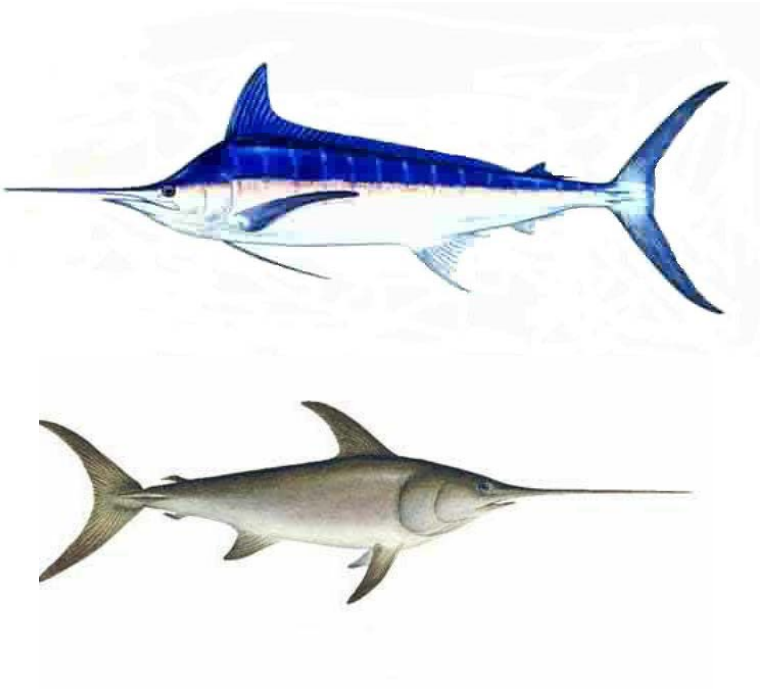
# Overview of the Japanese Fisheries for Blue Marlin in the Pacific Ocean up to 2010[1]

Ai Kimoto and Kotaro Yokawa
National Research Institute of Far Seas Fisheries
Shimizu, Shizuoka, Japan



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# OVERVIEW OF THE JAPANESE FISHERIES FOR BLUE MARLIN IN THE PACIFC OCEAN UP TO 2010

Ai Kimoto and Kotaro Yokawa

National Research Institute of Far Seas Fisheries (NRIFSF)

**Abstract**

*This paper overviewed the Japanese longline fishery in the Pacific Ocean for blue marlin up to 2010 through the temporal-spatial distribution of catch and effort, trends of total catch and effort, positive catch ratio, percentage of blue marlin caught in one operation, and nominal CPUE. Various Japanese fisheries have caught blue marlin in the Pacific Ocean, especially in the tropical area by distant-water longline. The total effort by distant-water lonline in the Pacifc Ocean has decreased since 1990s, with the decrement of the catch of blue marlin. The nominal CPUE since 1967 in the tropical area were varied around the average CPUE between 1967 and 2010. Although the nominal CPUE in the 1950s were substantially higher than the following years, it was revealed that the fishery data in that period overestimated the blue marlin catch due to the species misidentification of marlins. It was suggested that further careful considerations would be needed for the stock assessment on the CPUE series and the catch data, which partially included black marlin.*

## Introduction

To compehend the character of fishery is essential when the stock assessment is conducted. This paper overviewed primary information of Japanese fishery for blue marlin, because the ISC Billfish Working Group decided to conduct the stock assessment of blue marlin in the Pacific Ocean throught the cooperations with IATTC and WCPFC.

Various Japanese fisheries have caught blue marlin in the Pacific Ocean, especially in the tropical area by distant-water longline. The Japanese longline fishery covers a long period for a wide geographical distribution area in the entire Pacific Ocean. This report provides the distribution and the total number of hooks and catch in number. This document also shows catch amount of various fisheries obtained from Japanese year books, and the statistic from WCPFC and IATTC. Finally, nominal CPUE of Japanese distant-water longline was provided in this report.

## Material and Method

Various types of data were used. Historical total catch in number of blue marlin and

effort data between 1952 and 2010 were obtained from the logbook of the Japanese distant-water longline fishery complied by National Research Institute of Far Seas Fisheries (NRIFSF). The data contains the information of catch number and the number of hooks, and was aggregated by month, 5x5 degree blocks area. The spatial distribution (5x5 degree blocks) of catch and effort pattern in the entire Pacific Ocean were mapped by decade. The historical catch and effort data by area were also calculated. The area was divided into 4 larger areas: North Temperate, North Tropical, South Tropical and South Temperate areas (Figure 1-a, abbreviation; NTemp, NTrop, STrop, and STemp, respectively) to outline the data, and also into 17 smaller areas by 20x40 degree blocks (Figure 1-b) to conduct detailed examinations of the data.

Historical Japanese catch amount in metric ton by distant-water and coastal longline was obtained from WCPFC since 1970s and IATTC since 1950s (WCPFC, 2011 and IATTC, 2011). The catch in WCPO, western of 150W, were referred from WCPFC, because there is WCPFC-IATTC overlap area. The catch amount by other gear types: Japanese other longline, squid drift net, drift net, bait fishing, net fishing, trap net, and others-primarily harpoon, was compiled by Japanese year books since 1951. However above data except distant-water longline were reported by "marlins", which contains blue and black marlin.

Different from the north Pacific striped marlin, blue marlin have been only caught as bycatch by the Japanese longline fishery in the Pacific. Thus the ratio of zero catch of blue marlin was supposed to be substantially higher than that of the north Pacific striped marlin, and the possibility of the set by set data for the use of the estimation of abundance index was explored. Several approaches were conducted using the Japanese distant-water longline fishery catch and effort data (set by set data) compiled by NRIFSF. The data was continuously available since 1967, and was partially available for the former period between 1952 and 1957. Positive catch ratio by larger area (Figure 1-a) was analyzed before and after 1975 separately because the error check of the set by set data of billfishes in the period before 1975 have not conducted so far. The number of operations were also analyzed by the number of blue marlin caught in one operation, by percentage of blue marlin catch among marlins catch except valuable striped marlin (i.e. total catch of blue and black marlin, sailfish, and spearfish) in one operation, and by decade before 1975 in the 4 areas.

Finally, the nominal CPUEs and the nominal CPUEs of positive catch were also provided in the 4 areas, and each CPUE series was scaled by the average CPUE between 1967 and 2010. These indices were calculated with all data or partially-deleted data. Partially-deleted data were prepared by removing the operational data in which more than 6 blue marlin were caught and also blue marlin accounted for 100%, over 90% or over 80% of catch of marlins (blue and black marlin, sailfish, and spearfish). Those criteria was chosen arbitrarily by authors.

**Results and Discussion**

**Catch and Effort**

Japanese distant-water lonliners operated mainly near Japan (20-40N, west of the date line) in the 1950s (Figure 2, hooks), and gradually expanded their operating area since then. The longliners operated in the entire Pacific Ocean, especially in the north tropical area (NTrop) in the 1960s, and operated in the both north and south tropical areas (NTrop and STrop) in the 1970s and the 1980s (Figures 3 and 4). Since 1990s, the total number of hooks of distant-water longline has gradually declined, and a further decrease was observed in 2000s.

Blue marlin was caught by Japanese distant-water longline mostly in NTrop and STrop (Figure 3). Distatn-water longliners caught blue marlin around the date line in the tropical area (NTrop2 and 3, and STrop1 and 2) since the 1950s, and caught them in the entire tropical areas in the 1960s with the expansion of their efforts (Figures 2 and 5). The area of NTrop2 were the main area of blue marlin catch in the 1970s and the 1980s, and the catch in number has gradually decreased since the 1990s (Figure 5). Meanwhile, the catch number in STrop3 was increased since mid-1970s, and has suddenly depleted after the peak in the mid-1990s.

Available Japanese annual catches in metric ton related to blue marlin were tentatively summarized by type of gear in Tables 1 and 2, obtained from WCPFC, IATTC, and Japanese year books. Catch of blue marlin in metric ton by Japanese offshore and distat-water longline in the WCPO (Western and Central Pacific Ocean, west of 150W) were reported by WCPFC between 1971 and 2010, and also those in the EPO (Eastern Pacific Ocean, east of 150W) were reported by IATTC between 1954 and 2010 (Table1). In the WCPO, offshore and distant-water longliners caught 5,000 tons of blue marlin on average during the 1970s and the 1980s, and have caught 1,500 tons since the mid-1990s. In the EPO, the largest catch, 12,000 tons of blue marlin, was recorded in 1963, and smooth increase was observed since the early 1970s. After the second largest catch was observed in 1994, catches were suddenly dropped and recent catches were less than 1,000 tons.

Japanese coastal longline catches were also reported since 1969 by WCPFC, but the values included both blue and black marlin. The reported catch was increased since 1969, and the peak in the early 1990s with 2,000 tons was marked. Since then, catches were varied between 1,000 and 1,500 tons.

Japanese year books have been compiled since 1951, although they have totalized blue and black marlin catches in metric ton by gear (Table 2). There were some catches by drift net, bait fishing, and others which obtained primarily by harpoon. Catches by drift net and by others were mainly observed between the mid-1970s and the mid-1980s, with the values of 1,000 and 200 tons on average, respectively. A total 200 tons on average of blue and black marlin constantly have been caught by bait fishing since the mid-1970s. These data, however, should be broken down to the species level somehow for the use of stock assessment of blue marlin, preliminary check of the recent whole sale auction records data collected at the main landing ports for some of these fisheries suggested that the statistics were consisted chiefly of blue marlin, and the ratio of black marlin is rather low.

## Positive catch ratio

### Positive catch ratio since 1975

Positive catch ratio since 1975 (Figure 6-a) was examined using set-by-set data of Japanese distant-water longline. The ratio differed between temperate and tropical area, and the values in the tropical area where was habitat of blue marlin, were higher than those of temperate area. In NTrop, the ratio were between 80% and 90% before the early 1980s, and were constant with 95% since then. Meanwhile, the ratio was rapidly increased from 60% to 90% between the mid-1970s and the mid-1980s in STrop, and has gradually decreased to 60% since the late 1990s.

Compared to the ratio in the tropical area, the values were more variable in the temperate area, especially in STemp. The ratio in NTemp was varied between 50% and 80% in the whole periods, whereas the ratio in STemp ranged between 50% and 70% till the early 1990s. The positive catch ratio suddenly decreased in the early 1990s in STemp and has varied largely between 10% and 50% since then. The apparent annual trends observed in some areas indicates the fact that the set-by-set data is more preferable for the use of the estimation of abundance index of blue marlin than the aggregated data, which is used in the north Pacific striped marlin.

### Positive catch ratio before 1974

The positive catch ratio before 1974 was also examined because the variation of the ratio after 1975 was detected (Figure 6-b). In all areas, the ratio between 1967 and 1974 showed similar pattern to the following periods. However, the values before 1957 were high and over 90% in the tropical area, and highly fluctuated in the temperate area. With these trends, it would have possibilities that the quality of the data in the 1950s would be different from those after the mid-1960s. Furthermore, collecting detailed fishery data officially started since 1960s, and the data in 1950s were duplicated collected through the interview to fishermen, thus it was suggested to analyze separately the data in 1950s from the latter periods, especially for billfishes.

## Nominal CPUE and nominal CPUE of positive catch since 1967

Following the above studies, the trends of nominal CPUE and the nominal CPUE of positive catch since 1967 were shown by area in Figure 7, and were scaled to its average CPUE between 1967 and 2010. The nominal CPUEs in the both NTrop and STrop were decreased from 1.5 in the late 1960s to 0.8 in the early 1970s. Since then the CPUEs have varied between 1.0 and 1.5 of the average, and were about 0.9 on average in the 2000s. Overall, the values in STrop were more variable than NTemp.

In the temperate area, the nominal CPUEs fluctuated more than the tropical area, especially in STemp. Similarly, the rapid decrease was observed in the both tropical areas in the early 1970s. In NTemp, the nominal CPUEs varied between 0.6 and 1.4 of the average, and showed a increasing trend in the recent years. On the other hand, the nominal CPUEs largely varied 1.0 and 2.5 till 1970s in STemp, and had a sudden drop in the early 1990s. Although the value was stable around 0.5 of the average in 1990s, the lowest values about 0.15 were observed in the recent years.

The nominal CPUEs of positive catch showed a similar trend and value but less variable compared to the nominal CPUEs in all areas. The trends between two CPUEs were slightly different in STemp due to its highly variable positive catch ratio.

## Nominal CPUE in the 1950s

### Catch of blue marlin in one operation

Further analyses of operational data in the 1950s were made due to the disputable data. To characterize catch of blue marlin in each operation, the number of operations in each area were counted by period and by the number of blue marlin catch in one operation, and Figure 8 shows the cumulative percentage of the counted number of the total number of operations in the same area and period. It was detected that more than 90% of all operations in the same area and period caught between 0 and 4 blue marlin in one operation, except in the both NTrop and STrop in the 1950s, where the same ranged blue marlin catch accounted for 50% of all operations.

Additionally, the proportion of blue marlin catch among marlins (blue and black marlin, sailfish and spearfish) in each operation in the 1950s was examined in NTrop and STrop, when the large number of blue marlin, over 6 fish, was caught in one operation. It was revealed that catch of blue marlin accounted for a large percentage of catch of marlins in many operations in the 1950s that caught over 6 blue marlin (Figure 9). It was indicated that catch of blue marlin could contain other marlins in the 1950s, considering the number of blue marlin catch was normally between 0 and 4 in one operation, and detailed fishery data were duplicated through the interview to fishermen in that period.

The analysis results of the size data of blue marlin caught by Japanese longliners revealed that there were a notable number of unrealistic records of small blue marlin in the 1970s and 1980s (Kimoto and Yokawa, 2012). This indicates that the species misidentification of marlins existed even in these periods. Generally, the species identification of small marlins is rather difficult.

### Nominal CPUE

Figure 10 shows the nominal CPUE series in the 1950s by area with the latter time

series for the comparison, and the indices were scaled to its average between 1967 and 2010. The CPUEs in the 1950s were substantially higher than those in following periods in all areas.

To eliminate the possible influence of the contaminations by the other marlins in the catch, partial operational data that caught more than 6 blue marlin and also blue marlin accounted for 100%, over 90% or over 80% (rm100, rm90, or rm80 in Figure 10) of catch of marlins were removed from the analysis and obtained the new nominal CPUE series. The new nominal CPUEs without partially-deleted data were smaller than those with all data in the 1950s in the both NTrop and STrop. On the other hand, the partial removal did not affect on the nominal CPUEs in the temperate area and after the 1960s. The results of these analysis show the fact that the effect of the contaminations of data is high in the tropical areas where majority of blue marlin have been caught.

## Conclusion

This document reviewed the available Japanese fishery data for blue marlin in the entire Pacific Ocean, and some issues were raised on the fishery data, especially in the early periods. For example, catch statistics in metric ton in the WCPO by distant-water longline in the early periods were currently unknown, and some catch data of blue marlin were reported with black marlin. It was also pointed out that the fishery data around the 1950s possibly contained problems on the identification of marlins through the analysis in this document. Finally, it was suggested that additional careful considerations would be needed on the CPUE series and the catch data for the stock assessment. These data should be used only for the limited purpose until the time when the problem addressed in this study are fixed.

## References

IATTC. 2011. Catch of blue marlin in the IATTC convention area downloaded from the Public Domain data: http://www.iattc.org/Catchbygear/IATTC-Catch-by-species1.htm

Kimoto, A. and Yokawa, K. 2012. Review of size data for blue marlin caught by Japanese fisheries in the Pacific Ocean since 1970s. ISC/12/BILLWG/1/09.

WCPFC. 2011. Tuna Fishery Yearbook 2010. pp121.

Table 1. Japanese blue marlin catches (mt) by distant-water longline compiled by WCPFC, and Japanese blue and black marlin catches by coastal longline by WCPFC and IATTC up to 2010; "-" indicates data not available, and catch of 2009 and 2010 are preliminary (*).

| | Offshore and distant-water lognline | | Coastal longline |
|---|---|---|---|
| | WCPO (WCPFC) | EPO (IATTC) | WCPO[1)] (WCPFC) |
| 1951 | - | - | - |
| 1952 | - | - | - |
| 1953 | - | - | - |
| 1954 | - | 284 | - |
| 1955 | - | 789 | - |
| 1956 | - | 1732 | - |
| 1957 | - | 3717 | - |
| 1958 | - | 3767 | - |
| 1959 | - | 3084 | - |
| 1960 | - | 2682 | - |
| 1961 | - | 6248 | - |
| 1962 | - | 7437 | - |
| 1963 | - | 12043 | - |
| 1964 | - | 6092 | - |
| 1965 | - | 4560 | - |
| 1966 | - | 2888 | - |
| 1967 | - | 3398 | - |
| 1968 | - | 3710 | - |
| 1969 | - | 4664 | 117 |
| 1970 | - | 4086 | 160 |
| 1971 | 4765 | 2718 | 116 |
| 1972 | 6206 | 2381 | 217 |
| 1973 | 5194 | 3500 | 217 |
| 1974 | 5252 | 2721 | 186 |
| 1975 | 3474 | 2162 | 477 |
| 1976 | 3795 | 3175 | 436 |
| 1977 | 4240 | 2909 | 531 |
| 1978 | 5073 | 3026 | 849 |
| 1979 | 4514 | 4329 | 768 |
| 1980 | 6080 | 3748 | 702 |
| 1981 | 5397 | 3845 | 820 |
| 1982 | 5448 | 4368 | 722 |
| 1983 | 4240 | 4122 | 1058 |
| 1984 | 6006 | 4683 | 1306 |
| 1985 | 5185 | 3084 | 1037 |
| 1986 | 5423 | 4472 | 898 |
| 1987 | 3806 | 5881 | 1526 |
| 1988 | 4935 | 5002 | 1454 |
| 1989 | 3936 | 4872 | 1261 |
| 1990 | 2843 | 4552 | 1204 |
| 1991 | 2835 | 5033 | 1342 |
| 1992 | 2562 | 5234 | 1657 |
| 1993 | 3446 | 5381 | 2092 |
| 1994 | 3087 | 7654 | 1833 |
| 1995 | 3075 | 6011 | 1687 |
| 1996 | 1754 | 2605 | 1332 |
| 1997 | 1584 | 4312 | 1023 |
| 1998 | 1853 | 3459 | 1147 |
| 1999 | 2044 | 1946 | 1063 |
| 2000 | 1856 | 2012 | 1226 |
| 2001 | 1598 | 2336 | 1215 |
| 2002 | 1436 | 2223 | 915 |
| 2003 | 1459 | 2134 | 1228 |
| 2004 | 1642 | 1654 | 1444 |
| 2005 | 1469 | 1300 | 1129 |
| 2006 | 1525 | 870 | 1116 |
| 2007 | 1439 | 644 | 1226 |
| 2008 | 1264 | 509 | 1330 |
| 2009[2)] | 1170 | 684 | 1314 |
| 2010[2)] | 1393 | 780 | 1539 |

1); It contains catches of blue and black marlin.
2); Catch of 2008 and 2009 are preliminary.

Table 2. Japanese blue and black marlin catches (mt) by fisheries, 1951-2010; "-" indicates no effort or data not available, "0" indicates less than 1 metric ton, and catch of 2009 and 2010 are preliminary (*).

| | Other longline | Squid drift net | Drift net | Bait fishing | Net fishing | Trap net | Others[2)] | Total |
|---|---|---|---|---|---|---|---|---|
| 1951 | 15 | - | 0 | 0 | - | 1 | 9 | 25 |
| 1952 | 17 | - | - | 0 | 0 | 3 | 18 | 38 |
| 1953 | 6 | - | - | 1 | 2 | 1 | 12 | 22 |
| 1954 | 9 | - | 0 | 1 | 0 | 0 | 10 | 20 |
| 1955 | 1 | - | 0 | 2 | 0 | 1 | 6 | 10 |
| 1956 | 1 | - | 0 | 7 | 0 | 0 | 6 | 14 |
| 1957 | 4 | - | - | 15 | 0 | 0 | 15 | 34 |
| 1958 | 23 | - | - | 5 | 2 | 1 | 32 | 63 |
| 1959 | 11 | - | 0 | 8 | 1 | 2 | 60 | 82 |
| 1960 | 10 | - | 0 | 9 | 0 | 1 | 56 | 76 |
| 1961 | 17 | - | - | 5 | 1 | 2 | 64 | 89 |
| 1962 | 29 | - | 0 | 15 | 2 | 3 | 22 | 71 |
| 1963 | 3 | - | - | 7 | 26 | 4 | 33 | 73 |
| 1964 | 2 | - | - | 29 | 86 | 4 | 28 | 149 |
| 1965 | 6 | - | 0 | 11 | 0 | 3 | 50 | 70 |
| 1966 | 38 | - | - | 2 | 69 | 5 | 42 | 156 |
| 1967 | 31 | - | - | 8 | 17 | 7 | 82 | 145 |
| 1968 | 30 | - | - | 2 | - | 3 | 43 | 78 |
| 1969 | - | - | - | 18 | 2 | 7 | 182 | 209 |
| 1970 | 5 | - | - | 7 | - | 6 | 37 | 55 |
| 1971 | - | - | - | 6 | - | 1 | 49 | 56 |
| 1972 | - | - | 8 | 7 | 1 | 2 | 50 | 68 |
| 1973 | - | - | 268 | 23 | 46 | 2 | 88 | 427 |
| 1974 | 1 | - | 230 | 62 | 2 | 4 | 46 | 345 |
| 1975 | 2 | - | 795 | 148 | 1 | 3 | 77 | 1026 |
| 1976 | 5 | - | 581 | 203 | 5 | 3 | 315 | 1112 |
| 1977 | 1 | - | 998 | 194 | 24 | 2 | 130 | 1349 |
| 1978 | 1 | - | 884 | 200 | 3 | 3 | 393 | 1484 |
| 1979 | 0 | - | 513 | 168 | 6 | 3 | 261 | 951 |
| 1980 | 3 | - | 868 | 140 | 0 | 2 | 115 | 1128 |
| 1981 | 4 | - | 1165 | 188 | 15 | 4 | 124 | 1500 |
| 1982 | 3 | - | 955 | 172 | 26 | 4 | 218 | 1378 |
| 1983 | 5 | - | 931 | 231 | 150 | 12 | 280 | 1609 |
| 1984 | 2 | 3 | 243 | 186 | 208 | 3 | 219 | 864 |
| 1985 | 12 | 7 | 401 | 303 | 130 | 14 | 206 | 1073 |
| 1986 | 3 | 2 | 176 | 372 | 50 | 12 | 89 | 704 |
| 1987 | 9 | 0 | 256 | 286 | 44 | 6 | 71 | 672 |
| 1988 | 6 | 5 | 363 | 233 | 32 | 9 | 101 | 749 |
| 1989 | 3 | 7 | 293 | 395 | 43 | 8 | 74 | 823 |
| 1990 | - | 4 | 252 | 254 | 31 | 10 | 135 | 686 |
| 1991 | - | 2 | 178 | 172 | 37 | 15 | 14 | 418 |
| 1992 | - | 7 | 161 | 153 | 23 | 15 | 13 | 372 |
| 1993 | - | - | 146 | 190 | 41 | 11 | 37 | 425 |
| 1994 | - | - | 157 | 142 | 17 | 40 | 14 | 370 |
| 1995 | 1 | - | 142 | 174 | 34 | 23 | 10 | 384 |
| 1996 | 3 | - | 107 | 180 | 20 | 6 | 14 | 330 |
| 1997 | 1 | - | 76 | 237 | 17 | 12 | 5 | 348 |
| 1998 | 2 | - | 55 | 287 | 2 | 10 | 15 | 371 |
| 1999 | 1 | - | 77 | 173 | 1 | 5 | 5 | 262 |
| 2000 | 10 | - | 21 | 197 | 1 | 10 | 12 | 251 |
| 2001 | 8 | - | 162 | 138 | 1 | 6 | 7 | 322 |
| 2002 | 10 | - | 106 | 151 | 0 | 14 | 4 | 285 |
| 2003 | 4 | - | 37 | 178 | 0 | 13 | 4 | 236 |
| 2004 | 7 | - | 20 | 195 | 0 | 10 | 17 | 249 |
| 2005 | 6 | - | 37 | 195 | - | 7 | 11 | 256 |
| 2006 | 2 | - | 32 | 141 | 0 | 12 | 8 | 195 |
| 2007 | 1 | - | 76 | 162 | 0 | 19 | 13 | 271 |
| 2008 | 2 | - | 32 | 203 | 3 | 33 | 10 | 283 |
| 2009[2)] | 4 | - | 58 | 160 | 0 | 17 | 14 | 253 |
| 2010[2)] | 0 | - | 100 | 200 | 0 | 0 | 0 | 300 |

1); It contains trolling and harpoon but majority of catch obtianed by harpoon.

2); Catch of 2008 and 2009 are preliminary.

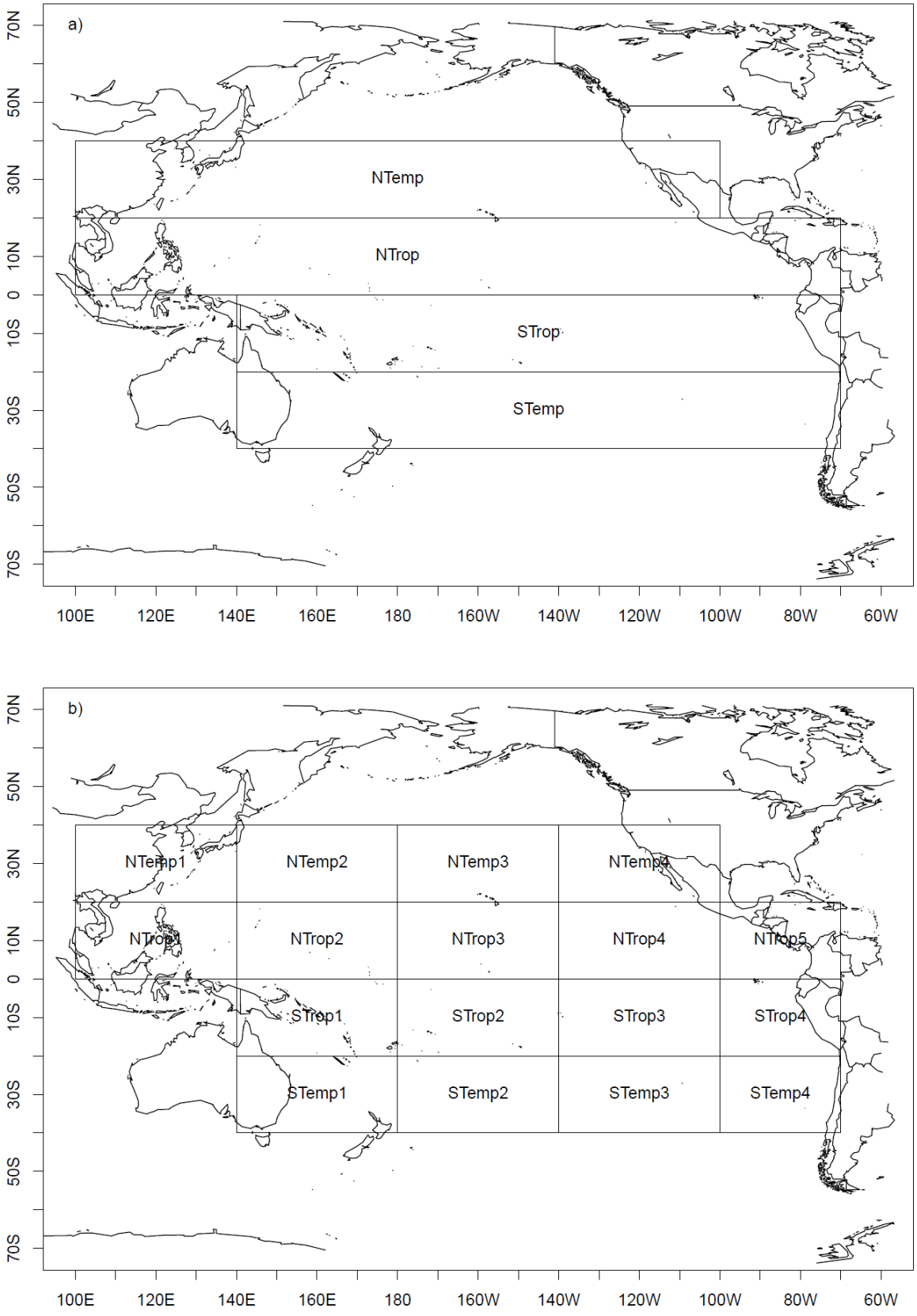


Figure 1. Two types of area stratification: a) 4 areas and b) 17 small areas.

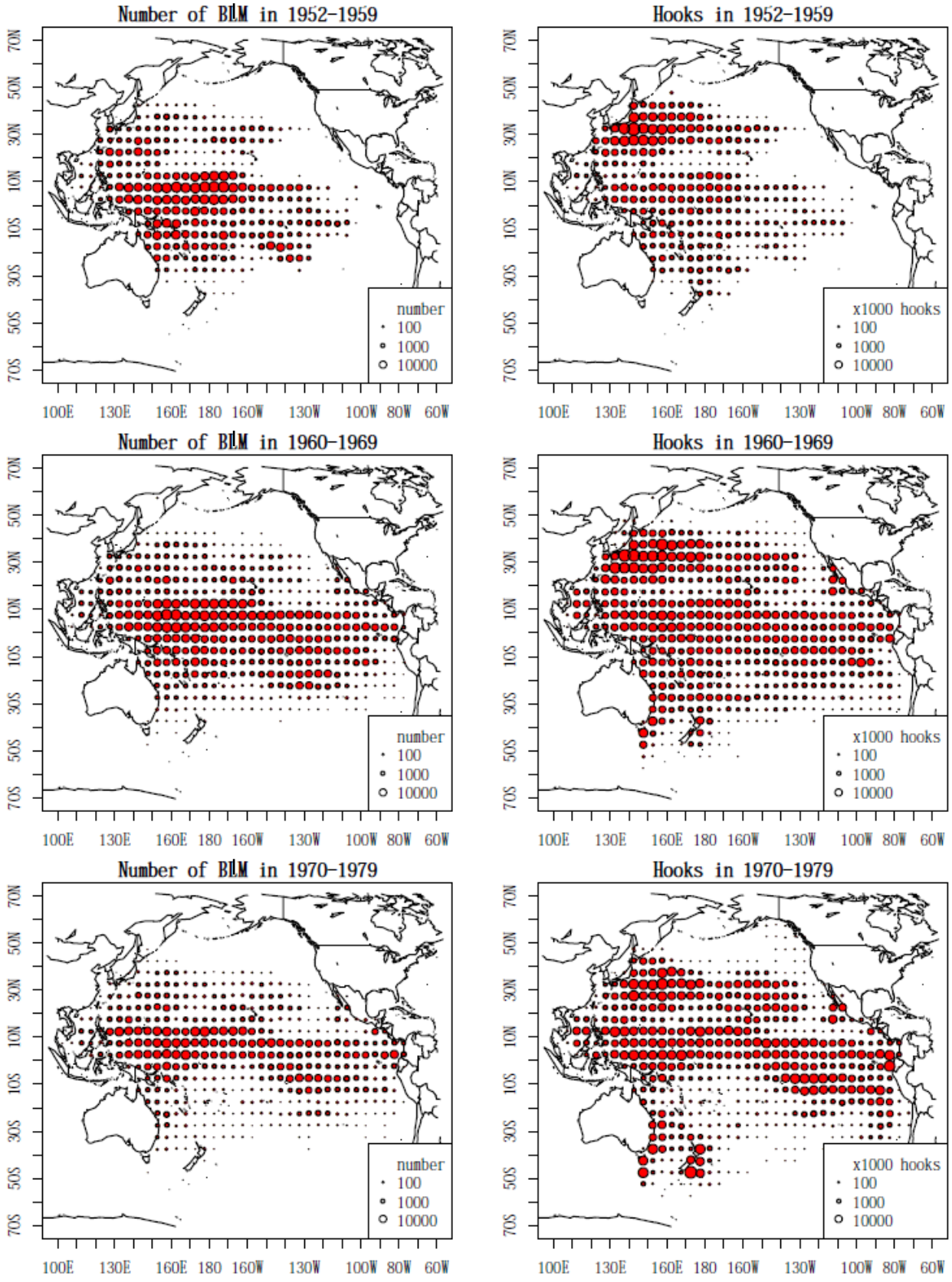


Figure 2. The spatial distribution (5x5 degree blocks) of catch in number (left column) and effort (right column) pattern by decade in the entire Pacific.

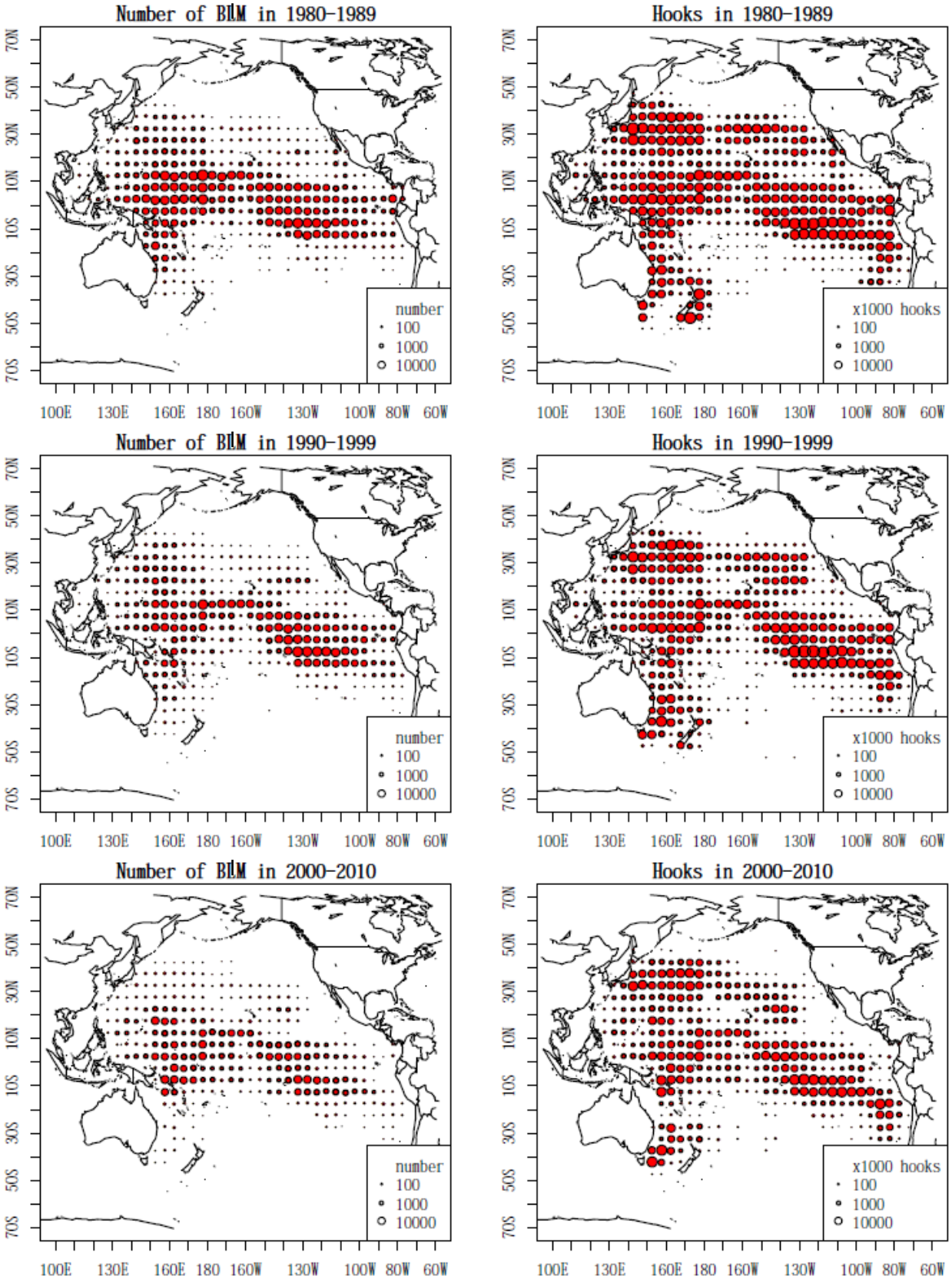


Figure 2. Continued.

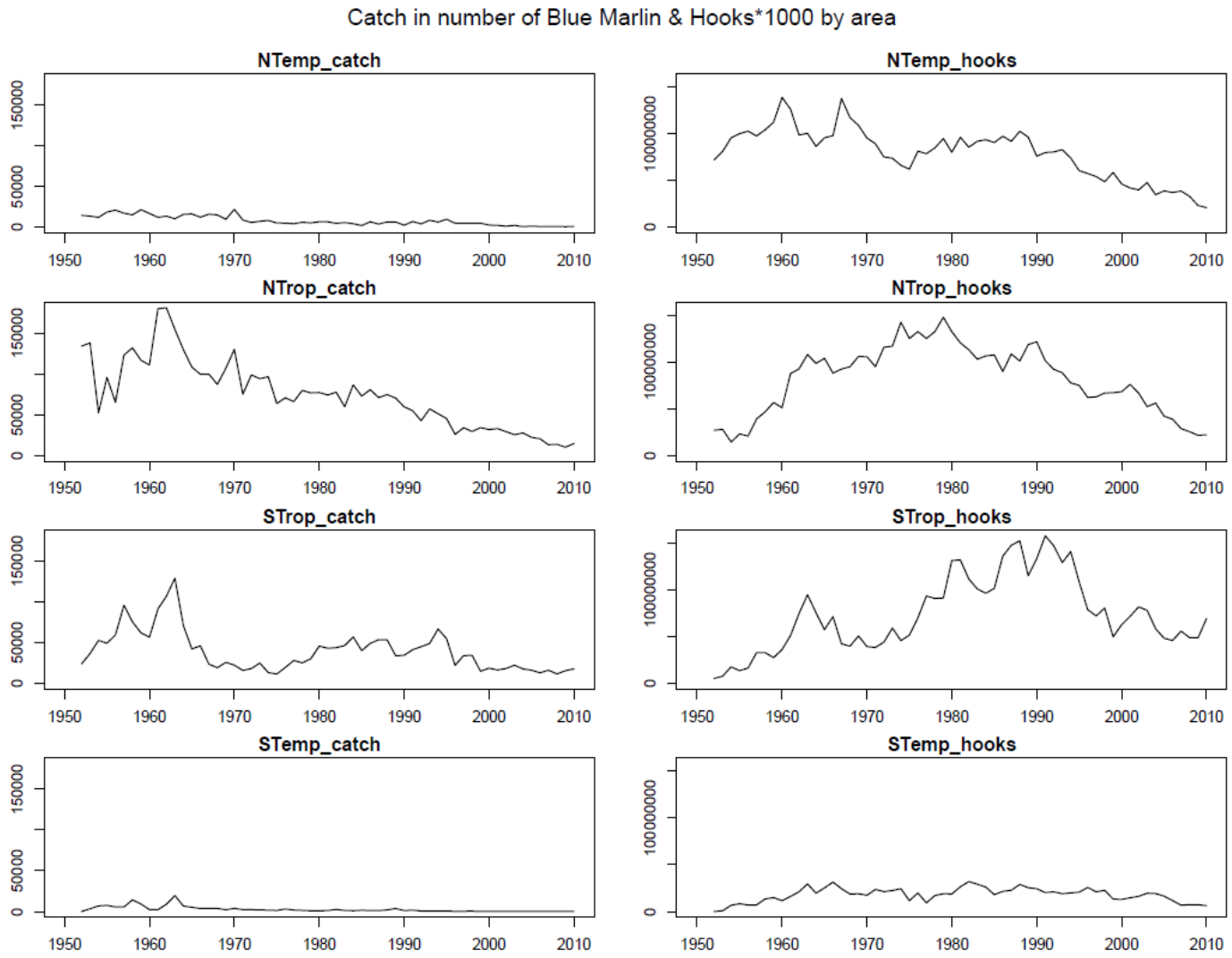


Figure 3. Catch in number of blue marlin (left column) and total hooks (right column) in the 4 areas (Figure 1-a) by Japanese distant-water longline for the period between 1952 and 2010.

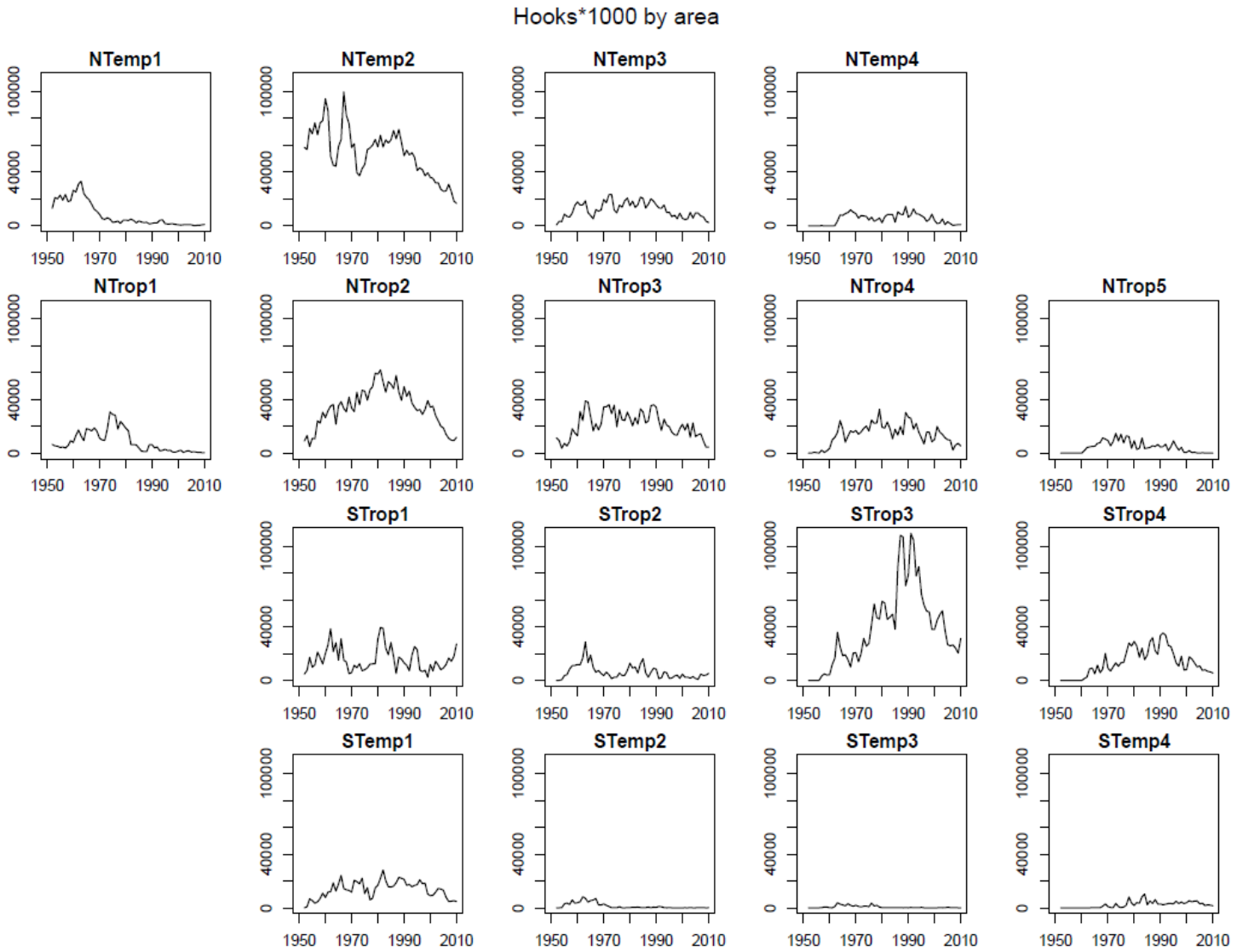


Figure 4. Total hooks in the small 17 areas (Figure 1-b) by Japanese distant-water longline for the period between 1952 and 2010.

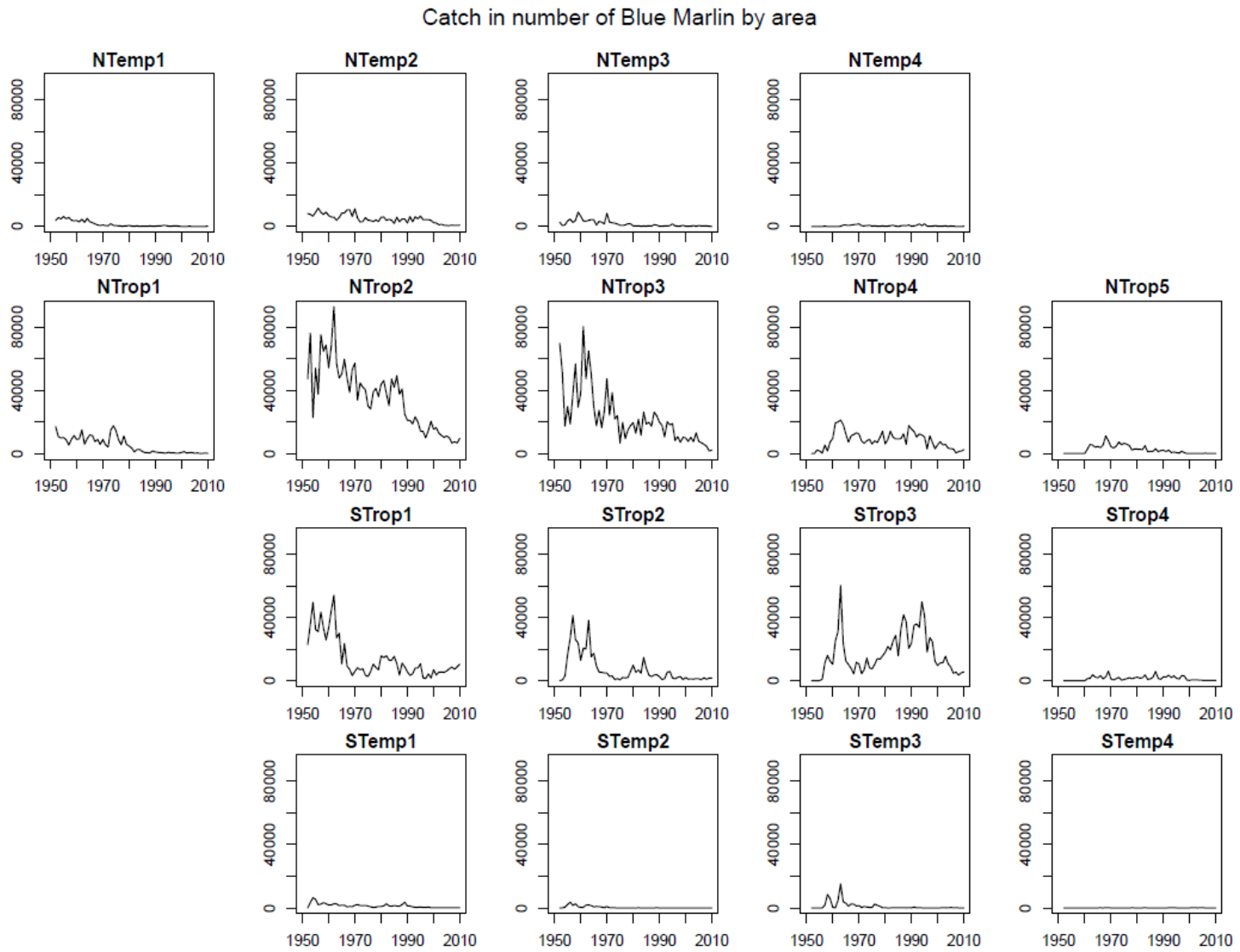


Figure 5. Catch in number of blue marlin in the small 17 areas (Figure 1-b) by Japanese distant-water longline for the period between 1952 and 2010.

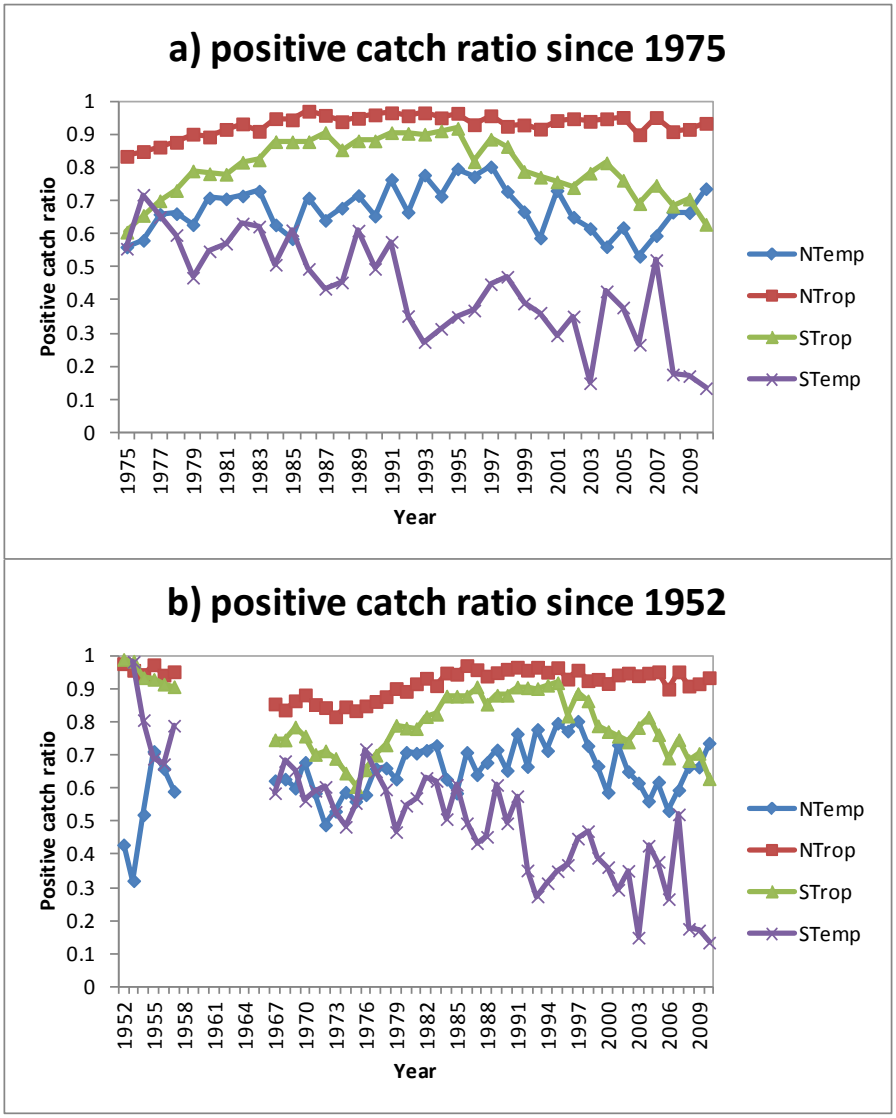


Figure 6. Positive catch ratio in the 4 areas (Figure 1-a) since 1975 (a) and since 1952 (b).

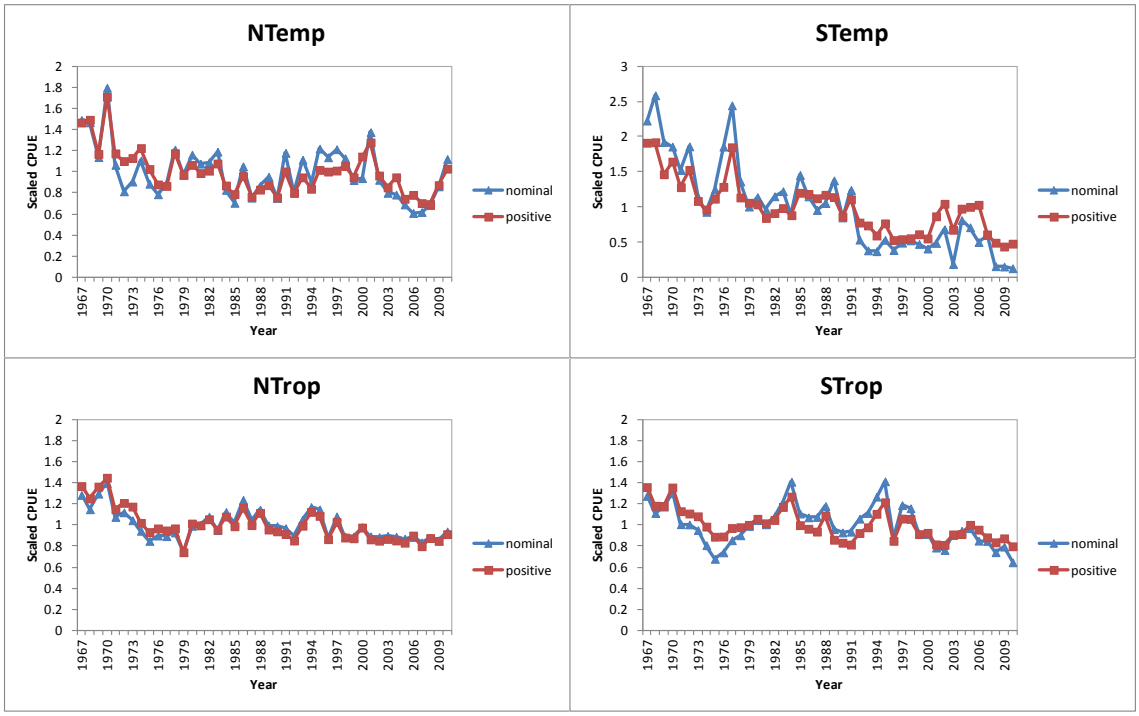


Figure 7. Scaled nominal CPUE (nominal) and nominal CPUE of positive catch (positive) since 1967 in the 4 areas (Figure 1-a). Each CPUE series were scaled by the average CPUE between 1967 and 2010.

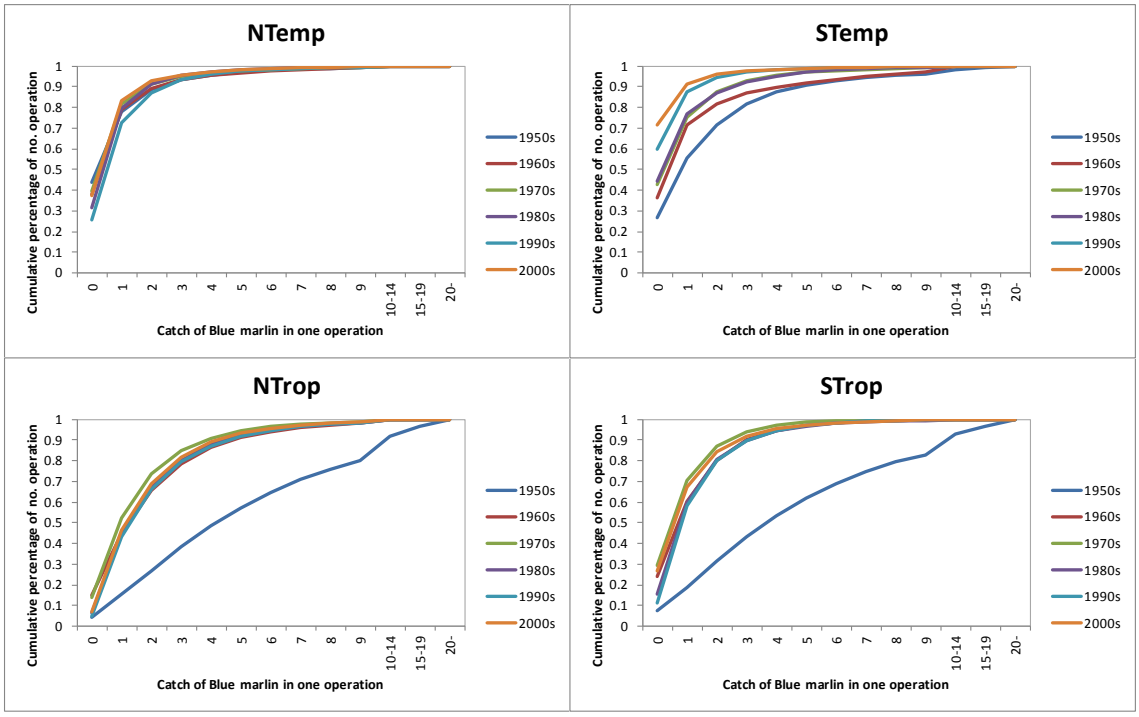


Figure 8. Cumulative percentage of number of operations by decade, area (Figure 1-a), and the number of blue marlin caught in one operation.

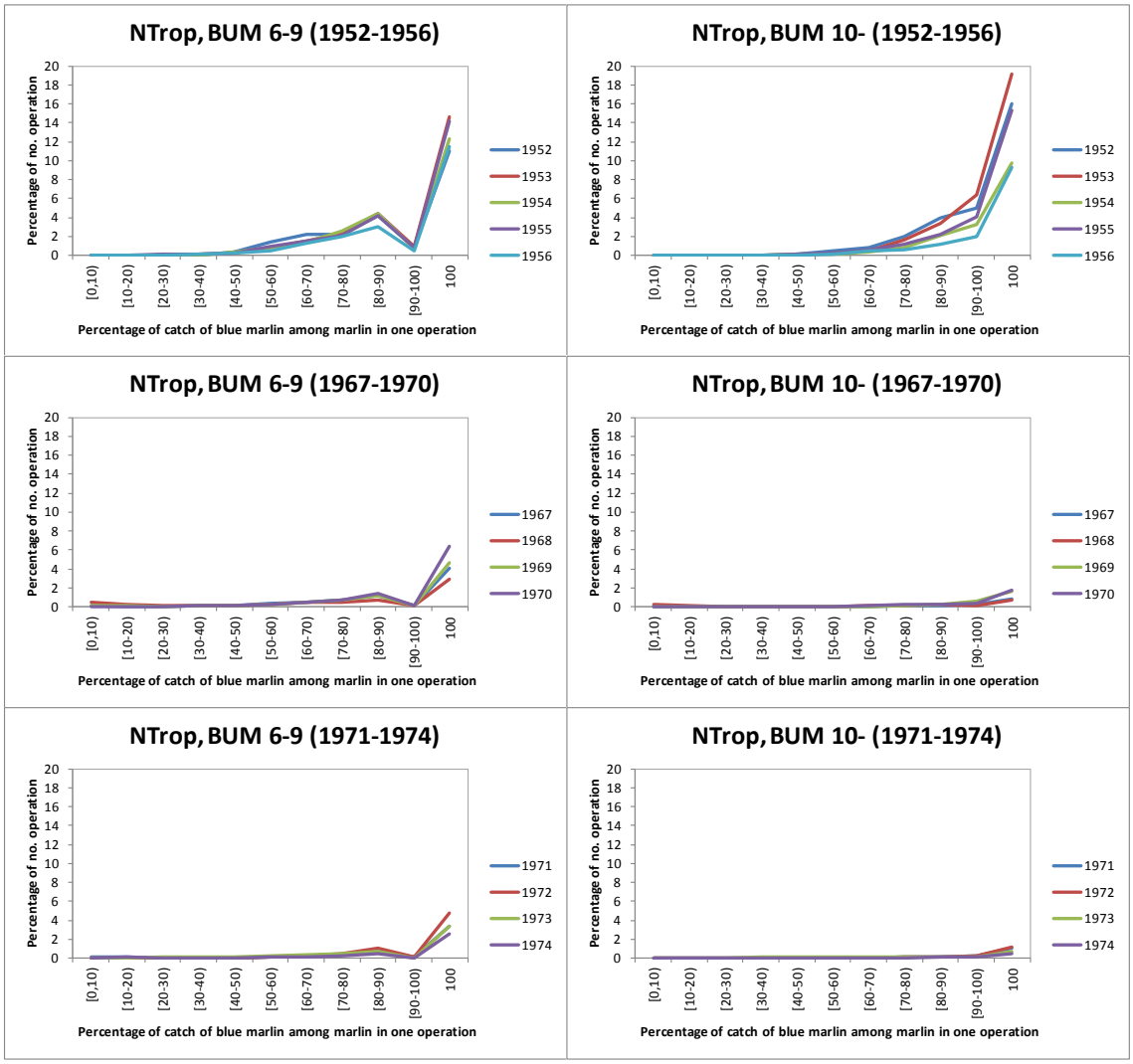


Figure 9. Percentage of number of operations that caught 6-9 (left column) or more than 10 (right column) blue marlin in the North and South Tropical areas, compared to the total number of operations in the same areas, by the percentage of catch of blue marlin among marlin (blue and black marlin, sailfish, and spearfish) in one operation for the period between 1952 and 1974.

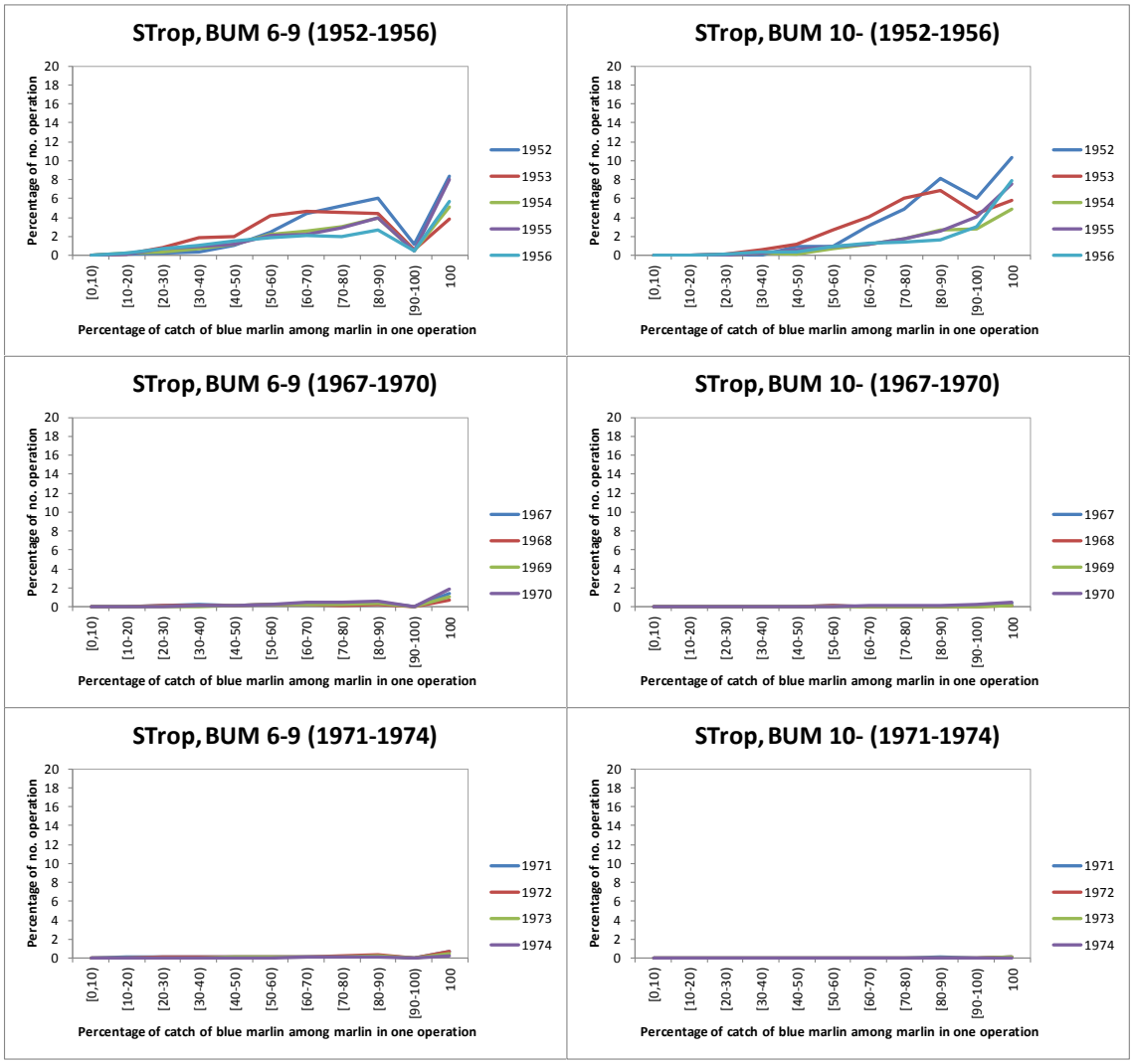


Figure 9. Continued.

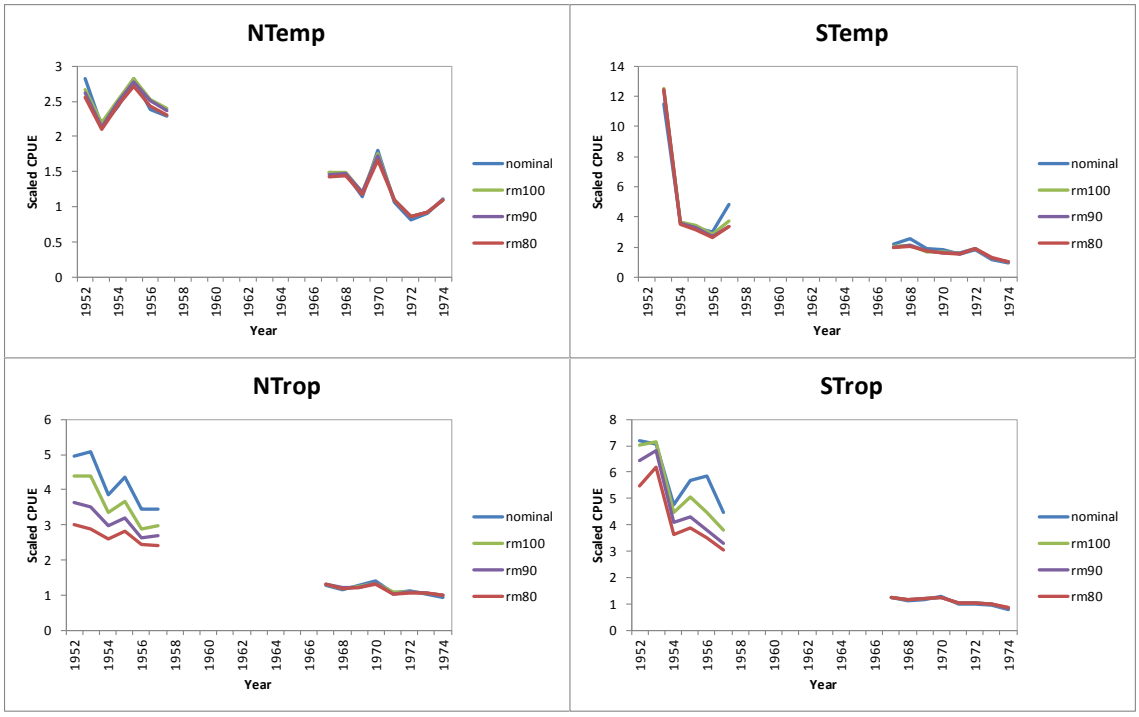


Figure 10. Scaled nominal CPUE using all data, and scaled nominal CPUE without partial operational data in which more than 6 blue marlin were caught and also blue marlin accounted for 100% (rm100), over 90% (rm90) or over 80% (rm80) of catch of marlin (blue and black marlin, sailfish, and spearfish) in the 4 areas (Figure 1-a). Each CPUE series were scaled by the average CPUE between 1967 and 2010.