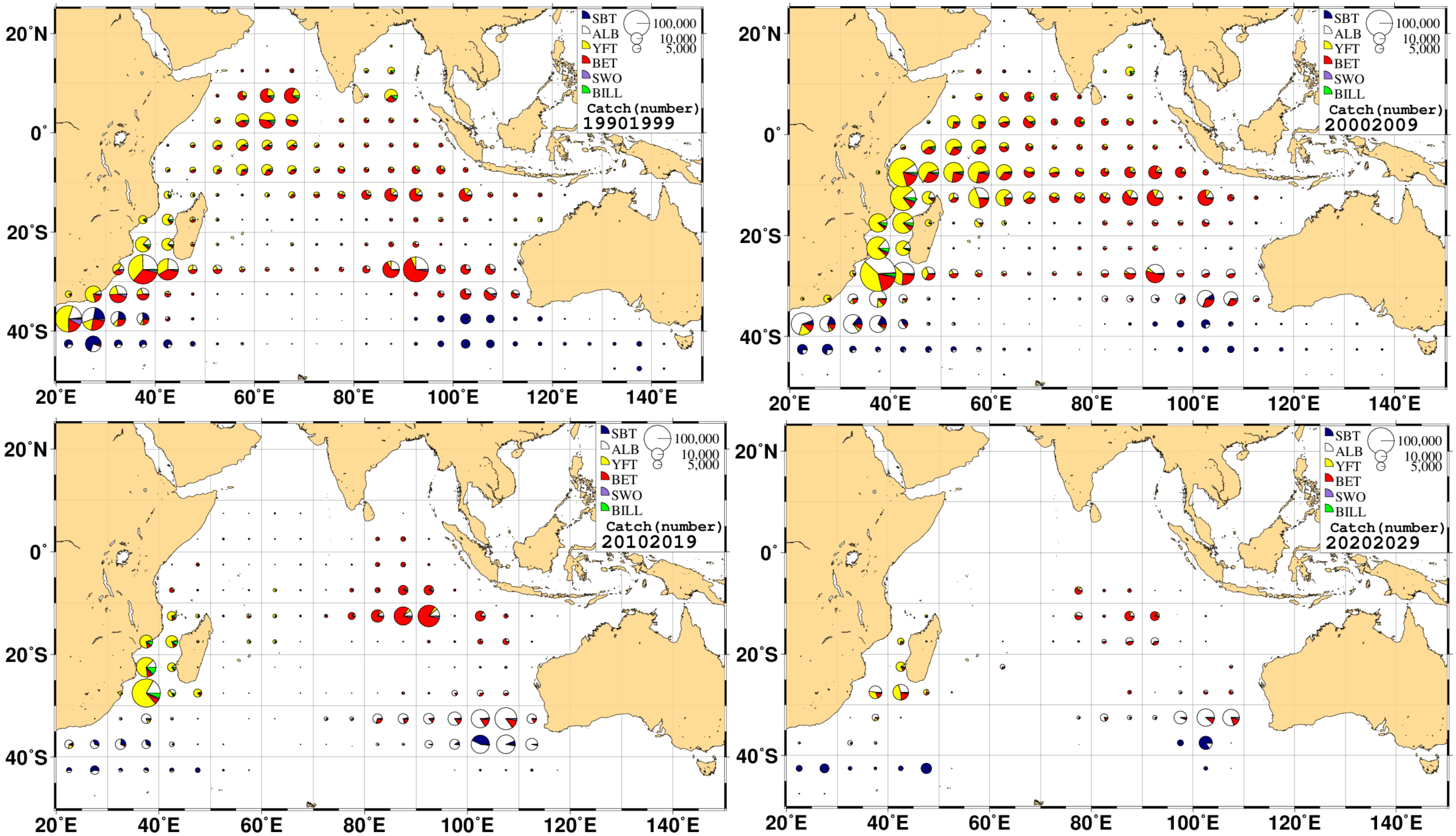

Fig. 6. The distribution of amount of catch in number by species for each decade by Japanese longline fishery. Size of circle shows amount of total of catches i.e. southern bluefin tuna (SBT), albacore (ALB), bigeye tuna (BET), yellowfin tuna (YFT), swordfish (SWO) and billfishes (BILL).(continued)

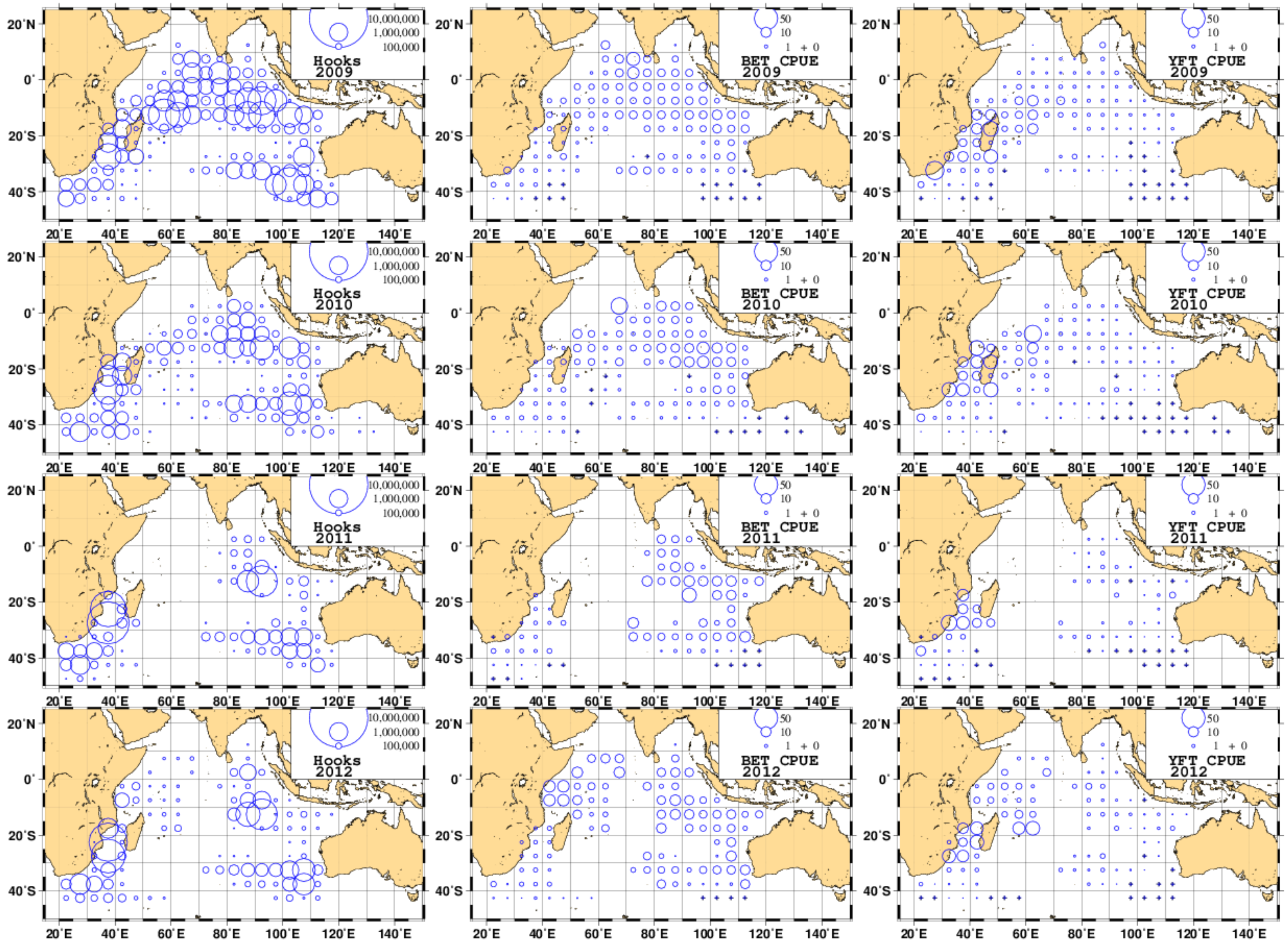

Fig. 7. The geographical distribution of the effort (number of hooks) and bigeye and yellowfin tuna CPUE (number of fish/1000hooks) in recent years by Japanese longline fishery.

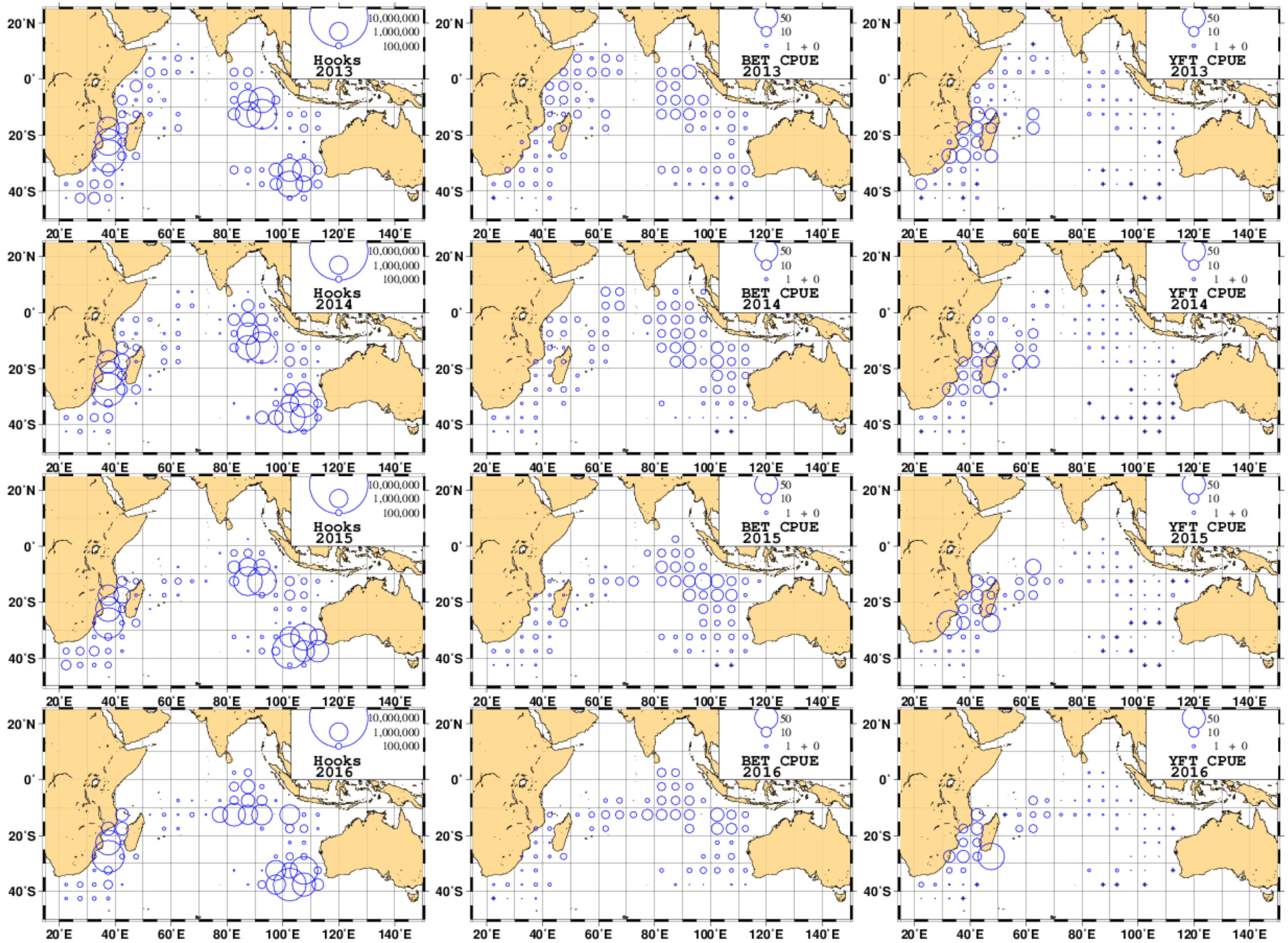

Fig. 7. The geographical distribution of the effort (number of hooks) and bigeye and yellowfin tuna CPUE (number of fish/1000hooks) in recent years by Japanese longline fishery. (continued)

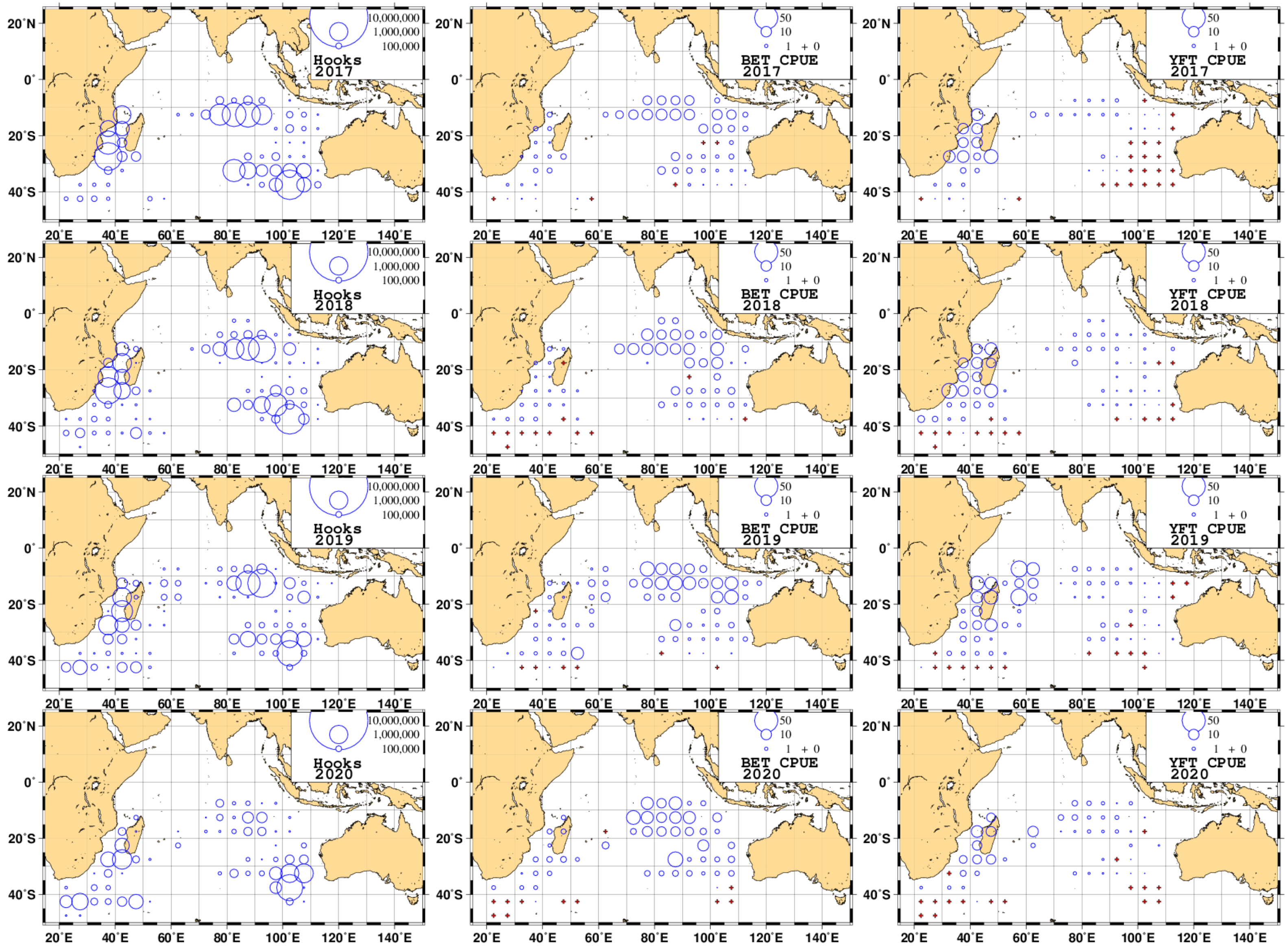

Fig. 7. The geographical distribution of the effort (number of hooks) and bigeye and yellowfin tuna CPUE (number of fish/1000hooks) in recent years by Japanese longline fishery. (continued)

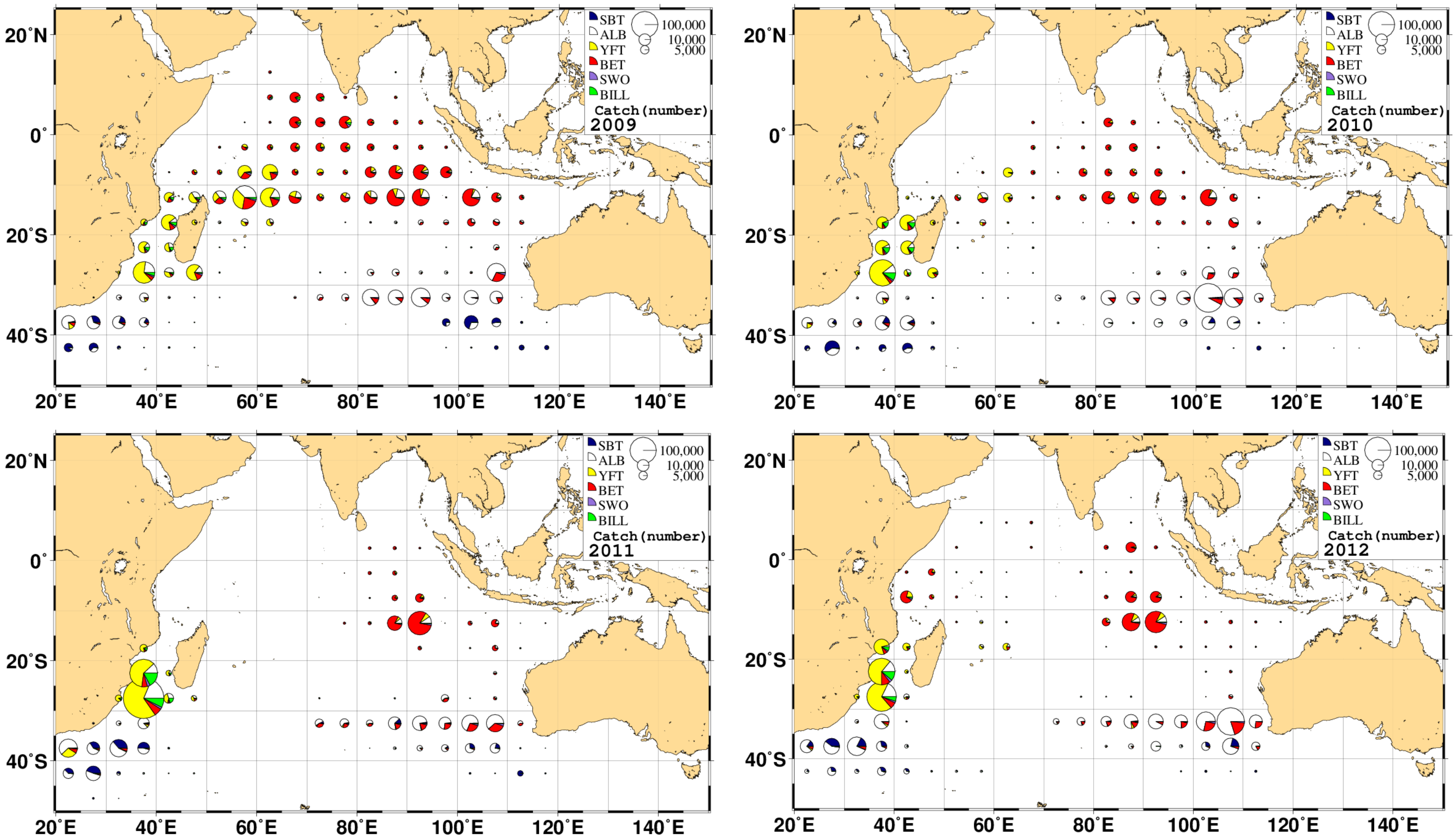

Fig. 8. Annual recent distribution of amount of catch in number by species by Japanese longline fishery. Size of circle shows amount of total of catches i.e. southern bluefin tuna (SBT), albacore (ALB), bigeye tuna (BET), yellowfin tuna (YFT), swordfish (SWO) and billfishes (BILL).

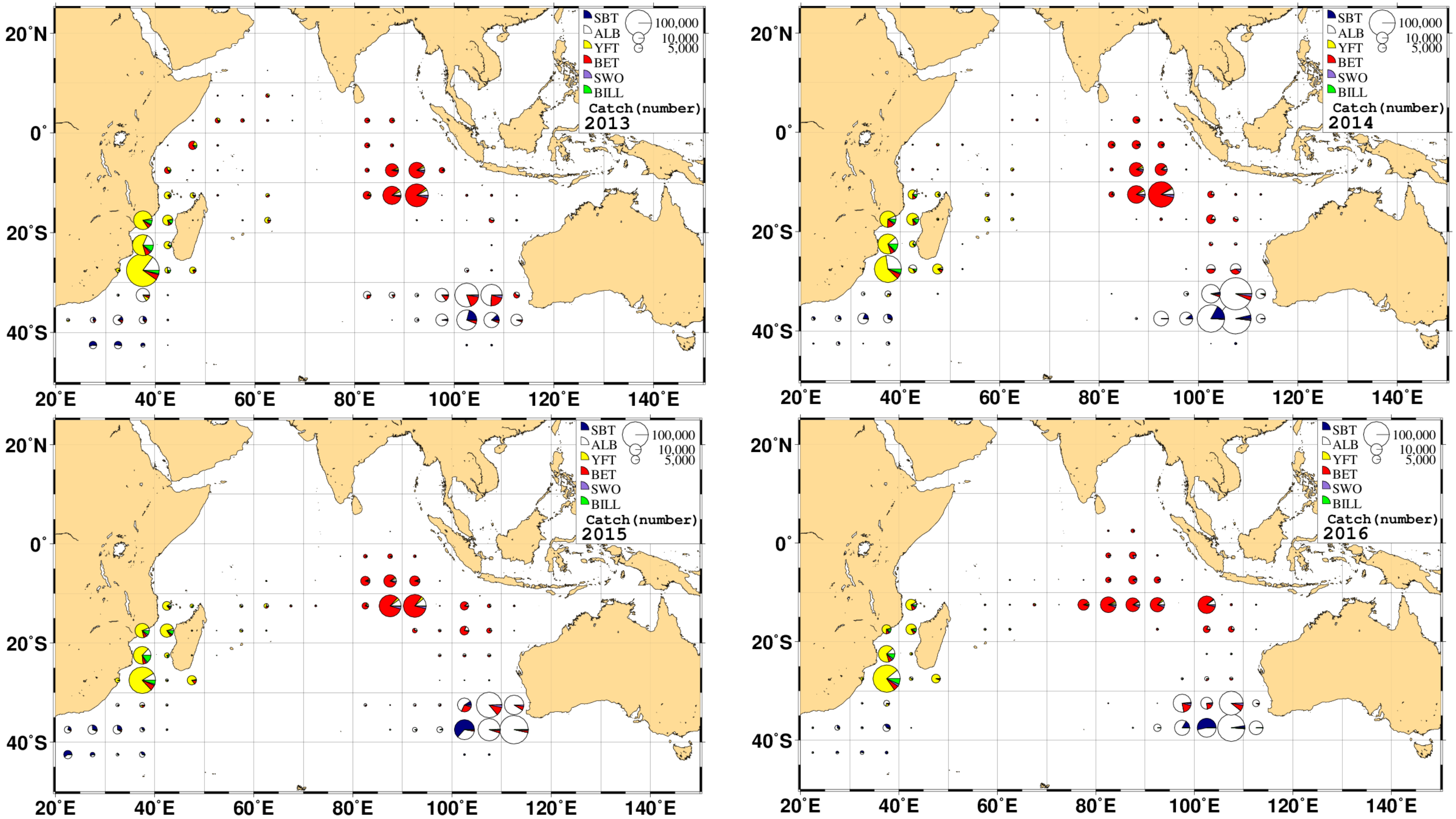

Fig. 8. Annual recent distribution of amount of catch in number by species by Japanese longline fishery. Size of circle shows amount of total of catches i.e. southern bluefin tuna (SBT), albacore (ALB), bigeye tuna (BET), yellowfin tuna (YFT), swordfish (SWO) and billfishes (BILL).(continued)

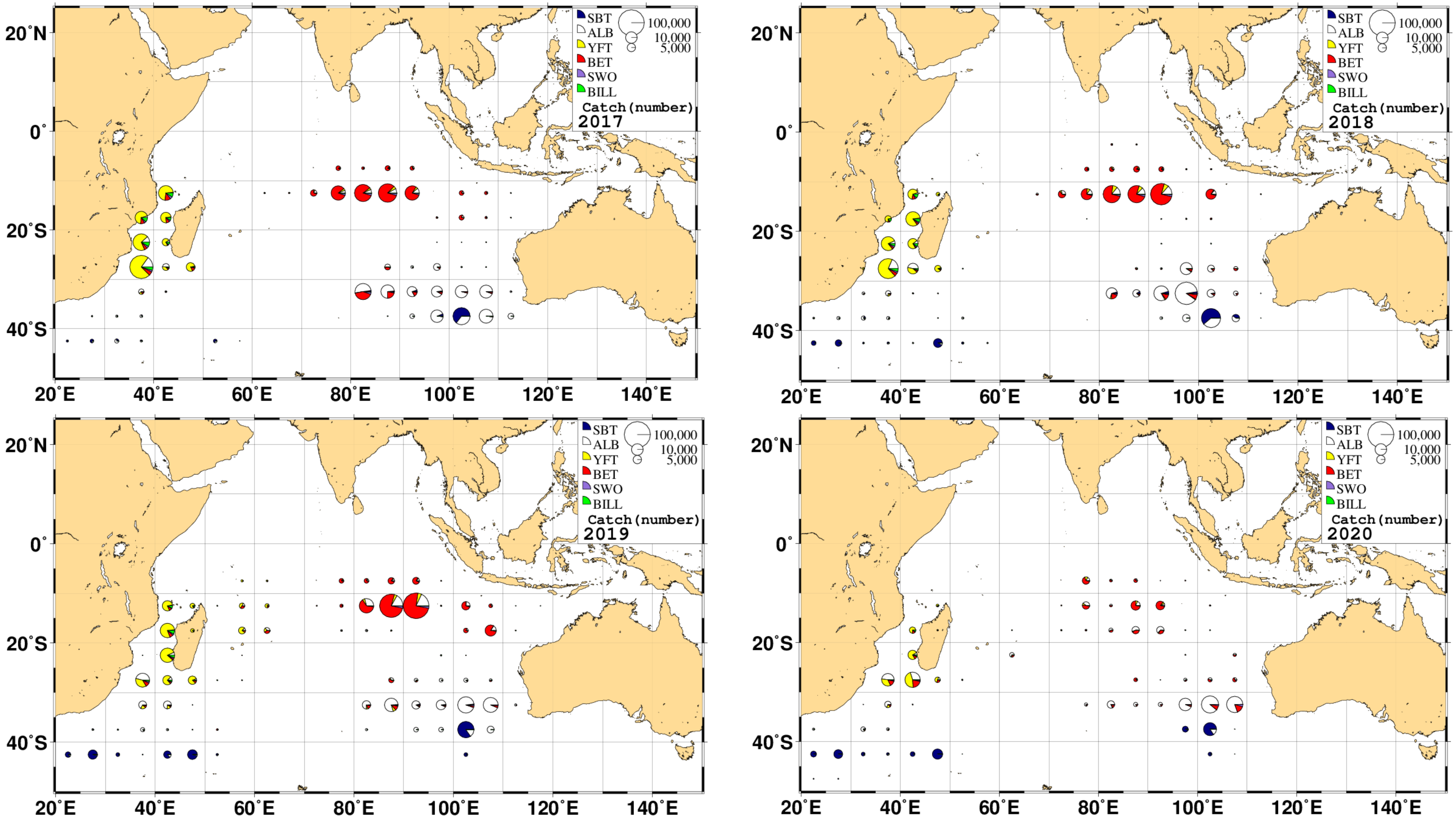

Fig. 8. Annual recent distribution of amount of catch in number by species by Japanese longline fishery. Size of circle shows amount of total of catches i.e. southern bluefin tuna (SBT), albacore (ALB), bigeye tuna (BET), yellowfin tuna (YFT), swordfish (SWO) and billfishes (BILL).(continued)

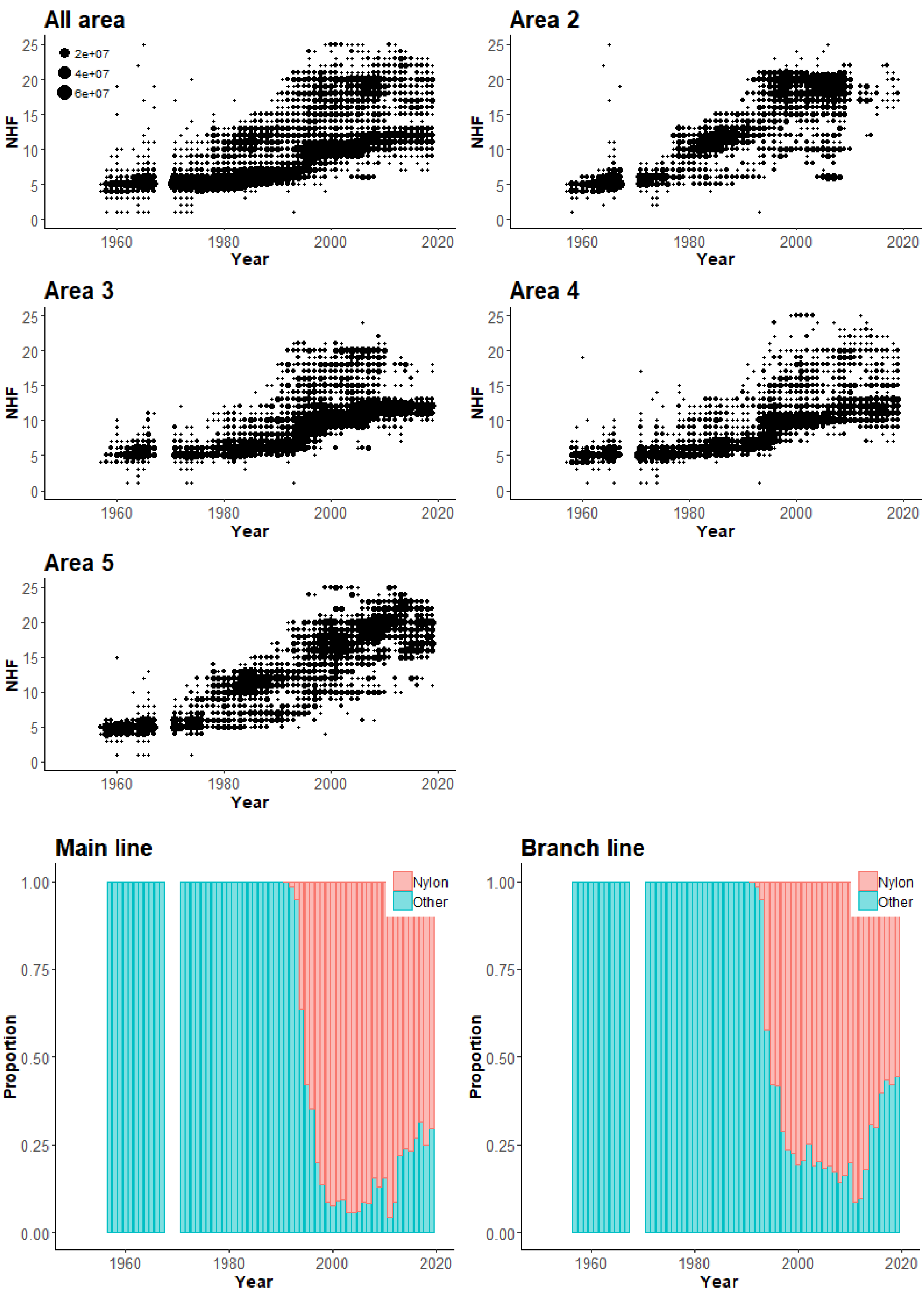

Fig. 9. Historical changes in the proportion of fishing effort by fishing gear (NHFCL and gear materials (main-line and branch-line)) by Japanese longline fishery. The area is shown in Fig. 1.

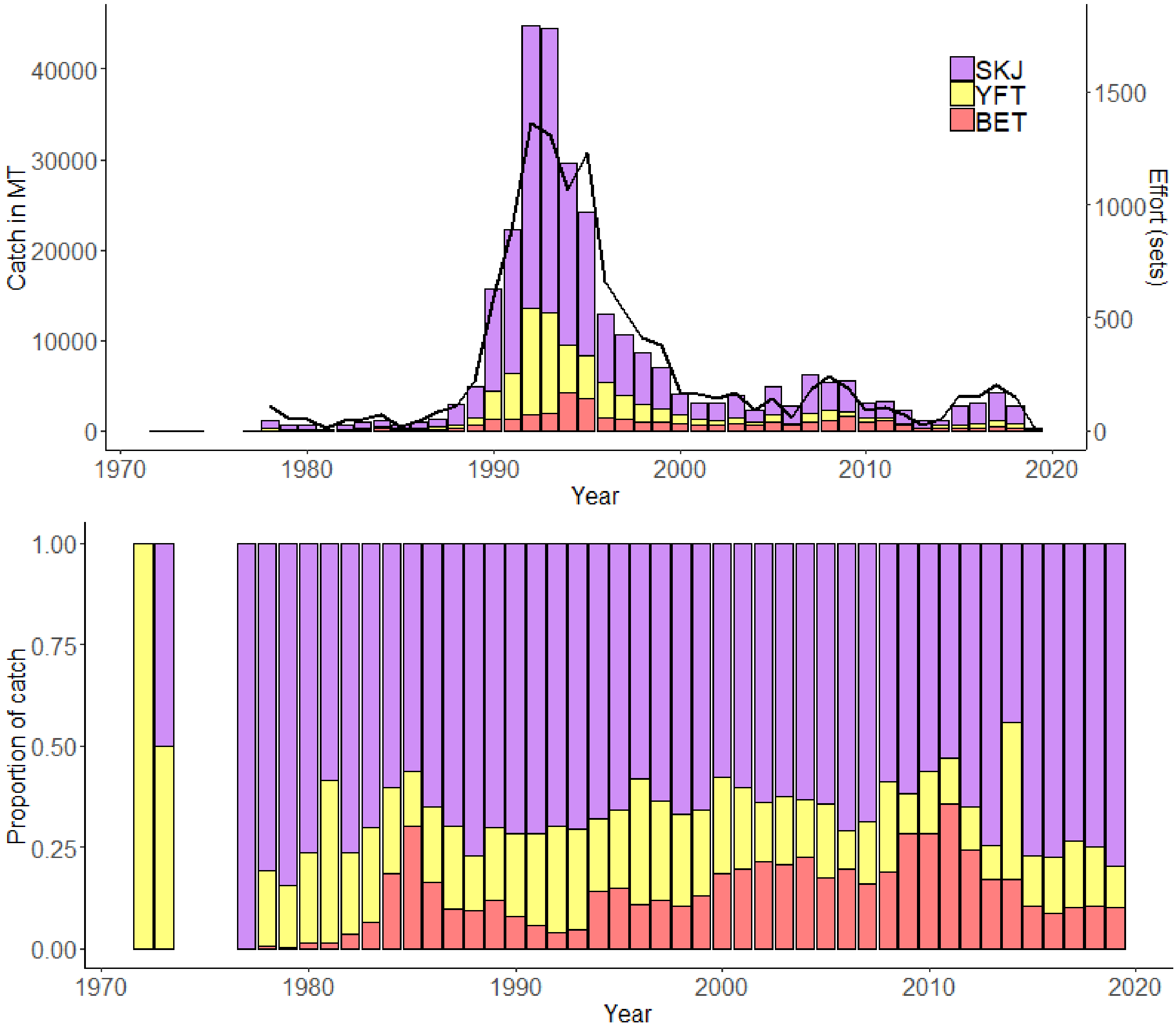

Fig. 10. The number of purse seine efforts (sets, black line) and catch of tropical tunas (bars: skipjack, yellowfin and bigeye tuna) (upper panel) and species composition (lower panel) caught by Japanese purse seine fishery in the Indian Ocean.

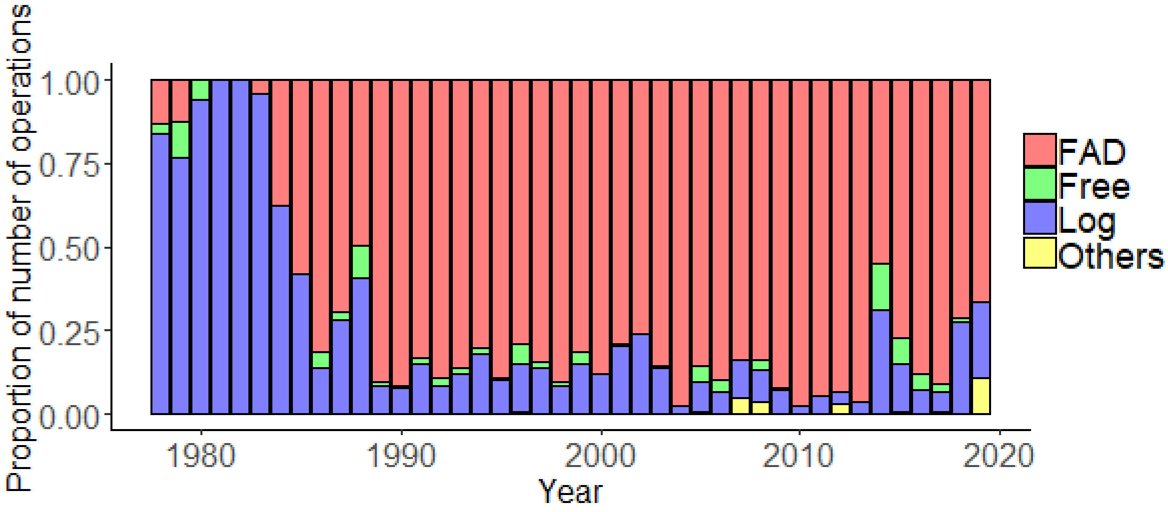

Fig. 11. The proportion of the number of set by school type for Japanese purse seine fishery in the Indian Ocean. Log: associated school with natural objects, FAD: FAD associated school, Free: free swimming school, Others: other types of school.

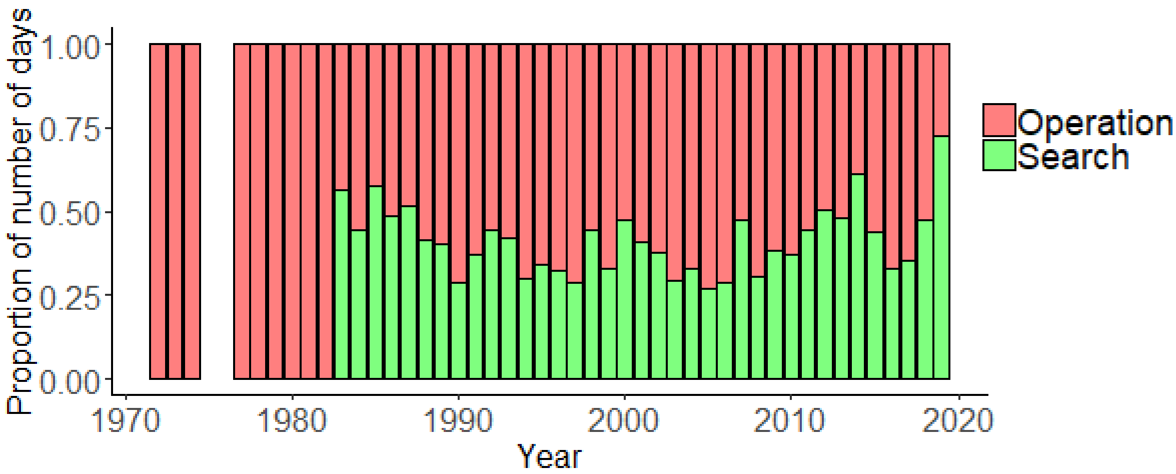

Fig. 12. The proportion of the number of days by activity for Japanese purse seine fishery. Note: search day was not recorded in the logbooks during the early period.

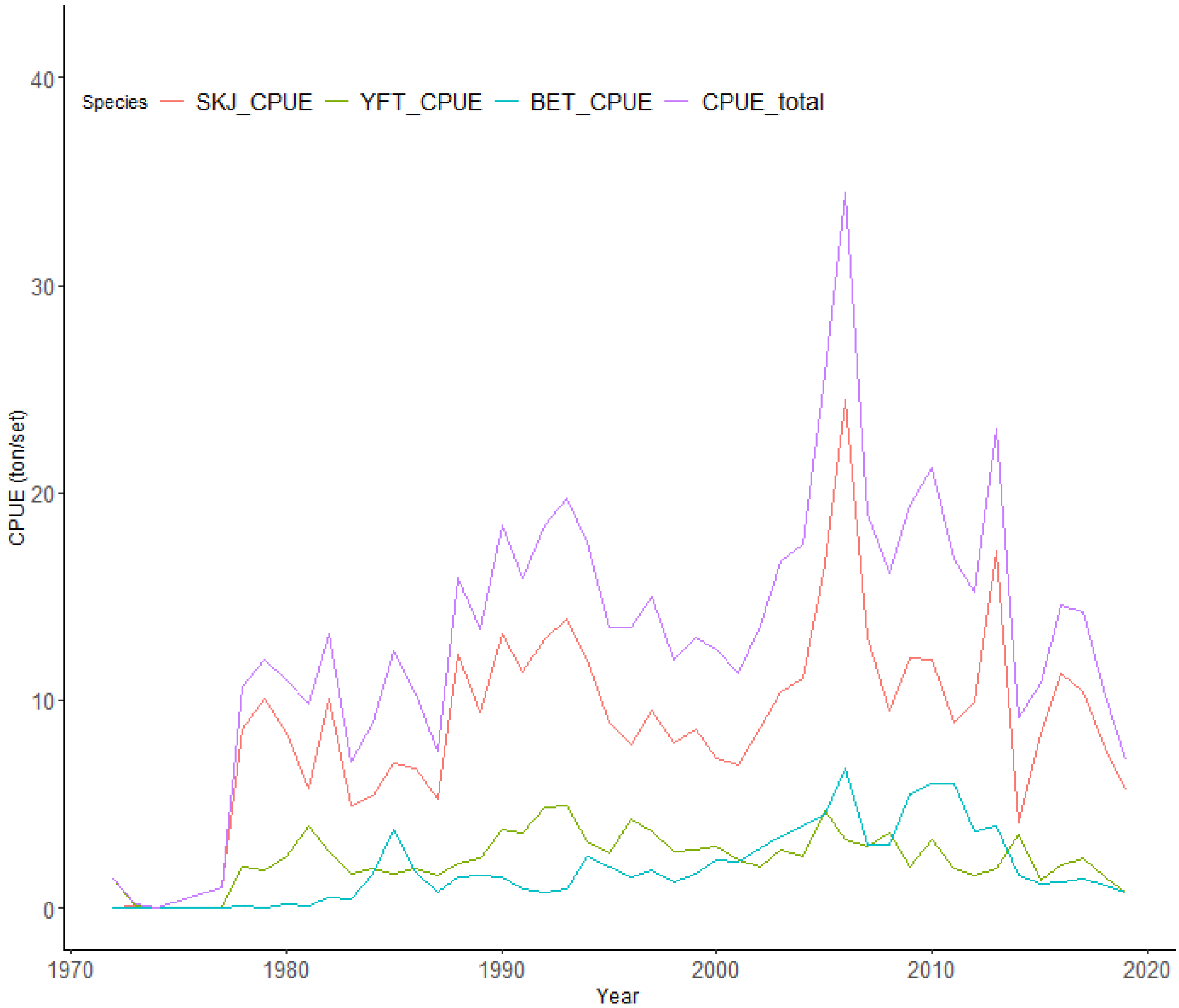

Fig. 13. The trends of nominal CPUE (catch per set) for Japanese purse seine fishery in the Indian Ocean. "CPUE_total" does not include other fish.

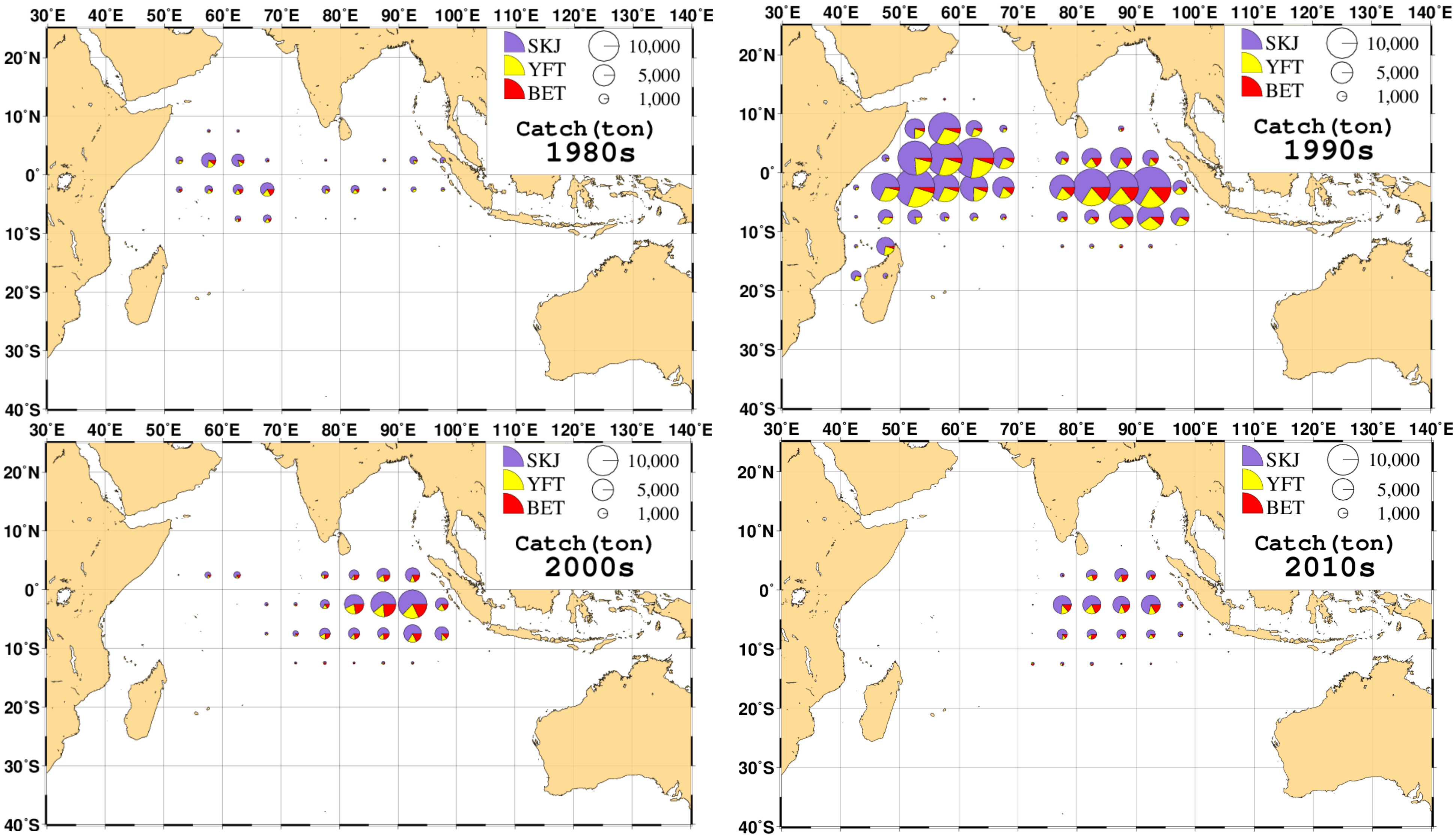

Fig. 14. The distribution of the amount of the catch in weight for the Japanese purse seine by species (SKJ; skipjack tuna, YFT; yellowfin tuna, BET; bigeye tuna) for each decade. Size of circles shows amount of total of catches (other fish are not included).

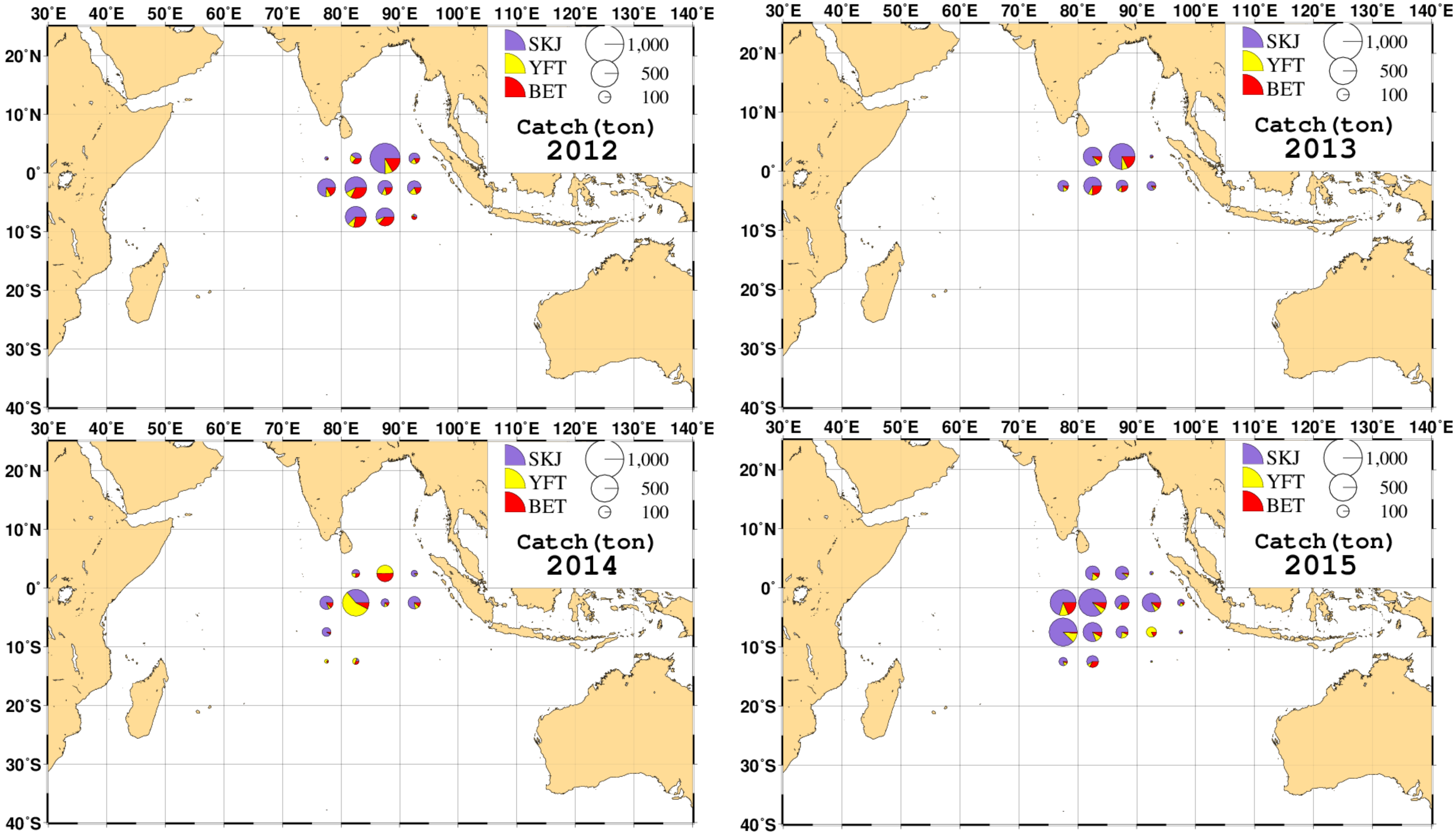

Fig. 15. Annual distribution of the amount of catch in weight for the Japanese purse seine by species (SKJ; skipjack tuna, YFT; yellowfin tuna, BET; bigeye tuna) in recent years. Size of the circles shows amount of total of catches (other fish are not included).

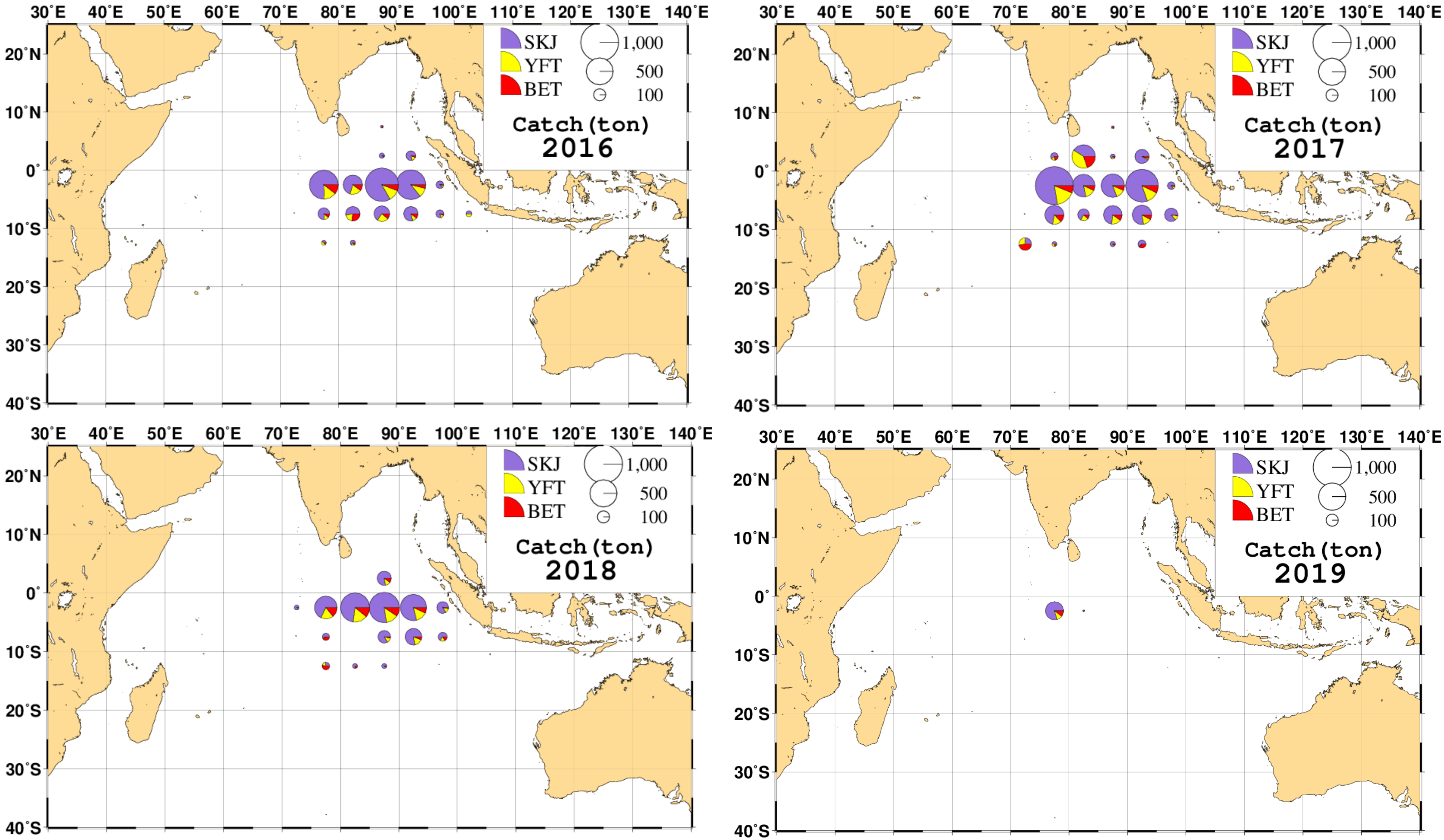

Fig. 15. Annual distribution of the amount of catch in weight for the Japanese purse seine by species (SKJ; skipjack tuna, YFT; yellowfin tuna, BET; bigeye tuna) in recent years. Size of the circles shows amount of total of catches (other fish are not included). (continued)

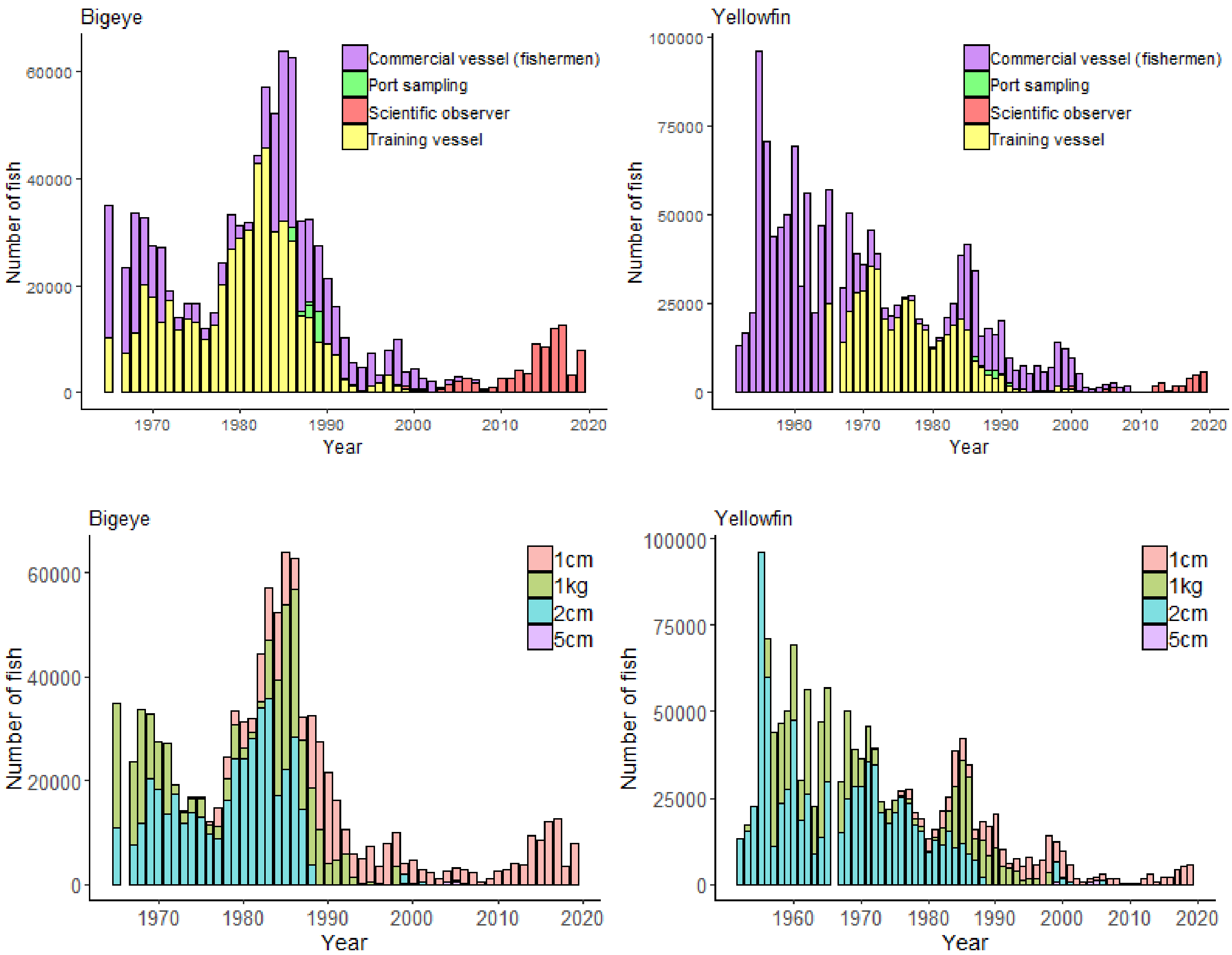

Fig. 16. Annual change in the number of size data by Japanese longline fishery. Upper: by sampling category, lower: by measurement unit.

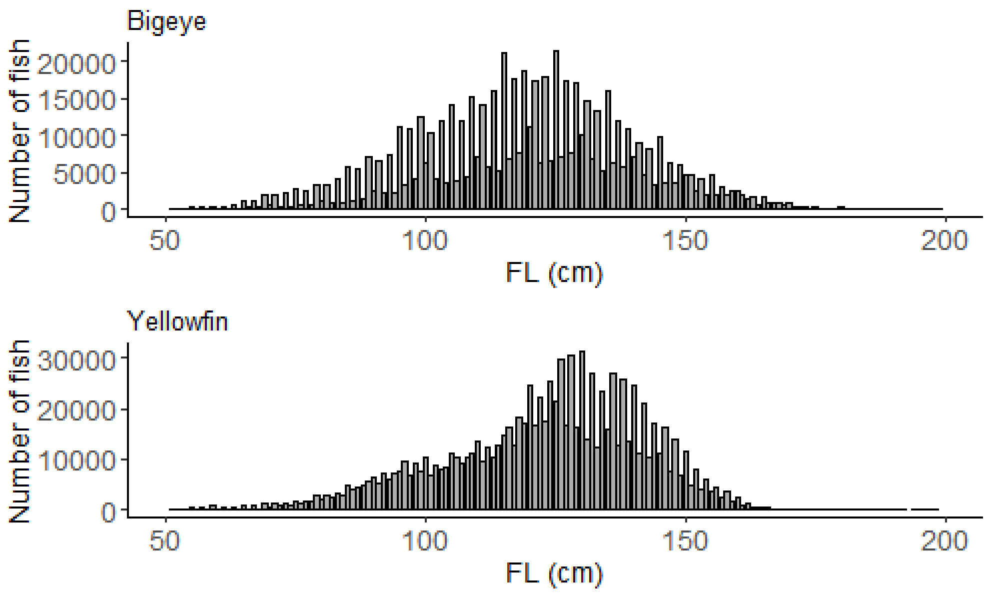

Fig. 17. Length frequency of bigeye and yellowfin tuna in the Indian Ocean caught by Japanese longline.

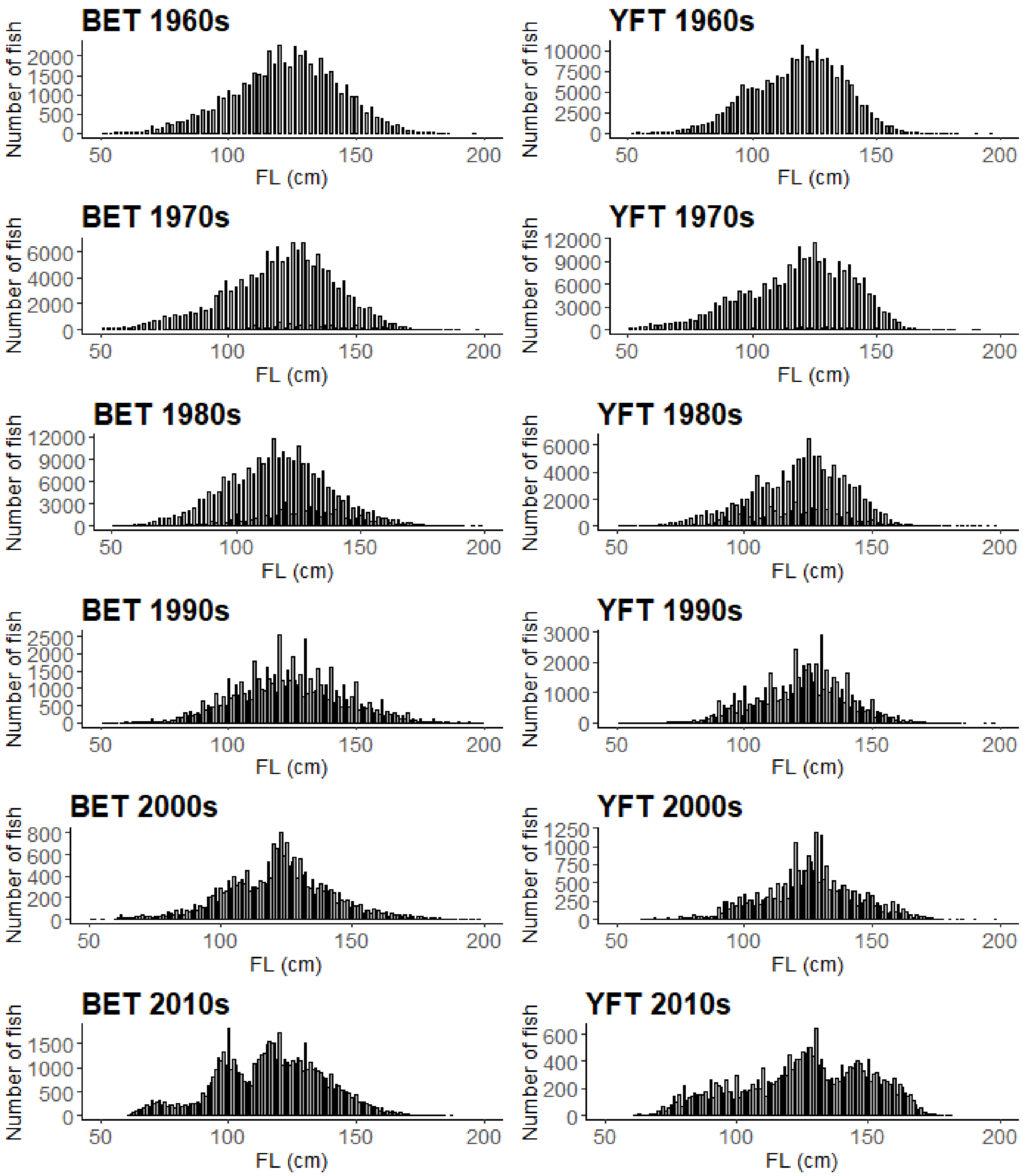

Fig. 18. Length frequency of bigeye and yellowfin tuna in the Indian Ocean caught by Japanese longline by decade.

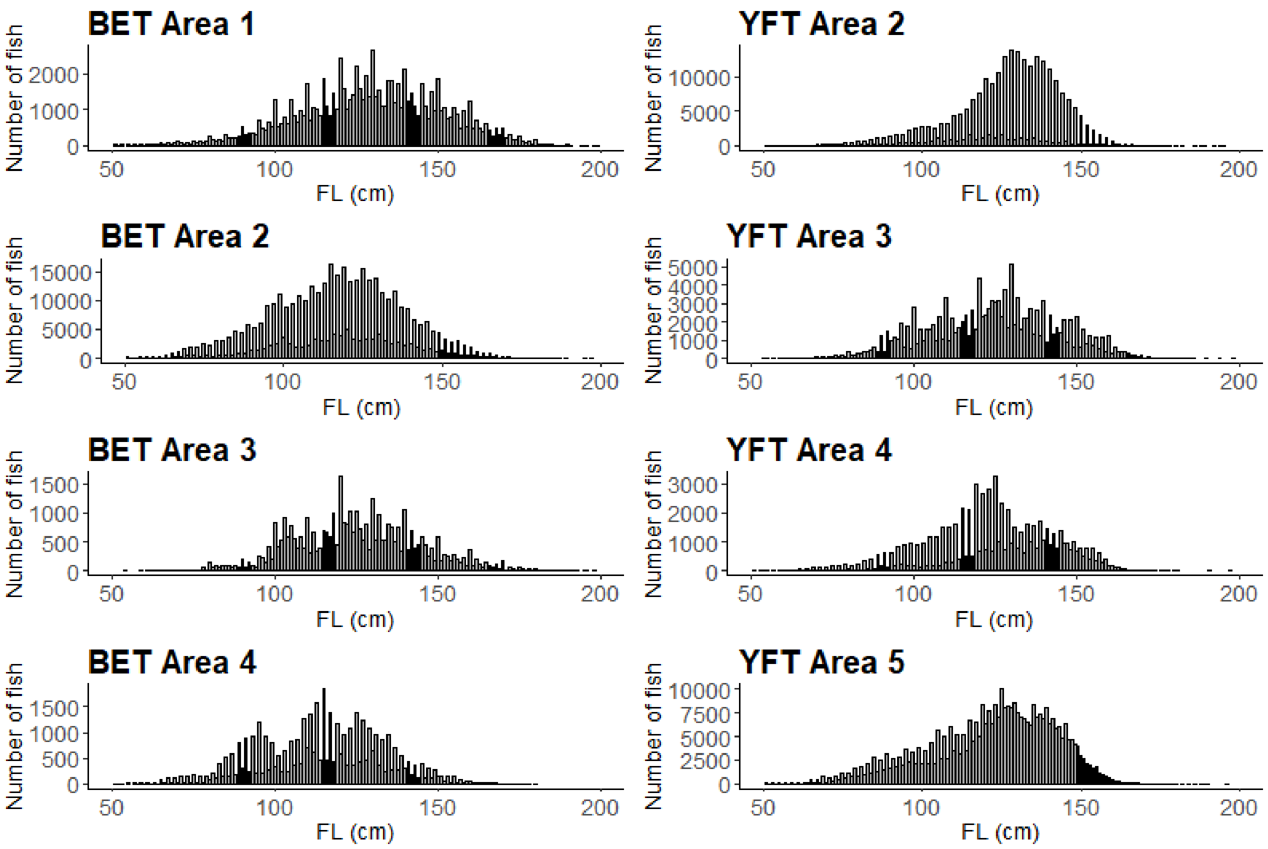

Fig. 19. Length frequency of bigeye and yellowfin tuna in the Indian Ocean caught by Japanese longline by area shown in Fig. 1.

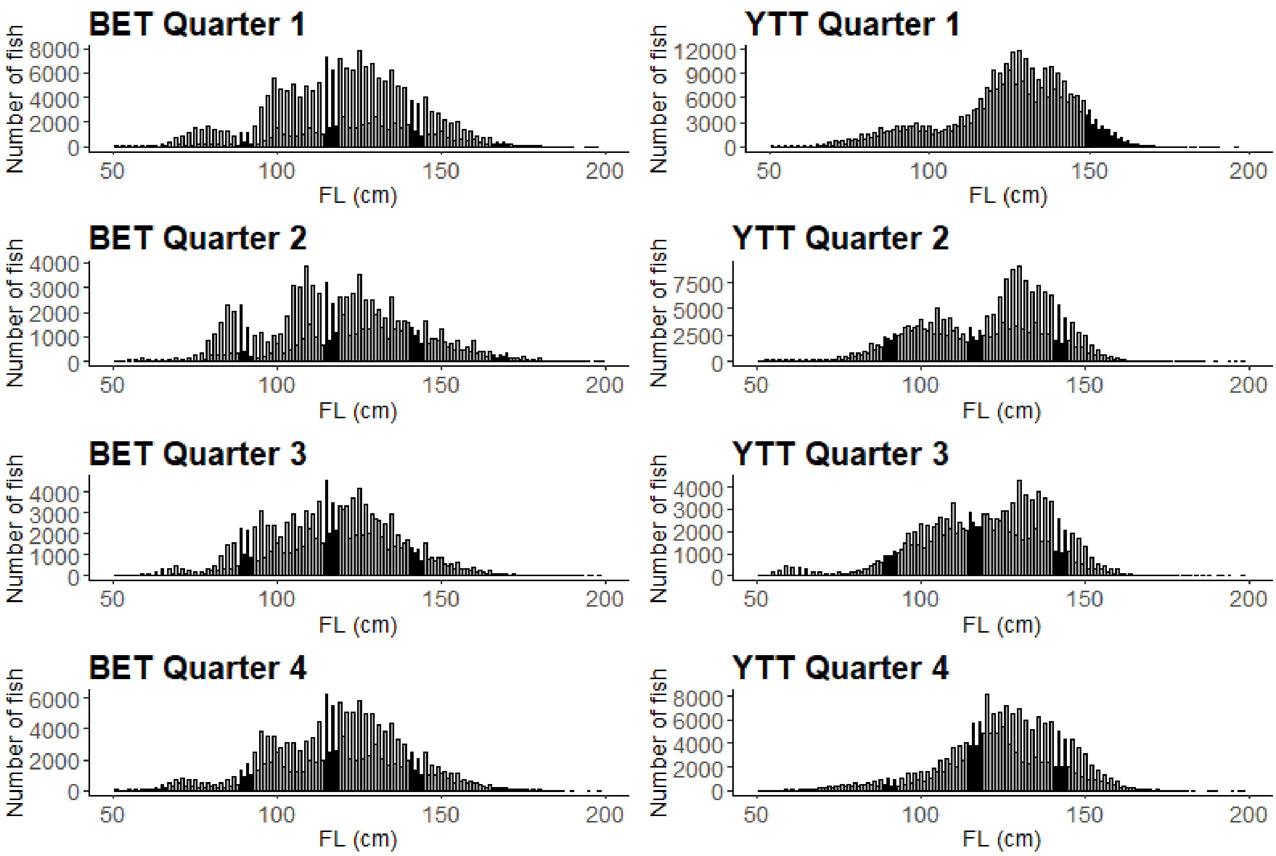

Fig. 20. Length frequency of bigeye and yellowfin tuna in the Indian Ocean caught by Japanese longline by quarter.