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Trends in catch, effort and nominal catch rates in the Japanese longline fishery for SBT – 2005 update.

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1 Abstract

This paper updates previous analyses of catch, effort and catch-rate data from the Japanese longline fishery. The recent trend in global catches is a decreasing one, with a marked decline of 20% in the estimated global SBT catches in 2000, followed by a 4% increase between 2000 and 2001. Global catch has declined by around 5% per year in subsequent years.

Fishing effort in Statistical Areas 4-7, 8 and 9 has been steadily decreasing since the late 1980s till 2000. This effort decrease continues in Area 4-7 and Area 8, but effort in Area 9 has increased in recent years. The total number of 5°X5° square/month strata being fished each year suggests a spatial and temporal contraction of fishing effort. 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 than 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 positive trend in catch rates for ages 3–7 and ages 8+ seen in recent years (1996–2002) has been reversed in the last two years. Catch rates for the 12+ age group aggregation have also declined over the last two years. The decline in the age specific trends in recent years for Area 9 and Areas 4–7 suggest a limited potential for the ages 8-11 to contribute to rebuilding of the spawning stock.

2 Introduction

The Scientific Committee conducted a detailed assessment of the SBT stock in 2004, with the next stock assessment scheduled for 2007. In the meantime fishery indicators will play an important role in the provision of advice to managers on the status of the SBT stock. 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, 2004). 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.

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, 2003 and 2004 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, Hartog et al 2004).

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 Japan previously reported for 1995 and 1996 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. 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 1995 and 1996 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.

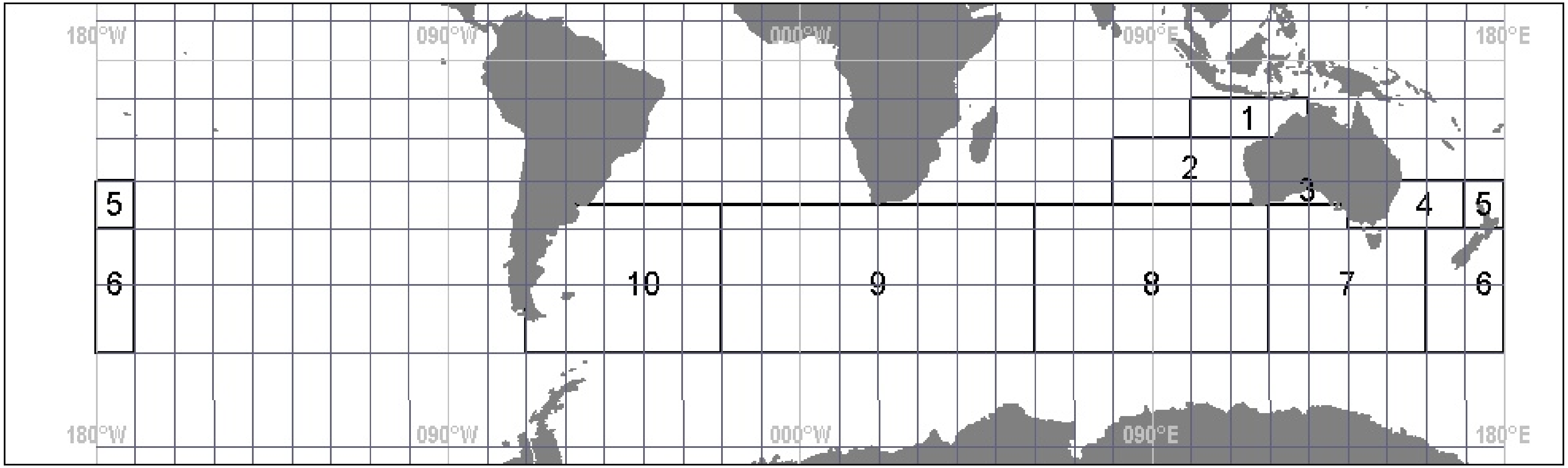


Figure 3-1 Traditional SBT statistical areas used for Japanese longline data.

4 Catch trends

Figure 4-1 provides estimates of the total annual catch of SBT in metric tonnes by country. Total estimated catches of SBT were decreasing between the early 1980s and the early 1990s. This was followed by a period of increase in global catch, peaking in 1999. The recent trend in global catches is a decreasing one, with a marked decline of 20% in the estimated global SBT catches in 2000, followed by a 4% increase between 2000 and 2001. Global catch has declined by around 5% per year in subsequent years.

Some of the changes in global catch stem from the fact that the Australian quota year starts in December and the fluctuation of catches that are taken during December. However, more significant, has been substantive decreases in the estimate of catches by Indonesia (down 73% from 1999) and Korea (down 91% from 1999).

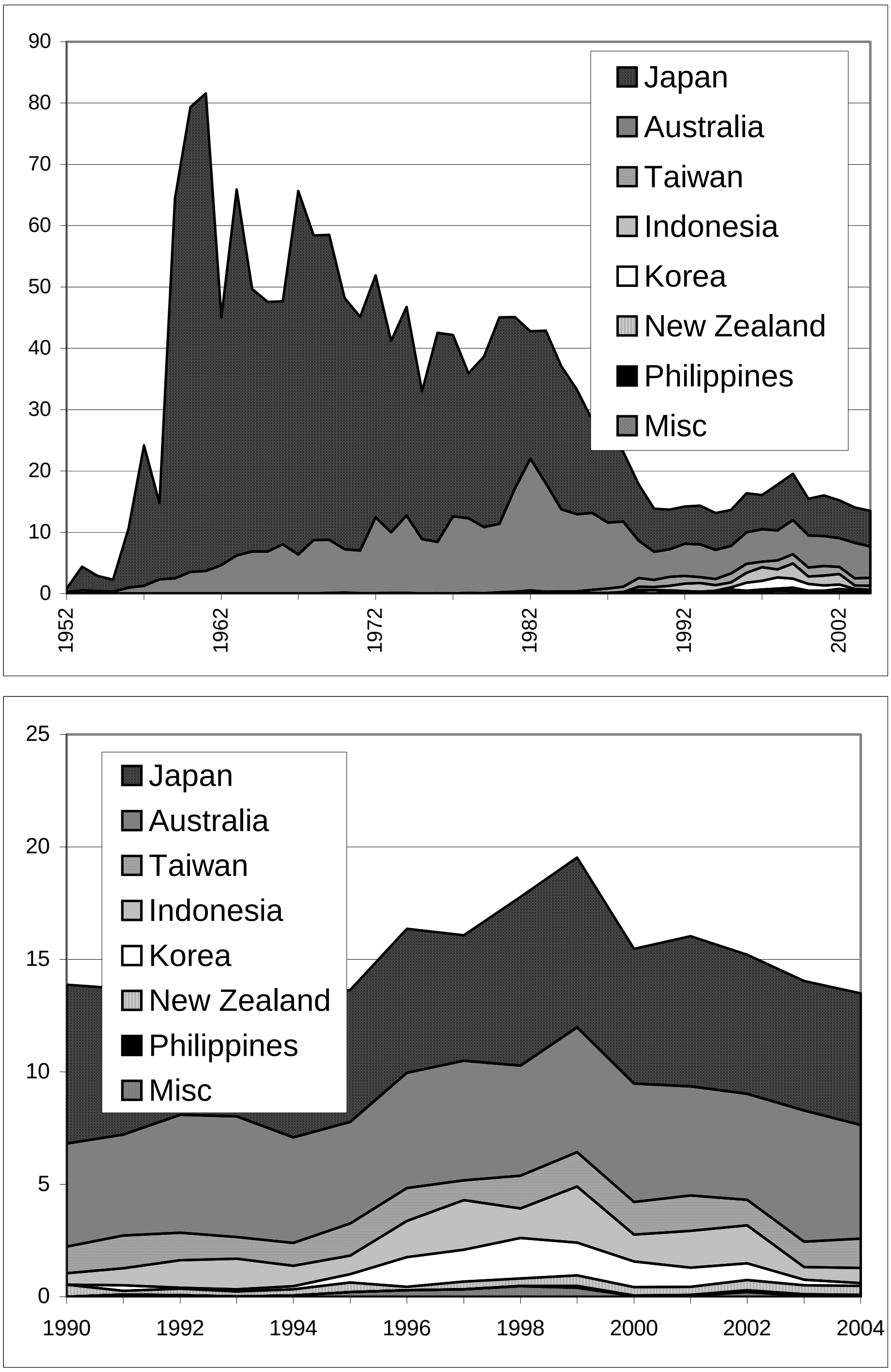


Figure 4-1 Estimates of the annual catch of SBT in metric tonnes by country.

5 Seasonal and Spatial distribution of effort

Figure 5-1 shows the number of years a particular five-degree square has been fished, with the data shown restricted to statistical areas 4–9 during the second and third quarters of the year. Some 40 squares fall into the category of having been fished more than 31 times at some point during a year since 1969, and 28 of these squares have been fished every year (Figure 5-2).

Figure 5-3 and Figure 5-4 provide an overview of the annual distribution of longline effort for 1997 through 2004 in Statistical Areas 4-9 during the second and third quarters. For comparison purposes, the 40 squares mentioned previously as having been regularly fished are shown as a highlighted area on the map. 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). Of particular interest is the easterly shift in effort in Statistical Area 9 and the westerly shift in effort in Statistical Area 8 in 2004, when compared to any of the previous years (Figure 5-4), such that there is an almost continuous longitudinal band of fishing effort across the southern Indian Ocean in 2004. There is virtually no effort in Area 7 west of Tasmania, a halt to a continuing spatial contraction in this once regularly fished area.

Fishing effort in Statistical Areas 4-7, 8 and 9 has been steadily decreasing since the late 1980s till 2000, with a small reversal of this trend around 1997 (Figure 5-5). Overall effort is up 7% since 2000. After a large increase in 2001, and a small increase in 2002, effort in Area 4-7 has dropped by 10% since 2000. Effort in Area 9 has increased by 33% since 2000, but this increasing trend has fluctuated substantially between years. The effort in Area 8 has remained steady compared to 2003, following a large (38%) decrease when comparing the effort in 2003 to 2002. Note that the 2004 figures are preliminary and are likely to increase when complete data become available.

The total number of 5°X5° square/month strata being fished each year suggests a spatial and temporal contraction of fishing effort. There was a slight increase in the number of squares fished in 2004 (which is likely to increase when new data are added), but the number of squares being fished in 2004 (128) is still small when compared with the number being fished (>200) prior to 1994 (Table 5-1). Fishing effort in recent years is concentrated in May–July (months 5–7) for Area 9, September (month 9) for Area 8 and April–July (months 4–7) for Areas 4–7(Figure 5-6, Table 5-2, Table 5-3 and Table 5-4).

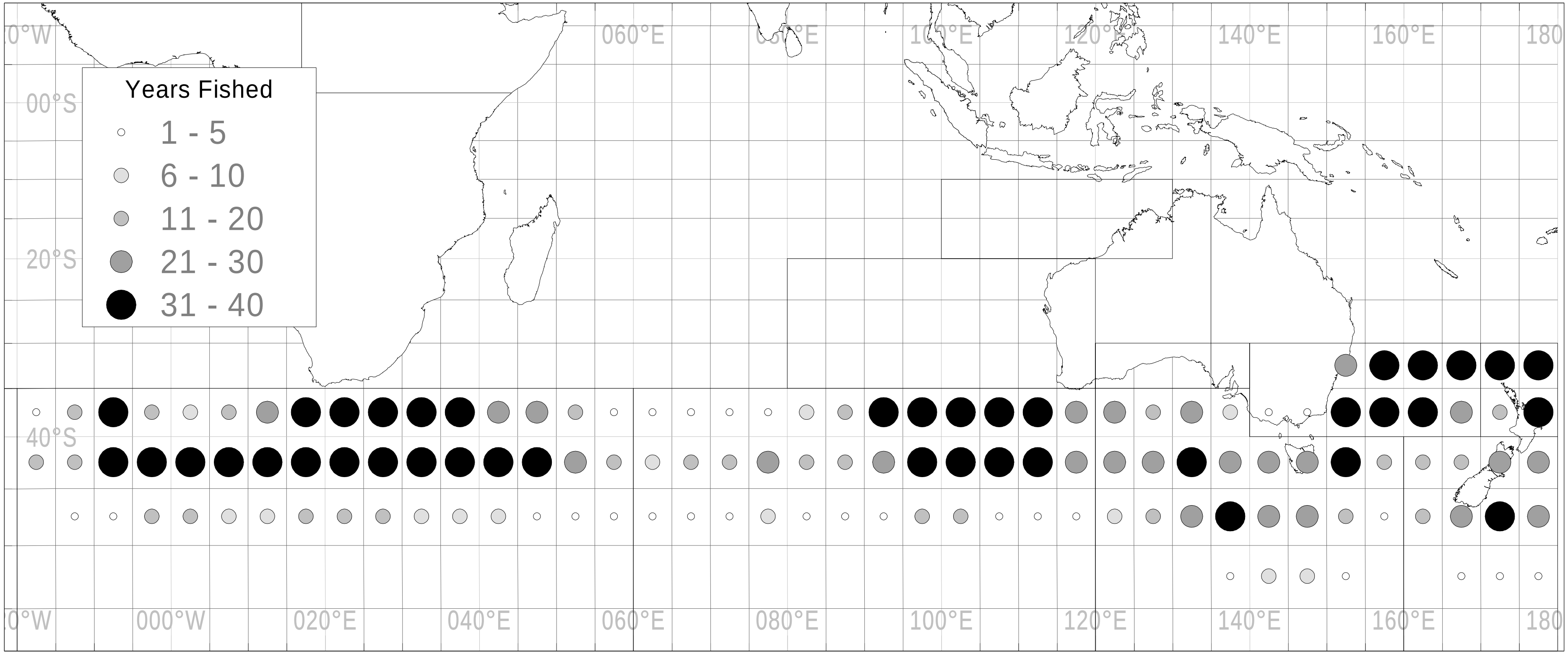


Figure 5-1 The geographic location of the five-degree squares in which fishing effort has occurred within statistical areas 4–9 during the second and third quarters of the year.

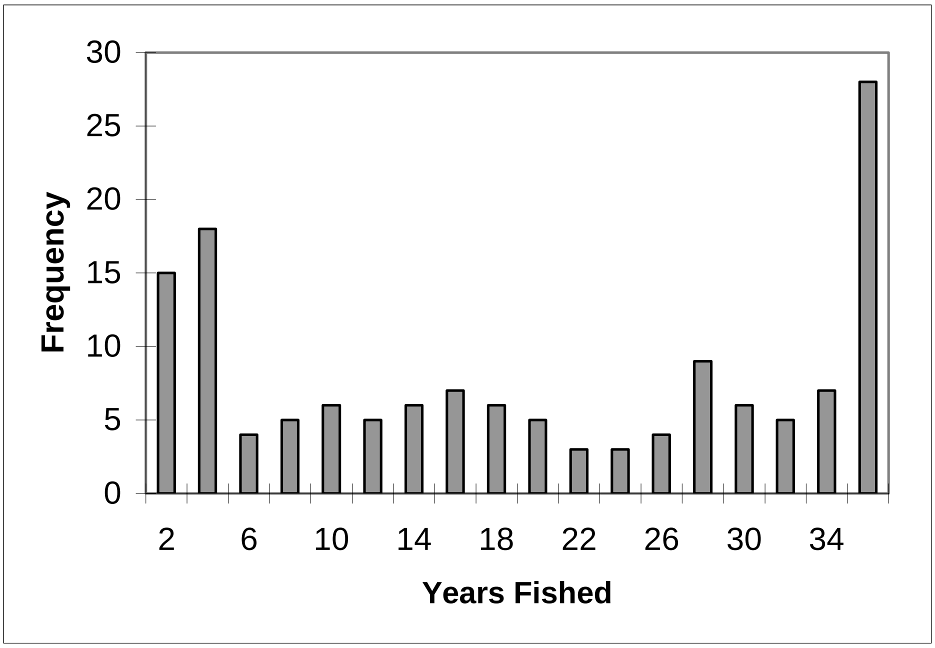


Figure 5-2 The frequency distribution of the number of years that a five degree square has been fished between 1969 and 2004 during the second and third quarters of the year. The x-axis values are the upper limit for each frequency bin.

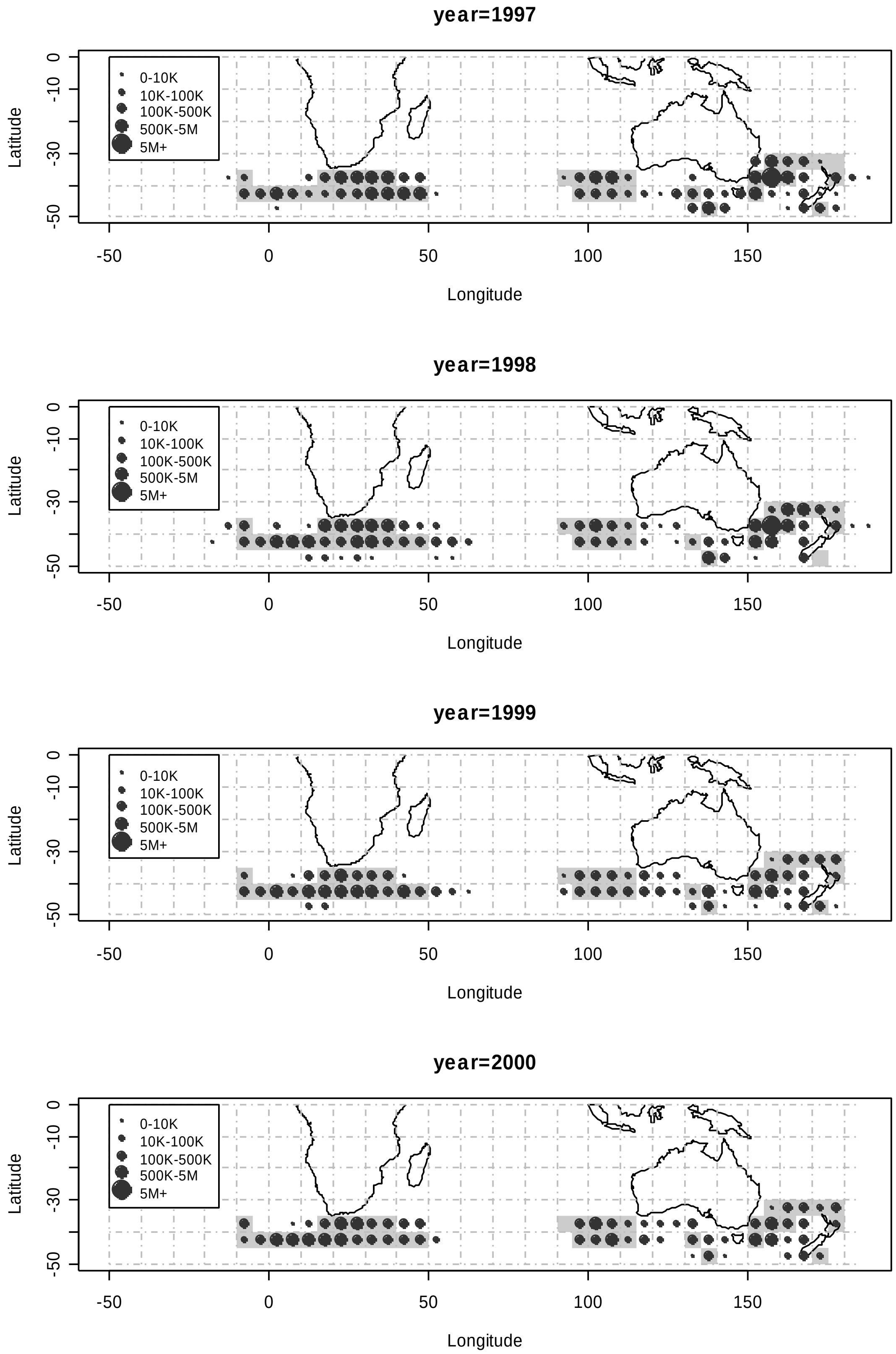


Figure 5-3 Distribution of fishing effort in the years 1997-2000, statistical areas 4-9, months 4-9. The grey shaded areas indicate the squares that have been fished for more than 31 years.

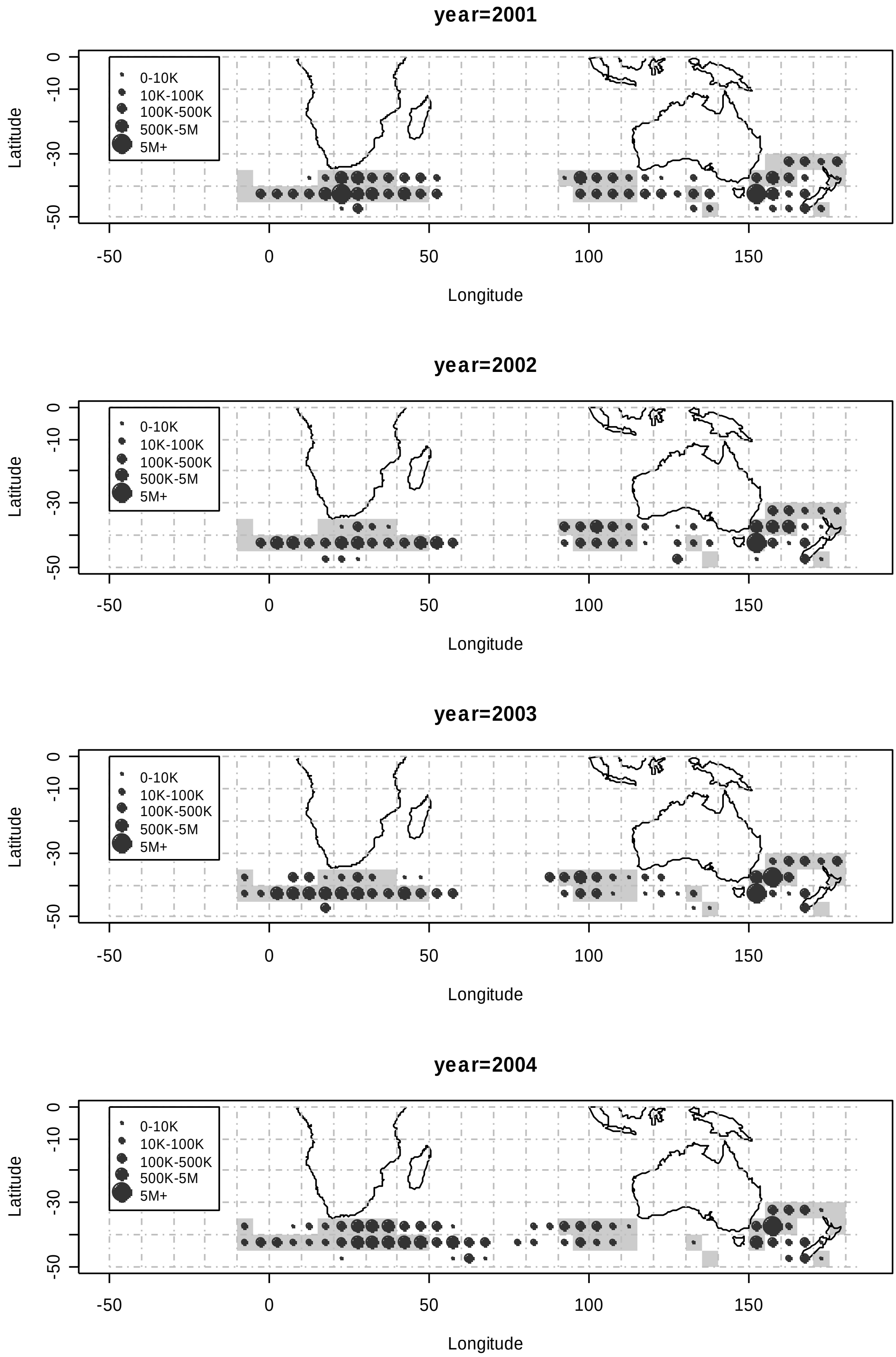


Figure 5-4 Distribution of fishing effort in the years 2001-2004, statistical areas 4-9, months 4-9. The grey shaded areas indicate the squares that have been fished for more than 31 years.

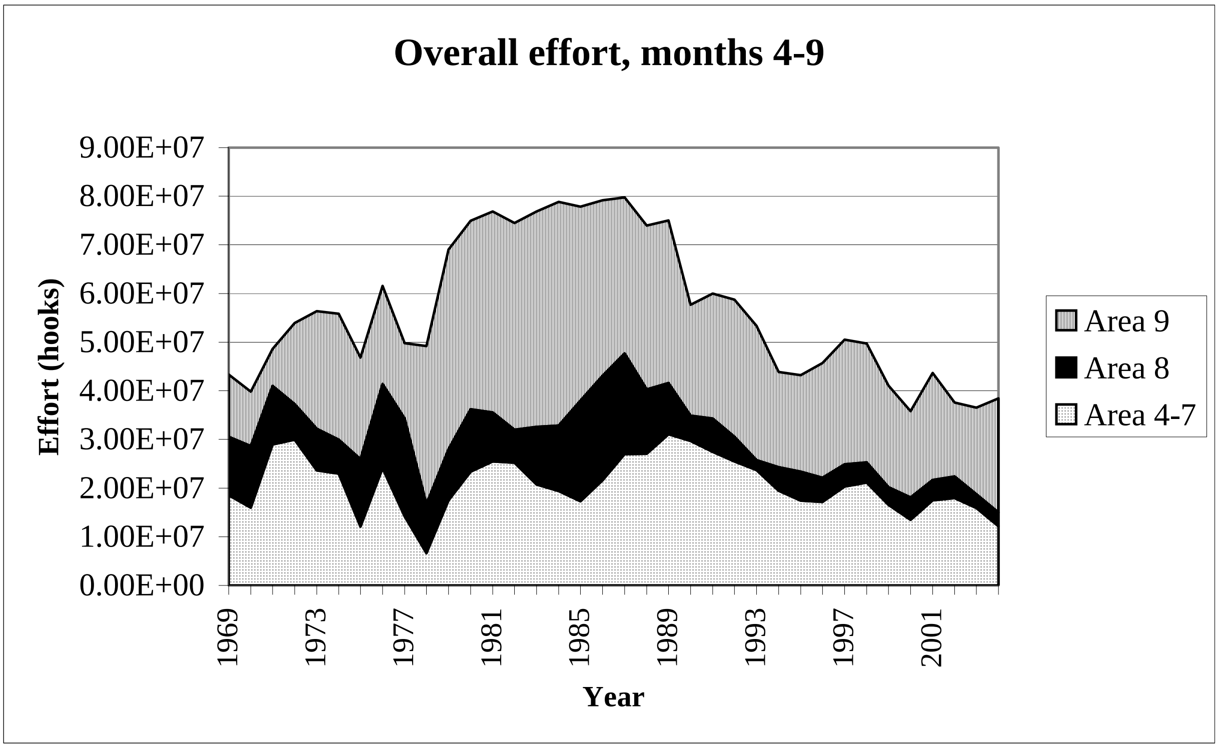


Figure 5-5 Fishing effort in Statistical Areas 4-7, 8 and 9, months 4-9.

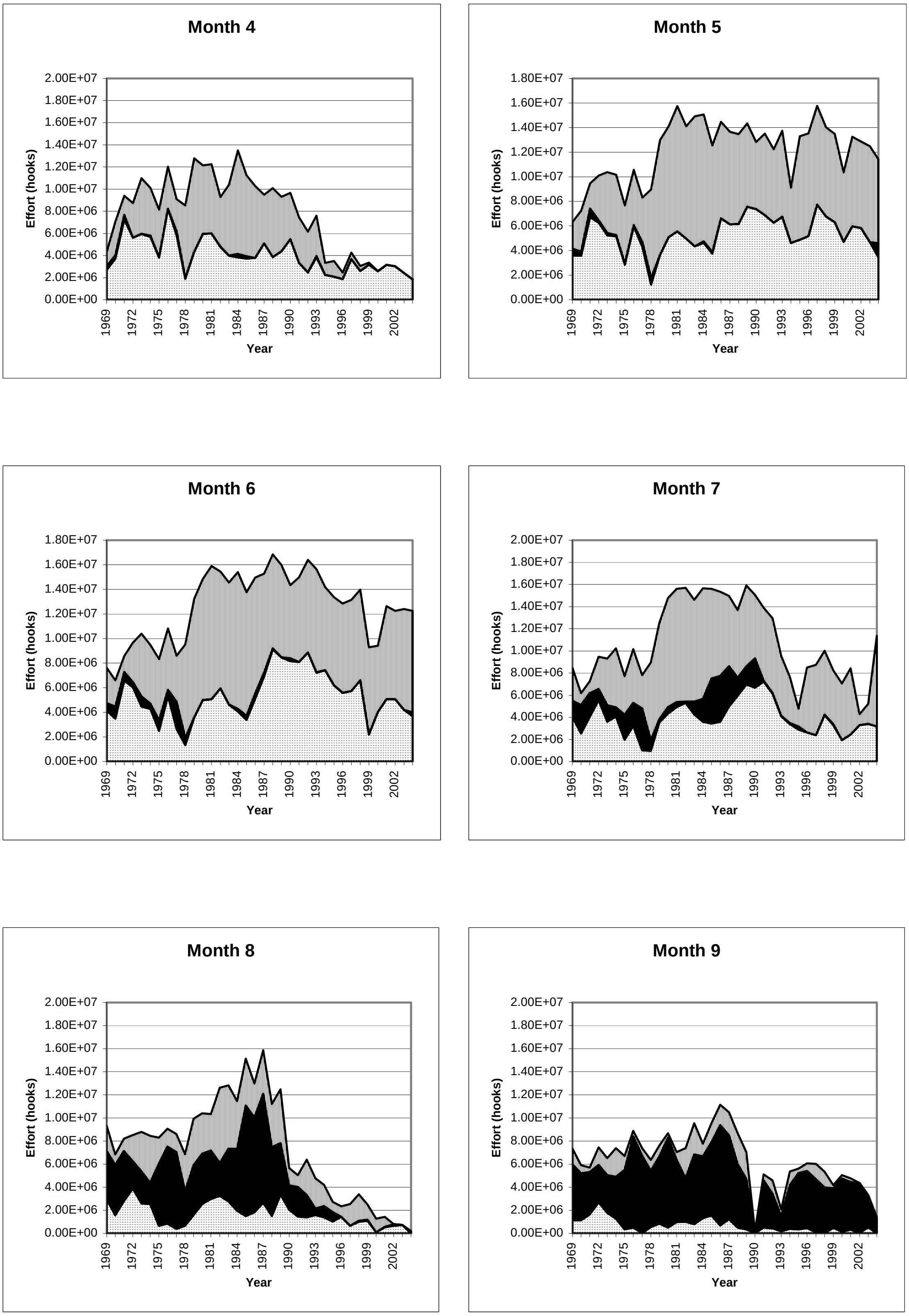


Figure 5-6 Monthly fishing effort in Statistical Areas 4-7 (horizontal dash fill), 8 (solid black) and 9 (vertical line fill).

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 than 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	14	22	27	25	4	18	110
2004	7	32	38	29	9	13	128

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 than 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	14	7	7	8	4	6	46
2004	7	8	9	9	2	0	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 than 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	0	0	0	0	12	12
2004	0	3	4	0	0	13	20

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 than 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	15	20	17	0	0	52
2004	0	21	25	20	7	0	73

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 227 strata with effort in at least one year but with no SBT catches, 16% 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, 54% of the strata in which no SBT were caught in at least one year were fished for 10 or more years. 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 2004 (i.e. from 37% to 4% in the number of strata and from 21% to 0.04% 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 2004 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.

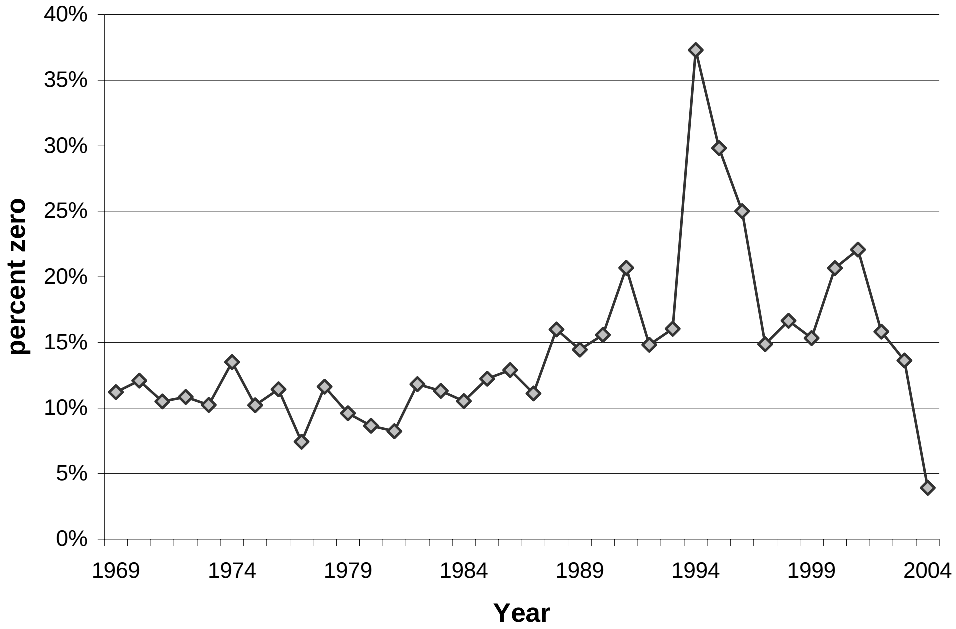


Figure 6-1 Percent of 5°X5° square/month strata fished (i.e. some reported effort) by Japanese longliners (within statistical areas 4-9 and in months 4-9) in which no SBT were caught.

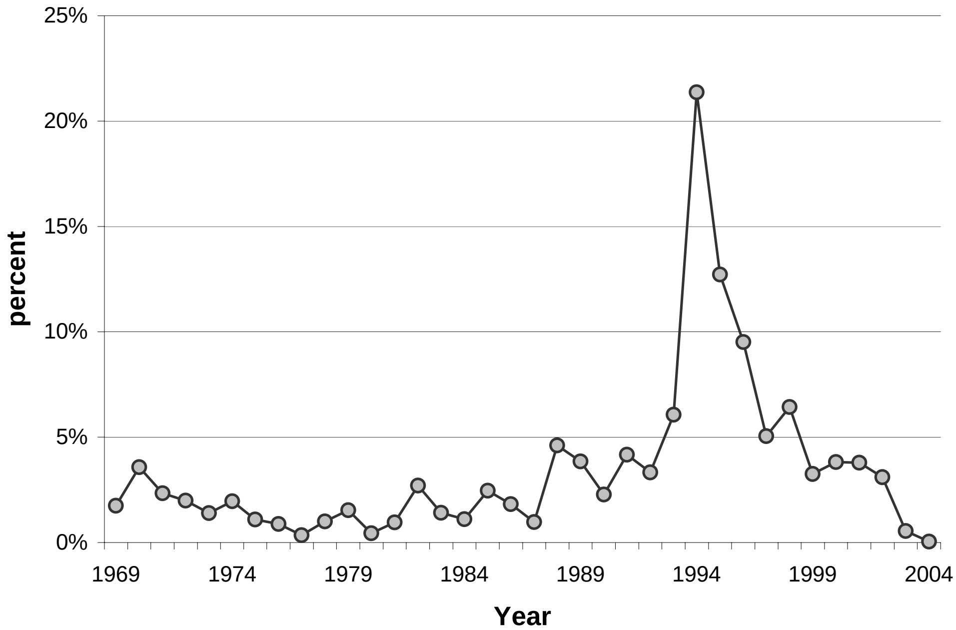


Figure 6-2 Percent of total number of hooks set by Japanese longliners (within statistical areas 4-9 and in months 4-9) in 5°X5° square/month strata in which no SBT were caught.

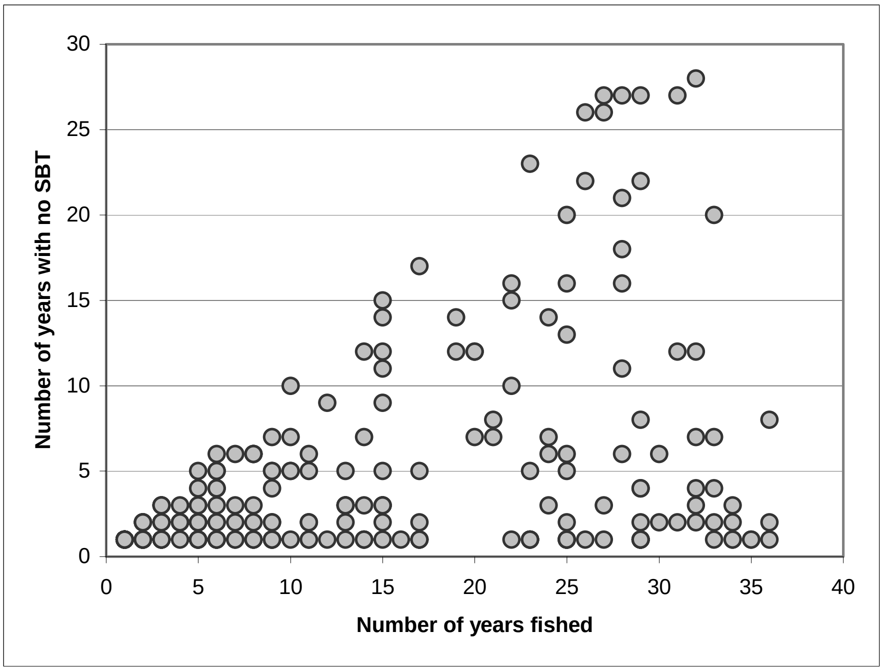


Figure 6-3 Comparison of the number of years a strata was fished and the number of years in which it never caught any SBT. Only strata which never caught SBT in at least one year are plotted. Note points can represent more than a single strata, particularly for strata which were not fished in many years.

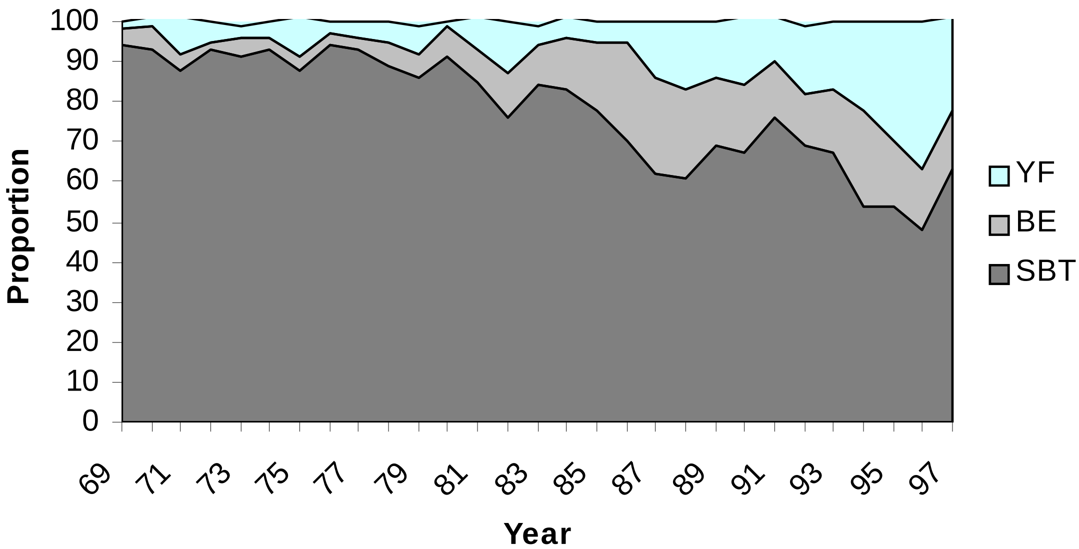


Figure 6-4 The proportion of the total catch of SBT, bigeye and yellowfin tuna by species caught by Japanese longliners within statistical areas 4-9 during month 4-9. Note that the data used in this figure are based on catch and effort data supplied previously by the Japanese National Research Institute 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.

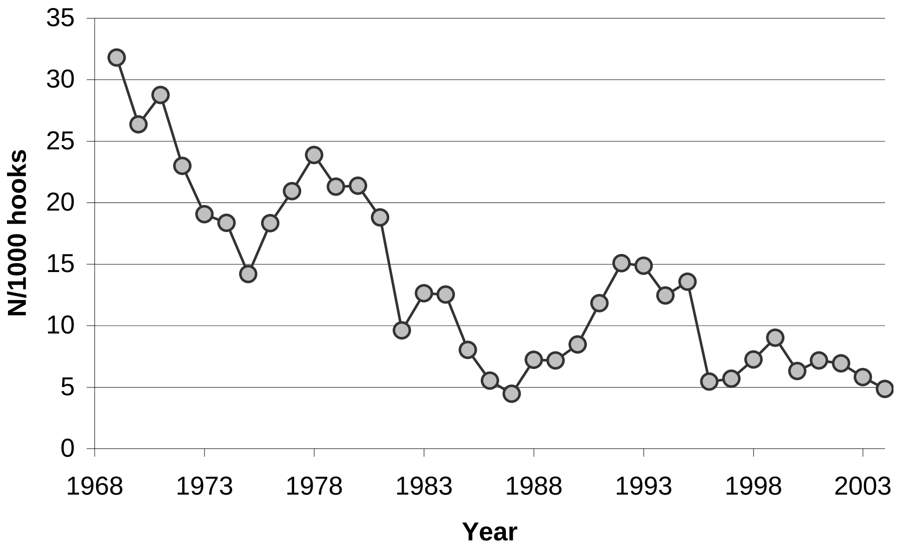


Figure 6-5 Mean catch rate (number of SBT per 1000 hooks) by Japanese longliners in the 10 highest rank 5°X5° squares/month strata within statistical area 4-9 during month 4-9.

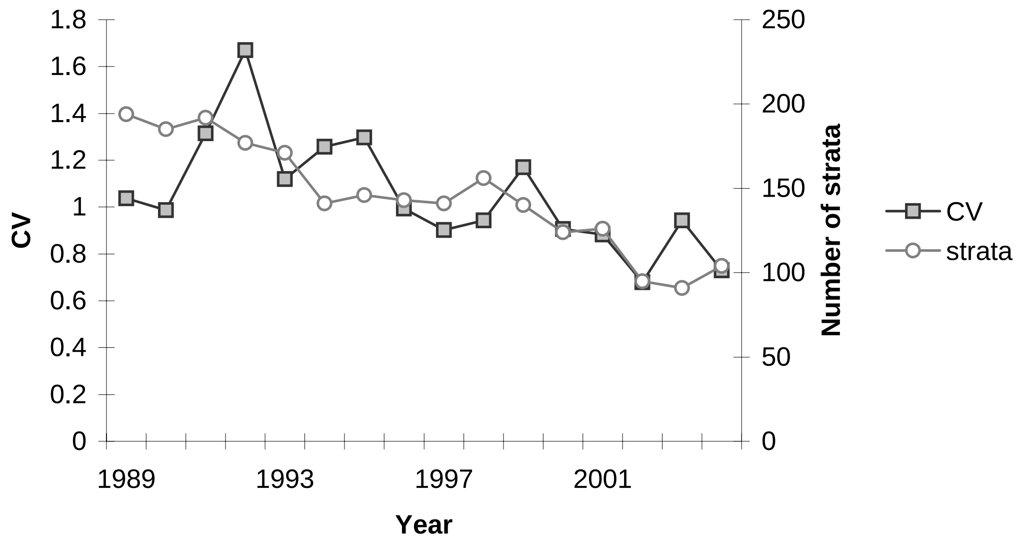


Figure 6-6 Comparison of the number strata fished in a year and the coefficient of variation in the nominal catch rate in those squares that were fished.

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.

The positive trend in catch rates for ages 3–7 and ages 8+ seen in recent years (1996–2002) has been sharply reversed in the last two years. Nominal catch rates for ages 3–7 are at a similar level to what they were in the mid 1990s. There was an increase in the catch rates of 3 year olds, but the 2004 catch rate is still at a similar level to the catch rates of 3 year olds in the late 1980s. The decrease in the aggregated age 3-7 index in 2004 is driven by the decreases in the age 4, 5, 6 and 7 indices, which have dropped from previous years, some significantly. The large drop in catch rates in 2003 for 4 year olds and in 2004 for 5 year olds suggests a particularly weak 1999 cohort (Figure 7-1). However, 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).

Any increase in catch rates for the 12+ group in recent years was reversed in 2003, and continued to decline in 2004. This is a worrying trend given that historically, the preliminary data is more optimistic in terms of catch rates (Figure 7-2).

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 2004. In contrast, for area 4-7 the indices for the three oldest age classes have been declining since 1999, with a reversal in 2004. However, the overall trend for the older ages in area 4-7 is downwards in recent years. Area 8 indices have been decreasing for nearly all ages since 2000, with increases in 2003 and 2004. The decline in the age specific trends in recent years for Area 9 and Areas 4–7 suggest a limited potential for the ages 8-11 to contribute to rebuilding of the spawning stock (Figure 7-3 and Figure 7-4).

The recent trends by fishing grounds are also quite different and conflicting for the age-specific indices. Area 4-7 shows a decline in catch rates for the young (4-8) age class, but an increase in catch rates for ages 9 and above (Figure 7-5). Area 8 continues to show improvement in catch rates across all ages except the 12+ group (Figure 7-6). All age indices for 2004 are down from 2003 for Area 9 (Figure 7-7) while at the same time, total effort in that area increased by 31%.

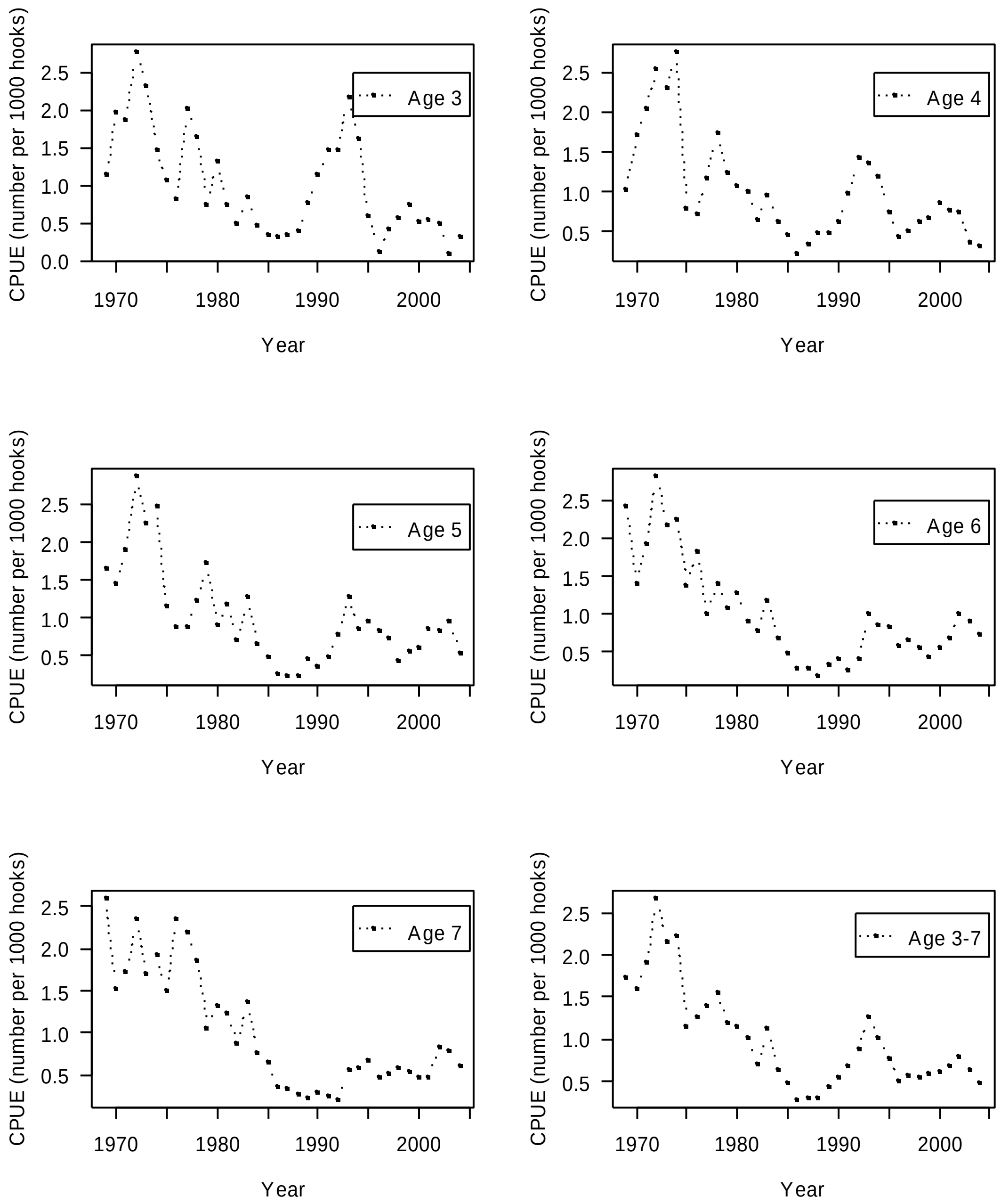


Figure 7-1 Nominal CPUE vs. Year for Japanese longline, Australian Joint Venture and New Zealand Joint Venture in Statistical Areas 4-9, ages 3,4,5,6,7 and 3-7. All indicies have been standardized by their means.

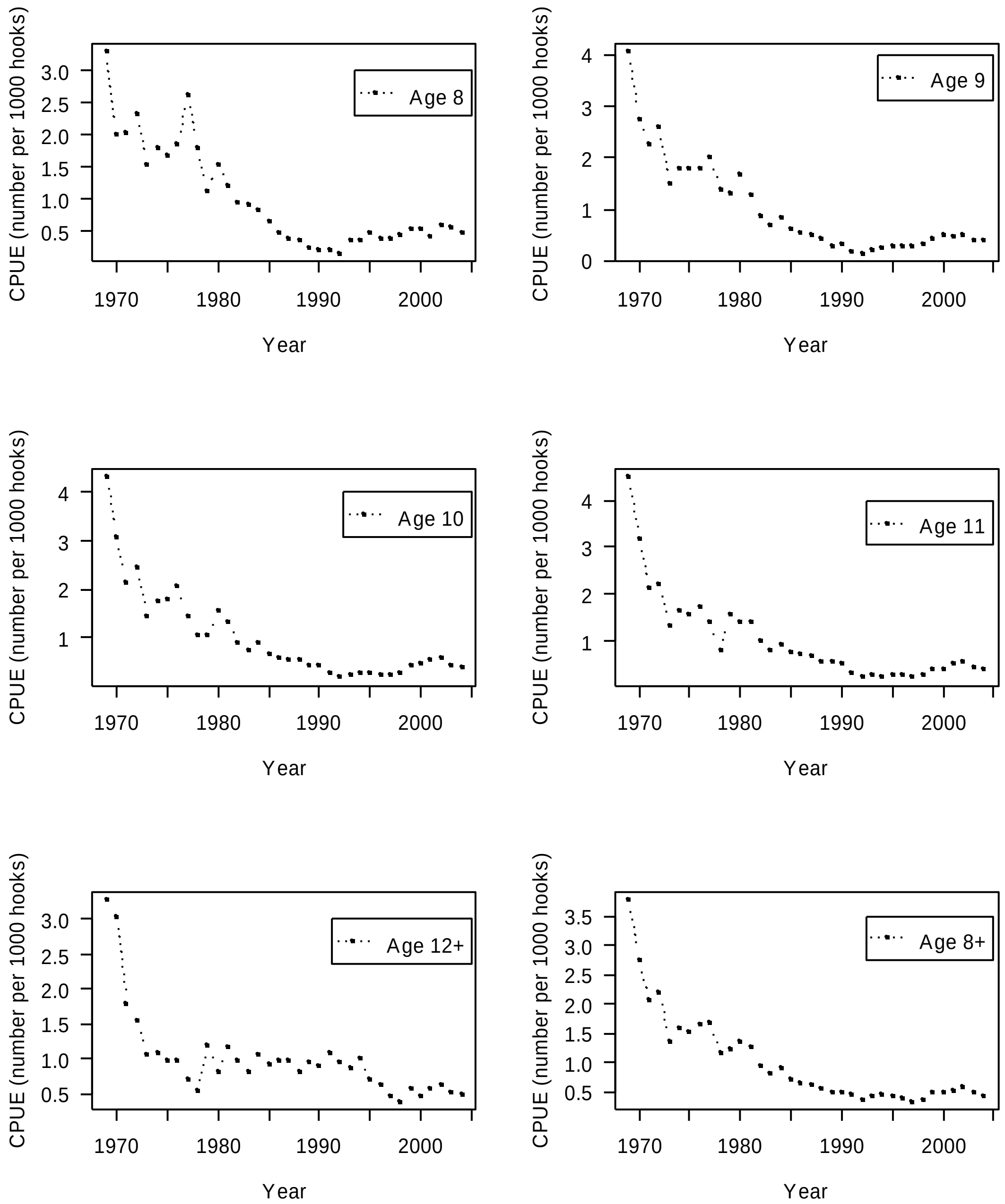


Figure 7-2 Nominal CPUE vs. Year for Japanese longline, Australian Joint Venture and New Zealand Joint Venture in Statistical Areas 4-9, ages 8,9,10,11,12+ and 8+. All indices have been standardized by their means.

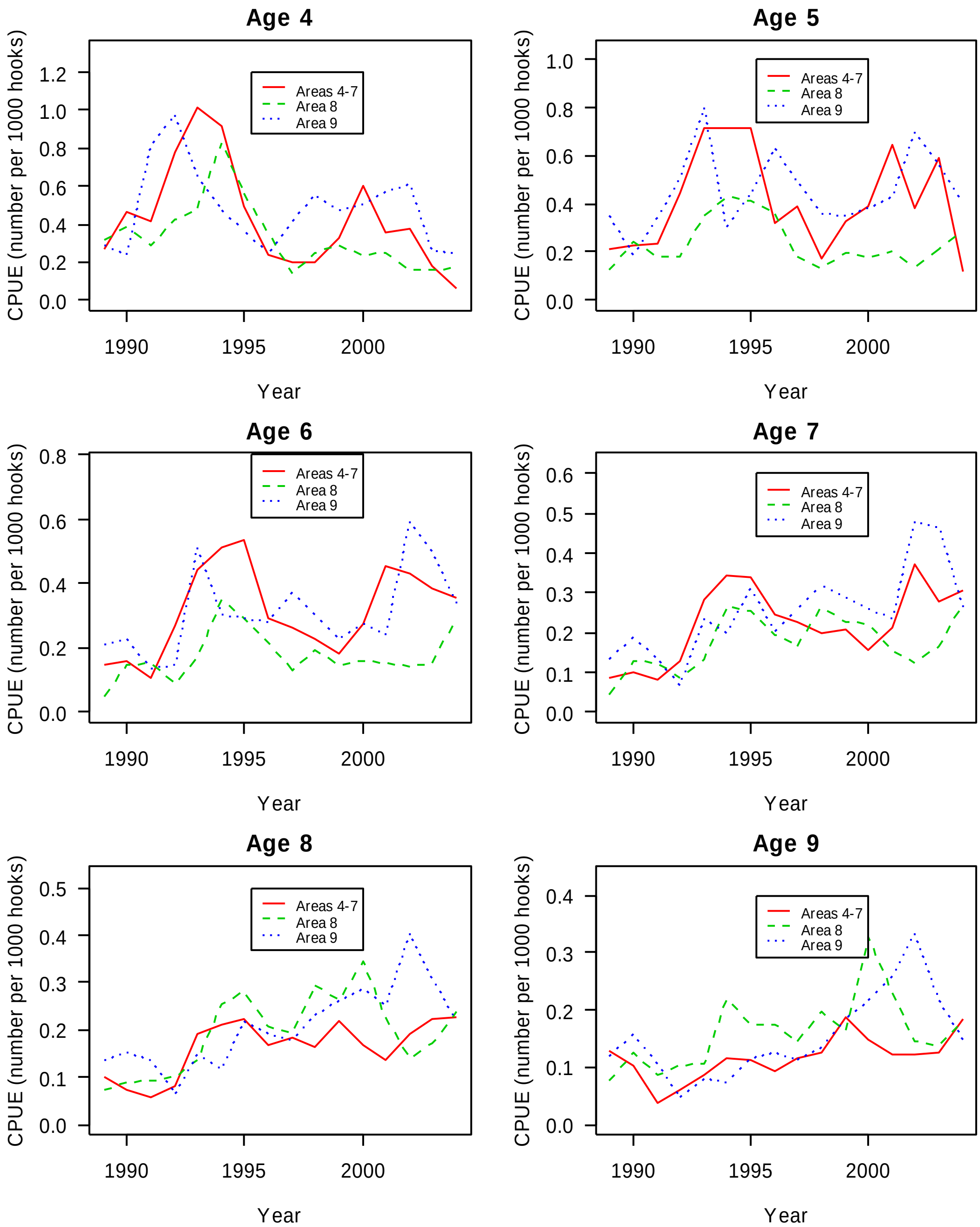


Figure 7-3 Comparison of age-specific nominal catch rates (Number per 1000 hooks) in recent years for different fishing regions. These indices have not been standardised by their means.

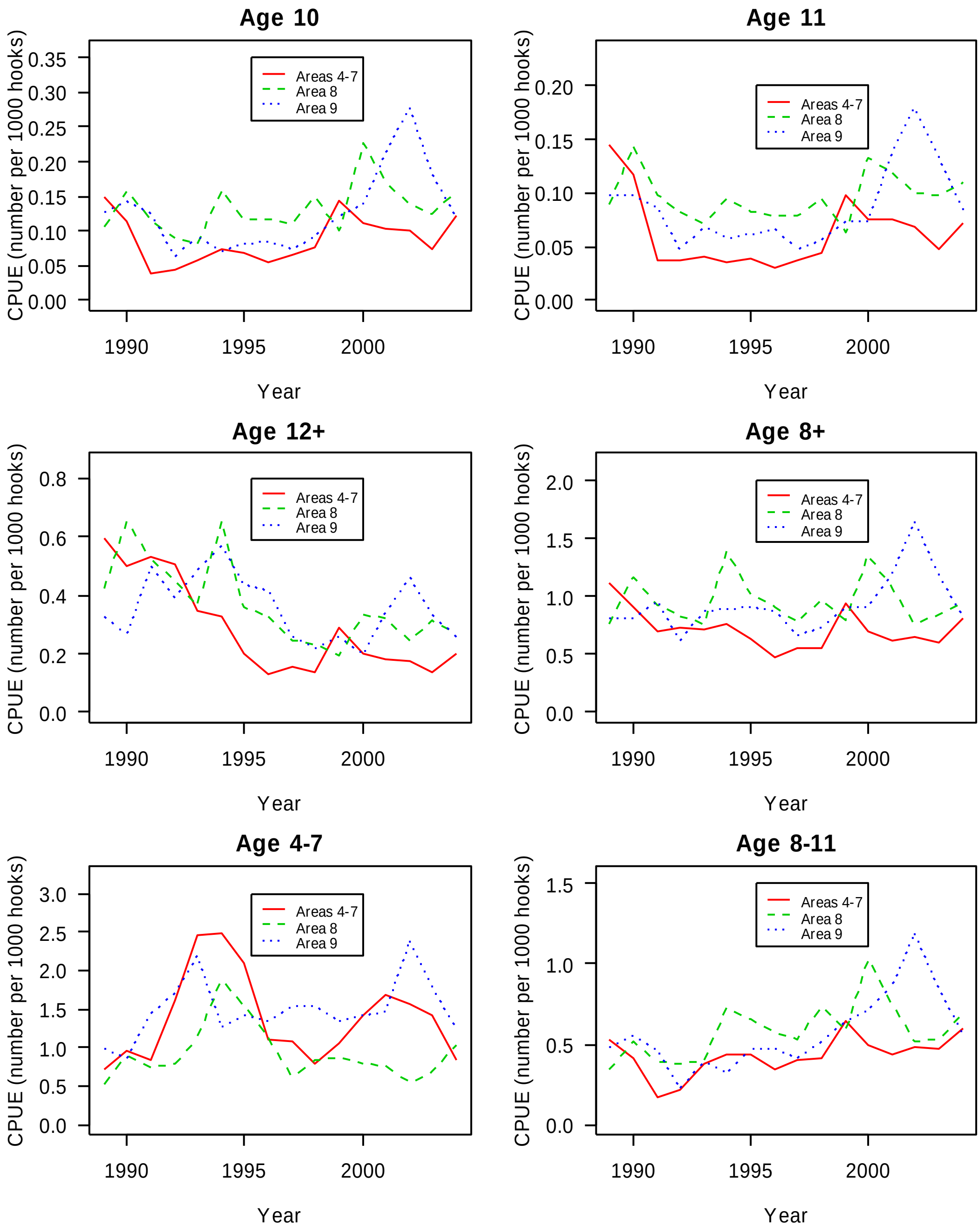


Figure 7-4 Comparison of age-specific nominal catch rates (Number per 1000 hooks) in recent years for different fishing regions. These indices have not been standardized by their means.

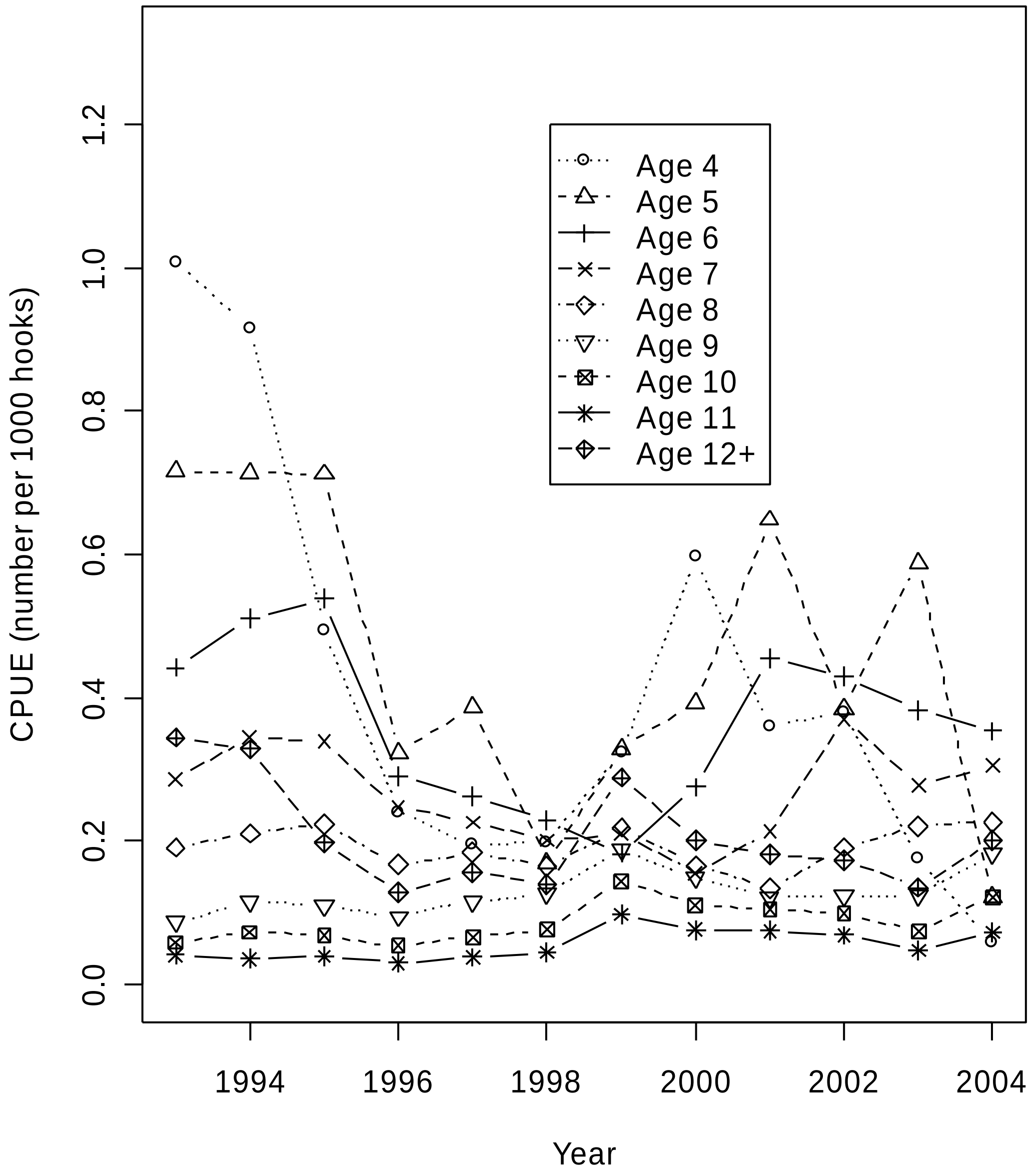


Figure 7-5 Comparison of recent nominal age-specific catch rates (Number per 1000 hooks) for Statistical Areas 4-7. These indices have not been standardized by their means.

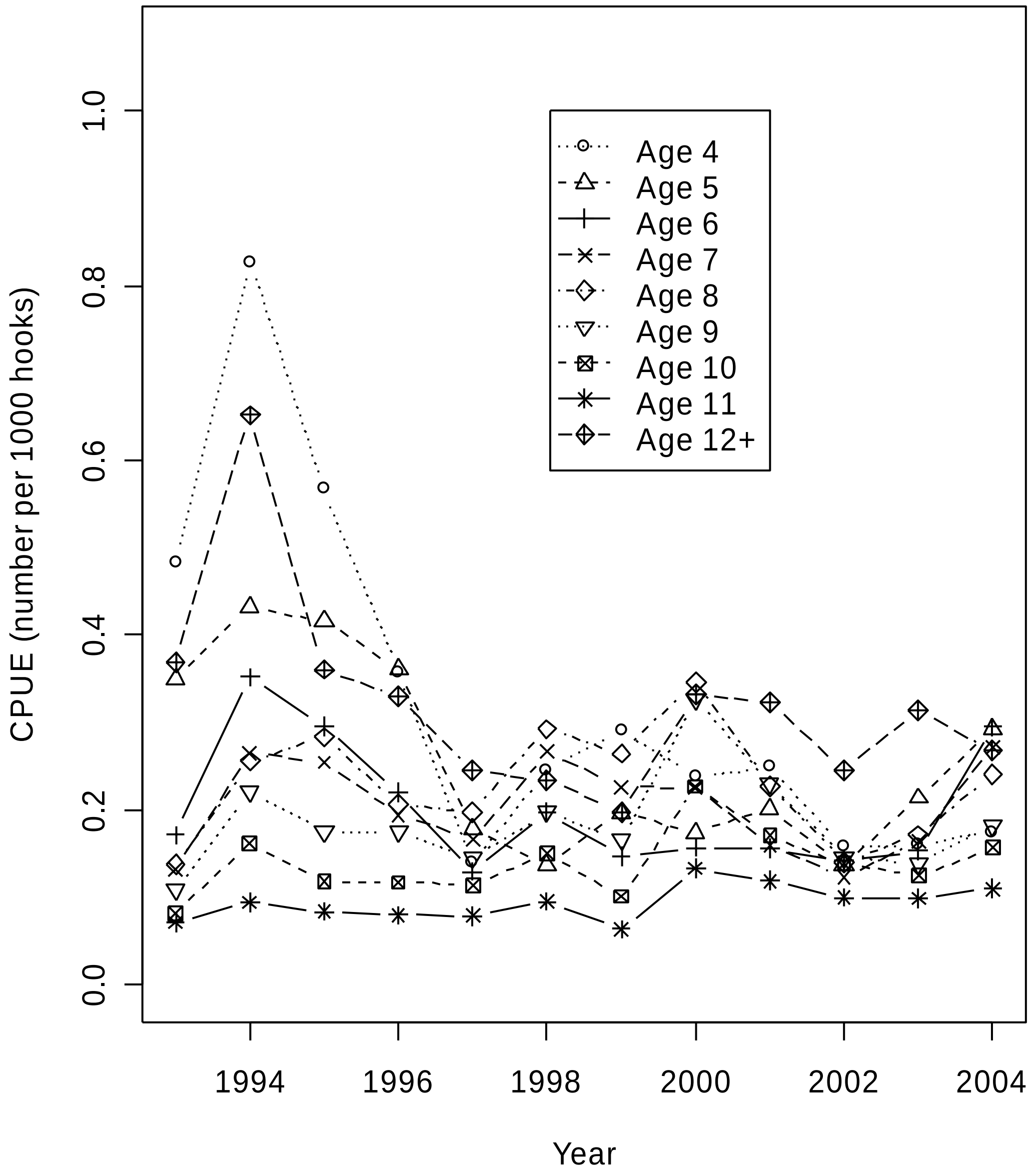


Figure 7-6 Comparison of recent nominal age-specific catch rates (Number per 1000 hooks) for Statistical Area 8. These indices have not been standardized by their means.

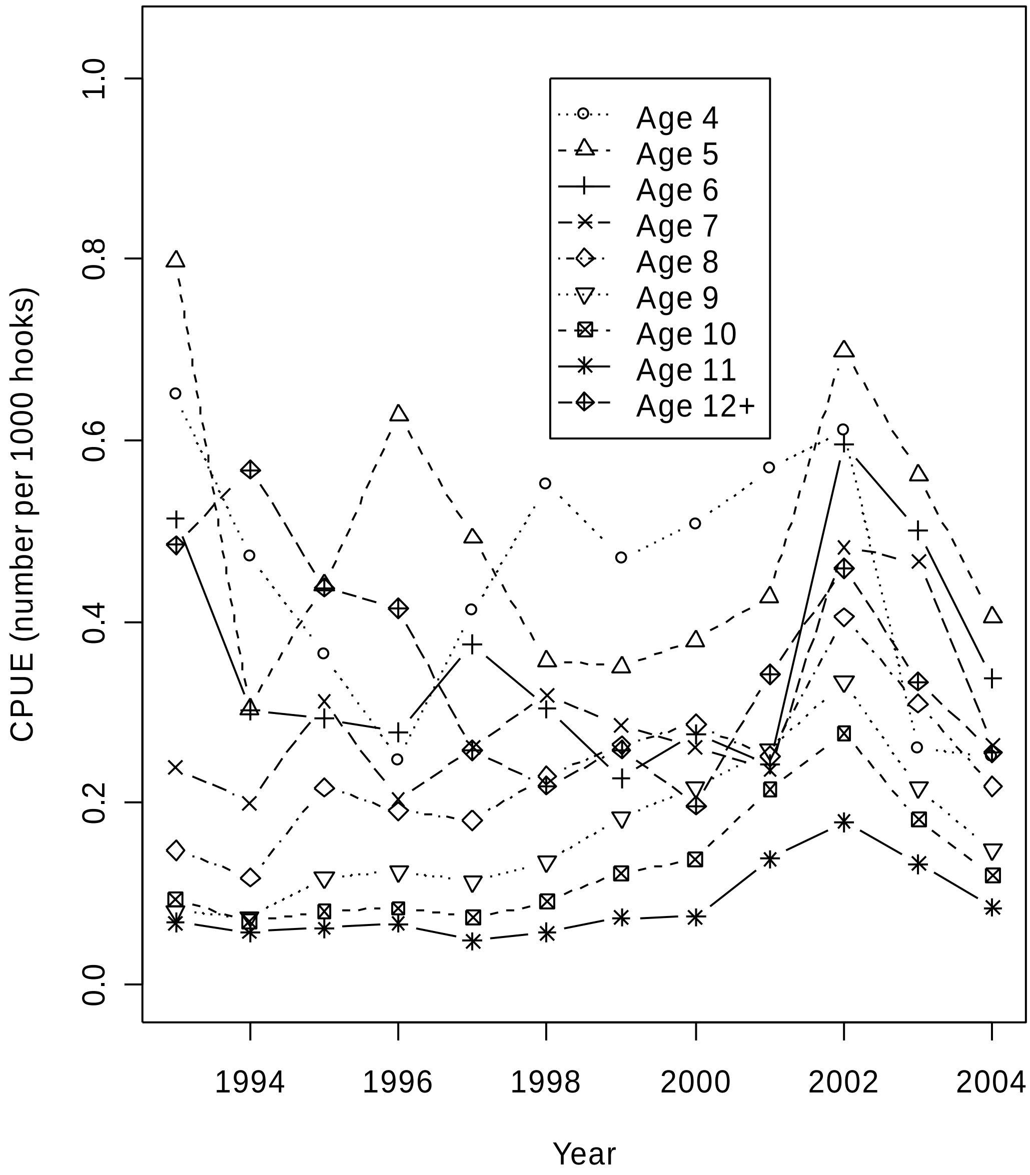
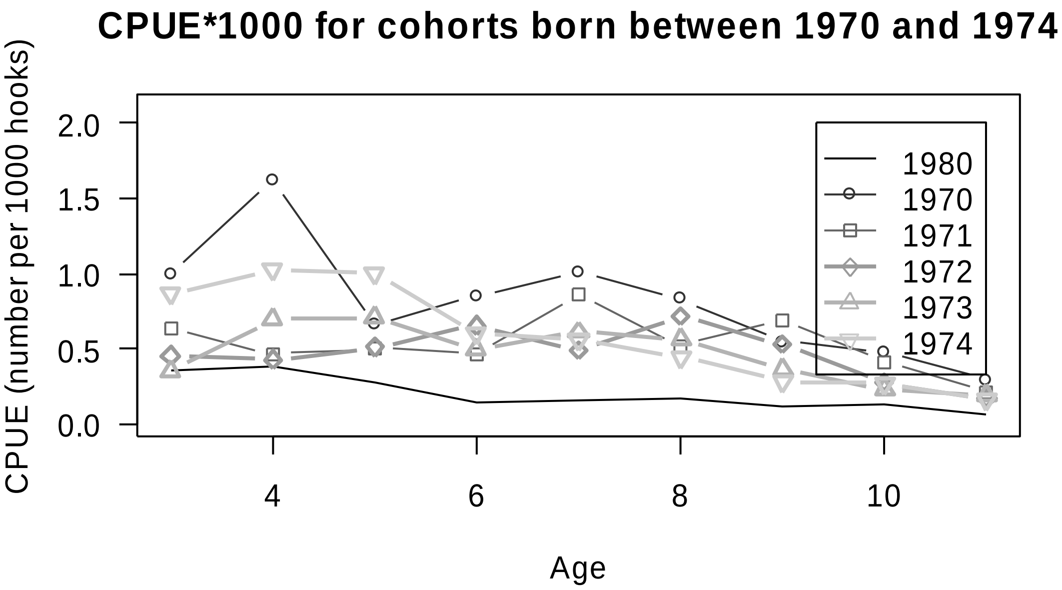


Figure 7-7 Comparison of recent nominal age-specific catch rates (Number per 1000 hooks) for Statistical Area 9. These indices have not been standardized by their means.

7.1 Catch rates by cohorts

Figure 7-8 to Figure 7-11 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 (Figure 7-10). As these more recent cohorts are beginning to mature, this suggests that they may have potential to contribute to rebuilding the spawning stock.



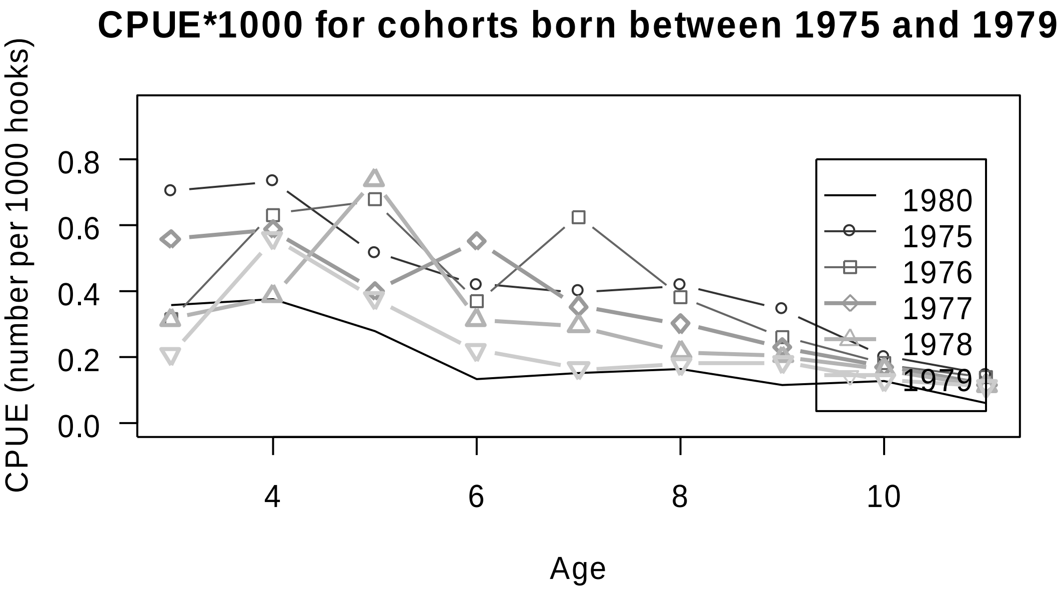
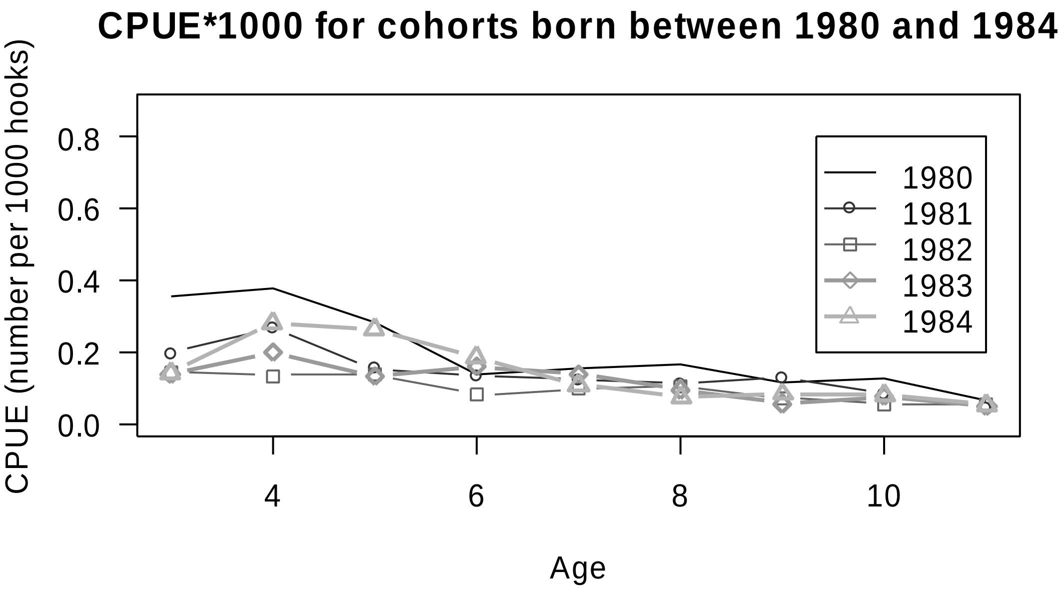


Figure 7-8 Nominal CPUE in Statistical Areas 4-9, months 4-9 for cohorts born between (a) 1970 and 1974, and (b) 1975 and 1979. The cohort born in 1980 is also shown for reference. These indices have not been standardized by their means.



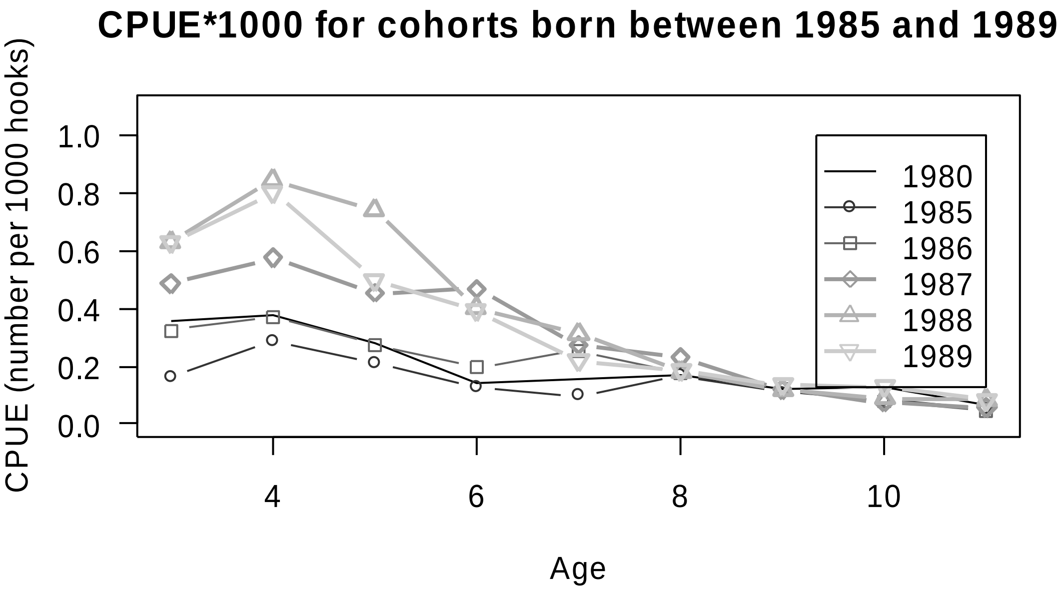
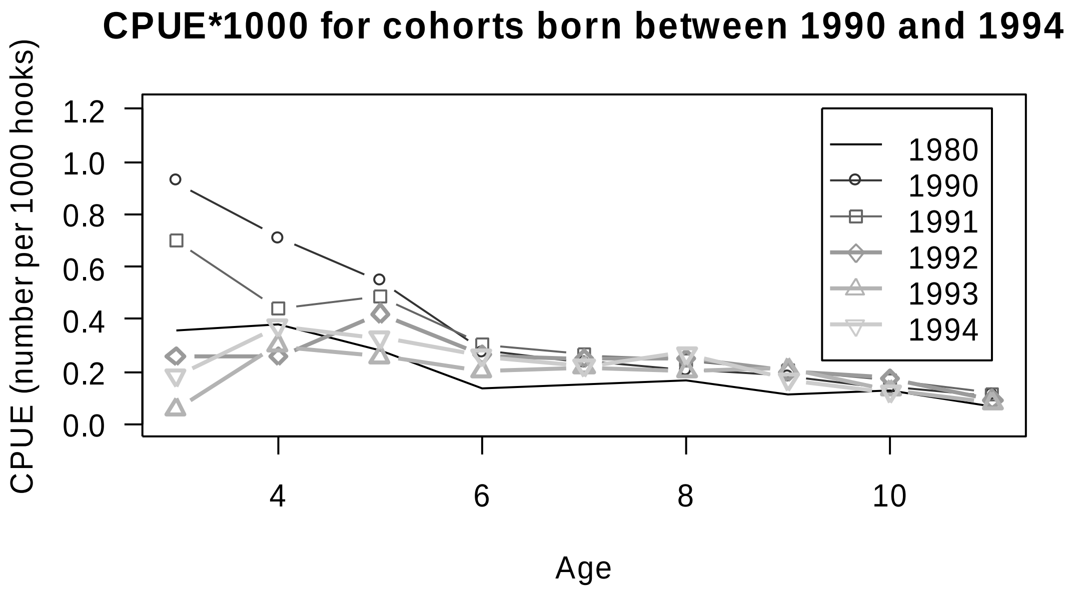


Figure 7-9 Nominal CPUE in Statistical Areas 4-9, months 4-9 for cohorts born between (a) 1980 and 1984, and (b) 1985 and 1989. The cohort born in 1980 is also shown for reference. These indices have not been standardized by their means.



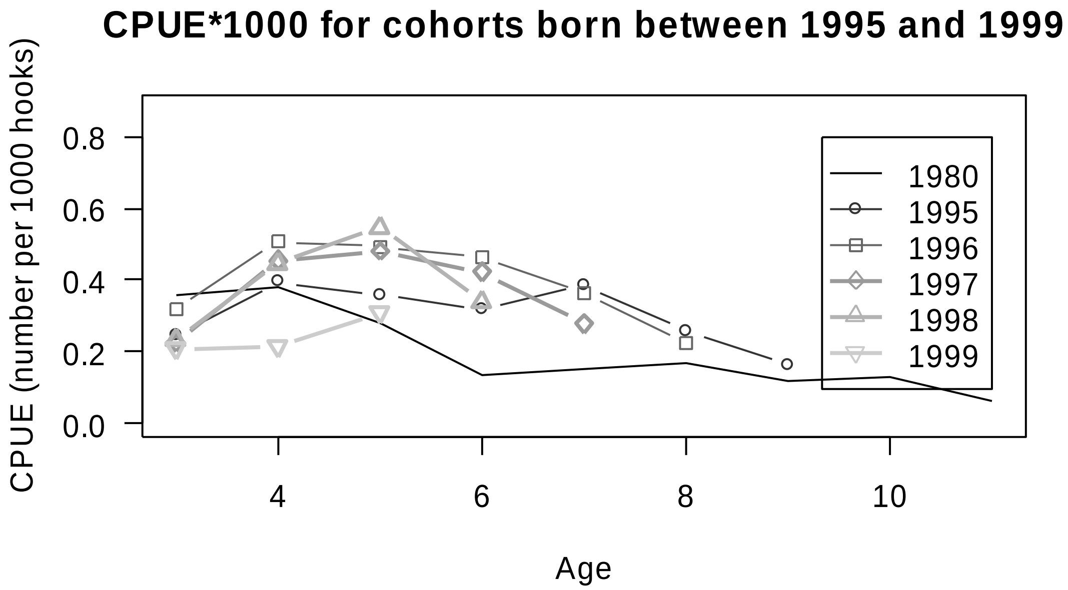


Figure 7-10 Nominal CPUE in Statistical Areas 4-9, months 4-9 for cohorts born between (a) 1990 and 1994, and (b) 1995 and 1999. The cohort born in 1980 is also shown for reference. These indices have not been standardized by their means.

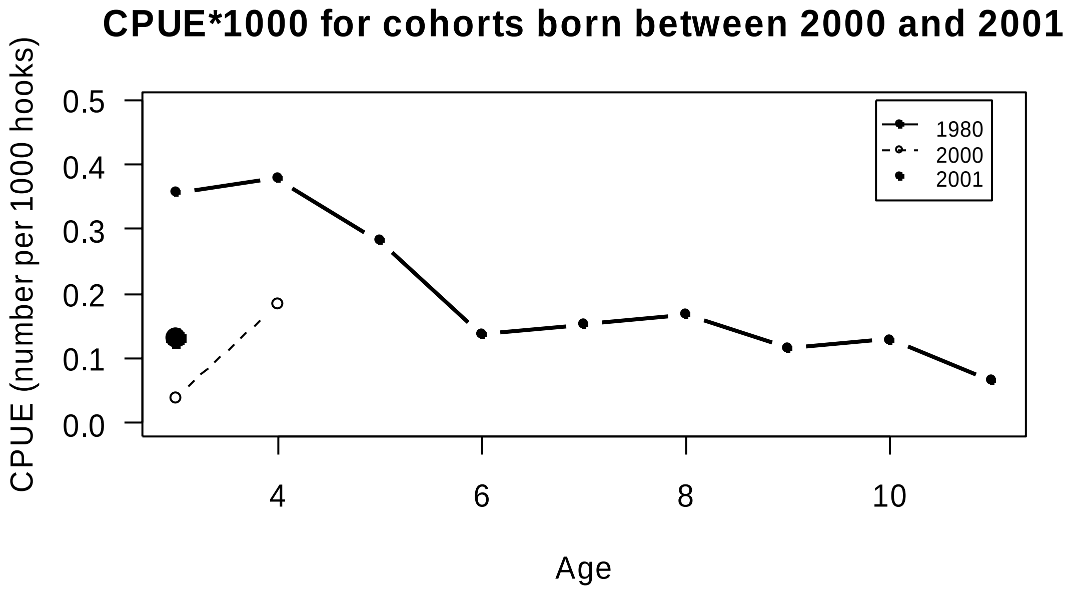


Figure 7-11 Nominal CPUE in Statistical Areas 4-9, months 4-9 for cohorts born between 2000 and 2001. The cohort born in 1980 is also shown for reference. These indices have not been standardized by their means.

8 Literature cited

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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.

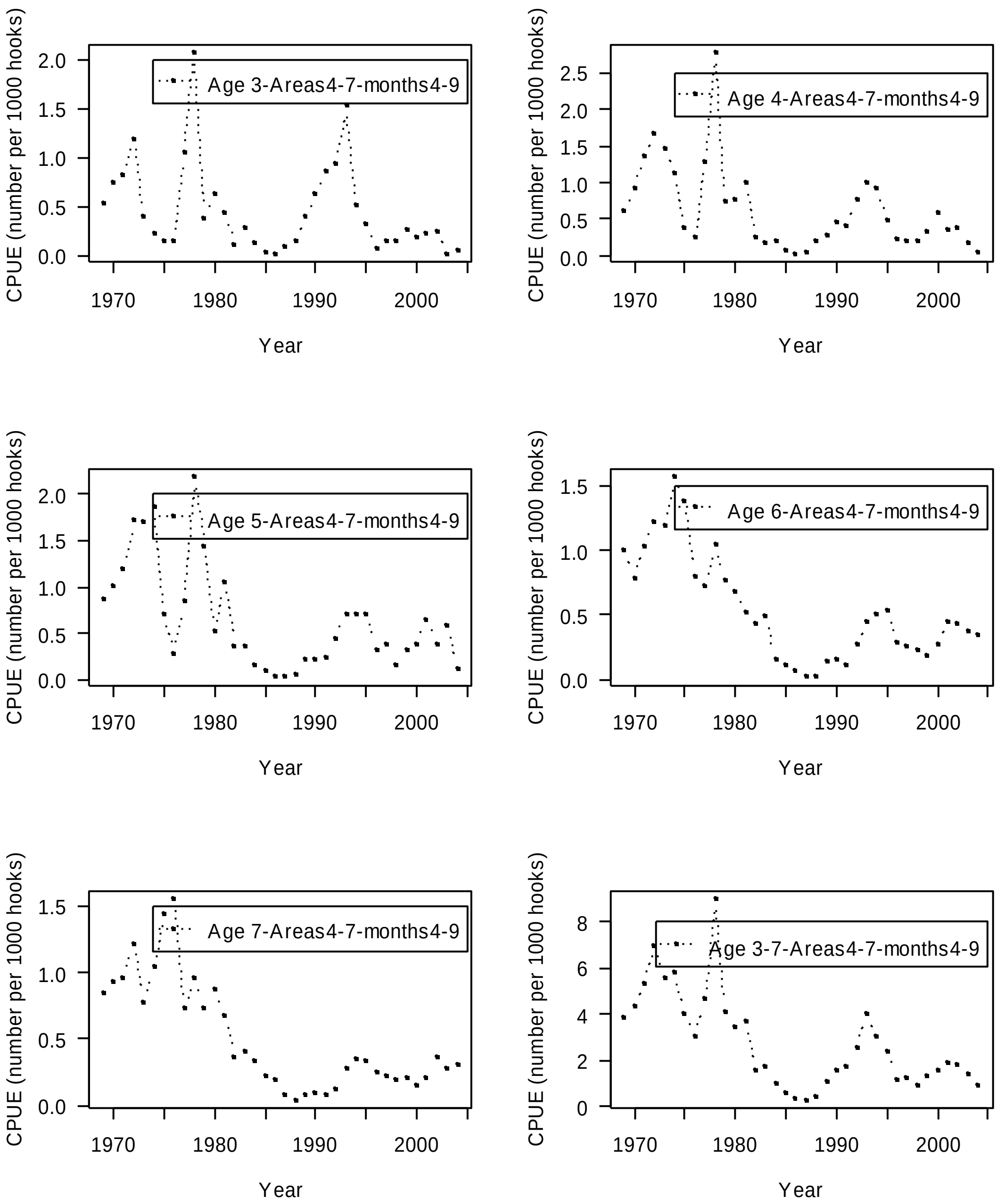

Figure 9-1 Nominal CPUE vs. Year for Japanese longline, Australian Joint Venture and New Zealand Joint Venture in Statistical Areas 4-7, ages 3,4,5,6,7 and 3-7.

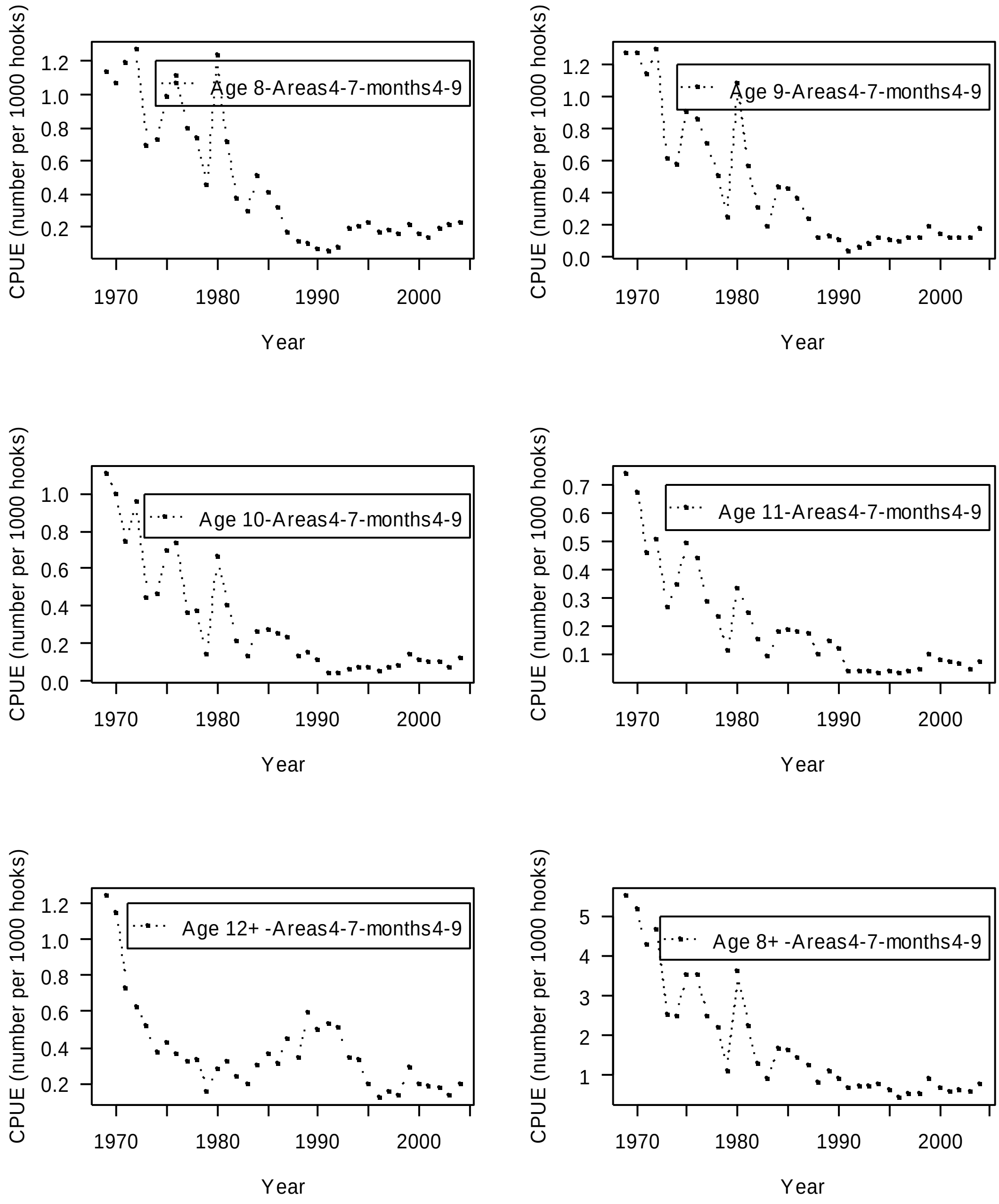

Figure 9-2 Nominal CPUE vs. Year for Japanese longline, Australian Joint Venture and New Zealand Joint Venture in Statistical Areas 4-7, ages 8,9,10,11,12+ and 8+.

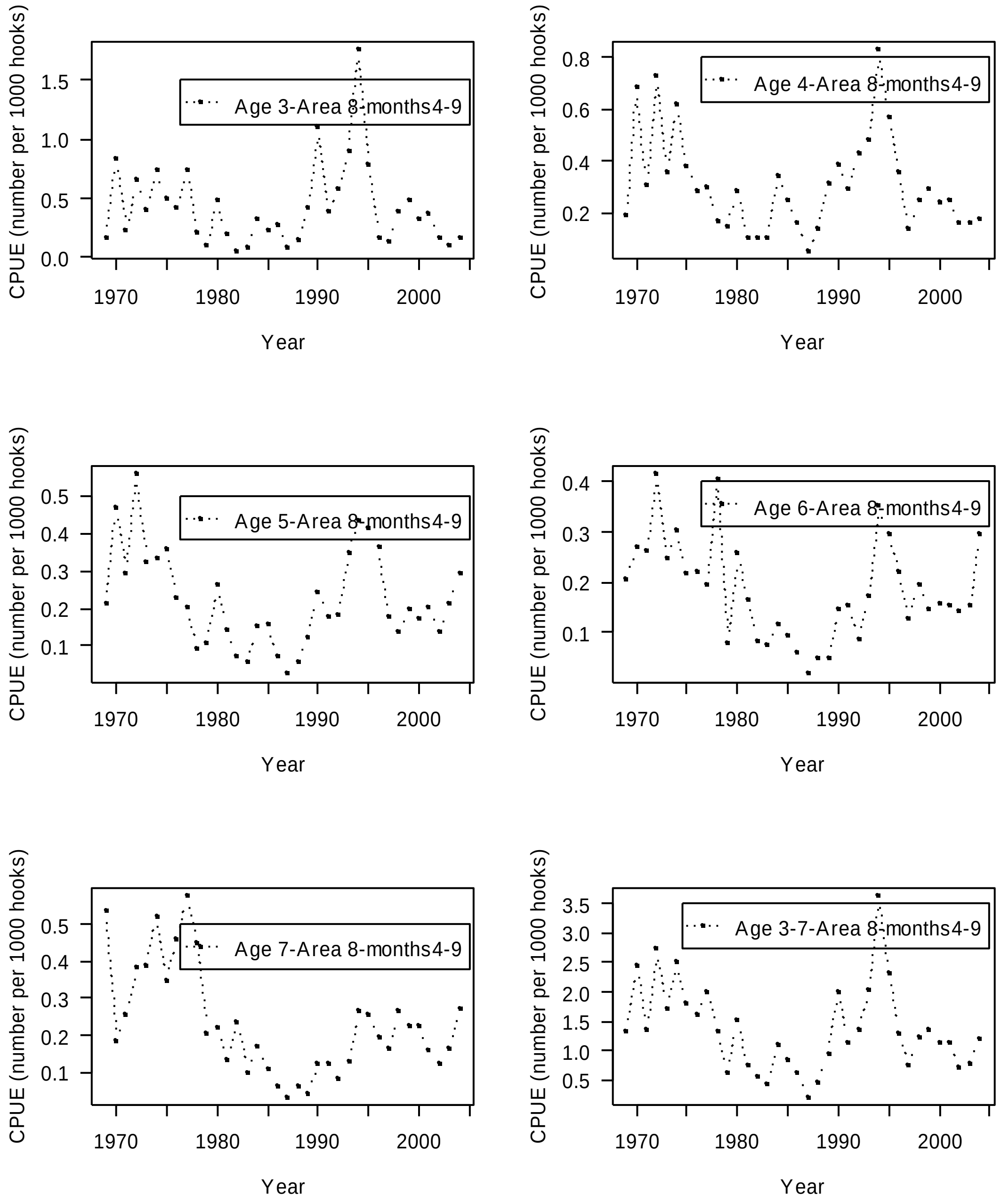

Figure 9-3 Nominal CPUE vs. Year for Japanese longline, Australian Joint Venture and New Zealand Joint Venture in Statistical Area 8, ages 3,4,5,6,7 and 3-7.

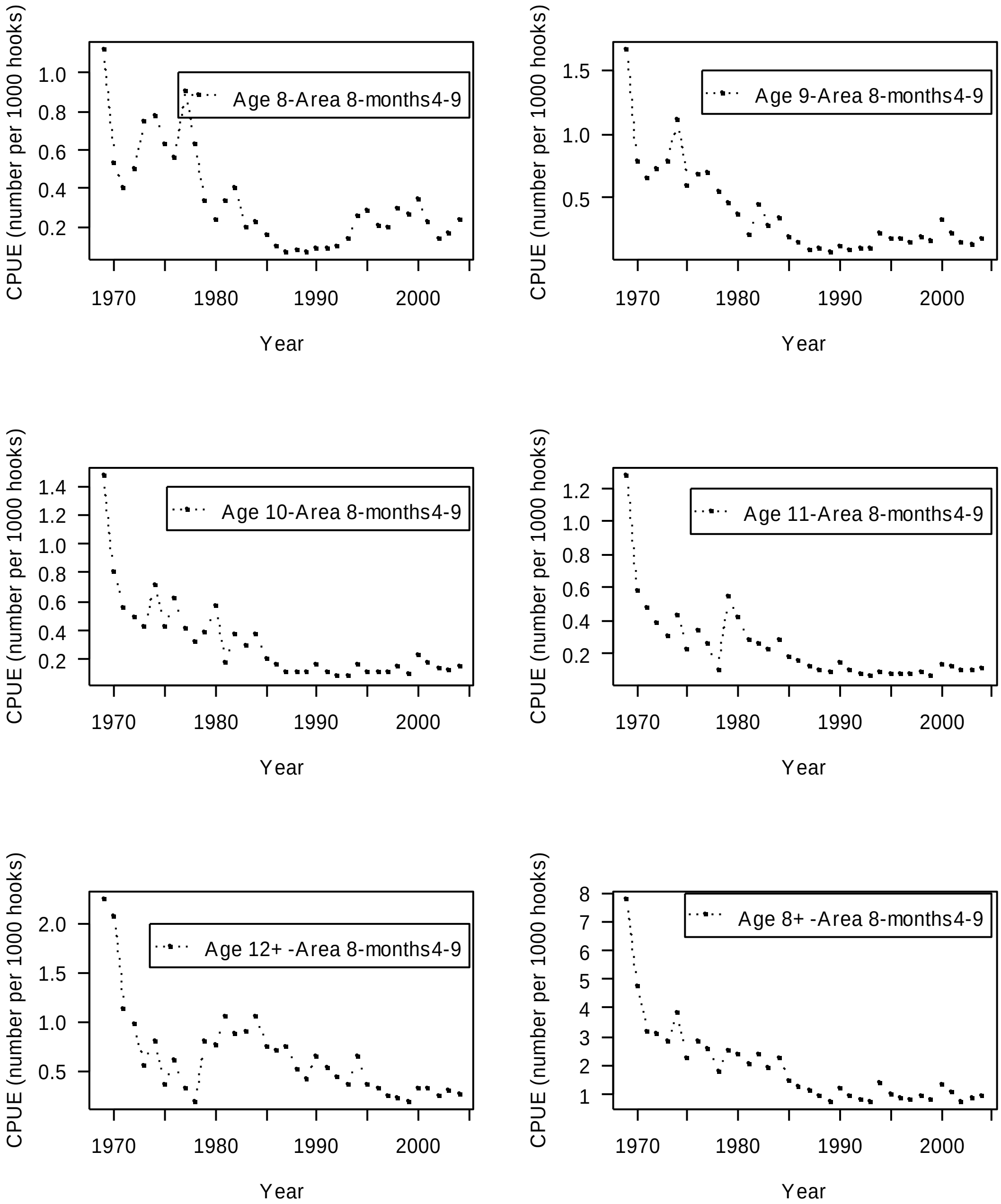

Figure 9-4 Nominal CPUE vs. Year for Japanese longline, Australian Joint Venture and New Zealand Joint Venture in Statistical Area 8, ages 8,9,10,11,12+ and 8+.

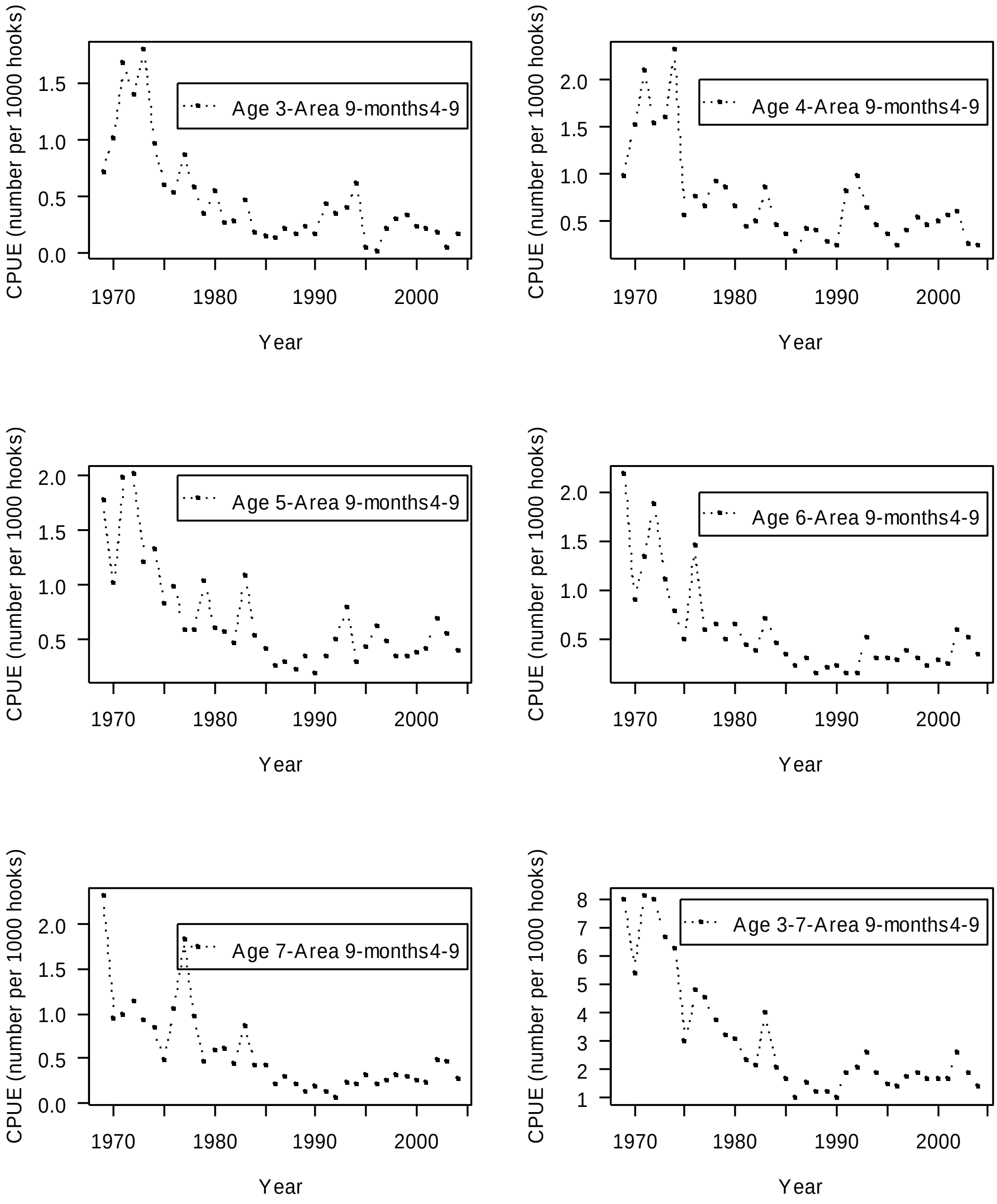

Figure 9-5 Nominal CPUE vs. Year for Japanese longline, Australian Joint Venture and New Zealand Joint Venture in Statistical Area 9, ages 3,4,5,6,7 and 3-7.

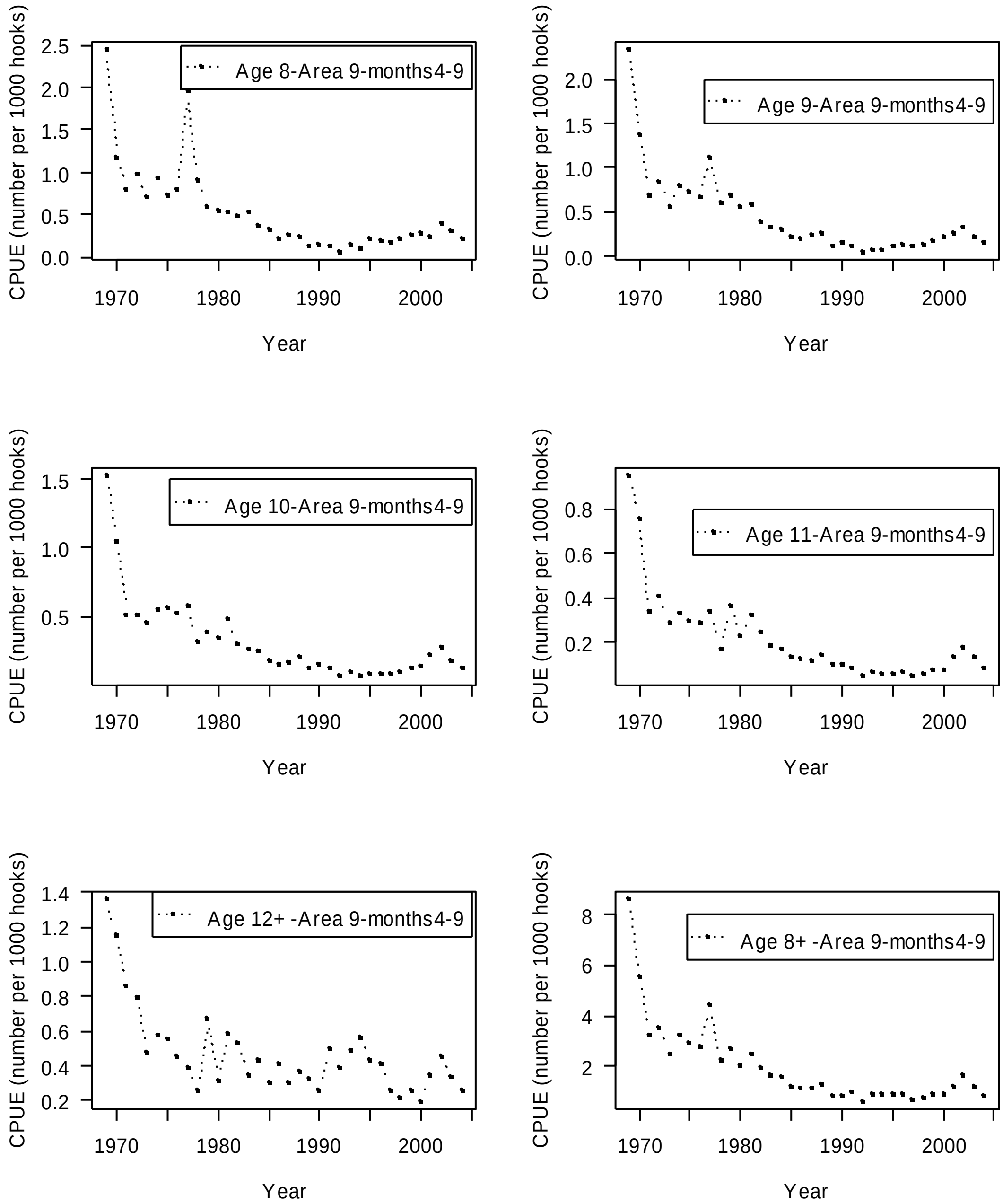

Figure 9-6 Nominal CPUE vs. Year for Japanese longline, Australian Joint Venture and New Zealand Joint Venture in Statistical Area 9, ages 8,9,10,11,12+ and 8+.