CSIRO
MARINE RESEARCH

Trends in catch, effort and nominal catch rates in the Japanese longline fishery for SBT – 2004 update.

Jason Hartog

Tom Polacheck

Scott Cooper

Prepared for the CCSBT 5th Meeting of the Stock Assessment Group (SAG5) and the 9th Meeting of the Scientific Committee (SC9)
6-11 and 13-16 September 2004, Seogwipo KAL Hotel in Jeju, Korea

TABLE OF CONTENTS

List of Figures

List of Tables

1 Abstract

This paper updates previous analyses of catch, effort and catch-rate data from the Japanese longline fishery. The estimated global catch of SBT increased by 4% from 2000 to 2001 followed by a 5% reduction in 2002 and a further 8% in 2003.

Fishing effort in Statistical Areas 4-7, 8 and 9 had been steadily decreasing since the late 1980s, with the exception of area 9 where fishing effort increased in 2003. Fishing effort continues to become more concentrated spatially and temporally. 2003 had had the smallest number of 5°X5°square/month strata ever fished (100 compared to the previous low of 120 in 2002). Effort in April and August has been dramatically reduced in 2003 when compared to average effort over recent years. In addition, the percentage of effort (number of hooks) in 5°X5°square/month strata in which no SBT were caught has declined from a high of 21% in 1994 to less then 0.2% in 2003, most likely as a result of declines in effort not targeted at SBT (e.g. bigeye and yellowfin). Similarly the number of 5°X5°square/month strata which had some effort but no SBT catch has declined from 38% to 8% of strata fished within a year, This suggest an increasing concentration of fishing effort in areas of higher SBT densities.

The aggregated nominal CPUE indices for age 3-7 and ages 8 plus showed a positive trend in catch rates in recent years that are not maintained when the 2003 data are added. There are decreases in all indexes except the age 5 index, with substantial decreases in the age 3 and 4 index. Comparison of all the age specific indices by area since 1992 suggest that there has been a rather continuous increase in Area 9 for all ages since the mid 1990’s, with a decline between 2002 and 2003. In contrast, for area 4-7 the indices for the three oldest age classes have been declining since 1999 and in area 8 they have been decreasing nearly for all ages since 2000, with small increases in 2003.

2 Introduction

The Scientific Committee is conducting a detailed analytical assessment of the SBT stock in 2004. This will be the first full assessment since 2001. The catch per unit effort (CPUE) time series for the Japanese longline fisheries forms a critical component for all analytical assessments. It is the only long term time series of relative abundance that is available for the stock, and therefore is the only time series of data for "tuning" the catch at size and age data within a catch at age analysis. In addition to analytical stock assessment results, fishery indicators have played an important role in the provision of advice to managers on the status of the SBT stock by the CCSBT Scientific Committee and its Trilateral predecessor extending back to at least 1988 (e.g. Anon 1988). The Japanese longline catch and effort data have been the basis for a number of the indicators used by the CCSBT Scientific Committee (e.g. Anon. 1988, 2001, 2002, 2003). Indicators have been used to provide a broad perspective on recent changes in the status of the stock independent of the dynamical and weighting assumptions embedded in the analytical stock assessment models. Evaluation of a range of indicators has allowed information that is not readily incorporated into an analytical assumption to be assessed with respect to the consistency of the results from analytical assessments and thus provides some additional indications of the overall robustness of the results.

Within the more recent SBT analytical stock assessment models, only aggregated CPUE indices are used, although estimates of age specific indices have formed an important component of the fishery indicators that are examined.. Given the critical role that these aggregated indices play and the role of fishery indicators in the CCSBT Scientific Committee's assessment process, it is useful to have a more detailed understanding of the actual trends underlying the aggregated indices. This document presents a more in depth examination of the Japanese catch, effort and catch rate data. The document is an update of similar documents presented in the past and is similar in format to those presented at the 2001, 2002 and 2003 meetings of the Stock Assessment Group (SAG) and Scientific Committee (SC) of the CCSBT (Polacheck and Ricard 2001, Ricard and Polacheck 2002, Hartog et al 2003).

3 Data

The primary data used in this paper are the catch, effort and size data provided by the National Research Institute of Far Seas Fisheries of Japan (NRIFSF) for the Japanese SBT longline fishery. All the data provided by NRIFSF are in aggregated form. The catch and effort and size data have been aggregated by NRIFSF into monthly and 5° latitudinal and longitudinal square strata. The monthly catch has been aged using cohort slicing following procedures developed within the CCSBT Scientific Committee (Anon. 1994, Anon. 2001, Preece et al. 2001). In addition to the data supplied by NRIFSF, data from joint venture operations in Australia and charter operations in New Zealand involving Japanese vessels have been included in the basic data sets used in this paper. The vessels involved in these operations also fished as Japanese vessels at other times of the year and their basic operational characteristics were similar whether the vessel was fishing as a Japanese vessel or under a joint venture/charter arrangement.

Most of the catch rate and effort results presented in this paper are restricted to data from commercial operations in Statistical Areas 4-9 (Figure 3-1) and from the second and third quarter of the year (April through September). This was done because the data from these areas and quarters are used in the construction of the CPUE indices that are in the analytical catch-at-age assessments. These statistical areas represent the primary fishing areas and major known feeding areas for SBT. The second and third quarters have been the periods of most consistent fishing effort within these statistical areas. Moreover, most SBT are expected to be within these areas during this period. In the rest of the year, interpretation of CPUE indices is confounded by the migration of adults to the spawning grounds off Indonesia and the migration of juvenile below age 5 to inshore waters around Australia.

It should be noted that NRIFSF supplied revised catch and effort data for the SBT fishery in 2004. These revisions included changes to the data for all years but the differences in terms of catch rates within the main fishing areas (i.e. statistical areas 4-9) and months (April through September) are generally small. However, for this reason, the results presented may differ from similar results presented in earlier versions of this paper.

It should be noted that Japan previously reported for 1994 and 1995 that a large number of small fish (<25kg) had not been retained as a result of an industry instituted practice on non-observed vessels to return all landed non-dead small SBT in these two years. Although no data on these non-retained catches was included in the 2004 revised data, estimates of the number of non-retained fish were supplied in previous data supplied by NRIFSF. The estimated number of non-retained fish in these two years constituted a substantial number of fish. However, large uncertainty exists about these non-retained catches and how the figures relate to non-retained catches in other years. The estimates of the non-retained catches in 1994 and 1995 have never been included in the estimated CPUE trends. As such, the age specific CPUE estimates for younger ages and the aggregated estimates for these two years should be interpreted with caution.

Note that catch trends (unless otherwise noted) are for the entire calendar year and include all SBT catches.

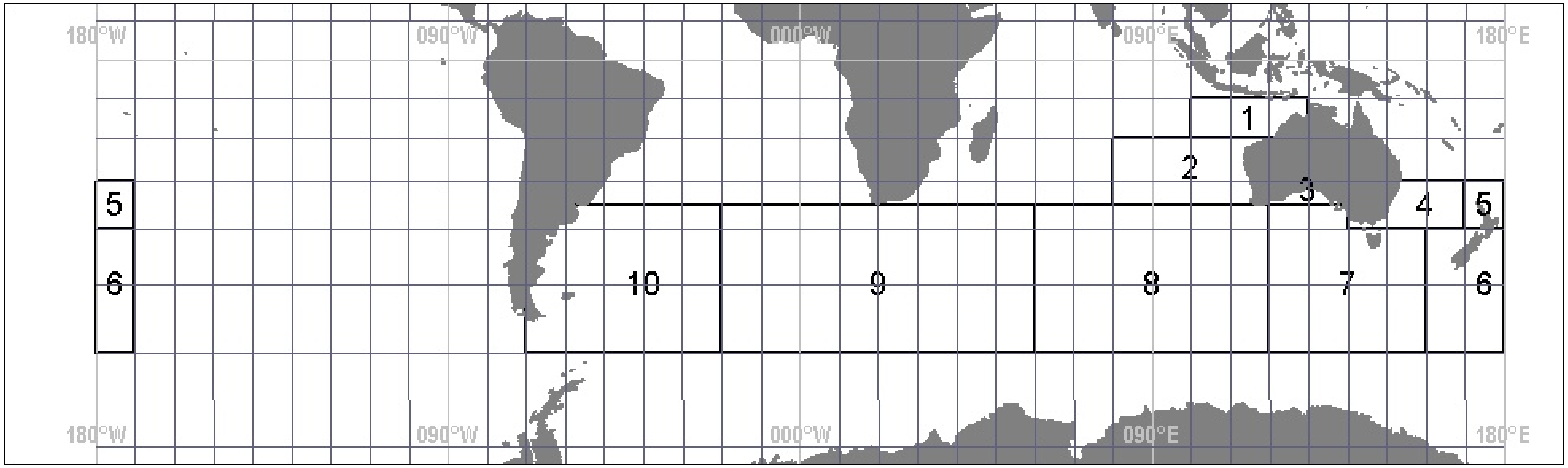
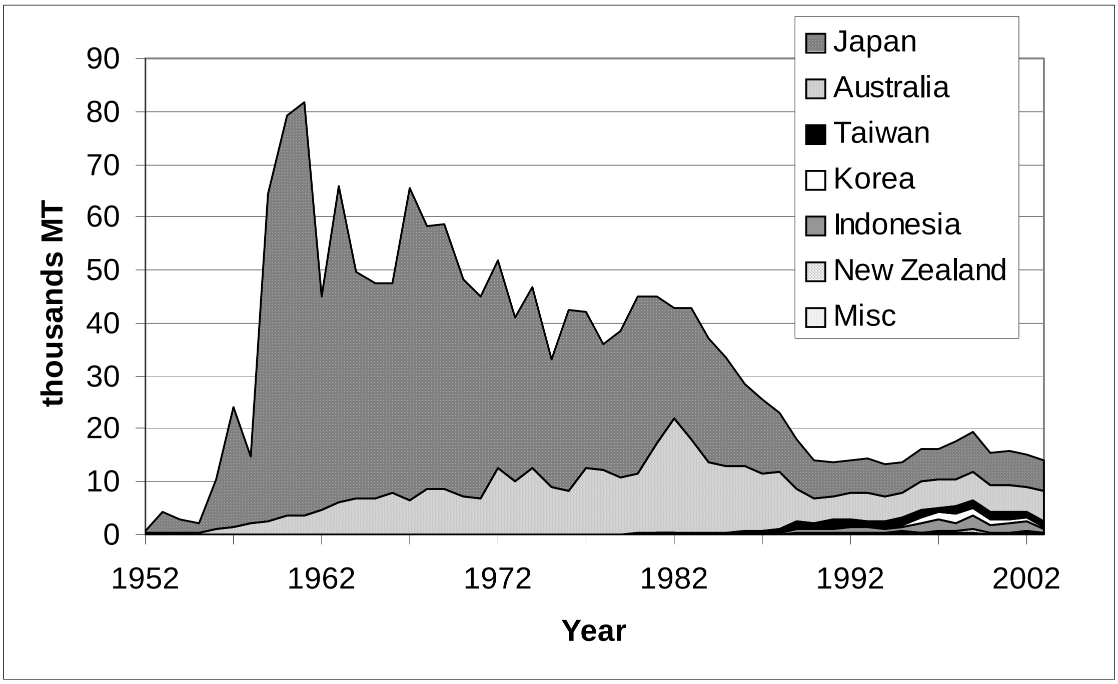


Figure 3-1 Traditional SBT statistical areas used for Japanese longline data.

4 Catch trends

Figure 4-1 provides estimates of the total annual catch of SBT in metric tonnes by country. Since the early 1990s, total estimated catches of SBT have been increasing. However, between 1999 and 2000, there has been a marked decline of 20% in the estimated global SBT catches, followed by a 4% increase between 2000 and 2001 and then a decrease of around 5% between 2001 and 2002, and 8% between 2002 and 2003. Part of the increases and decreases in the last two years stem from the fact that the Australian quota year starts in December and fluctuations in the extent of catches taken during December. However, more significant, has been substantive decreases in the estimate the catches by Indonesia and Korea.



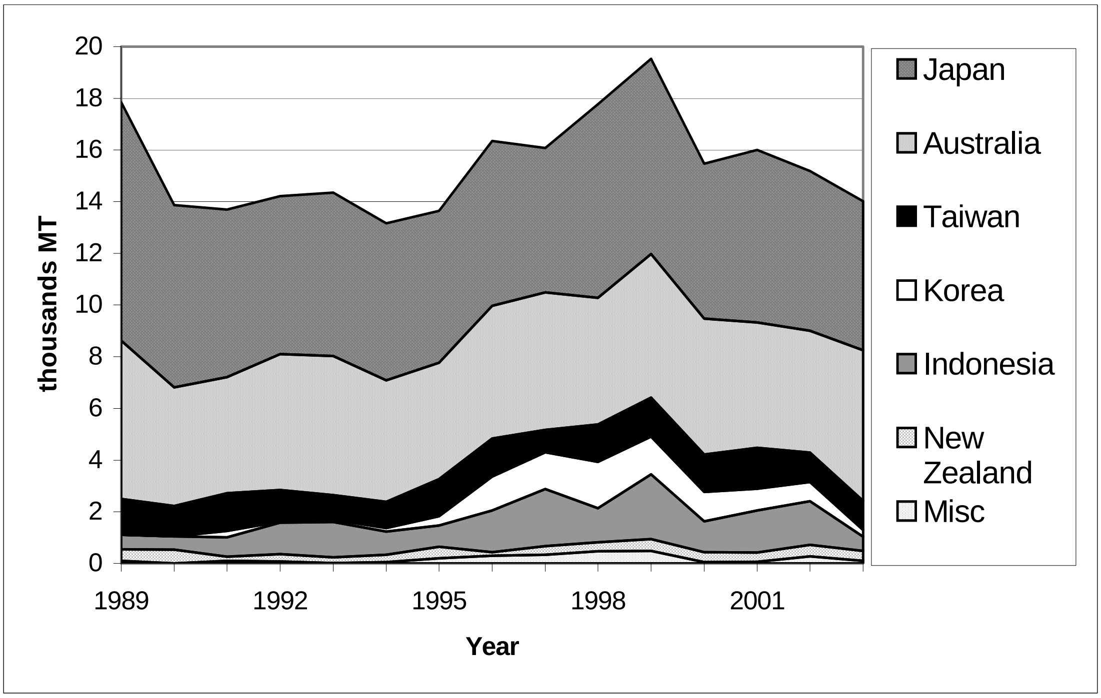


Figure 4-1 Estimates of the annual catch of SBT in metric tonnes by country.

5 Seasonal and Spatial distribution of effort

Figure 5-1 to Figure 5-8 provide an overview of the annual distribution of longline effort for 1996 through 2003 in Statistical Areas 4-9 during the second and third quarters. The general distributional patterns were similar over this period with effort concentrated over a relative wide longitudinal band around South Africa, a narrow band in the Southeast Indian Ocean and in the Tasman Sea region. However, also evident in these figures are annual changes in the location and intensity of fishing (e.g. southeast area of New Zealand).

Fishing effort in Statistical Areas 4-7, 8 and 9 had been steadily decreasing since the late 1980s. However, there had been a substantial increase of 22% in overall fishing effort from 2000 to 2001 followed by a decrease of 14% in 2002 that has continued in 2003 (10%), although the 2003 figure is preliminary and is likely to increase when complete data become available (Figure 5-9). Effort in area 9 increased by 25% between 2000 and 2001 followed by a 30% decrease in 2002 and then a 16% increase in 2003. Effort in areas 4-7 and area 8 decreased by 26% and 38% respectively in 2003.

Fishing effort continues to be concentrated spatially and temporally. Thus, fishing effort was only reported in 100 5°X5° square/month strata in 2003, which is the smallest number ever reported (Table 5-1). The previous low was 120. Fishing effort is concentrating in May – July (months 5-7), there being almost no effort in April, August and September in areas 8 and 9 (Table 5-3 and Table 5-4).

Figure 5-11 shows the spatial and temporal change in effort by month by comparing the effort in 5x5 squares in 2003 with the average effort in 5x5 squares over 1999-2001. The months of April and August show the biggest differences with effectively no effort in August in 2003, and most of the effort in April concentrated off the East coast of Tasmania, and indeed an increase in effort in that 5x5 square in April. Virtually no effort is being made in the squares south of the Great Australian Bight in months 4-6.

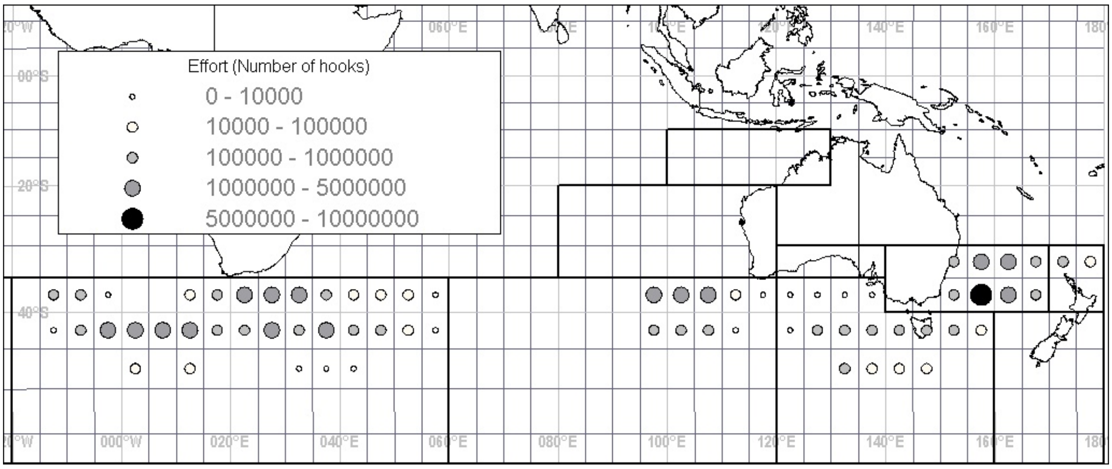


Figure 5-1 Distribution of fishing effort in 1996, statistical areas 4-9, months 4-9.

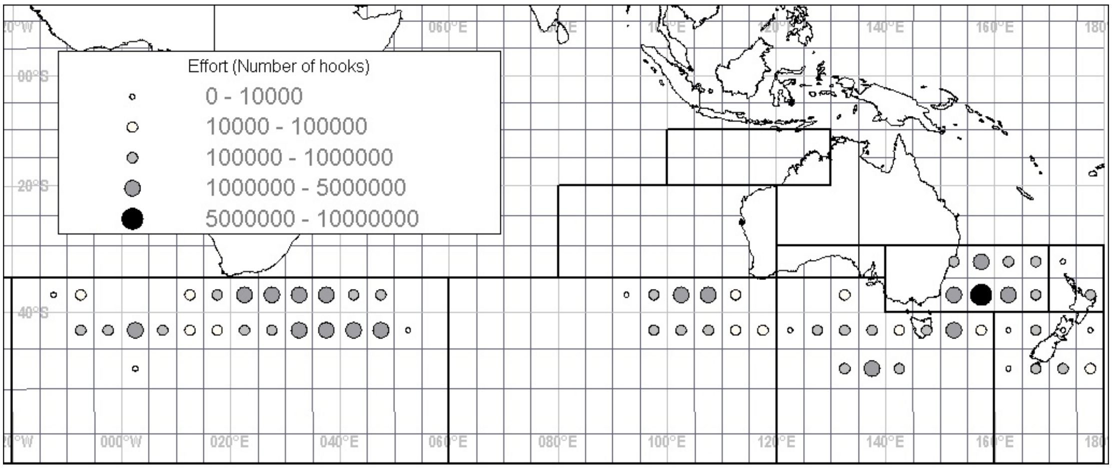


Figure 5-2 Distribution of fishing effort in 1997, statistical areas 4-9, months 4-9.

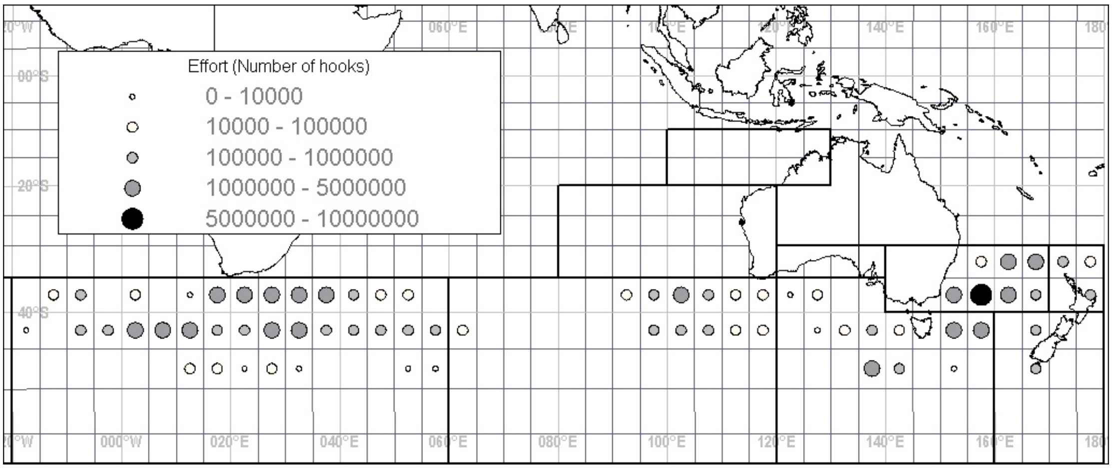


Figure 5-3 Distribution of fishing effort in 1998, statistical areas 4-9, months 4-9.

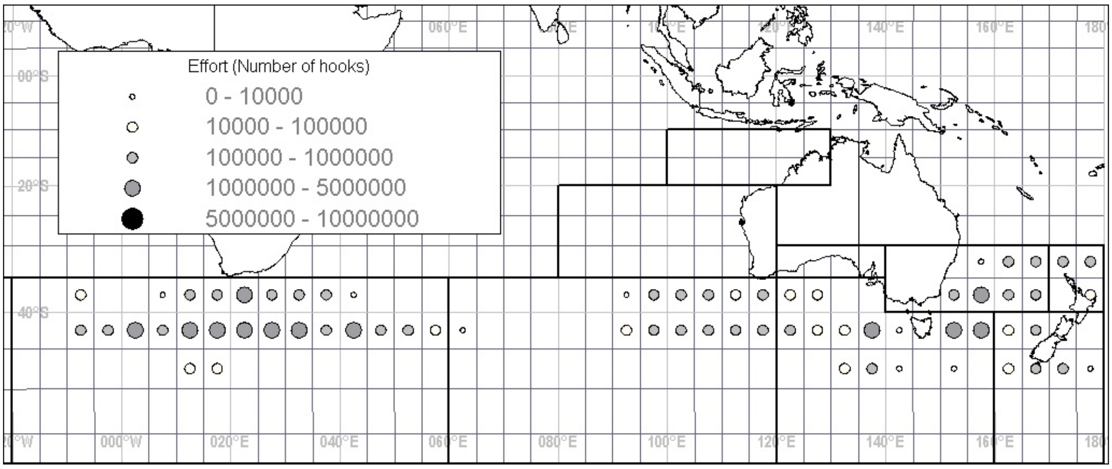


Figure 5-4 Distribution of fishing effort in 1999, statistical areas 4-9, months 4-9.

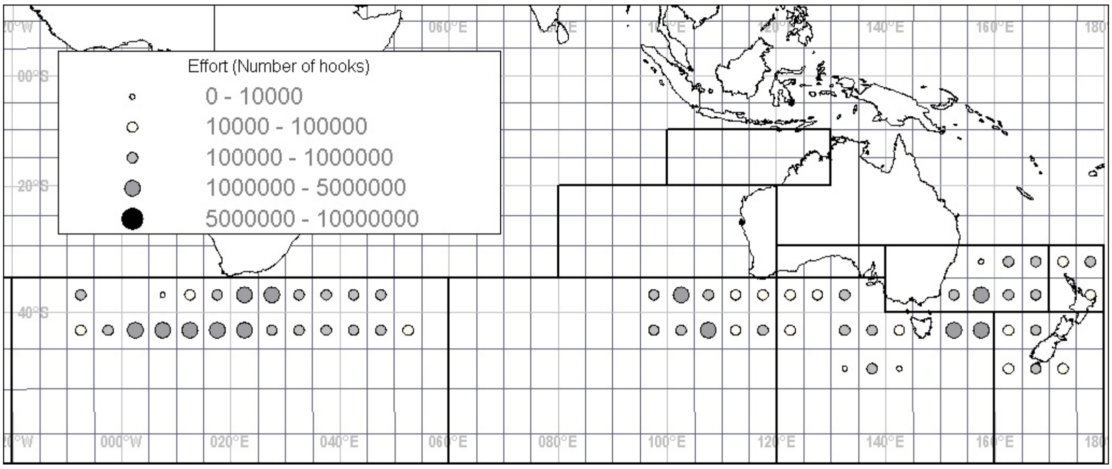


Figure 5-5 Distribution of fishing effort in 2000, statistical areas 4-9, months 4-9.

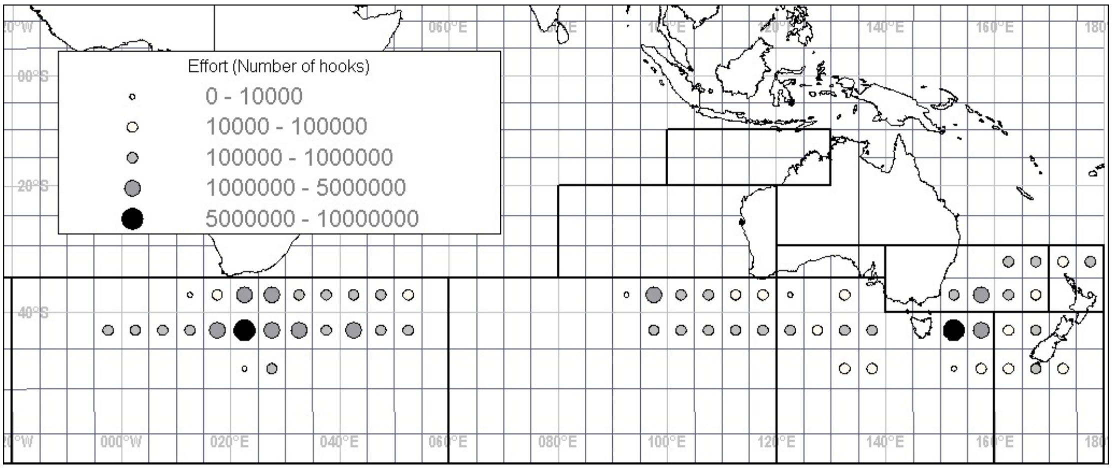


Figure 5-6 Distribution of fishing effort in 2001, statistical areas 4-9, months 4-9.

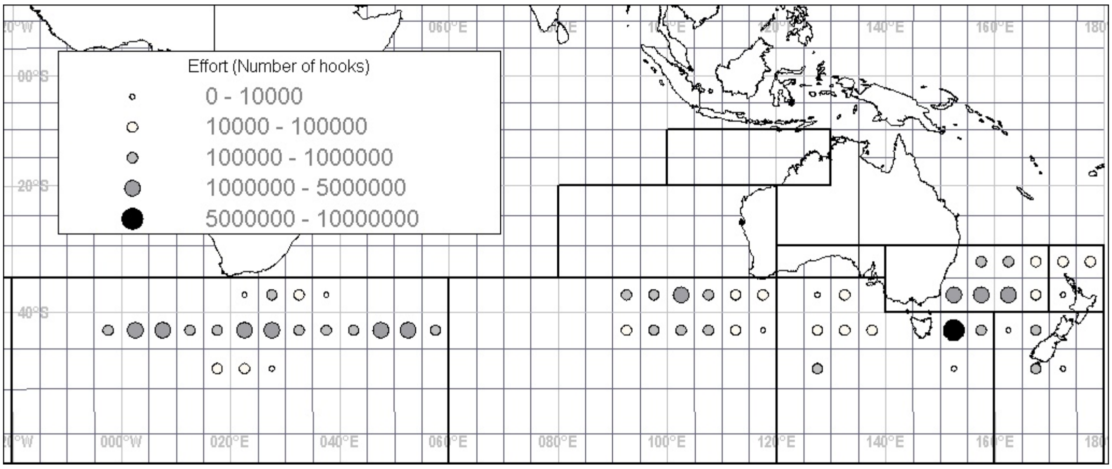


Figure 5-7 Distribution of fishing effort in 2002, statistical areas 4-9, months 4-9.

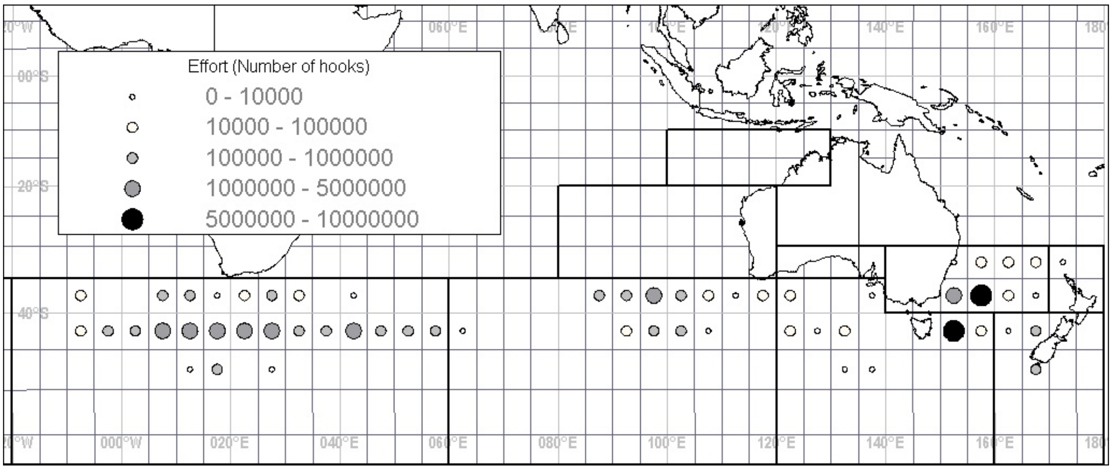


Figure 5-8 Distribution of fishing effort in 2003, statistical areas 4-9, months 4-9.

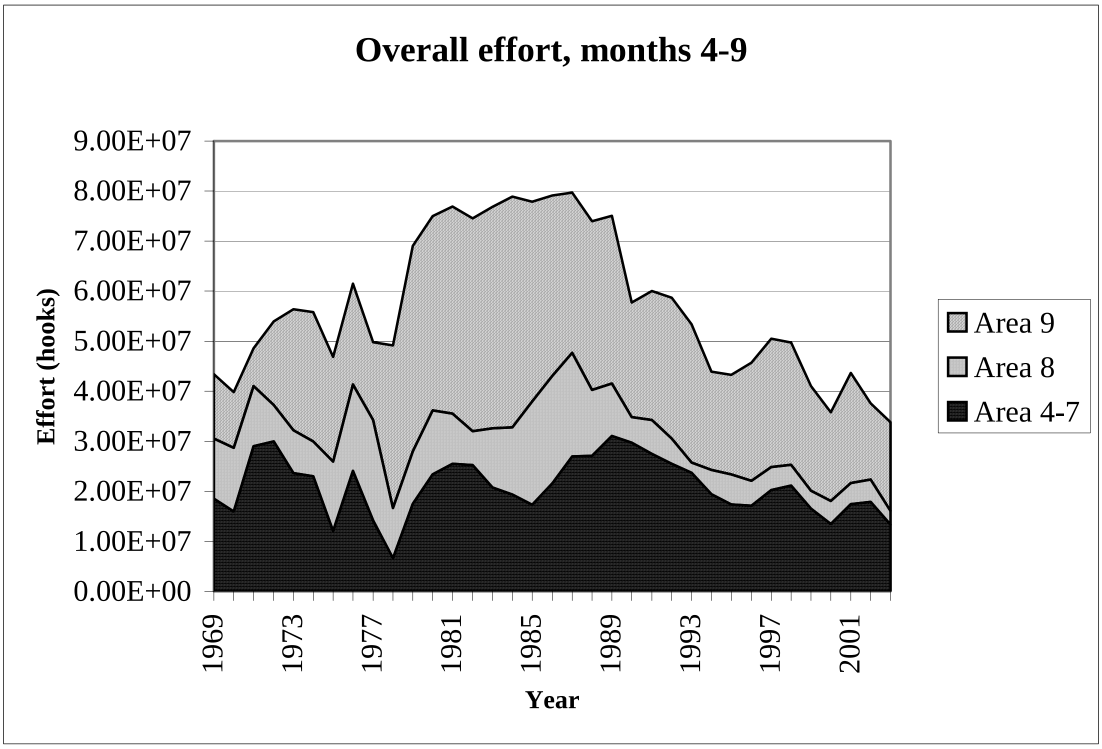


Figure 5-9 Fishing effort in Statistical Areas 4-7, 8 and 9, months 4-9.

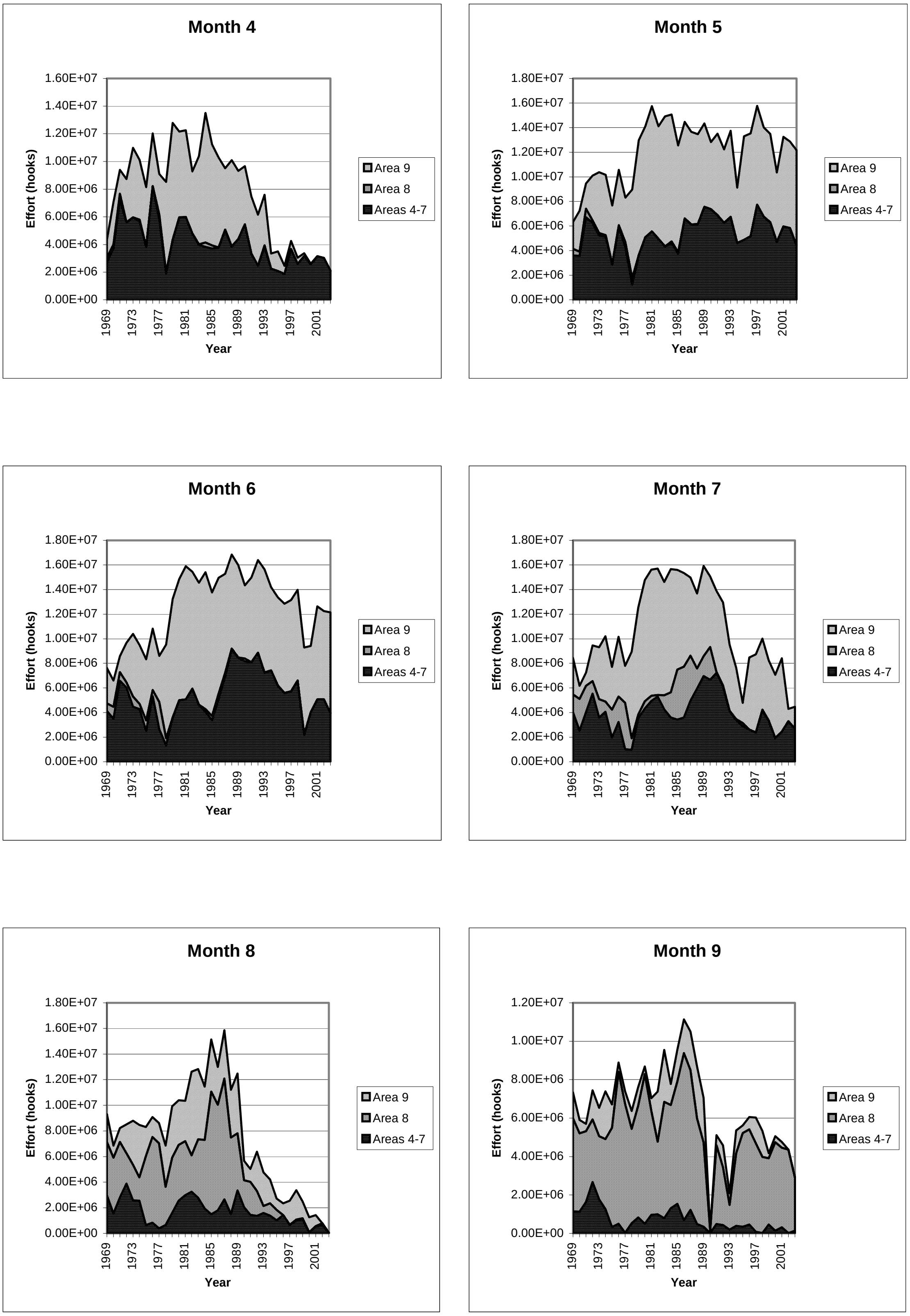


Figure 5-10 Monthly fishing effort in Statistical Areas 4-7, 8 and 9.

Table 5-1 Number of squares fished by year and month in statistical areas 4-9. Note that total is the total number of 5x5 square/month strata (i.e. some 5x5 squares are fished in more then one month).

NUMBER_OF_SQUARES_SA_4-9							
YEAR	MONTH_4	MONTH_5	MONTH_6	MONTH_7	MONTH_8	MONTH_9	TOTAL
1969	48	69	55	59	52	38	321
1970	68	75	68	42	41	37	331
1971	55	63	52	42	34	40	286
1972	41	47	38	38	36	40	240
1973	42	47	48	44	39	34	254
1974	52	59	41	32	33	42	259
1975	44	50	42	44	39	36	255
1976	37	51	47	40	37	42	254
1977	46	52	44	33	26	28	229
1978	43	48	35	34	32	23	215
1979	35	44	34	40	34	42	229
1980	43	40	39	36	34	28	220
1981	42	42	37	37	31	30	219
1982	42	41	37	40	40	37	237
1983	39	37	39	36	35	35	221
1984	45	57	47	40	26	32	247
1985	44	51	52	38	31	29	245
1986	43	48	52	40	36	29	248
1987	39	44	49	45	32	34	243
1988	43	48	45	43	35	30	244
1989	36	39	47	46	36	31	235
1990	42	48	47	49	33	12	231
1991	31	51	44	45	33	28	232
1992	37	44	41	46	24	24	216
1993	38	46	40	44	24	20	212
1994	19	33	51	28	20	18	169
1995	21	44	40	26	22	18	171
1996	15	46	49	37	16	17	180
1997	25	42	44	33	7	17	168
1998	19	44	47	37	22	17	186
1999	26	38	30	38	25	19	176
2000	23	32	35	34	9	17	150
2001	17	33	32	32	19	21	154
2002	13	28	27	28	10	14	120
2003	10	24	28	23	2	13	100

Table 5-2 Number of squares fished by year and month in statistical areas 4-7. . Note that total is the total number of 5x5 square/month strata (i.e. some 5x5 squares are fished in more then one month).

NUMBER_OF_SQUARES_SA_4-7							
YEAR	MONTH_4	MONTH_5	MONTH_6	MONTH_7	MONTH_8	MONTH_9	TOTAL
1969	16	32	18	18	19	12	115
1970	33	34	27	14	17	11	136
1971	17	34	27	14	17	17	126
1972	22	27	19	12	17	16	113
1973	26	28	19	14	14	14	115
1974	23	33	20	12	13	19	120
1975	20	27	16	11	12	11	97
1976	22	29	23	13	13	15	115
1977	20	28	18	4	4	3	77
1978	18	18	8	7	7	4	62
1979	14	21	15	11	9	15	85
1980	18	20	16	7	10	8	79
1981	15	21	18	10	13	12	89
1982	18	19	17	14	14	15	97
1983	22	20	15	11	14	10	92
1984	20	31	23	12	12	10	108
1985	22	23	20	10	9	8	92
1986	20	27	24	16	9	10	106
1987	20	25	27	16	12	13	113
1988	20	23	23	18	12	10	106
1989	17	20	25	19	11	6	98
1990	22	24	26	19	13	2	106
1991	14	28	26	23	14	7	112
1992	13	22	26	23	10	6	100
1993	13	24	21	22	7	3	90
1994	9	12	23	12	5	2	63
1995	12	20	19	12	8	3	74
1996	9	20	19	12	10	5	75
1997	21	20	24	12	3	3	83
1998	14	15	19	14	8	2	72
1999	19	19	7	14	9	4	72
2000	18	16	14	13	5	4	70
2001	16	16	12	14	6	5	69
2002	13	13	12	14	6	2	60
2003	10	7	8	6	2	2	35

Table 5-3 Number of squares fished by year and month in statistical area 8. . Note that total is the total number of 5x5 square/month strata (i.e. some 5x5 squares are fished in more then one month).

NUMBER_OF_SQUARES_SA_8							
YEAR	MONTH_4	MONTH_5	MONTH_6	MONTH_7	MONTH_8	MONTH_9	TOTAL
1969	10	18	17	18	14	18	95
1970	10	14	19	11	10	12	76
1971	15	11	9	10	10	12	67
1972	0	5	6	9	9	8	37
1973	1	4	10	9	13	9	46
1974	7	3	5	8	7	10	40
1975	6	4	5	15	14	16	60
1976	0	5	9	12	16	15	57
1977	10	7	12	14	12	15	70
1978	5	12	7	8	13	11	56
1979	1	1	3	6	13	18	42
1980	3	0	2	8	11	14	38
1981	0	1	0	9	7	13	30
1982	2	0	0	6	10	14	32
1983	2	1	3	7	10	12	35
1984	4	5	8	9	6	12	44
1985	3	6	11	11	11	13	55
1986	1	1	6	11	15	12	46
1987	0	0	8	12	12	12	44
1988	0	1	3	10	10	12	36
1989	0	1	3	9	12	13	38
1990	0	0	1	13	13	7	34
1991	0	0	2	3	11	12	28
1992	2	0	0	2	8	11	23
1993	2	1	2	2	8	12	27
1994	0	0	2	2	6	11	21
1995	0	0	1	5	9	10	25
1996	0	2	2	1	0	8	13
1997	0	0	0	0	0	10	10
1998	0	1	0	2	2	11	16
1999	0	1	1	4	3	12	21
2000	0	0	0	0	0	10	10
2001	0	0	0	0	2	11	13
2002	0	0	0	1	4	12	17
2003	0	1	0	0	0	11	12

Table 5-4 Number of squares fished by year and month in statistical area 9. . Note that total is the total number of 5x5 square/month strata (i.e. some 5x5 squares are fished in more then one month).

NUMBER_OF_SQUARES_SA_9							
YEAR	MONTH_4	MONTH_5	MONTH_6	MONTH_7	MONTH_8	MONTH_9	TOTAL
1969	22	19	20	23	19	8	111
1970	25	27	22	17	14	14	119
1971	23	18	16	18	7	11	93
1972	19	15	13	17	10	16	90
1973	15	15	19	21	12	11	93
1974	22	23	16	12	13	13	99
1975	18	19	21	18	13	9	98
1976	15	17	15	15	8	12	82
1977	16	17	14	15	10	10	82
1978	20	18	20	19	12	8	97
1979	20	22	16	23	12	9	102
1980	22	20	21	21	13	6	103
1981	27	20	19	18	11	5	100
1982	22	22	20	20	16	8	108
1983	15	16	21	18	11	13	94
1984	21	21	16	19	8	10	95
1985	19	22	21	17	11	8	98
1986	22	20	22	13	12	7	96
1987	19	19	14	17	8	9	86
1988	23	24	19	15	13	8	102
1989	19	18	19	18	13	12	99
1990	20	24	20	17	7	3	91
1991	17	23	16	19	8	9	92
1992	22	22	15	21	6	7	93
1993	23	21	17	20	9	5	95
1994	10	21	26	14	9	5	85
1995	9	24	20	9	5	5	72
1996	6	24	28	24	6	4	92
1997	4	22	20	21	4	4	75
1998	5	28	28	21	12	4	98
1999	7	18	22	20	13	3	83
2000	5	16	21	21	4	3	70
2001	1	17	20	18	11	5	72
2002	0	15	15	13	0	0	43
2003	0	16	20	17	0	0	53

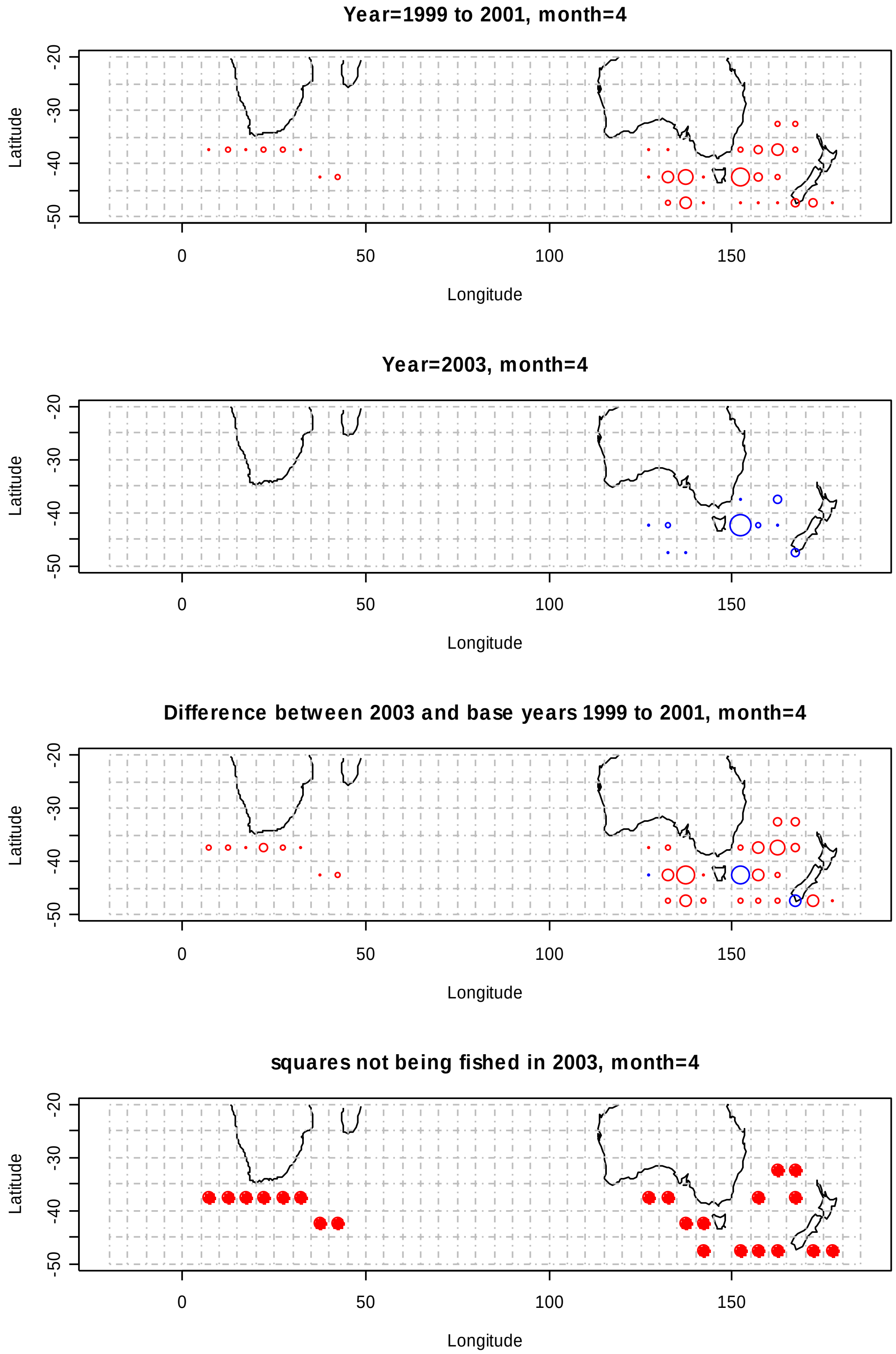


Figure 5-11 Comparison of the effort in 2003 by month and square to the average effort between 1999 and 2001 (baseline) by month and square. Panel 3 shows the absolute difference between 2003 and the baseline average with the effort colouring being blue if a square in 2003 was larger than the corresponding square in the baseline, and red if it was smaller. Panel 4 shows the squares that were not fished in 2003 that were previously fished in the baseline.

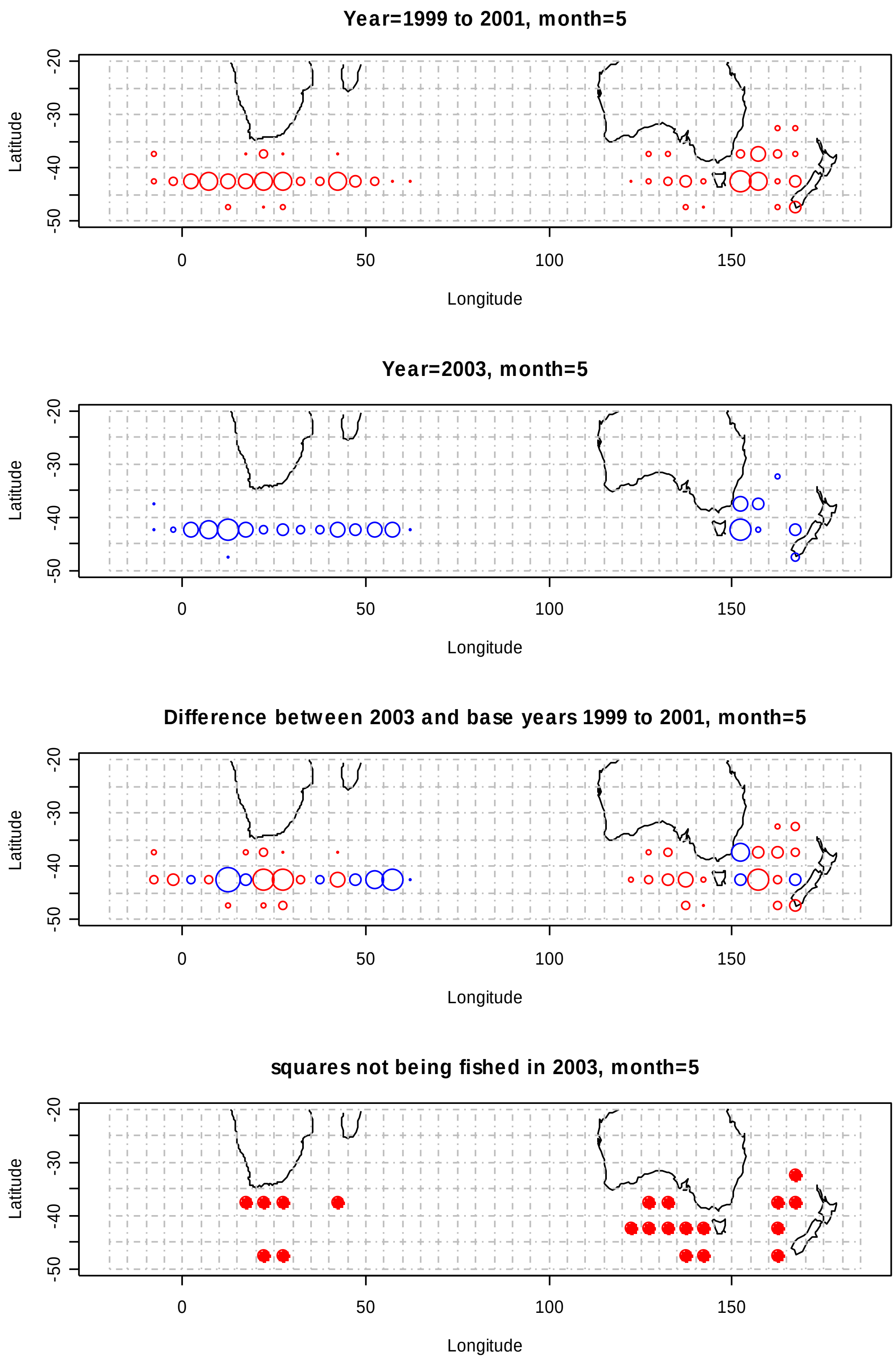


Figure 5-11 (cont)

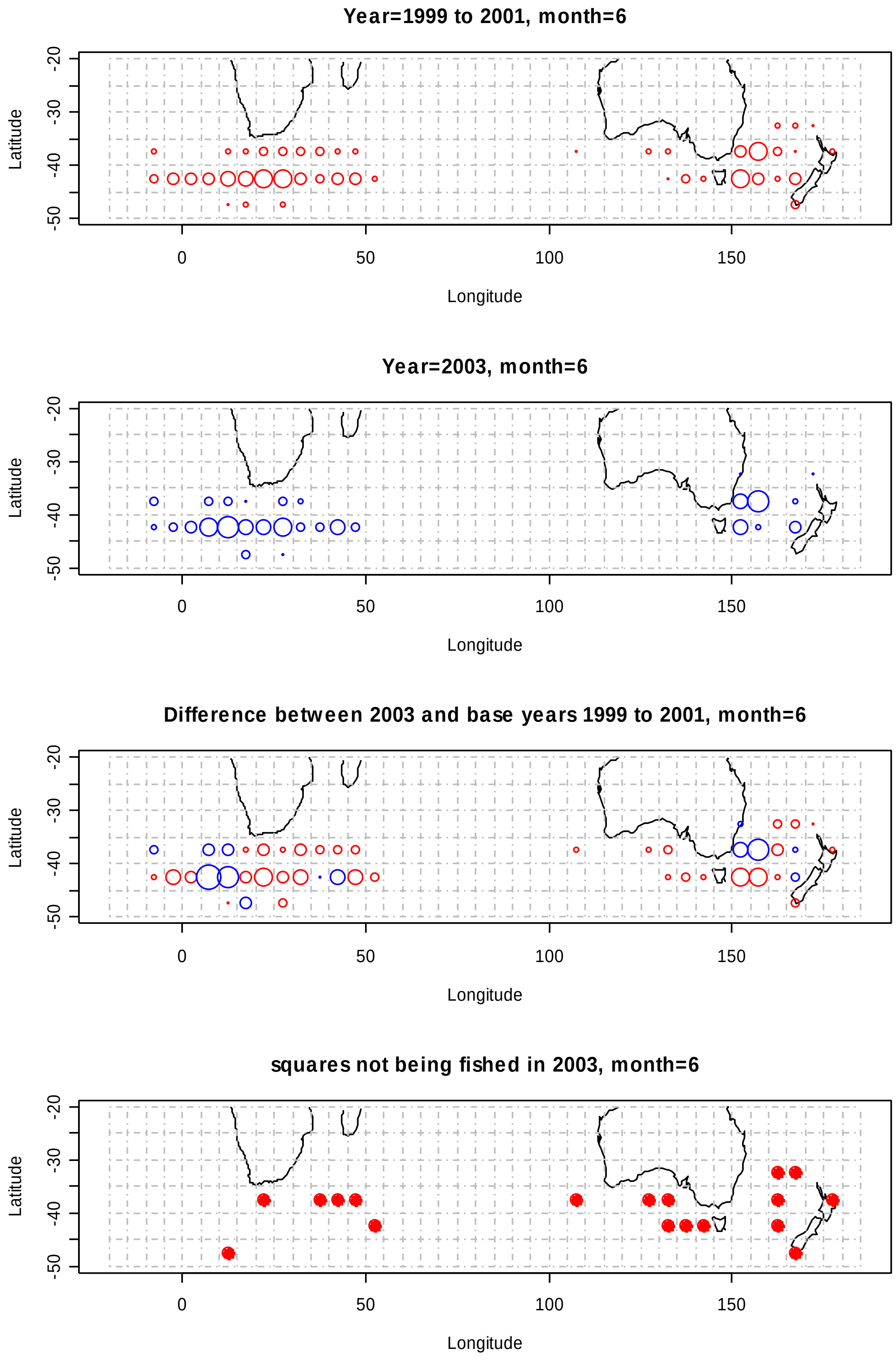


Figure 5-11 (cont)

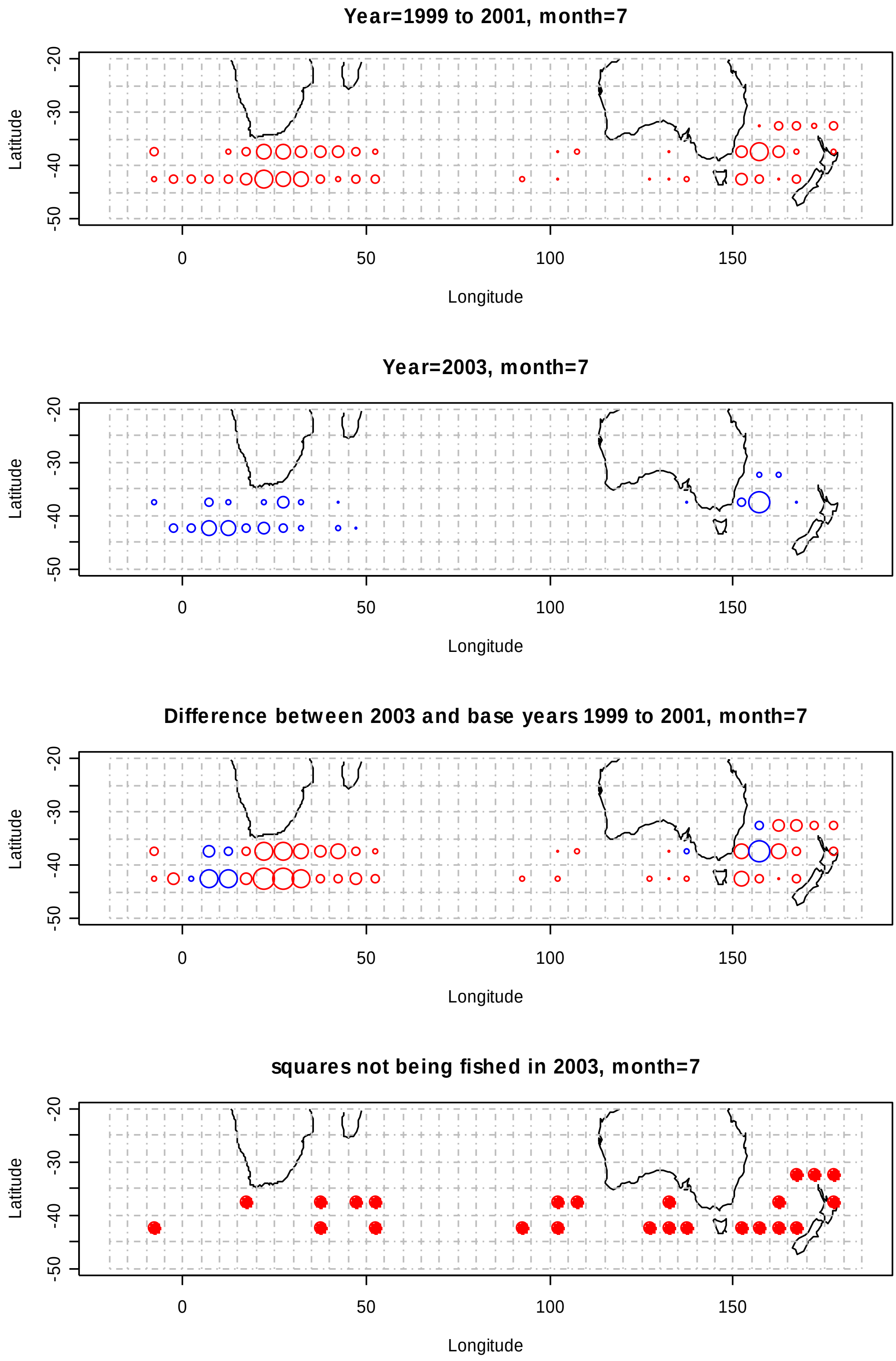


Figure 5-11 (cont)

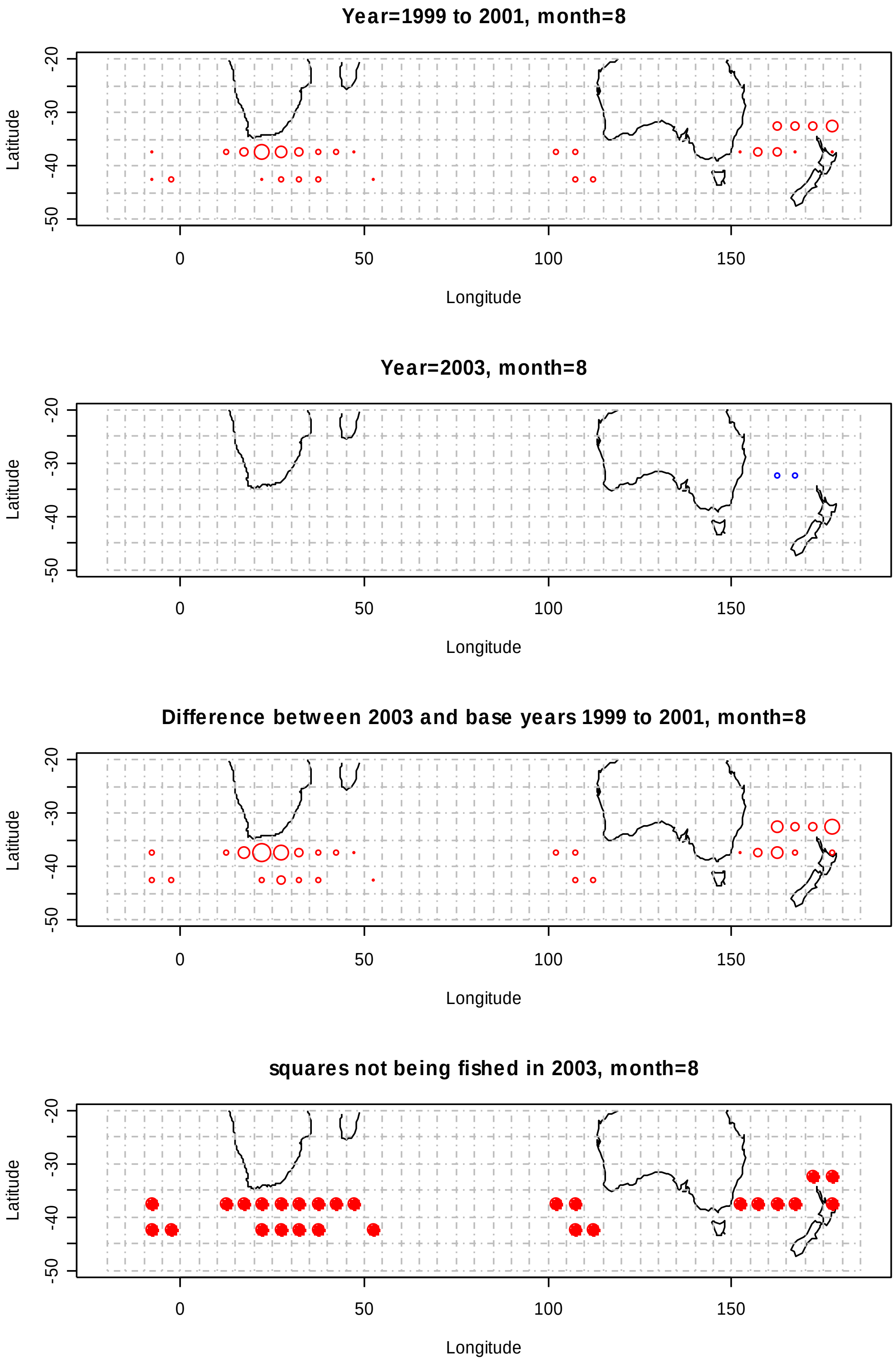


Figure 5-11 (cont)

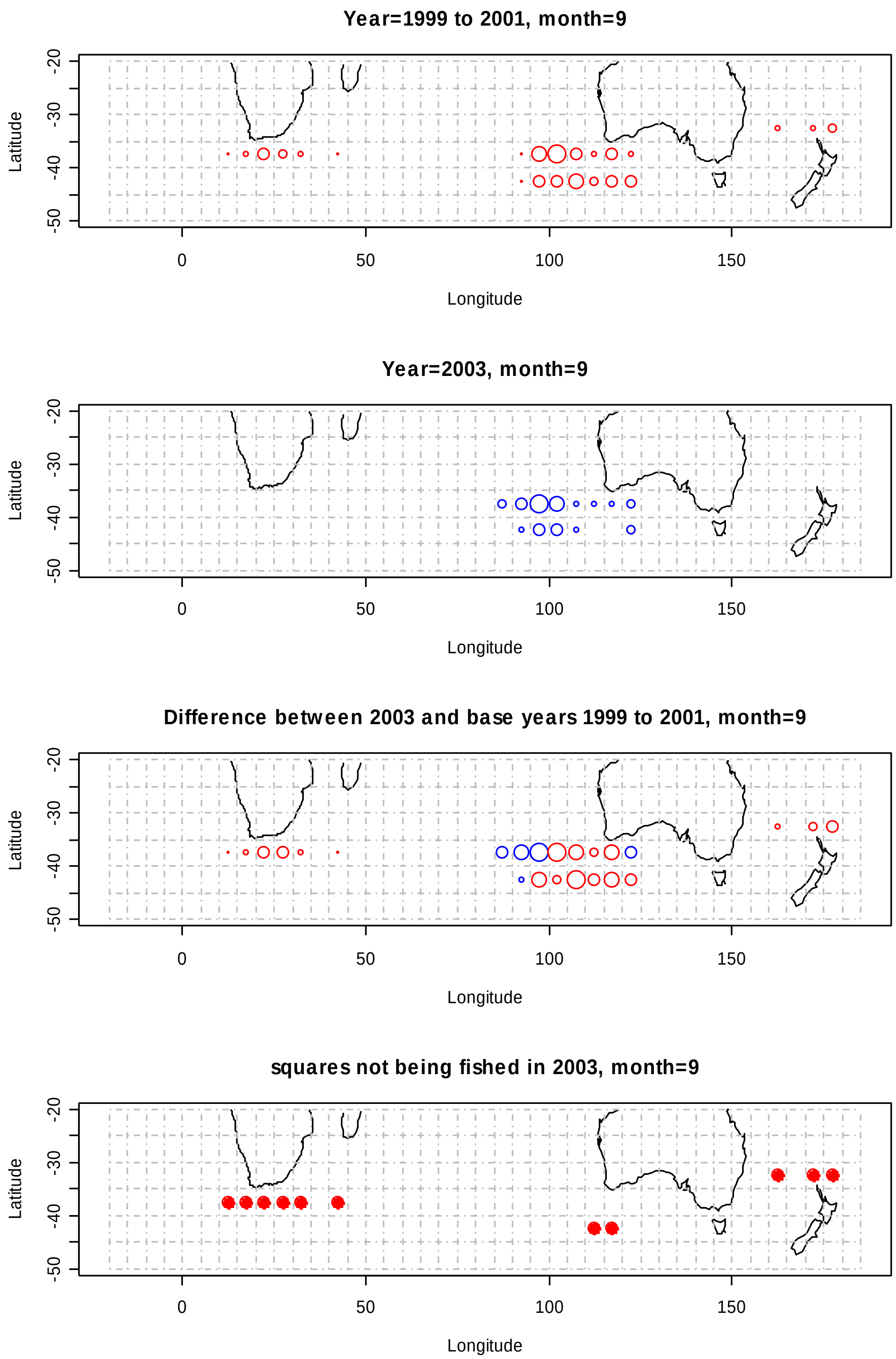


Figure 5-11 (cont)

6 Effort with no SBT catches

Within the main SBT fishing areas and seasons, there has always been some effort in 5x5 degree square/month strata in which there was no SBT caught (Figure 6-1 and Figure 6-2). Some of this effort appears to have been related to searching for fish because of uncertainties about the location of SBT (e.g. the percent to the total effort in squares in which no SBT were caught declined during the first 10 years of the time series, while the actual number of strata with zero catch was relatively stable). Thus, out of the 225 strata with effort in at least one year but with no SBT catches, 41% of these were only fished in one or two years. However, some of the effort in non-zero squares appears to be related to targeting on non-SBT catches (i.e. Bigeye and Yellowfin). Thus, there are a number of strata that have been relatively consistently fished and in which SBT were infrequently caught (Figure 6-3). For Example, 33% of the strata in which no SBT were caught in at least one year were fished for 10 or more years. For those strata no SBT were caught in 90% of the years that they were fished. All of these more persistently fished strata occurred in the more northerly latitude bands within statistical areas 4-9, where bigeye and yellowfin would be expected to be more common.

In the 1980s both the fraction of the effort in strata with no SBT catch began to increase as did the proportion of bigeye and yellowfin catches in the total catch (Figure 6-1, Figure 6-2 and Figure 6-4). While there is potential confounding between changes in species targeting and decreasing abundance of SBT (e.g. the proportion of SBT in the catch would be expected to decrease irrespective of changes in catches if SBT were declining and bigeye and yellowfin abundances were constant). Nevertheless, the persistence and increases in the number of strata fished with no SBT and the increasing percentage of effort in such squares in the late 1980s through the mid-1990s along with the increasing fraction of non SBT tuna catches strongly suggests that the increasingly high effort in this period was due to changes in targeting. In any case, both the number of strata with effort and no SBT catches and the percent of the total effort in such squares has decreased sharply from its peak in 1994 to a low in 2003 (i.e. from 37% to 8% in the number of strata and from 21% to 0.2% of the total effort). This combined with the decreases in the number of strata actually fished (Table 5-1) suggests a substantive change in effort targeted at non-SBT catches. Unfortunately, catch compositional data are not available past 1997 so it is not possible to determine if the decrease in effort in strata with no SBT catches is linked with decreases in non SBT tuna catches.

Large changes in targeting can induce biases into temporal trends in CPUE. Thus, the large decreases in the percentage of effort with zero SBT catches combined with the decrease in the number of squares fished between 1994 and 2003 suggest that any change in the nominal CPUE time series over this period would be positively biased with respect to the actual trend during this period (i.e. any increase would be an overestimate and any decrease would be an underestimate). Similarly in the standardized CPUE series, the combination of a decrease in the number of strata without any SBT and in the total number of strata with effort would tend to induce a positive bias in such series, particularly those that extrapolated positive densities into unfished areas (e.g. constant square, geo-statistical and B-ratio).

It is also worth noting that accompanying the overall decrease in the number of strata fished, that there has been a relatively constant decrease in the maximum catch rates within those squares fished (Figure 6-5) and in recent years a reduction in the variability in the catch rates among those squares fish (Figure 6-6). This is consistent with effort becoming more targeted and concentrated on those areas with high SBT abundances.

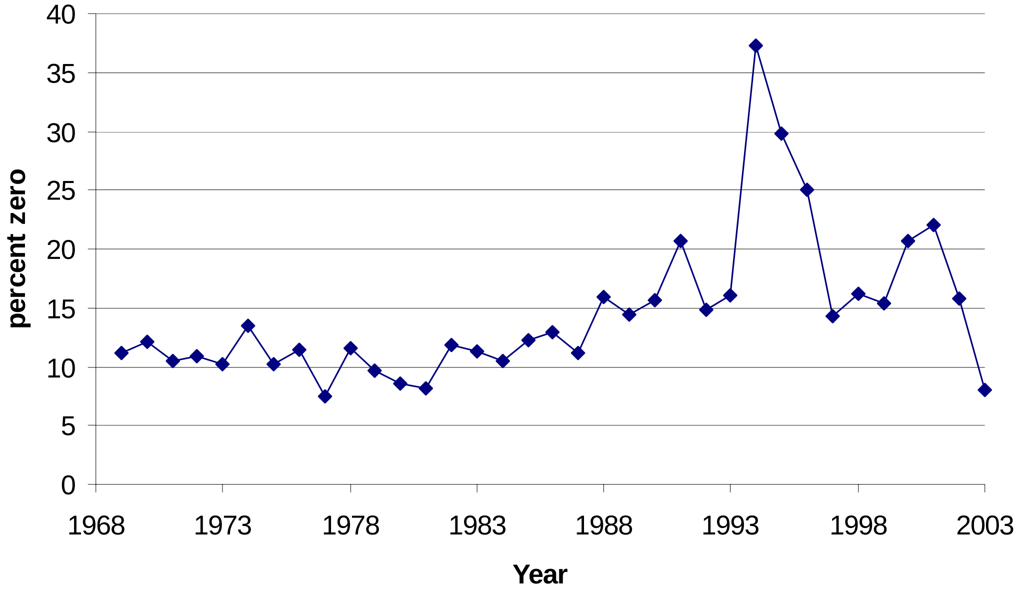


Figure 6-1 Percent of 5°X5° squares/month strata fished (i.e. some reported effort) by Japanese longliners within statistical areas 4-9 and in months 4-9 in which no SBT were caught.

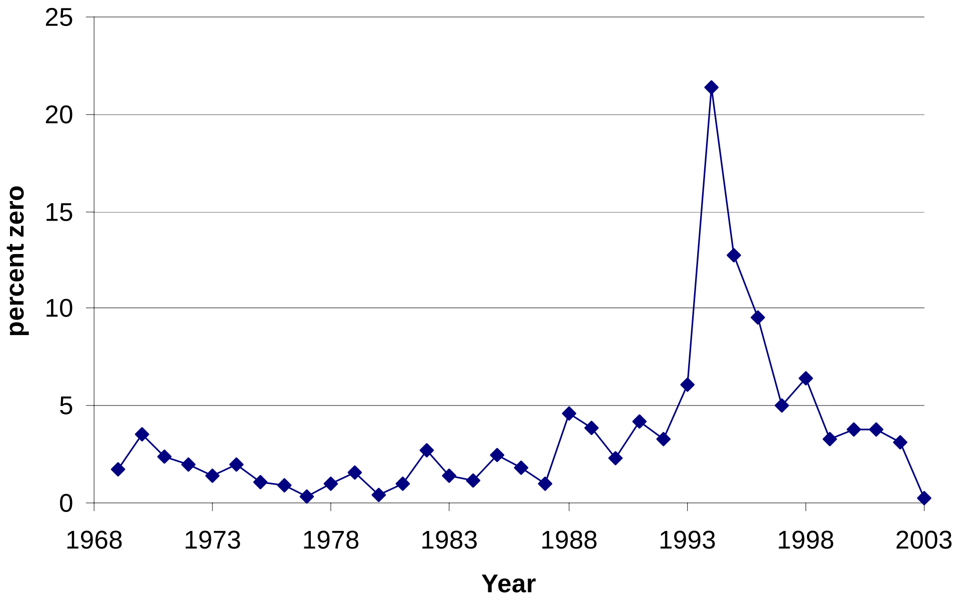


Figure 6-2 Percent of total number of hooks set by Japanese longliners fished within statistical areas 4-9 and in months 4-9 that was within 5°X5° squares/month strata in which no SBT were caught.

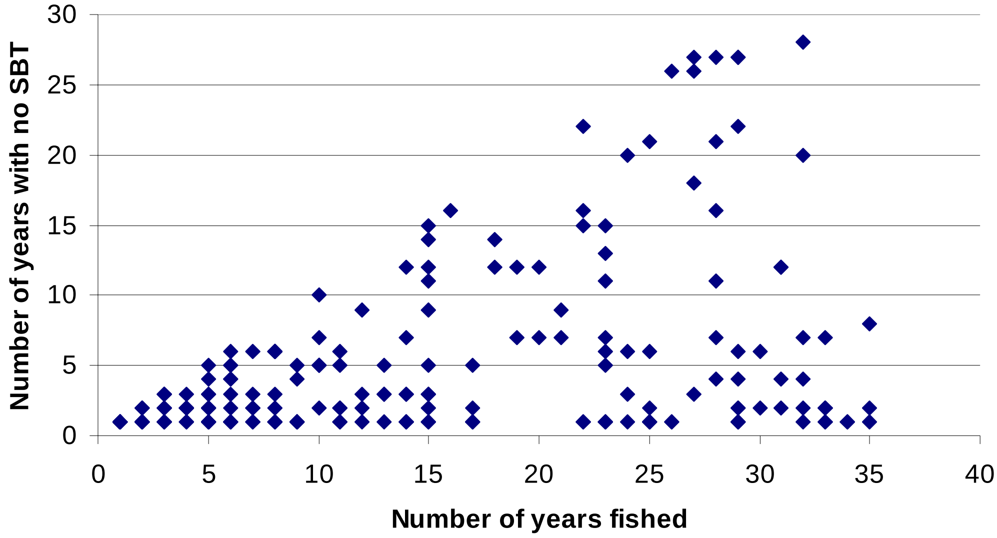


Figure 6-3 Comparison of the number of years a strata was fished and the number of years in which it never caught any SBT. Only strata which never caught SBT in at least one year are plotted. Note points can represent more then a single strata, particularly for strata which were not fished in many years.

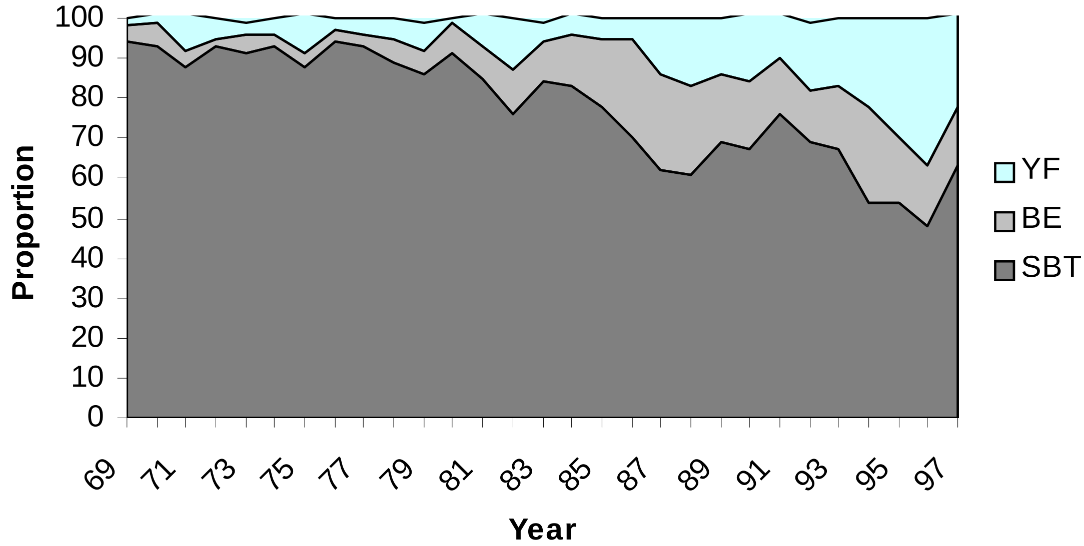


Figure 6-4 The proportion of the total catch of SBT, bigeye and yellowfin tuna by species caught by Japanese longliners within statistical areas 4-9 during month 4-9. Note that the data used in this figure are based on catch and effort data supplied previously by the Japanese National Research Institute of Far Seas Fisheries (NRIFSF) as revised data supplied in 2004 contains no non-SBT catches nor did any of the data supplied by NRIFSF for years past 1997.

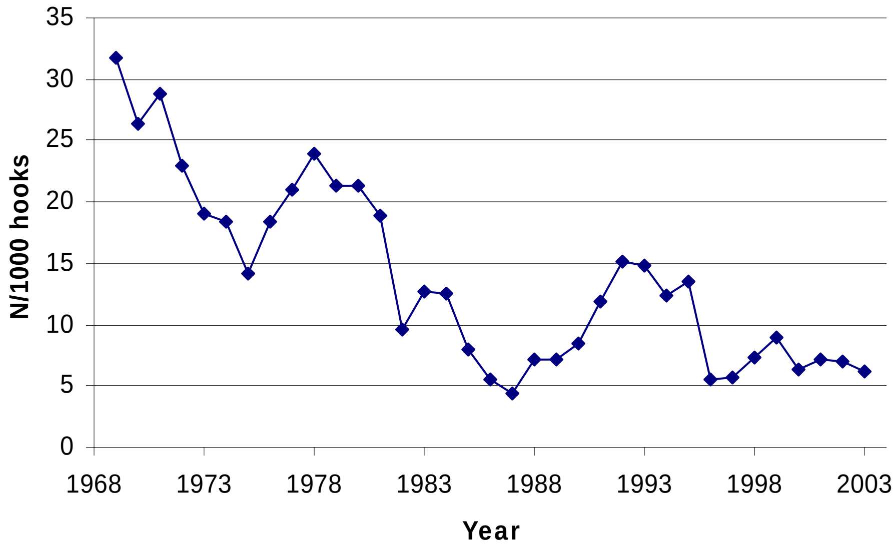


Figure 6-5 Mean catch rate (number of SBT per 1000 hooks) by Japanese longliners in the 10 highest rank 5°X5° squares/month strata within statistical area 4-9 during month 4-9.

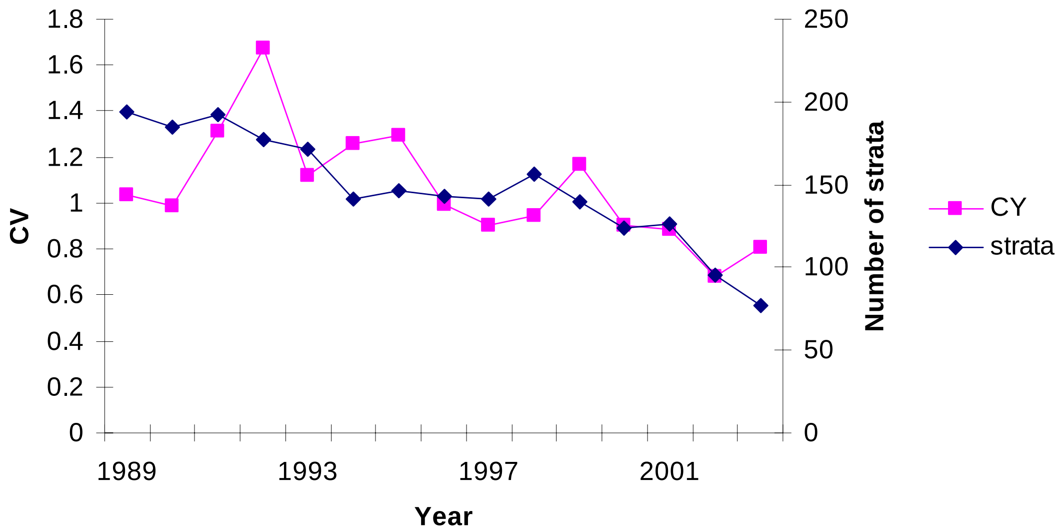


Figure 6-6 Comparison of the number strata fished in a year and the coefficient of variation in the nominal catch rate in those squares that were fished.

7 Trends in nominal catch rates

Figure 7-1 and Figure 7-2 provide nominal catch rate estimates (total catch over total effort) by age for Japanese longline vessels based on the combined data for statistical areas 4-9 from quarters 2 and 3. Figure 7-3 provides a more detailed representation of recent changes in age specific catch rates. In Figure 7-3 the catch rates for ages 4-11 have all been overlaid and the series of figures provides a synopsis of the changes over 2-3 year intervals. Figure 7-4 provides a synopsis of the catch rate for the 12+ age group.

The aggregated indices for age 3-7 and ages 8 plus show a positive trend in catch rates in recent years (1996-2002), but this positive trend is not maintained when the 2003 data are added. The decrease in the aggregated age 3-7 index in 2003 is driven by the decreases in the age 3 and 4 indices, which have dropped significantly from previous years, and the small decrease in the index for the 6 and 7 index. This may indicate that the most recent cohorts may not be as strong as those immediately preceding them. However, Figure 7-3 indicates that in the past that changes in juvenile catch rates (particularly in the early 1990's) are not necessarily reflected in subsequent changes at older ages and emphasize that interpretation of catch rate changes can be confounded by changes in selectivity among age classes (potentially as the result of changes in targeting).

The recent trends by fishing grounds are also quite different and conflicting for the age-specific indices. Thus, the increases between 2001 and 2002 in the spatially aggregated indices for all areas for ages 9, 10, 11 and 12+ are the result of increased catch rate in Area 9 in 2002 while the indices for these ages either declined or were essentially unchanged in Areas 8 and 4-7 (Figure 7-5 and Figure 7-6). The decrease in catch rates between 2002 and 2003 in the spatially aggregated indices for all areas for ages 9, 10, 11 and 12+ are also being driven by the decreased catch rate in Area 9 in 2003, while again the indices for these were essentially unchanged in Areas 8 and 4-7 (Figure 7-5 and Figure 7-6). Comparison of all the age specific indices by area since 1992 suggest that there has been a rather continuous increase in Area 9 for all ages since the mid 1990's, with a decline between 2002 and 2003. In contrast, for area 4-7 the indices for the three oldest age classes have been declining since 1999 and in area 8 they have been decreasing nearly for all ages since 2000, with small increases in 2003. The variations among the age specific trends by area suggest quite different potential for the ages 8-11 to contribute to rebuilding of the spawning stock. It is not clear to what extent the differences among statistical areas reflect differences in targeting/selectivity and the extent to which they reflect large scale spatial structure and different spatial trends in the population. The differences also confound interpretation of any combined index. Any trends in the nominal indices will be sensitive to the relative amounts of effort in the different statistical areas. Spatially weighted indices would similarly be sensitive to the relative number of squares fished in each statistical area (see Table 5-2 to Table 5-4).

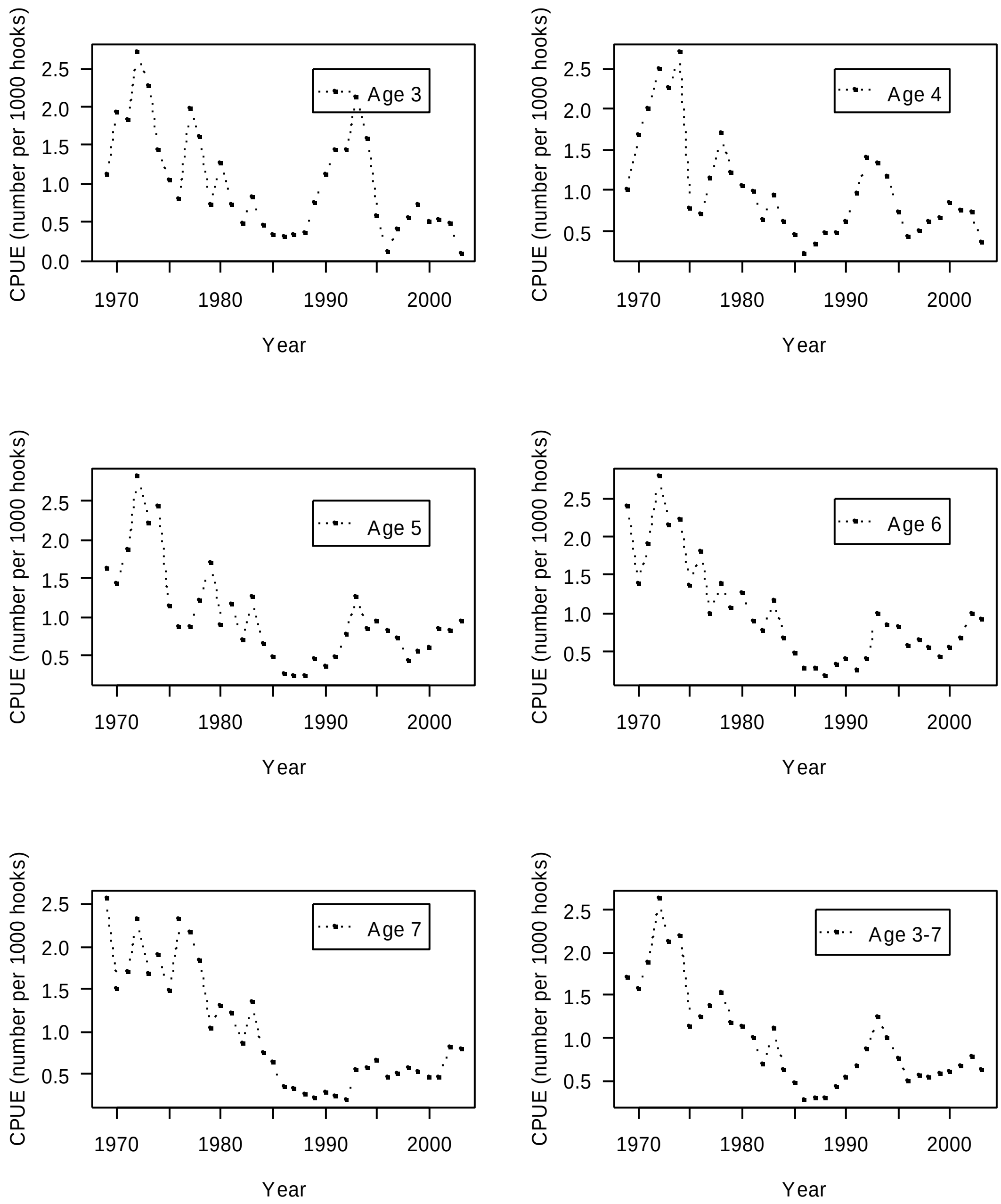


Figure 7-1 Nominal CPUE vs Year for Japanese longline, Australian Joint Venture and New Zealand Joint Venture in Statistical Areas 4-9, ages 3,4,5,6,7 and 3-7. All indicies have been standardized by their means.

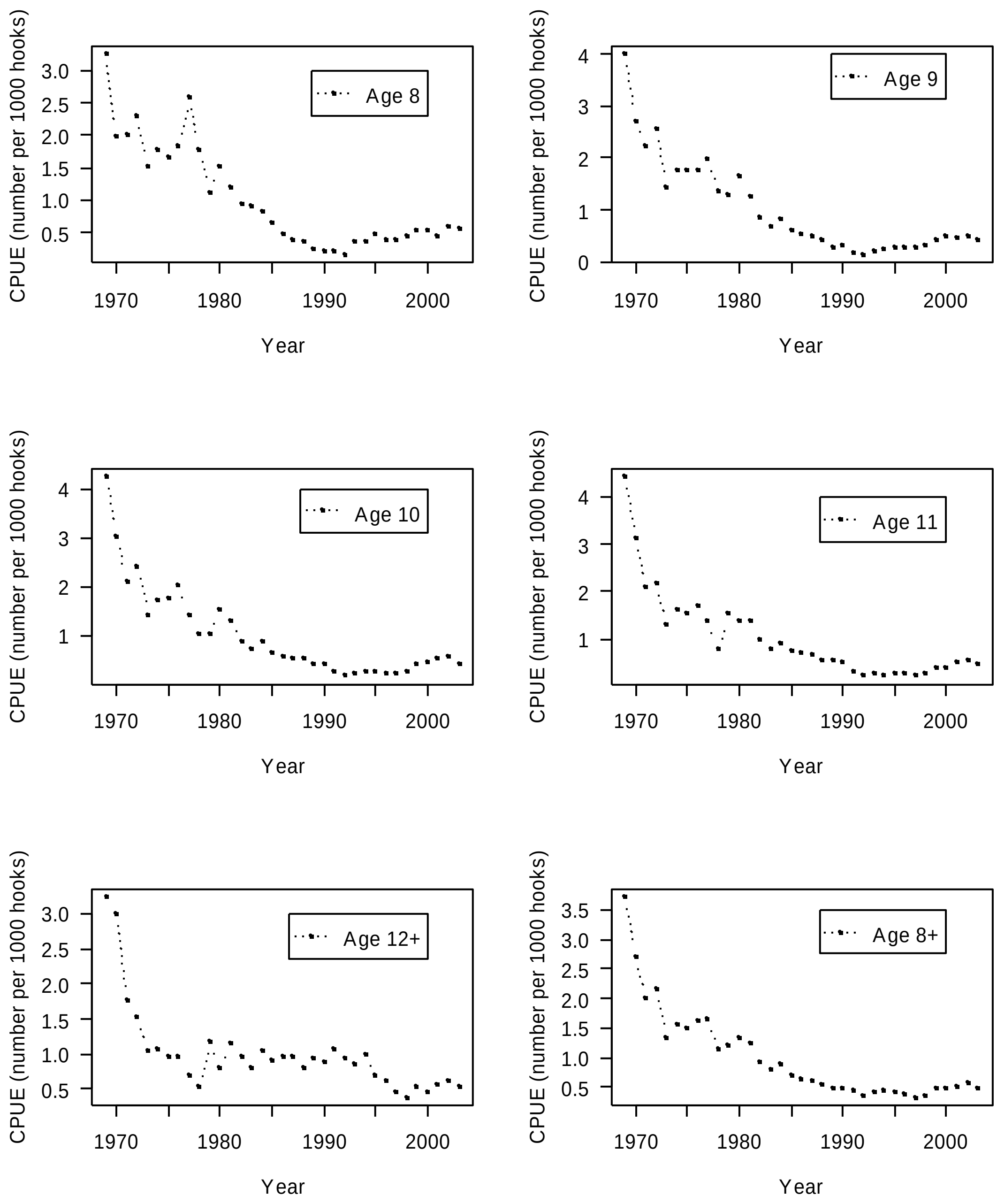


Figure 7-2 Nominal CPUE vs Year for Japanese longline, Australian Joint Venture and New Zealand Joint Venture in Statistical Areas 4-9, ages 8,9,10,11,12+ and 8+.   All indicies have been standardized by their means.

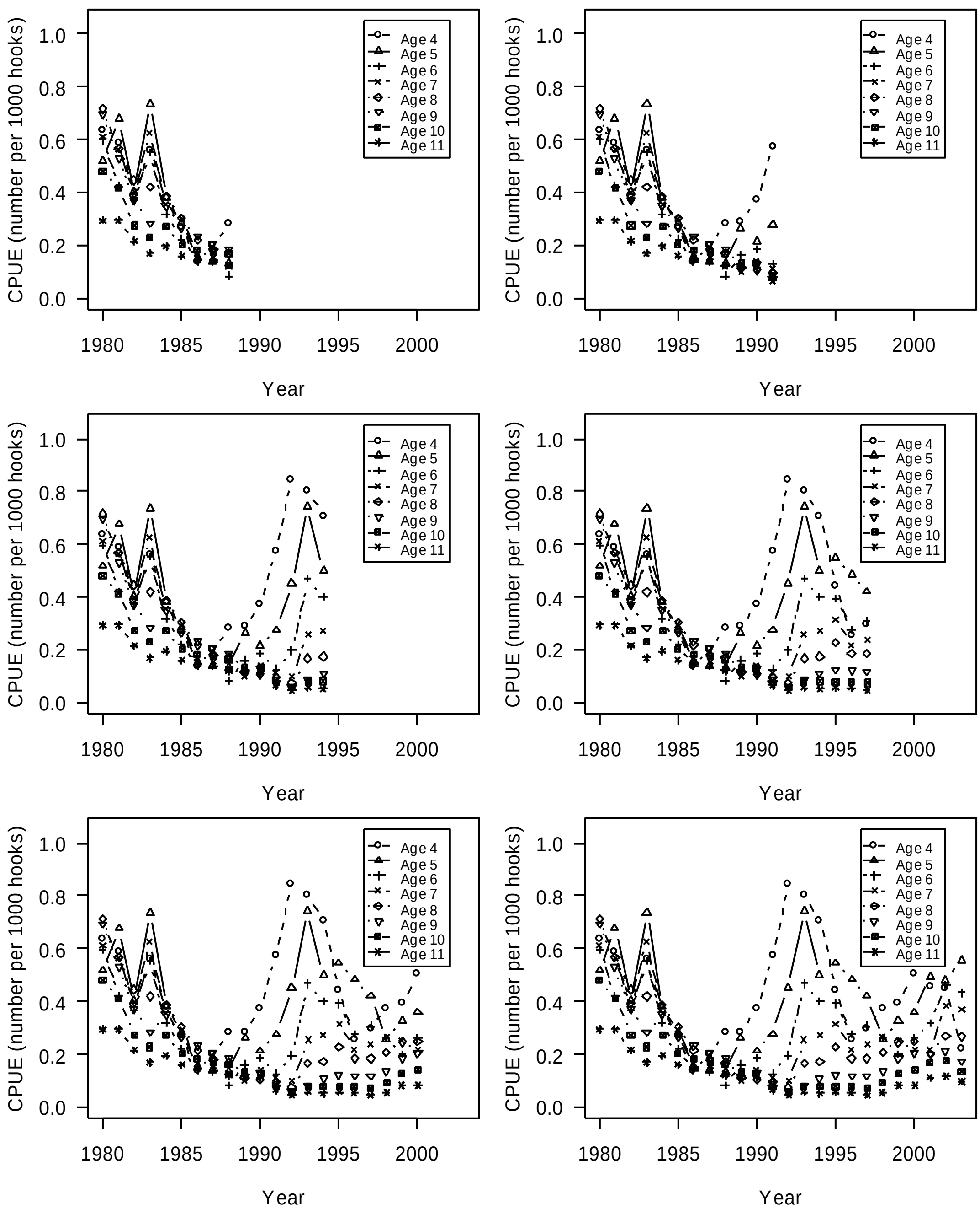


Figure 7-3 Synopsis of changes in nominal age-specific CPUE indices in recent years. Theses indices have not been standardized by their means.

Figure 7-4 Synopsis of changes in nominal age-specific CPUE index for the 12+ age group in recent years. Theis index has not been standardized by its mean.

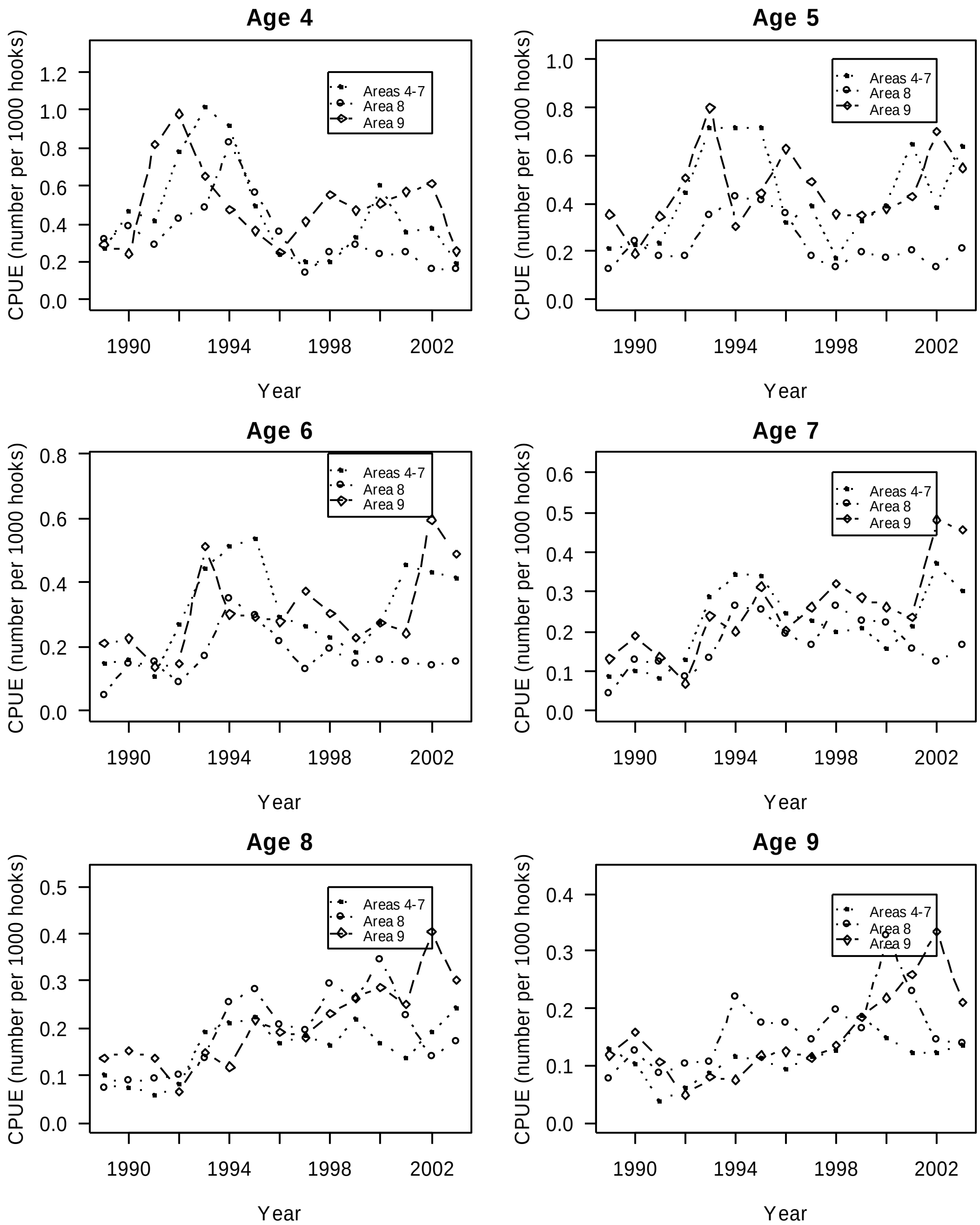


Figure 7-5 Comparison of age-specific nominal catch rates(Number per 1000 hooks) in recent years for different fishing regions. These indices have not been stadardized by their means.

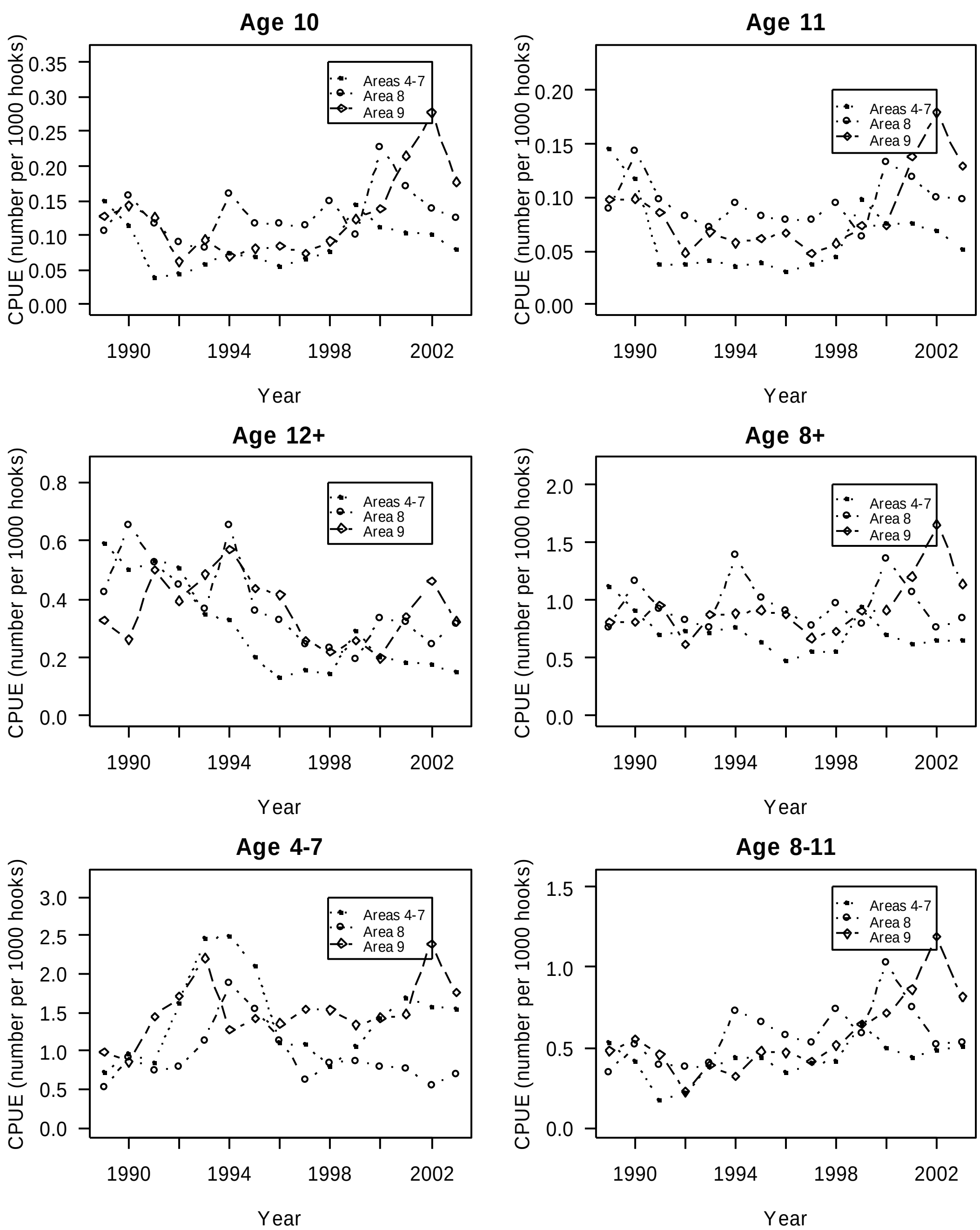


Figure 7-6 Comparison of age-specific nominal catch rates (Number per 1000 hooks) in recent years for different fishing regions. These indices have not been standardized by their means.

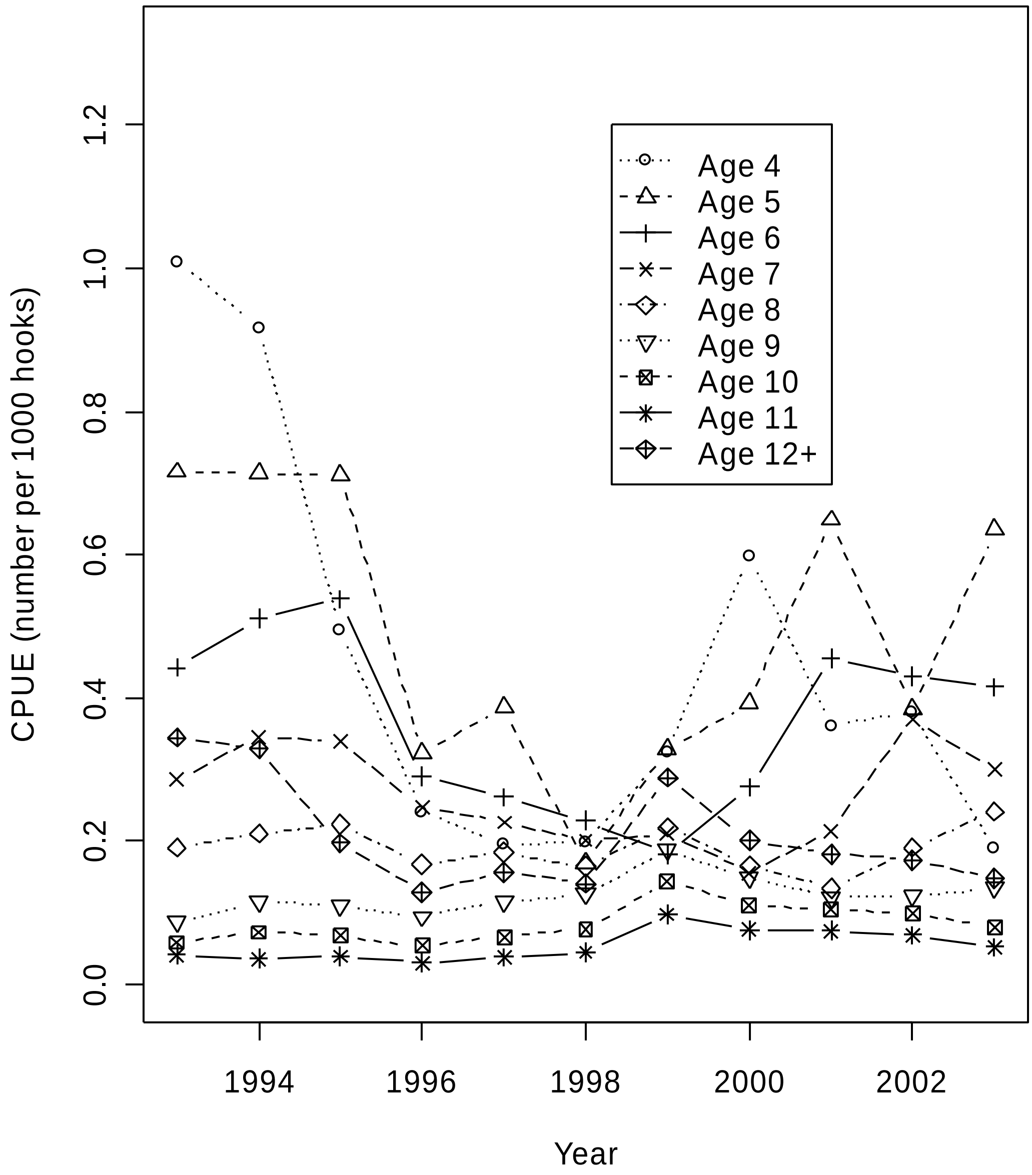


Figure 7-7 Comparison of recent nominal age-specific catch rates (Number per 1000 hooks) for Statistical Areas 4-7. These indices have not been standardized by their means.

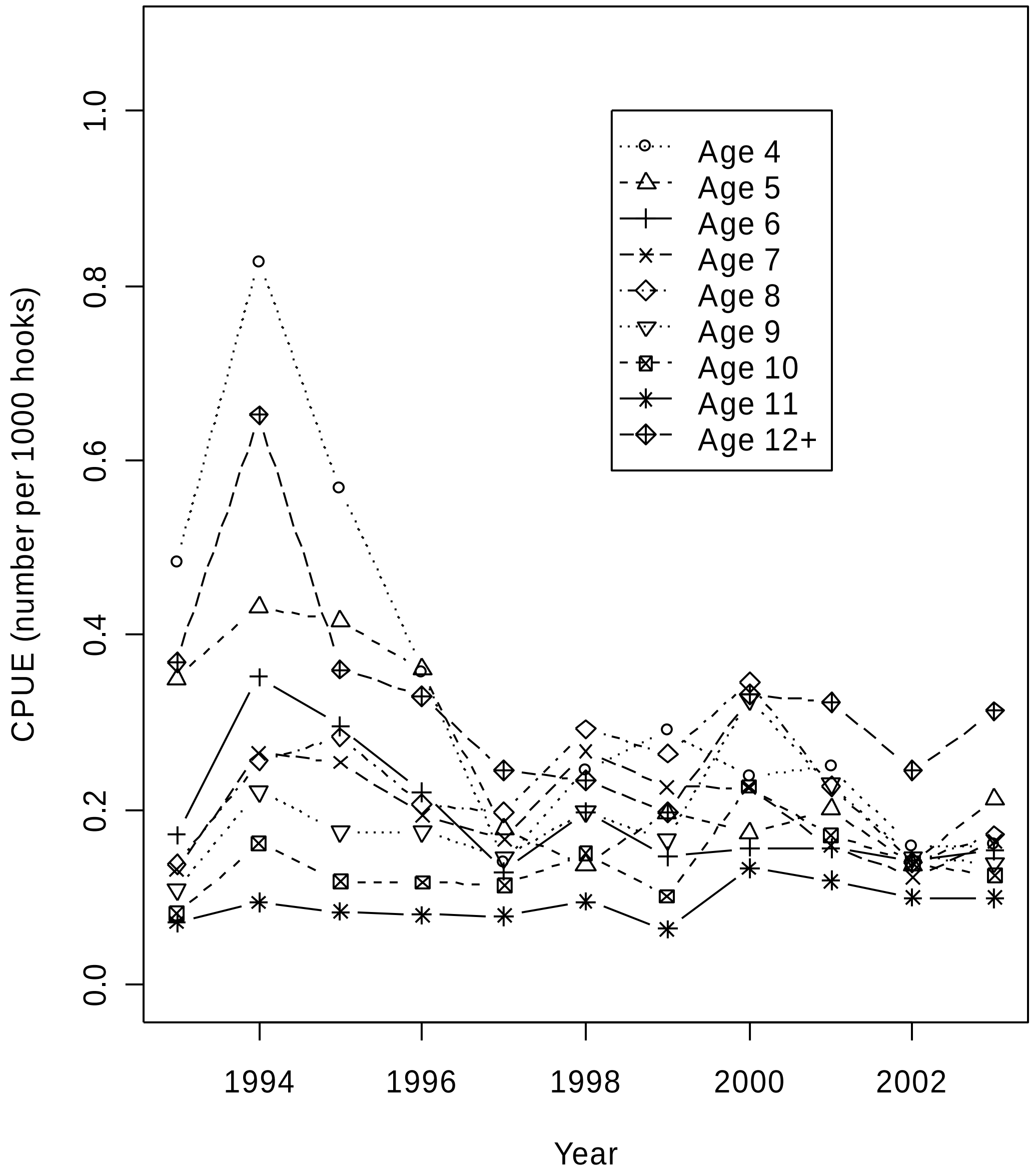


Figure 7-8 Comparison of recent nominal age-specific catch rates (Number per 1000 hooks) for Statistical Area 8. These indices have not been standardized by their means.

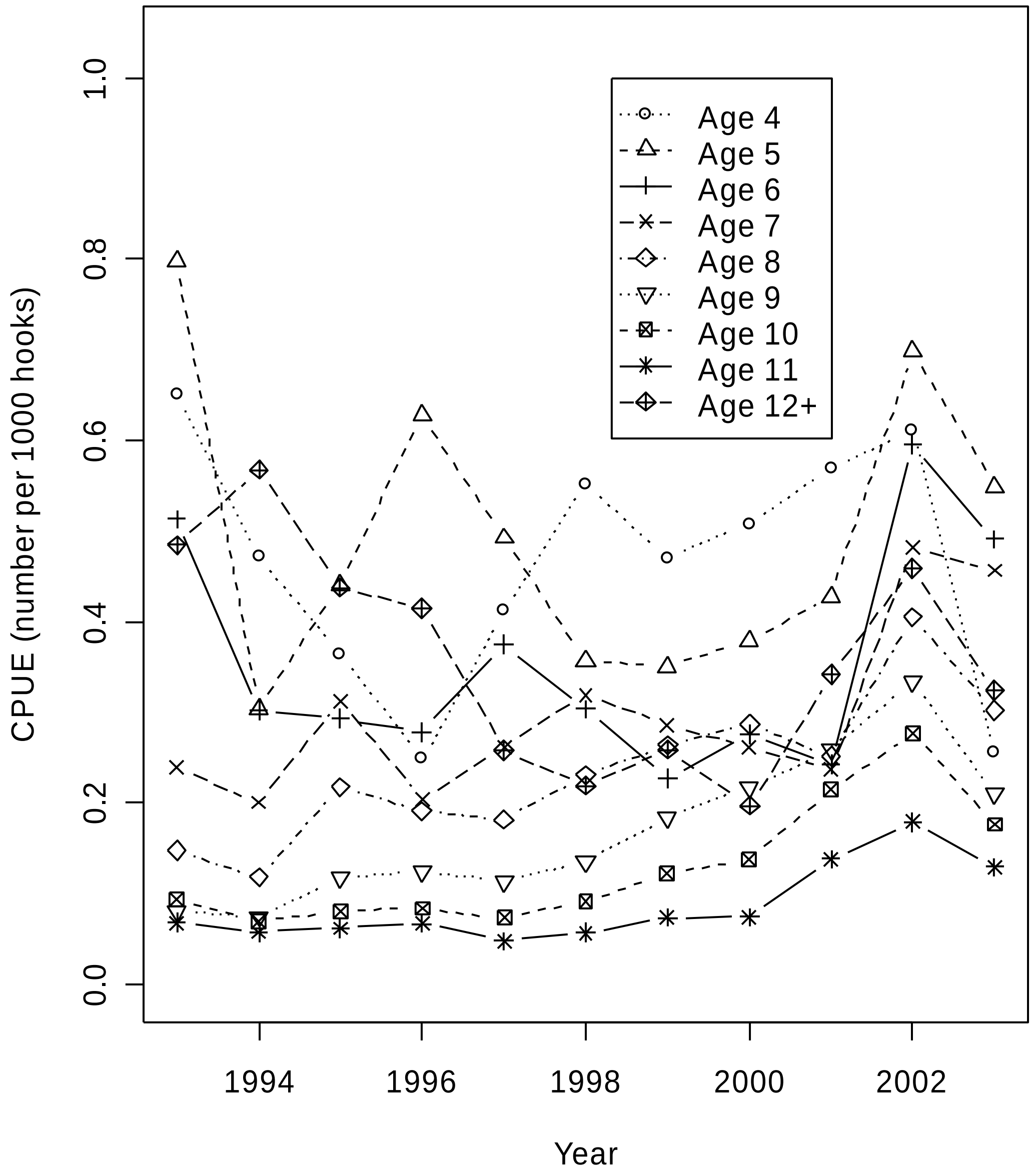
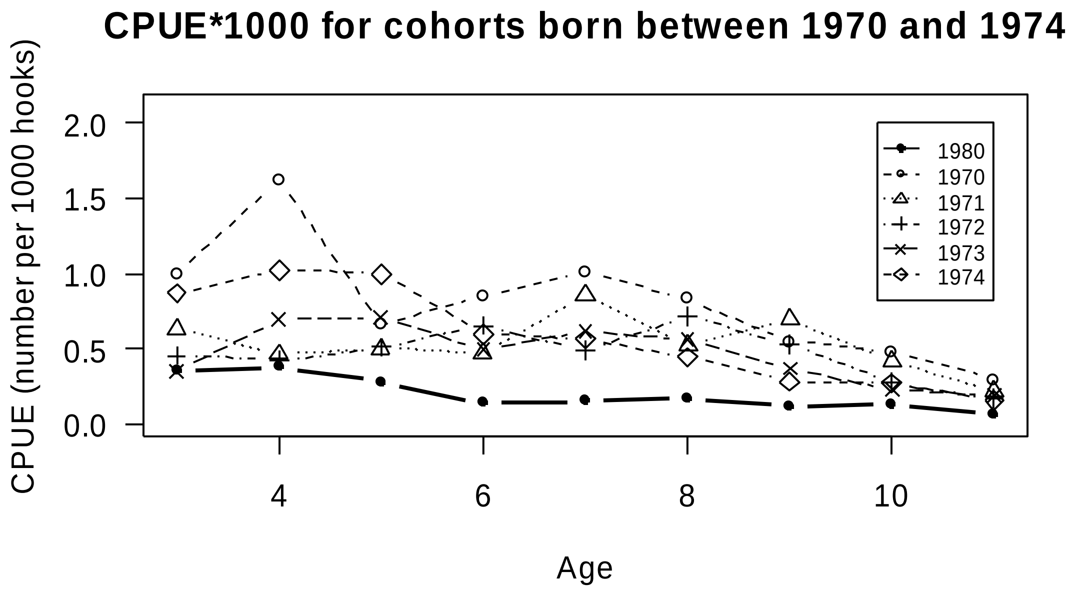


Figure 7-9 Comparison of recent nominal age-specific catch rates (Number per 1000 hooks) for Statistical Area 9. These indices have not been standardized by their means.

7.1 Catch rates by cohorts

Figure 7-10 to Figure 7-12 provides an alternative examination of the nominal age specific CPUE rates. In these figures, the catch rates for individual cohorts are plotted as a function of age. These figures provide a graphical means to evaluate how the changes in CPUE for younger ages sequentially translate into subsequent catch rates as the cohort ages. A line showing the nominal catch rates for the 1980 cohort has been included in all of the figures as a reference. For cohorts born in the 1990's, catch rates for a given age are tending to remain above the corresponding catch rate for those in the 1980's. As these more recent cohorts are beginning to mature, this suggesting that they may potentially have more to contribute to rebuilding the spawning stock.



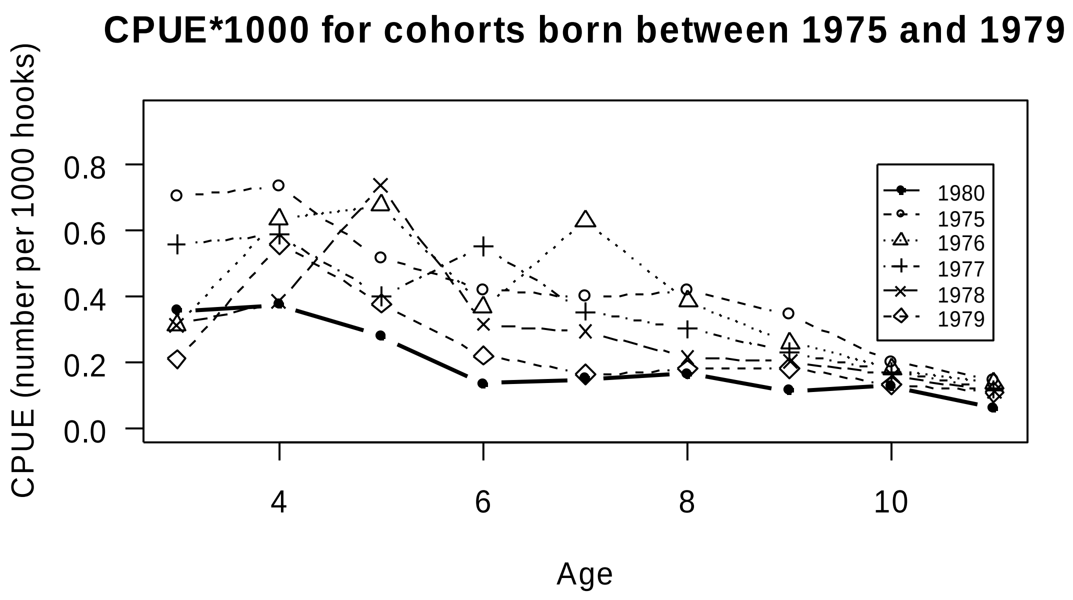
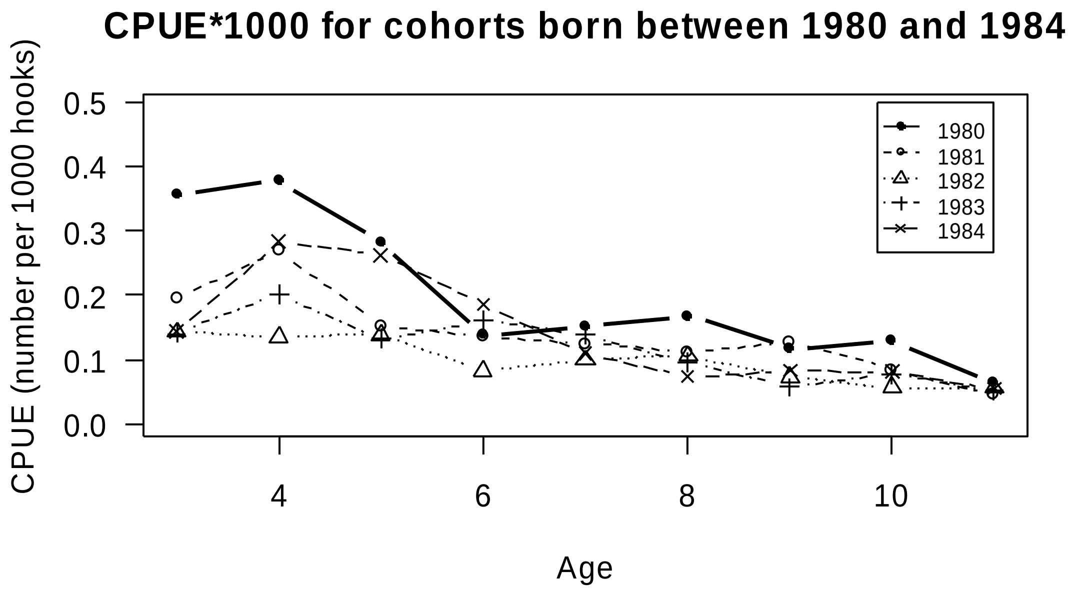


Figure 7-10 Nominal CPUE in Statistical Areas 4-9, months 4-9 for cohorts born between (a) 1970 and 1974, and (b) 1975 and 1979. The cohort born in 1980 is also shown for reference. These indices have not been standardized by their means.



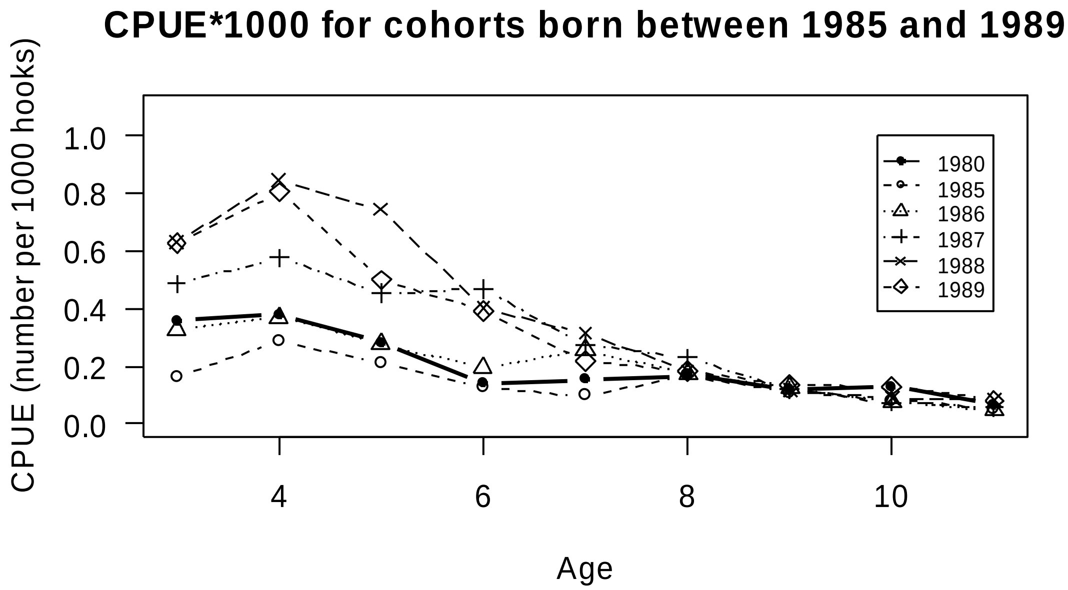
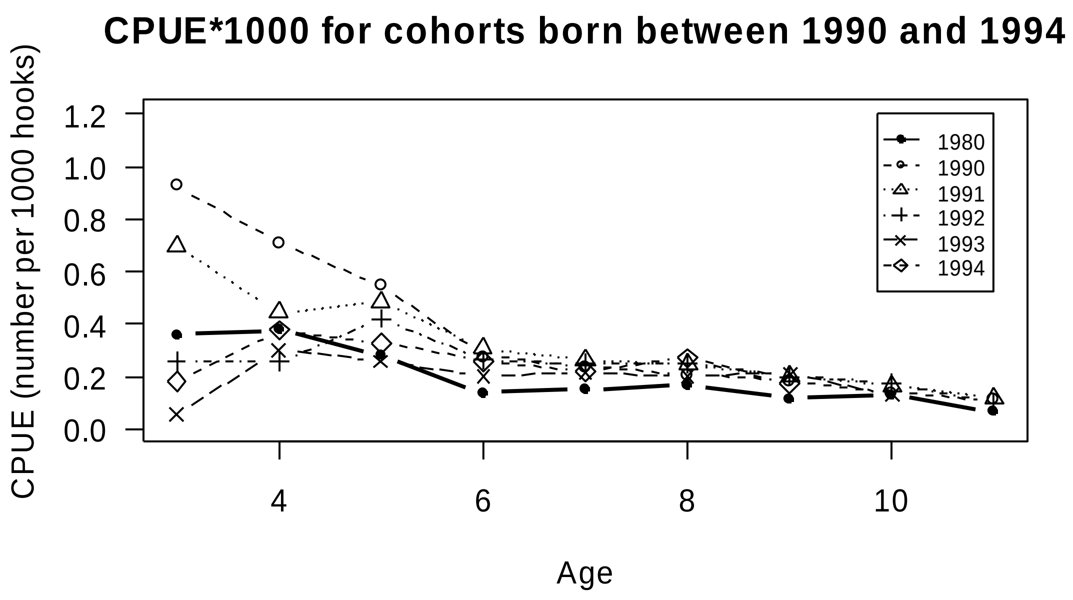


Figure 7-11 Nominal CPUE in Statistical Areas 4-9, months 4-9 for cohorts born between (a) 1980 and 1984, and (b) 1985 and 1989. The cohort born in 1980 is also shown for reference. These indices have not been standardized by their means.



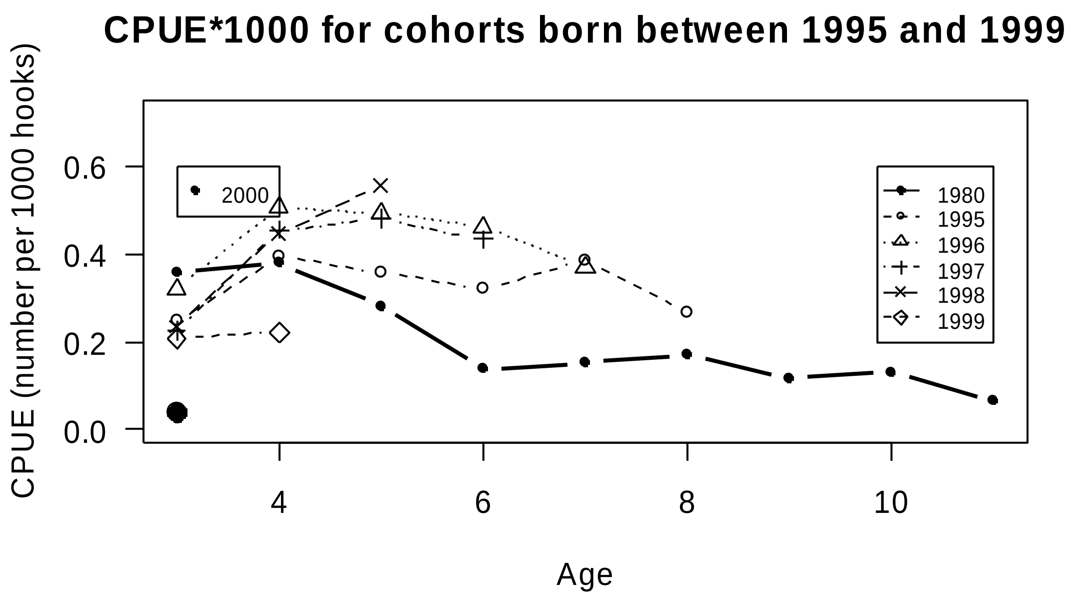


Figure 7-12 Nominal CPUE in Statistical Areas 4-9, months 4-9 for cohorts born between (a) 1990 and 1994, and (b) 1995 and 1999. The cohort born in 1980 is also shown for reference. These indices have not been standardized by their means.

8 Literature cited

Anon. 1994. Report of the Southern Bluefin Tuna Trilateral Workshop . Hobart, 17 January – 4 February 1994. CSIRO Marine Research.

Anon. 2001. Report of the Fifth Meeting of the Scientific Committee. Tokyo, 19-24 March 2001.

Polacheck, T. and D. Ricard. 2001. Trends in Catch, Effort and Nominal Catch Rates in the Japanese SBT Longline Fishery for SBT. CCSBT-SC/0108/22.

Preece, A., T. Polacheck, D. Kolody, P. Eveson, D. Ricard, P. Jumppanen, J. Farley and T.Davis. 2001. Summary of the Primary Data Inputs to CSIRO's 2001 Stock Assessment Models. CCSBT-SC/0108/21.

Ricard, D. and Polacheck T.. 2002. Trends in Catch, Effort and Nominal Catch Rates in the Japanese SBT Longline Fishery for SBT – an update. CCSBT-SC/0209/26.

Hartog, J. Ricard, D., Polacheck T. and Cooper, S. 2002. Trends in Catch, Effort and Nominal Catch Rates in the Japanese SBT Longline Fishery for SBT – 2003 update. CCSBT-SC/0309/26.

9 Appendix

Annual trends in nominal SBT catch rates by area and in the monthly nominal catch rates by areas and for all areas combined.

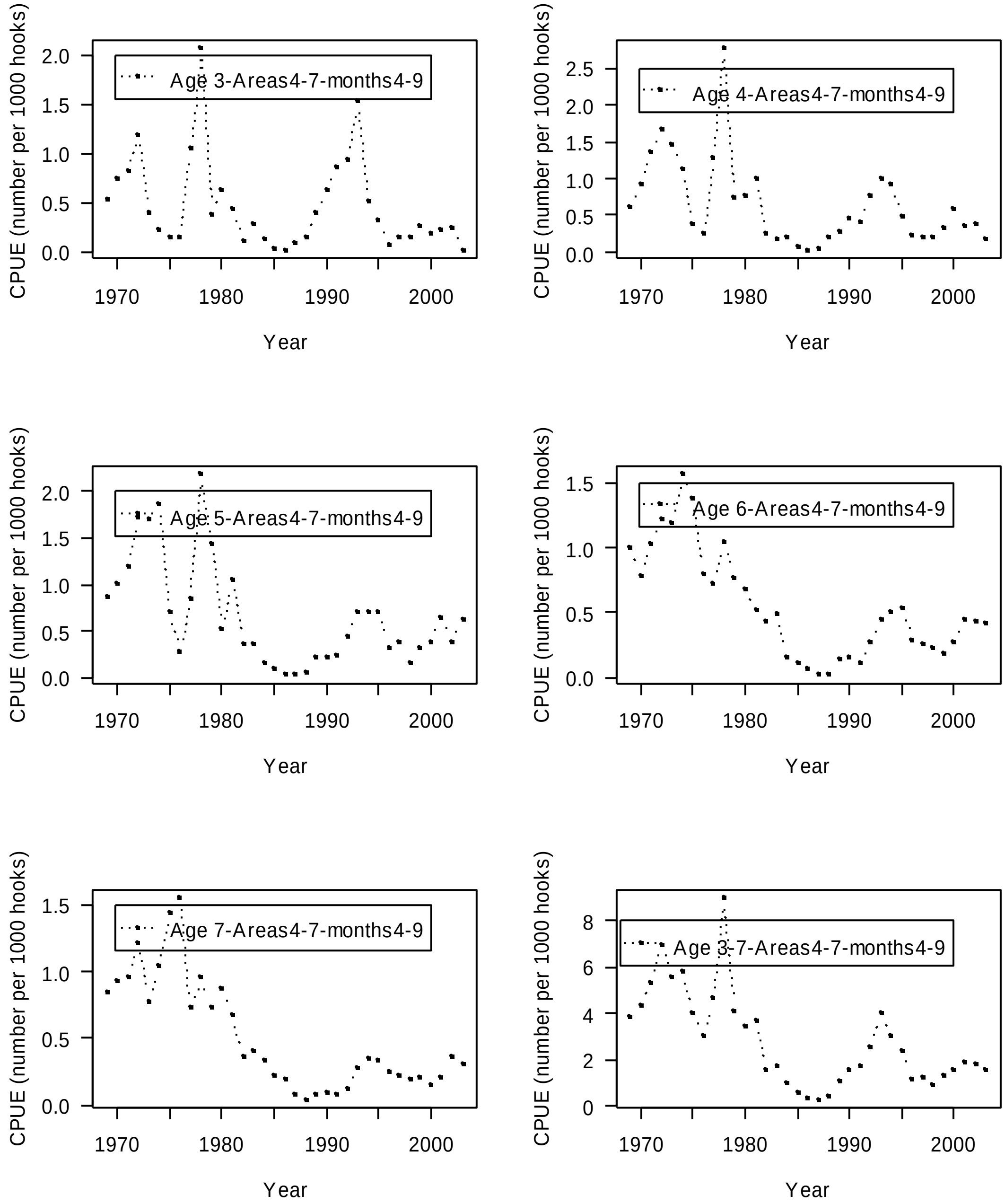


Figure 9-1 Nominal CPUE vs Year for Japanese longline, Australian Joint Venture and New Zealand Joint Venture in Statistical Areas 4-7, ages 3,4,5,6,7 and 3-7.

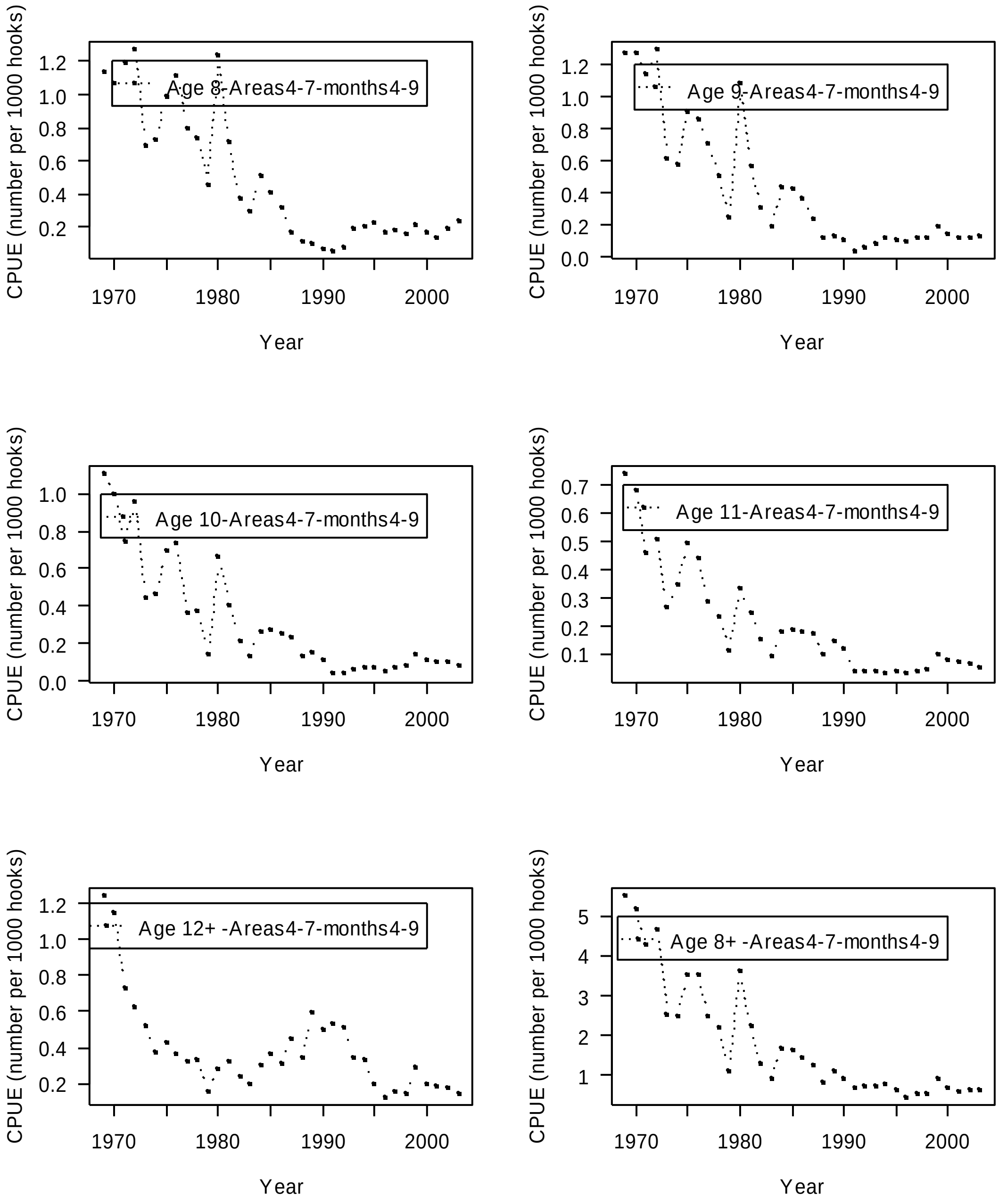


Figure 9-2 Nominal CPUE vs Year for Japanese longline, Australian Joint Venture and New Zealand Joint Venture in Statistical Areas 4-7, ages 8,9,10,11,12+ and 8+.

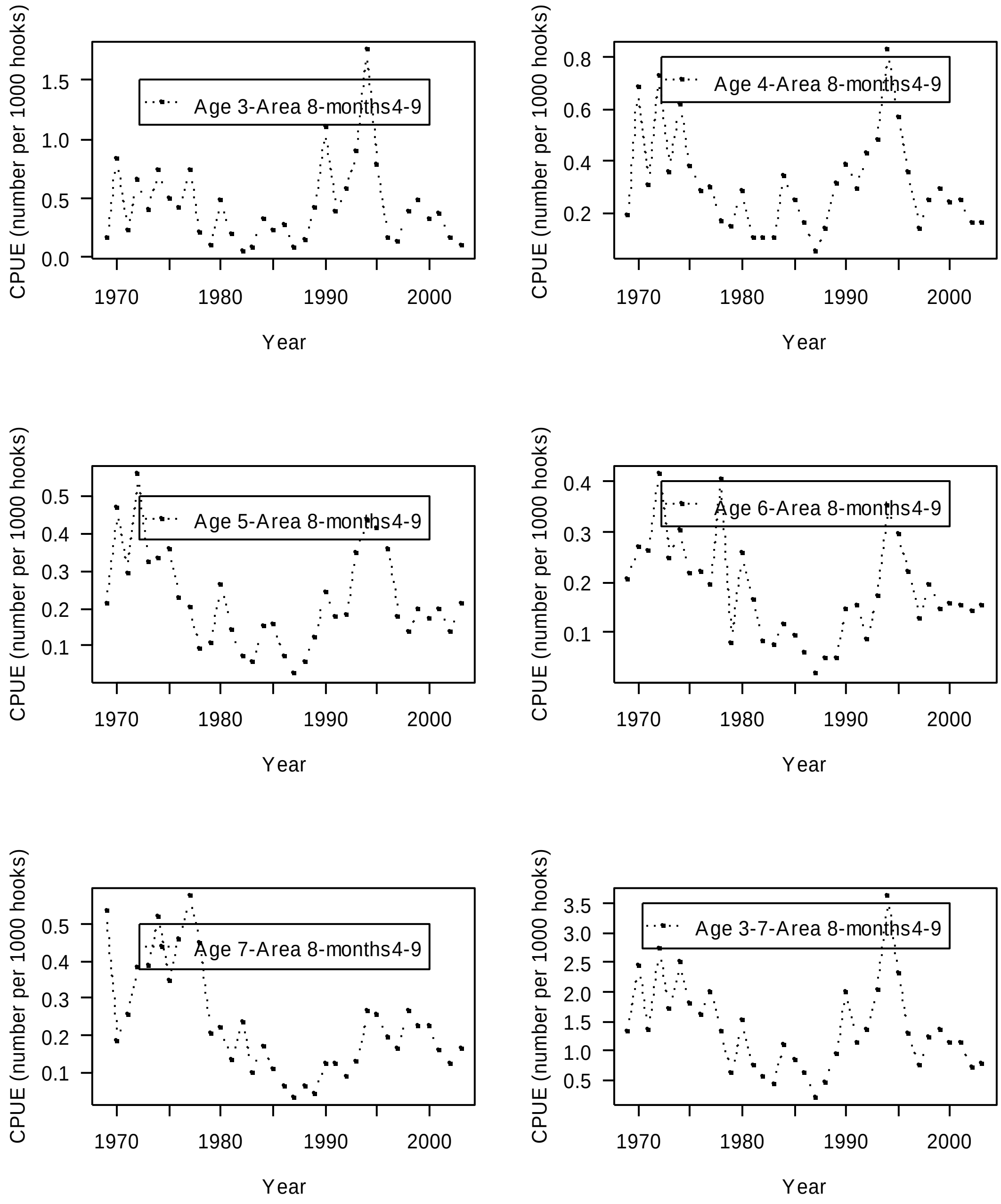


Figure 9-3 Nominal CPUE vs Year for Japanese longline, Australian Joint Venture and New Zealand Joint Venture in Statistical Area 8, ages 3,4,5,6,7 and 3-7.

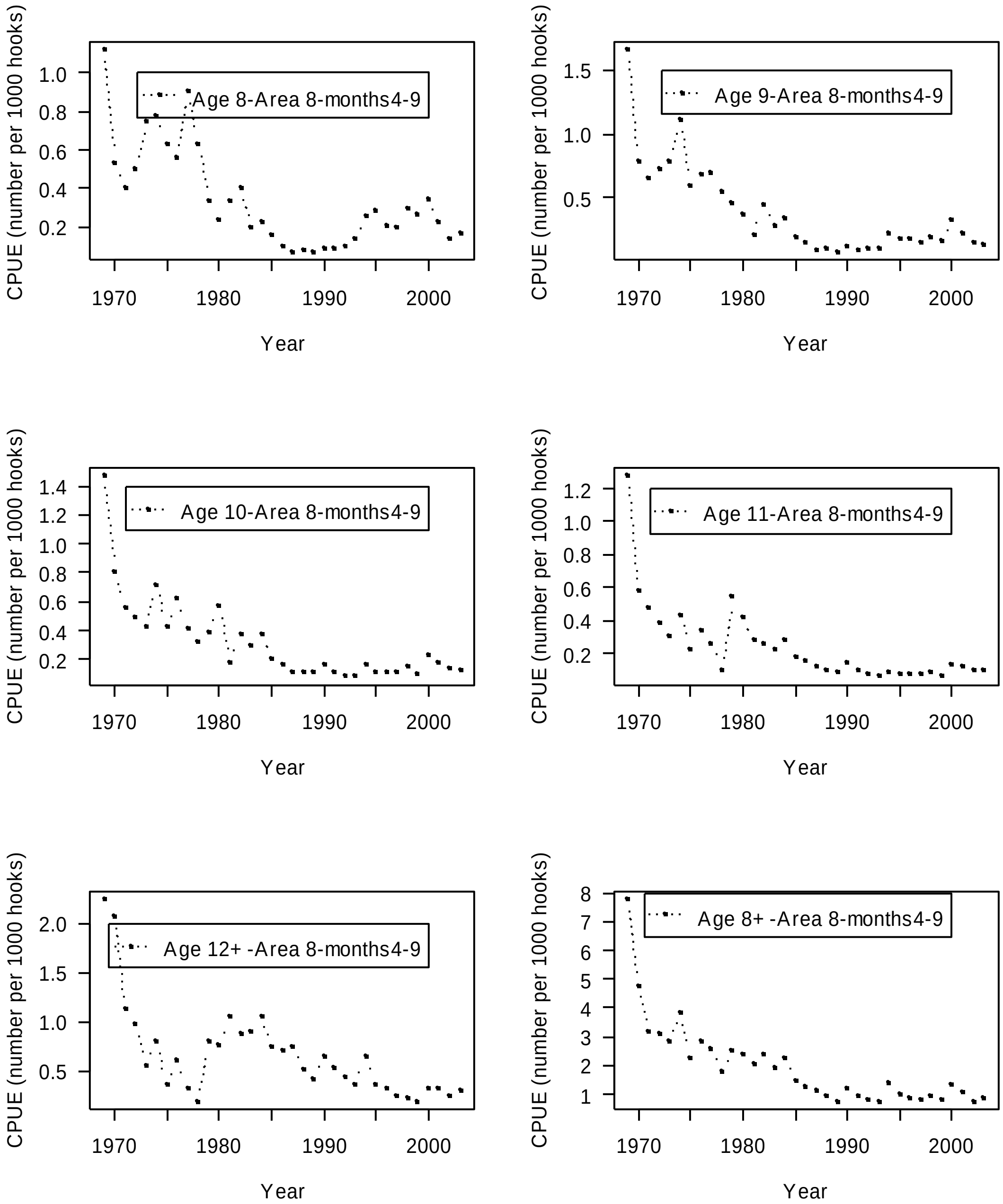


Figure 9-4 Nominal CPUE vs Year for Japanese longline, Australian Joint Venture and New Zealand Joint Venture in Statistical Area 8, ages 8,9,10,11,12+ and 8+.

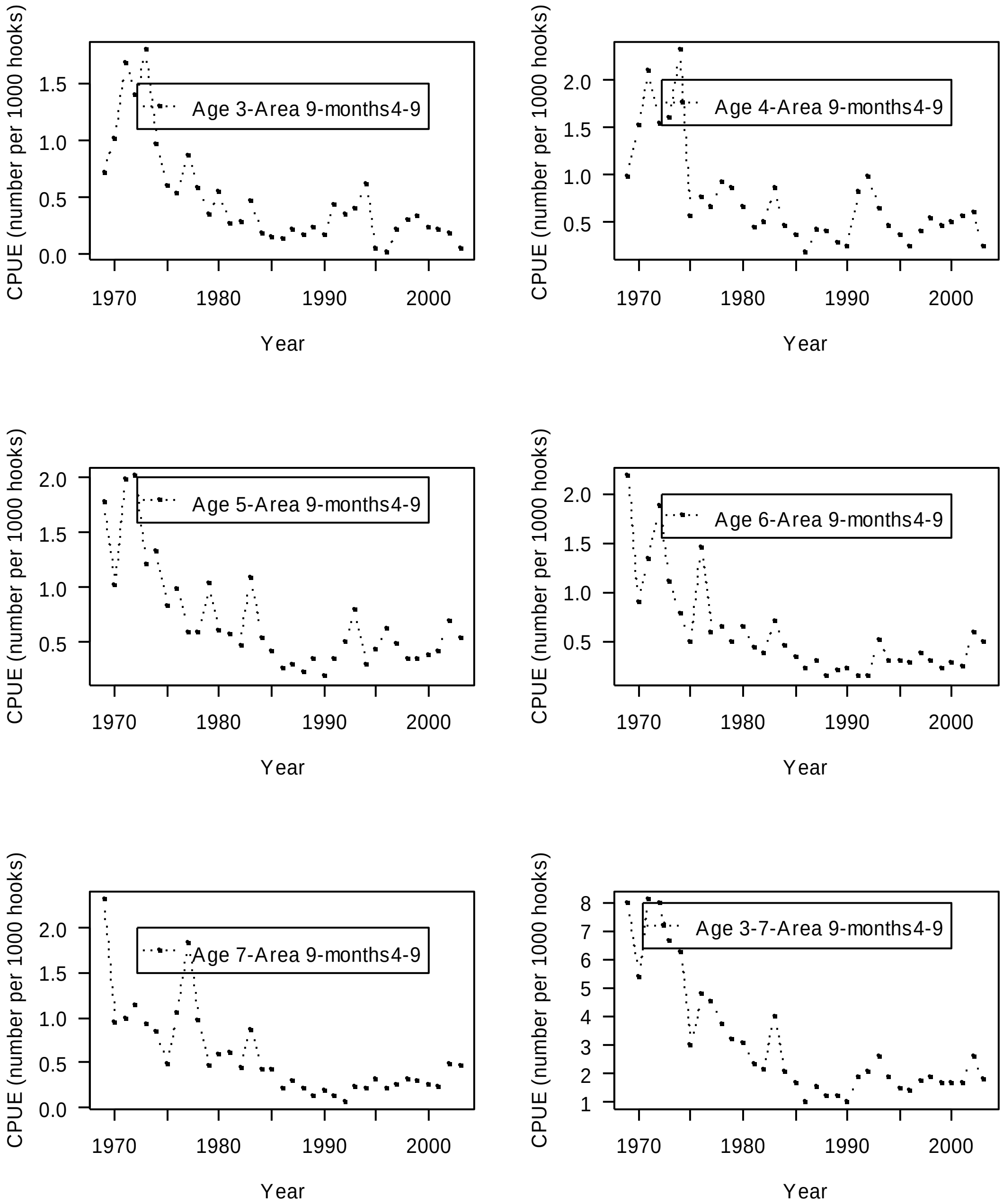


Figure 9-5 Nominal CPUE vs Year for Japanese longline, Australian Joint Venture and New Zealand Joint Venture in Statistical Area 9, ages 3,4,5,6,7 and 3-7.

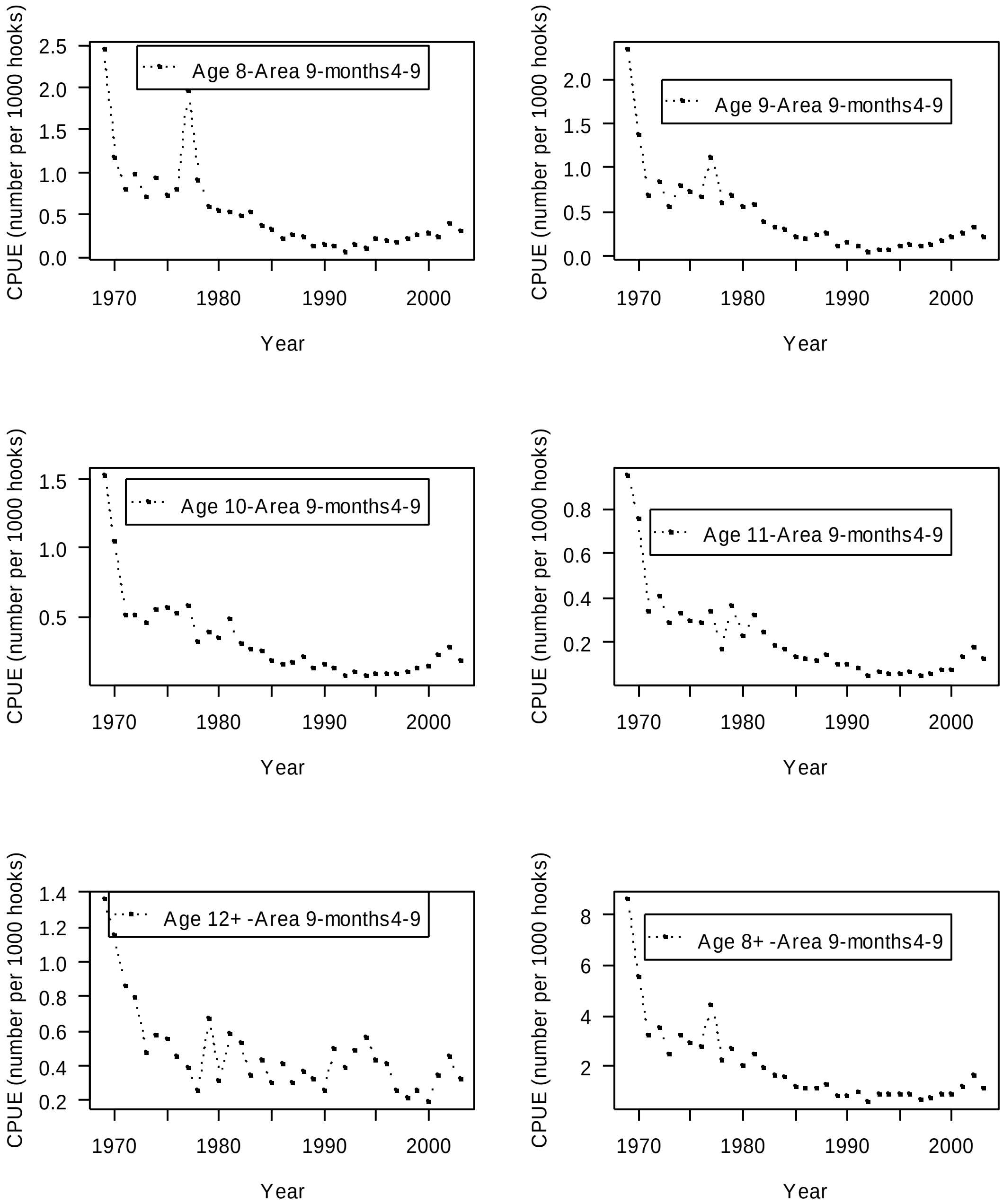


Figure 9-6 Nominal CPUE vs Year for Japanese longline, Australian Joint Venture and New Zealand Joint Venture in Statistical Area 9, ages 8,9,10,11,12+ and 8+.

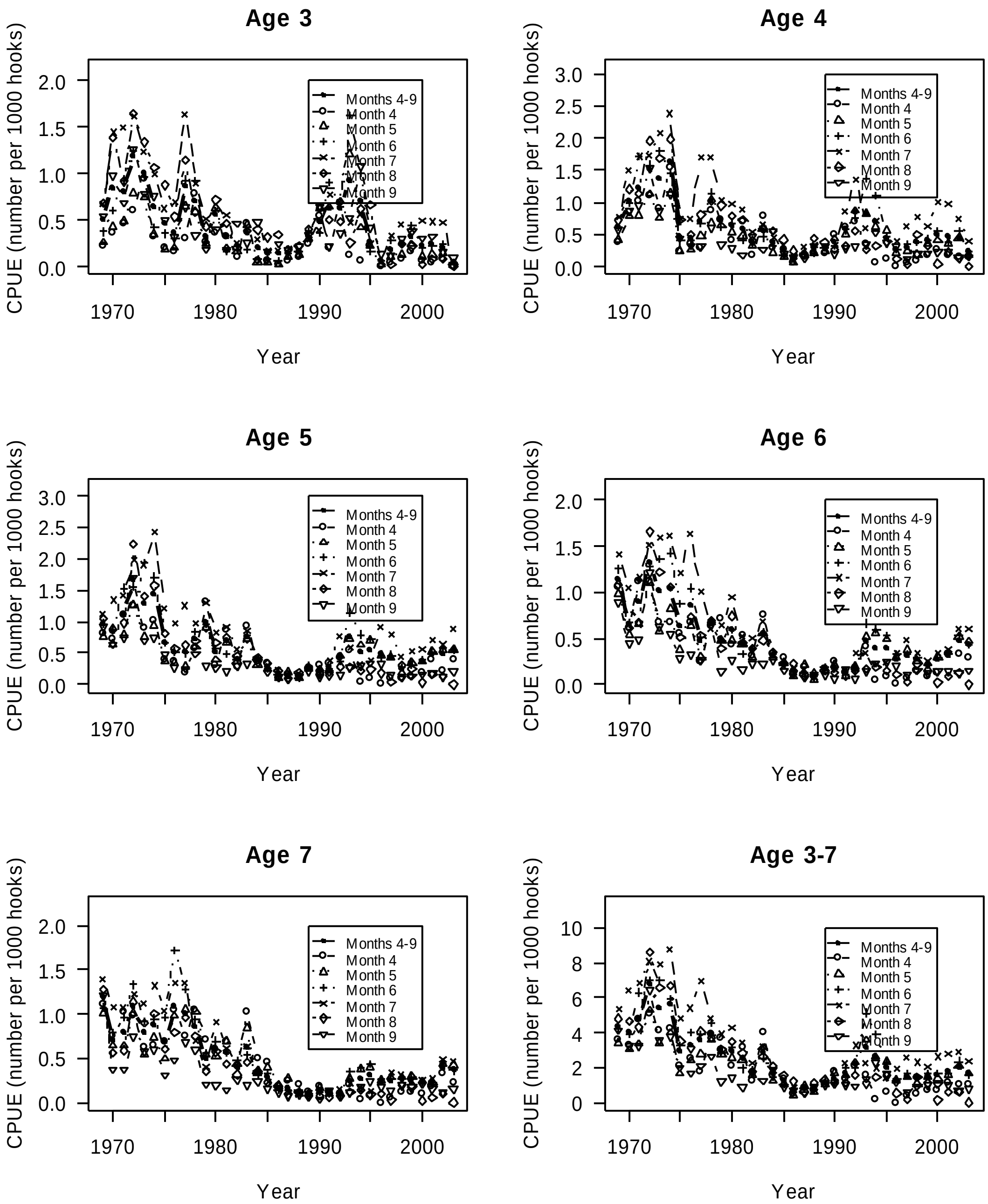


Figure 9-7 Nominal CPUE vs Year for Japanese longline, Australian Joint Venture and New Zealand Joint Venture in Statistical Areas 4-9, ages 3,4,5,6,7 and 3-7. The total yearly CPUE is shown along with the monthly CPUEs.

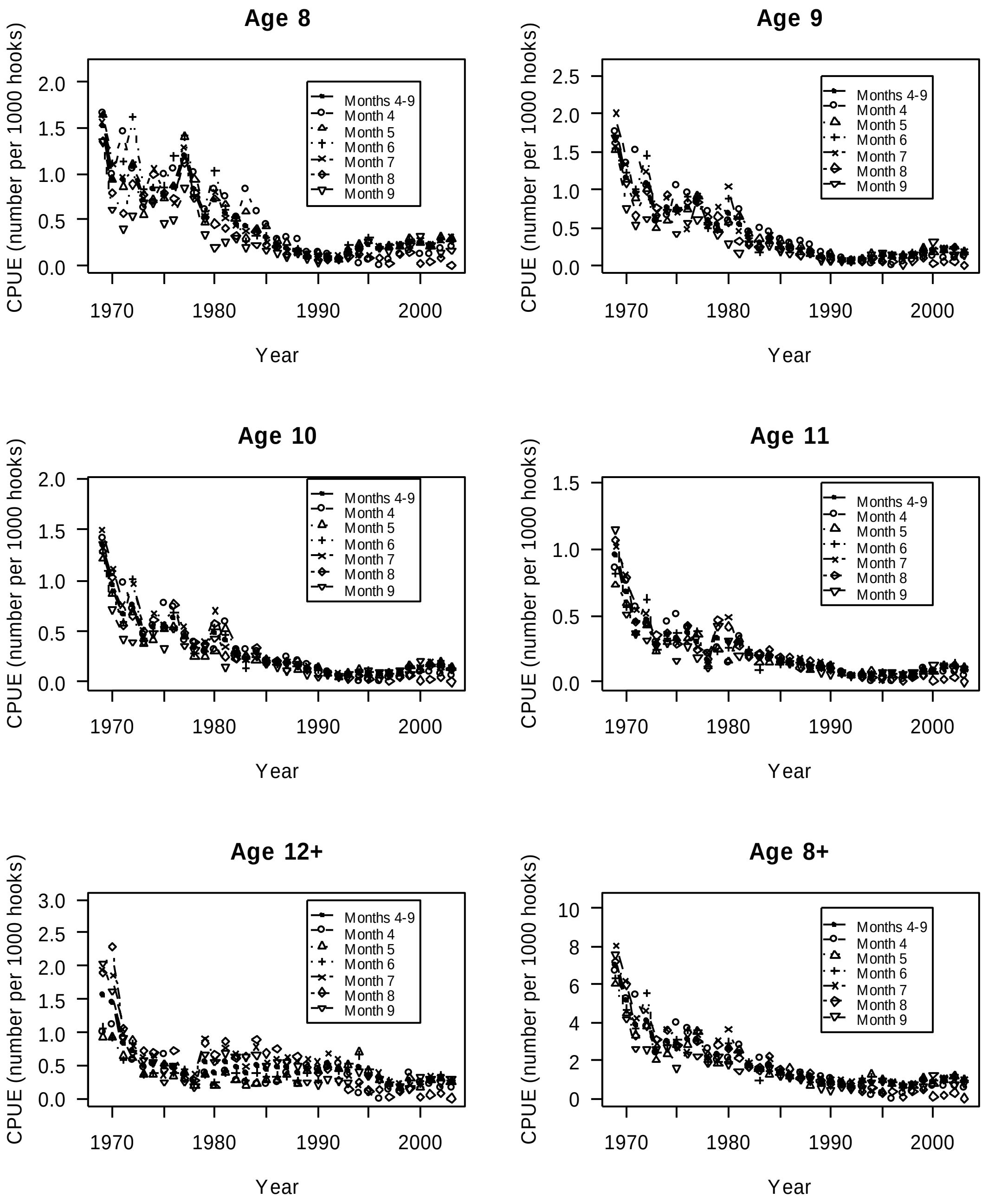


Figure 9-8 Nominal CPUE vs Year for Japanese longline, Australian Joint Venture and New Zealand Joint Venture in Statistical Areas 4-9, ages 8,9,10,11,12+ and 8+. The total yearly CPUE is shown along with the monthly CPUEs.