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Preliminarily analysis for target species of Japanese longline fishery operated in the North Pacific Ocean

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SUMMALY

In order to understand the target species of Japanese longline fishery in the Pacific Ocean from 1993 to 2002, we investigated historical changes of (1) species composition (albacore, bigeye and yellowfin) of the fishery, (2) distribution of number of fish per set using operational logbook data and (3) market price in Japanese fishing ports, and amount of import. Four pieces of evidence revealed the operation of targeting albacore of Japanese longline fishery in the North Pacific Ocean increased in this period from 1993 to 2002. First, the historical trend for species composition represented the proportion for albacore was high and the proportion for bigeye was low in this period. Second, elongation of fishing season for albacore of the large vessel occurred for the large vessel, which had been often observed before 1970 when the fishery mainly targeted albacore. Third, the proportion of zero catch and more than 100 fish per set for albacore of the large vessel was lower and very high, respectively. Such high proportion was also observed before 1970. The last one, the total quantity demanded for albacore and bigeye increased and decreased, respectively.

1. INTRODUCTION

Standardized CPUE for albacore caught by Japanese longline fishery in the North Pacific Ocean increased and decreased in 1990s (from 1992 to 2002), and the stock assessment model cannot explain this trend. Therefore further exploration of Japanese longline CPUE was recommended in the last stock assessment (Anonymous ISC 2011). To address the point, we focus on historical changes of target species of the fishery. If albacore had been targeted in 1990s by Japanese longline, nominal CPUE could be high and then the standardized CPUE might be biased without consideration for targeting effect.

Japanese fishermen of longline with large vessel (larger than 20 gross register tonnages (GRT)) had generally targeted albacore until early 1970s, and then they changed their target species as bigeye in tandem with the penetration of deep setting and nylon for material of main and branch line. After that the main target species was not seen as not having largely changed. However consistent increasing of albacore catch by Japanese longline fishery since 1990 in the Indian Ocean (Matsumoto 2012) and increasing trend with some fluctuation since 1995 in the Atlantic Ocean (Anonymous ICCAT 2012a) indicate changing of target species of the fishery after 1990s.

For small vessel (10-19 GRT), it is difficult to descript historical target species before 1993 due to lack of logbook. However we try to review typical fishing schedule and target species. Application of deep setting and nylon for line material seems to have smaller impact on changing target species rather than large vessel. The small vessels have changed target species seasonally and opportunistically as albacore, yellowfin, bigeye and bluefin. They target albacore in 1st quarter and then move to bluefin, and stop fishing from June to August. They resume fishing in September to catch bigeye in eastern area of the North Pacific Ocean (35 to 40 N, from coast line of Japan to 160 E). The fishing season for bigeye continue to December or early January. They also catch yellowfin in coastal area from late spring to summer. There should be many exemptions for the typical schedule. For example, some vessels go to tropical area year-round and catch tropical tuna, and smaller sized vessels tend to operate in coastal area and target albacore, and some vessels catch albacore in southern part of the eastern area in 4th quarter in recent years.

In order to understand the target species of Japanese longline fishery in the Pacific Ocean from 1993 to 2002, we investigated historical changes of (1) species composition (albacore, bigeye and yellowfin) of the fishery, (2) distribution of number of fish per set using operational logbook data and (3) market price in Japanese fishing ports, and amount of import.

2. MATERIALS AND METHODS

In this paper, two kinds of data were mainly used. One is the Annual Report of Catch Statistic on Fishery and Aquaculture published by the Statistics and Information Department, Ministry of Agriculture, Forestry and Fisheries (SID report). This report provides comprehensive statistic for Japanese fisheries including catch, number of vessel, and market price by species. The amount of catch by species from 1970 and the market prices from 1977 were used. The market price is based on information from large number of fishing port (155 ports in 2011). The other is logbook database which has been compiled at National Research Institute of Far Seas Fisheries (NRIFSF) based on the logbook mandatory submitted by fishermen. The databases for LL vessels larger than 20 GRT (large vessel) and for LL of 10-19 GRT (small vessel) are available for 1952-2011 and 1994-2011, respectively. The coverage rates of logbooks for large and small vessel were near 100% and about 70%, respectively (Matsumoto et al. 2013). In this document, the catch in number and effort was not raised for small vessel. For the species composition analysis the Japanese longline catch and effort statistics from 1952 up to 2011 were used. The amounts of catch by species (albacore yellowfin and bigeye) in this document are estimated by same procedure documented in Satoh et al (2012) using SID report and logbook database. We used trade statistics of Japan Ministry of Finance for amount of import of frozen albacore, yellowfin and bigeye from 1988 (http://www.customs.go.jp/toukei/info/). All statistics except for trade statistics for 2011 and 2012 in this report were preliminary.

3. RESULTS AND DISCUSSIONS

3.1. Species composition

The number of large longline vessel and the number of hooks had decreased consistently since 1994 (**Fig. 1**). On the other hand, the number of small vessel and the number of hooks had slightly increased since 1994. The fishing ground for the large vessel distribute all over the world including the North Pacific Ocean, small vessels operate in the vicinity of Japan (**Appendices 1, 2**). The proportion of effort for the large vessel by sea area (the Atlantic Ocean, the Indian Ocean, North Pacific Ocean (10-40N) and other part of the Pacific Ocean) indicated that the proportion for the North Pacific Ocean did not change from 1993 to 2002 (**Fig. 2**) and shifting of effort from other area to the north Pacific was not clear. Therefore we should focus on the North Pacific Ocean.

The amount of albacore was higher from 1993 to 2002 for the both vessel type (**Fig. 3**). The amount of bigeye and yellowfin decreased in the same period for the both vessel type. The historical trend for species composition for the both vessel type represented complementary relationship between albacore and bigeye (**Fig. 4**). In this period with higher albacore CPUE, the proportion for albacore was high and the proportion for bigeye was low.

In this period (from 1993 to 2002) the relatively large catch of albacore for the large vessel was detected in 2nd and 3rd quarter, whereas catches for bigeye and yellowfin in the same season did not occur (**Fig. 5**). Such elongation of fishing season for albacore often occurred before 1970 when the fishery mainly targeted albacore. For the small vessel, there was no large difference between the period from 1993 to 2002 and after 2003(**Fig. 6**), partially because the catch of albacore for the small vessel remained much higher since 1994 (**Fig. 3**).

3.2. Number of fish per set

The proportion of zero catch (zero fish per set) for albacore of large vessel from 1993 to 2002 was lower than other years especially in 2nd and 3rd quarter (**Fig. 7**). The proportion of medium catch, more than one fish to less than 20 fish per set, did not change between the period (1993 to 2002) and other years. The proportion for large catch, more than 20 fish to less than 100 fish per set, increased in this period in all four quarters. The proportion for more than 100 fish per set in this period drastically increased in main fishing season (1st and 4th quarter). Such high proportion was also observed before 1970. For bigeye and yellowfin in this period (**Figs. 8, 9**), the proportions of zero catch per set increased and the proportion of medium catch (>=1 and <20 fish per set) decreased. Same analysis was applied for the small vessel (**Figs. 10-12**), the proportion for more than 100 fish per set from 1994 to 2002 in 1st quarter was larger than after 2003, and the zero catch for yellowfin increased and the proportion for medium catch (>=1 and <20 fish per set) decreased.

3.3. Market price and amount of import

Market prices (yen kg^{-1}) for fresh and frozen albacore in this period from 1993 to 2002 showed stable, for fresh albacore was from 331 yen kg^{-1} in 1993 to 278 yen kg^{-1} in 2002 (**Fig. 13**). The prices for fresh bigeye was 1,609 (yen kg^{-1}) in 1993 and then decreased to 1,006 (yen kg^{-1}) in 2002, which is about 40% discount. The products of the market price and amount of catch are total value of albacore and bigeye, which is roughly considered as total quantity demanded for these species. The main usages for albacore and bigeye are for canning and sashimi, respectively, thus it is questionable that albacore can replace bigeye straightforward. However in this period the total quantity demanded for albacore and bigeye increased and decreased, respectively (**Fig. 14**). Japan had experienced long business depression in this period, therefore Japanese consumer may tend to select more reasonable tuna under the tight economic times. Total catch for these tuna species by Japanese fishery, including longline, purse seine, pole and-line, etc, revealed decreasing of amounts of catch for bigeye and yellowfin. Total amount of import for frozen yellowfin showed downward trend from 1994 to 1999. In addition, unfortunately we cannot detect statistics of import for bigeye in this period (**Fig. 15**). Therefore the decreasing of demand for bigeye could be derived from shortage in supply for bigeye, and the shortage was not adequately filled with yellowfin, thus albacore should partially compensate the deficiency of bigeye in this period.

The directivity for albacore could be induced by shortage of supply of bigeye around 1992, where stock status of bigeye had become worse in many areas (**Appendices 3-6**, WCPO; Davies et al (2011), EPO; Aires-da-Silva and Maunder (2012b), IDO; Nishida and Rademeyer (2011), ATL; Anonymous (ICCAT 2012b)). The first choice for the replacement may be yellowfin, however amount of catch for yellowfin of Japanese fishery and amount of import did not increase in this period. Their stock status in early 1990 had become worse or was stable (**Appendices 7-10**, WCPO; Langley et al (2011), EPO; Aires-da-Silva and Maunder (2012a), IDO; Langley et al (2012), ATL; Anonymous (ICCAT 2011a)). Just at that time stock size of the North Pacific albacore had start to increase, which leaded to high availability of albacore. The good catch of albacore did not result in falling down of their market price due to weak supply of bigeye and yellowfin. The stable market price of albacore is sufficient reason for Japanese fishermen to continue to target albacore.

In summary, four pieces of evidence revealed the operation of targeting albacore of Japanese longline fishery in the North Pacific Ocean increased in this period from 1993 to 2002. First, the historical trend for species composition represented the proportion for albacore was high and the proportion for bigeye was low in this period. Second, elongation of fishing season for albacore of the large vessel occurred for the large vessel, which had been often observed before 1970 when the fishery mainly targeted albacore. Third, the proportion of zero catch and more than 100 fish per set for albacore of the large vessel was lower and very high, respectively. Such high proportion was also observed before 1970. The last one, the total quantity demanded for albacore and bigeye increased and decreased, respectively.

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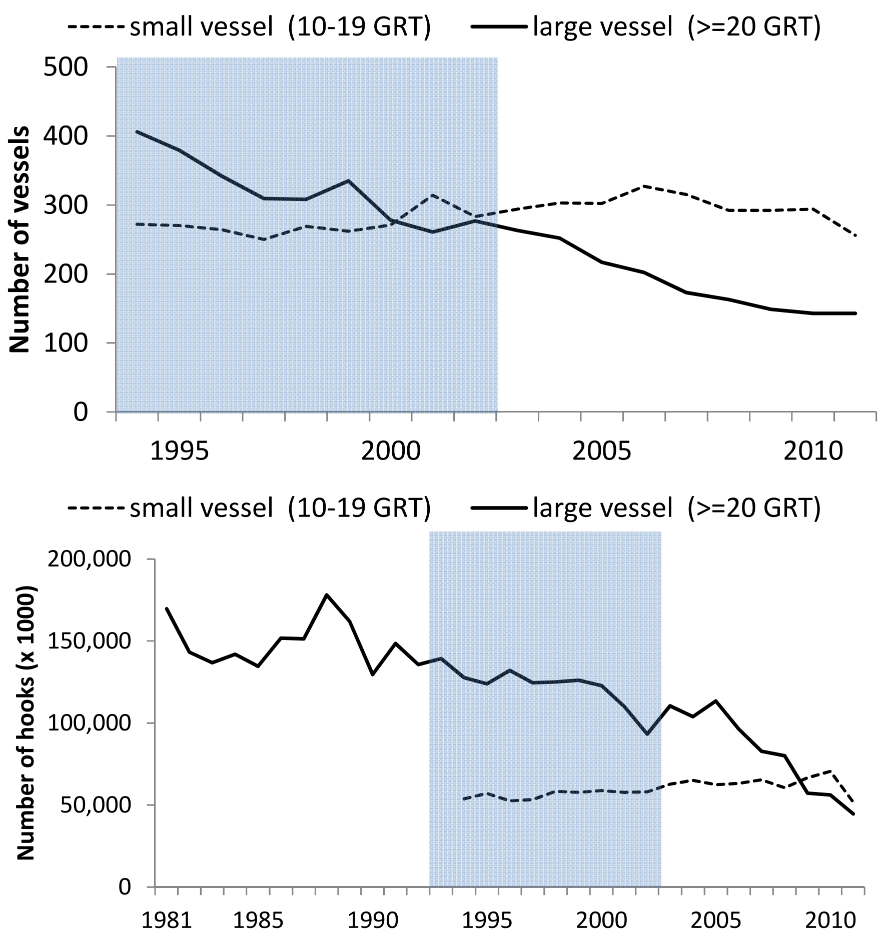


Fig. 1 Historical changes of number of active vessel (upper) and number of hooks (lower) by vessel size of Japanese longline in the North Pacific Ocean. The period with higher CPUE represent blue shaded area.

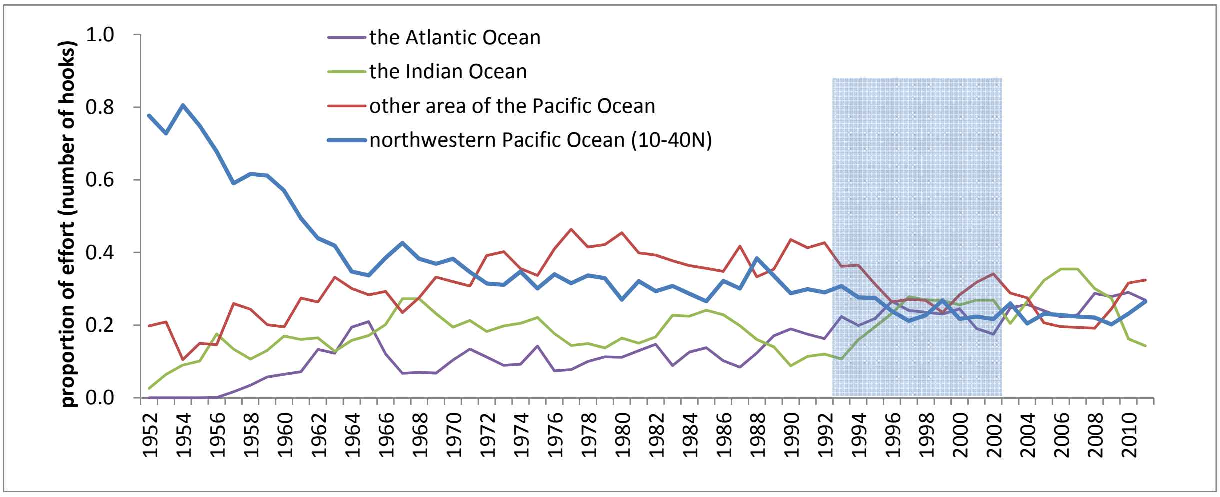


Fig. 2 Historical changes of proportion of effort (number of hooks) by Ocean and area. The period with higher CPUE represent blue shaded area.

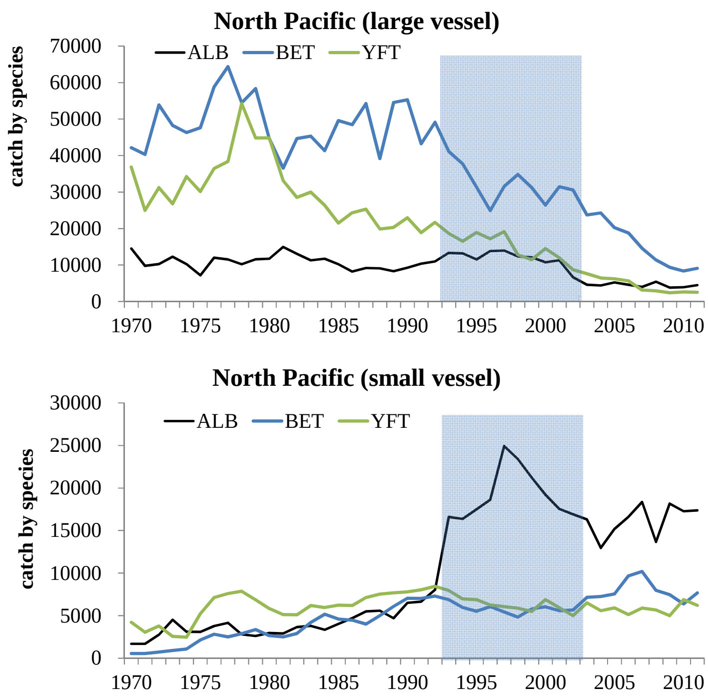


Fig. 3 Amount of catch (ton) by species of Japanese longline operated in the North Pacific Ocean. Upper panel for large vessel (distant water + offshore water, >=20GRT), lower panel for small vessel (coastal water, 10-19 GRT). The period with higher CPUE represent blue shaded area.

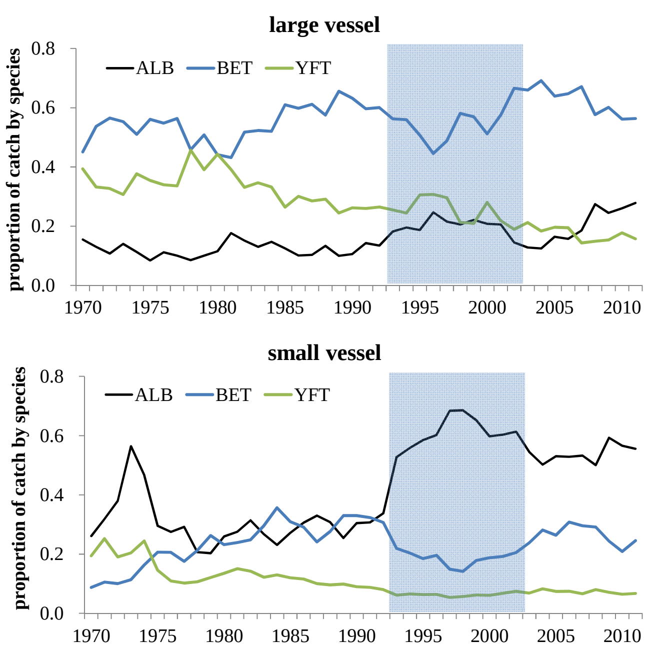


Fig. 4 Proportion of amount of catch by species of Japanese longline operated in the North Pacific Ocean. Upper panel for large vessel (distant water + offshore water; >=20GRT), lower panel for small vessel (coastal water, 10-19 GRT). The period with higher CPUE represent blue shaded area.

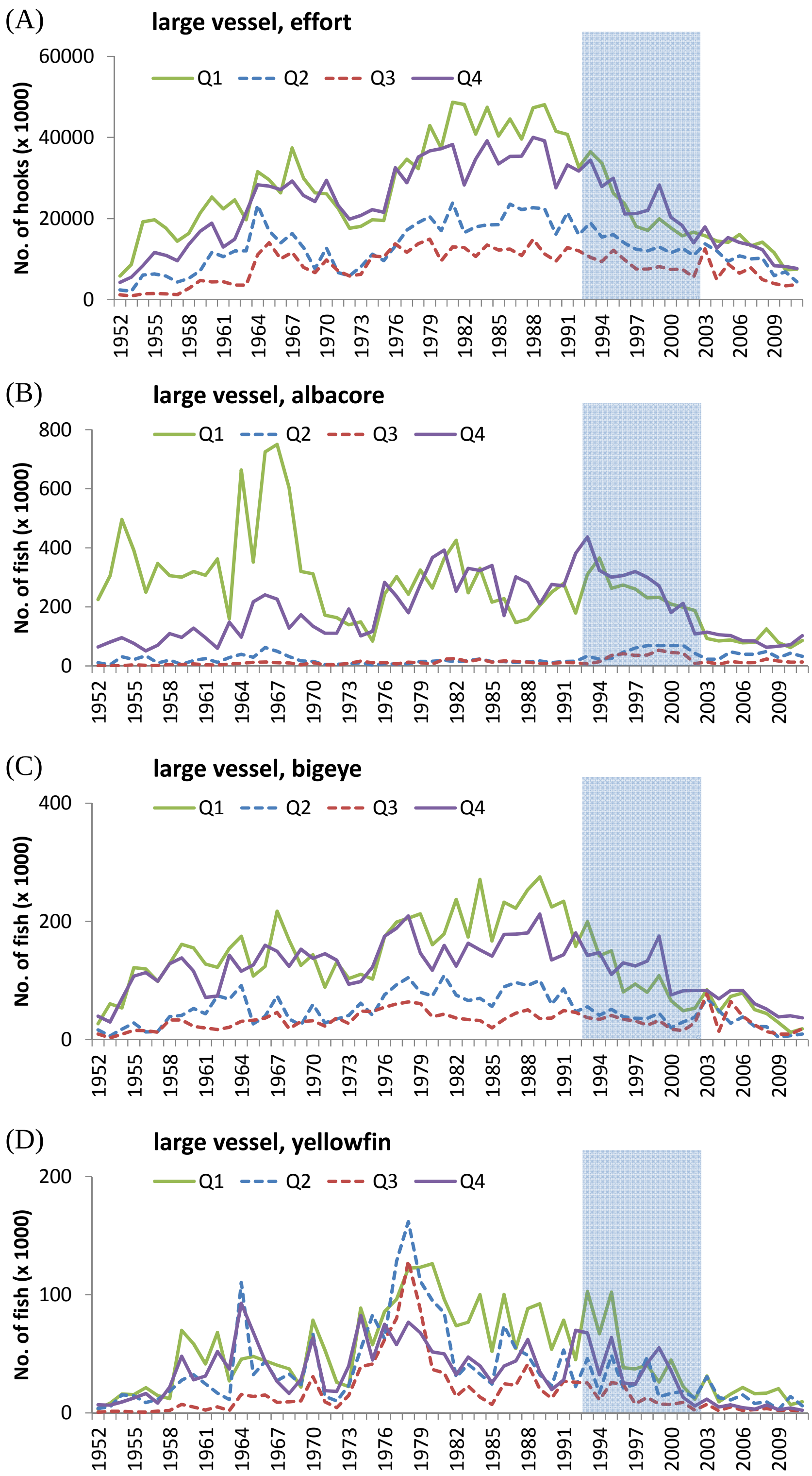


Fig. 5 Historical changes of **effort** (A; number of hooks (x1000)), (B) **albacore**, (C) **bigeye** and (D) **yellowfin** by quarter caught by Japanese **large longline vessel** in the North Pacific Ocean (10-40N). The period with higher CPUE represent blue shaded area.

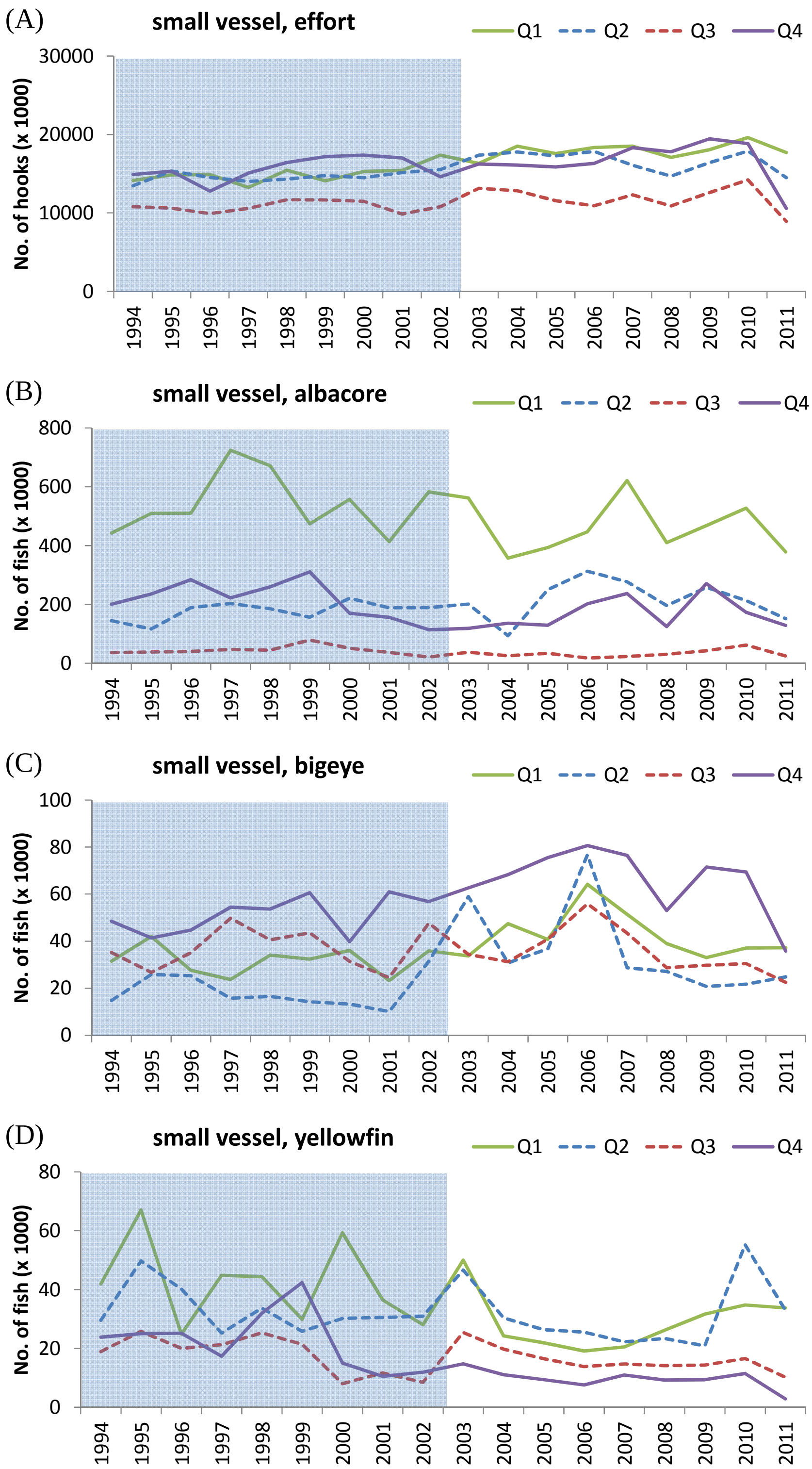


Fig. 6 Historical changes of **effort** (A; number of hooks (x1000)), (B) **albacore**, (C) **bigeye** and (D) **yellowfin** by quarter caught by Japanese **small longline vessel** in the North Pacific Ocean (10-40N). The period with higher CPUE represent blue shaded area.

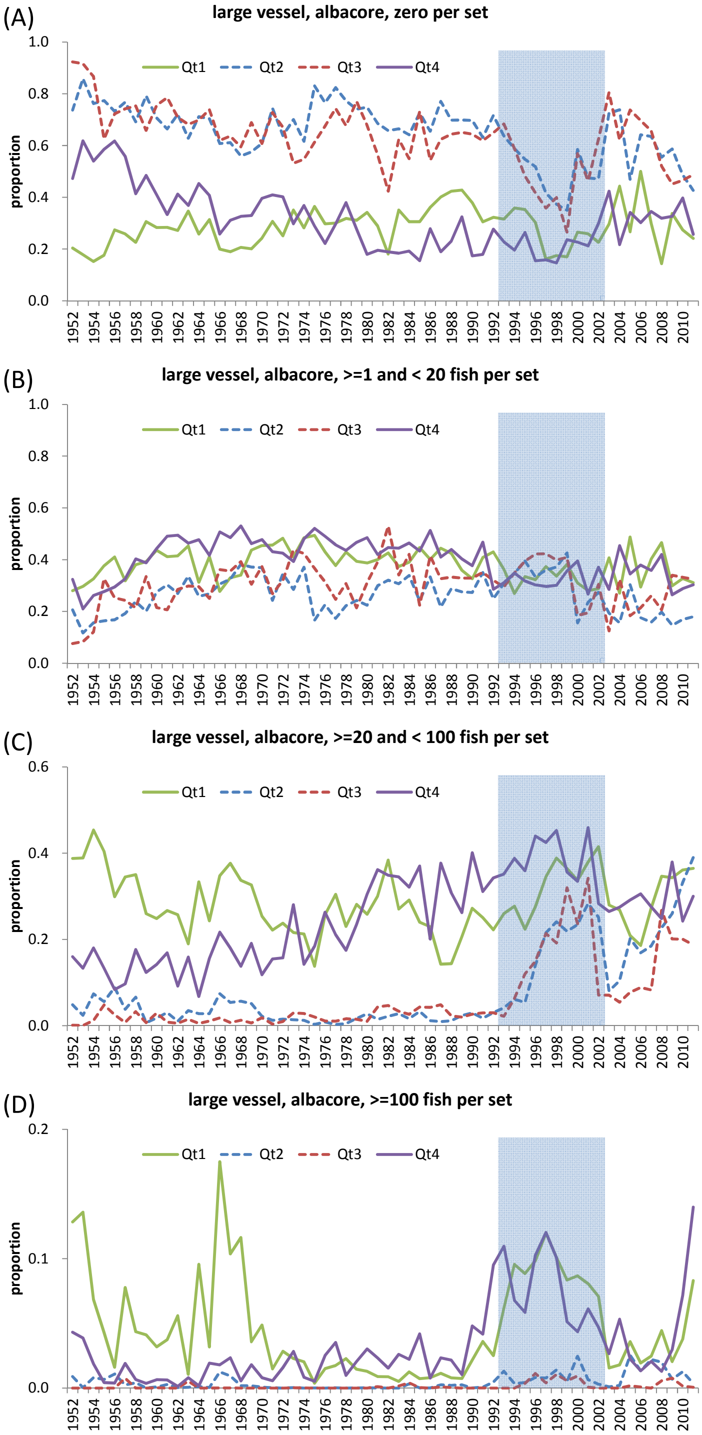


Fig. 7 Proportion of catch number per set of **albacore** by quarter caught by Japanese **large longline vessel** in the North Pacific Ocean. (A) case for zero catch per set, (B) case for 1-19 fish per set, (C) case for 20-99 fish per set, (D) case for more than 100 fish per set. The period with higher CPUE represent blue shaded area. For each quarter the sum of proportion from four panels is 1.

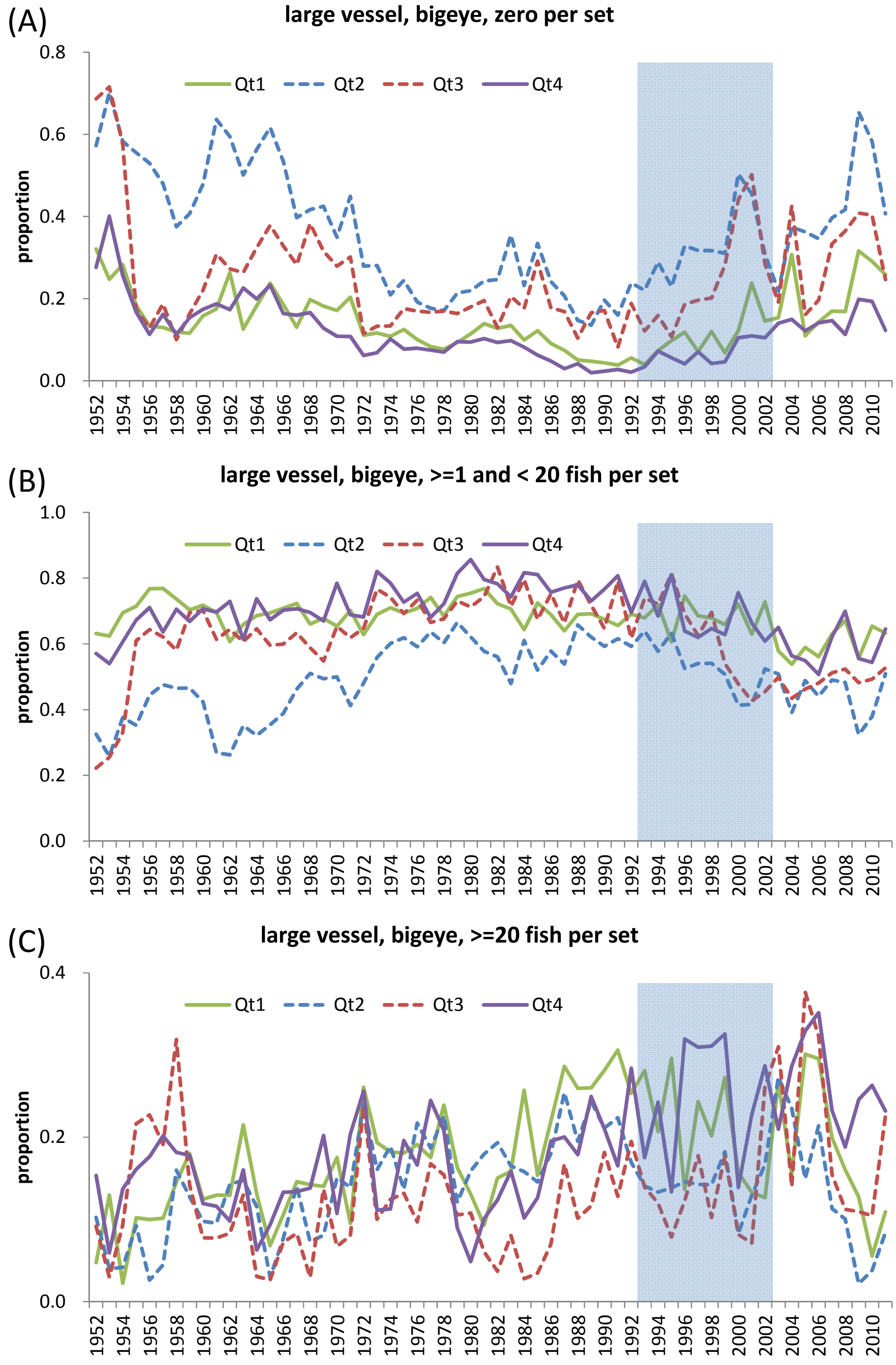


Fig. 8 Proportion of catch number per set of **bigeye** by quarter caught by Japanese **large longline vessel** in the North Pacific Ocean. (A) case for zero catch per set, (B) case for 1-19 fish per set, (C) case for more than 20 fish per set. The period with higher CPUE represent blue shaded area. For each quarter the sum of proportion from three panels is 1.

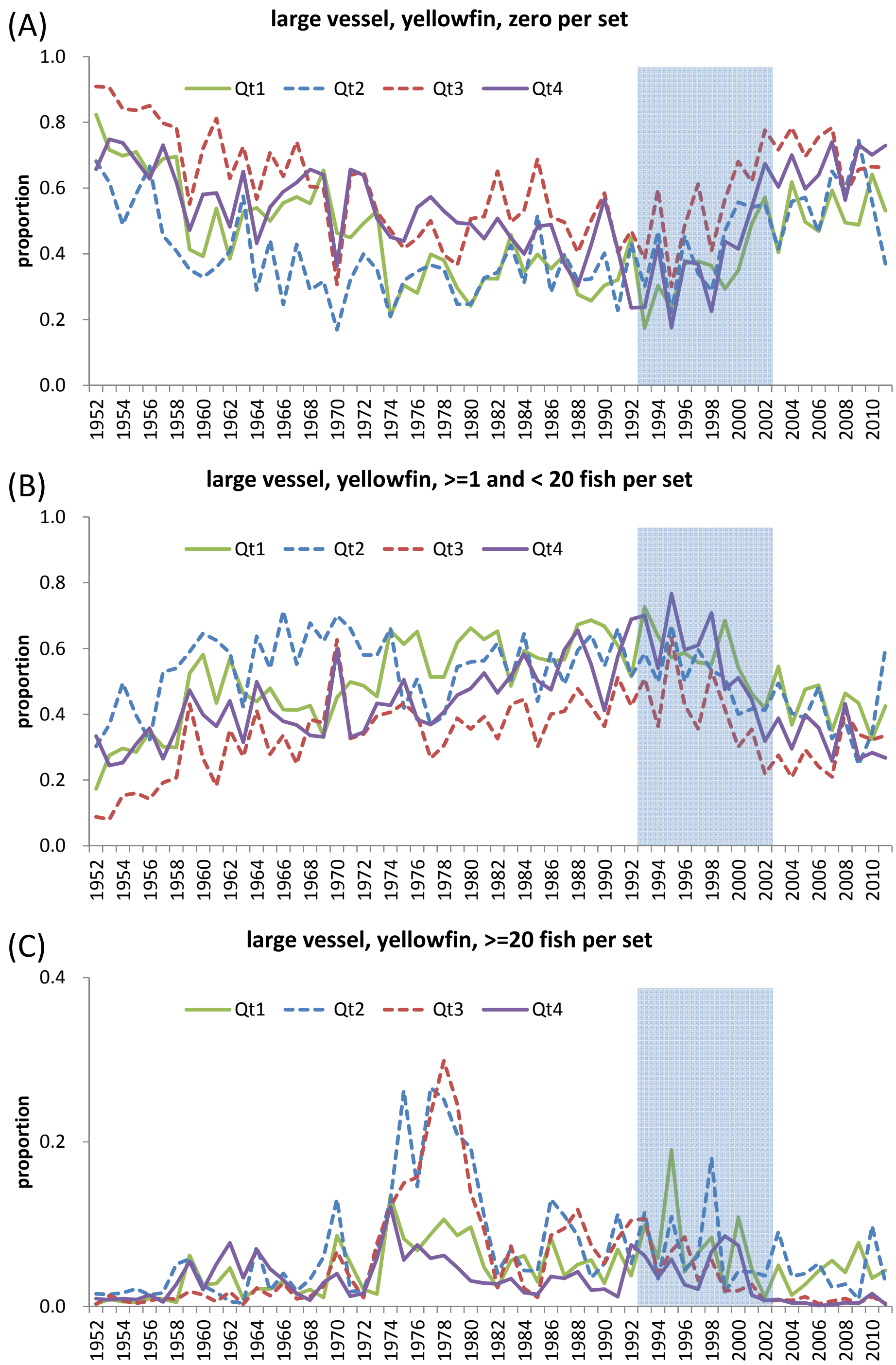


Fig. 9 Proportion of catch number per set of **yellowfin** by quarter caught by Japanese **large longline vessel** in the North Pacific Ocean. (A) case for zero catch per set, (B) case for 1-19 fish per set, (C) case for more than 20 fish per set. The period with higher CPUE represent blue shaded area. For each quarter the sum of proportion from three panels is 1.

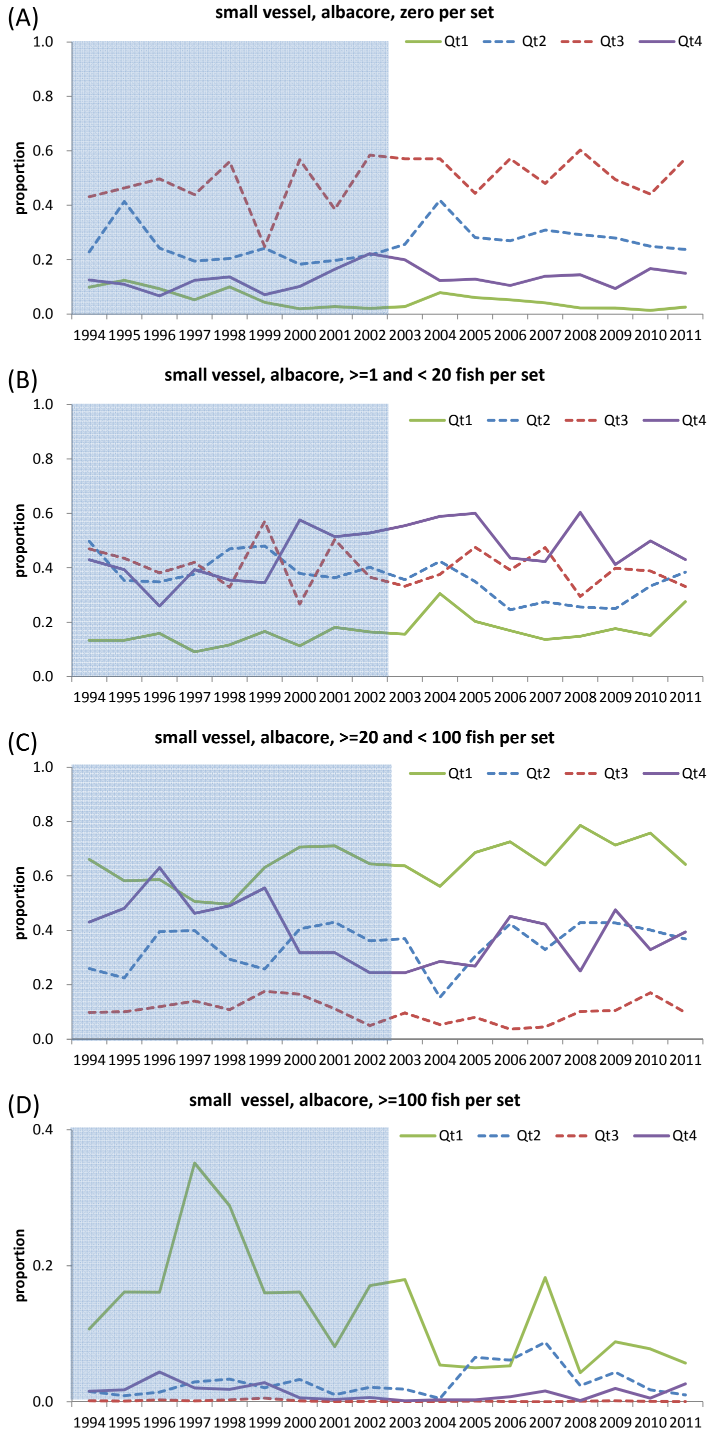


Fig. 10 Proportion of catch number per set of **albacore** by quarter caught by Japanese **small longline vessel** in the North Pacific Ocean. (A) case for zero catch per set, (B) case for 1-19 fish per set, (C) case for 20-99 fish per set, C) case for more than 100 fish per set. The period with higher CPUE represent blue shaded area. For each quarter the sum of proportion from four panels is 1.

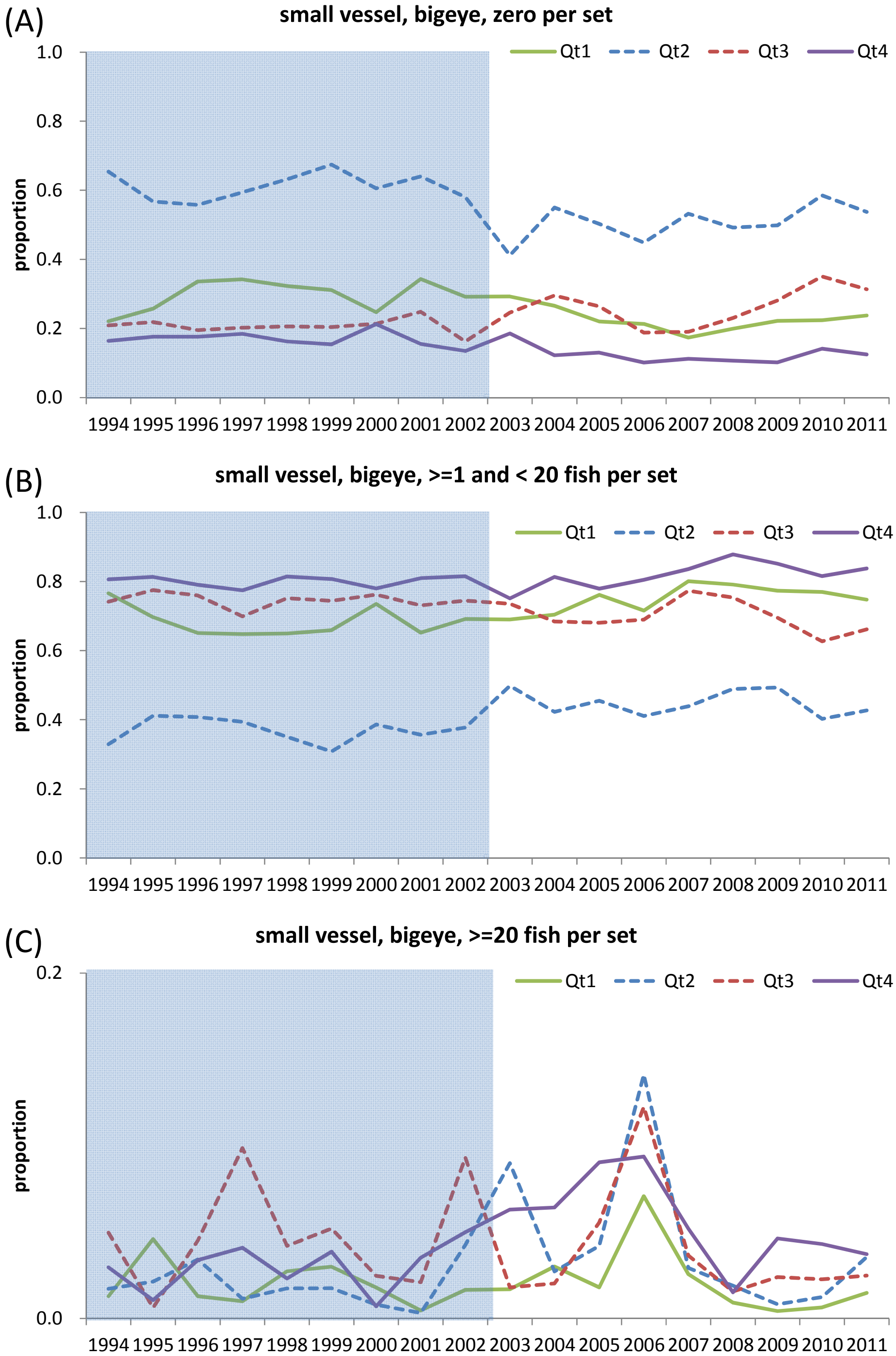


Fig. 11 Proportion of catch number per set of **bigeye** by quarter caught by Japanese **small longline vessel** in the North Pacific Ocean. (A) case for zero catch per set, (B) case for 1-19 fish per set, (C) case for more than 20 fish per set. The period with higher CPUE represent blue shaded area. For each quarter the sum of proportion from three panels is 1.

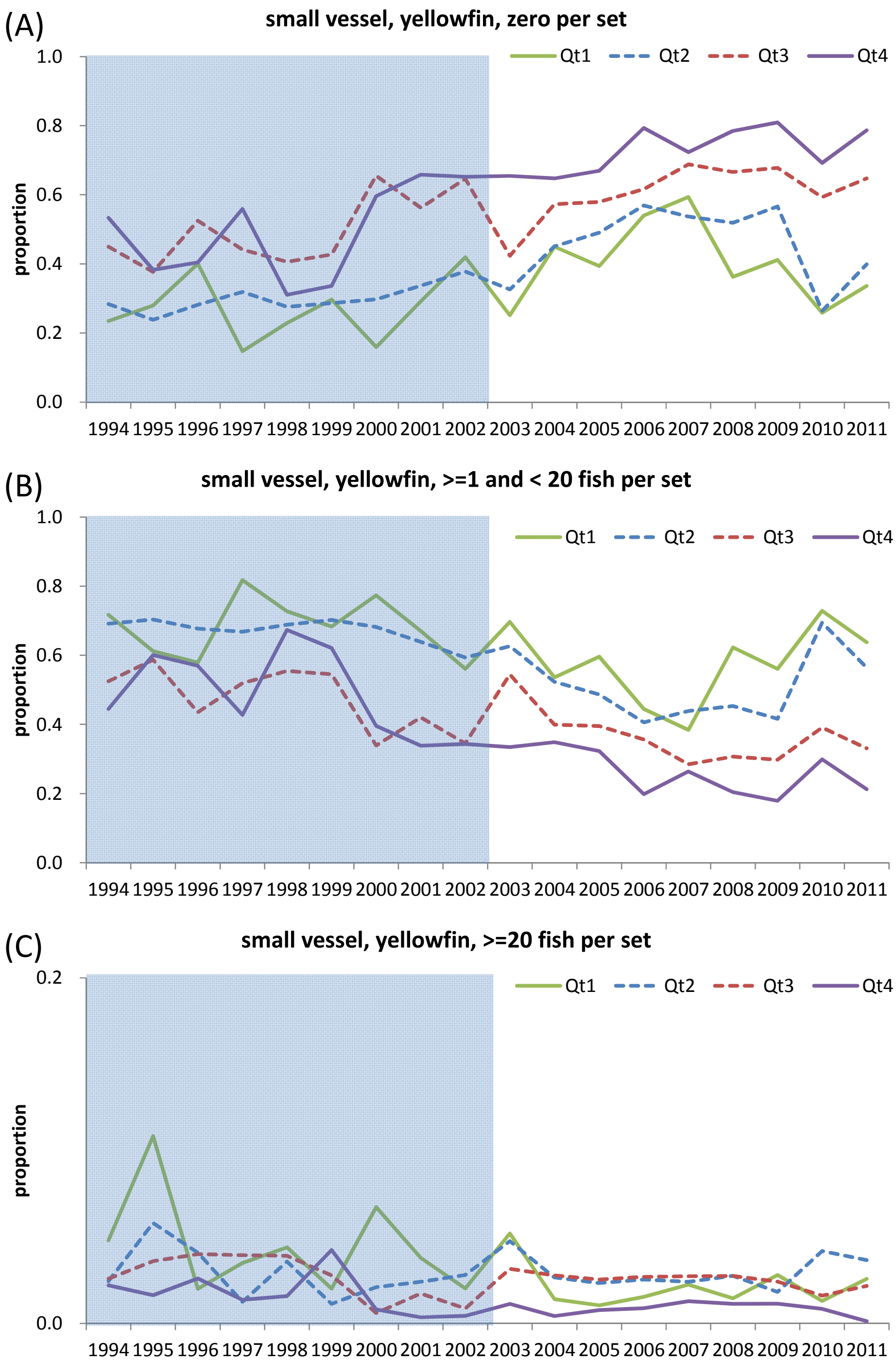
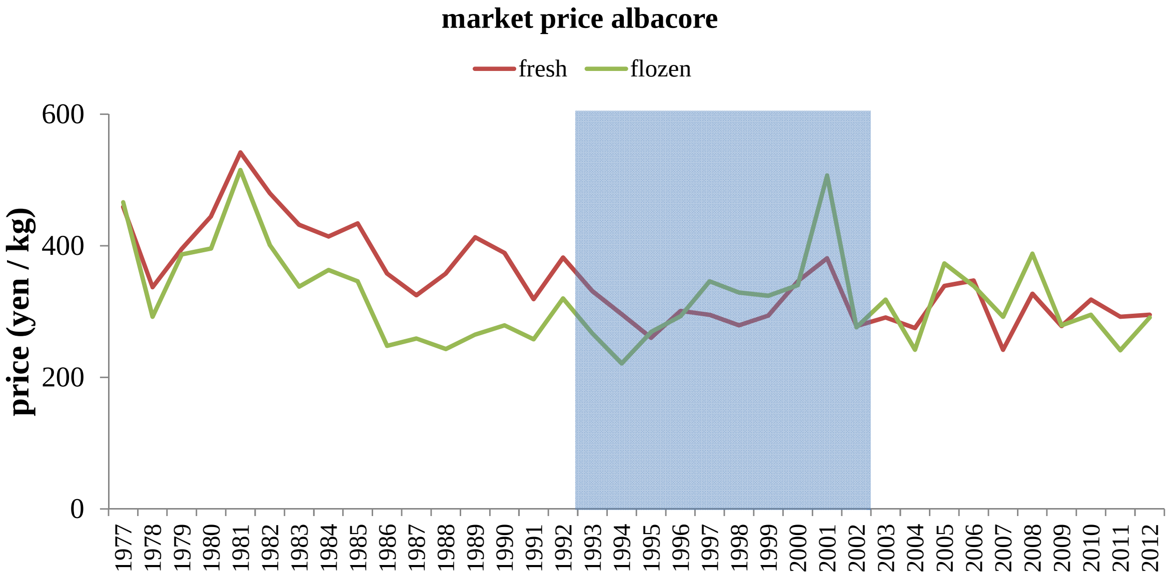


Fig. 12 Proportion of catch number per set of **yellowfin** by quarter caught by Japanese **small longline vessel** in the North Pacific Ocean. (A) case for zero catch per set, (B) case for 1-19 fish per set, (C) case for more than 20 fish per set. The period with higher CPUE represent blue shaded area. For each quarter the sum of proportion from three panels is 1.



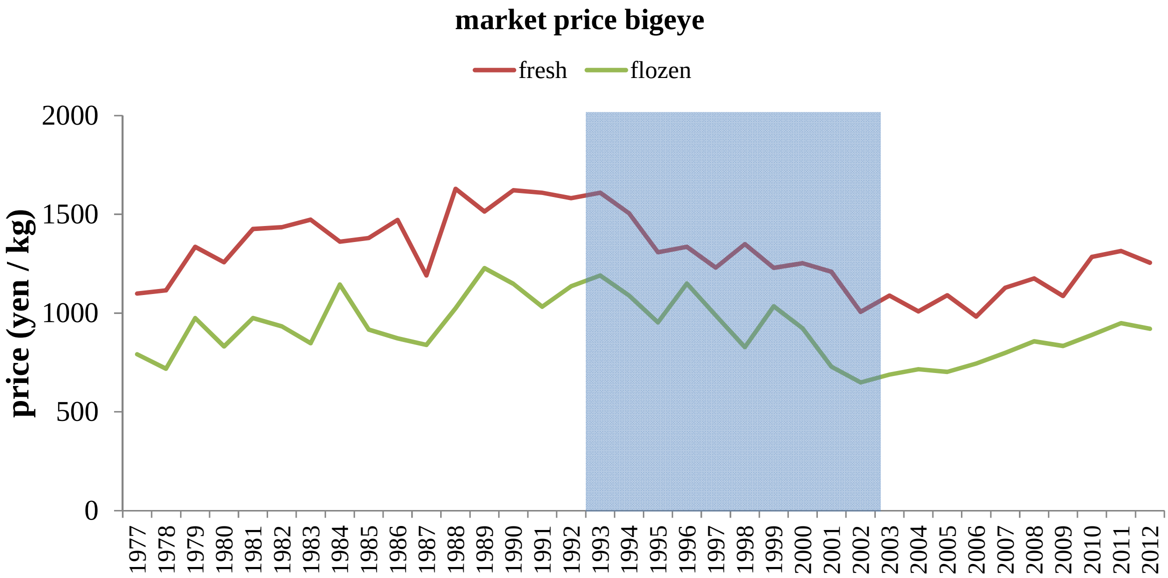
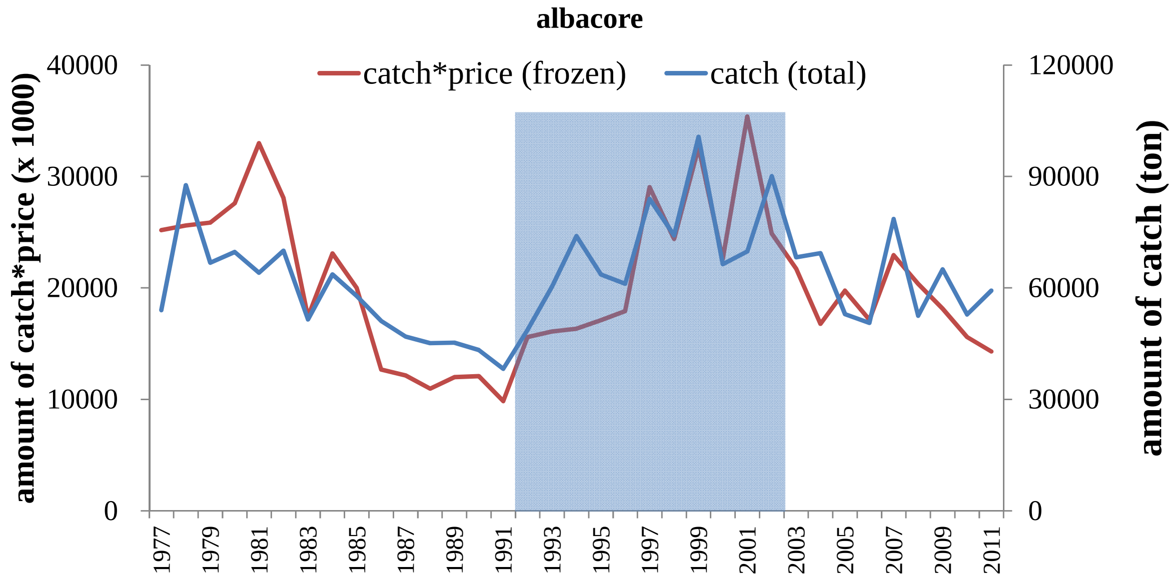


Fig. 13 Historical changes of market price of frozen and fresh for **albacore** (upper panel) and **bigeye** (lower panel) in Japanese fishing ports (155 ports in 2011).



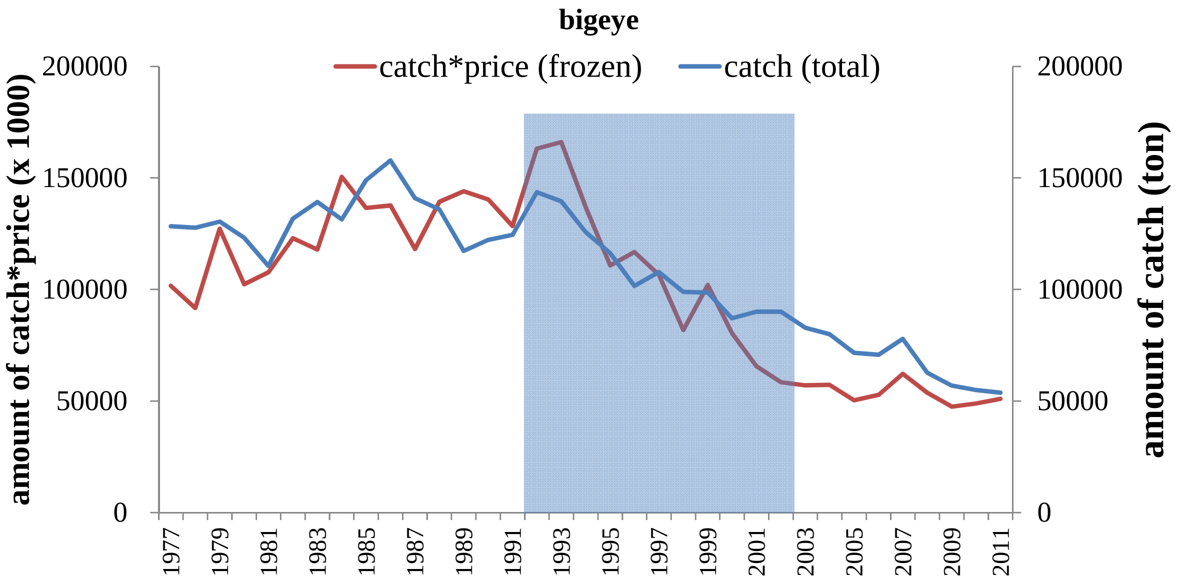


Fig. 14 Historical changes of products of market price of frozen and total catch for **albacore** (upper panel) and **bigeye** (lower panel). The amounts of catch are total yield caught by Japanese fishing vessel of any fisheries in the North Pacific Ocean (north of equatorial).

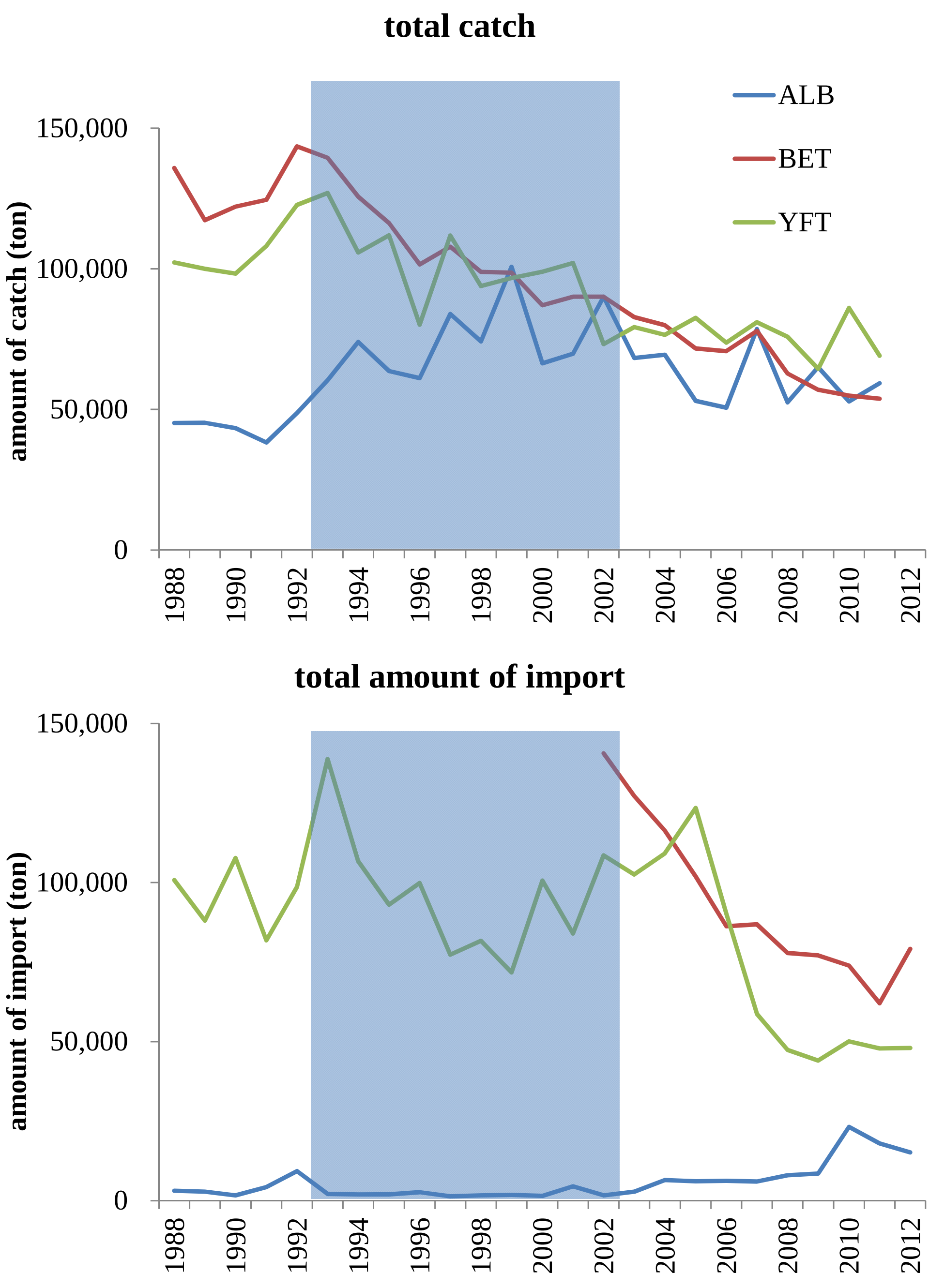
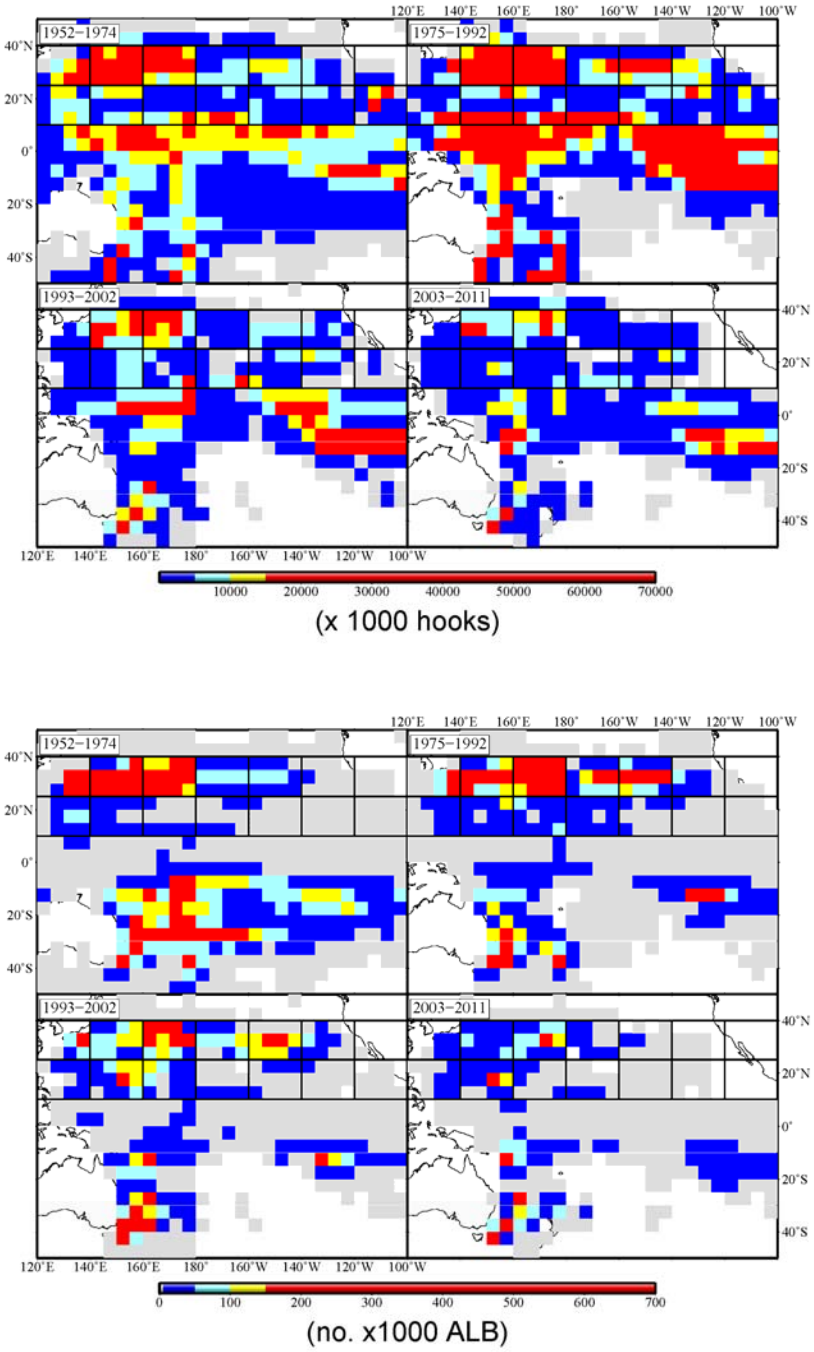
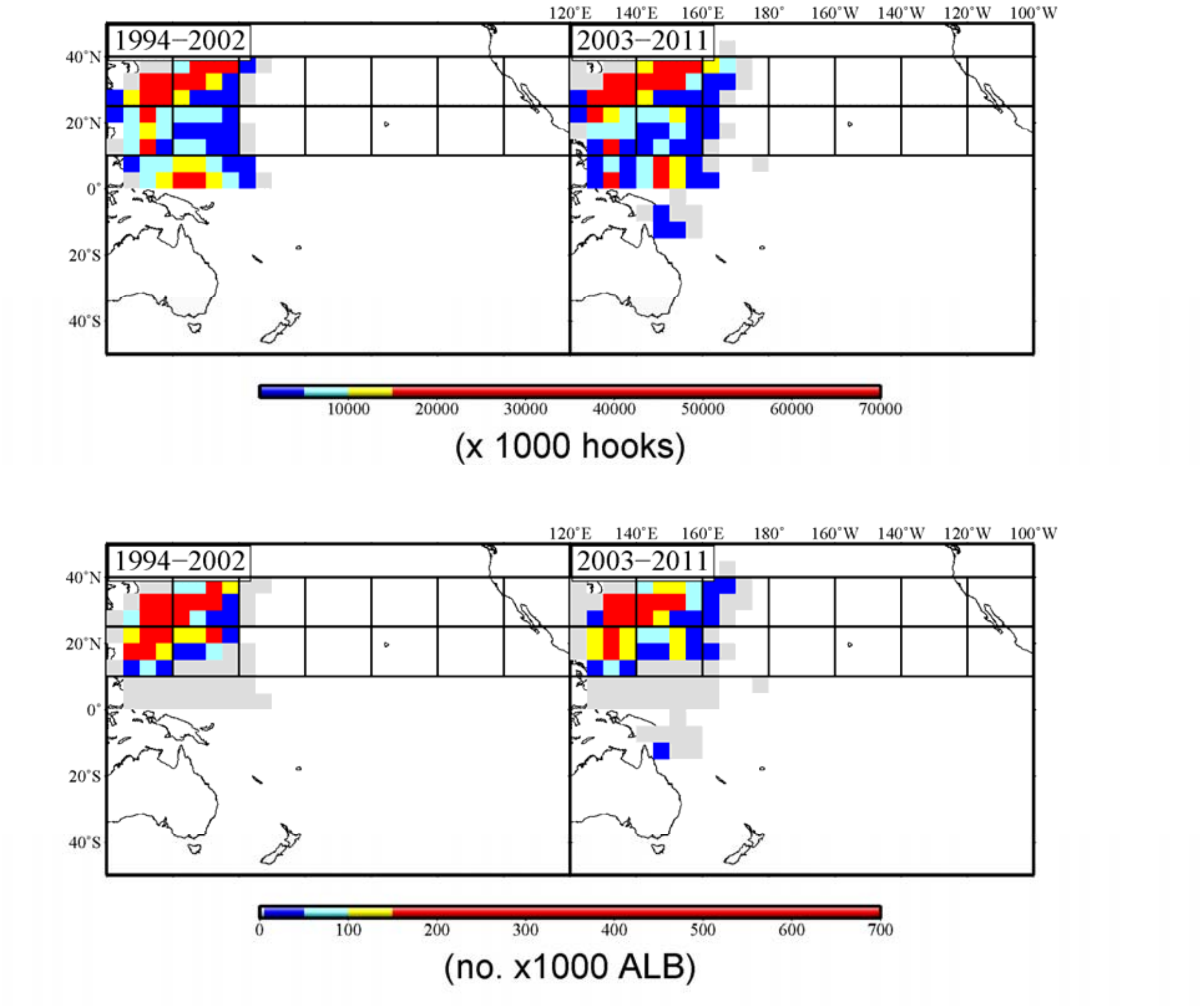


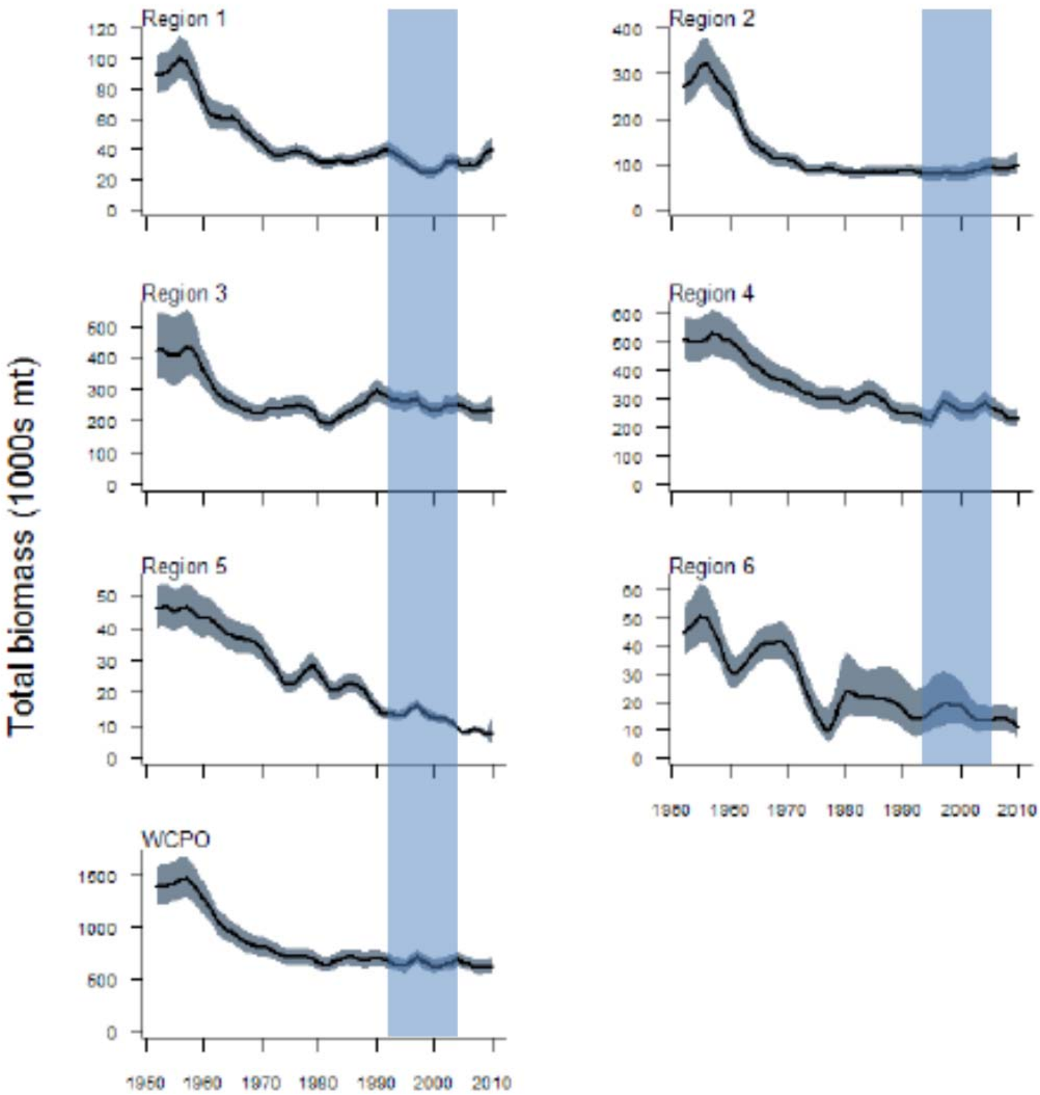
Fig. 15 Recent trends of total catch of Japanese fishery (upper panel), total amount of import by species of Japan (lower panel).



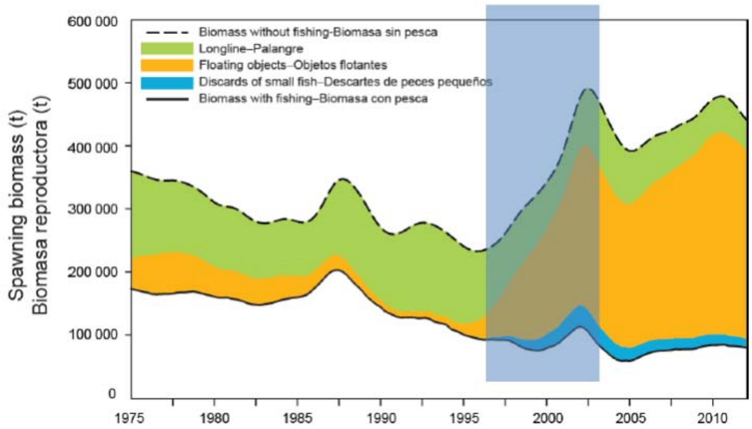
Appendix 1 Geographical distribution of **effort** (x 1000 number of hooks; upper panel) and number of **albacore** (x 1000 fish; lower panel) of **large vessel** (>20 GRT) four periods (before 1974, 1975 to 1992, 1993 to 2002 and after 2003).



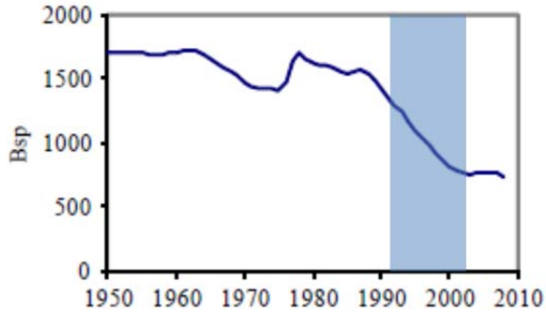
Appendix 2 Geographical distribution of **effort** (x 1000 number of hooks; upper panel) and number of **albacore** (x 1000 fish; lower panel) of **small vessel** (10-20 GRT) four periods (1994 to 2002 and after 2003).



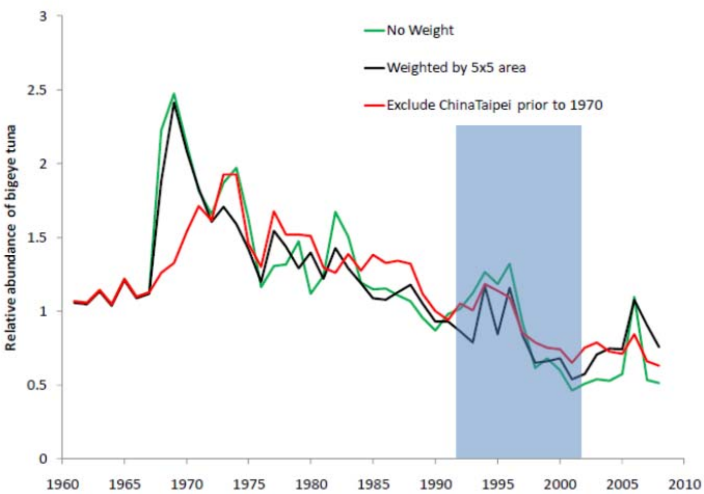
Appendix 3 Annual average biomass of **bigeye** by region of **western central Pacific Ocean** (from figure 36 of Davies et al (2011)). The region 1 is vicinity of Japan. The regions 3 and 4 are tropical area, main fishing ground for bigeye.



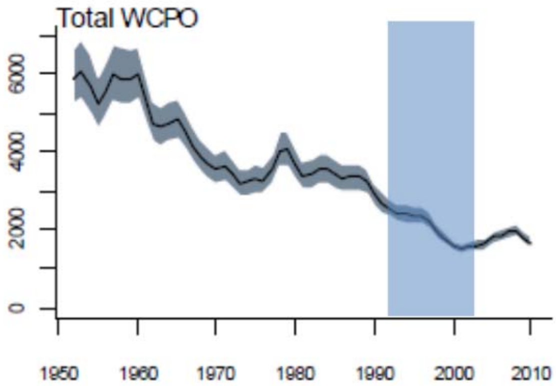
Appendix 4 Annual spawning biomass of **bigeye** of **eastern Pacific Ocean** (from figure 5 of Aires-da-Silva and Maunder (2012a)). The black solid line indicates spawning biomass with fishing.



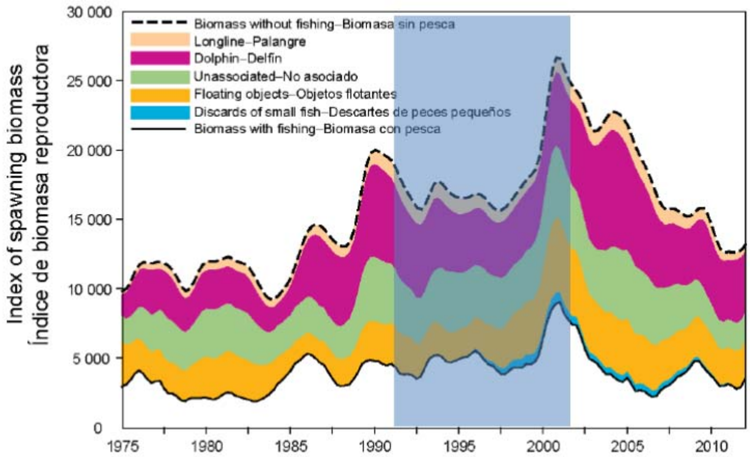
Appendix 5 Annual spawning biomass of **bigeye** of **the Indian Ocean** (from figure 11 of Nishida and Rafemeyear (2011)).



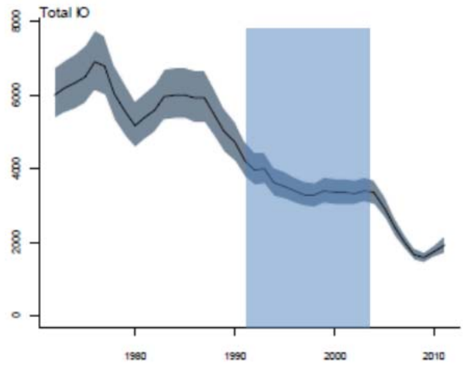
Appendix 6 Annual changes of relative abundance of **bigeye** of **the Atlantic Ocean** (from BET-figure 5 of Anonymous ICCAT (2012b)).



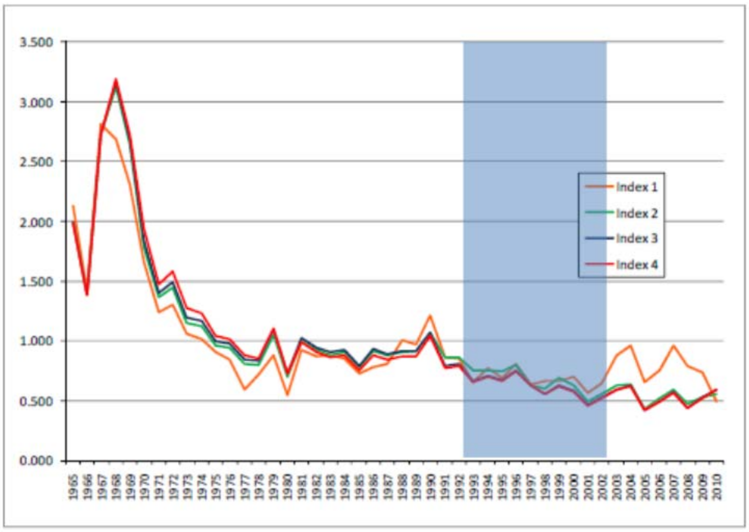
Appendix 7 Annual average biomass of **yellowfin** by region of **western central Pacific Ocean** (from figure 46 of Langley et al (2011)).



Appendix 8 Annual spawning biomass of **yellowfin** of **eastern Pacific Ocean** (from figure 5 of Aires-da-Silva and Maunder (2012b)). The black solid line indicates spawning biomass with fishing.



Appendix 9 Annual spawning biomass of **yellowfin** of **the Indian Ocean** (from figure 31 of Langley et al (2012)).



Appendix 10 Annual changes of relative abundance of **yellowfin** of **the Atlantic Ocean** (from figure 17 of Anonymous ICCAT (2011)).