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EXECUTIVE SUMMARY

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Jack mackerel catch and effort data recorded on TCEPR and CELR forms spanning the 1989–90 to 2003–04 fishing years were extracted from the Ministry of Fisheries catch-effort database for JMA 1, JMA 3, and JMA 7. Historical catch data were transcribed into electronic format from a number of published sources and tabulated to provide indicative summaries of the levels of domestic commercial catch in each QMA before 1989–90.

The TCEPR and CELR data were used to review all fisheries in JMA 1, 3, and 7 for the period 1989–90 to the end of the 2003–04 fishing year. The review included a summary and description of the commercial catch history and a history (by fishing year) of catch by method and target species; spatio-temporal distributions of catch size from the purse-seine, mid-water trawl, and bottom trawl fisheries; a history of estimated targeted/non-targeted catch by method; and estimated catch by target species for fisheries where the quantities of data were sufficient.

In most cases these summaries comprised tabulation of data. In some cases the data were plotted to illustrate or emphasise the presence of trends. Usually percentages of the total jack mackerel catch were included in the data tabulations to detect or demonstrate shifts in the relative representation of the factors being summarised; sometimes these percentages were used as the basis for plotted summaries.

The first available records of commercial catches of jack mackerel were from 1939–40 when a total of 2.1 t was recorded from all ports combined. Between 1939–40 and 1965 the total domestic catch fluctuated around values that were mostly less than 20 t but peaked at 27 t in 1949, with most catch taken in JMA 1. After 1965, total landings rose steadily, mainly as a result of increasing landings in JMA 1, although the catch in JMA 7 took a step up in 1966 that was sustained throughout the period and tended to increase. Landings in JMA 3 were always low except in 1964 and 1965.

The deepwater fishery has contributed the largest volume to total landings since at least 1970 when the Japanese fleet took the majority of catch. Exactly when this began is unclear, but information from the popular press suggests fishing by several Japanese trawlers beginning about 1967. Japanese catch peaked at about 18 000 t in 1972 and remained at 13 000 t or more until 1977 when a dramatic reduction occurred as the result of a 5000 t quota and 100 mm codend being imposed after declaration of the Exclusive Economic Zone in 1978. This reduction in foreign licensed catch was initially offset by the increasing purse-seine activity mentioned above, and by the eventual increase in landings by the foreign chartered fleet.

The rising trend that began in the pre-1989–90 fishery with the increased purse-seine activity and landings by the foreign chartered fleet continued after introduction of the QMS and was sustained until 1992–93 when the total jack mackerel fishery peaked at 47 400 t. By this time, landings from JMA 1, which were almost 100% of the purse-seine catch, represented the smallest contribution to the total catch. By contrast, landings in JMA 3 and 7, which comprised a high percentage of those taken by the foreign chartered fleet, contributed more than 70% of the total jack mackerel catch from all areas combined.

Since 1992–93, total landings have dropped to about 33 000 t in each of 2002–03 and 2003–04. A salient feature of this decline was the lowest point of about 20 300 t that occurred in 1999–2000. Since then the trend of total catch has been increasing, mainly as a result of increasing annual catches in JMA 7, with contribution from a smaller corresponding rise in JMA 1. Landings in JMA 3 have continued to decline throughout the period and are currently at very low levels, probably reflecting the reduced availability of *Trachurus murphyi*.

1. INTRODUCTION

1.1 General overview

Jack mackerels are managed as a three-species complex with a single quota in each of four Fishstocks (shown as geographical boundaries in Figure 1 and again with their constituent fisheries statistical areas in Figure 2) — JMA 1, 3, 7, and 10, though there are no landings from JMA 10. This complex comprises *Trachurus declivis* and *T. novaezelandiae*, referenced here collectively as the "native" species, based on their being endemic before invasion of New Zealand waters by *T. murphyi* (Kawahara et al 1988, Jones 1990, Taylor 2002, Taylor 2004), the third species in the complex. The stock status of the native species may have been altered by the presence of a species as biologically adaptable as *T. murphyi* (Taylor 2002). The terms "Fishstock" and "Quota Management Area (QMA)" are used interchangeably in this document.

Although the jack mackerel fishery is not of high commercial value, it is of considerable volume, and it is reasonable to suggest that, within the marine ecosystem, jack mackerel are an important prey species. Because they are aggregated in catch records as JMA, separate information for each species is unavailable from landings records, either as stock indices using catch per unit effort (CPUE) or in catch histories from the jack mackerel Fishstocks. To address this deficiency, data on species composition of the jack mackerel catch have been collected in the JMA 1 purse-seine and JMA 7 TCEPR fisheries since the quota increases of the early 1990s and, more recently, in the JMA 7 inshore trawl fishery. These data are essential to separating catches of the individual species for production of catch histories, CPUE indices, and scaling length frequencies to total catch in fishery.

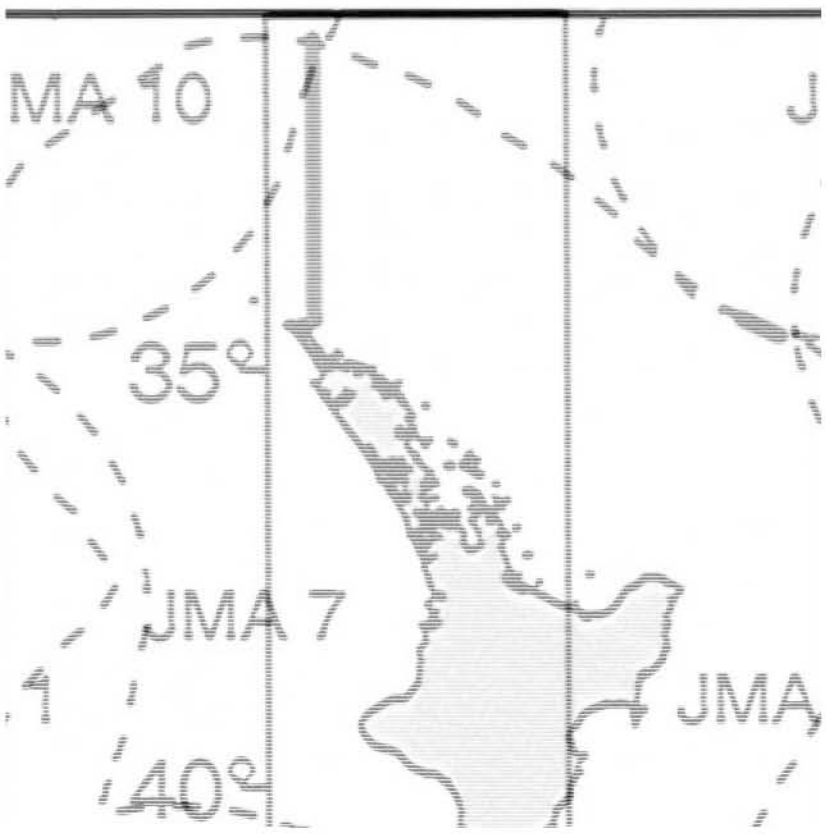

Figure 1: The jack mackerel Fishstocks; broken lines indicate the boundary of the New Zealand Exclusive Economic Zone; solid lines indicate Fishstock boundaries.

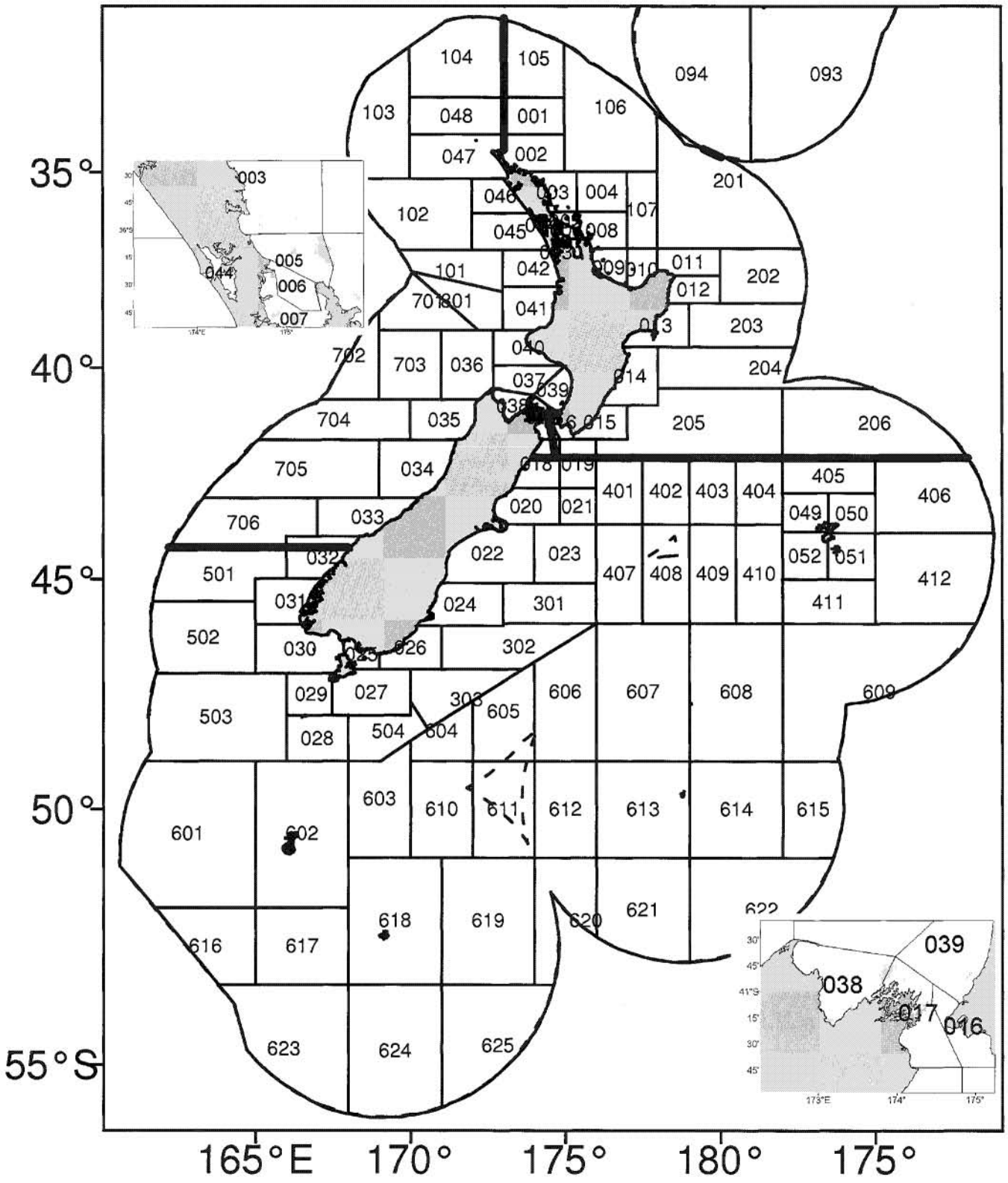

Figure 2: New Zealand fisheries statistical areas; northern insert shows detail for Kaipara-Hauraki Gulf; southern insert shows detail for Golden Bay-Tasman Bay-Cook Strait.

1.2 Biology and distribution of jack mackerel

Certain aspects of the biology of jack mackerels are important in understanding their availability and vulnerability to fishing. These include their preference for particular habitats and resultant distributions, reproductive and feeding behaviour, which are believed to be the underlying cause of their presence in schools at the surface where they are visible to the spotter pilot and vulnerable to purse-seine, and their tendency to form mixed schools with other species which can result in bycatch issues, particularly where there is limited availability of annual catch entitlement (ACE) of the bycatch species.

From work by Horn (1991a), the three *Trachurus* species have different geographical distributions, with some overlap in their ranges: *T. novaezelandiae* predominates in waters shallower than 150 m and warmer than 13 °C, and is uncommon south of latitude 42° S; *T. declivis* generally occurs north of 45° S in deeper waters than *T. novaezelandiae*, but shallower than 300 m and in temperatures less than 16 °C; and *T. murphyi* occurs over a wide latitudinal range (e.g., from 0° S to 50° S off South America) to depths of at least 500 m. Based on this information for the two New Zealand species, we can conclude that, while there is overlap in their ranges, *T. novaezelandiae* follows a more northerly, onshore distribution than *T. declivis*. For *T. murphyi*, the situation is less clear, but we do know from other sources (see Taylor (2002) for summary) that this species prefers cooler water than the New Zealand species. This, coupled with anecdotal information from the fishery, indicates that its distribution is more southerly than that of the two New Zealand species.

1.3 Literature review

The first published analysis of commercial jack mackerel fisheries data was by James (1975). Stephenson & Robertson (1977) showed that the jack mackerel population comprised two species (*T. novaezelandiae* and *T. declivis*) and provided criteria to identify them. Brief descriptions of the commercial jack mackerel fishery were completed by Robertson (1977) and Robertson & Eggleston (1979). A more extensive description was presented to the Pelagic Fisheries Conference in 1977 (Robertson 1978).

Eggs of the two New Zealand species were first described by Robertson (1975). The description was improved by Crossland (1981), who also described distributions of their eggs and larvae in the Hauraki Gulf. Distributions of eggs and larvae over a more extensive area of northeast New Zealand were documented by Crossland (1982).

Invasion of New Zealand waters by the South American jack mackerel *T. murphyi* was confirmed by Kawahara et al. (1988). Jones (1988) reviewed the fishery, based on the presence of the three species, and Jones (1990) provided an extensive summary of their taxonomy and biology and the commercial fisheries for them in New Zealand (data from that report were used in the present study to describe the commercial fishery before 1989–90).

Horn (1991a) documented a stratified random trawl survey of jack mackerels from 1990 in which distribution and density patterns were summarised and biomass was estimated along with biological data, population structure with depth, data on reproductive state and isopod parasites, and comparisons of gear performance, fish distribution and size, and biomass estimates were made with a survey in 1981. Horn (1991b) provided estimates of instantaneous mortality for the two New Zealand species and estimate of jack mackerel biomass in west coast waters between 37°30' and 41°30'S, although the estimates of biomass were not considered satisfactory indices for use in a stock reduction analysis, resulting in a biomass projection method being used to calculate virgin and current biomass. Horn (1993) investigated growth, age structure, and productivity of the two New Zealand species.

Taylor (1998) used species proportions estimated from market sampling data collected from the JMA 1 purse-seine fleet between 1994 and 1996 to produce catch histories for the three species for use in a stock reduction model. Similarly, Taylor (1999) investigated the feasibility of producing a stock assessment for the two New Zealand species in JMA 7. Taylor (2002) used existing data to investigate the stock structure of *T. murphyi* in the South Pacific Ocean and examine the degree to which it has become established in New Zealand waters. Species proportions of the three jack mackerel species have been updated for the fishing years from 1999–2000 to 2004–2005 by Taylor (2004) and Taylor & Julian (2008), as part of the ongoing stock monitoring program for jack mackerel.

1.4 Objective and scope of the present analysis

This report documents the results of a study of New Zealand's jack mackerel (*Trachurus*) fisheries funded by the Ministry of Fisheries under research project JMA2004/02, Objective 1 "Stock assessment of the two native species of jack mackerel". The relevant specific objective was to provide a descriptive analysis of New Zealand's jack mackerel fisheries by summarising existing catch-effort data recorded on TCEPR and catch effort and landing return (CELR) forms. These forms were designed as part of the Quota Management System (QMS) and can provide data only since 1989–90. For completeness, summaries of records from the fishery before 1989–90 are also included.

2. METHODS

2.1 Data sources

Jack mackerel catch and effort data recorded on TCEPR and CELR forms spanning the 1989–90 to 2003–04 fishing years were extracted from the Ministry of Fisheries catch-effort database for JMA 1, JMA 3, and JMA 7. Historical data were transcribed into electronic format from a number of sources: earliest domestic landings (for the years 1940–1974) from the series Marine Department Report on Fisheries; Fisheries Research Division Reports and a New Zealand Fisheries Data Report for data from 1974–1984 (King 1985, 1986, King et al. 1985, 1987); summaries of less accessible data (e.g., from the Fisheries Statistics Unit — FSU) were incorporated into summary tables from those published by Jones (1990) and Annala et al. (2003).

2.2 Data processing

2.2.1 Historical data — the commercial fishery before 1989–90

Data on catches of mackerel (defined as *T. declivis* in Anon (1967)) were transcribed from published tables into Microsoft Excel. Earliest landing weights were available as hundredweights (cwt) and converted to metric tonnes using the relationship of 1 cwt = 50.8023 kg at the first step. Early domestic catches were assigned to Fishstocks using the assignment criteria summarised in Appendix A, Table A1. Although it is assumed that the absolute amounts are not great, based on the tonnages landed into ports that should be considered borderline cases, it is unknown how much catch was erroneously assigned to a given Fishstock using this method. Consequently, the resulting tables are intended as indicative summaries only of the levels of domestic commercial catch in each QMA.

2.2.2 The recent commercial fishery — analyses based on TCEPR and CELR data

The New Zealand jack mackerel fishery, including all fisheries in JMA 1, 3, and 7, was reviewed for 1989–90 to the end of the 2003–04 fishing year, which included the following summaries.

- A summary and description of the commercial catch history; a history (by fishing year) of catch by method and target species.

- Spatio-temporal distributions of catch size from the purse-seine, mid-water trawl, and bottom trawl fisheries.
- A history of estimated targeted/non-targeted catch by method.
- Estimated catch by target species for fisheries where the quantities of data are sufficient.

In most cases these summaries comprised tabulation of data. In some cases the data were plotted to illustrate or emphasise the presence of trends. Usually percentages of the total jack mackerel catch were included in the data tabulations to detect or demonstrate shifts in the relative representation of the factors being summarised; sometimes these percentages were used as the basis for plotted summaries.

3. RESULTS

3.1 The commercial jack mackerel fishery before 1989–90

The first available records of commercial catches of jack mackerel were from 1939–40, when there were landings of 28 cwt at Wellington, 4 cwt at Blenheim, and 9 cwt at Part Chalmers. Conversion of these values to tonnes provided an estimate of 2.1 t for the total commercial jack mackerel catch in all areas during 1939–40. In the early years, from 1939 to 1943, commercial catch data were collected over a statistical year of 1 April–31 March. After 1943–44, data were collected by calendar year until the now familiar fishing year of 1 October–30 Spetember was introduced in 1983–84.

Between 1939–40 and 1965 the total domestic catch for all areas combined fluctuated around values that were mostly less than 20 t but peaked at 27 t in 1949 (Table 1); most of this catch was taken in JMA 1. After 1965, total landings rose steadily, mainly as a result of increasing landings in JMA 1, although the catch in JMA 7 took a step up in 1966 and 1967 that was sustained throughout the period and tended to increase, particularly towards the end. Landings in JMA 3 were always low except in the last two years.

Table 1: Estimated landings (t) in the domestic commercial fishery between 1939–40 and 1982; values are indicative only because original data were recorded by port of landing and assigned to Fishstocks according to the port's geographic position; *1 April–31 March, remainder are calendar years. Sources: Marine Department reports on fisheries, King (1985, 1986) King et al. (1985, 1987).

Year	JMA1	JMA3	JMA7	Total	Year	JMA1	JMA3	JMA7	Total
1939–40*	1.4	0.5	0.2	2.1	1961	2.2	0.1	4.3	6.5
1940–41*	0.8	1.1	1.9	3.8	1962	6.1	0.1	4.8	11.0
1941–42*	0.5	0.1	1.5	2.0	1963	7.9	1.6	11.6	21.0
1942–43*	3.7	0.0	0.4	4.1	1964	5.7	4.0	9.9	19.7
1943–44*	0	0.3	0	0.3	1965	15.3	0.2	7.1	22.6
1944	9.5	0.1	0	9.6	1966	47.3	0.2	52.7	100.2
1945	8.0	0	0	8.0	1967	213.2	0.1	249.3	462.7
1946	3.5	0.1	6.4	9.9	1968	137.0	0	435.6	572.6
1947	15.2	0.3	2.3	17.8	1969	132.4	0.1	168.8	301.3
1948	4.7	0.0	4.1	8.7	1970	74.3	0.1	175.6	249.9
1949	7.8	0.1	19.2	27.0	1971	325.1	0.2	306.1	631.4
1950	10.7	5.3	0.0	16.0	1972	321.9	0.9	263.5	586.3
1951	4.6	4.7	0.0	9.3	1973	398.3	0.9	324.0	723.2
1952	2.1	3.9	6.8	12.8	1974	1 262.0	3.0	224.0	1 489.0
1953	0.3	3.2	8.7	12.1	1975	124.0	0	138.0	262.0
1954	4.3	0.1	1.4	5.7	1976	621.0	0	367.0	988.0
1955	4.2	0.0	10.6	14.7	1977	1 300.0	0	367.0	1 667.0
1956	1.1	0.1	2.3	3.5	1978	1 246.0	0	483.0	1 729.0
1957	0.5	0.5	6.4	7.3	1979	2 125.0	0	927.0	3 052.0
1958	0.5	0	8.7	9.2	1980	2 499.0	79.0	667.0	3 245.0
1959	2.6	0.2	0	2.8	1981	2 821.0	80.0	570.0	3 471.0
1960	2.7	0	4.0	6.8	1982	1 601.0	117.0	1 023.0	2 741.0

The total recorded jack mackerel landings from all sources between 1970 and 1987–88 are summarised in Table 2. Features to note are the dramatic reduction in Japanese catch after 1977–78, which resulted in a similar reduction to the total catch, which in turn took some time to recover as the catch from domestic and chartered vessels increased and, along with contributions from the Korean fleet, eventually rose to almost 27 000 t in 1986–87.

Table 2: Total reported jack mackerel landings (t) in the New Zealand EEZ by nation from 1970 to 1987–88. Source: Fisheries Statistics Unit, after Annala et al. (2003).

	Domestic	Chartered	Foreign licensed vessels				Grand
Year	vessels	vessels	Japan	Korea	Russia	Total	total
1970	250	–	8 128	–	–	8 128	8 378
1971	631	–	13 301	–	–	13 301	13 932
1972	586	–	18 070	–	600	18 670	19 256
1973	723	–	14 964	–	200	15 164	15 887
1974	1 473	–	17 738	–	100	17 838	19 311
1975	317	–	13 486	–	–	13 486	13 803
1976	1 044	–	15 145	–	400	15 545	16 589
1977	1 719	–	14 539	1534	700	16 773	18 492
1978#	1 817	2	4 786	–	–	4 786	6 605
1979#	3 131	631	3 187*	–	640	3 827	7 589
1980	3 320	N/A	1 254*	–	–	1 254	4 574
1981	3 542	3 136	3 983*	–	–	3 983	10 664
1982	2 822	4 380	2 936*	–	–	2 936	10 138
1983	2 604	5 997	4 140	345	0	4 485	13 086
1983–84†	4 458	8 035	3 599	764	0	4 363	16 856
1984–85	3 363	9 786	5 332	1 091	0	6 423	19 572
1985–86	4 117	8 015	1 573	1 083	0	2 656	14 788
1986–87	7 190	16 022	2 950	595	0	3 545	26 757
1987–88	6 854	13 045	2 106	624	0	2 730	22 629

(Source = FSU. The slight difference in total catch given in Table 1 and this table for 1983–84 to 1985–86 arises from the different methods used to summarise data. The 1986–87 and 1987–88 FSU data were derived independently from that of the QMS.)
*Japanese fisheries data (annual). #1 April– 31 March year. †1 October – 30 September year from 1983–84.

The importance of purse-seine landings to the domestic fishery before 1989–90 is clear from the summary produced by Jones (1990) (Table 3). Based on calendar years, the percentage of the total domestic catch taken by purse-seine fluctuated a little from 1974 to 1978, but then remained reasonably stable between 75% and 89% from 1979 to 1988.

Table 3: Purse-seine (PS) catches (t) by calendar year, 1979–1985, showing percentage that was jack mackerel (JMA) and the percentage of total jack mackerel catch that was taken by purse-seine. Source: Fisheries Statistics Unit, after Jones (1990).

Year	Total PS Catch (all spp)	JMA PS catch	JMA as % of PS catch	Total JMA catch	% of JMA caught by PS	Year	Total PS Catch (all spp)	JMA PS catch	JMA as % of PS catch	Total JMA catch	% of JMA caught by PS
1974	2 000	900	45	1 400	64	1982	11 000	2 300	21	2 800	82
1975	1 500	-	-	300	-	1983	13 800	2 100	15	2 600	81
1976	2 200	400	18	1 000	40	1984	12 900	4 100	32	4 600	89
1977	4 400	1 100	25	1 700	64	1985	11 400	3 700	32	4 100	75
1978	6 300	600	9	1 800	33	1986	17 400	4 200	24	5 500	76
1979	8 900	2 400	27	3 100	77	1987	19 900	5 500	27	6 500	84
1980	10 000	2 600	26	3 300	78	1988	18 400	5 400	29	NA	-
1981	12 000	2 900	24	3 500	83						

3.2 The TCEPR/CELR fishery

3.2.1 Annual landings by Fishstock

Total jack mackerel landings for all Fishstocks combined rose dramatically through the early 1990s (Figure 3), peaked at 47 400 t in 1992–93, declined to 34 800 in 1995–96 and fluctuated around 32–35 000 t for several years before falling dramatically to 20 000 t in 1999–00. They then climbed back to the mid 1990s level of about 35 000 t, where they remained for the last two years of the 1989–90 to 2003–04 period.

The dramatic increase in the early 1990s was contributed to by increasing landings in all three Fishstocks, though catch in JMA 7 began to decline in 1992–93 while those in JMA 1 and JMA 3 continued to rise. The JMA 1 peak of 12 900 t occurred in 1993–94, a year after the first of two peaks in JMA 3 — 16 700 t in 1992–93 and 18 000 t in 1995–96. Subsequent declines reached lows of 2800 t in JMA 1 and 7300 t in JMA 7, both in 1999–00; landings in JMA 3 continued to decline to the end of the period

The second increase from 1999–2000 in total landings from all Fishstocks combined is almost completely the result of a major increase in JMA 7 to a level where landings for the last two years of the period exceeded the earlier peak for JMA 7 in 1991–92. The JMA 7 fishery produced the highest total annual catch of 25,820 t during 2003–04, in contrast to the total annual catches of JMA 1 and 3 at 6900 t and 600 t respectively.

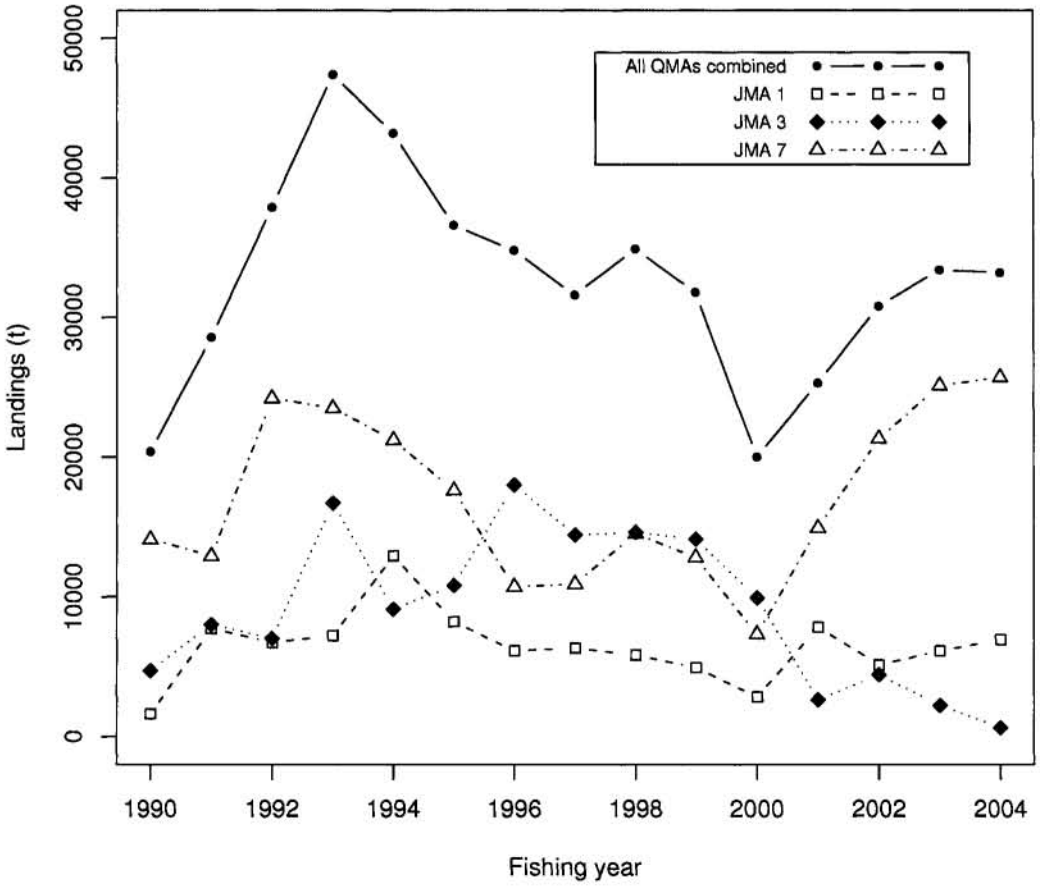

Figure 3: Catches by Fishstock and for all Fishstocks combined by fishing year from 1989–90 to 2003–04; 1990 represents 1989–90 etc. Source: MFish catch effort database, *MOBY*.

3.2.2 Monthly landings by Fishstock

In their simplest interpretation, aggregated monthly summaries suggested a bimodal seasonal pattern for the combined data, with peaks in December and June (Figure 4). This pattern was largely the result of contributions from JMA 7. In addition, subtle features in the combined plot reflected a shorter-term bimodal seasonality in the data from JMA 3, with peaks in January and April. The JMA 1 data followed a different pattern, building gradually from almost zero representation in March, to a peak in September, followed by a sudden decline in October and a gradual decline to the minimum in March.

Monthly distributions of estimated catch by fishing year, individual Fishstocks, and all Fishstocks combined are shown in Appendix B and estimated percentages of the total catch in Appendix C. Graphical monthly distributions for each QMA are shown in Figures 5–7. For all QMAs combined, catches of jack mackerel occurred throughout the fishing year with December, June and January resulting in the greatest catch, with mean catches of 4145 t (12.8% of the total), 3940 t (12.4% of the total) and 3675 t (10.9% of the total) respectively during these months. In recent years, the catch appeared higher during December and June (Appendices B & C). Monthly catch for December from 2000–01 to 2003–04 occurred as 5060 t, 8370 t, 6630 t and 8640 t respectively, resulting in 20.0%, 27.1%, 19.8% and 25.9% of the total annual catch during this month. By comparison, the lowest catch was in August with an annual mean total catch of 1549 t that was 4.9% of total catch. During 1992–93, 0.4% of the total catch, or 190 t, occurred during August, in contrast to 16.5% or 7,850 t during January of the same year (Appendices B & C).

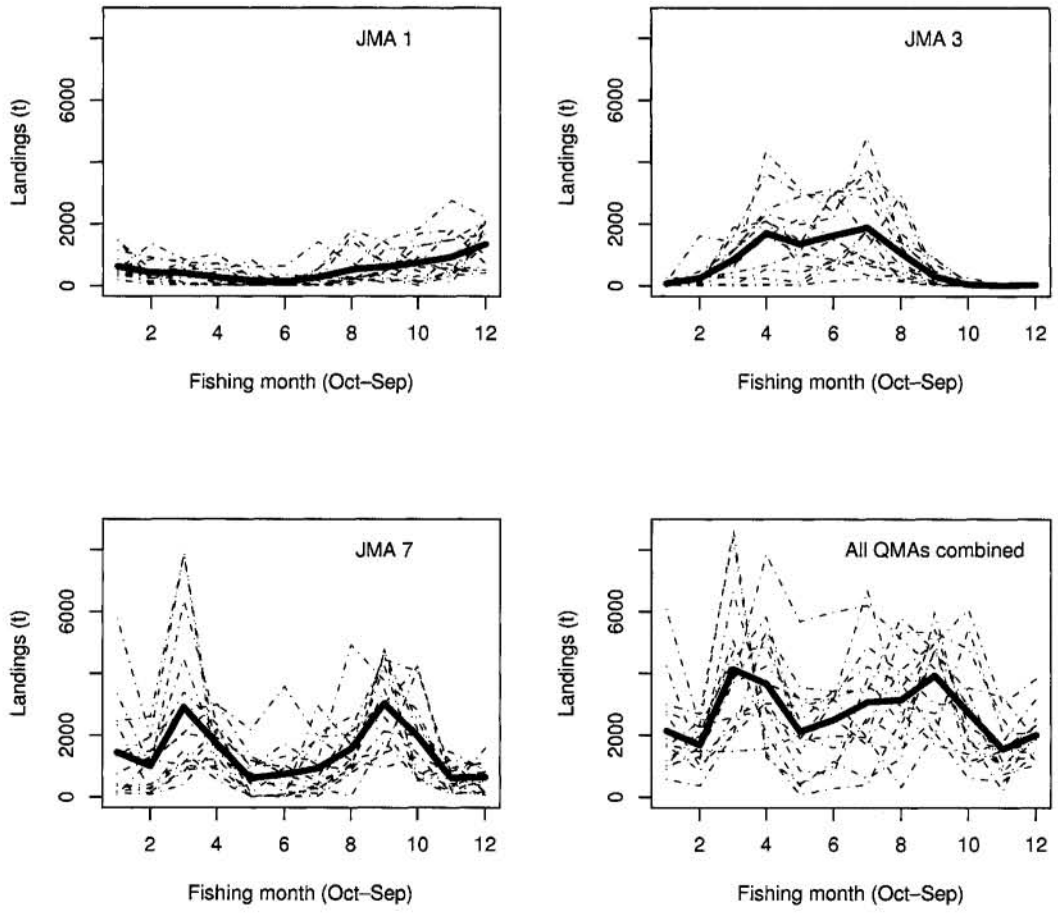

Figure 4: Monthly landings by Fishstock and for all Fishstocks combined; broken lines are individual annual plots for the fishing years 1989–90 to 2003–04; the solid line represents means of the monthly values for all years; month 1 is October, the first month of the fishing year, etc. Source: MFish catch-effort database, *MOBY*.

A high degree of seasonality was evident within JMA 1 consistently from the 1993–94 fishing year. Most landings occurred from May or June until about December (Figure 5). September and August showed the highest continuous catches, with respective means of 22.4% and 14.0% and mean monthly catches of 1344 t and 928 t throughout this period within JMA 1 (Appendices B & C). The total annual catch of jack mackerel in JMA 1 peaked during 1993–94 and 1994–95, and included the largest catch per month of 2750 t during August 1994–95 (Figure 5). The fishing years of 1993–94 and 1994–95 showed extended catch seasons for the fishery, with high catches occurring from May to January. The monthly catch distributions occurred at a high level from May to September during the fishing years of 1993–94 to 1997–98 and 2001–02. In contrast, small catches in the fishery occurred in the remaining fishing years of 1998–99 and 1999–2000. For 2003–04, the main period of catch occurred in May, June, and September, with monthly catches of 1630 t, 720 t and 2170 t respectively, representing 23.6%, 10.4%, and 31.4% of the total annual catch.

A consistent seasonal pattern was evident in the JMA 3 fishery throughout the 1990s (Figure 6) when most catch occurred over summer–autumn, continuing from December until May or June. Catch in JMA 3 increased in 1992–93 to 1999–2000 but has shown a declining trend since 2000–01. The highest continuous catches were in January, April, and March, providing annual mean catches of 1698 t, 1623 t and 1882 t respectively throughout this period that represent 16.0%, 19.9%, and 22.1% respectively of the mean total annual catch. The overall catch in JMA 3 was highest during the fishing years of 1992–93, 1995–96, and 1997–98, with total catches of 16 720 t, 17 990 t and 14 520 t respectively (Appendices B & C). This includes the largest catch per month (4790 t — Table B1), which occurred during April of 1997–98 (Figure 6). High monthly catches occurred over an extra month in 1996–97, with the main catch season running from November until June.

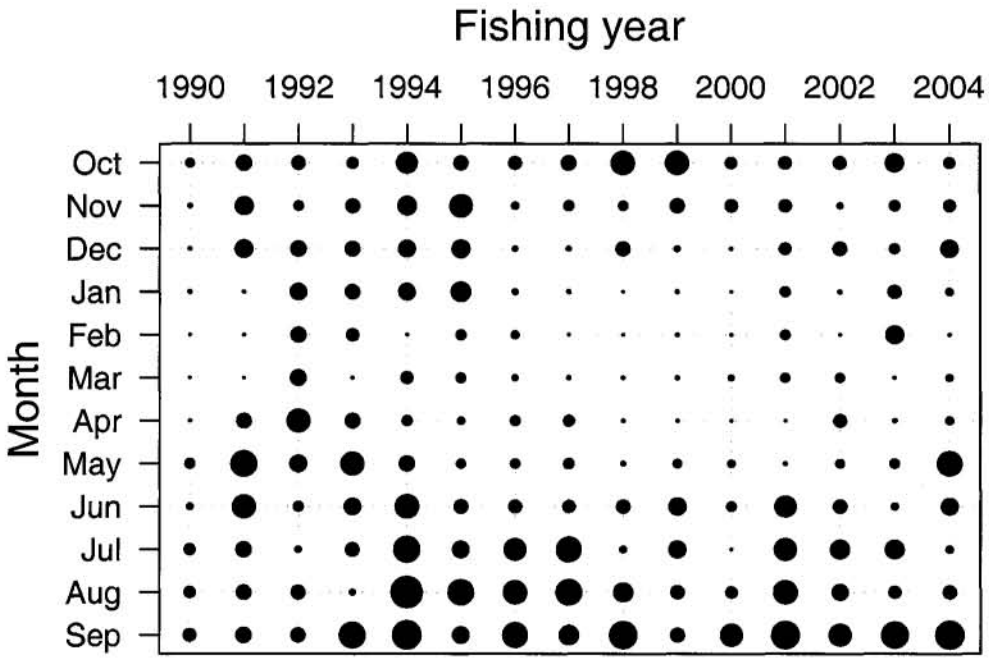

Figure 5: Monthly distribution of catch (t) in the JMA 1 fishery. The area of the circles is proportional to the catch; the largest circle represents 2750 t; 1990 represents 1989–90, etc. Source: MFish catch effort database, *MOBY*.

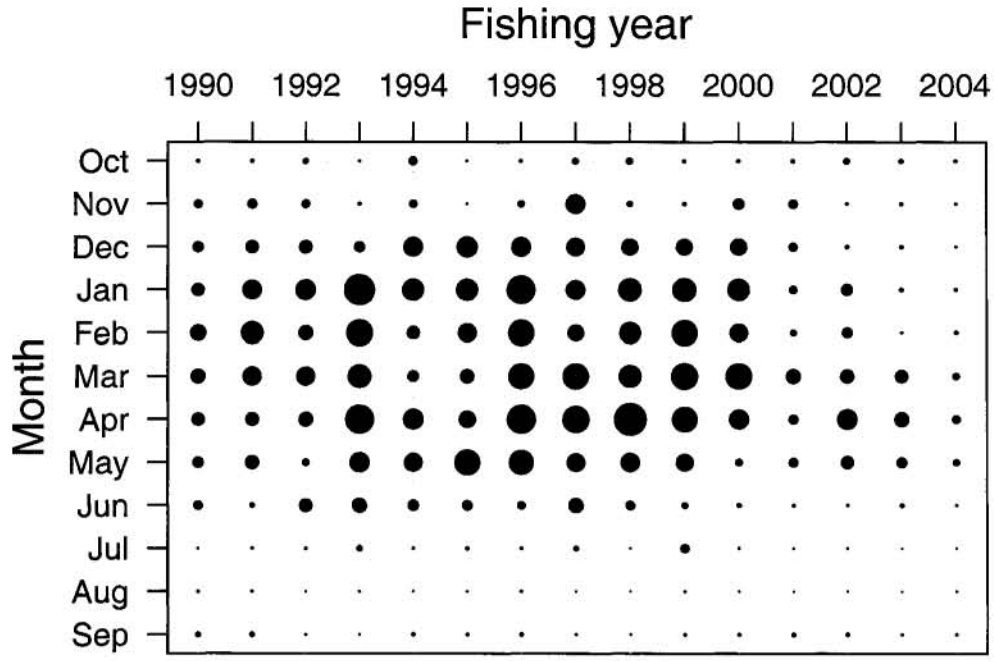

Figure 6: Monthly distribution of estimated catch (t) in the JMA 3 fishery. The area of the circles is proportional to the catch; the largest circle represents 4790 t; 1990 represents 1989–90, etc. Source: MFish catch effort database, *MOBY*.

Currently, the JMA 7 fishery has two seasons— a summer season from April–May through to July and a well defined winter season from October to January (Figure 7). This is based on a pronounced gap in landings in February–March, which provides an end to the summer season, and a less pronounced reduction in landings in August–September. In earlier years, between 1989–90 and 1997–98, the catch was distributed more evenly throughout the year, although catches were often higher during the defined summer and winter seasons. In particular, 1992–93 shows regular catches from October continuing until July.

The JMA 7 fishery showed a marked low point during 1999–2000, with a total annual catch of 7370 t (Figure 3, Appendices B & C). From 2000–01 to 2003–04 an increase in total annual catch has resulted, coinciding with a strong degree of seasonality described above. December and January show the highest continuous catches of jack mackerel, with means of 15.3% and 18.0% respectively and mean monthly catches of 2907 t and 3029 t (Appendices B & C). The highest catch of 7870 t occurred twice in December, in 2001–02 and 2003–04 (Figure 7, Table B1).

3.2.3 Jack mackerel catch by statistical area

The New Zealand fisheries statistical areas are shown in Figure 2. Annual landings by statistical area are shown in Figures 8–10. These figures demonstrate that landing levels of jack mackerel from adjacent statistical areas can vary markedly. The landing patterns are discussed by fishing area.

Landings within JMA 1 have been distributed mainly throughout the coastal statistical areas (001–016), showing a predominance of those in the Bay of Plenty (Figure 8). The most highly represented

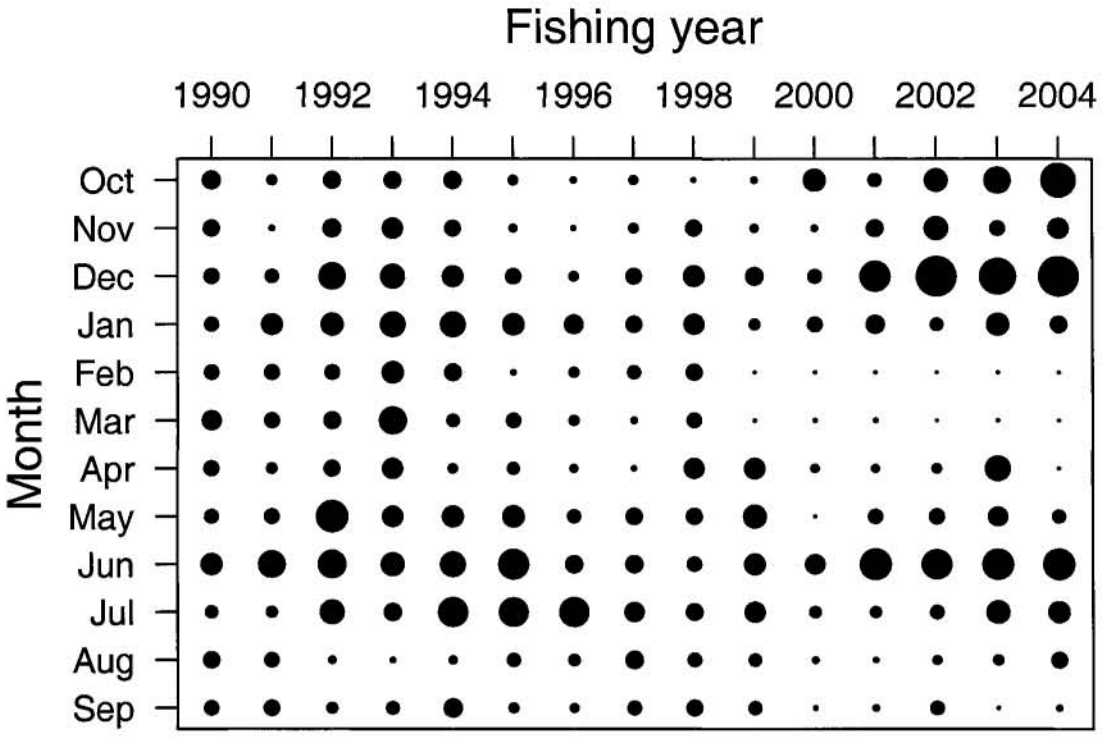

Figure 7: Monthly distribution of estimated catch (t) in the JMA 7 fishery. The area of the circles is proportional to the catch; the largest circle represents 7870 t; 1990 represents 1989–90, etc. Source: MFish catch effort database, *MOBY*.

areas remained reasonably constant throughout this period. High levels of estimated catch are evident from areas 009 and 008, with the exception of fishing years 1993–94 and 1994–95 when areas 002 and 003 appeared highest. During 1993–94, the largest catch of 6450 t taken in statistical area 002 throughout this period occurred (Figure 8). Areas 014, 015, and 016 provided a much smaller, southern contribution to the total annual catches of JMA 1.

Landings within JMA 3 have been distributed throughout a number of statistical areas since 1989–90, although the relative importance of the most highly represented areas changed throughout this period (Figure 9). High levels of estimated catch in area 018 gradually decreased from 1993–94 with a roughly corresponding increase in areas 021 (until 1996–97) and 022 (until 1999–2000). Area 028 has been well represented throughout most of this period, including the largest catch record during 1998–99 of 7030 t, until the general decline described elsewhere in this document began about 2000–01. Areas 025, 026, and, to a lesser extent, 504 and 602, contributed smaller amounts to the total annual catch from 1995–96 to 1999–2000 (Figure 9).

The distribution of landings by statistical area within JMA 7 was dominated by coastal areas of the west coast (see Figure 2), including areas 034 to 036 along the northern west coast of the South Island and areas 037, 039, 040, and 041 along the west coast of the North Island (Figure 10). Landings within JMA 7 were distributed continuously throughout these main areas over this period. Statistical areas 040 and 041 contributed particularly high landings during 1991–92 to 1993–94 and from 2001–02 to 2003–04, reflecting an increase in more recent times of catches in northern areas that had contributed lower catch between 1994–95 and 1999–2000. This northern trend is also represented by an extreme increase in catch from area 042 during 2003–04, were the largest catch in the JMA 7 series of 10 400 t occurred, and a lesser but marked increase in area 045. Areas 017, 045 to 047, and 801 also represent, although to a lesser extent, contributions to the total annual catch within JMA 7. Catch from statistical area 801 was the highest contribution from an offshore area.

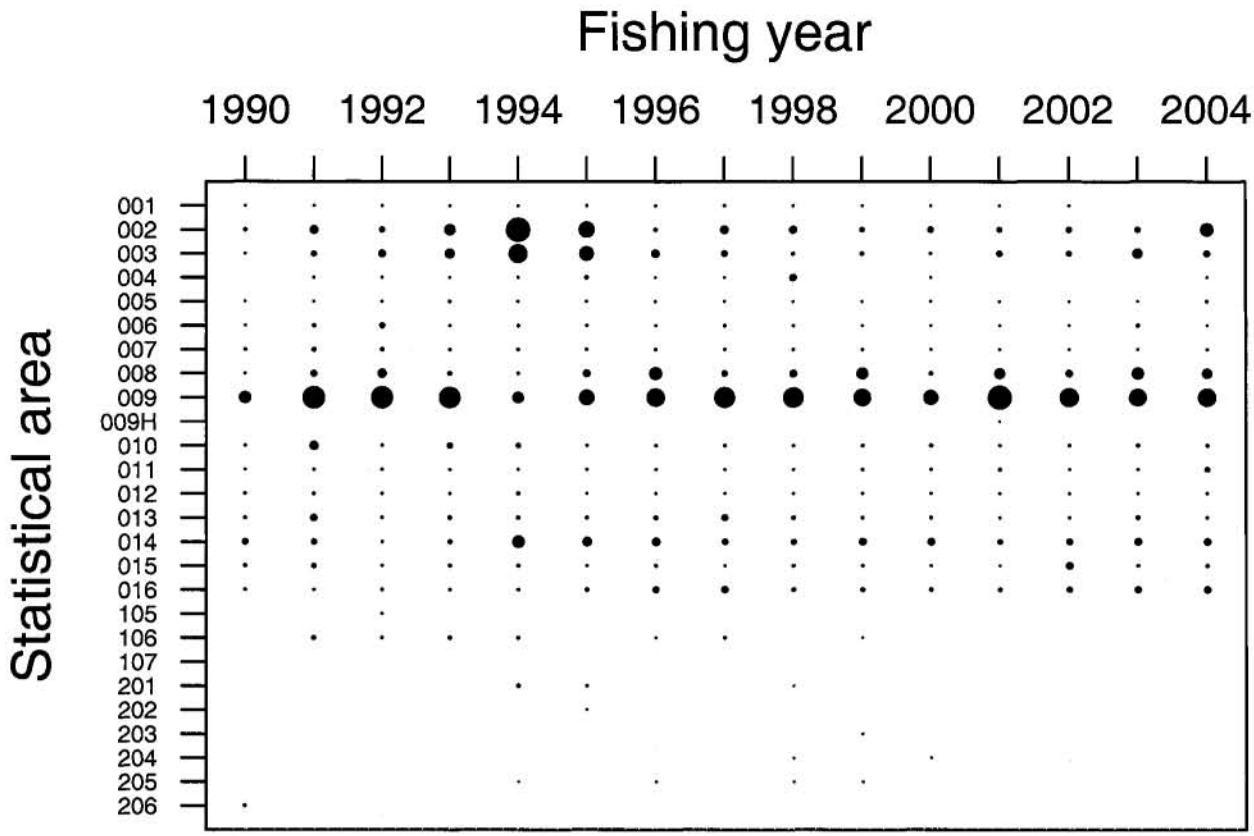

Figure 8: Estimated catch in the JMA 1 fishery by year and statistical area. The area of the circles is proportional to the catch; the largest circle represents 6450 t. The statistical areas 001–016 are coastal areas and run from north to south; the statistical areas 105–206 also run from north to south and are further out to sea; 1990 represents 1989–90, etc. Source: MFish catch effort database, *MOBY*.

3.2.4 Jack mackerel catch by form type

Catch and effort data for jack mackerel are recorded on TCEPR and CELR forms in each quota management area. In JMA 3 and JMA 7, most catch of jack mackerel is by large, deepwater TCEPR trawl fisheries. Both the domestic purse-seine and the domestic inshore trawl fleets use CELR forms to record landing information.

Most of the total catch of jack mackerel from all Fishstocks combined was recorded using TCEPR forms (mean percentage for all landings = 74%) (Table 4), which reflects the dominance of large, deepwater trawl vessels in the fishery. The increase in total catch of all Fishstocks from 1989–90 to the peak catch of 47 600 t in 1992–93 coincided with an increase in recording of catch on both TCEPR and CELR forms. However, the decline that occurred from 1992–93 to 1999–2000, when the lowest total catch of 20 300 t was taken, was due largely to a major decline in CELR from JMA 3 and 7. TCEPR records also showed a decrease in total catch throughout this period, although results remained considerably higher from this form type for catch totals and the percentage of total catch (Table 4).

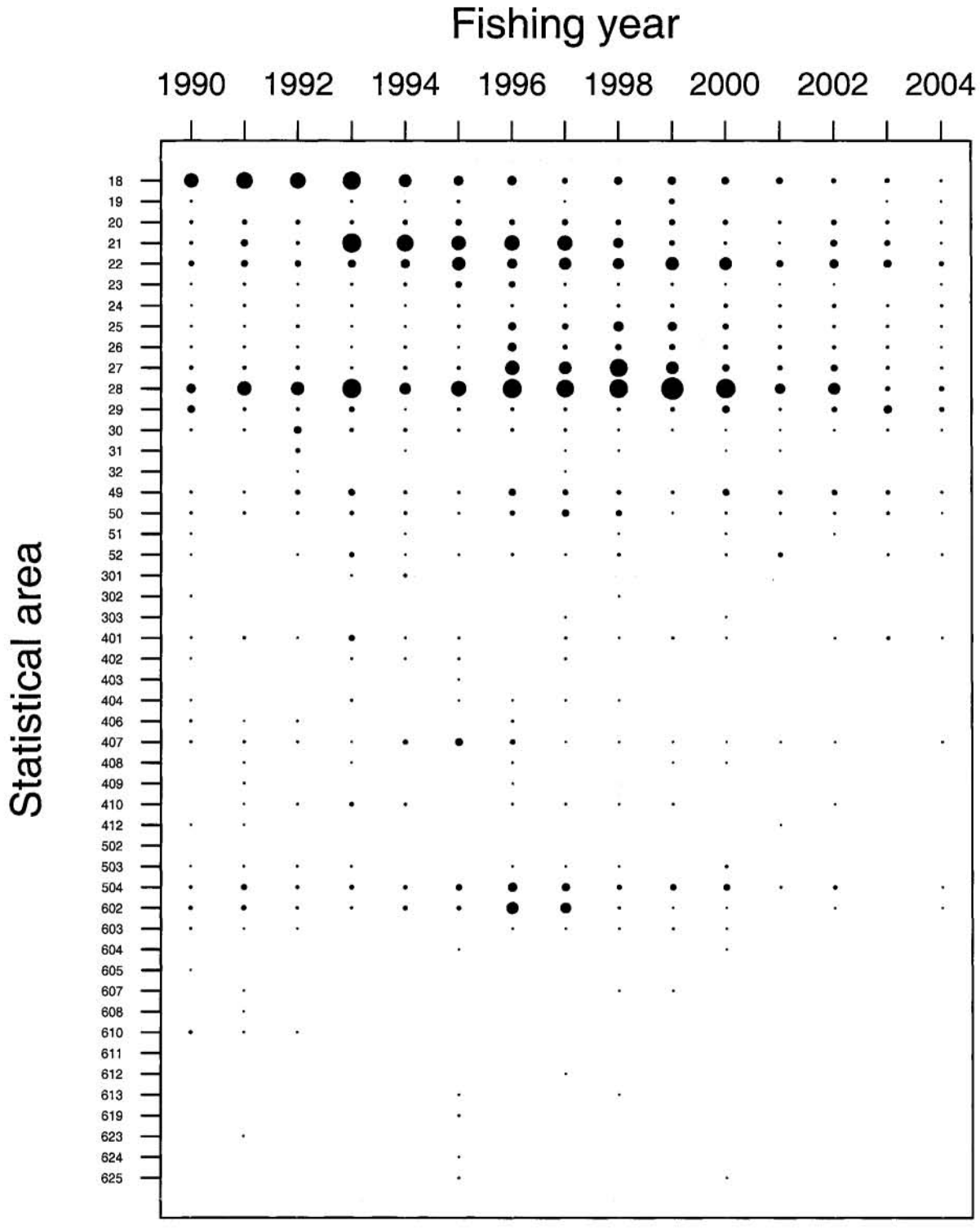

Figure 9: Distribution of estimated catch in the JMA 3 fishery, by statistical area and fishing year. The area of the circles is proportional to the catch; the largest circle represents 7030 t; 1990 represents 1989–90, etc. Source: MFish catch effort database, *MOBY*.

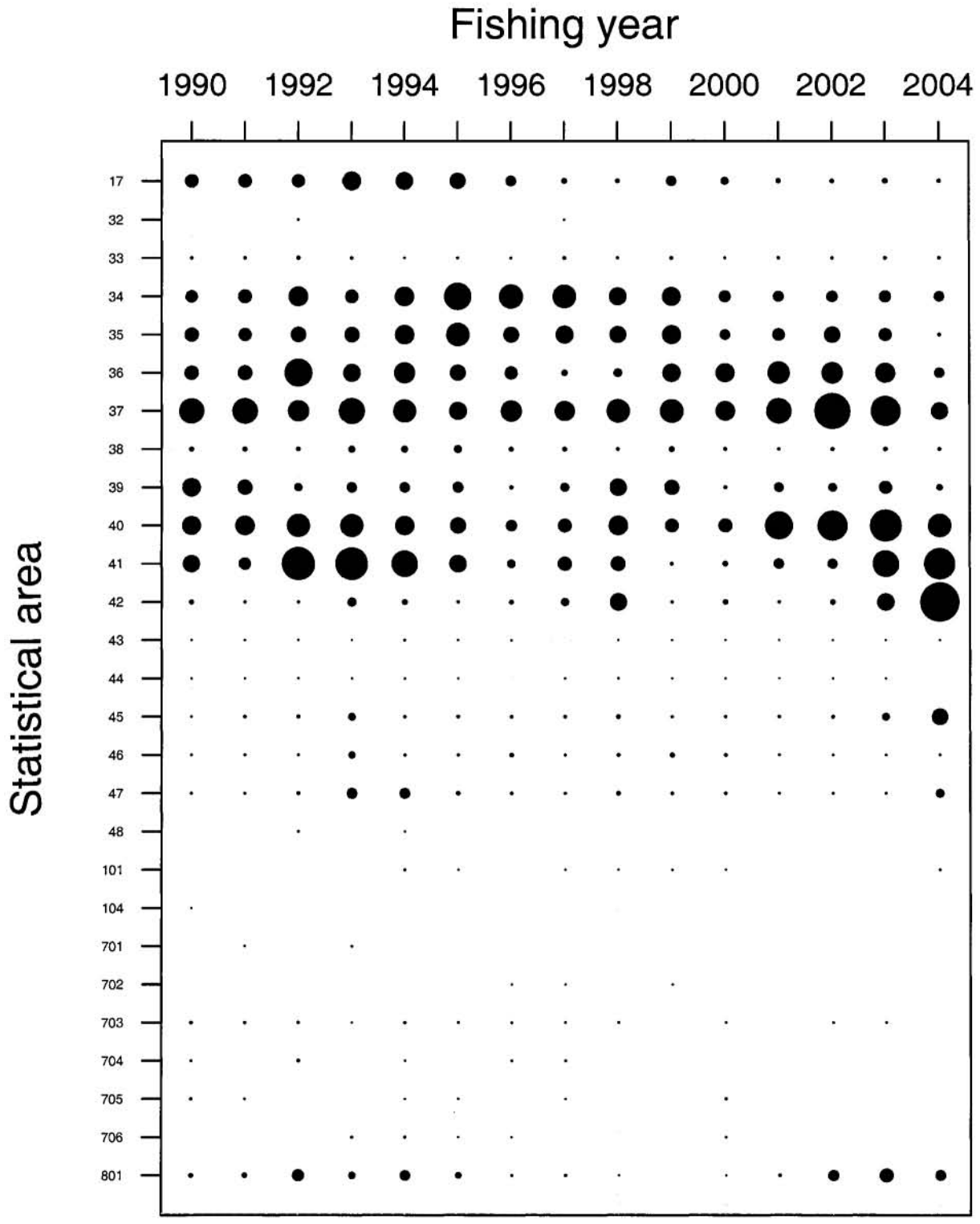

Figure 10: Distribution of estimated catch in the JMA 7 fishery by statistical area and fishing year. The area of the circles is proportional to the catch; the largest circle represents 10 400 t; 1990 represents 1989–90, etc. Source: MFish catch effort database, *MOBY*.

Table 4: Estimated jack mackerel catches (t) and percentages of total catch by form type (CEL = CELR = catch effort landing returns, TCEP = TCEPR = trawl catch effort processing returns), Fishstock, and fishing year. Source: MFish catch effort database, *MOBY*.

	JMA 1					JMA 3				
Fishing Year	CEL (t)	TCEP (t)	CEL (%)	TCEP (%)	Total (t)	CEL (t)	TCEP (t)	CEL (%)	TCEP (%)	Totals (t)
1989–90	1 700	0	100	0	1 700	2 500	2 200	53	47	4 700
1990–91	7 800	0	100	0	7 800	3 600	4 300	46	54	7 900
1991–92	6 700	0	100	0	6 700	3 200	3 800	46	54	7 000
1992–93	7 200	100	99	1	7 300	4 400	12 300	26	74	16 700
1993–94	12 900	100	99	1	13 000	2 000	7 100	22	78	9 100
1994–95	8 000	200	98	2	8 200	1 100	9 700	10	90	10 800
1995–96	5 800	400	94	6	6 200	900	17 100	5	95	18 000
1996–97	6 000	400	94	6	6 400	300	14 100	2	98	14 400
1997–98	5 700	200	97	3	5 900	700	13 800	5	95	14 500
1998–99	4 600	200	96	4	4 800	1 000	13 200	7	93	14 200
1999–00	2 800	100	97	3	2 900	700	9 300	7	93	10 000
2000–01	7 700	100	99	1	7 800	400	2 100	16	84	2 500
2001–02	4 900	200	96	4	5 100	200	4 200	5	95	4 400
2002–03	5 800	300	95	5	6 100	100	2 000	5	95	2 100
2003–04	6 600	300	96	4	6 900	0	600	0	100	600
Means	6 280	173	97	3	6 453	1 407	7 720	17	83	9 127

	JMA 7					All QMAs combined				
Fishing Year	CELR (t)	TCEP (t)	CEL (%)	TCEP (%)	Total (t)	CELR (t)	TCEPR (t)	CEL (%)	TCEP (%)	Totals (t)
1989–90	1100	13 000	8	92	14 100	5 300	15 200	26	74	20 500
1990–91	1200	11 800	9	91	13 000	12 600	16 100	44	56	28 700
1991–92	1 200	23 100	5	95	24 300	11 100	26 900	29	71	38 000
1992–93	3 700	19 900	16	84	23 600	15 300	32 300	32	68	47 600
1993–94	2 700	18 500	13	87	21 200	17 600	25 700	41	59	43 300
1994–95	1 900	15 700	11	89	17 600	11 000	25 600	30	70	36 600
1995–96	700	10 000	7	93	10 700	7 400	27 500	21	79	34 900
1996–97	100	10 800	1	99	10 900	6 400	25 300	20	80	31 700
1997–98	500	14 100	3	97	14 600	6 900	28 100	20	80	35 000
1998–99	600	12 200	5	95	12 800	6 200	25 600	19	81	31 800
1999–00	300	7 100	4	96	7 400	3 800	16 500	19	81	20 300
2000–01	100	14 700	1	99	14 800	8 200	16 900	33	67	25 100
2001–02	100	21 200	0	100	21 300	5 200	25 600	17	83	30 800
2002–03	300	24 900	1	99	25 200	6 200	27 200	19	81	33 400
2003–04	400	25 400	2	98	25 800	7 000	26 300	21	79	33 300
Means	993	16 160	6	94	17 153	8 680	24 053	26	74	32 733

In JMA 1, CELR records dominated the landing data (mean annual proportion = 97%) because of the purse-seine fishery located within this area (Table 4). During the fishing years 1989–90 to 1991–92, 100% of total landings were recorded on CELR forms and from 1991–92 to 2003–04 only 3% of total catch, on average, was recorded using TCEPRs. Total catch from JMA 1 showed a peak of 13 000 t in 1993–94, which was very similar to the CELR peak catch of 12 900 t during this year. The mean

CELR landing total for all years between 1989–90 and 2003–04 was 6280 t, which contrasted strongly with the annual TCEPR mean of 173 t.

In JMA 3, data from both the CELR and TCEPR landing records showed a major decrease in total catch from the 1995–96 fishing year. Although TCEPR landings represented the dominant fishing type throughout this period (mean annual proportion = 83%), with the exception of the first year (1989–90) when the proportion was 47%, TCEPR catch totals declined from a peak of 17,100 t in 1995–96 to 600 t in 2003–04, the lowest value in the series, eclipsing the next lowest value by 1400 t (Table 4). Similarly, CELR records showed a decline from a peak catch of 4400 t in 1992–93 to 0 t in the 2003–04 fishing year.

Landings in JMA 7 were the highest of all the three Fishstocks (mean annual proportion = 17 153 t), with most catch recorded on TCEPR forms (mean annual proportion = 94%) (Table 4). This reflects the dominance of the large, deepwater trawl fleet within this area. CELR records show an increase from 1100 t in 1989–90 to a peak total catch of 3700 t in 1992–93. Since 1995–96, CELR catches have been low, fluctuating between 100 and 700 t and resulting in mean annual landings between 1995–96 and 2003–04 of 344 t. Peak catch totals for TCEPR landing records occurred during 1991–92 (23 100 t) and 2003–04 (25 400 t) (Table 4).

3.2.5 Jack mackerel catch by fishing method

Jack mackerel are taken by three fishing methods in each QMA, although their relative importance varies between Fishstocks. For all QMAs combined, midwater trawling has been the predominant method throughout the period with the exception of the 1989–90 and 1993–94 fishing years, resulting in a mean total annual catch of 17 580 t and representing 54% of the overall catch (Table 5). Consequently, purse-seine and bottom trawl combined have contributed almost half (46%) of the overall landings with mean annual landings for the period of 8427 t (26%) and 6653 t (20%) respectively, including peaks of 17 500 t for purse-seine in 1993–94 and 15 300 t for bottom trawling in 1992–93. Total landings by all methods increased from 20 500 t 1989–90 to a peak of 47 400 t in1992–93. Purse-seine landings showed a general decline from 17 500 t in the peak year (1993–94) to 6800 t in the most recent year (2003–04). Bottom trawl catch totals also followed this decline after a second peak of 11 400 t in 1997–98, to 400 t in 2003–04. The lowest catch total for all methods combined of 20 300 t in 1999–00 resulted from low catches of all three methods (Table 5).

The jack mackerel catch within JMA 1 was almost entirely from the purse-seine fishery. On average 6180 t (96% of the total catch) were caught annually by the purse-seine fleet within this area, in contrast with the 133 t and 93 t from bottom and midwater trawl respectively (see Table 2). Midwater trawl landings occurred in JMA 1 only from 1994–95 to 1998–99 and 2001–02 to 2003–04. The purse-seine catch increased from 1500 t in 1989–90 to a peak of 12 900 t in 1993–94, declined to a minimum catch of 2700 t in 1999–2000, and has sustained an average annual catch of 6225 t between 2000–01 and 2003–04.

In JMA 3, highest catches for the first three years (1989–90 to 1991–92) were by purse-seine (Table 5 & Figure 11). From 1992–93 to 2003–04, midwater trawling produced highest catches with a mean annual catch of 6,773 t. A strongly declining trend occurred in various years for all three fishing methods: the purse-seine catch declined from 4400 t in 1992–93 to 0 t in 2003–04; bottom trawl peaked at 2000 t in 1997–98 and declined to a total catch of 100 t in 2003–04; and midwater trawl declined from a peak in 1995–96 of 15 700 t to 500 t in 2003–04. Since 1997–98, the total catch of all methods combined reflects this declining trend. The midwater trawl fishery in JMA 3 has been particularly important with annual landings remaining consistently high at about 80% of the estimated total catch since 1994–95 (Figure 11) although recent years have seen a decline in this fishery also.

Table 5: Estimated jack mackerel catch (t), by fishing gear (purse-seine, bottom trawl, mid-water trawl, and all gears combined), Fishstock, and fishing year. Source: MFish catch effort database, *MOBY*.

	JMA 1				JMA 3			
Fishing year	Purse seine	Bottom trawl	Midwater trawl	Total all methods	Purse seine	Bottom trawl	Midwater trawl	Total all methods
1989–90	1 500	100	0	1 600	2 500	1 800	400	4 700
1990–91	7 600	100	0	7 700	3 600	1 500	2 900	8 000
1991–92	6 600	100	0	6 700	3 200	1 000	2 800	7 000
1992–93	7 000	200	0	7 200	4 400	700	11 600	16 700
1993–94	12 800	100	0	12 900	2 000	600	6 500	9 100
1994–95	7 900	200	100	8 200	1 000	700	9 100	10 800
1995–96	5 700	200	200	6 100	900	1 400	15 700	18 000
1996–97	5 800	200	300	6 300	200	1 900	12 300	14 400
1997–98	5 600	100	100	5 800	600	2 000	12 000	14 600
1998–99	4 600	200	100	4 900	900	800	12 400	14 100
1999–00	2 700	100	0	2 800	500	1 000	8 400	9 900
2000–01	7 700	100	0	7 800	300	300	2 000	2 600
2001–02	4 900	100	100	5 100	100	900	3 400	4 400
2002–03	5 800	100	200	6 100	100	500	1 600	2 200
2003–04	6 500	100	300	6 900	0	100	500	600
Means	6 180	133	93	6 407	1 353	1 013	6 773	9 140

	JMA 7				All Fishstocks combined			
Fishing year	Purse seine	Bottom trawl	Midwater trawl	Total all methods	Purse seine	Bottom trawl	Midwater trawl	Total all methods
1989–90	1 000	11 100	2 000	14 100	5 000	13 000	2 400	20 400
1990–91	1 000	7 900	4 000	12 900	12 200	9 500	6 900	28 600
1991–92	1 100	12 100	11 000	24 200	10 900	13 200	13 800	37 900
1992–93	3 500	14 400	5 600	23 500	14 900	15 300	17 200	47 400
1993–94	2 700	10 100	8 400	21 200	17 500	10 800	14 900	43 200
1994–95	1 800	3 200	12 600	17 600	10 700	4 100	21 800	36 600
1995–96	600	4 200	5 900	10 700	7 200	5 800	21 800	34 800
1996–97	0	3 400	7 500	10 900	6 000	5 500	20 100	31 600
1997–98	400	9 300	4 800	14 500	6 600	11 400	16 900	34 900
1998–99	500	2 900	9 400	12 800	6 000	3 900	21 900	31 800
1999–00	200	400	6 700	7 300	3 400	1 500	15 100	20 000
2000–01	100	1 300	13 500	14 900	8 100	1 700	15 500	25 300
2001–02	0	1 800	19 500	21 300	5 000	2 800	23 000	30 800
2002–03	200	300	24 600	25 100	6 100	900	26 400	33 400
2003–04	300	200	25 200	25 700	6 800	400	26 000	33 200
Means	893	5 507	10 713	17 113	8 427	6 653	17 580	32 660

In JMA 7, bottom trawling dominated the catch of jack mackerel from 1989–90 to 1993–94 (Table 5 & Figure 12). Subsequently, from 1994–95 to 2003–04, most catch was taken by mid-water trawling, with the exception of the 1997–98 fishing year. Midwater trawl catches have increased from 4800 t in 1997–98, to 25 200 t in 2003–04. By contrast, both purse-seine and bottom trawl fisheries in JMA 7 showed a declining trend from 1997–98, with catches from bottom trawl decreasing dramatically from about 75% of the estimated total catch during 1997–98 (9300 t) to 2% or 200 t in 2003–04.

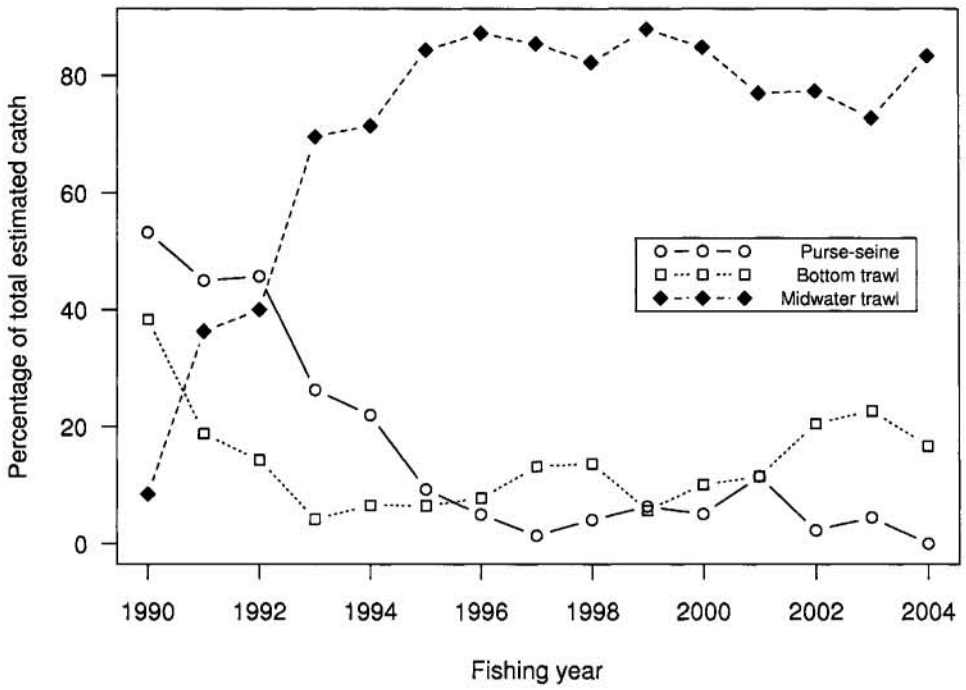

Figure 11: Percentage of estimated annual catch of jack mackerel in JMA 3 by gear type; 1990 represents 1989–90, etc. Source: MFish catch effort database, *MOBY*.

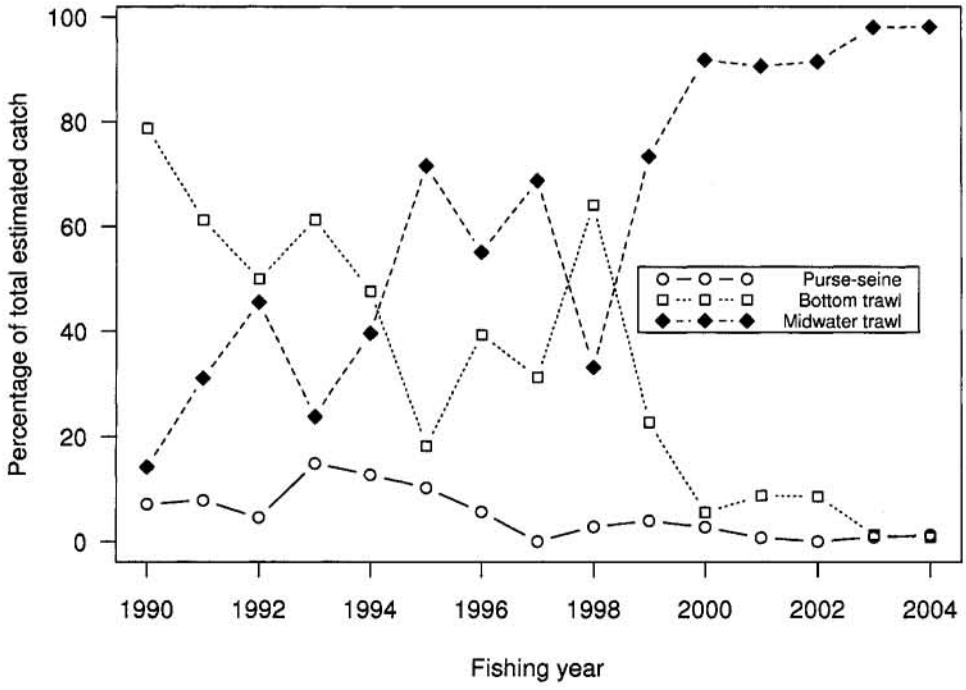

Figure 12: Percentage of estimated annual catch of jack mackerel in JMA7 by gear type; 1990 represents 1989–90, etc. Source: MFish catch effort database, *MOBY*.

Substantial catches were taken by purse-seine within JMA 7 from 1989–90 to 1994–95, but catches declined dramatically between 1994–95 and 1996–97 (from 1800 t to 600 t), and total catches remained very low from then onwards. The peak catch of 25 700 t that occurred for all methods in 2003–04 is similar to the earlier peak of 24 200 t in 1991–92.

3.2.6 Estimated target / non target jack mackerel catch

By Fishstock

Estimated jack mackerel catches from targeted and non-targeted landings for each QMA and all Fishstocks combined are shown in Table 6. For all Fishstocks combined, the percentage of total jack mackerel catch that was targeted increased from 62% in 1995–96 to 94% in 2003–04, except for a slight regression in 1999–2000. During 1992–93, 1995–96, and 1996–97, the percentages of catch that were targeted (76%, 62%, and 67% respectively) were all below the annual mean of 79% as a result of unusually high targeted catches. For example, during 1995–96 a non-targeted catch of 13 200 t of jack mackerel occurred in contrast to an annual mean catch of 6520 t over the period from 1989–90 to 2003–04. In contrast, the low percentage of 69% that was targeted catch in 1999–2000 was the result of an unusually low catch (9700 t) of targeted jack mackerel compared with the annual mean of 25 807 t.

Targeted landings dominated the catch in JMA 1, with the exception of the 1989–90 fishing year. This resulted in an annual mean targeted catch of 5347 t, which was 80 % of the total catch over the period from 1989–90 to 2003–04 (Table 6). The mean annual non-targeted catch was 1113 t over this period. During 2000–01 and 2001–02, the targeted percentage increased to 90% and 89% respectively within JMA 1, also coinciding with the minimum non-target species catch in 2001–02 of 600t. A peak catch in the JMA 1 fishery occurred in 1993–94, with 11 400 t of targeted jack mackerel and 1600 t of non-target jack mackerel resulting in targeted landings representing 87% of the total catch.

In JMA 3 targeted and non-targeted catches were more similar than in the other Fishstocks, with annual means of 4773 t and 3953 t respectively. This similarity was notable from 1989–90 until 1996–97, but after a further two years, when targeted landings were about 80% of the total catch, there was a fluctuation in dominance between targeted and non-targeted catch as the total catch waned.

In JMA 7, the targeted catch was consistently high. Peak targeted landings of 97% and 98% of the total catches occurred throughout the four most recent years of the period — 2000–01 to 2003–04 (Table 6). Targeted catch within JMA 7 was the highest for all QMAs, with a mean annual catch of 15 687 t, compared with the 5347t in JMA 1 and 4773 t in JMA 3. The non-targeted catch within JMA 7 showed a general decline from a peak of 3300 t during 1994–95 to 400 t in both the 2000–01 and 2002–03 fishing years. In contrast, an increasing trend is evident within targeted catch in recent years from 6800 t in 1999–2000 to 25 200 t during 2003–04.

By method — JMA 1

Estimated purse-seine landings of jack mackerel in JMA 1 indicate high levels of catch from targeted sets between 1989–90 and 2003–04, with an annual mean of 84% of the total landings (Table 7). With the exception of 1989–90, when the proportion of non-targeted landings was higher (52% of the total catch), targeted landings dominated the JMA 1 fishery. Non-targeted landings occurred at low levels, with an annual mean of 867 t per year, in contrast to the targeted catch of 5320 t per year. Targeted landings increased from 700 t in 1989–90, but were relatively stable around the mean annual value of 5040 t for the fishing years from 1994–95 to 2003–04, despite an unusually high peak at 11 300 t in1993–94. During 2001–02, 94% of the jack mackerel catch (4600 t) was targeted, with non-targeted landings totalling only 300 t. From 1989–90 until 1996–97, non-targeted landings fluctuated, but were

Table 6: Estimated jack mackerel catch (t): targeted or non-targeted (nearest 100 t) and percentage of the total catch that was targeted, by QMA and fishing year. Source: MFish catch effort database, *MOBY*.

	JMA 1			JMA 3		
Fishing year	Targeted catch	Non-targeted catch	Percent targeted	Targeted catch	Non-targeted catch	Percent targeted
1989–90	800	1 000	44	1 300	3 500	27
1990–91	5 800	2 000	74	2 400	5 600	30
1991–92	5 900	800	88	3 200	3 800	46
1992–93	5 800	1 500	80	8 400	8 300	50
1993–94	11 400	1 600	87	4 800	4 200	53
1994–95	6 600	1 500	81	6 000	4 800	55
1995–96	5 200	1 000	84	8 300	9 700	46
1996–97	4 800	1 500	76	7 400	7 000	51
1997–98	5 100	700	88	11 400	3 100	79
1998–99	3 900	1 000	80	11 900	2 300	84
1999–00	2 200	700	76	700	3 000	70
2000–01	7 000	800	90	1 500	1 100	57
2001–02	4 600	600	89	2 700	1 700	61
2002–03	5 100	1 100	82	1 400	800	65
2003–04	6 000	900	87	200	400	41
Means	5 347	1 113	80	4 773	3 953	54

	JMA 7			All Fishstocks combined		
Fishing year	Targeted catch	Non-targeted catch	Percent targeted	Targeted catch	Non-targeted catch	Percent targeted
1989–90	12 100	2 000	86	14 200	6 500	69
1990–91	11 100	1 800	86	19 300	9 400	67
1991–92	22 500	1 700	93	31 600	6 300	83
1992–93	21 900	1 700	93	36 100	11 500	76
1993–94	18 300	3 000	86	34 500	8 800	80
1994–95	14 300	3 300	81	26 900	9 600	74
1995–96	8 100	2 500	76	21 600	13 200	62
1996–97	9 100	1 800	83	21 300	10 300	67
1997–98	13 900	600	96	30 400	4 400	87
1998–99	11 900	900	93	27 700	4 200	87
1999–00	6 800	600	92	9 700	4 300	69
2000–01	14 500	400	97	23 000	2 300	91
2001–02	20 800	500	97	28 100	2 800	91
2002–03	24 800	400	98	31 300	2 300	93
2003–04	25 200	600	98	31 400	1 900	94
Means	15 687	1 453	90	25 807	6 520	79

often considerably higher than 1000 t, with a peak of 1900 t in 1990–91 resulting in an annual mean over those years of about 1140 t. Since 1997–98, however, annual non-targeted landings have usually been considerably less than 1000 t with an annual mean for that period (1997–98 to 2003–04) of about 560 t. The particularly high percentages for targeted catch since 1997–98, relative to the earlier years, are not the result of an increase in targeted catch, but have occurred because of this reduction in absolute values of non-targeted landings, particularly in 1997–98 (91%), 2000–01 (91%), 2001–02 (94%), and 2003–04 (92%).

Table 7: Estimated targeted and non-targeted catch of jack mackerel and percentage of total catch that was targeted, by purse-seine in JMA 1 & 3 (nearest 100 t). Source: MFish catch effort database, *MOBY*.

	JMA 1			JMA 3		
Fishing year	Non-targeted	Targeted	Percentage targeted	Non-targeted	Targeted	Percentage targeted
1989–90	800	700	48	1 520	980	39
1990–91	1 900	5 700	75	1 680	1 900	53
1991–92	700	5 900	90	480	2 690	85
1992–93	1 200	5 800	82	200	4 190	95
1993–94	1 500	11 300	88	210	1 780	89
1994–95	1 300	6 600	84	0	1 040	100
1995–96	600	5 200	90	220	660	75
1996–97	1 100	4 700	81	90	110	56
1997–98	500	5 100	91	10	570	99
1998–99	700	3 900	85	90	840	90
1999–00	500	2 200	80	0	500	99
2000–01	700	7 000	91	30	290	91
2001–02	300	4 600	94	0	120	100
2002–03	700	5 100	88	30	90	76
2003–04	500	6 000	92	0	0	–
Means	867	5 320	84	304	1 051	76

By method—JMA 3

Throughout much of the period between 1989–90 and 2003–04, targeted landings in the JMA 3 purse-seine fishery were greater than non-targeted landings (Table 7), resulting in targeted landings representing 76% of total landings overall. This dominance is evident with the exception of the 1989–90 fishing year, in which non-targeted landings were 1520 t, contrasting strongly with the 980 t for targeted landings. Targeted landings increased from 39% of all landings in 1989–90 to 95% in 1992–93. Highest representation of targeted catch occurred during 1994–95 and 2001–02 when they accounted for 100% of all landings, and in 1997–98 and 1999–00 when they accounted for 99%. These percentages resulted from particularly low levels of non-targeted landings in most years since 1994–95. Purse-seine landings in JMA 3 have declined considerably since 1993–94, to result in zero catch from both targeted and non-targeted sets in 2003–04, in contrast to a mean annual targeted catch of 1051 t from 1989–90 to 2003–04.

Estimated landings in the JMA 3 bottom trawl fishery were low, resulting in low targeted and non-targeted landings, with mean catches of 179 t and 824 t respectively from 1989–90 to 2003–04 (Table 8). Non-targeted landings were always higher than targeted catch, representing 84% of the total. The highest targeted catch of 44% occurred in 2002–03. The non-targeted catch was characterised by regular fluctuations, declining from 1510 t in 1989–90 to 510 in 1993–94, then increasing to 1620 t in 1996–97, and declining from 1000 t in 1999–2000 to 120 t in 2003–04. Targeted landings in the JMA 3 bottom trawl fishery were low throughout the period at 16% of the total catch and representing only 1% total landings during the 1992–93 and 2003–04 fishing years.

Targeted and non-targeted landings in the JMA 3 midwater trawl fishery each made up about 50% of the total landings (Table 8). The percentage of targeted landings increased from 1% of the total in 1989–90, to 88% (10 890 t) during 1998–99, with non-targeted landings predominating in the early years from 1989–90 through to 1993–94 and in 1995–96. Estimated catches showed a general decline for both non-targeted and targeted landings from 1999–2000 to 2003–04. In 1999–2000, total landings comprised 2020 t of non-targeted and 6400 t of targeted catches. By contrast, total catch during 2003–04 comprised only 240 t and 250 t of non-targeted and targeted landings respectively. Annual means of non-targeted and targeted catches for the entire period were 2819 t and 3955 t respectively.

Table 8: Estimated targeted and non-targeted catch of jack mackerel in JMA 3 and the percentage of total catch that was targeted, by bottom and mid-water trawl (nearest 10 t). Source: MFish catch effort database, *MOBY*.

	Bottom trawl			Mid-water trawl		
Fishing year	Non-targeted	Targeted	Percentage targeted	Non-targeted	Targeted	Percentage targeted
1989–90	1 510	260	15	430	0	1
1990–91	1 090	370	25	2 820	90	3
1991–92	890	150	14	2 430	380	14
1992–93	690	10	1	7 410	4 220	36
1993–94	510	60	10	3 510	3 000	46
1994–95	570	90	13	4 260	4 870	53
1995–96	1 120	280	20	8 350	7 330	47
1996–97	1 620	310	16	5 280	6 990	57
1997–98	1 380	570	29	1 700	10 280	86
1998–99	720	120	15	1 500	10 890	88
1999–00	1 000	40	4	2 020	6 400	76
2000–01	250	0	2	800	1 150	59
2001–02	630	230	27	1 060	2 340	69
2002–03	260	200	44	470	1 140	71
2003–04	120	0	1	240	250	50
Means	824	179	16	2 819	3 955	50

By method—JMA 7

The targeted catch of jack mackerel dominated the JMA 7 bottom trawl fishery from 1989–90 to 2001–02 (Table 9), with mean annual catches that were 79% of the total catch. The mean annual non-targeted catch was 373 t from 1989–90 to 2003–04, which contrasts strongly with the mean of 5147 t for targeted landings. Targeted catches increased from 10 300 t (93% of the total) in 1989–90 to 14 100 t (98% of the total) in 1992–93, but have gradually declined since. This is particularly evident during 2001–02 to 2003–04, with 100 t (22% of the total) of targeted jack mackerel landed in 2003–04, in contrast with the overall mean of 5147 t from 1989–90 to 2003–04.

The estimated targeted catch within the JMA 7 midwater trawl fishery was higher than the estimated non-targeted catch, with a mean annual proportion of 88% from 1989–90 to 2003–04 (Table 9). The targeted catch increased from 1999–2000 to 2003–04, with 24 800 t (98% of the total) landed during 2003–04, in contrast with the mean targeted catch of 9853 t. From 1999–00 to 2003–04, 98% to 99% of the total catch was from targeted midwater tows. Non-targeted landings of jack mackerel showed a decline from 2400 t in 1993–94, to 100 t in 1999–00 and each of the remaining years except 2003–04. The targeted catch of jack mackerel dominated the midwater trawl fishery within JMA 7. Non-targeted landings of jack mackerel were low, with a mean of 860 t per yr, in contrast with the mean targeted catch of 9853 t.

By Target Species

Percentages of the estimated total annual jack mackerel catch by the top target species for each Fishstock are shown in Figures 13–15 and Appendix D. A common feature in all Fishstocks is the predominance of jack mackerel landings taken as the targeted species.

In JMA 1, 70–90% of the total estimated catch of jack mackerel was from targeted landings (Figure 13, Table 6). The remaining 10–30% was taken in kahawai, blue mackerel, and hoki targeted trawls. Sets targeting kahawai have produced the highest percentage of jack mackerel bycatch of the top three target species between 1989–90 and 2000–01 inclusive, with the exception of fishing years 1992–93

Table 9: Estimated targeted and non-targeted catch of jack mackerel in JMA 7 and the percentage of total catch that was targeted, by bottom and midwater trawl (to the nearest 100 t). Source: MFish catch effort database, *MOBY*.

Fishing year	Non-targeted	Targeted	Percentage targeted	Non-targeted	Targeted	Percentage targeted
1989–90	800	10 300	93	300	1 600	83
1990–91	400	7 500	94	900	3 100	77
1991–92	300	11 800	97	1 100	9 900	90
1992–93	300	14 100	98	500	5 000	90
1993–94	500	9 600	95	2 400	6 100	72
1994–95	700	2 500	79	2 400	10 200	81
1995–96	400	3 700	90	2 000	3 900	66
1996–97	300	3 100	91	1 500	6 000	80
1997–98	300	9 100	97	400	4 400	92
1998–99	300	2 600	90	600	8 900	94
1999–00	200	200	47	100	6 600	98
2000–01	300	1 100	80	100	13 400	99
2001–02	400	1 400	77	100	19 400	99
2002–03	200	100	42	100	24 500	99
2003–04	200	100	22	400	24 800	98
Mean	373	5147	79	860	9853	88

and 1994–95. A major reduction in jack mackerel bycatch from kahawai targeted sets occurred from 2000–01 to 2003–04. Jack mackerel bycatch from tows targeting hoki was lowest of all the four target species, occurring only during 1994–95 to 1998–99 and from 2001–02 to 2003–04.

Within JMA 3, targeted jack mackerel catch predominated except in 1990–91 (Figure 14, Table 6). Jack mackerel bycatch occurred in both squid and barracouta targeted tows from 1989–90 to 2003–04. A decline in the jack mackerel bycatch from squid targeted tows occurred during the 1997–98 fishing year, from about 35% of jack mackerel taken from squid targeted landings in 1996–97 to under 10% during 1997–98. A corresponding increase in targeted jack mackerel catch was evident in 1997–98. The targeted jack mackerel catch then underwent a declining trend from 1999–2000 to 2003–04, with an approximately corresponding nett increase from squid and barracouta-targeted tows combined.

In JMA 7, targeted jack mackerel landings predominated, with bycatch from hoki and barracouta targeted tows generally being less than 10% between 1989–90 and 2003–04 inclusive (Figure 15, Table 6). A peak of around 18% in jack mackerel bycatch from hoki targeted catches occurred from 1993–94 to 1995–96, followed by a declining trend to 1997–98. This corresponded to a mirror-image trend in the targeted jack mackerel catch, which first declined and subsequently recovered during this same period. Between 1997–98 and 2003–04 inclusive, bycatch of jack mackerel from hoki and barracouta targeted catches become very low, with almost 100% catch of targeted jack mackerel occurring from 2000–01.

3.5 Jack mackerel trawl catch rates – JMA 7

3.5.1 Catch per tow (t/tow)

For TCEPR tows in JMA 7, probability distributions of jack mackerel catch per tow and median catch rates are shown in Figures 16 and 17. There is a high probability of catch per tow around 0.6 to 0.7 for the capture of 1 t or less per tow, which is consistent from 1989–90 to 2003–04. The probability

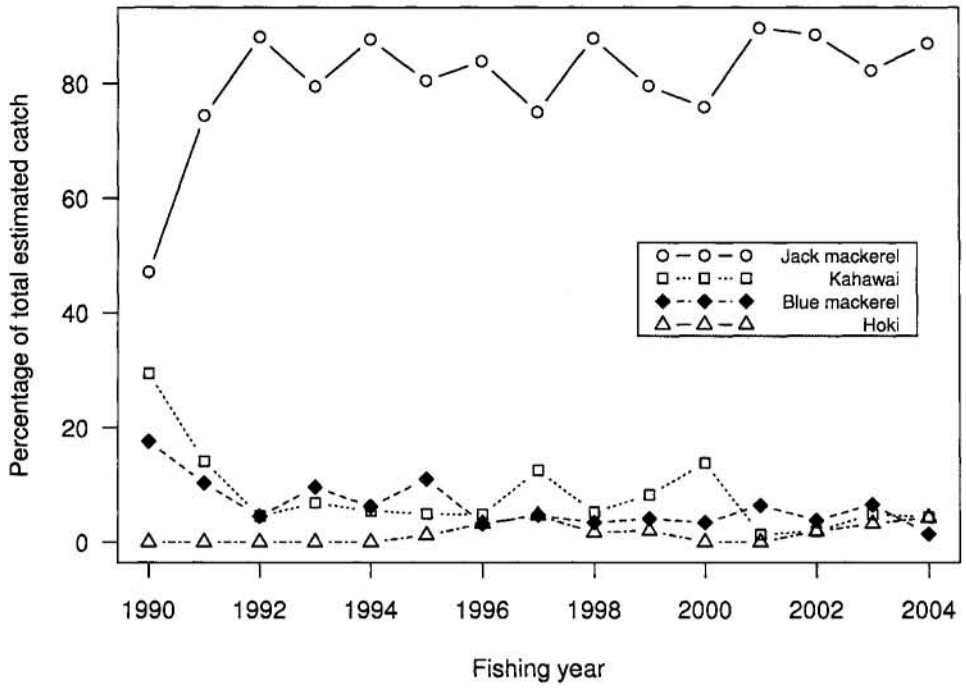

Figure 13: Percentage of total estimated annual jack mackerel catch in JMA 1 for the top four target species. Source: MFish catch effort database, *MOBY*.

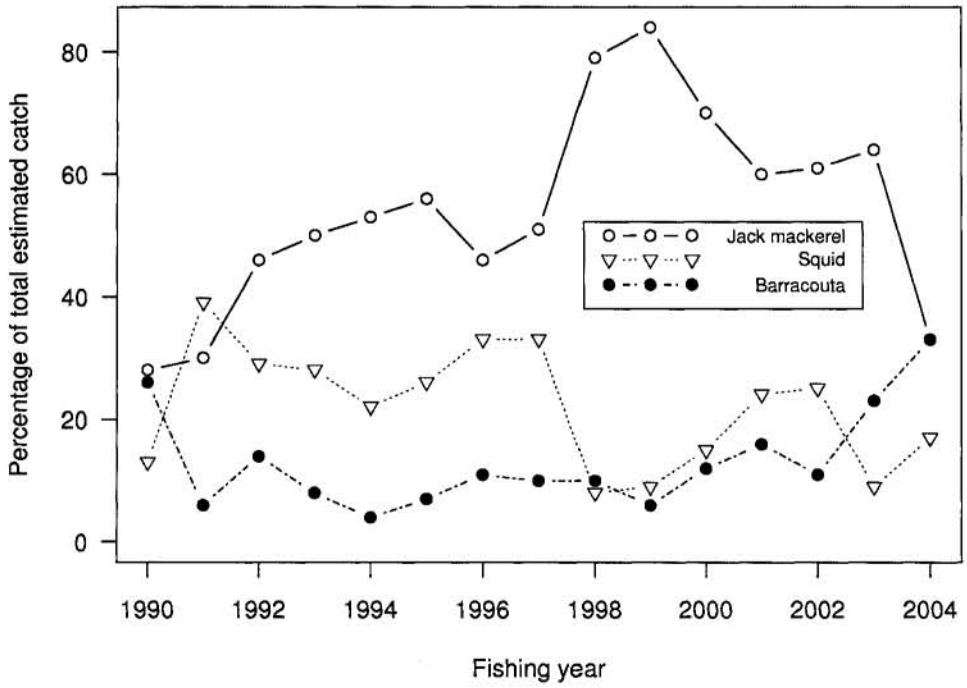

Figure 14: Percentage of total estimated annual jack mackerel catch by the top three target species. Source: MFish catch effort database, *MOBY*.

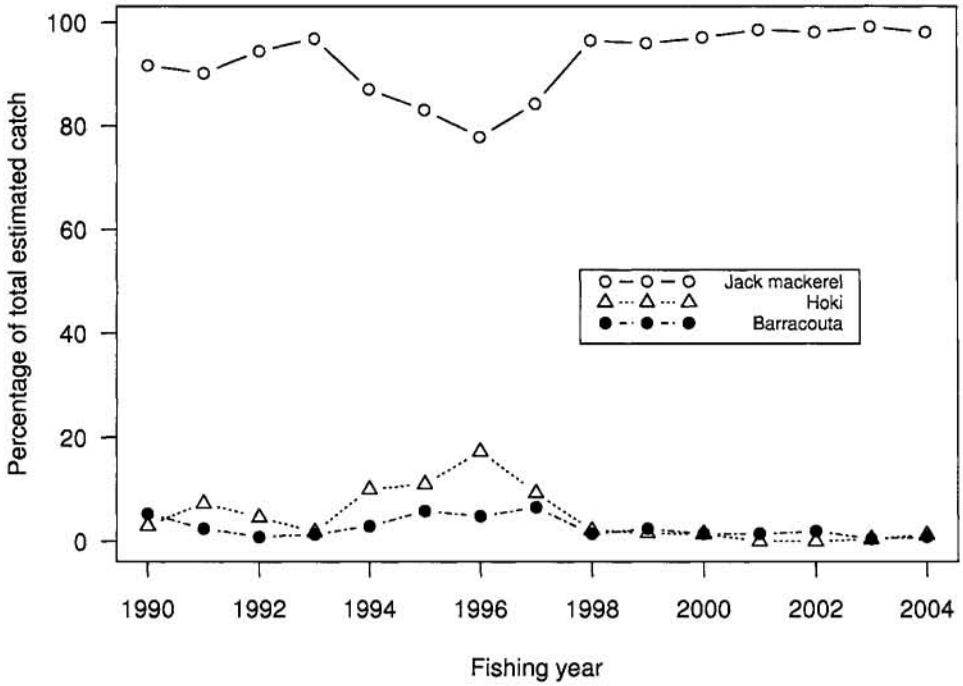

Figure 15: Percentage of total estimated annual jack mackerel catch by the top three target species. Source: MFish catch effort database, *MOBY*.

distribution decreases dramatically at the first step, so that the probability of catching 2 t per tow is about 0.1 in most cases. Probabilities for the capture of more than 2 tonnes remain reasonably flat, declining gradually to about 15 t in most years.

The small increase in probability of catch for 10 t and 15 t per tow that is evident in most fishing years is most likely an artifact resulting from tonnages being rounded when recorded, thus providing a dataset comprising a mixture of discrete and continuous contributions from the fishery.

Median catch rates (t/tow) shown in Figure 16 have values around 0.5 t per tow during all fishing years recorded. Small increases in the median catch rate occurred during 1994–95 and 2002–03 fishing years resulting in values around 0.7 and 0.8 t per tow respectively. Overall, there is the slight hint of an increasing trend throughout the median catch rate time series.

3.7 Catch per km (t/km)

In JMA 7, for TCEPR tows only, the probability of jack mackerel catch per kilometre (t/km) and the median catch rate are shown in Figures 18 and 19. The average probability of catch per km for 10 t ranges from 0.3 to 0.5, with the probability declining with increased tonnage (Figure 16). This trend is consistent throughout all fishing years from 1989–90 to 2003–04. The median catch rate (t/km) shown in Figure 17 indicates that an average of about 18 t per km is generally consistent, with peaks occurring during 1994–95 and 2002–03, and a slight increase evident from 1997–98 to 2002–03.

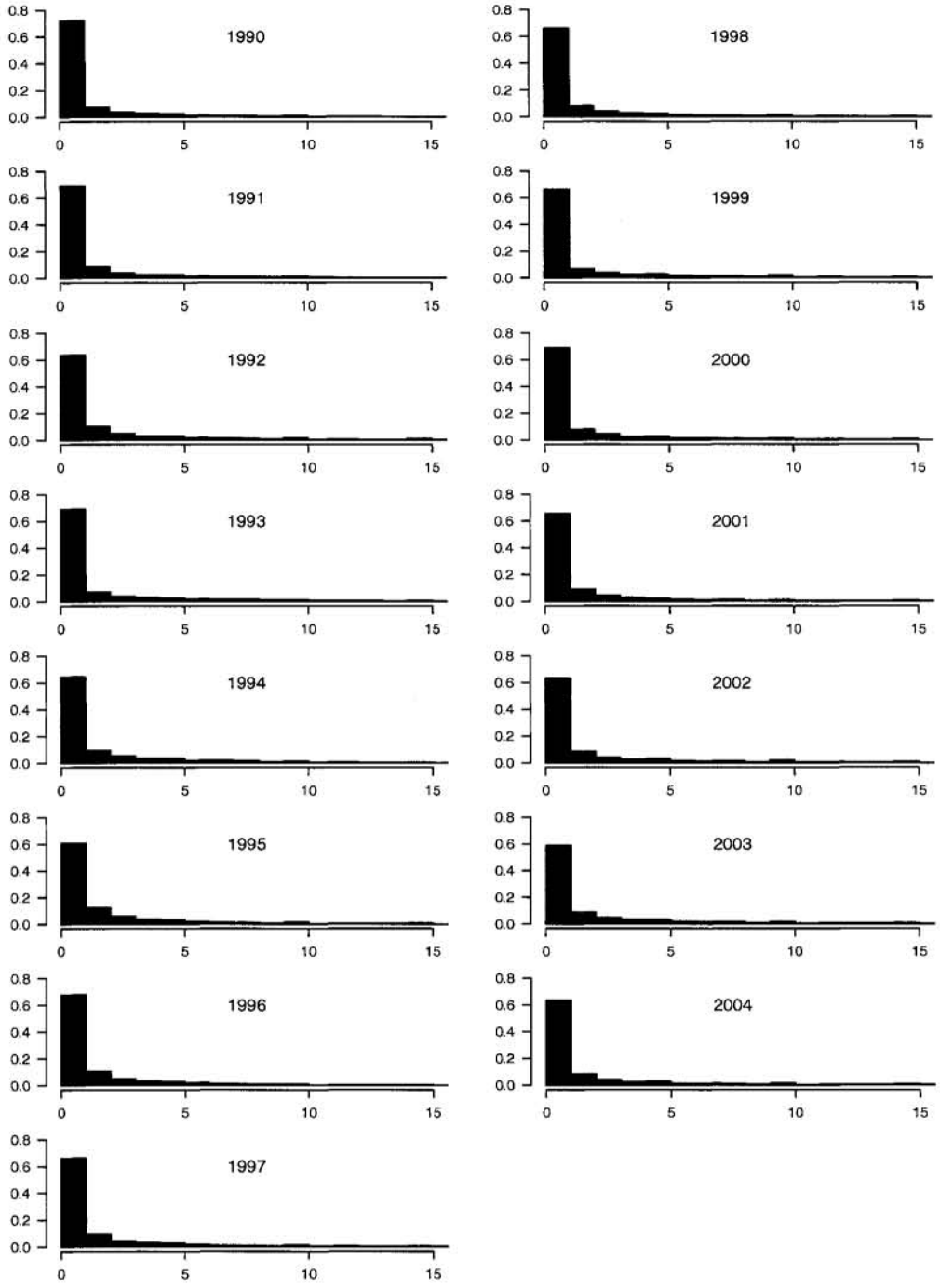

Figure 16: Probability distributions of catch per tow (t/tow) for JMA 7 by fishing year; 1990 represents 1989–90, etc. Source: MFish catch effort database, *MOBY*, TCPER data only.

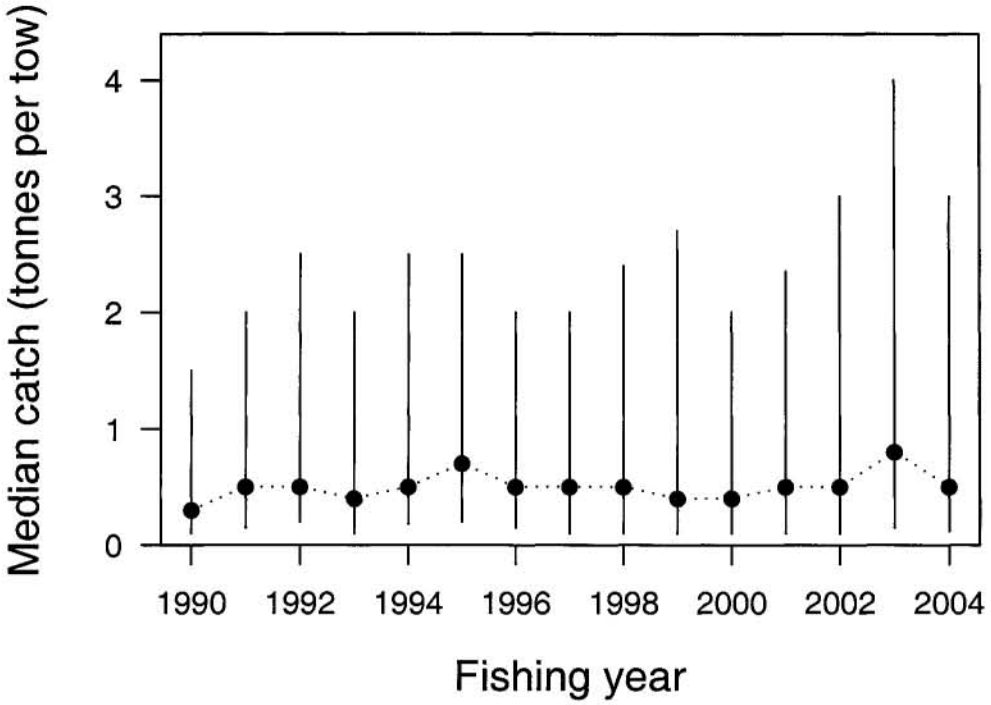

Figure 17: Median catch rate (t/tow) for TCEPR tows that either targeted or caught jack mackerel. Lower and upper quartiles are shown for the catch rate by fishing year; 1990 represents 1989–90, etc. Source: MFish catch effort database, *MOBY*, TCPER data only.

4. DISCUSSION

4.1 The fishery before 1989–90

Results presented by Jones (1990), and included here, demonstrate the importance of purse-seine landings to the domestic jack mackerel catch. The first evidence for this is the increase in domestic catch around 1976 when the purse-seine fishery in what is now JMA 1 began to develop into a major contributor to the total annual catch of several schooling pelagic species. Jones (1990) made reference to the increasing domestic catch at this time, which he explained as increased activity of the purse-seine fleet following importation of four additional purse-seiners under a duty-free incentive scheme described by Anon (1977).

The deepwater fishery has contributed the largest volume to total landings since at least 1970 when the Japanese fleet took most of the catch. Exactly when this began is unclear, but information from the popular press (Berry 1969a, 1969b, 1972) suggests fishing by several Japanese trawlers beginning about 1967. More precise information is unavailable from MFish because New Zealand could not impose a requirement for catch records when fishing was outside the 12 n. mile limit. Japanese catch peaked at about 18 000 t in 1972 and remained at 13 000 t or more until 1977 when a dramatic reduction occurred. This was the result of a 5000 t quota and 100 mm codend being imposed after declaration of the Exclusive Economic Zone (EEZ) in 1978 (Jones 1990). This reduction in foreign licensed catch was initially offset by the increasing purse-seine activity mentioned above, and by the eventual increase in landings by the foreign chartered fleet.

4.2 The TCEPR/CELR fishery

The rising trend that began in the pre-1989–90 fishery with the increased purse-seine activity and landings by the foreign chartered fleet continued after introduction of the QMS and was sustained until 1992–93 when the total jack mackerel fishery peaked at 47 400 t. By this time, landings from JMA 1,

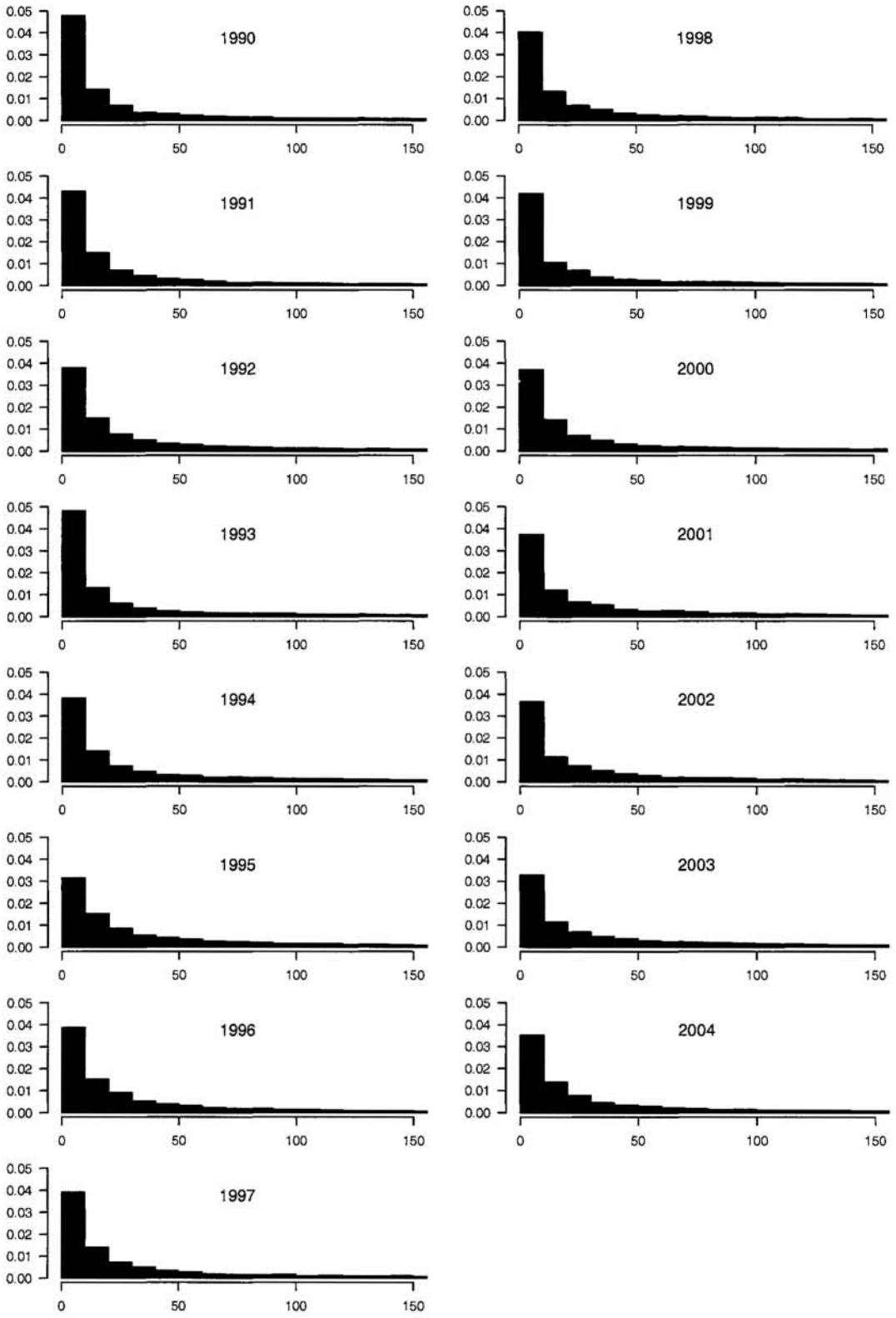

Figure 18: Probability distribution of catch per km (t/km) for JMA 7 by fishing year; 1990 represents 1989–90 etc. Source: MFish catch effort database, *MOBY*, TCPER data only.

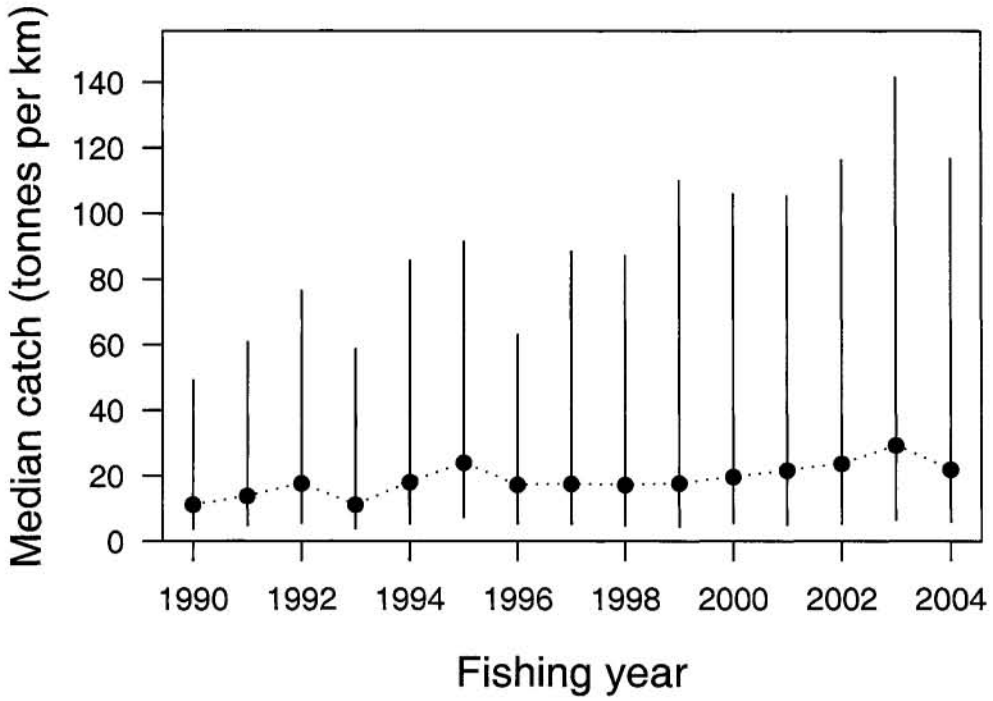

Figure 19: Median catch rate (t/km) for TCEPR tows that either targeted or caught jack mackerel by fishing year; 1990 represents 1989–90 etc. Lower and upper quartiles are shown for the catch rate. Source: MFish catch effort database, *MOBY*, TCPER data only.

which comprised almost 100% of the purse-seine catch, represented the smallest contribution to the total catch. By contrast, landings in JMA 3 and 7, which comprised a high percentage of those taken by the foreign chartered fleet, contributed more than 70% of the total jack mackerel catch from all areas combined.

Since 1992–93, total landings have declined to about 33 000 t in each of 2002–03 and 2003–04, the last two years of the study period. A salient feature of this decline was the low point of about 20 300 t that occurred in 1999–2000. Since then the trend of total catch has been increasing, mainly as a result of increasing annual catches in JMA 7, with contribution from a smaller corresponding rise in JMA 1. Landings in JMA 3 have continued to decline throughout.

The overall peak in 1992–93 is undoubtedly related to the *T. murphyi* invasion, with the subsequent declining trend reflecting what appears to be the gradual decline of this species in New Zealand waters, as documented by Taylor & Julian (2008). The recent overall increase is more difficult to explain, however. Two factors come to mind. Firstly, it is interesting that this increase is evident in both JMA 1 and 7. And secondly, there does not seem to be any pattern that can be related to any one of the three species. Comparing the annual and monthly catches with species proportion estimates from Taylor & Julian (2008) provides no clues to any changes in targeting.

In following this exercise, however, one becomes aware of the fact that the information we are currently gathering is not extensive enough to understand the fishery, particularly in JMA 7. The numbers of tows that have been sampled for species composition in any one month are very low, with some months contributing no data at all. Furthermore, some months with no sampling data have been when large volumes of jack mackerel have been taken. If there is a species-related pattern, we do not have the data to investigate it.

One piece of evidence that suggests there could be a species-related factor underlying this rising trend in JMA 7 is the change in geographical distribution that has occurred in recent years. We know that *T. novaezelandiae* follows a more northerly distribution than the other two species. Given its relatively

small average size and the rapid increase in the JMA 7 catch, some extra effort should be exerted in determining reliable estimates of the species composition of landings from this Fishstock. Sampling to date has been constrained by other duties required of MFish observers while on board the foreign licensed vessels comprising this fleet, but with the additional observer hours now available in the JMA 7 TCEPR fishery, improving the sampling design to ensure representative data must now be possible.

Some features of the purse-seine fishery warrant further comment. The reduction in jack mackerel bycatch in JMA 1 since 1997–98, from an annual average of more than 1100 t between 1989–90 and 1996–97, to an annual average of less than 600 t since seems initially to have been the result of a reduction in the volume of bycatch taken in sets that targeted blue mackerel. More recently, however, (since 2000–01), it has been the result of a reduction in sets targeting kahawai, which is a reflection of a "conflict of interest" between kahawai and jack mackerel targeting because of their presence in mixed schools. Recent reductions in the kahawai purse-seine quota have resulted in purse-seine operators avoiding jack mackerel when they are mixed in schools with kahawai.

Operational factors are responsible for the large reduction in purse-seine landings in JMA 7 that occurred around 1995–96 and 1996–97. This decline coincided with the sale of the purse-seiner FV *Shemara*, whose last landing date was 28/04/1996 (John Ayers, Sealord Ltd, pers. comm.). Coupled with this was the closure of the Sanford Ltd factory in Nelson in November 2002, although the effect of this second event is not so clear in the data and Sanfords still operate the vessel that was stationed in Nelson within JMA 7, albeit at a lower level of effort in that area.

5. ACKNOWLEDGMENTS

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Appendix A: Background information for assigning historical data to Fishstocks

Table A1: Basis for assignment of historical data to Fishstocks; place names indicate port of landing; assignment of ports was mostly quite clear, but it is likely that some catch could have been taken in a Fishstock other than the one assigned, particularly in the Wellington-Makara-Paremata-Paraparaumu area

JMA 1	JMA 3	JMA 7
Mangonui	Kaikoura	Manukau
Russell	Lyttelton	Raglan
Whangarei	Akaroa	New Plymouth
Auckland	Oamaru	Manawatu
Coromandel	Timaru	Wanganui
Thames	Port Chalmers	Picton
Mercury Bay		Blenheim
Tauranga		French Pass
Whakatane		Nelson
Gisborne		Motueka
Napier		Westport
Paraparaumu		Greymouth
Paremata		
Wellington		
Makara		

Appendix B: Estimated monthly catch (t) in the jack mackerel fishery by QMA and fishing year.

A) JMA1

	Month (t)												
Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total catch (t)
1989–90	190	40	20	30	10	10	10	250	100	310	320	410	1 700
1990–91	590	850	800	20	10	10	540	1 800	1 420	600	550	600	7 790
1991–92	450	220	620	700	590	630	1 410	730	240	90	500	510	6 690
1992–93	300	490	540	530	380	10	550	1 420	710	470	80	1 800	7 280
1993–94	1 140	910	730	720	10	360	250	580	1 490	1 840	2 750	2 220	13 000
1994–95	500	1 360	840	1 010	250	230	120	200	480	710	1 760	710	8 170
1995–96	410	130	60	80	150	80	240	220	410	1 270	1 480	1 670	6 200
1996–97	550	250	50	30	10	30	300	280	390	1 670	1 800	990	6 350
1997–98	1 460	210	500	10	10	20	20	50	450	100	950	2 020	5 800
1998–99	1 470	510	70	30	30	30	20	170	790	770	460	500	4 850
1999–00	330	400	20	10	20	80	10	130	230	10	330	1 320	2 890
2000–01	390	380	340	250	220	200	10	30	1 180	1 280	1 490	2 070	7 840
2001–02	410	80	460	30	10	200	410	180	470	950	660	1 290	5 150
2002–03	850	270	240	440	830	20	30	220	110	910	360	1 880	6 160
2003–04	300	350	770	130	20	110	150	1 630	720	120	430	2 170	6 900
mean	623	430	404	268	170	135	271	526	613	740	928	1 344	6 451

B) JMA3

	Month (t)												
Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total catch (t)
1989–90	20	240	430	650	1 050	840	650	450	290	0	10	70	4 700
1990–91	30	340	660	1 590	2 180	1 500	710	770	70	10	10	70	7 940
1991–92	100	250	720	1 810	900	1 510	850	160	720	20	0	0	7 040
1992–93	10	20	440	4 340	3 130	2 400	3 710	1 690	880	100	0	0	16 720
1993–94	260	210	1 620	2 090	670	500	1 790	1 420	470	10	0	30	9 070
1994–95	0	0	1 880	2 090	1 480	800	1 190	2 930	390	30	0	20	10 810
1995–96	20	150	1 590	3 640	2 980	2 910	3 720	2 680	230	20	10	40	17 990
1996–97	120	1 610	1 410	1 570	1 100	3 020	3 180	1 430	890	70	0	10	14 410
1997–98	150	90	1 160	2 330	1 980	2 200	4 790	1 520	300	0	0	0	14 520
1998–99	30	40	1 110	2 470	2 890	3 130	2 820	1 270	110	260	0	20	14 150
1999–00	20	470	1 130	2 080	1 370	3 040	1 620	170	50	0	0	20	9 970
2000–01	40	300	270	220	120	880	330	310	20	0	0	50	2 540
2001–02	130	10	40	530	420	780	1 770	660	20	0	0	30	4 390
2002–03	50	20	40	40	10	680	870	420	40	0	0	10	2 180
2003–04	20	10	0	20	30	150	230	130	0	0	0	10	600
mean	67	251	833	1 698	1 354	1 623	1 882	1 067	299	35	2	25	9 135

C) JMA7

Fishing year	Month (t) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total catch (t)
1989–90	1 490	1 190	1 030	890	940	1 720	1 020	860	2 140	680	1 210	930	14 100
1990–91	410	110	800	2 080	1 000	1 020	480	990	3 490	540	930	1 100	12 950
1991–92	1 340	1 480	3 380	2 340	980	1 310	1 170	4 920	3 760	2 800	230	530	24 240
1992–93	1 320	1 950	2 780	2 980	2 170	3 570	1 940	2 010	2 580	1 380	110	740	23 530
1993–94	1 370	1 150	2 070	3 010	1 310	720	390	2 120	3 020	4 220	260	1 570	21 210
1994–95	400	260	1 090	2 190	110	940	630	2 220	4 450	4 060	790	420	17 560
1995–96	140	80	390	1 650	430	430	260	790	1 390	4 170	590	330	10 650
1996–97	340	400	1 140	1 210	780	170	100	1 240	1 430	1 790	1 440	860	10 900
1997–98	80	1 170	2 040	1 900	1 180	950	1 880	1 190	950	1 290	830	1 140	14 600
1998–99	180	290	1 490	530	20	40	2 030	2 590	2 110	1 980	700	790	12 750
1999–00	2 320	160	860	1 000	30	50	290	20	1 800	600	170	70	7 370
2000–01	750	1 300	4 450	1 550	20	70	260	910	4 770	530	100	150	14 860
2001–02	2 450	2 600	7 870	720	10	10	390	1 050	4 270	820	330	820	21 340
2002–03	3 320	950	6 350	2 320	20	30	2 950	1 690	4 570	2 470	440	30	25 140
2003–04	5 760	1 950	7 870	1 260	20	20	20	770	4 700	2 160	1 150	140	25 820
mean	1 445	1 003	2 907	1 709	601	737	921	1 558	3 029	1 966	619	641	17 135

D) All QMAs

Fishing year	Month (t) Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total catch (t)
1989–90	1 700	1 470	1 480	1 570	2 000	2 570	1 680	1 560	2 530	990	1 540	1 410	20 500
1990–91	1 030	1 300	2 260	3 690	3 190	2 530	1 730	3 560	4 980	1 150	1 490	1 770	28 680
1991–92	1 890	1 950	4 720	4 850	2 470	3 450	3 430	5 810	4 720	2 910	730	1 040	37 970
1992–93	1 630	2 460	3 760	7 850	5 680	5 980	6 200	5 120	4 170	1 950	190	2 540	47 530
1993–94	2 770	2 270	4 420	5 820	1 990	1 580	2 430	4 120	4 980	6 070	3 010	3 820	43 280
1994–95	900	1 620	3 810	5 290	1 840	1 970	1 940	5 350	5 320	4 800	2 550	1 150	36 540
1995–96	570	360	2 040	5 370	3 560	3 420	4 220	3 690	2 030	5 460	2 080	2 040	34 840
1996–97	1 010	2 260	2 600	2 810	1 890	3 220	3 580	2 950	2 710	3 530	3 240	1 860	31 660
1997–98	1 690	1 470	3 700	4 240	3 170	3 170	6 690	2 760	1 700	1 390	1 780	3 160	34 920
1998–99	1 680	840	2 670	3 030	2 940	3 200	4 870	4 030	3 010	3 010	1 160	1 310	31 750
1999–00	2 670	1 030	2 010	3 090	1 420	3 170	1 920	320	2 080	610	500	1 410	20 230
2000–01	1 180	1 980	5 060	2 020	360	1 150	600	1 250	5 970	1 810	1 590	2 270	25 240
2001–02	2 990	2 690	8 370	1 280	440	990	2 570	1 890	4 760	1 770	990	2 140	30 880
2002–03	4 220	1 240	6 630	2 800	860	730	3 850	2 330	4 720	3 380	800	1 920	33 480
2003–04	6 080	2 310	8 640	1 410	70	280	400	2 530	5 420	2 280	1 580	2 320	33 320
mean	2 134	1 683	4 145	3 675	2 125	2 494	3 074	3 151	3 940	2 741	1 549	2 011	32 721

Appendix C: Monthly estimated percentage of catch (%) in the JMA fishery by QMA and fishing year.

A) JMA 1

	Month (% of total catch)												
Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total catch (t)
1989–90	11.2	2.4	1.2	1.8	0.6	0.6	0.6	14.7	5.9	18.2	18.8	24.1	1 700
1990–91	7.6	10.9	10.3	0.3	0.1	0.1	6.9	23.1	18.2	7.7	7.1	7.7	7 790
1991–92	6.7	3.3	9.3	10.5	8.8	9.4	21.1	10.9	3.6	1.3	7.5	7.6	6 690
1992–93	4.1	6.7	7.4	7.3	5.2	0.1	7.6	19.5	9.8	6.5	1.1	24.7	7 280
1993–94	8.8	7.0	5.6	5.5	0.1	2.8	1.9	4.5	11.5	14.2	21.2	17.1	13 000
1994–95	6.1	16.6	10.3	12.4	3.1	2.8	1.5	2.4	5.9	8.7	21.5	8.7	8 170
1995–96	6.6	2.1	1.0	1.3	2.4	1.3	3.9	3.5	6.6	20.5	23.9	26.9	6 200
1996–97	8.7	3.9	0.8	0.5	0.2	0.5	4.7	4.4	6.1	26.3	28.3	15.6	6 350
1997–98	25.2	3.6	8.6	0.2	0.2	0.3	0.3	0.9	7.8	1.7	16.4	34.8	5 800
1998–99	30.3	10.5	1.4	0.6	0.6	0.6	0.4	3.5	16.3	15.9	9.5	10.3	4 850
1999–00	11.4	13.8	0.7	0.3	0.7	2.8	0.3	4.5	8.0	0.3	11.4	45.7	2 890
2000–01	5.0	4.8	4.3	3.2	2.8	2.6	0.1	0.4	15.1	16.3	19.0	26.4	7 840
2001–02	8.0	1.6	8.9	0.6	0.2	3.9	8.0	3.5	9.1	18.4	12.8	25.0	5 150
2002–03	13.8	4.4	3.9	7.1	13.5	0.3	0.5	3.6	1.8	14.8	5.8	30.5	6 160
2003–04	4.3	5.1	11.2	1.9	0.3	1.6	2.2	23.6	10.4	1.7	6.2	31.4	6 900
mean	10.5	6.5	5.7	3.6	2.6	2.0	4.0	8.2	9.1	11.5	14.0	22.9	6 451

B) JMA 3

	Month (% of total catch)												
Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total catch (t)
1989–90	0.4	5.1	9.1	13.8	22.3	17.9	13.8	9.6	6.2	0.0	0.2	1.5	4 700
1990–91	0.4	4.3	8.3	20.0	27.5	18.9	8.9	9.7	0.9	0.1	0.1	0.9	7 940
1991–92	1.4	3.6	10.2	25.7	12.8	21.4	12.1	2.3	10.2	0.3	0.0	0.0	7 040
1992–93	0.1	0.1	2.6	26.0	18.7	14.4	22.2	10.1	5.3	0.6	0.0	0.0	16 720
1993–94	2.9	2.3	17.9	23.0	7.4	5.5	19.7	15.7	5.2	0.1	0.0	0.3	9 070
1994–95	0.0	0.0	17.4	19.3	13.7	7.4	11.0	27.1	3.6	0.3	0.0	0.2	10 810
1995–96	0.1	0.8	8.8	20.2	16.6	16.2	20.7	14.9	1.3	0.1	0.1	0.2	17 990
1996–97	0.8	11.2	9.8	10.9	7.6	21.0	22.1	9.9	6.2	0.5	0.0	0.1	14 410
1997–98	1.0	0.6	8.0	16.0	13.6	15.2	33.0	10.5	2.1	0.0	0.0	0.0	14 520
1998–99	0.2	0.3	7.8	17.5	20.4	22.1	19.9	9.0	0.8	1.8	0.0	0.1	14 150
1999–00	0.2	4.7	11.3	20.9	13.7	30.5	16.2	1.7	0.5	0.0	0.0	0.2	9 970
2000–01	1.6	11.8	10.6	8.7	4.7	34.6	13.0	12.2	0.8	0.0	0.0	2.0	2 540
2001–02	3.0	0.2	0.9	12.1	9.6	17.8	40.3	15.0	0.5	0.0	0.0	0.7	4 390
2002–03	2.3	0.9	1.8	1.8	0.5	31.2	39.9	19.3	1.8	0.0	0.0	0.5	2 180
2003–04	3.3	1.7	0.0	3.3	5.0	25.0	38.3	21.7	0.0	0.0	0.0	1.7	600
mean	1.2	3.2	8.3	16.0	12.9	19.9	22.1	12.6	3.0	0.3	0.0	0.6	9 135

C) JMA7

	Month (% of total catch)												
Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total catch (t)
1989–90	10.6	8.4	7.3	6.3	6.7	12.2	7.2	6.1	15.2	4.8	8.6	6.6	14 100
1990–91	3.2	0.8	6.2	16.1	7.7	7.9	3.7	7.6	26.9	4.2	7.2	8.5	12 950
1991–92	5.5	6.1	13.9	9.7	4.0	5.4	4.8	20.3	15.5	11.6	0.9	2.2	24 240
1992–93	5.6	8.3	11.8	12.7	9.2	15.2	8.2	8.5	11.0	5.9	0.5	3.1	23 530
1993–94	6.5	5.4	9.8	14.2	6.2	3.4	1.8	10.0	14.2	19.9	1.2	7.4	21 210
1994–95	2.3	1.5	6.2	12.5	0.6	5.4	3.6	12.6	25.3	23.1	4.5	2.4	17 560
1995–96	1.3	0.8	3.7	15.5	4.0	4.0	2.4	7.4	13.1	39.2	5.5	3.1	10 650
1996–97	3.1	3.7	10.5	11.1	7.2	1.6	0.9	11.4	13.1	16.4	13.2	7.9	10 900
1997–98	0.5	8.0	14.0	13.0	8.1	6.5	12.9	8.2	6.5	8.8	5.7	7.8	14 600
1998–99	1.4	2.3	11.7	4.2	0.2	0.3	15.9	20.3	16.5	15.5	5.5	6.2	12 750
1999–00	31.5	2.2	11.7	13.6	0.4	0.7	3.9	0.3	24.4	8.1	2.3	0.9	7 370
2000–01	5.0	8.7	29.9	10.4	0.1	0.5	1.7	6.1	32.1	3.6	0.7	1.0	14 860
2001–02	11.5	12.2	36.9	3.4	0.0	0.0	1.8	4.9	20.0	3.8	1.5	3.8	21 340
2002–03	13.2	3.8	25.3	9.2	0.1	0.1	11.7	6.7	18.2	9.8	1.8	0.1	25 140
2003–04	22.3	7.6	30.5	4.9	0.1	0.1	0.1	3.0	18.2	8.4	4.5	0.5	25 820
mean	8.2	5.3	15.3	10.4	3.6	4.2	5.4	8.9	18.0	12.2	4.2	4.1	17 135

D) All QMAs

	Month (% of total catch)												
Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total catch (t)
1989–90	8.3	7.2	7.2	7.7	9.8	12.5	8.2	7.6	12.3	4.8	7.5	6.9	20 500
1990–91	3.6	4.5	7.9	12.9	11.1	8.8	6.0	12.4	17.4	4.0	5.2	6.2	28 680
1991–92	5.0	5.1	12.4	12.8	6.5	9.1	9.0	15.3	12.4	7.7	1.9	2.7	37 970
1992–93	3.4	5.2	7.9	16.5	12.0	12.6	13.0	10.8	8.8	4.1	0.4	5.3	47 530
1993–94	6.4	5.2	10.2	13.4	4.6	3.7	5.6	9.5	11.5	14.0	7.0	8.8	43 280
1994–95	2.5	4.4	10.4	14.5	5.0	5.4	5.3	14.6	14.6	13.1	7.0	3.1	36 540
1995–96	1.6	1.0	5.9	15.4	10.2	9.8	12.1	10.6	5.8	15.7	6.0	5.9	34 840
1996–97	3.2	7.1	8.2	8.9	6.0	10.2	11.3	9.3	8.6	11.1	10.2	5.9	31 660
1997–98	4.8	4.2	10.6	12.1	9.1	9.1	19.2	7.9	4.9	4.0	5.1	9.0	34 920
1998–99	5.3	2.6	8.4	9.5	9.3	10.1	15.3	12.7	9.5	9.5	3.7	4.1	31 750
1999–00	13.2	5.1	9.9	15.3	7.0	15.7	9.5	1.6	10.3	3.0	2.5	7.0	20 230
2000–01	4.7	7.8	20.0	8.0	1.4	4.6	2.4	5.0	23.7	7.2	6.3	9.0	25 240
2001–02	9.7	8.7	27.1	4.1	1.4	3.2	8.3	6.1	15.4	5.7	3.2	6.9	30 880
2002–03	12.6	3.7	19.8	8.4	2.6	2.2	11.5	7.0	14.1	10.1	2.4	5.7	33 480
2003–04	18.2	6.9	25.9	4.2	0.2	0.8	1.2	7.6	16.3	6.8	4.7	7.0	33 320
mean	6.8	5.3	12.8	10.9	6.4	7.8	9.2	9.2	12.4	8.1	4.9	6.2	32 721

Appendix D: Species Composition, catch of jack mackerel, with top target species for JMA 1, 3 & 7.

	JMA 1				Catch (t)	JMA 3				Catch (t)	JMA 7			Catch (t)
Fishing year	Kahawai	Blue mackerel	Hoki	Jack mackerel	All species	Squid	Barracouta	Jack mackerel	All species		Barracouta	Hoki	Jack mackerel	All species
1989–90	500	300	0	800	1 700	600	1 200	1 300	4 700		700	400	12 100	13 200
1990–91	1 100	800	0	5 800	7 800	3 100	500	2 400	7 900		300	900	11 100	12 300
1991–92	300	300	0	5 900	6 700	2 000	1 000	3 200	7 000		200	1 100	22 500	23 800
1992–93	500	700	0	5 800	7 300	4 700	1 400	8 400	16 700		300	400	21 900	22 600
1993–94	700	800	0	11 400	13 000	2 000	400	4 800	9 100		600	2 100	18 300	21 000
1994–95	400	900	100	6 600	8 200	2 800	800	6 000	10 800		1 000	1 900	14 300	17 200
1995–96	300	200	200	5 200	6 200	6 000	1 900	8 300	18 000		500	1 800	8 100	10 400
1996–97	800	300	300	4 800	6 400	4 800	1 500	7 400	14 400		700	1 000	9 100	10 800
1997–98	300	200	100	5 100	5 800	1 200	1 500	11 400	14 500		200	300	13 900	14 400
1998–99	400	200	100	3 900	4 900	1 300	800	11 900	14 200		300	200	11 900	12 400
1999–00	400	100	0	2 200	2 900	1 500	1 200	7 000	10 000		100	100	6 800	7 000
2000–01	100	500	0	7 000	7 800	600	400	1 500	2 500		200	0	14 500	14 700
2001–02	100	200	100	4 600	5 200	1 100	500	2 700	4 400		400	0	20 800	21 200
2002–03	300	400	200	5 100	6 200	200	500	1 400	2 200		100	100	24 800	25 000
2003–04	300	100	300	6 000	6 900	100	200	200	600		200	300	25 200	25 700
mean	433	400	93	5 347	6 467	2 133	920	5 193	9 133		387	707	15 687	16 780