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Review of species aggregated sharks data caught by Japanese offshore and distant-water longliners in the north Pacific in 1975-1993

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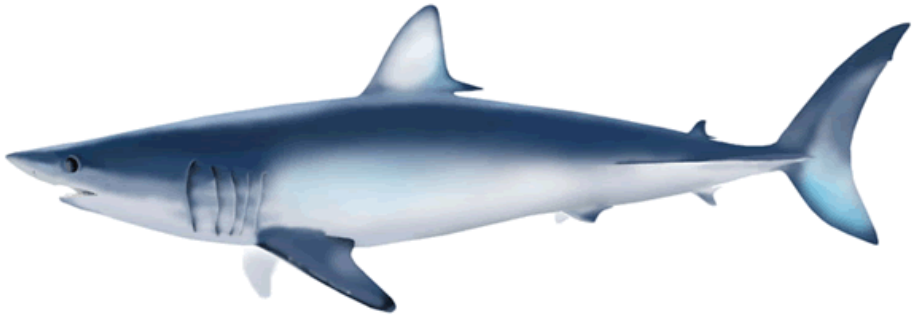

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Introduction

The catch and effort data of Japanese offshore and distant-water longliners have been offered important information about stock status of major shark species in the three oceans (e.g., ICCAT (2009) and Clarke (2011)) due to its quality and wider coverage. Because older Japanese log-book data of tuna-longline fishery does not contain the information of live released and dead discarded sharks, a filtering method to extract the data of all sharks caught using the reporting rate of sharks in the log-book were developed by Nakano and Clarke (2006) and applied on the data in the Atlantic and the Indian Oceans (Matsunaga (2007) and Matsunaga (2008)). Though Japanese offshore and distant-water longliners primary targets tunas, one fleet of offshore longline based on Kesennnuma fishing port seasonally targets blue shark (), and this may affects on the report rate of sharks in the longline log-book data. In the present study, the sharks catch and effort data in the log-book of Japanese offshore and distant-water longliners in the period between 1975 and 1993 were reviewed to investigate adequate method to process these data for their use of stock assessments of major shark species in the north Pacific such as blue and mako sharks. Because only species aggregated catch data is available in the period of analyzed, species specific patterns in the data were not reviewed in this study.

Materials and Methods

The catch and effort were obtained from Japanese longline fishery statistics compiled by the National Research Institute of Far Seas Fisheries for 1975-1993, when the information about gear configuration (HPB, number of hooks between floats) are available but only species aggregated shark catch data (data of "sharks" hereafter) are recorded. Because Japanese longliners were requested to record retained sharks into their log-book, data of sharks believed only to include catch of commercially valuable shark species such as blue shark, mako sharks and salmon sharks. The set-by-set data were used for the analysis but the data without HPB information were excluded.

For the analysis of catch number, amount of effort (number of hooks) and CPUE (number/1,000 hooks) of sharks, set by set data were categorized by area, subarea, gear configuration (HPB) as well as vessel types (offshore and distant-water) and the region of vessel register prefectures. The area and subarea stratifications used in this study are shown in Figures 1 and 2. The gear configuration are classified into two categories, shallow sets (HPB<7) and deep sets (HPB>6) to simplify the analysis.

Japanese offshore longliners keep their catch as fresh and Japanese distant-water longliners keep their catch as frozen. Because the market values of fresh and frozen sharks are usually different, Japanese offshore and distant-water longliners would have different strategy for the retention of their shark catches.

The category of the region of vessel register is shown in Figure 3. Japanese longliners generally operates as a fleet which is composed by longliners registered to the same prefecture or region to obtain effective searching of good fishing grounds. Japanese longliners belongs to a same fleet or fleets registered in the same region usually have same annual operational pattern, same target species (they can change by area and season), as well as same markets for their catches. Thus, they would have same strategy for the shark retention. The longliners registered in Toyama prefecture (placed in the Hokuriku region) are classified into Pacific side of Tohoku as they belong to the union in that region.

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Results and Discussions

(1) Outline of the operations in the north Pacific

In the north Pacific, the amount of effort of Japanese offshore longliners are roughly 40 % of the total in the period analyzed (Fig. 3), and almost all of them are obtained from the area 1, while the main fishing grounds of Japanese distant-water longliners are in the areas 2 and 3 (Fig. 4). In the area 1, shallower sets (HPB is 3-6) are the main configuration for both offshore and distant-water longliners in the late 1970s, but they gradually replaced by deeper sets (Fig. 5). Within the shallower sets in the area 1, sets with 5-6 HPB occupied majority until the beginning of the 1980s and it is gradually replaced by sets with 3-4 HPB and 5-6 sets are almost disappeared in the end of the 1980s. In the areas 2 and 3 of the distant-water longliners, almost no sets with 3-4 HPB are observed in the period analyzed, and set depth of the gear are continuously going deeper from sets with 5-6 HPB to sets with 13-15 or over 15 HPB in the period analyzed.

Japanese offshore longliners operated in the north Pacific are mostly come from Pacific side of Tohoku and Kyushu regions (Fig. 6), and Japanese distant-water longliners are mainly come from Hokkaido, Pacific side of Tohoku and Kyushu regions in the period analyzed. Though the amount of effort is not such large, the offshore longliners in Hokkaido regions and the distant-water longliners in Kanto regions are also operated in the north Pacific constantly.

In the following analysis, we picked up major fleets of offshore and distant-water longliners to examine their shark retention strategy. In the analysis, fleets in Hokkaido and in Pacific side of Tohoku (Tohoku, hereafter) were combined as most of them belong to the same union and taking same fishing strategy (Kesennnuma Skippers and radio operators union, personal comm..).

(2) Analysis of data of major fleets of offshore longliners

The catch number of sharks occupies more than half of the total catch of the Shallow sets (HPB<7) of the offshore longliners in Tohoku (including Hokkaido) in the area 1, but its ratio is less than 10 % in the area 2 (Figs. 7 and 8). This difference could at least partially due to the difference of target species as the some swordfish catches observed in the area 1 which almost disappeared in the area 2. In the north Pacific, swordfish and blue shark frequently caught together. As for the deep sets, some sharks catch observed in the area 1 but few in the area 2. This would suggest that the deep sets by Hokkaido offshore longliners unload most of their shark catches when they operate only in the northwest Pacific.

The ratio of sharks to the total catch of the offshore longliners in Kyushu is much smaller than those of Tohoku in both areas and gear types, and reported catch of sharks by Kyushu offshore longliners is almost negligible (Figs. 9 and 10). This should indicates that they mostly release or discard their shark catches.

The catch numbers of sharks by shallow sets of Tohoku offshore longliners are obtained in all subareas in the northwest Pacific (subareas 1, 2, 4, and 5), and the ratio of sharks catch in each subareas to the total seems roughly same pattern with the ratio of the amount of effort (Fig. 11, left column). The catch numbers of sharks by deep sets of Tohoku offshore longliners are obtained mostly in the eastern side of the northwest Pacific (subareas 2 and 5, Fig. 12), and their total catch of sharks is roughly one third of that by shallow sets.

The shallow sets by Kyushu offshore longliners are only conducted in the period between 1975 and 1984, and their shark catches is quite small (less than 1 % of Tohoku fleet), though the

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amount of effort is roughly about 10 % of Tohoku fleet in that period (Fig. 11, right column). The almost of the shallow sets were conducted in the southern part of the northwestern Pacific (subarea 4 and 5), but more than half of their shark catch obtained from the northern part (subareas 1 and 2). Because the shallow sets by Kyushu offshore longliners seems only target tunas, this fact would indicate that CPUE of sharks in the northern part in the northwestern Pacific is higher than in the southern part. Similar pattern is also observed for the deep sets of Kyushu offshore longliners (Fig. 12).

The ratio of catch of sharks to the total is relatively higher and shows stable or gradually changing trend for shallow and deep sets of Tohoku region (including Hokkaido, Fig. 13). This indicates that the Tohoku offshore longline fleet reports their shark catch constantly and their data should well represent their catch of sharks. Observed gradual increase or decrease of the ratio of catch of sharks would at least partially reflect the change of target species. The offshore surface longliners based on Kesennuma (This is roughly identical to the shallow sets of Tohoku and Hokkaido offshore fleets) fishing port conducting swordfish, blue shark and tunas using shallow sets in the period , and CPUE of blue shark is lower when they target tunas than swordfish or blue shark (Yokawa, 2009).

The ratios of catch of sharks are relatively low and largely fluctuating for the Kyushu offshore longliners (Fig. 13). Catches of sharks by the Kyushu offshore longliners should be estimated using information from other fleets, such as the Tohoku offshore longliners. The annual trends of the ratio of sharks

(3) Analysis of data of major fleets of distant-water longliners

Among three major fleets of Japanese distant-water longliners operated in the north Pacific, deep sets and shallow sets of Tohoku fleet (including Hokkaido) occupied major part in the area 1, while the ratio of Tohoku shallow sets decreased in the areas 2 and 3 (Fig. 14). The ratio of catch of sharks in the Tohoku distant-water fleet is apparently high in the area 1 than in the areas 2 and 3 for both shallow and deep sets (Fig. 15). The trend of the ratio of sharks seems relatively stable or gradually changing in the period analyzed for all areas and operational types (Fig. 16). This would indicate that the Tohoku distant-water longliners report their shark catches under constant condition. Gradual change of the ratio of catch of sharks would at least partially reflect change of target species or change of HPB values. In general, CPUE of sharks getting lower as the set depth of hooks deeper. Thus, the data of sharks by Tohoku distant-water longliners could be used for the analysis of shark catches in the north Pacific with some appropriate processing of data. The observed high catch ratio of marlins in the shallow sets in the area 3 could be due to the striped marlin directed sets (Yokawa, 2005).

In contrast to Tohoku distant-water fleet, the ratio of catch of sharks is generally rather low for Kyushu distant-water fleet for all areas and operational types, and they largely fluctuate annually (Figs. 17 and 18). This indicates that the scientific values of the shark data of Kyushu distant-water fleet is quite limited in compare to the ones of Tohoku, and the catch of sharks by Kyushu fleet should be corrected using data of other fleets.

The catch data of sharks of distant-water longliners in Kanto by shallow sets in the area shows general similar pattern with those by Tohoku shallow sets in the area 1 (Figs. 19 and 20). During the period between 1978 and 1981, Kanto deep sets in the area 1 also report high catch ratio of sharks. These data could be used for the analysis of sharks data. The ratio of sharks in the catch by deep sets in the areas 2 and 3 were low but showing relatively stable annual

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trends. They may also give some information about the catch of sharks in these areas.

The analysis of data of the distant-water longliners belong to the major fleets in the Pacific reveals the fact that same as the case of the offshore longliners, Tohoku fleet (including longliners in Hokkaido region) possesses relatively good quality of information about the catch of sharks. And also Kanto fleet would contain some good quality of data. On the contrary, the quality and quantity of shark data of Kyushu fleet is rather poor and they need to be corrected using information from other fleets.

Figure 21 shows the annual trends of the amount of effort of shallow sets of major three fleets (Tohoku, Kyushu and Kanto) by subarea, and Figure 22 shows the catch number of sharks. Shallow sets of Tohoku fleet are appeared in all subareas and they more or less report some good number of catches of sharks in all subareas. This indicates that the estimation of total catch number of sharks by distant-water longliners in the north Pacific could be done using data of Tohoku fleet. In addition to this, catch and effort data of Tohoku distant-water fleet distributes in all subareas in the period analyzed, and they could also be used for the analysis of CPUE of sharks (Figs. 23 and 24). The data of other minor fleet may have partially good information about their catch of sharks same as Kanto fleet, and further analysis of data of these minor fleet may increase the amount of data could be used for the stock analysis of sharks in the north Pacific.

The catch of sharks by Japanese coastal longliners are mainly obtained in the higher latitudinal areas in the northwest Pacific, and High CPUE also concentrates into the same area (Fig. 25). The catch of sharks by Japanese distant-water longliners seems to spread over in the north Pacific especially in the higher latitudinal area in the northwest Pacific and the tropical eastern Pacific(Fig. 26).

The catch and effort data of sharks by shallow sets of Tohoku coastal longline fleet is mainly obtained in the higher latitudinal area in the northwest Pacific in the period analyzed (Fig. 27). The catch of sharks by shallow sets of Kyushu coastal longline fleet is also obtained in the same area as Tohoku fleet, but their effort mainly deployed in the lower latitudinal area. The catch of sharks and amount of effort of deep sets of Tohoku and Kyushu offshore longline fleets are mostly obtained from 25N- 40N and 0N-10N in the northwest Pacific (Fig. 28).

The average effort distribution patterns of shallow and deep sets of Tohoku, Kyushu and Kanto seems generally overlapping (Figs. 29 and 30). The shallow sets mainly appeared in the higher latitudinal area in the northwest and north-central Pacific, while deep sets distributed in the tropical area in the north Pacific.

Conclusion

This documents review the sharks data (data of aggregated commercially important shark species) of Japanese offshore and distant-water longliners in the period between 1975 and 1993. These are high contrast in the reporting rate of sharks between fleets classified by the region of Japan where longliners are registered. The fleets in the Pacific side of Tohoku and Hokkaido are reported some large number of catch of sharks, and the ratio of sharks to the total are generally constant or gradually changes by year. This indicates that those fleets reported their catch of sharks under a fixed rule. On the other side, the fleet in Kyushu does not report or seldom report their catch or sharks, and the ratio of catch of sharks fluctuated largely year to year. Thus, the sharks data of Kyushu fleets are supposed not to represent the actual catches of sharks of them, but only represent number of sharks they unloaded. Thus, the sharks data of fleets in the Pacific

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side of Tohoku and Kyushu would be able to use for the stock assessments of sharks in the north Pacific with some appropriate processing.

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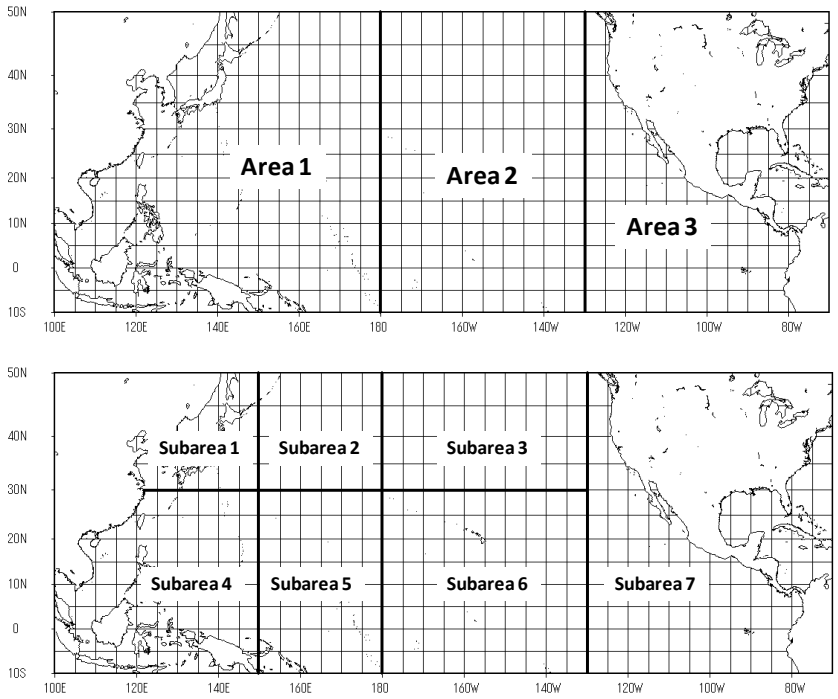

Fig. 1. Area and subarea stratification used in this study.

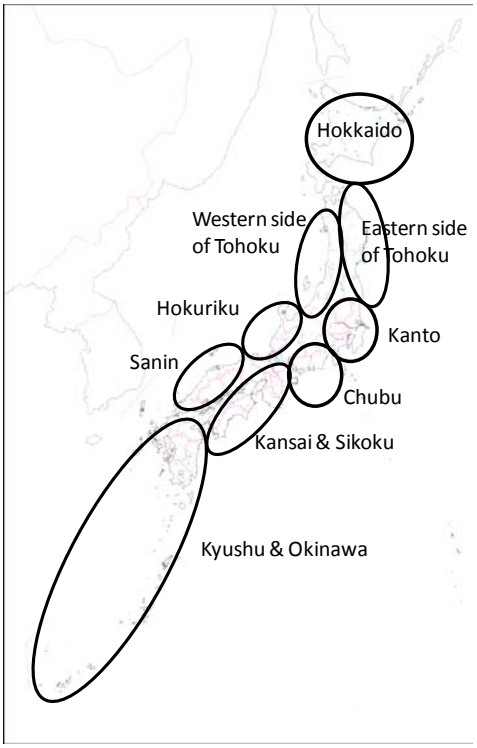

Fig. 2. Regional stratification used for the analysis based on prefectures of vessel registers.

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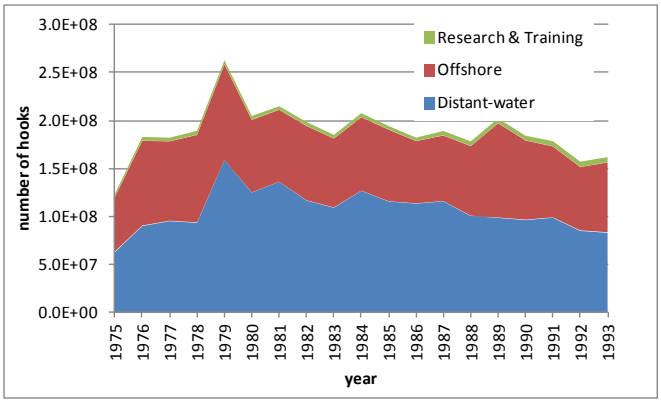

Fig. 3. Annual trend of the amount of effort (number of hooks) of Japanese offshore and distant-water longliners in the period of 1975 – 1993 by the type of vessels.

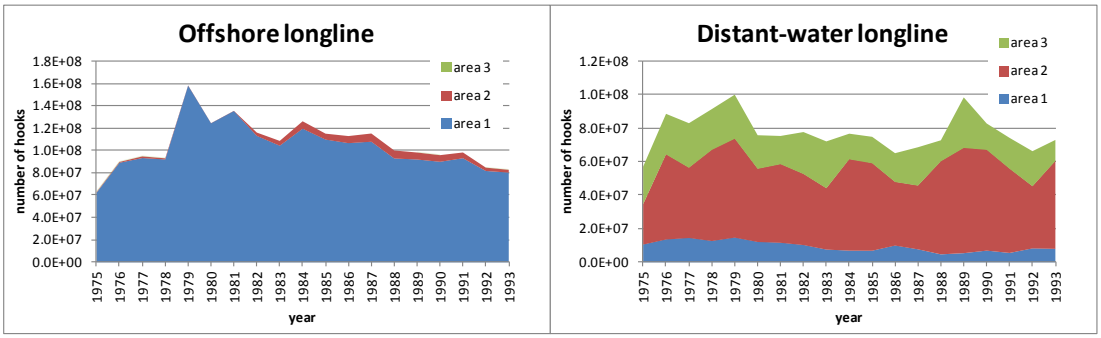

Fig. 4. Annual trend of the amount of effort (number of hooks) by area in the period of 1975 – 1993 for Japanese offshore and distant-water longliners.

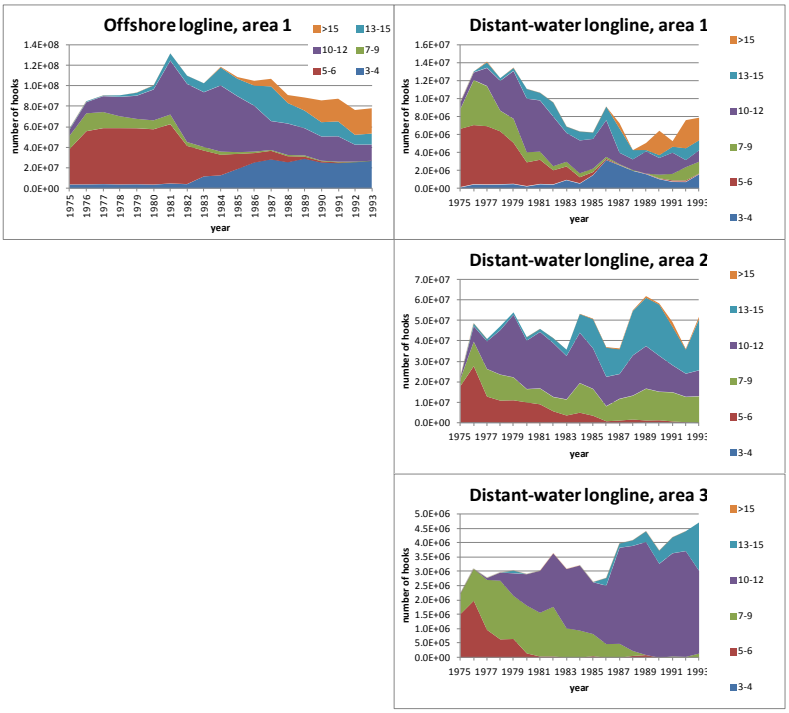

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Fig. 5. Annual trend of the amount of sharks catch number by area, by vessel type, and by gear configuration (number of hooks between floats) of Japanese offshore and distant-water longliners in 1975 and 1993. Information of areas 2 and 3 of the offshore longliners are not shown due to small number of data.

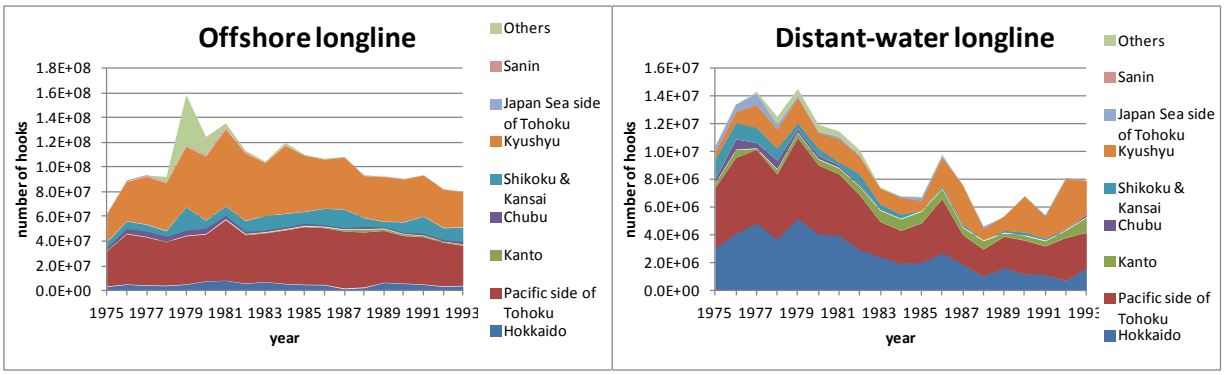

Fig. 6. Annual trend of the amount of effort of the offshore longliners (left) and distant-water longliners (right) by the region of the prefecture of the vessel register.

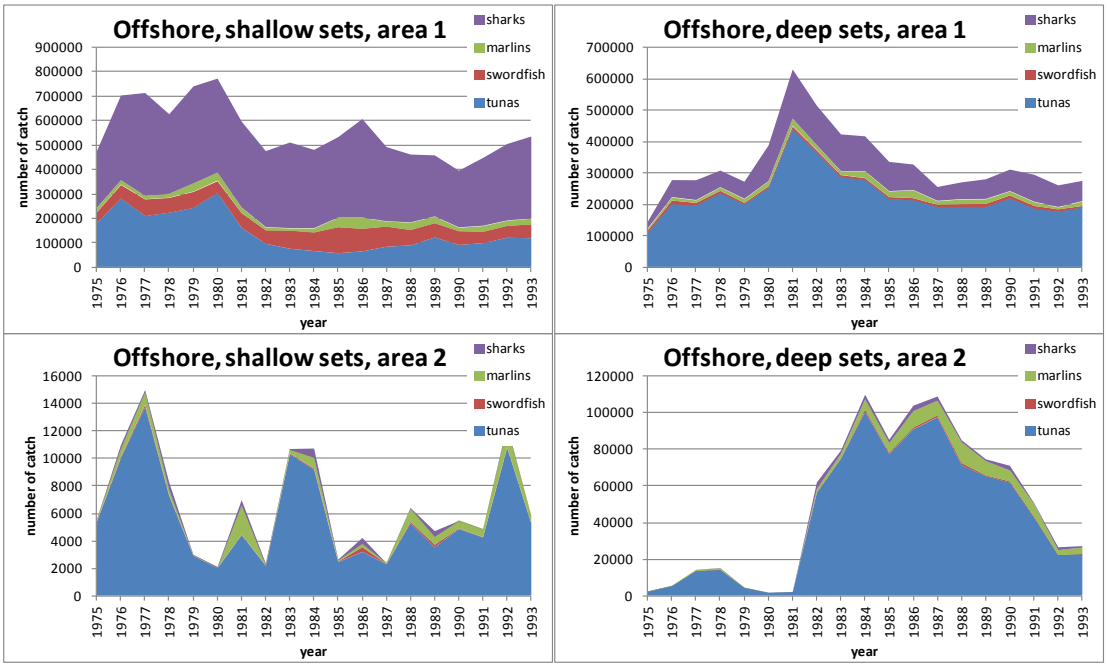

Fig. 7. Catch composition of Japanese offshore longliners registered in the eastern side of Tohoku and Hokkaido regions, by area and by gear type in the period between 1975 and 1993. Tunas indicate the aggregated catch number of Pacific bluefin tuna, bigeye tuna, yellowfin tuna and albacore, and marlins indicate the aggregated catch number of blue marlin, black marlin, sailfish and spearfish.

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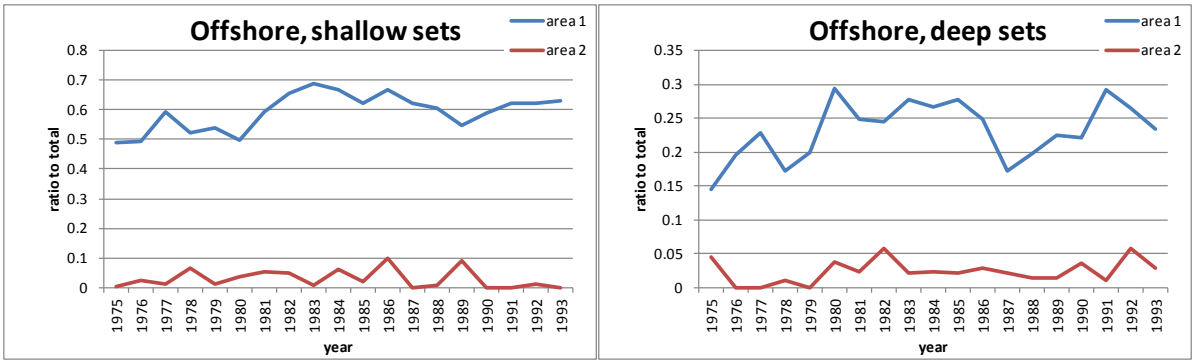

Fig. 8. Ratio of catch number of sharks to the sum of sharks, tunas, swordfish and marlins caught by Japanese offshore longliners registered in the eastern side of Tohoku and Hokkaido regions, in the period of 1975 and 1993, by area and by gear type.

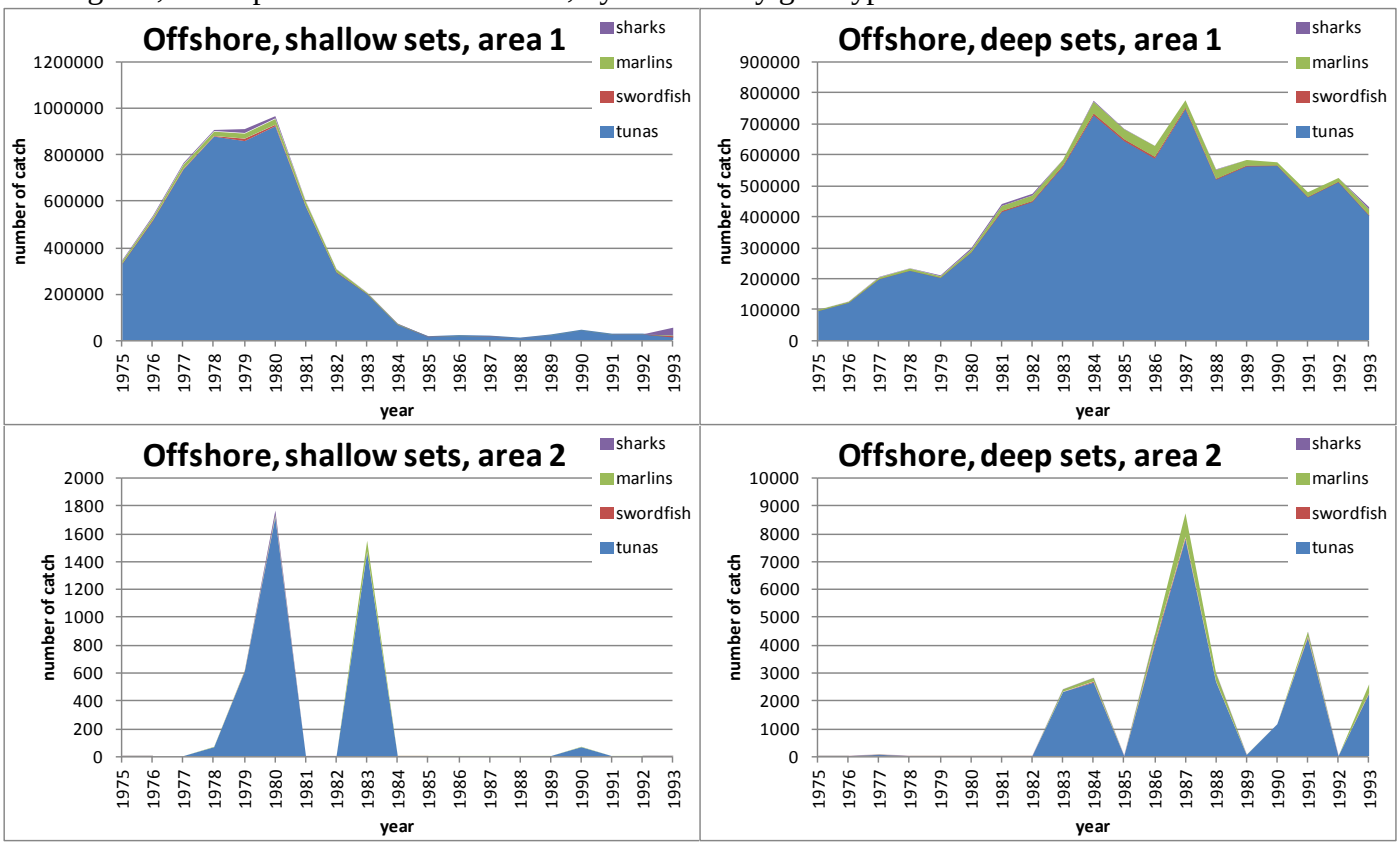

Fig. 9. Catch composition of offshore longliners registered in the Kyushu region, by area and by gear type in the period between 1975 and 1993. Tunas indicate the aggregated catch number of Pacific bluefin tuna, bigeye tuna, yellowfin tuna and albacore, and marlins indicate the aggregated catch number of blue marlin, black marlin, sailfish and spearfish.

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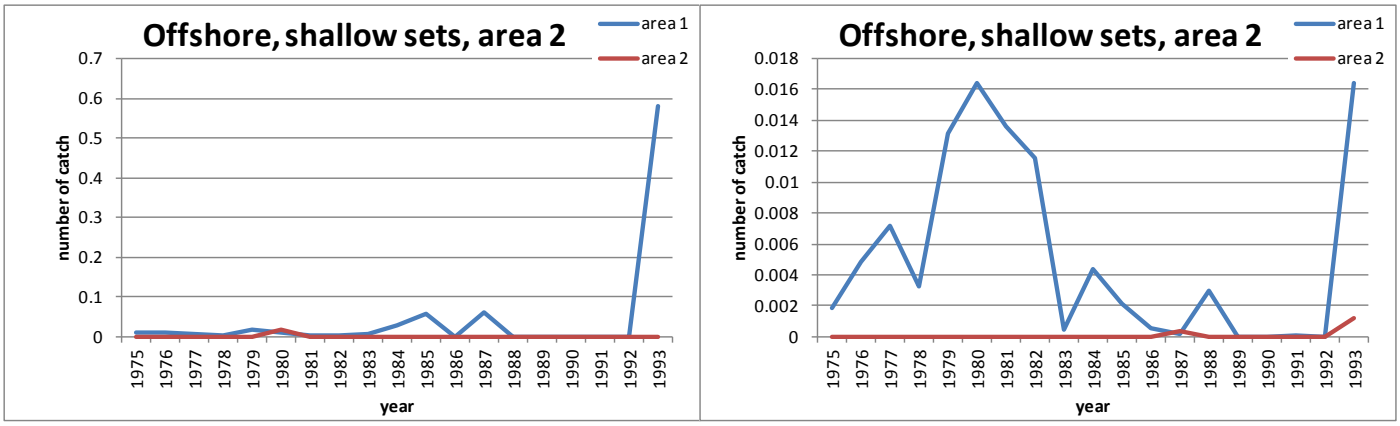

Fig. 10. Ratio of catch number of sharks to the sum of sharks, tunas, swordfish and marlins caught by Japanese offshore longliners registered in the Kyushu region, in the period of 1975 and 1993, by area and by gear type.

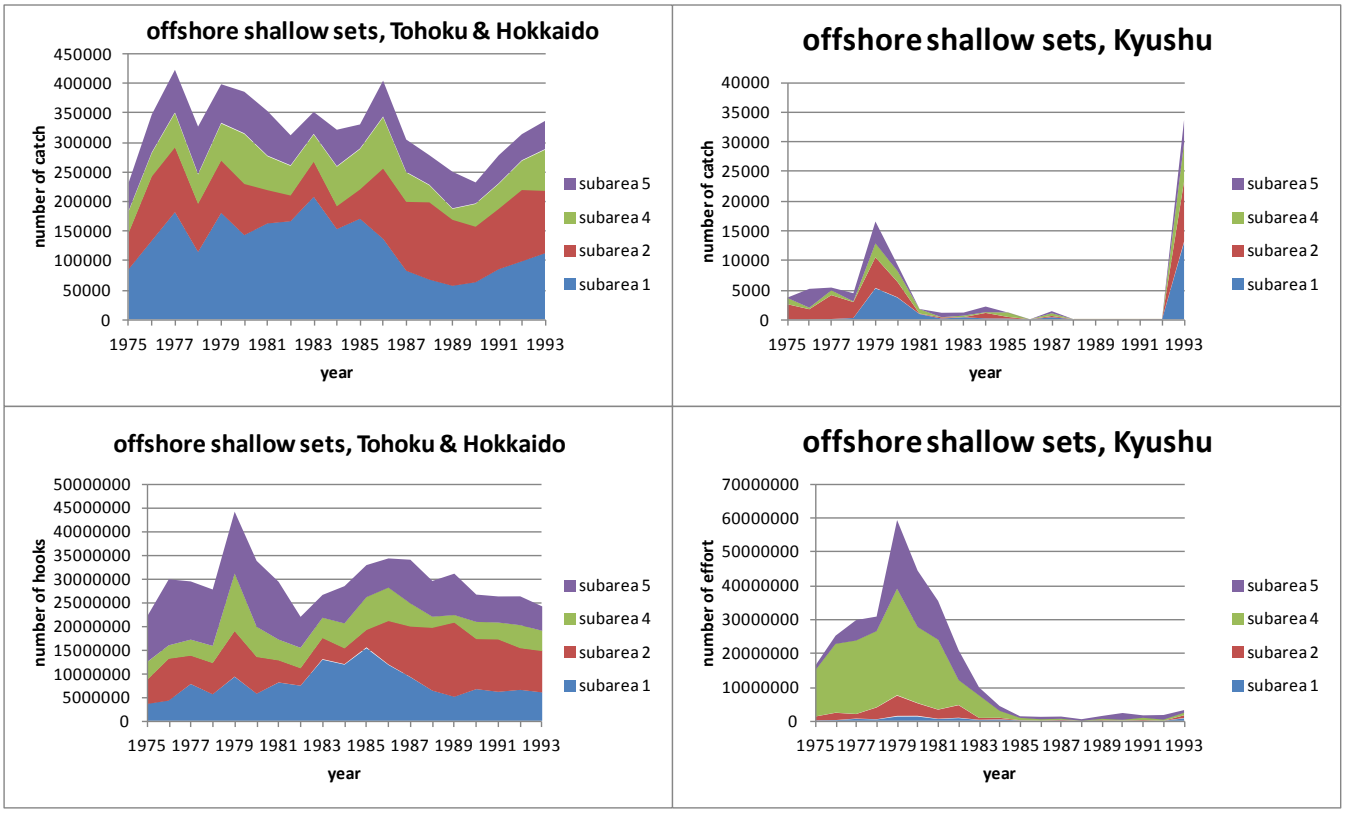

Fig. 11. The catch number of sharks and amount of effort of shallow sets (HPB<7) of Japanese offshore longliners registered in the Tohoku and Hokkaido regions (left column) and Kyushu regions (right column) by subareas.

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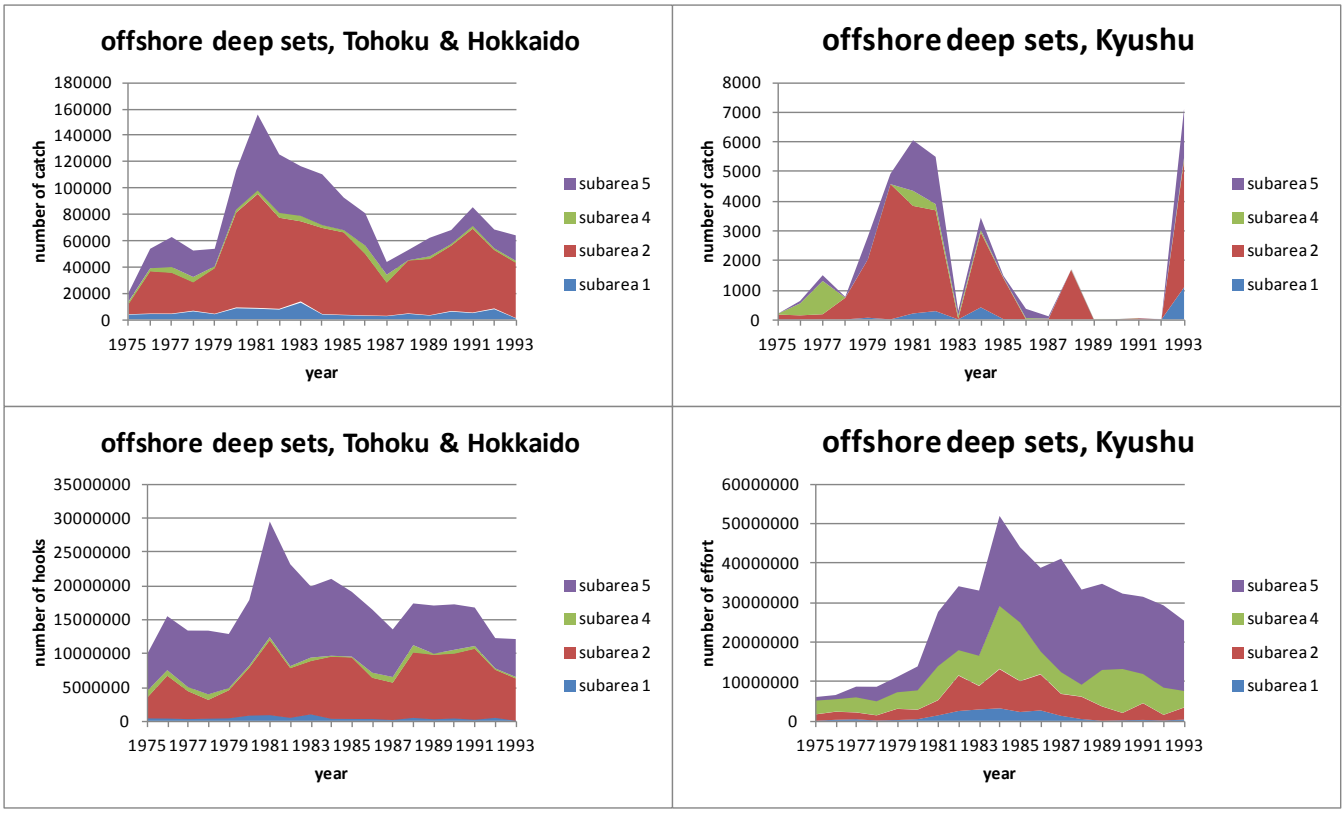

Fig. 12. The catch number of sharks and amount of effort of deep sets (HPB>6) of Japanese offshore longliners registered in the Tohoku and Hokkaido regions (left column) and Kyushu regions (right column) by subareas.

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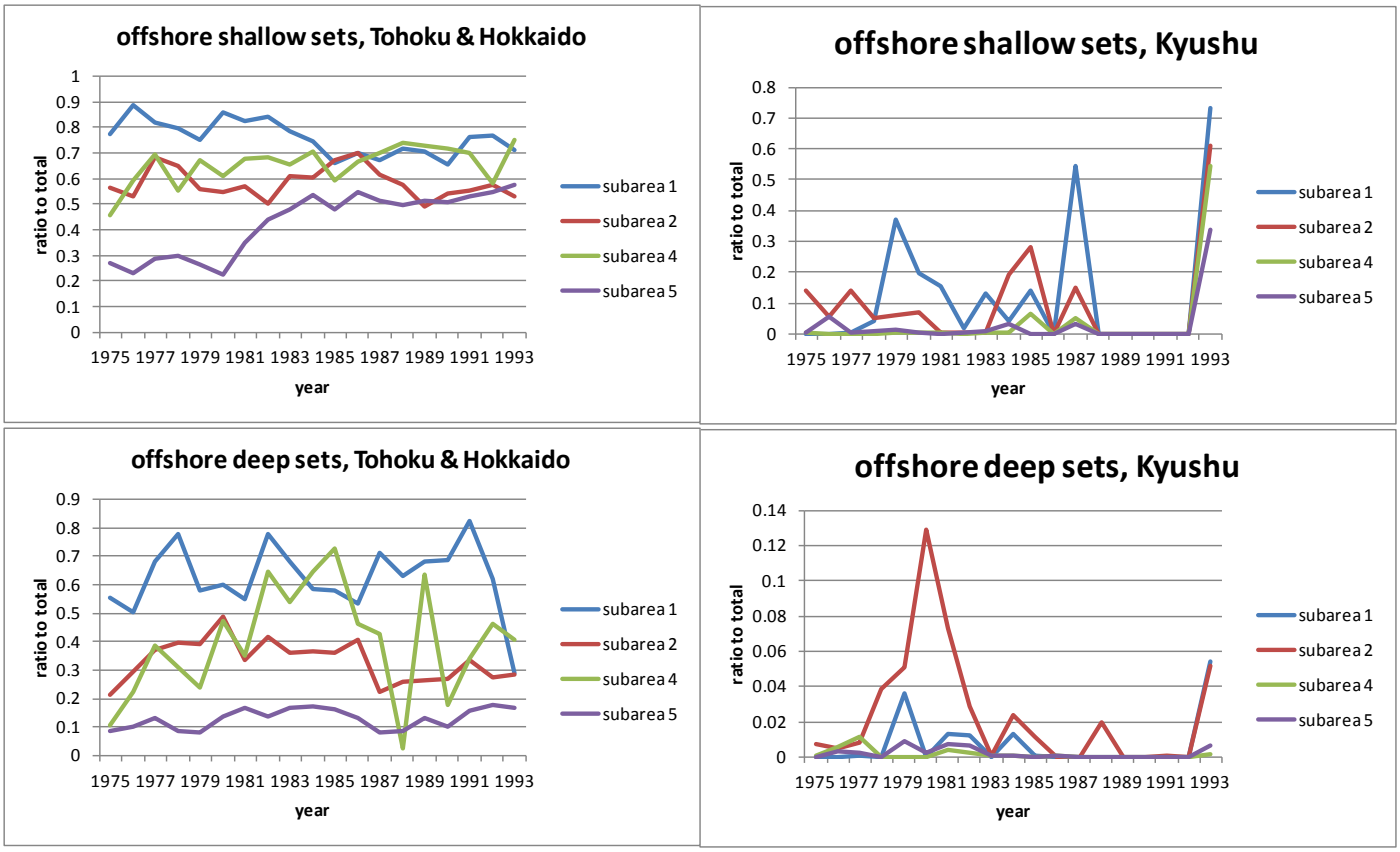

Fig. 13. Ratio of catch number of sharks to the sum of sharks, tunas, marlins and swordfish of the shallow sets of Japanese offshore longliners registered in Tohoku and Hokkaido regions by subarea, and Kyushu region (upper panels) and those for deep sets (lower panels).

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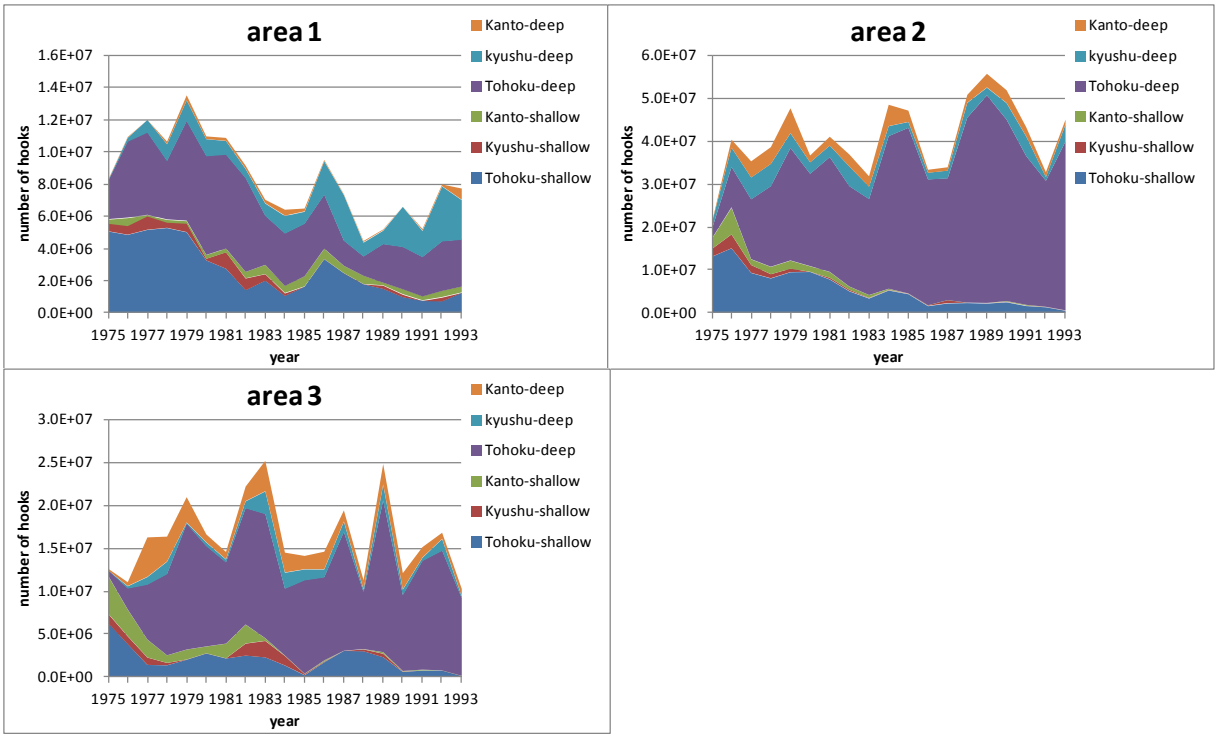

Fig. 14. Amount of effort of shallow and deep sets by area of Japanese distant-water longliners registered in Tohoku (including Hokkaido), Kyushu region and Kanto regions.

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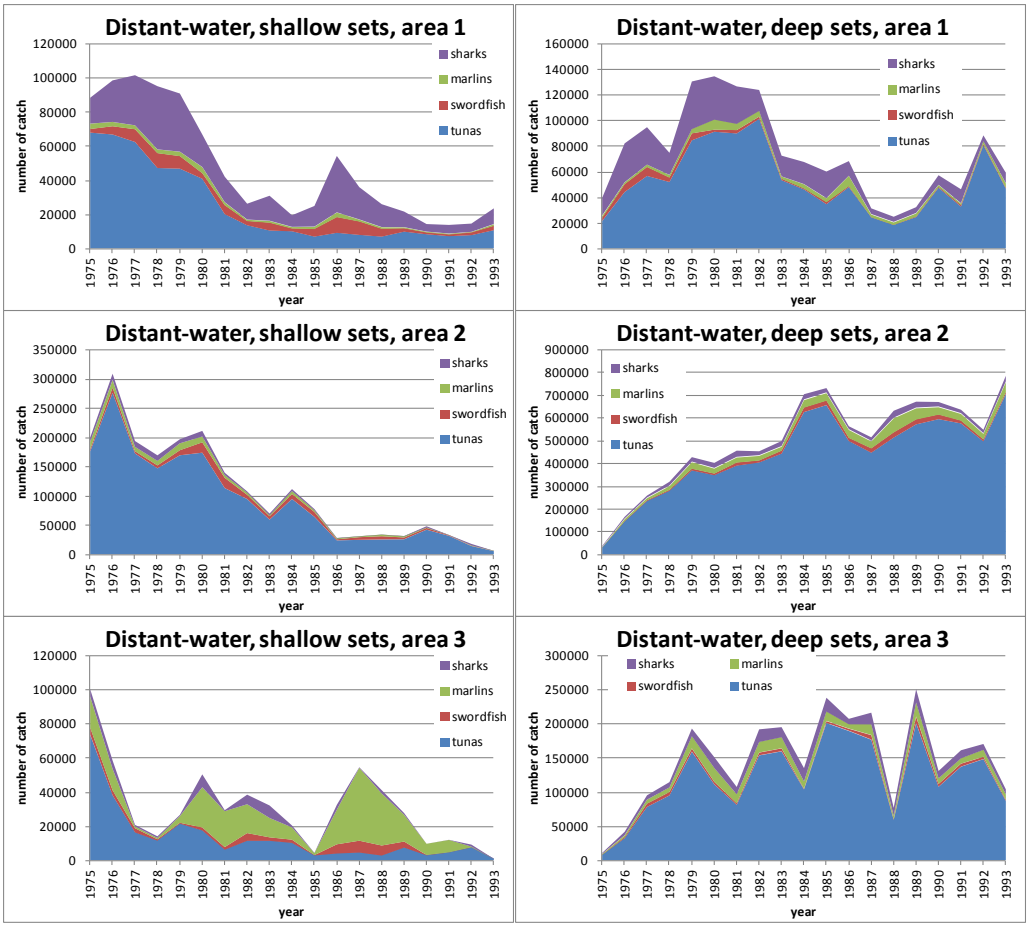

Fig. 15. Catch composition of distant-water longliners registered in the Tohoku and Hokkaido regions, by area and by gear type in the period between 1975 and 1993. Tunas indicate the aggregated catch number of Pacific bluefin tuna, bigeye tuna, yellowfin tuna and albacore, and marlins indicate the aggregated catch number of blue marlin, black marlin, sailfish and spearfish.

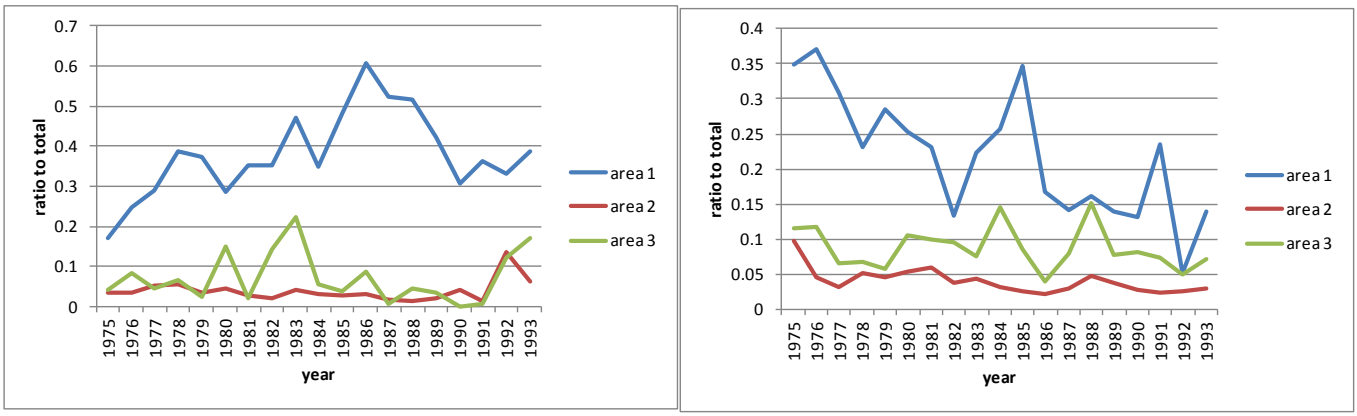

Fig. 16. Ratio of catch number of sharks to the sum of sharks, tunas, swordfish and marlins caught by Japanese offshore longliners registered in the Tohoku and Hokkaido regions, in the period of 1975 and 1993, by area and by gear type.

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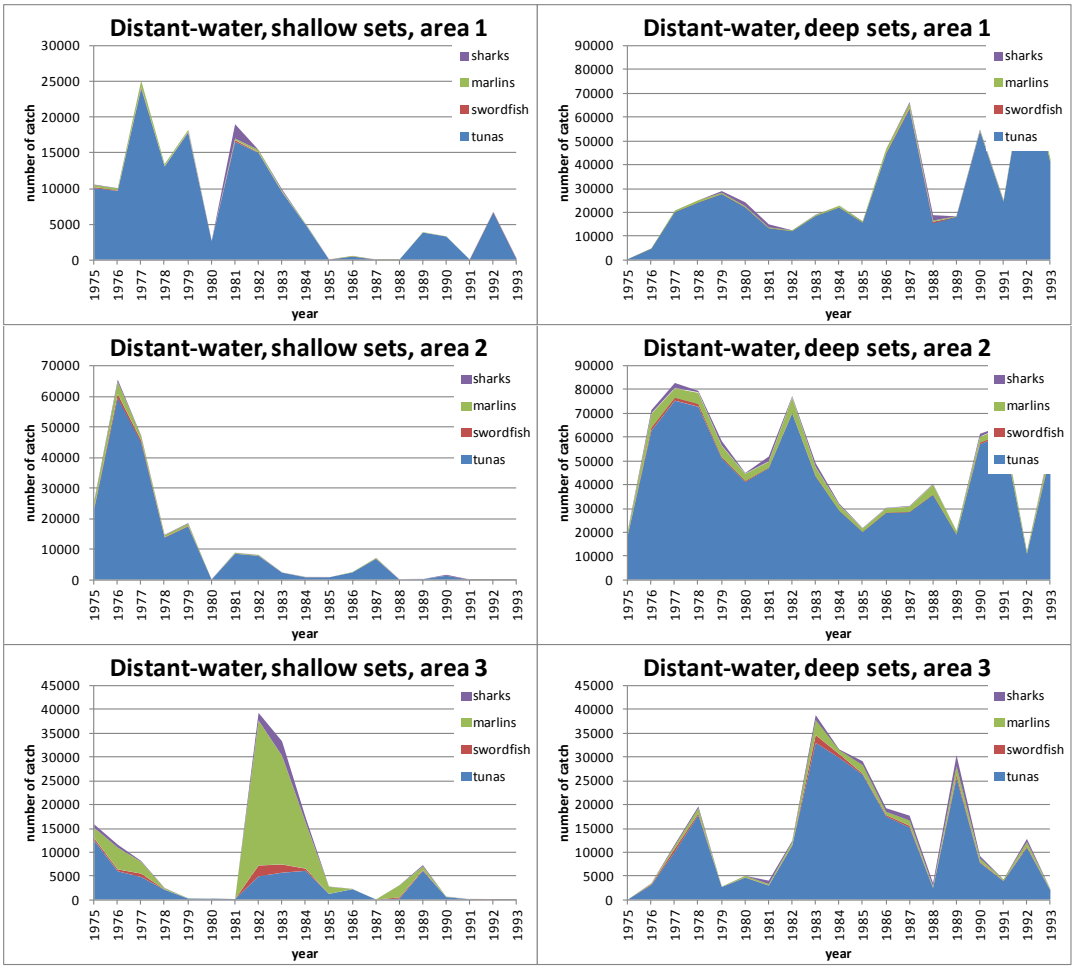

Fig. 17. Catch composition of distant-water longliners registered in the Kyushu region, by area and by gear type in the period between 1975 and 1993. Tunas indicate the aggregated catch number of Pacific bluefin tuna, bigeye tuna, yellowfin tuna and albacore, and marlins indicate the aggregated catch number of blue marlin, black marlin, sailfish and spearfish.

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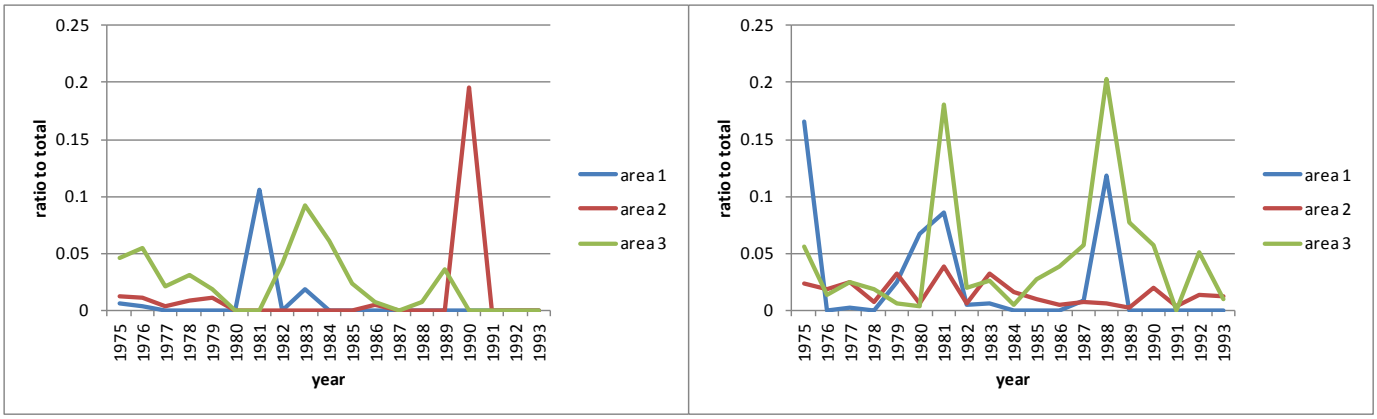

Fig. 18. Ratio of catch number of sharks to the sum of sharks, tunas, swordfish and marlins caught by Japanese offshore longliners registered in the Kyushu region, in the period of 1975 and 1993, by area and by gear type.

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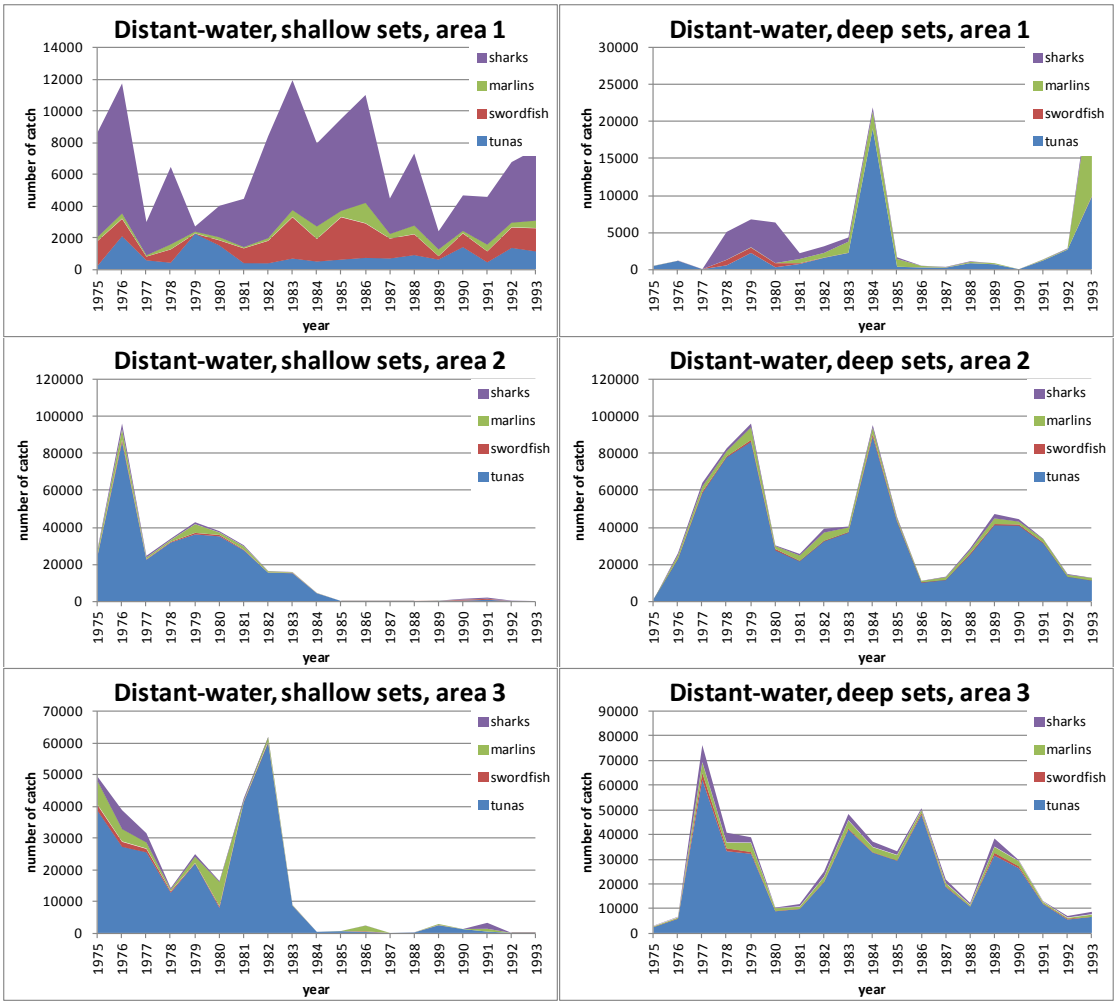

Fig. 19. Catch composition of distant-water longliners registered in the Kanto region, by area and by gear type in the period between 1975 and 1993. Tunas indicate the aggregated catch number of Pacific bluefin tuna, bigeye tuna, yellowfin tuna and albacore, and marlins indicate the aggregated catch number of blue marlin, black marlin, sailfish and spearfish.

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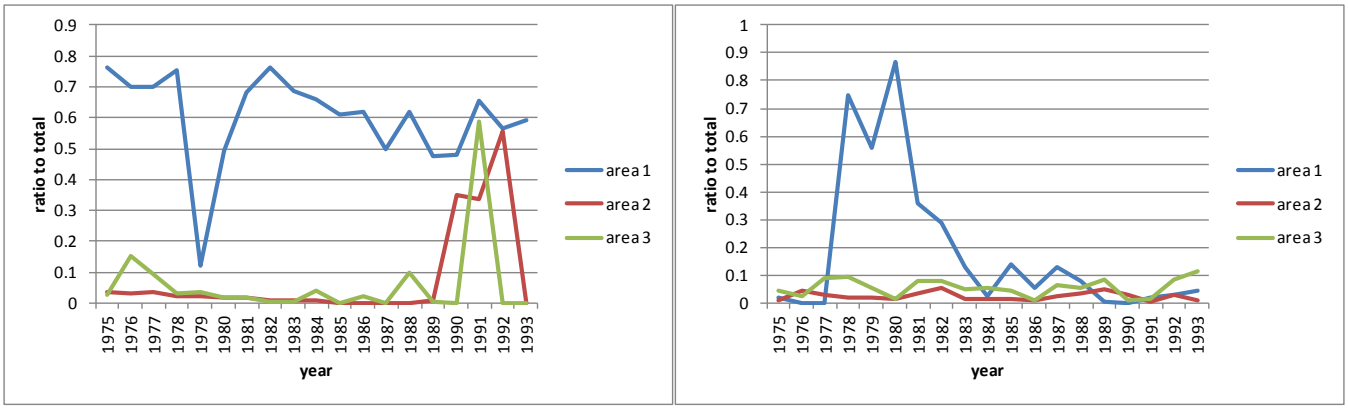

Fig. 20. Ratio of catch number of sharks to the sum of sharks, tunas, swordfish and marlins caught by Japanese offshore longliners registered in the Kanto region, in the period of 1975 and 1993, by area and by gear type.

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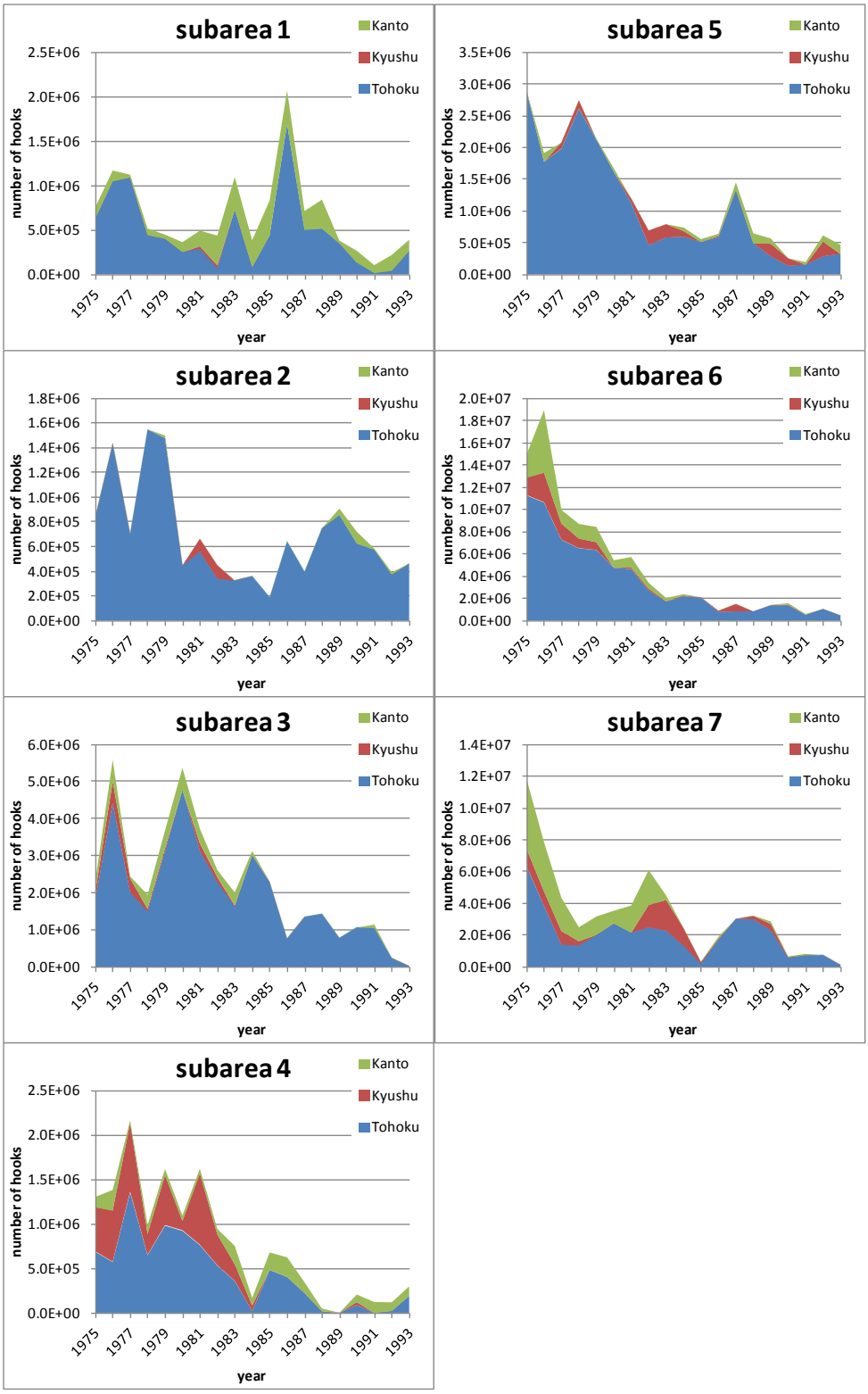

Fig. 21. Amount of effort of shallow sets of distant-water longliners registered in Tohoku (including Hokkaido), Kyushu and Kanto regions by subarea.

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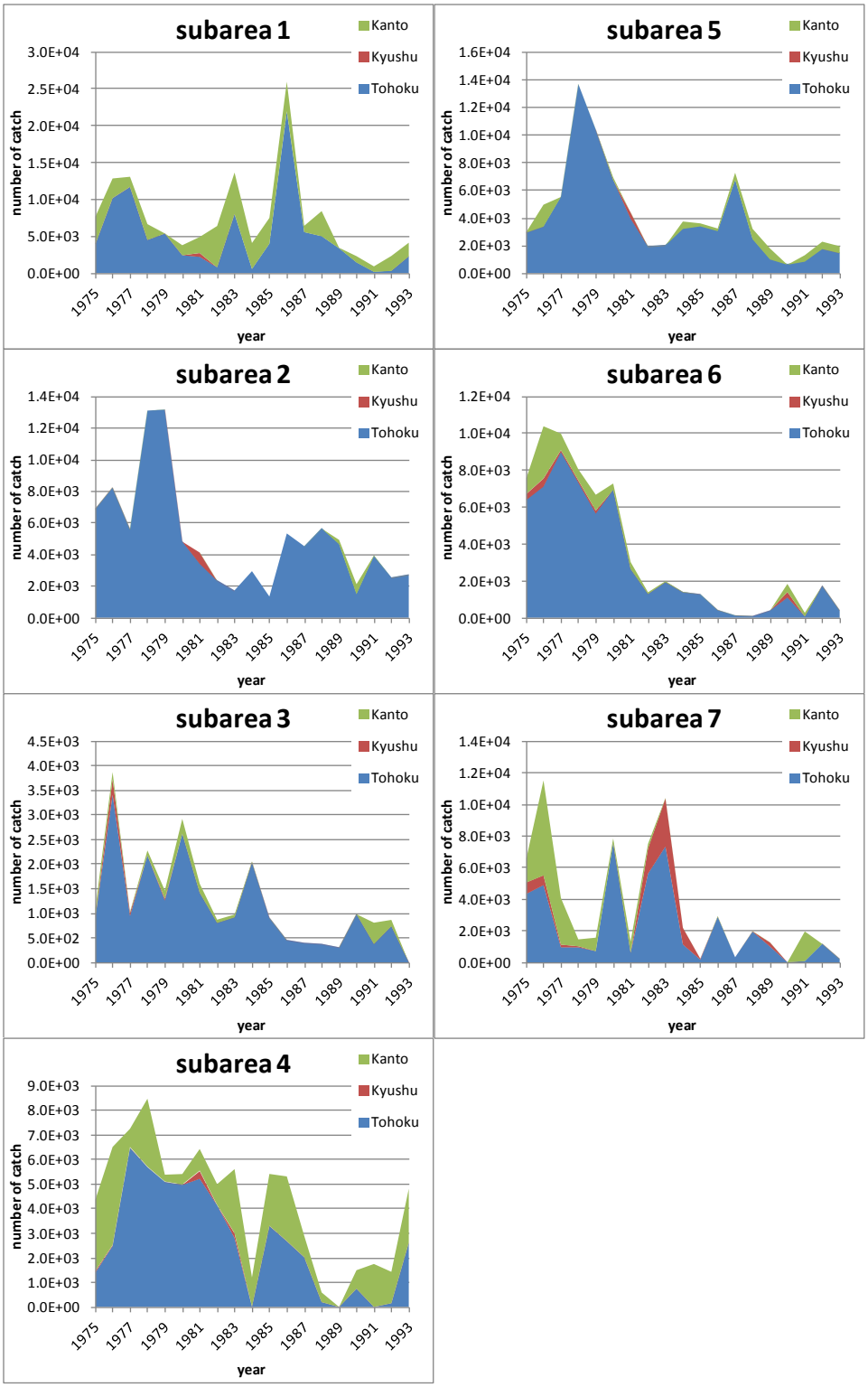

Fig. 22. Number of sharks catches of shallow sets of distant-water longliners registered in Tohoku (including Hokkaido), Kyushu and Kanto regions by subarea.

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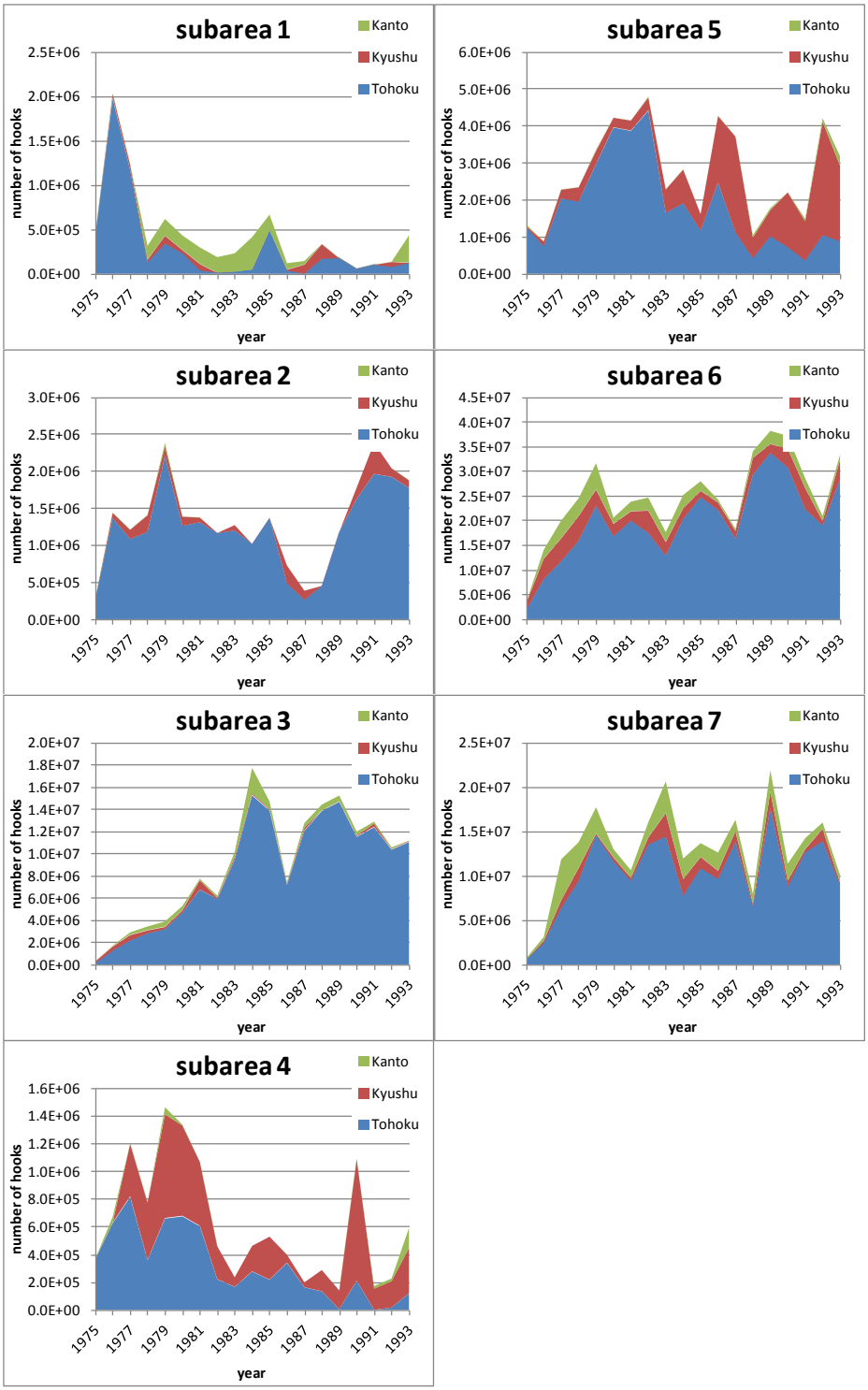

Fig. 23. Amount of effort of deep sets of distant-water longliners registered in Tohoku (including Hokkaido), Kyushu and Kanto regions by subarea.

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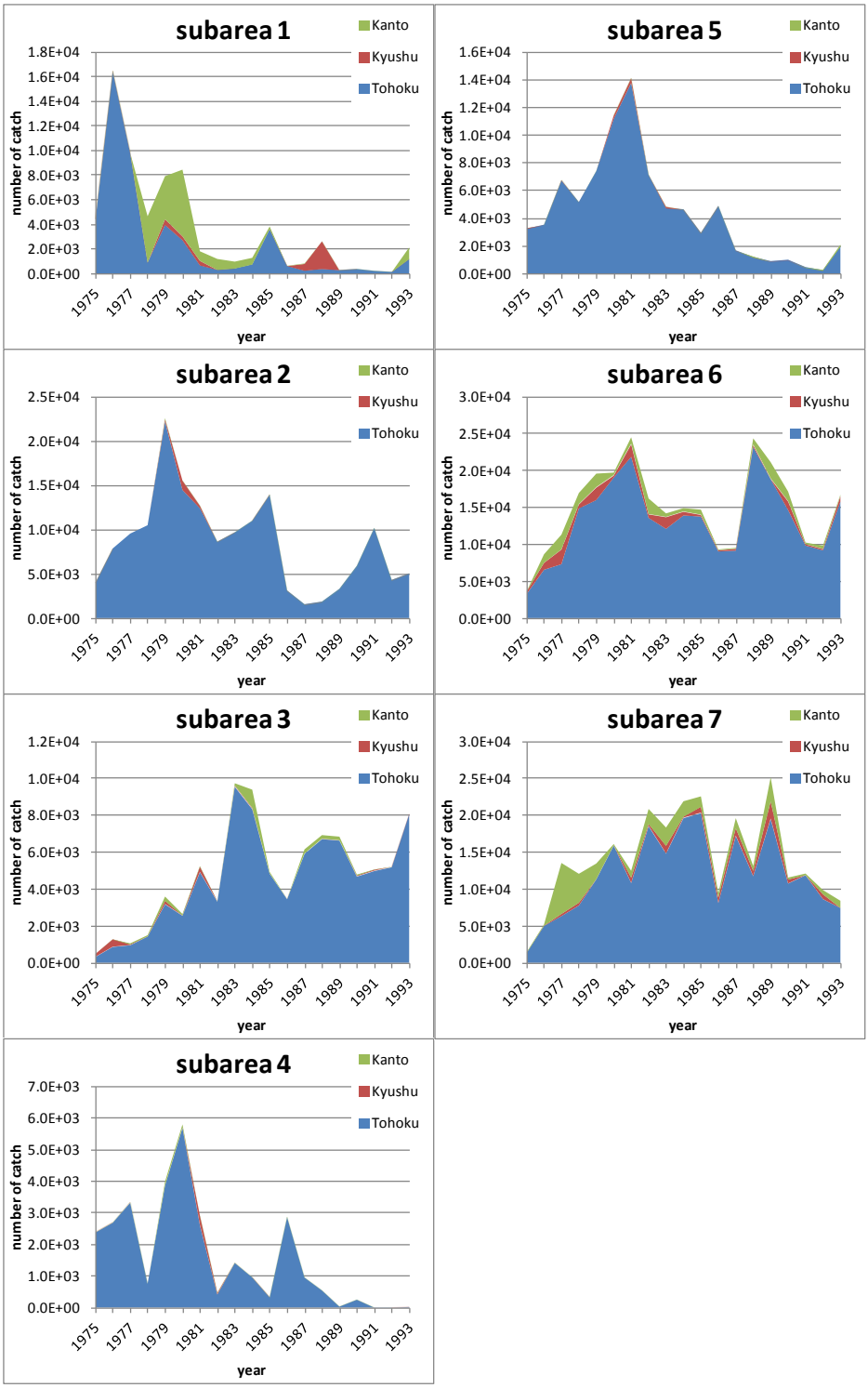

Fig. 24. Number of sharks catches of deep sets of distant-water longliners registered in Tohoku (including Hokkaido), Kyushu and Kanto regions by subarea.

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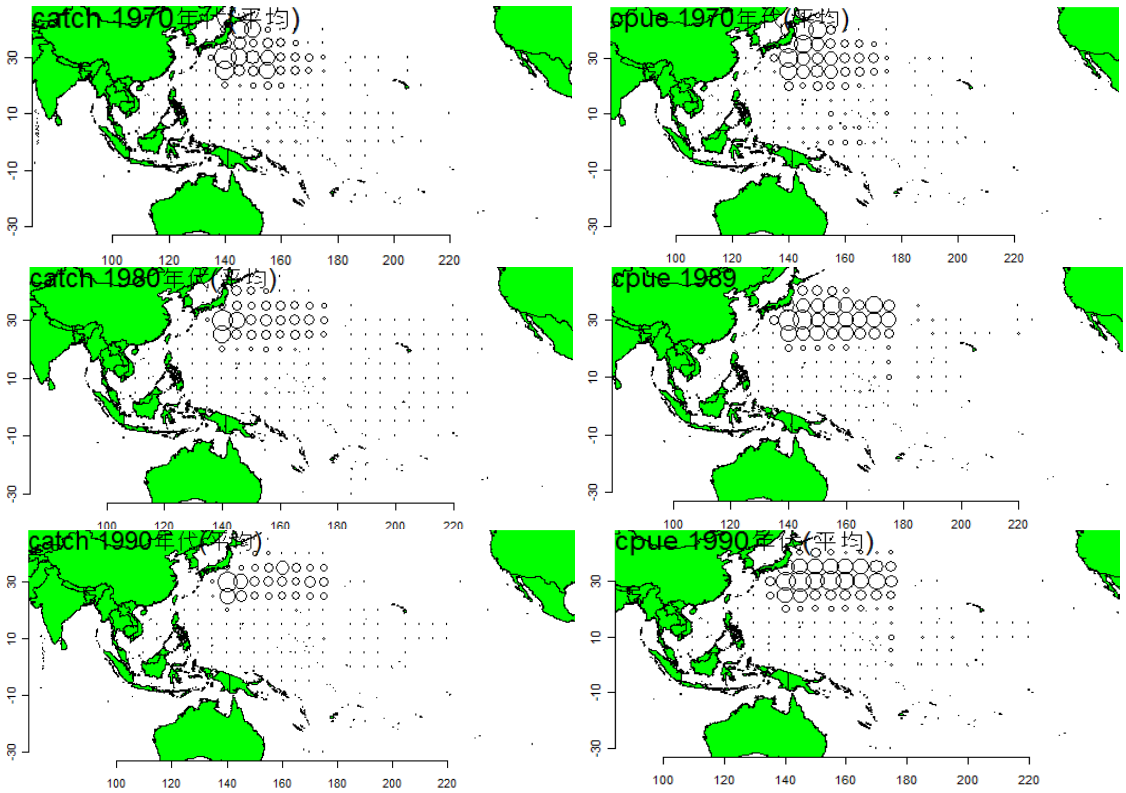

Fig. 25. The average catch number and CPUE distribution of sharks caught by Japanese offshore longliners in the periods of 1975 – 1979, 1980 – 1989, and 1990 – 1993.

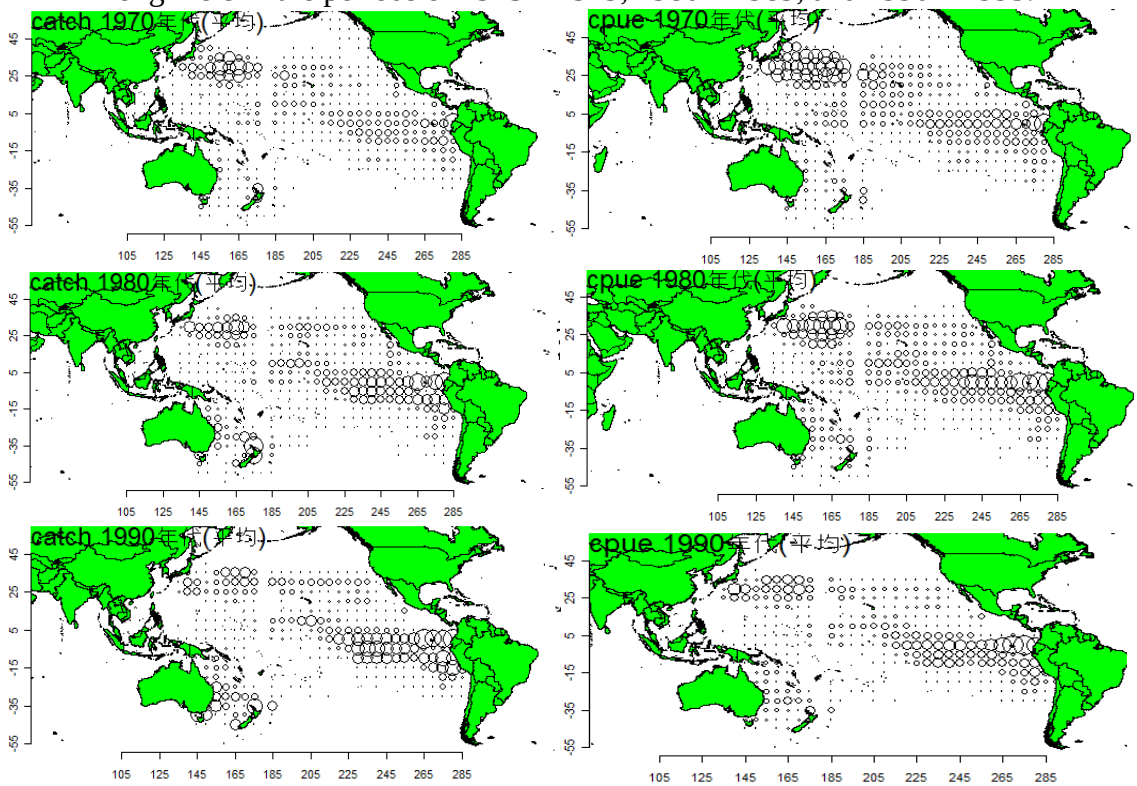

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Fig. 26. The average catch number and CPUE distribution of sharks caught by Japanese distant-water longliners in the periods of 1975 – 1979, 1980 – 1989, and 1990 – 1993.

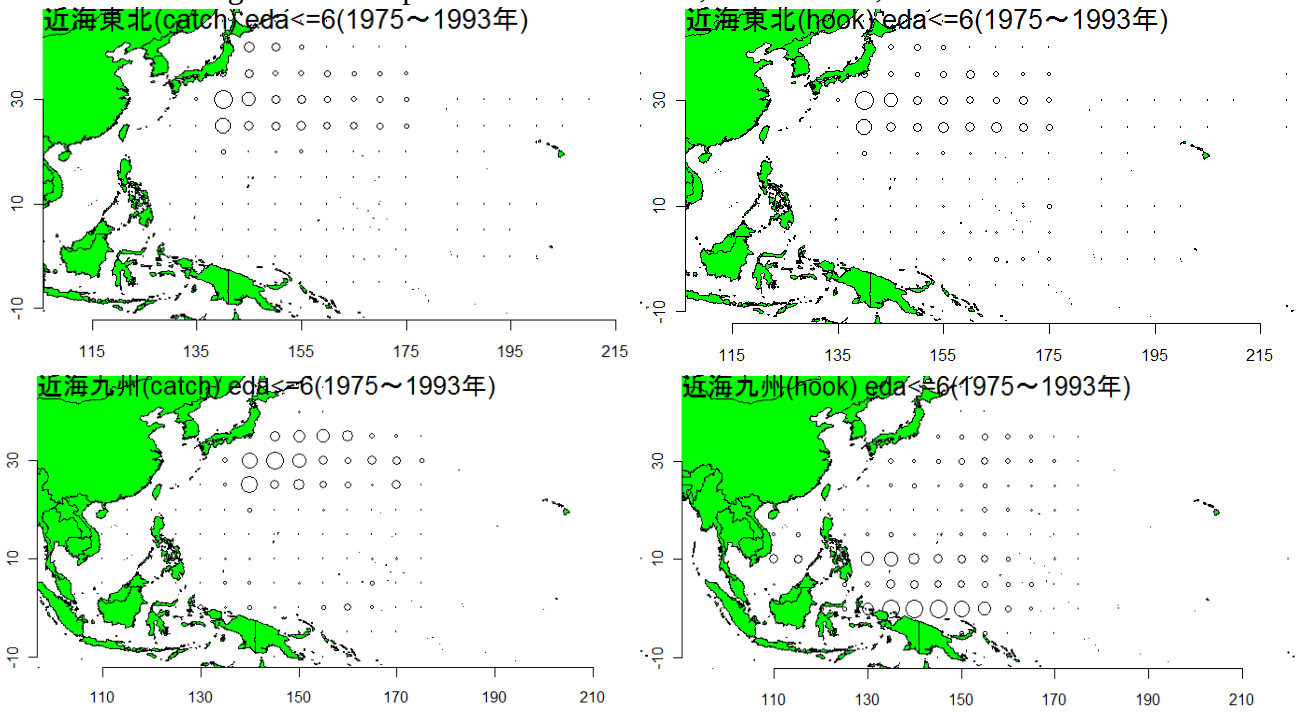

Fig. 27. The average catch number and amount of effort (number of hooks) distribution of sharks in the period of 1975 - 1993 caught by shallow sets (HPB<7)) of Japanese offshore longliners registered in Tohoku (upper panels) and Kyushu (lower panels) regions.

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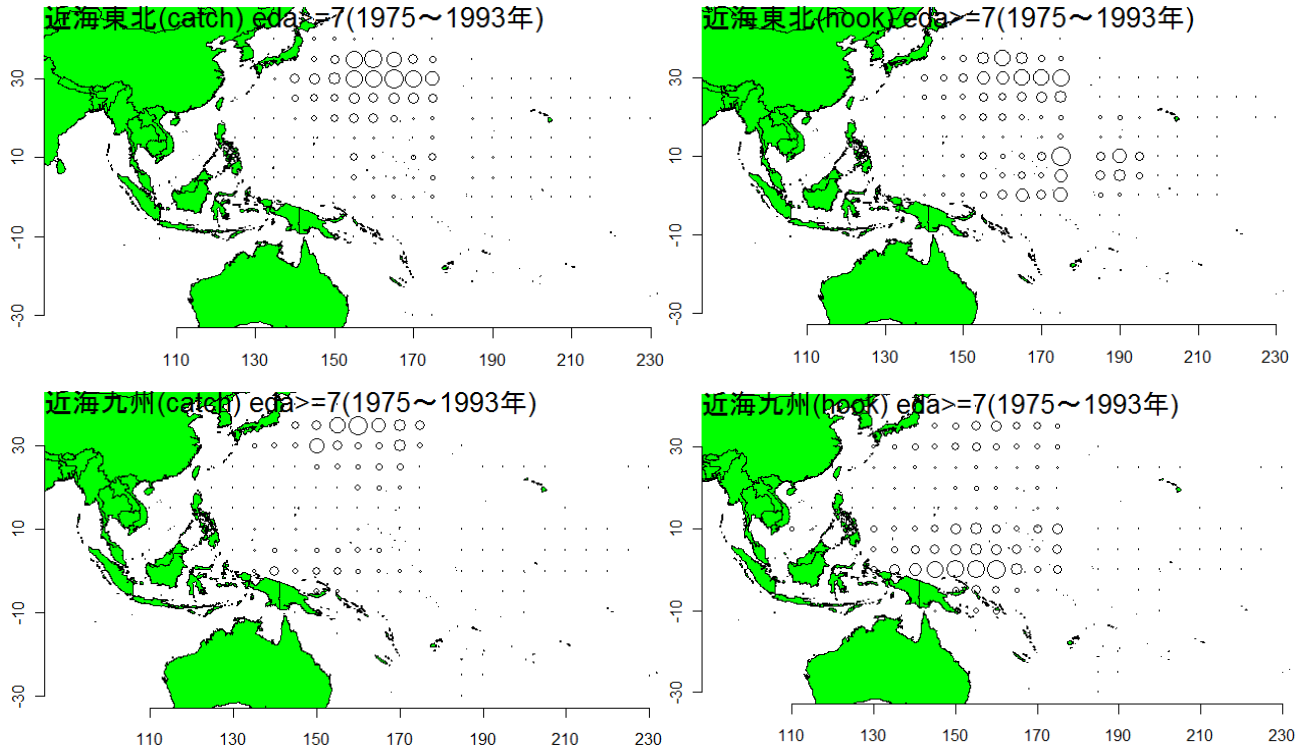

Fig. 28. The average catch number and amount of effort (number of hooks) distribution of sharks in the period of 1975 - 1993 caught by deep sets (HPB>6) of Japanese offshore longliners registered in Tohoku (upper panels) and Kyushu (lower panels) regions.

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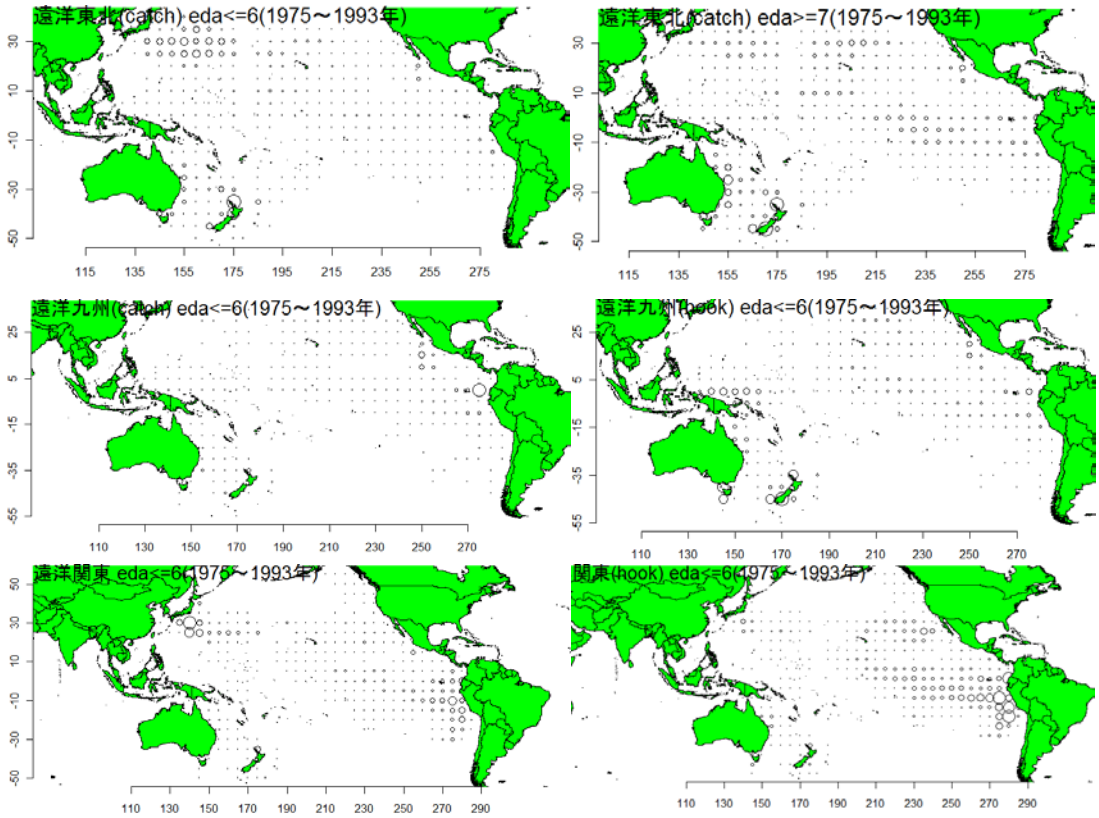

Fig. 29. The average catch number and effort (number of hooks) of sharks in the period of 1975 – 1993 caught by shallow sets (HPB<7) of Japanese distant-water longliners registered in the Tohoku (upper), Kyushu (middle), and Kanto (lower) regions.

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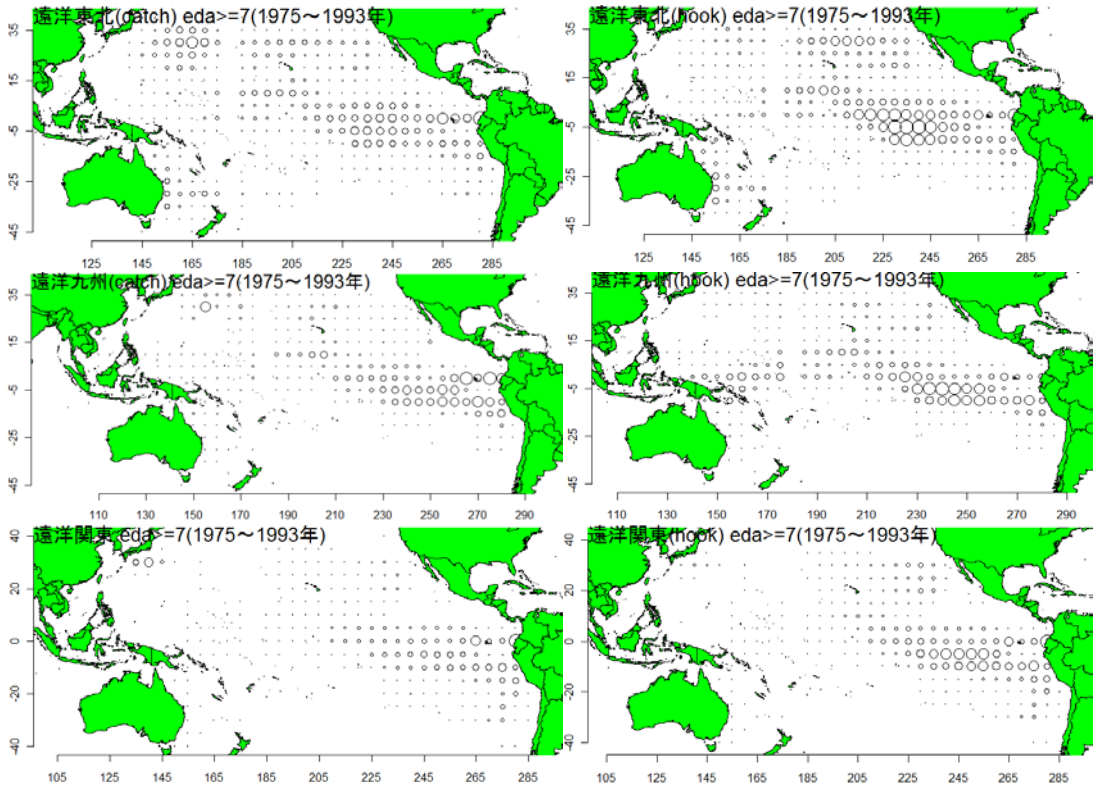

Fig. 30. The average catch number and effort (number of hooks) of sharks in the period of 1975 – 1993 caught by deep sets (HPB>6) of Japanese distant-water longliners registered in the Tohoku (upper), Kyushu (middle), and Kanto (lower) regions.

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