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Te Tautiaki i nga tini a Tangaroa

**Descriptive analysis of catch and effort data from New Zealand  
black cardinalfish (*Epigonus telescopus*) fisheries  
for the fishing years 1979–80 to 2002–03**

M. R. Dunn

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M. R. Dunn

NIWA  
Private Bag 14901  
Wellington

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## EXECUTIVE SUMMARY

Dunn, M.R. (2005). Descriptive analysis of catch and effort data from New Zealand black cardinalfish (*Epigonus telescopus*) fisheries for the fishing years 1979–80 to 2002–03.

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This report updates descriptive analyses of commercial catch and effort data for all the main black cardinalfish fisheries in the New Zealand Exclusive Economic Zone (EEZ) to the end of the 2002–03 fishing year. It also includes a description of one fishery outside the EEZ, on the northern Challenger Plateau and southern Lord Howe Rise. The distribution, catch, effort, and catch rate trends are described for each fishery.

Catches peaked during the last three fishing years in Wairarapa and North Colville. Recent catches were relatively high in Kaikoura, Tuaheni High, and Ritchie Hill and Rockgarden. Recent catches were relatively low in East Cape, Mercury-Colville, and White Island. There was no clear trend in catches for North Challenger or Lord Howe.

Exploitation began as a bycatch in other fisheries in the 1980s, with a target fishery developing in the 1990s. Targeted effort increased in recent years in Wairarapa and North Colville, and was relatively high in Tuaheni High, Ritchie Hill, and Rockgarden. There was no clear trend in targeted effort in other areas.

Most targeted fishing effort, and peak catch rates, were at depth classes between 600 and 899 m, except in Wairarapa, where peak catch rates were shallower, at 400–699 m. Several fisheries also exhibited a second peak in catch rates in deeper water, between 900 and 1199 m.

Catches of black cardinalfish were relatively low between June and August, with the exception of Tuaheni High, where most catches were taken between April and October, and Mercury-Colville, where catches were taken throughout the year.

In the target fisheries, catch rates were relatively high in recent years in Kaikoura, and increasing in Wairarapa, East Cape, and White Island. Catch rates were relatively low in Tuaheni High and Mercury-Colville, and there was no clear trend for Wairarapa, Ritchie Hill and Rockgarden, North Colville, and North Challenger and Lord Howe.

The use of unstandardised catch rates to indicate temporal or spatial trends in abundance may be confounded by changes in fleet composition, and trends in mean vessel length were apparent for five of the nine fisheries described.

## 1. INTRODUCTION

Black cardinalfish (*Epigonus telescopus*, Risso 1810), have been reported at depths between 75 and 1200 m in the North Atlantic, Southeast Atlantic, off southwest Africa, in the Indian Ocean, and in the southwest Pacific including the waters around New Zealand (Maugé & Mayer 1990). They have been reported throughout the New Zealand Exclusive Economic Zone (EEZ), with adult fish typically occurring at depths between 300 and 1100 m, and most commonly in mobile schools up to 150 m off the bottom over hills and rough ground (Field et al. 1997). The timing of spawning around New Zealand has not been described, but spawning takes place in spring in the North Atlantic, and the juveniles are pelagic (Maugé & Mayer 1990). Adult fish are known to feed on a range of fish and planktonic and benthic crustaceans (Maugé & Mayer 1990). Black cardinalfish are the only commercially exploited species of cardinalfish in New Zealand waters (Annala et al. 2004).

The exploitation of black cardinalfish within the New Zealand EEZ started as a bycatch in the early 1980s, with a targeted fishery also developing since the mid 1990s (Field et al. 1997). The species came into the Quota Management System (QMS) on 1<sup>st</sup> October 1998, and Total Allowable Commercial Catches (TACCs) were set for Quota Management Areas (QMAs) 2–8 (Figure 1). In the following year, TACCs were set for QMAs 1 and 9. No TACC has been set for QMA 10. None of the TACCs have been changed since their introduction (Annala et al. 2004). There have been no scientific studies to determine the number or boundaries of black cardinalfish stocks in New Zealand waters.

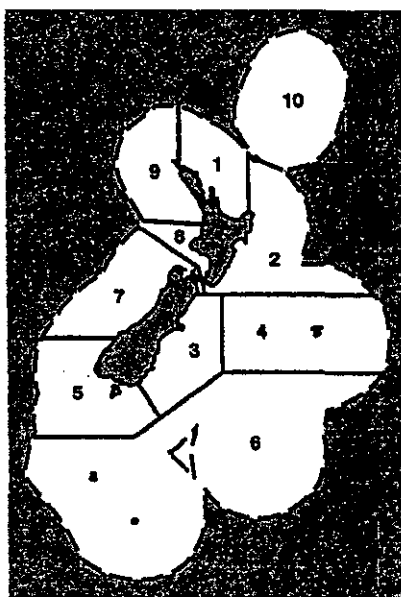


Figure 1: Location of Quota Management Areas (QMAs) for black cardinalfish within the New Zealand EEZ. Reproduced from Annala et al. (2004).

Catch and effort statistics for the black cardinalfish fisheries were first described by Field et al. (1997), for the fishing years 1982–83 to 1994–95 (New Zealand fishing years run from 1 October to 30 September). The largest fishery was identified on the east coast of the North Island (QMA 2), and an analysis of catch and effort, including a stock assessment, up until 1998–99 was conducted for this fishery in 2001 (Field & Clark 2001). The stock assessment indicated a heavily depleted stock, but was rejected by the Fisheries Plenary because the model biomass trajectory did not fit the catch per unit effort (CPUE) index well (Annala et al. 2004). Phillips (2002) then analysed catch, effort and CPUE in QMA 1 up until 2000–01. QMA 1 contains the second largest fishery, and the analysis indicated a substantial decline in CPUE, although the CPUE indices were not considered reliable indicators of stock abundance. There have been no other studies of New Zealand black cardinalfish fisheries, and consequently the status of the stocks is poorly known (Annala et al. 2004).

The only study of biological parameters for black cardinalfish used otolith samples from QMA 2 (Tracey et al. 2000). The use of otolith annuli counts for estimating age has not been validated for this species, but results indicated slow growth, low natural mortality rate, high age of recruitment (full recruitment at about 45 years), and high longevity (maximum age was 104 years, with mean c.v. of ageing estimated at 16.7%).

The work described in this report was carried out under Ministry of Fisheries (MFish) project MOF200301F objective 1: "To provide a descriptive analysis of the commercial catch and effort data from black cardinalfish fisheries, with the inclusion of data up to the end of the 2002–03 fishing year".

## 2. METHODS

### 2.1 Data sources

All records where black cardinalfish was specified as targeted and/or caught on Trawl Catch Effort Processing Returns (TCEPR) or Catch, Effort and Landing Returns (CELR) were extracted from the Ministry of Fisheries (MFish) Catch Effort Database. This data set covered the fishing years 1990–91 to 2002–03, with 14 270 TCEPR and 1015 CELR records, giving a total of 15 285 records, where each record was equivalent to one fishing event. The TCEPR forms gave tow-by-tow information, with location and estimated catch for each trawl. The CELR forms provided daily catch records with effort estimated as the number and total duration of tows in the day. CELR forms tended to be used by smaller inshore vessels. Larger deepwater vessels (over 28 m in length) were required to complete TCEPR forms. In addition, all records where black cardinalfish were caught were extracted from the Fisheries Statistics Unit Database (new\_fsu). This data set covered the fishing years 1979–80 to 1987–88, with a total of 842 records, where each record was equivalent to one fishing event. The total data set therefore consisted of 16 127 records.

The years 1988–89 and 1989–90 were therefore missing. Data for the 2002–03 fishing year may also be incomplete because forms not yet supplied by fishing vessels will not be entered into the Ministry database. All data were loaded into a relational (ACCESS) database at NIWA.

Records were selected using the 3-letter species code CDL, but the meaning of this code has varied over time. Before 01/10/1991 and after 15/07/1999 the code refers to *Epigonus telescopus*, but between those dates refers to *Epigonus* spp. Because *E. telescopus* is the only commercial species, this is likely to cause little or no bias.

### 2.2 Data grooming and analysis

Data were error-checked for obvious mistakes in the following fields:

- Bottom depth (checked where more than 1500 m or less than 200 m).
- Position (checked where further south than 49° S, further north than 30° S, further east than 175° W, and further west than 160° E; and where large differences in start and finish coordinates).
- Estimated trawl speed (calculated as distance (from shoot and haul positions) divided by duration (from shoot and haul times): checked where more than 5 kts or less than 1.5 kts).
- Duration (checked for TCEPR records where duration more than 10 hours and estimated trawl speed more than 2 kts different from recorded trawl speed).
- Vessel length (checked for consistency).

Records were amended where typing or recording mistakes could be resolved (e.g., by examining that vessel's tows in sequence). Records containing errors that could not be resolved or corrected were excluded from further analyses. Of the total data set of 16 127 records, 65 records had errors which

were corrected, and 282 had errors which could not be resolved and were excluded from further analysis. The groomed dataset consisted of 15 845 records (13 991 TCEPR, 1015 CELR, 838 new\_fsu).

In this report, vessel length has been used to identify large-scale changes in vessel catching composition. Vessel length was used rather than vessel power or tonnage because the latter two fields contained a greater number of clear errors and inconsistencies, and there was insufficient time to make checks and corrections.

According to MFish (2003), "the criteria for recording the fishing method codes for *bottom trawl* and *mid-water trawl* are not clear, and there is no legal definition of the difference between a bottom trawl and a mid-water trawl". Before 1989, a method code for *single trawl* was also used, which may have been either a bottom or mid-water trawl. However, almost all catches of black cardinalfish have been reported to the code *bottom trawl* (Section 3.1: Table 1). Therefore, in subsequent analyses (Sections 3.2 to 3.7) the data for *single trawl*, *midwater trawl*, and *bottom trawl* have been combined and treated as a single method code, *trawl*.

All estimates of trawl catch rates use *t/tow* rather than *t/hour*. This because most fishing was known to take place on aggregations, where *t/hour* has less meaning (Field et al. 1997). Patterns in the catch rate (*t/tow*) by depth have been smoothed by summing catch and effort for 100 m depth bins (e.g., 200–299 m indicates a depth greater or equal to 200 m and less than 300 m).

Patterns of catch by month have been presented as bubble plots, in which the catches have been normalised across all years. This means the catch in each year/month is presented as a proportion of the maximum. The maximum is indicated in the title for each plot.

A known but unquantified source of mortality for black cardinalfish has been the discarding at sea of this species whilst target fishing for higher value species (Annala et al. 2003). This study has not incorporated any adjustments to catch levels for these discards.

The following description of the overall fishery (Section 3.1) uses all records in the groomed data set (15 845 records). The subsequent sections describe the fisheries in specific areas. These areas are defined in Section 3.2, and the fishery descriptions are then presented in Sections 3.3 to 3.7. The specific fishery descriptions use the groomed data set, but also only those records where position details were available (as positional data were necessary to select by area). This selection did not reduce the number of TCEPR records (13 991), as TCEPR records all contain positional data, but reduced the number of new\_fsu records from 838 to 521, and the CELR number of records from 1015 to 50.

### 3. RESULTS

#### 3.1 Overall fishery

Almost all estimated catches have been taken using trawls (more than 98%; Table 1), of which almost all were reported using the code *Bottom trawl* (about 97%), with *Midwater trawl* accounting for a maximum of 15% in 1991–92, and 2.4% overall. The code *Single trawl* accounted only for 0.2% of total trawl catches. As described in the methods (Section 2.2), the method codes *bottom trawl*, *midwater trawl* and *single trawl* were combined in subsequent analyses.

The estimated catches were lower than the reported landings for all years except 1993–94, 1998–99, and 2000–01 (Table 2). However, there is a linear relationship between the estimated catches and the reported landings ( $R^2=0.92$ ), with the estimated catches on average 58% of the landings until 1987–88, and 90% since 1990–91.

**Table 1: Estimated catches of black cardinalfish by fishing method from 1979-80 to 2002-03, rounded to the nearest tonne. \* missing data; “-” not applicable.**

Fishing year	Bottom trawl	Mid-water trawl	Single trawl	Bottom longline	Other
1979-80	35	0	0	0	0
1980-81	0	0	8	0	0
1981-82	0	0	22	0	0
1982-83	90	0	0	0	0
1983-84	125	0	0	0	0
1984-85	388	0	0	0	0
1985-86	275	0	3	0	0
1986-87	749	0	43	0	0
1987-88	1 232	0	12	0	0
1988-89*	-	-	-	-	-
1989-90*	-	-	-	-	-
1990-91	4 136	71	0	1	4
1991-92	1 383	249	0	2	3
1992-93	2 013	147	0	<1	1
1993-94	3 791	109	0	1	14
1994-95	3 439	73	0	1	1
1995-96	3 407	17	0	1	1
1996-97	4 044	53	0	<1	<1
1997-98	2 335	61	0	<1	<1
1998-99	2 269	57	0	<1	4
1999-2000	3 122	37	0	<1	<1
2000-01	2 254	8	0	<1	<1
2001-02	2 327	56	0	1	1
2002-03	2 676	58	0	<1	2

The estimated catches from TCEPR records allow analysis on a tow-by-tow basis, but it is mandatory to report catch weights on TCEPR forms only for the “top five” species (meaning the five species with greatest weight or value). Black cardinalfish are unlikely to be in the top five for all tows, and as a consequence the TCEPR data underestimate true black cardinalfish catches from these trips. This source of error is the most likely cause for the estimated catch being lower than the reported landings. Since 1991-92, almost all estimated catches have been reported on TCEPR forms, approaching 100% coverage in the last three fishing years (Table 2).

Whilst the catches from the groomed data set are lower than those given in the Plenary document (Annala et al. 2004), the proportion of the catch taken from each QMA is similar, with the greatest catches in QMA 2, then QMA 1, QMA 3 and QMA 7 (Table 3). Within QMAs, the pattern of catches by fishing year is also similar, although there are a few exceptions (Table 3). The Plenary catch for QMA 1 in 1998-99 is 24 t, whereas the catch from the groomed data set is 621 t. The pattern of catches in earlier years (before 1988-89: data from new\_fsu) is also different, for example in QMA 3 the large Plenary catch in 1984-85 is not present in the groomed data set, and similarly the large Plenary catch in QMA 4 in 1997-98 is also not present. However, in general the patterns of catch in the groomed data set are similar to those given in the Plenary document.



**Table 2: Summary of estimated catches (to the nearest tonne) of black cardinalfish by catch-effort form type, and the catches from TCEPR forms as a percentage of catches from TCEPR+CELR forms between 1990–91 and 2002–03. The “reported landings” are reproduced from the Fisheries Plenary (Annala et al. 2004), and are the best estimate of black cardinalfish catches for the period 1982–83 to 2002–03, taken from various sources. \* missing data; “–” not applicable.**

Fishing year	FSU	CELR	TCEPR	Total estimated catch	% of total estimated catch on TCEPR forms	Reported landings
1979–80	35	–	–	35	–	–
1980–81	8	–	–	8	–	–
1981–82	22	–	–	22	–	–
1982–83	90	–	–	90	–	78
1983–84	125	–	–	125	–	220
1984–85	388	–	–	388	–	532
1985–86	278	–	–	278	–	292
1986–87	792	–	–	792	–	1 814
1987–88	1 244	–	–	1 244	–	1 638
1988–89*	–	–	–	–	–	1 800
1989–90*	–	–	–	–	–	2 385
1990–91	–	1 276	2 935	4 211	69.7	4 311
1991–92	–	168	1 467	1 635	89.7	1 838
1992–93	–	150	2 011	2 161	93.1	2 366
1993–94	–	188	3 726	3 914	95.2	3 801
1994–95	–	226	3 286	3 513	93.6	3 710
1995–96	–	272	3 169	3 441	92.1	4 490
1996–97	–	287	4 048	4 335	93.4	4 567
1997–98	–	64	2 333	2 397	97.3	2 743
1998–99	–	72	2 258	2 330	96.9	1 921
1999–2000	–	96	3 064	3 160	96.9	4 377
2000–01	–	7	2 255	2 262	99.7	2 213
2001–02	–	2	2 382	2 384	99.9	2 839
2002–03	–	8	2 728	2 736	99.7	2 996

### 3.2 Definition of fishery areas

Five main fishery areas were determined from examination of the overall patterns of catches over time (presented as an animation to the MFish Deepwater Fisheries Assessment Working Group, and summarised in Figure 2), and two of these areas were also subdivided. The fishery areas were:

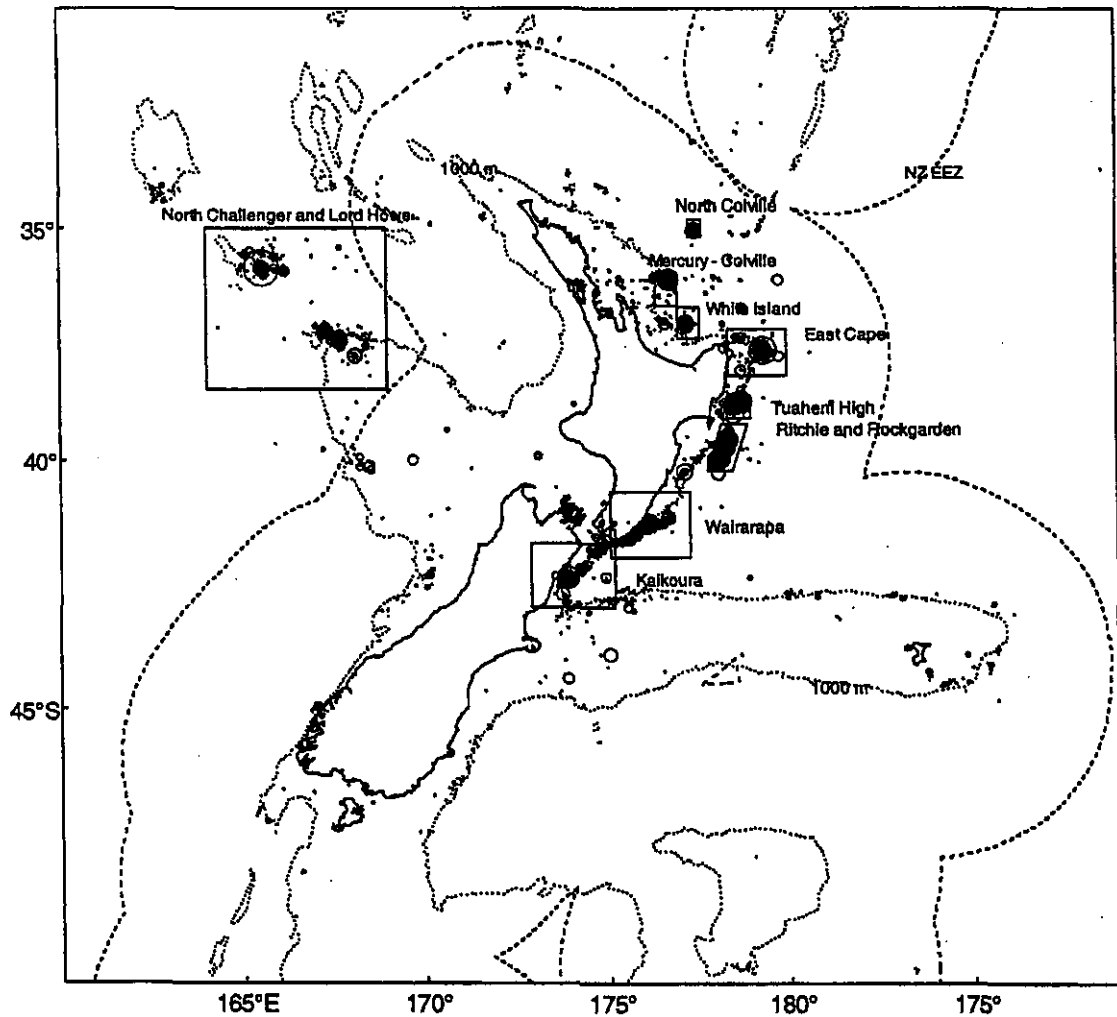
1. Kaikoura. The area between 172.9° E and 175.2° E, and between 41.7° S and 43.1° S. Catches from this area are included in QMA 2 and QMA 3.
2. Wairarapa. The area between 175.1° E and 177.3° E, and between 40.65° S and 42° S. Catches from this areas are included in QMA 2.
3. East Coast. Catches from this area are included in QMA 2.
  - a. Ritchie Hill and the Rockgarden. The area bounded by points at 178.2° E 39.2° S, 177.8° E 40.2° S, 178.5° E 40.2° S and 178.9° E 39.2° S.
  - b. Tuaheni High. The area between 178.35° E and 179° E, and between 38.6° S and 39.1° S.
  - c. East Cape. The area between 178.4° E and 180°, and between 37.2° S and 38.2° S.
4. Bay of Plenty. Catches from this area are included in QMA 1.
  - a. North Colville. The area between 177.3° E and 177.7° E, and between 34.8° S and 35.2° S.
  - b. Mercury-Colville. The area between 176.4° E and 177° E, and between 36° S and 36.7° S.
  - c. White Island. The area between 177° E and 177.6° E, and between 36.75° S and 37.4° S.
5. North Challenger and Lord Howe. The area between 164° E and 169° E, and between 35° S and 38.5° S. This area is outside the New Zealand Exclusive Economic Zone (EEZ).

**Table 3: Summary of estimated catches (to the nearest tonne) of black cardinalfish by Quota Management Area (QMA), also showing the Total Allowable Commercial Catch (TACC) in the last row. N/A includes catches where positional errors indicate the catch was taken on land. \* missing data; “-” not applicable.**

Fishing year	QMA										N/A	Outside
	1	2	3	4	5	6	7	8	9	10		
1979–80	0	0	35	0	0	0	0	0	0	0	0	0
1980–81	0	0	<1	0	0	0	0	0	0	0	0	8
1981–82	0	0	22	0	0	0	0	0	0	0	0	0
1982–83	0	90	<1	0	0	0	0	0	0	0	0	0
1983–84	0	97	2	0	0	0	<1	0	0	0	0	0
1984–85	0	111	60	0	0	0	<1	0	0	0	0	0
1985–86	0	16	41	1	0	0	2	0	0	0	0	<1
1986–87	0	60	44	1	0	<1	<1	0	0	0	0	0
1987–88	0	786	23	0	0	0	1	0	0	0	0	2
1988–89*	-	-	-	-	-	-	-	-	-	-	-	-
1989–90*	-	-	-	-	-	-	-	-	-	-	-	-
1990–91	<1	2 450	524	5	2	0	<1	0	0	0	4	0
1991–92	0	1 242	185	15	1	0	15	0	0	0	0	11
1992–93	<1	1 362	399	1	0	0	1	<1	0	0	56	192
1993–94	98	2 368	140	3	3	0	38	0	0	3	2	1 070
1994–95	1 078	1 882	50	1	0	0	18	6	0	0	22	229
1995–96	1 284	1 609	21	4	8	0	30	0	<1	6	0	271
1996–97	1 872	1 626	41	8	0	0	19	0	0	0	4	479
1997–98	1 088	1 024	41	13	0	1	25	0	0	<1	0	142
1998–99	621	1 077	160	32	0	0	20	0	<1	0	0	367
1999–2000	859	1 854	187	19	0	<1	14	0	9	2	0	153
2000–01	214	1 061	91	29	67	0	<1	0	18	0	0	776
2001–02	374	1 614	137	13	12	0	<1	0	3	0	0	228
2002–03	529	1 712	169	64	2	0	25	0	2	0	<1	226
TACC	1 200	2 223	196	5	2	1	39	0	4	-	-	-

In previous reports, Wairarapa and East Coast were analysed together as the QMA 2 fishery (Field & Clark 2001). An attempt has been made to split the Bay of Plenty (QMA 1) fishery in the same way as Phillips (2002), although details of the subarea boundaries used were not previously specified, and so any comparisons are only approximate. In addition to updating fisheries previously described, this report also gives the first detailed description of the Kaikoura fishery, North Colville fishery, and of the North Challenger and Lord Howe fishery.

It is important to note that the North Challenger and Lord Howe fishery was included only because it falls close to the EEZ, and the absence of fishery descriptions for other areas outside the EEZ does not imply that they do not exist (for example, preliminary analyses indicated some catches were also taken outside the EEZ on the Louisville Seamount Chain, east of 175° W). The description of fisheries outside the EEZ was not a contracted part of this study.



**Figure 1: Unstandardised estimated catch rates (t/tow) of black cardinalfish for tows from all trawls from 1979–80 to 2002–03, with circle area proportional to catch rate (maximum = 236 t/tow), showing the main fishery areas, the position of the 1000 m isobath, and the New Zealand EEZ.**

The data set used in the subsequent fishery descriptions should be fairly representative of the fishery for the period after 1989–90. For this period, the catches included in the fishery descriptions represent about 79% of the catches as given in the Plenary document (Annala et al. 2004), as they represent 88% of the total catches from the TCEPR and CELR forms (Table 4), which in turn represent 90% of the catches given in the Plenary document (see Table 2).

However, the descriptions may be poorly representative for 1979–80 to 1987–88, as the fishery descriptions represent only about 45% of the total catches from the new\_fsu data (Table 4), and therefore represent only about 26% of the catches as given in the Plenary document.

**Table 4: Catches by fishery area (t) and fishing year for records where positional data were available, the total of these catches, and this total as a percentage of the total estimated catch (sum of TCEPR + CELR + new\_fsu). A percentage less than 100% indicates records (and thus catches) were lost from the following fishery descriptions because the records did not have positional data. \* data missing; “-” not applicable.**

Fishing year	Kaikoura	Wairarapa	East Coast	Bay of Plenty	North Challenger and Lord Howe	Total	% of total estimated catches
1979–80	1	0	0	0	0	1	1
1980–81	<1	0	0	0	8	8	100
1981–82	0	0	0	0	0	0	0
1982–83	0	90	0	0	0	90	100
1983–84	1	97	0	0	0	97	78
1984–85	50	74	23	0	0	147	38
1985–86	36	15	1	0	0	52	19
1986–87	35	26	33	0	0	94	12
1987–88	24	6	698	0	2	730	59
1988–89*	-	-	-	-	-	-	-
1989–90*	-	-	-	-	-	-	-
1990–91	514	114	2 307	0	0	2 935	70
1991–92	185	208	1 032	0	10	1 435	88
1992–93	422	246	1 073	0	179	1 920	89
1993–94	170	384	1 856	98	1 044	3 552	91
1994–95	118	270	1 488	1 016	227	3 120	89
1995–96	21	82	1 488	1 265	244	3 100	90
1996–97	75	346	1 182	1 859	444	3 907	90
1997–98	37	29	934	1 067	142	2 209	92
1998–99	155	127	904	619	301	2 107	90
1999–2000	206	161	1 530	853	151	2 902	92
2000–01	84	196	838	204	485	1 807	80
2001–02	168	163	1 397	368	159	2 255	95
2002–03	182	266	1 362	490	223	2 524	92

### 3.3 Kaikoura

#### 3.3.1 The fishery

The earliest reported estimated catches of black cardinalfish were taken in the Kaikoura fishery, although initially only as a bycatch. The first targeted fishing was reported later, in 1984–85 (Table 5). With the exception of 1990–91, catches have been relatively low from the target fishery, and most catches have been taken as a bycatch in the hoki fishery, with relatively large catches taking place during the last five fishing years. Bycatch of black cardinalfish in the orange roughy fishery was relatively high only in the 1980s and early 1990s, and effectively ceased in recent years.

#### 3.3.2 Location

Most effort targeting black cardinalfish has been in depth classes between 600 and 799 m, although peak catch rates occurred slightly deeper, in the depth class 800–899 m (Figure 3). Despite different patterns of effort by depth, peak catch rates were also at 800–899 m in the hoki and orange roughy target fisheries. Catch rates were relatively low in all fisheries at depths greater than 1000 m, and in the target fishery at depths less than 600 m and greater than 900 m.

Most catches have been taken in two specific areas, one at about 174° 50' E and 41° 50' S, and one further south at about 174° E and 42° 30' S (Figure 4). The latter area has been more frequently fished, and was the main fishing area during the last three fishing years. Note that there may be some errors in

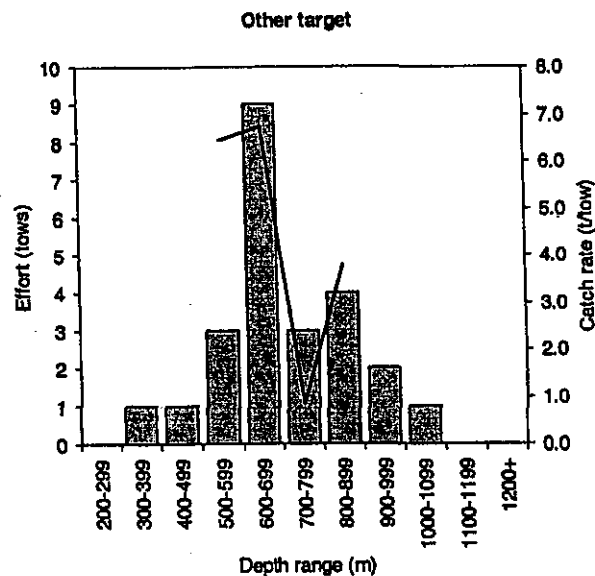
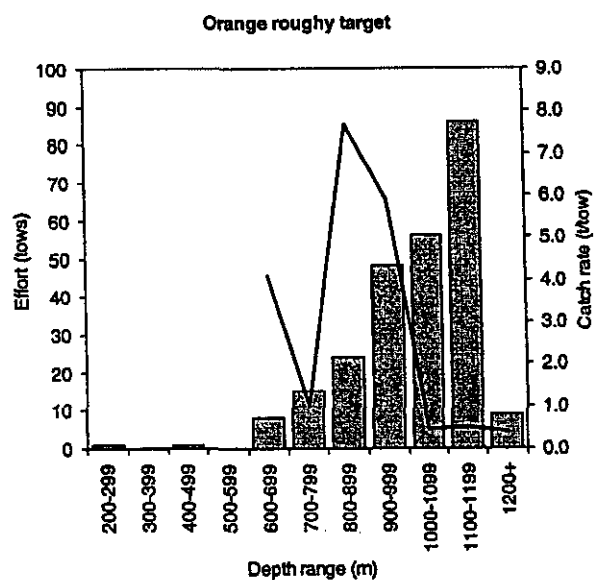
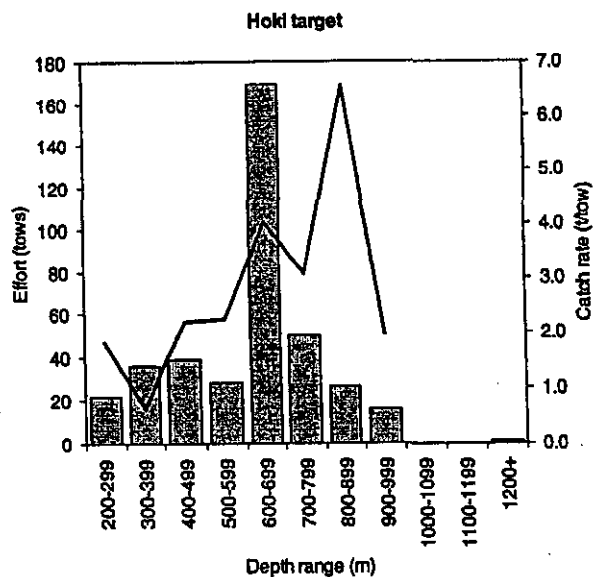
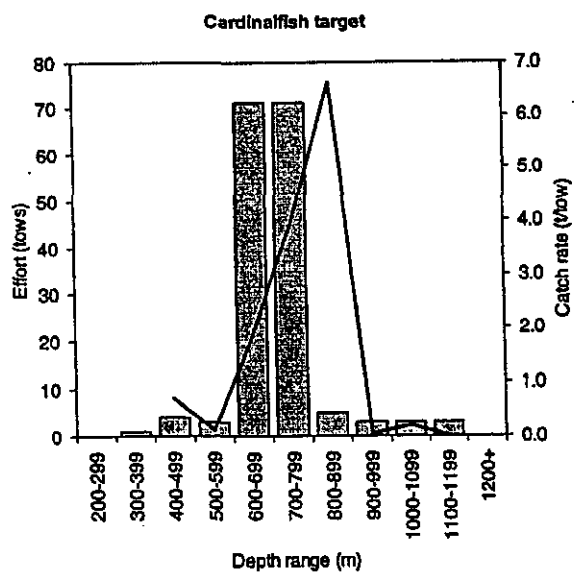
**Table 5: Estimated trawl catches (t) of black cardinalfish by target species for the Kaikoura fishery.**  
**\* data missing; “-” not applicable.**

Fishing year	Unspecified	Alfonsino	Black cardinalfish	Hoki	Orange roughy	Oreos	Smooth oreo
1979–80	0.5	0	0	0	0	0	0
1980–81	0	0	0	0.5	0	0	0
1981–82	0	0	0	0	0	0	0
1982–83	0	0	0	0	0	0	0
1983–84	0	0	0	0	0.7	0	0
1984–85	0	0	32.5	0	17.2	0	0
1985–86	0	0	1.7	0.1	34.0	0	0
1986–87	0	0	0	33.0	1.9	0	0
1987–88	0	0	0	0	24.2	0	0
1988–89*	–	–	–	–	–	–	–
1989–90*	–	–	–	–	–	–	–
1990–91	0	0	269.4	148.5	23.8	0	72.9
1991–92	0	0	62.2	51.4	70.8	0	0.5
1992–93	0	1.8	0.9	172.0	247.3	0	0
1993–94	0	0.8	4.0	4.4	130.4	30.0	<0.1
1994–95	0	33.7	0	2.8	79.1	2.5	<0.1
1995–96	0	0	<0.1	20.5	0.3	0	0
1996–97	0	0	21.5	53.3	0	0.2	0
1997–98	0	0	0	37.4	0	0	0
1998–99	0	0	0	140.7	14.0	0	0
1999–2000	0	0	32.7	173.6	<0.1	0	0
2000–01	0	0	0	84.2	<0.1	0	0
2001–02	0	0	24.1	144.1	<0.1	0	0
2002–03	0	0	0.4	181.7	0	0	0

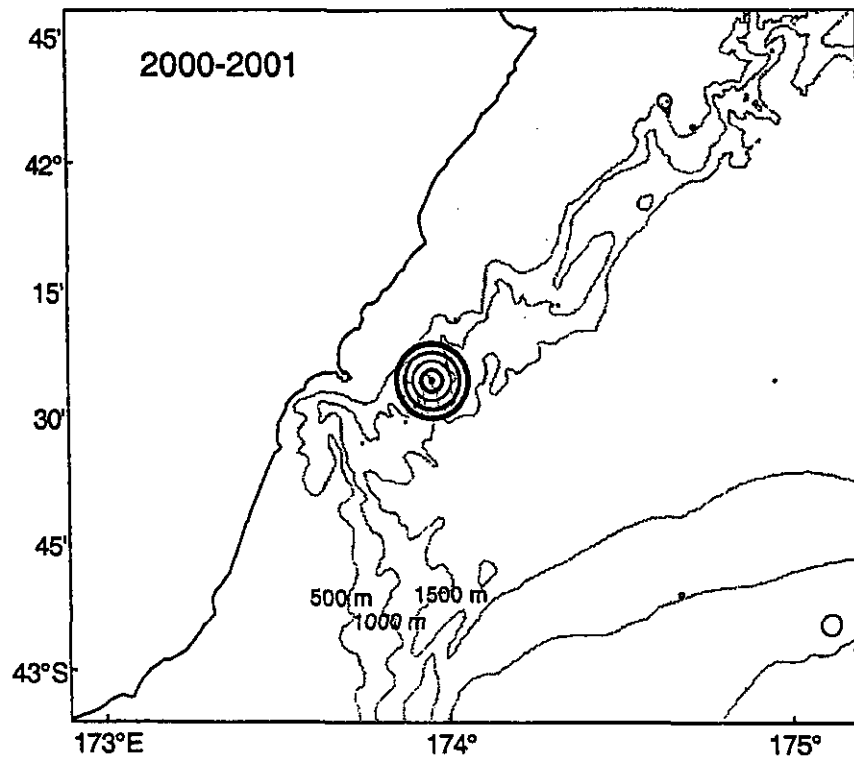
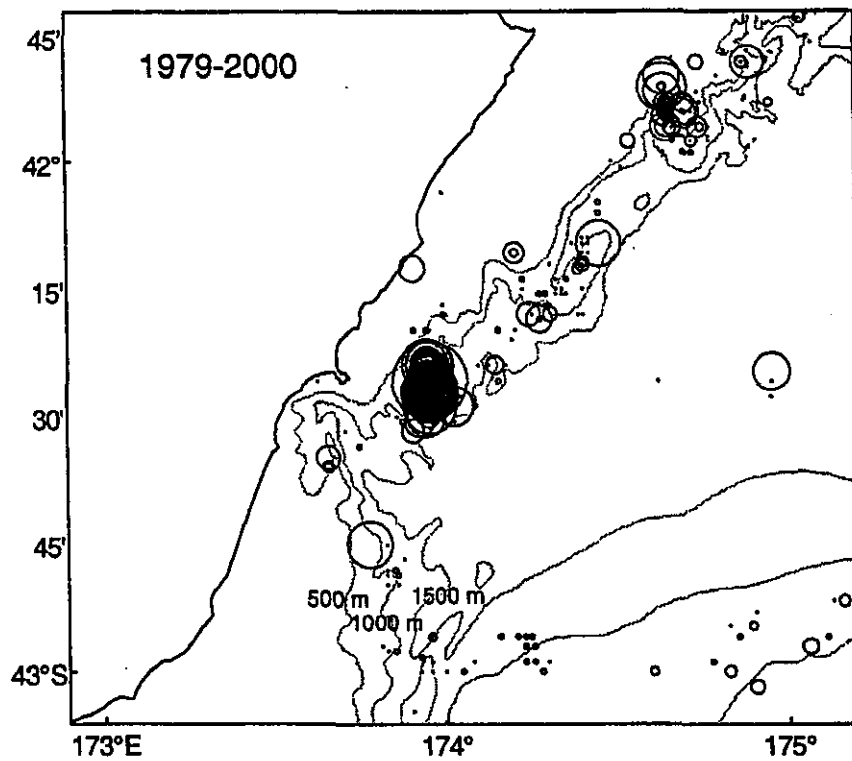
the positional data, as the catches at about 175° E and 42° 20' S may really have been from the fishery at the same latitude but 174° E.

### 3.3.3 Seasonality

The seasonal pattern of catches was generally similar in the black cardinalfish and orange roughy target fisheries, with most catches taken between November and April, although some smaller catches were also taken by the orange roughy target fishery between May and September (Figure 5). After the early 1990s, catches from these two fisheries decreased, and most of the catches were taken in the hoki fishery. In the hoki fishery, catches of black cardinalfish were taken over a wider part of the year, but decreased in July and August, and with peak catches generally between September and March. The decrease in catches during July and August is likely to be associated with the vessels focusing effort elsewhere, specifically in the hoki spawning fishery.



**Figure 3: Total estimated effort (no. tows; bars) and catch rates (t/tow; lines) by depth class and target species for the Kaikoura fishery.**



**Figure 4: Estimated trawl catch rate (t/tow) of black cardinalfish by fishing position and fishing year for the Kaikoura fishery. Catch rate proportional to circle area (maximum 85 t/tow).**

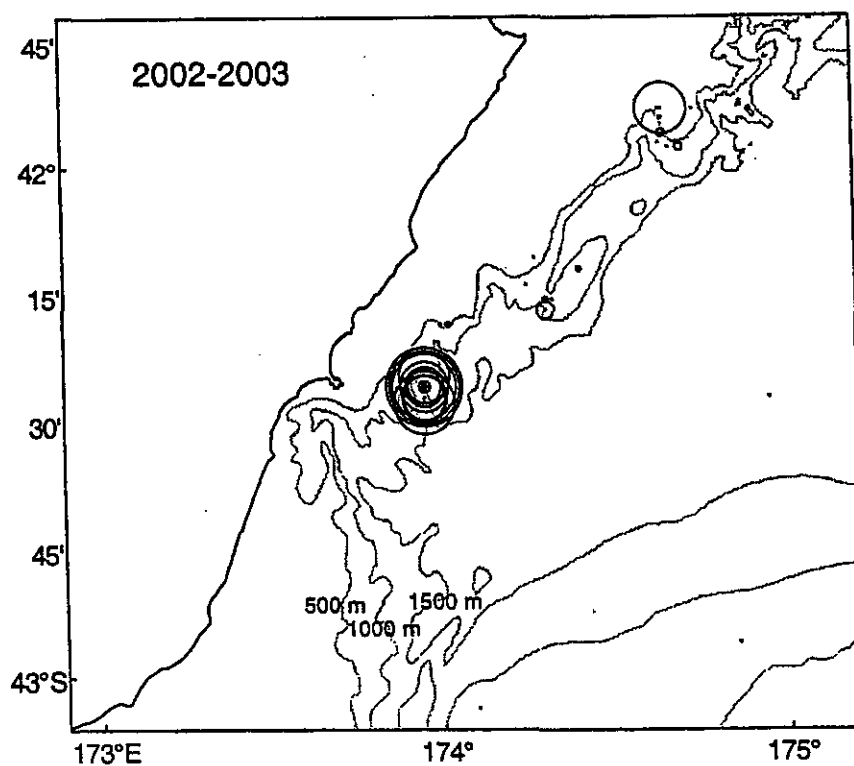
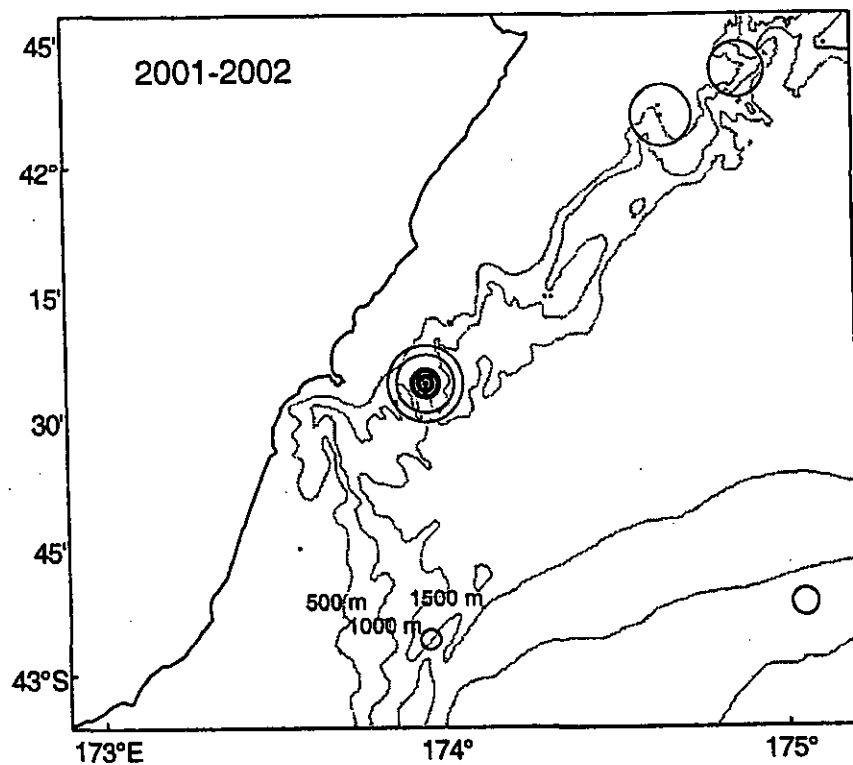


Figure 4 (cont.): Estimated trawl catch rate (t/tow) of black cardinalfish by fishing position and fishing year for the Kaikoura fishery. Catch rate proportional to circle area (maximum 85 t/tow).



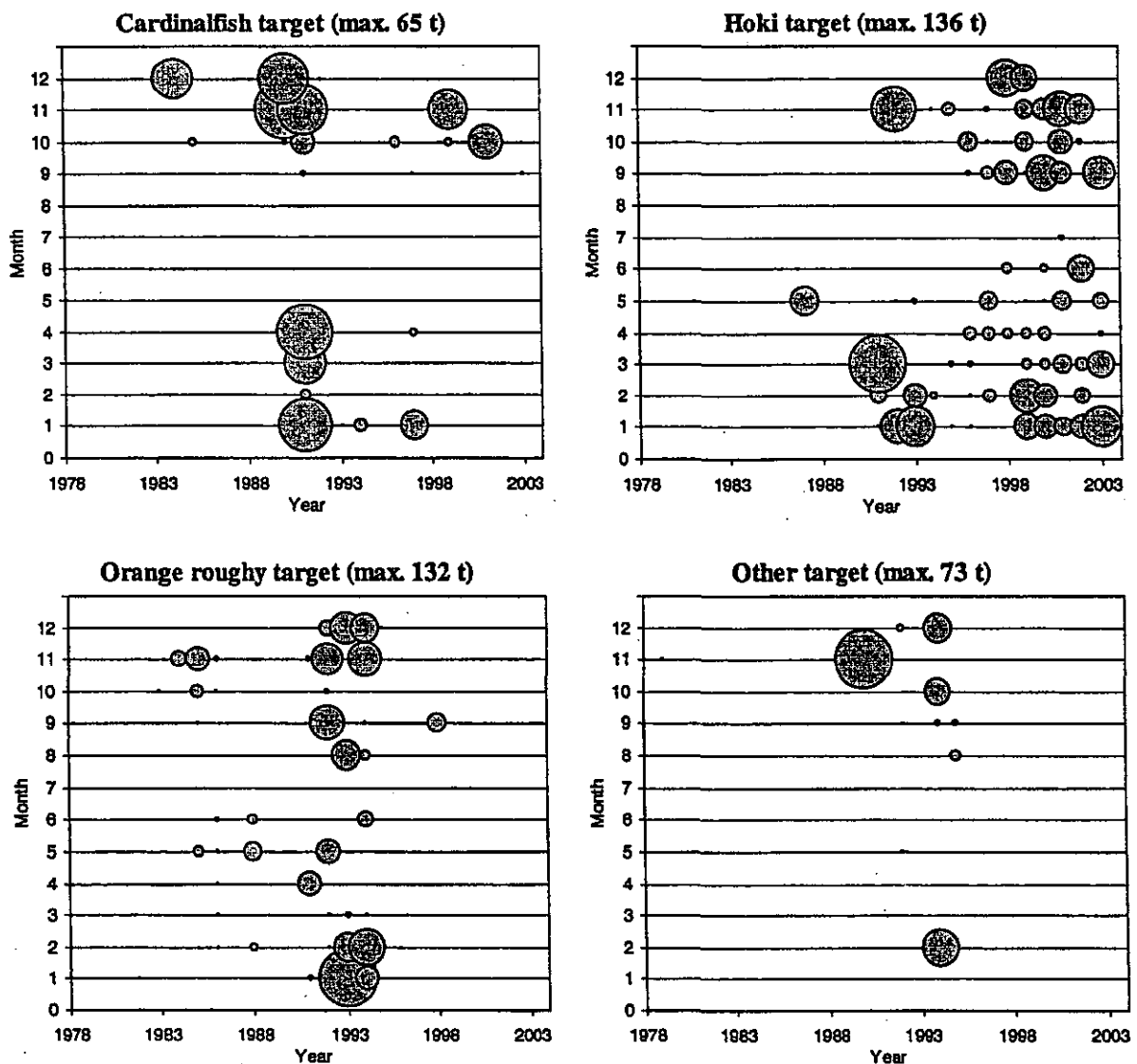


Figure 5: Bubble plots showing normalised estimated catches of black cardinalfish by month and year, for different target species for the Kalkoura fishery, with the maximum catch value shown in brackets (t).

### 3.3.4 Catch and effort trends

A relatively small number of vessels have operated in the black cardinalfish target fishery off Kaikoura, with only one vessel active in 2002–03 (Table 6). The mean length of the vessels also increased between 1990–91 and 2002–03, with the smallest vessel in the last two fishing years being larger than the largest vessel in the first five fishing years.

There are insufficient data to describe catch and effort in the target fishery (Table 6). The catch rates from the fisheries targeting other species were high in the first half of the 1990s, then decreased to a low in 1997–98, during which catch rates were of a similar magnitude to pre-1989 estimates, and then increased steadily from 1997–98 to 2002–03. Catches followed a similar overall pattern to catch rates. Effort levels were more variable, but the overall trend is increasing.

**Table 6: Estimated catch (t), number of tows, and catch rate (t/tow) by fishing year for vessels targeting black cardinalfish, or targeting other species, for the Kaikoura fishery, with the number of vessels and vessel length statistics for the black cardinalfish target fishery. Catch rate calculated only for a minimum of 20 tows. \* missing data; “-” not applicable.**

Fishing year	No. vessels	Vessel length (m)			Black cardinalfish target			Other-target		
		min	mean	max	No. tows	Catch (t)	t/tow	No. tows	Catch (t)	t/tow
1979–80	0	–	–	–	–	–	–	1	0.5	–
1980–81	0	–	–	–	–	–	–	1	0.5	–
1981–82	0	–	–	–	–	–	–	–	–	–
1982–83	0	–	–	–	–	–	–	–	–	–
1983–84	0	–	–	–	–	–	–	6	0.7	–
1984–85	1	–	–	–	1	32.5	–	20	17.2	0.9
1985–86	2	–	–	–	2	1.7	–	55	34.2	0.6
1986–87	0	–	–	–	–	–	–	22	34.9	1.6
1987–88	0	–	–	–	–	–	–	60	24.2	0.4
1988–89*	–	–	–	–	–	–	–	–	–	–
1989–90*	–	–	–	–	–	–	–	–	–	–
1990–91	5	23.8	33.3	35.6	82	269.4	3.3	31	245.1	7.9
1991–92	3	27.2	34.8	35.6	20	62.2	3.1	39	122.7	3.1
1992–93	2	27.6	31.5	34.4	7	0.9	–	52	421.1	8.1
1993–94	2	30.6	31.6	35.6	5	4.0	–	33	165.7	5.0
1994–95	1	27.6	27.6	27.6	3	0	–	18	118.1	–
1995–96	2	34.3	35.5	42.4	7	0	–	16	20.8	–
1996–97	4	30.6	34.8	41.7	14	21.5	–	35	53.5	1.5
1997–98	2	28.0	31.2	34.3	6	0	–	35	37.4	1.1
1998–99	2	34.3	35.7	37.0	2	0	–	64	154.7	2.4
1999–2000	3	34.3	36.3	42.7	14	32.7	–	56	173.7	3.1
2000–01	0	–	–	–	0	–	–	37	84.2	2.3
2001–02	3	36.6	38.3	42.7	4	24.1	–	39	144.1	3.7
2002–03	1	38.0	38.0	38.0	1	0.4	–	44	181.7	4.1

### 3.4 Wairarapa

#### 3.4.1 The fishery

The fishery off Wairarapa was the second to report catches of black cardinalfish, but the first to develop a target fishery, in which catches were first reported in 1982–83 (Table 7). However, no further targeted fishing was reported until 1990–91. The annual pattern of catches has been similar in the orange roughy and alfonsino target fisheries, with relatively high catches taken in the early and mid 1990s, and a decline thereafter. The largest catches were taken in the black cardinalfish target fishery, and the proportion of the total catch taken in this fishery has been increasing since the mid 1990s, with the largest catch reported in the 2002–03 fishing year.

#### 3.4.2 Location

Most effort targeting black cardinalfish has been in the depth class 500–599 m, although peak catch rates also occurred slightly shallower, from 400 to 699 m (Figure 6). A second, smaller peak in catch rates also occurred deeper, in the depth class 900–999 m. The effort in the alfonsino fishery was greater in shallower depths, and in the orange roughy fishery greater in deeper depths, but both also indicate higher catch rates shallower than 700 m, and for alfonsino a decline in catch rates shallower than 500 m. However, neither indicate a second peak in catch rates in deeper water.

**Table 7: Estimated trawl catches (t) of black cardinalfish by target species for the Wairarapa fishery.**  
**\* data missing; “-” not applicable.**

Fishing year	Bluenose	Alfonsino	Black cardinalfish	Hoki	Orange roughy	Other <sup>1</sup>
1982–83	0	7.5	53.4	0	29.0	0
1983–84	0	0	0	0	96.7	0
1984–85	0	10.0	0	0	61.2	3.0
1985–86	0	0.1	0	0	14.3	0.4
1986–87	0	3.5	0	0	22.6	0
1987–88	0	1.6	0	0	4.0	0
1988–89*	–	–	–	–	–	–
1989–90*	–	–	–	–	–	–
1990–91	2.3	0.2	46.3	15.0	50.1	0
1991–92	0	28.7	62.0	5.3	112.0	0
1992–93	0	99.7	125.4	0	20.5	0
1993–94	0	78.4	130.9	22.8	151.8	0
1994–95	0	173.7	63.1	0.1	33.0	0
1995–96	0	2.3	50.3	5.0	24.3	0
1996–97	25.0	20.1	208.2	64.3	6.3	22.2
1997–98	0	2.0	18.6	3.8	4.8	0
1998–99	0	0.0	107.8	8.7	5.1	5.8
1999–2000	31.0	0.0	112.2	12.7	5.2	0
2000–01	10.0	42.0	94.4	47.2	2.9	0
2001–02	0	18.6	128.0	15.7	0.5	0.2
2002–03	0	32.0	228.9	5.4	<0.1	0

1. Other target species includes unspecified, capro dory, mixed oreos, smooth oreo, and warehou. Capro dory (species code CDO) may be a typing error for black cardinalfish (CDL).

Most of the catches have been taken in three areas, one on the area of relatively shallow ground (less than 1000 m depth) surrounded by deeper water at about 176° 40' E and 41° 15' S (labelled “offshore” in Figure 7, fishing year 2000–01), one inshore at about 176 15° E and 41 20' °S (labelled “inshore”), and one over a wider area further south, centred around about 175 45° E and 41 35' °S (labelled “south”). In the last three fishing years most catches have been taken in the inshore area, which appears to have been the focus for black cardinalfish catches.

### 3.4.3 Seasonality

Catches of black cardinalfish in the target fishery were made throughout the year, but were relatively low in July and August (Figure 8). The catches between February and April were relatively high in 1993 and since 2001, but were relatively low or absent in the intervening years. Catches from the orange roughy target fisheries were mostly taken from September through to February. This general pattern, with a decrease around July, was also seen for the black cardinalfish bycatch in the alfonsino and other species target fisheries. Compared to the fisheries targeting other species, catches from the black cardinalfish target fishery were relatively high in the months of May and June.

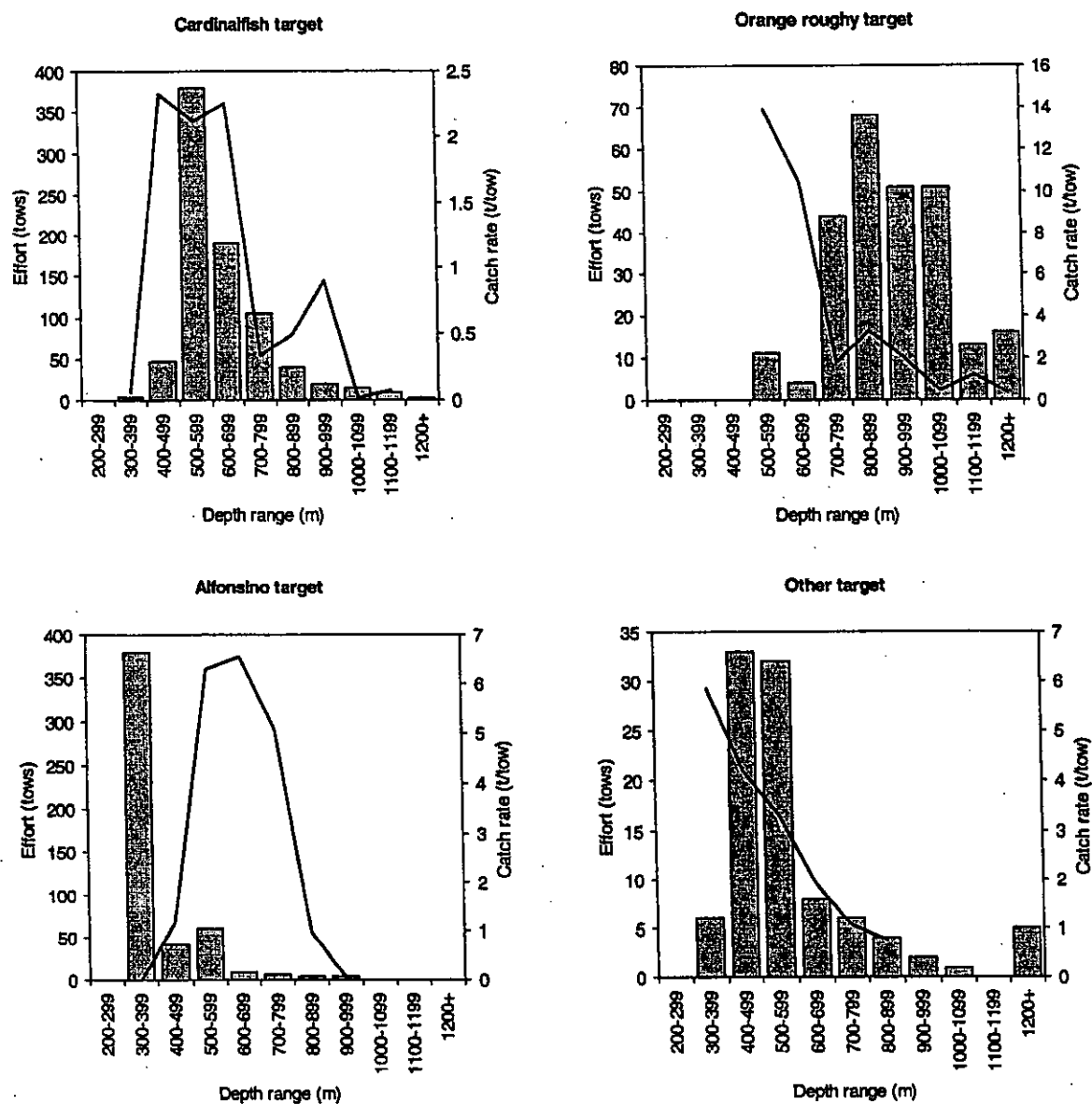


Figure 6: Total estimated effort (no. tows; bars) and catch rates (t/tow; lines) by depth class and target species for the Wairarapa fishery.

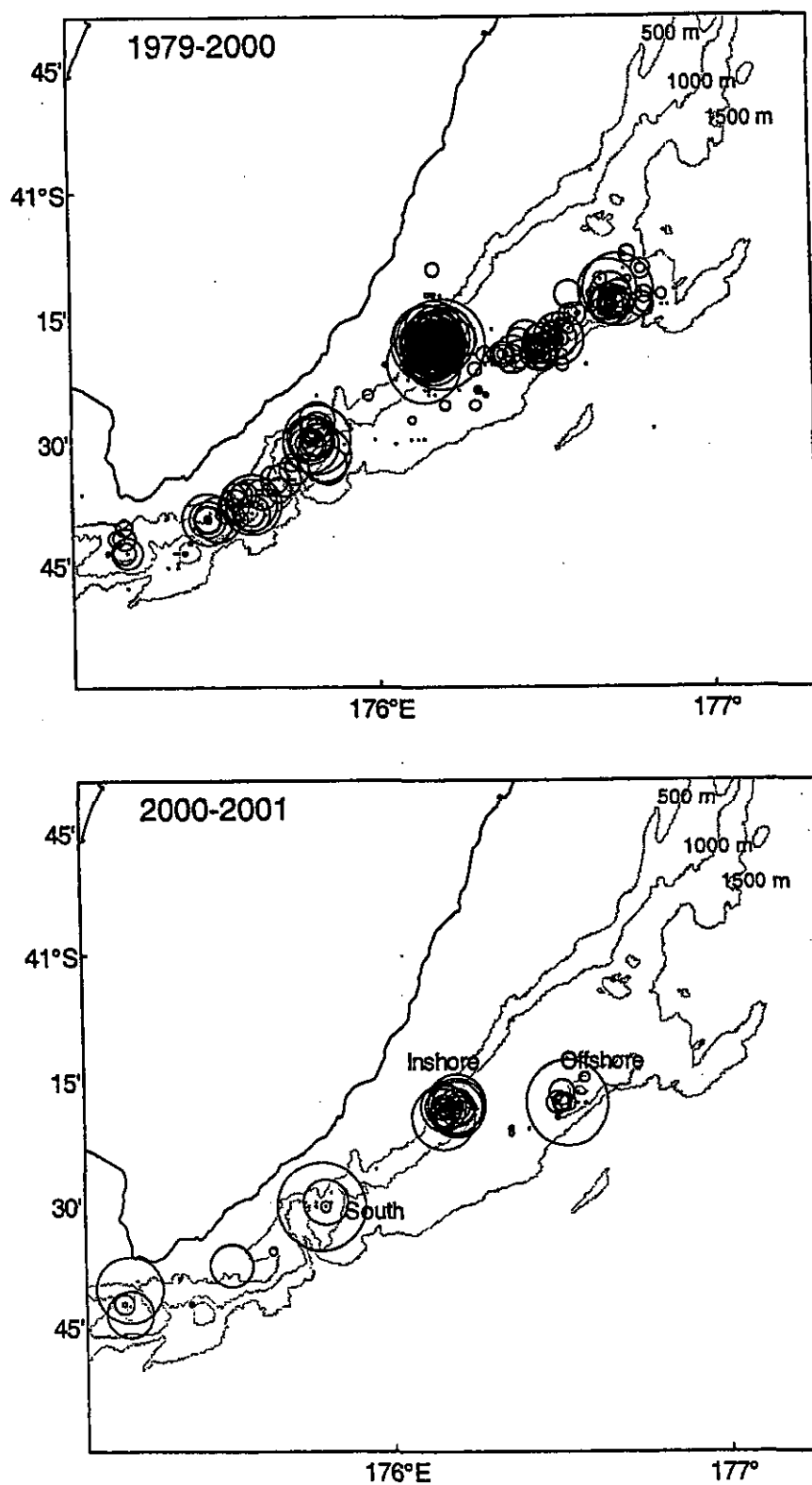


Figure 7: Estimated trawl catch rate (t/tow) of black cardinalfish by fishing position and fishing year for the Wairarapa fishery. Catch rate proportional to circle area (maximum 70 t).

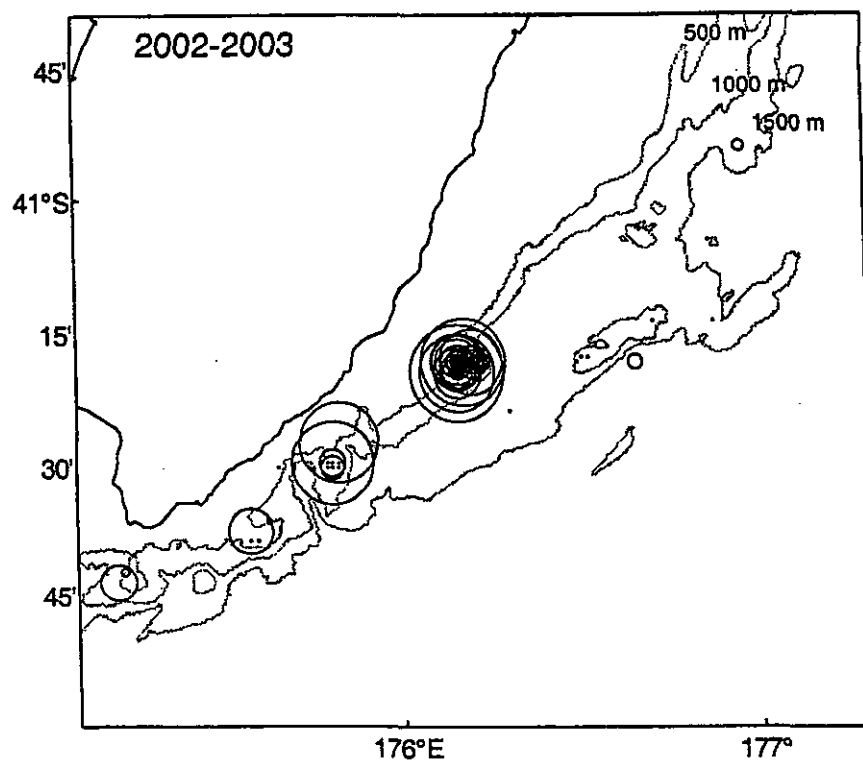
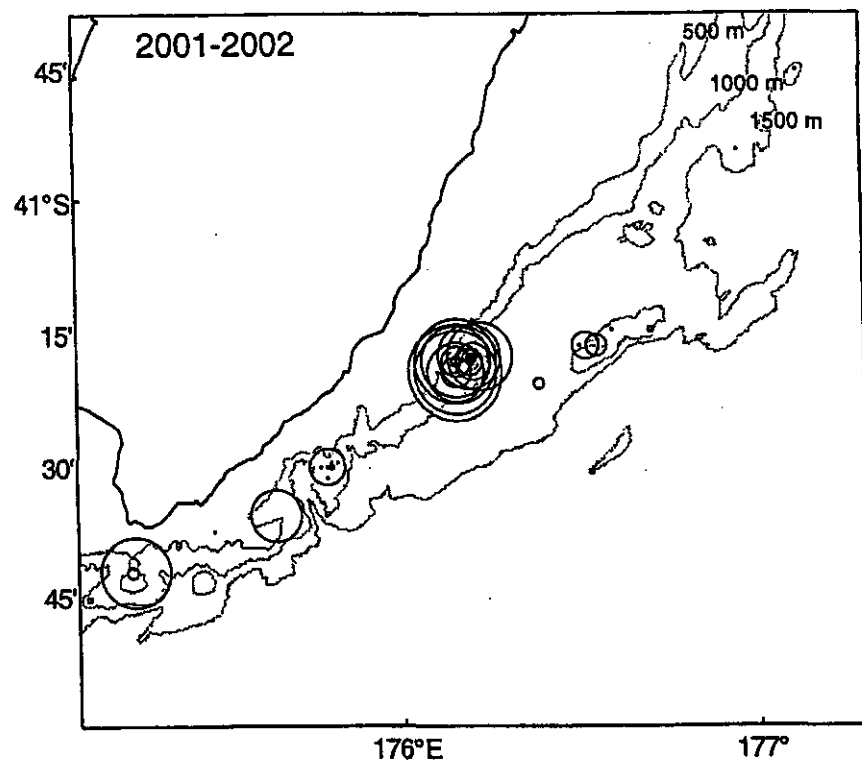
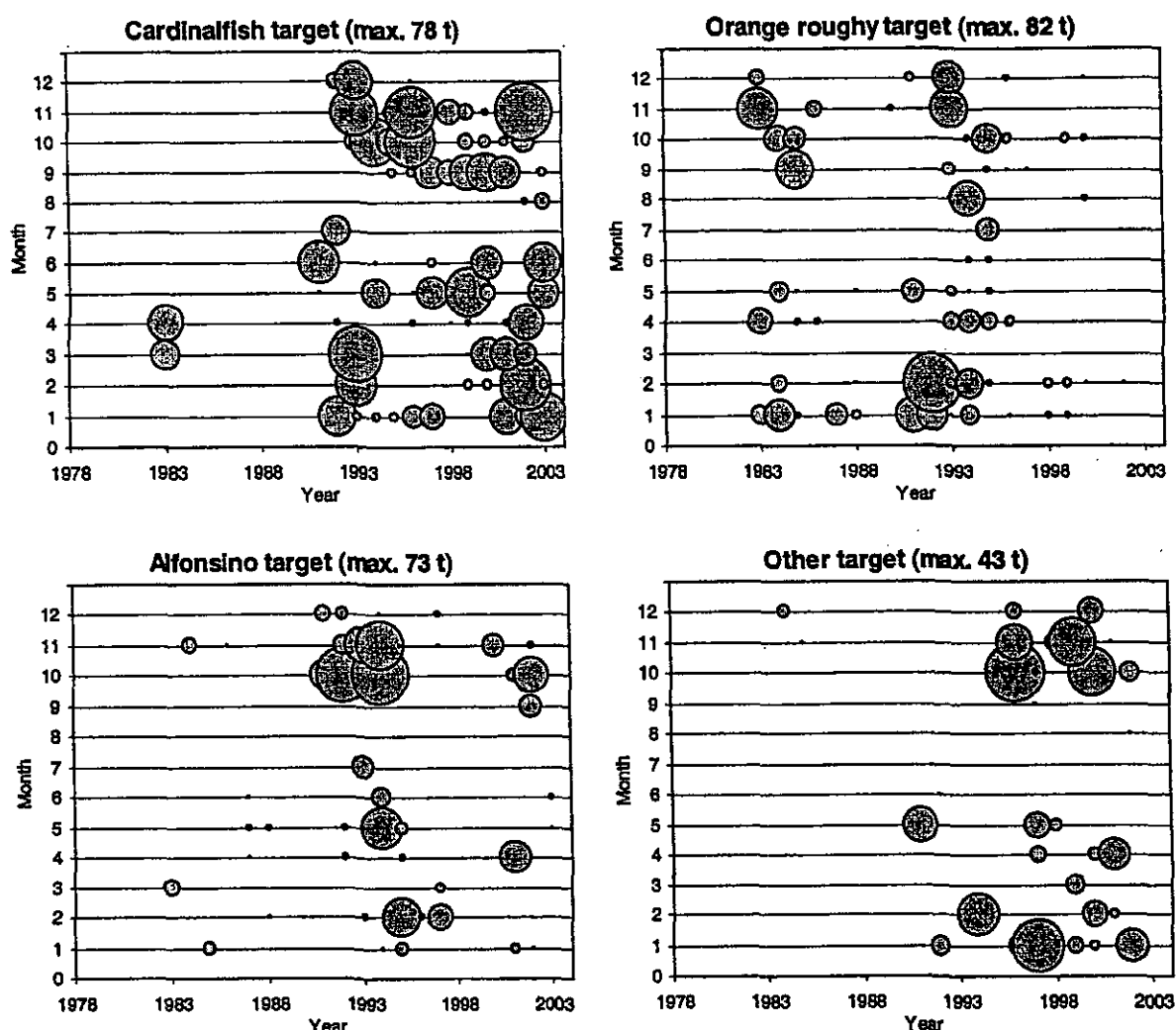


Figure 7 (cont.): Estimated trawl catch rate (t/tow) of black cardinalfish by fishing position and fishing year for the Wairarapa fishery. Catch rate proportional to circle area (maximum 70 t).



**Figure 8:** Bubble plots showing normalised estimated catches of black cardinalfish by month and year, for different target species for the Wairarapa fishery, with the maximum catch value shown in brackets (t).

### 3.4.4 Catch and effort trends

The mean length of vessels in the black cardinalfish target fishery has increased slowly between 1990–91 and 2002–03 (Table 8). The targeted effort was variable between 1990–91 and 1996–97, but subsequently increased steadily, with the second highest effort level, and largest catches, being taken in 2002–03. The number of vessels operating in the target fishery has also been increasing, although the number decreased in 2002–03. Catch rates have been variable, and show no clear trend.

Both fishing effort and catches of black cardinalfish in the fisheries targeting other species have been relatively low since 1997–98, with catches at a similar level to those reported between 1982–83 and 1987–88. Catch rates have been variable, decreased rapidly in the early 1980s, and were relatively high in the early 1990s.

Table 8: Estimated catch (t), number of tows, and catch rate (t/tow) by fishing year for vessels targeting black cardinalfish, or targeting other species, for the Wairarapa fishery, with the number of vessels and vessel length statistics for the black cardinalfish target fishery. Catch rate only calculated for a minimum of 20 tows. \* missing data; “–” not applicable.

Fishing year	Black cardinalfish target							Other-target		
	No. vessels	Vessel length (m)			No. tows	Catch (t)	t/tow	No. tows	Catch (t)	t/tow
1982–83	1	–	–	–	5	53	10.7	6	37	–
1983–84	0	–	–	–	0	–	–	23	97	4.2
1984–85	0	–	–	–	0	–	–	50	74	1.5
1985–86	0	–	–	–	0	–	–	33	15	0.4
1986–87	0	–	–	–	0	–	–	20	26	1.3
1987–88	0	–	–	–	0	–	–	10	6	–
1988–89*	–	–	–	–	–	–	–	–	–	–
1989–90*	–	–	–	–	–	–	–	–	–	–
1990–91	5	27.2	33.0	35.6	26	46	1.8	13	68	–
1991–92	4	27.2	33.2	35.6	31	62	2.0	36	146	4.1
1992–93	7	27.2	33.4	42.4	51	125	2.5	23	120	5.2
1993–94	5	27.2	34.7	42.4	103	131	1.3	47	253	5.4
1994–95	4	27.6	37.5	42.7	32	63	2.0	53	207	3.9
1995–96	6	30.6	35.5	42.7	79	50	0.6	23	32	1.4
1996–97	8	27.2	38.0	42.7	85	208	2.4	35	138	3.9
1997–98	5	34.3	40.8	43.0	26	19	0.7	14	11	–
1998–99	8	33.2	38.2	43.0	52	108	2.1	14	20	–
1999–2000	10	27.6	37.9	44.7	67	112	1.7	26	49	1.9
2000–01	8	27.2	39.1	44.7	77	94	1.2	22	102	4.6
2001–02	8	27.6	37.8	42.7	80	128	1.6	17	35	–
2002–03	6	34.3	40.1	42.7	98	229	2.3	22	37	1.7

### 3.5 East Coast

#### 3.5.1 The fishery

The fishery on the east coast of the North Island was the third fishery to develop, and has yielded the greatest catches. In the following description three subareas were defined, Tuaheni High, Ritchie Hill and Rockgarden, and East Cape (see Section 3.2).

At East Cape, the first black cardinalfish catches were reported as a bycatch of orange roughy fishing in 1984–85, and the largest catches in this fishery taken in the early 1990s (Table 9). The black cardinalfish target fishery developed in the early 1990s, with greatest catches taken in the mid to late 1990s. East Cape was the last of the three subareas on the east coast to develop a black cardinalfish target fishery.

The largest fishery for black cardinalfish on the east coast has been at Tuaheni High (Table 10). The first catches in this area were reported as a bycatch in the orange roughy fishery in 1984–85, and the first catches in the target fishery in 1987–88. Particularly large catches were taken in 1990–91, but this was not seen in the other areas (East Cape or Ritchie Hill and Rockgarden). Catches in the target fishery at Tuaheni High have increased in the last three fishing years, with catches in 2002–03 being the second highest recorded.



**Table 9: Estimated trawl catches (t) of black cardinalfish by target species for the East Cape fishery.**  
 \* data missing; "-" not applicable.

Fishing year	Alfonsino	Black cardinalfish	Hoki	Orange roughy	Other <sup>1</sup>
1984-85	0	0	0	0.3	0
1985-86	0	0	0	0	0
1986-87	0	0	0	0	0
1987-88	0	0	0	0	0
1988-89*	-	-	-	-	-
1989-90*	-	-	-	-	-
1990-91	0	0	0	0	0
1991-92	0	1.8	0	0	0
1992-93	0	25.0	0	0	0
1993-94	0	34.2	0	253.7	0.2
1994-95	0.1	174.7	0	408.6	0
1995-96	70.3	349.9	0	322.1	0
1996-97	0	81.2	0	50.9	0.1
1997-98	0	165.9	<0.1	28.2	10.0
1998-99	0	152.9	0	102.8	0
1999-2000	0.3	97.0	0	124.8	0
2000-01	0	6.0	3.0	0.2	0
2001-02	0	22.6	0	3.1	0
2002-03	<0.1	122.2	0	34.1	0

1. Other target species includes bluenose, mixed oreos and capro dory.

**Table 10: Estimated trawl catches (t) of black cardinalfish by target species for the Tuaheni High fishery.**  
 \* data missing; "-" not applicable.

Fishing year	Alfonsino	Black cardinalfish	Hoki	Orange roughy	Other <sup>1</sup>
1984-85	0	0	0	9.8	0
1985-86	0	0	0	0	0
1986-87	0.1	0	0	0	0
1987-88	0.1	358.7	0	277.7	0
1988-89*	-	-	-	-	-
1989-90*	-	-	-	-	-
1990-91	0	1 660.8	109.5	15.0	0
1991-92	0	407.3	0	60.0	0
1992-93	0	328.7	0	18.5	0
1993-94	0	452.8	0	616.7	0
1994-95	0	579.1	0	99.9	0
1995-96	0	366.5	0	72.7	48.1
1996-97	19.6	447.8	11.5	141.0	63.7
1997-98	9.3	8.8	0	2.3	0
1998-99	0	198.4	0	50.1	0
1999-2000	0	441.5	16.0	201.1	0
2000-01	0	346.0	53.5	0.1	0
2001-02	0	495.2	<0.1	0	0
2002-03	0.1	777.5	<0.1	0	0

1. Other target species includes bluenose and mixed oreos.

The target fishery at Ritchie Hill and Rockgarden was the first to develop on the east coast (Table 11). The greatest catches of black cardinalfish were initially taken as a bycatch in the orange roughy fishery, but catches in this fishery declined rapidly after 1999-2000. Conversely, catches from the target fishery have been relatively high in recent years, with the highest black cardinalfish catch recorded in 2001-02. A significant bycatch of black cardinalfish in the alfonsino target fishery was reported only for the Ritchie Hill and Rockgarden area of the east coast.

**Table 11: Estimated trawl catches (t) of black cardinalfish by target species for the Ritchie Hill and Rockgarden fishery. \* data missing; "-" not applicable.**

Fishing year	Alfonsino	Black cardinalfish	Hoki	Orange roughy	Other <sup>1</sup>
1984-85	13.0	0	0	0	0
1985-86	0.1	0	0	1.0	0
1986-87	7.4	21.3	0	0	0
1987-88	2.4	37.5	0	0	0.2
1988-89*	-	-	-	-	-
1989-90*	-	-	-	-	-
1990-91	40.3	100.5	0	380.4	0
1991-92	215.7	186.5	0	159.3	0
1992-93	115.1	253.1	0	332.5	0
1993-94	79.0	60.8	0	357.9	0
1994-95	23.9	29.8	0	169.1	3.2
1995-96	1.1	188.1	0	69.5	0
1996-97	83.8	231.9	0	50.6	0
1997-98	33.0	562.2	0	104.7	9.5
1998-99	0.3	234.8	0	165.1	0.1
1999-2000	5.2	463.5	1.7	178.8	0.1
2000-01	0.8	379.0	8.5	36.5	4.0
2001-02	1.8	862.8	1.0	10.2	0
2002-03	20.0	406.5	0.7	1.0	0

1. Other target species includes bluenose, mixed oreos, barracouta, and gemfish.

### 3.5.2 Location

In the East Cape black cardinalfish target fishery, the peak catch rate was in depth classes between 600 and 899 m, with a second smaller peak at 1100-1199 m (Figure 9). However, effort was concentrated at the shallow end of this depth range, between 600-699 m. The orange roughy target fishery supported the presence of the second peak in catch rates in 1100-1199 m.

In the Tuaheni High black cardinalfish target fishery, there was a clear peak in both effort and catch rates in the depth class 700-799 m (Figure 10). There was no indication of a peak in catch rates in deeper water. In the orange roughy target and other species target fisheries, the peak catch rate was consistently at a depth of 700-799 m. The orange roughy target fishery also indicated a second peak in catch rates at 1100-1199 m.

In the Ritchie Hill and Rockgarden black cardinalfish target fishery, the peak catch rates were in the depth class 600-699 m, following the pattern of effort, but with a second peak in catch rates at 1000-1099 m (Figure 11). Highest catch rates in the 600-699 m depth class were repeated in the alfonsino and other species target fisheries, but were shallower, at 500-599 m, in the orange roughy target fishery. The catch rates in the orange roughy target fishery generally decreased with increasing depth, and did not indicate a second peak in catch rates in deeper water.

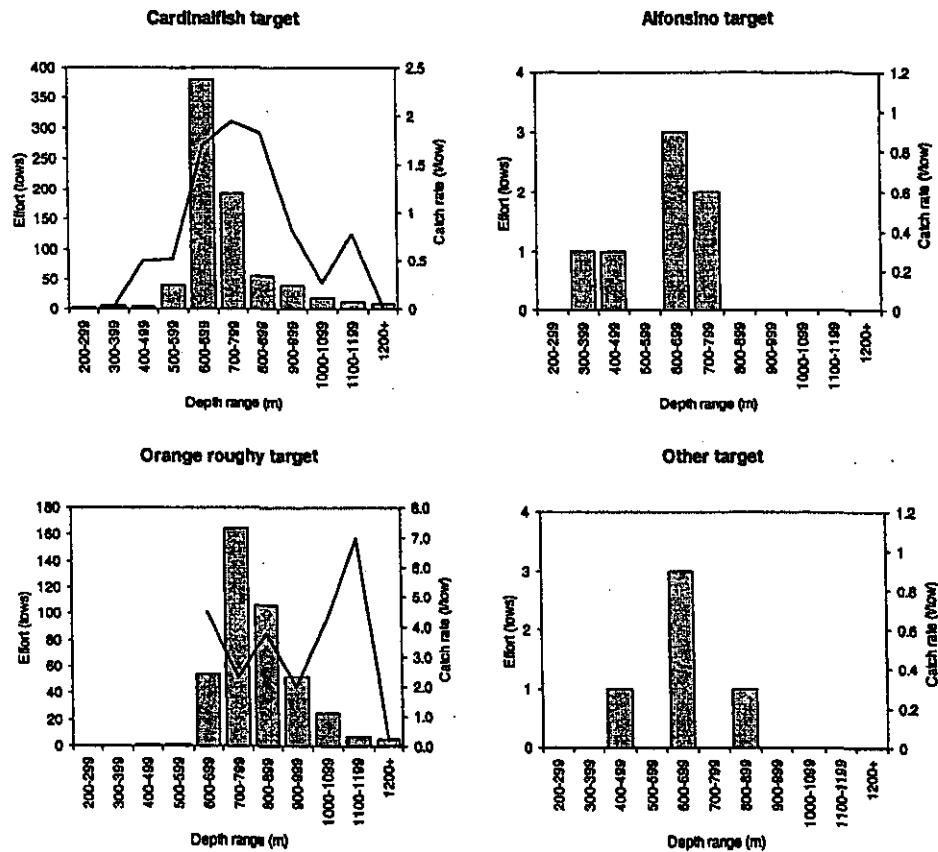


Figure 9: Total estimated effort (no. tows; bars) and catch rates (t/tow; lines) by depth class and target species for the East Cape fishery.

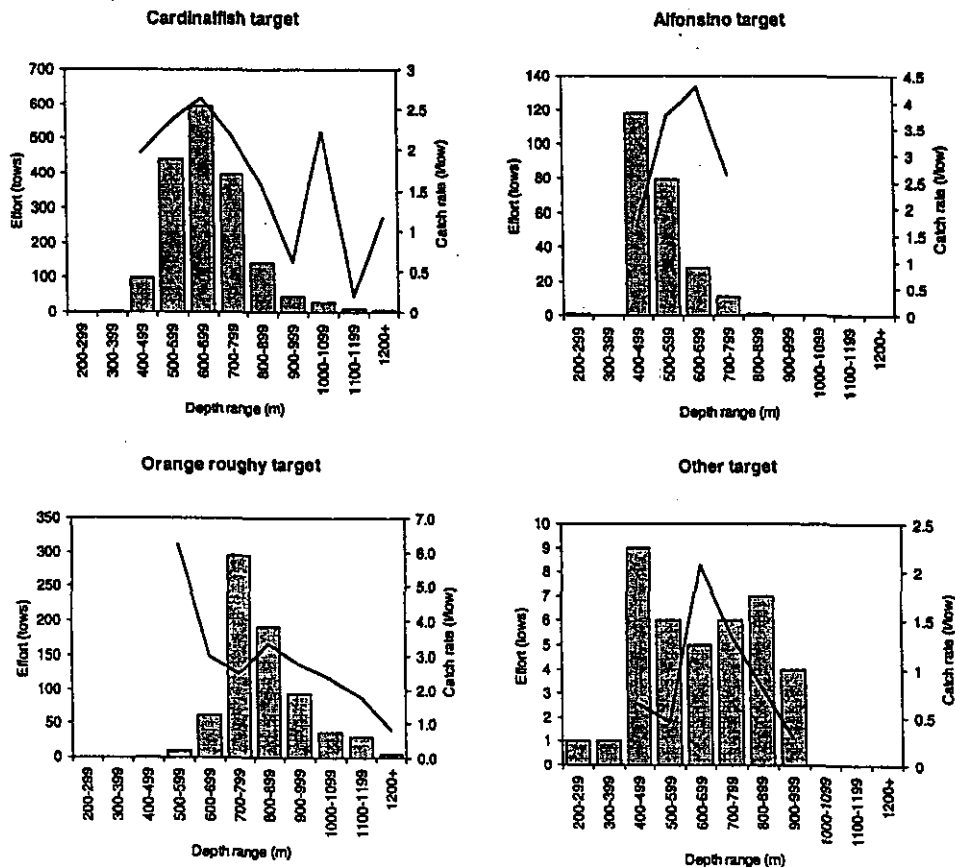
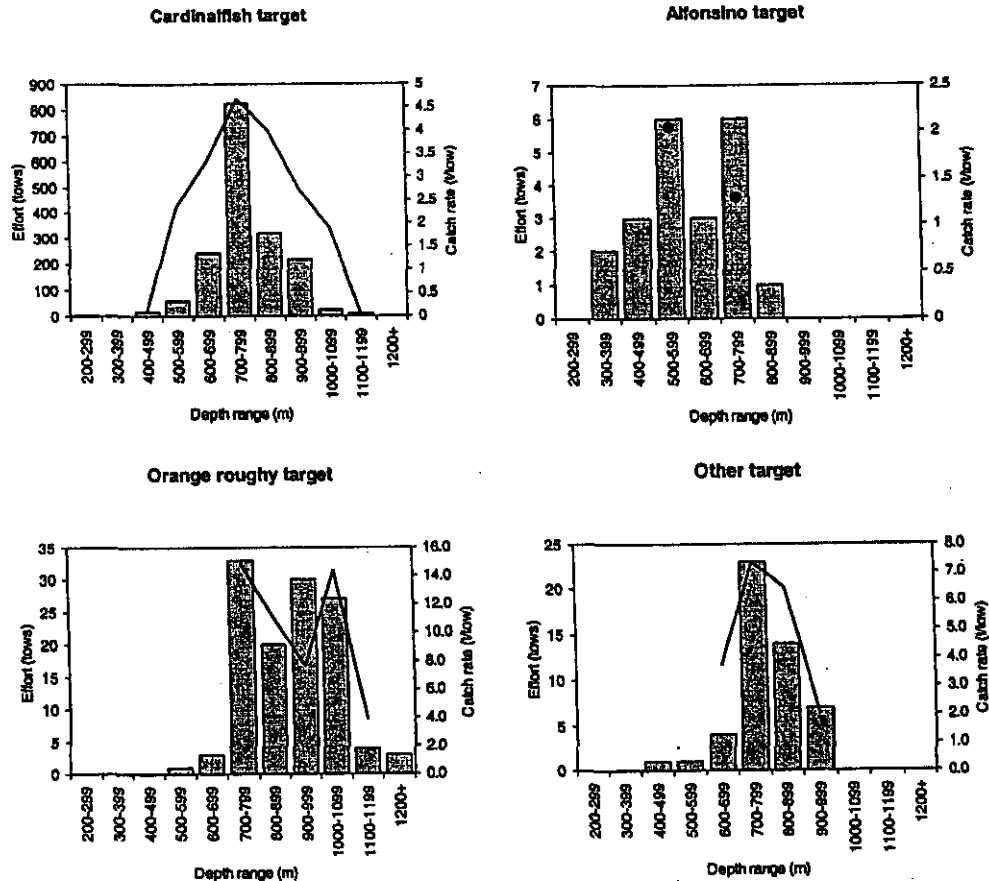


Figure 10: Total estimated effort (no. tows; bars) and catch rates (t/tow; lines) by depth class and target species for the Tuaheni High fishery.



**Figure 11: Total estimated effort (no. tows; bars) and catch rates (t/tow; lines) by depth class and target species for the Ritchie Hill and Rockgarden fishery.**

In the East Cape fishery, most of the black cardinalfish catches have been taken in a single area known as the East Cape Hills, at about 179° 30' E and 37° 40' S (Figure 12). A number of catches have been taken in other areas, and in 2002–03 similar catch rates were also taken in the vicinity of a hill feature at about 178° 50' E and 37° 25' S.

In the Tuaheni High fishery, catch rates have come from two areas, the first at the western end of the area at about 178° 50' E and 37° 45' S, and the second to the east at about 178° 35' E and 37° 45' S (Figure 12). The western area has consistently been the focus of the fishery.

In the Ritchie Hill and Rockgarden fishery, the areas fished are more diverse, although a focus for catches and effort is apparent at the southern end of the area, known as the Rockgarden, at about 178° 10' E and 40° S (Figure 12).

Note that there are a number of small catches taken in very deep water (more than 1500 m), for example at around 179° E and 40° S. Unless these catches were taken from seamounts, the extreme depth recorded in these general areas suggests that these records probably contain positional errors.

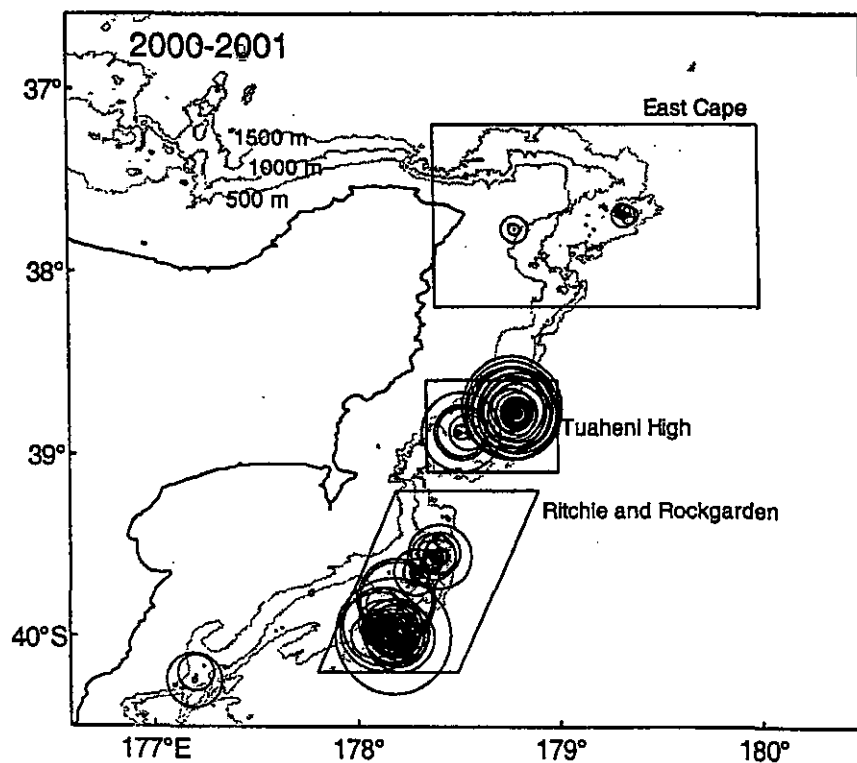
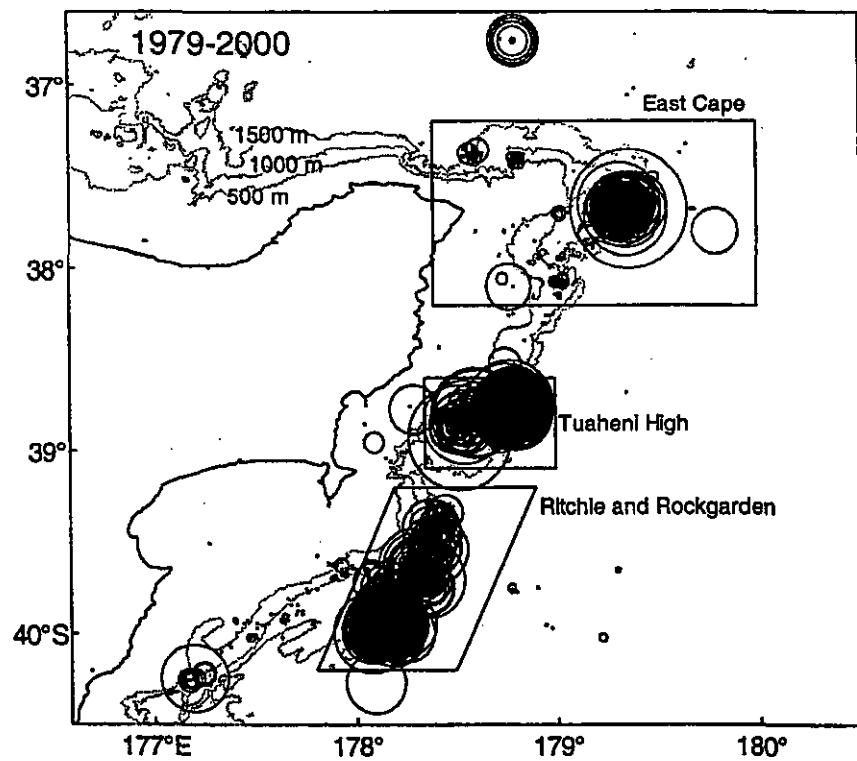


Figure 12: Estimated trawl catch rate (t/tow) of black cardinalfish by fishing position and fishing year for the east coast fishery. Catch rate proportional to circle area (maximum 147 t).

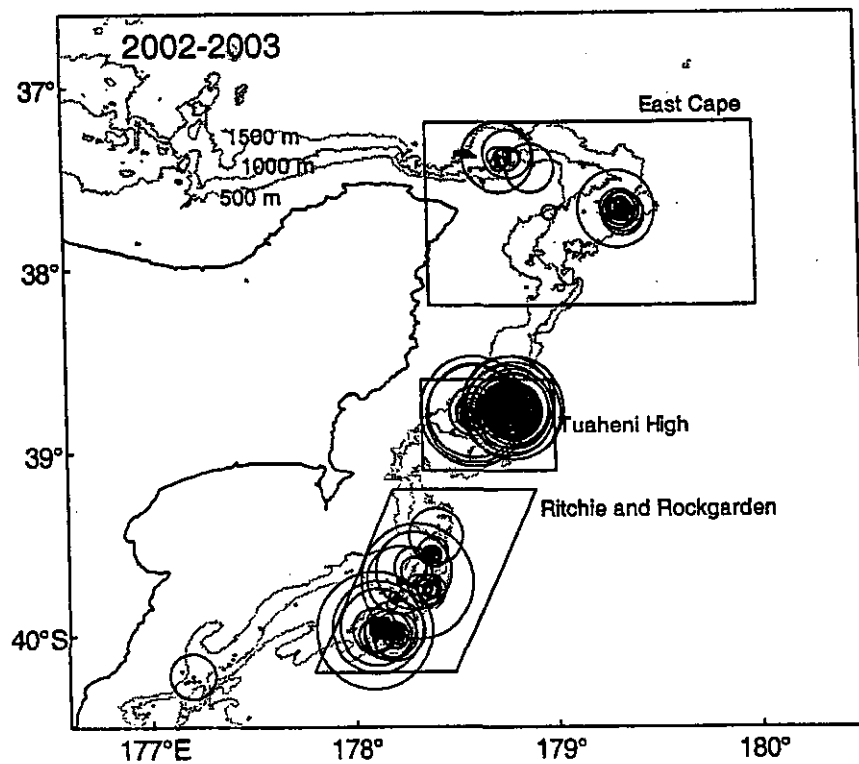
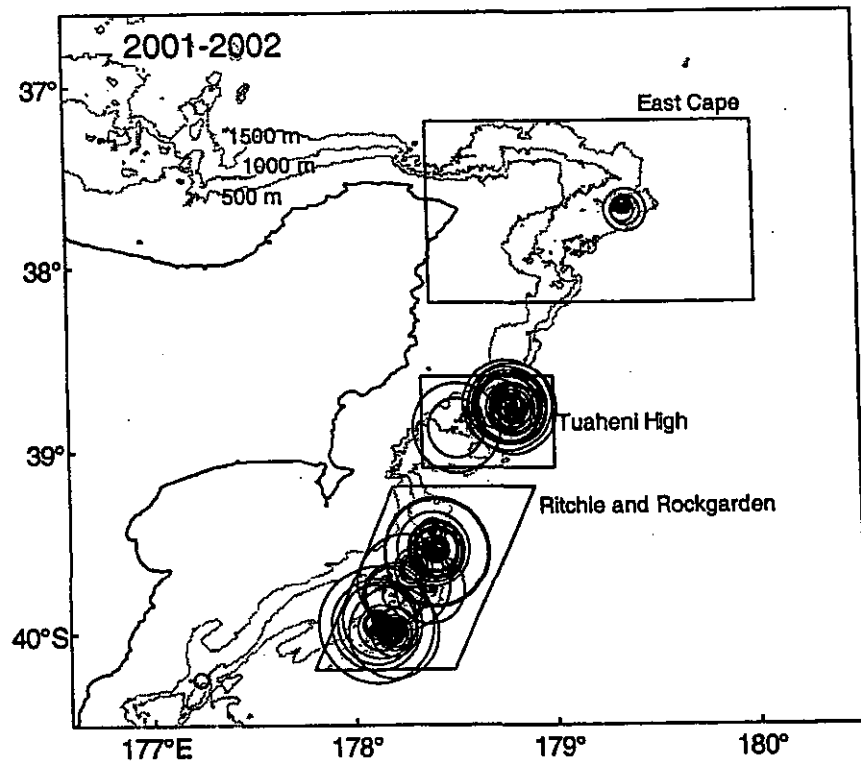


Figure 12 (cont.): Estimated trawl catch rate (t/tow) of black cardinalfish by fishing position and fishing year for the east coast fishery. Catch rate proportional to circle area (maximum 147 t).

### 3.5.3 Seasonality

Catches of black cardinalfish in the East Cape target fishery were made throughout the year, but the catches were consistently high between January and April, and relatively low in June, July, and September (Figure 13). Catches from the orange roughy fishery were largely taken between October and March, and in the mid 1990s.

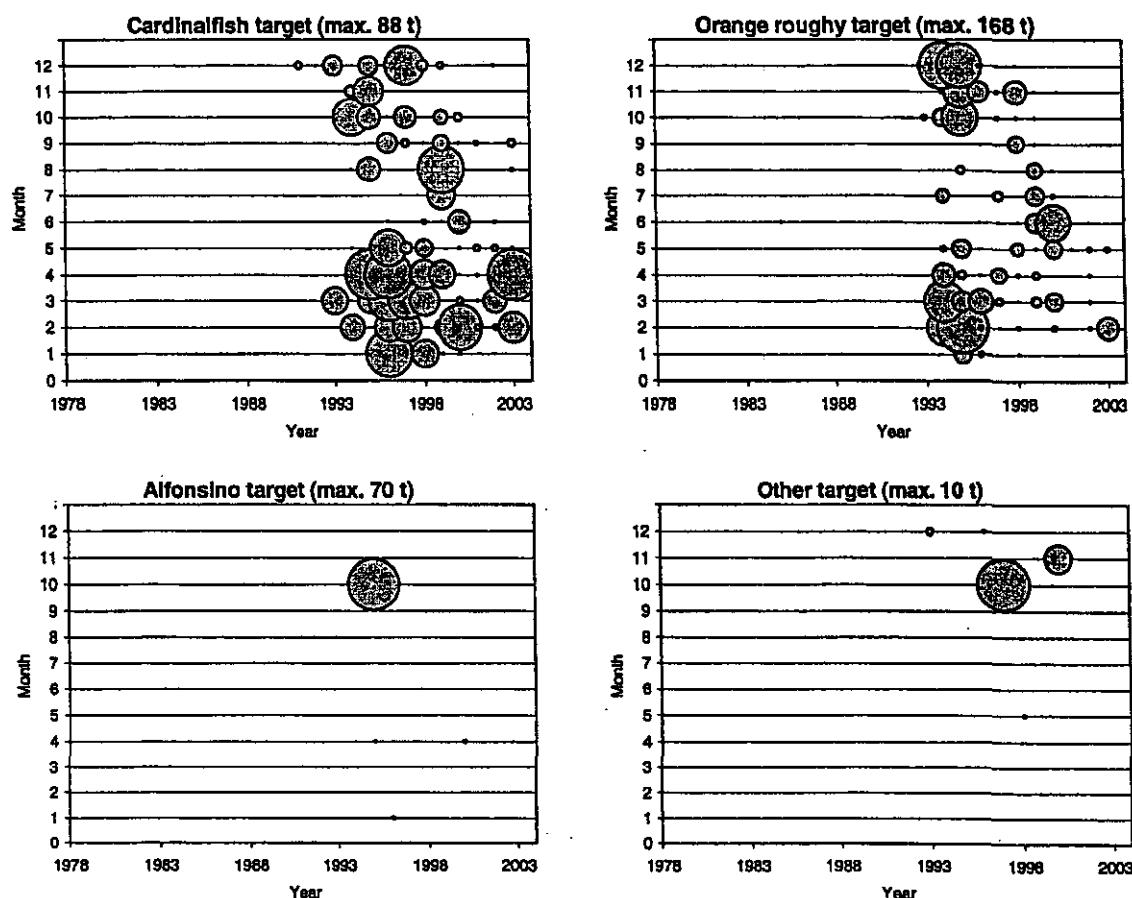


Figure 13: Bubble plots showing normalised estimated catches of black cardinalfish by month and year, for different target species for the East Cape fishery, with the maximum catch value shown in brackets (t).

Catches of black cardinalfish in the Tuaheni High target fishery were made throughout the year, with no clear seasonal pattern (Figure 14). However, since 1998 the catches between November and March have been relatively low, and therefore the fishery was concentrated between April and October. Most of the catches from the orange roughy target fishery were taken in 1994, and between March and August.

Catches of black cardinalfish in the Ritchie Hill and Rockgarden fishery were made throughout the year, but were relatively low in June, July, and August, and greatest between November and May (Figure 15). The seasonal pattern of catches of black cardinalfish was similar in the orange roughy target fishery. Catches from the alfonsino target fishery were largely taken between October and December in the early 1990s.

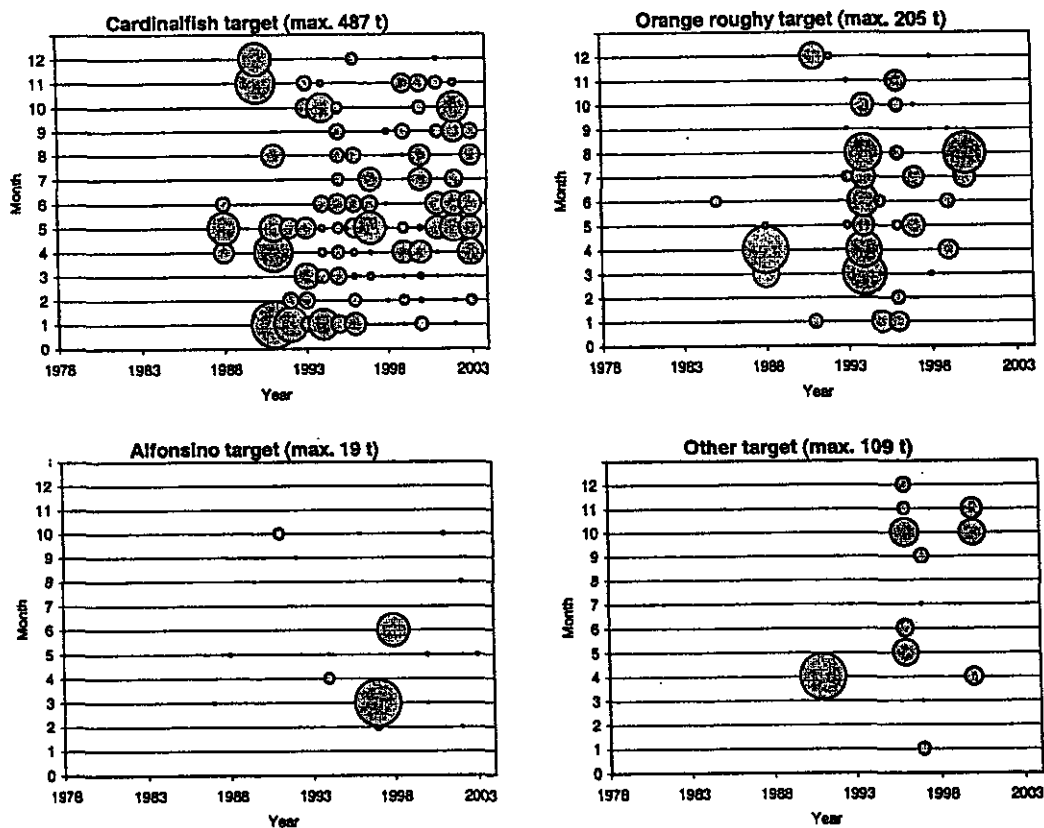


Figure 14: Bubble plots showing normalised estimated catches of black cardinalfish by month and year, for different target species for the Tuaheni High fishery, with the maximum catch value shown in brackets (t).

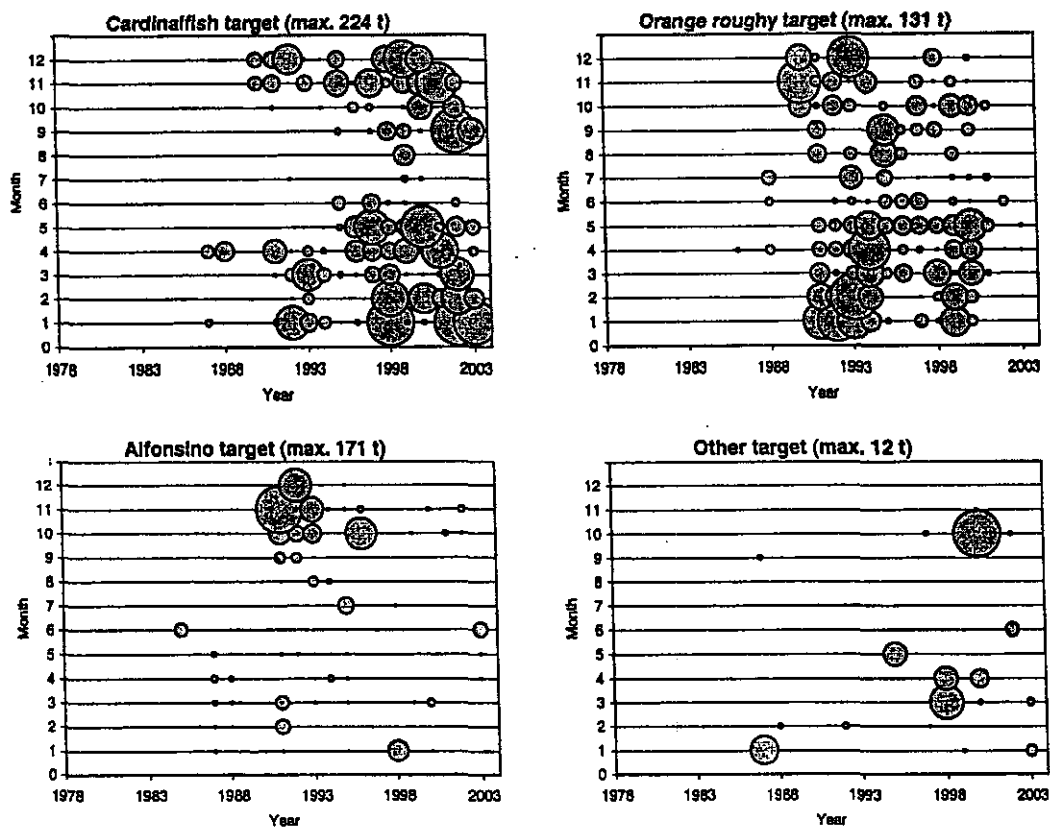


Figure 15: Bubble plots showing normalised estimated catches of black cardinalfish by month and year, for different target species for the Ritchie Hill and Rockgarden fishery, with the maximum catch value shown in brackets (t).



### 3.5.4 Catch and effort trends

In the East Cape fishery, the length of vessels in the black cardinalfish target fishery has shown no clear trend (Table 12). The targeted effort increased to a peak in 1995–96, then declined, reaching a low in 2000–01. Effort has subsequently increased, with effort in 2002–03 at a level comparable to that in the late 1990s. The trend in catches has followed effort. Effort in the fisheries targeting other species has been relatively low since 2000–01, although catches showed a downward trend since 1994–95. Catch rates in the non-target fishery showed a similar trend to catches. Catch rates in the target fishery declined from 1994–95 to 2000–01, then increased to 2002–03, when catch rates were at a level comparable with the late 1990s.

**Table 12: Estimated catch (t), number of tows, and catch rate (t/tow) by fishing year for vessels targeting black cardinalfish, or targeting other species, for the East Cape fishery, with the number of vessels and vessel length statistics for the black cardinalfish target fishery. Catch rate calculated for a minimum of 20 tows. \* missing data; “–” not applicable.**

Fishing year	Black cardinalfish target							Other-target		
	No. vessels	Vessel length (m)			No. tows	Catch (t)	t/tow	No. tows	Catch (t)	t/tow
		min	mean	max						
1984–85	0	–	–	–	–	–	–	1	0	–
1985–86	0	–	–	–	–	–	–	–	–	–
1986–87	0	–	–	–	–	–	–	–	–	–
1987–88	0	–	–	–	–	–	–	–	–	–
1988–89*	–	–	–	–	–	–	–	–	–	–
1989–90*	–	–	–	–	–	–	–	–	–	–
1990–91	0	–	–	–	–	–	–	–	–	–
1991–92	3	29.3	29.3	29.3	3	2	–	0	–	–
1992–93	1	34.4	34.4	34.4	1	25	–	0	–	–
1993–94	3	29.8	35.0	42.4	18	34	–	59	254	4.3
1994–95	5	27.2	38.1	42.4	75	175	2.3	71	409	5.8
1995–96	11	11.7	35.9	42.8	205	350	1.7	49	392	8.0
1996–97	9	27.2	33.4	42.7	67	81	1.2	30	51	1.7
1997–98	8	26.0	37.3	42.4	88	166	1.9	54	38	0.7
1998–99	11	26.0	34.2	43.7	83	153	1.8	72	103	1.4
1999–2000	9	25.3	34.2	43.7	101	97	1.0	63	125	2.0
2000–01	8	26.0	32.1	43.7	28	6	0.2	8	3	–
2001–02	6	26.0	33.2	42.7	24	23	0.9	19	3	–
2002–03	7	27.6	38.2	42.8	76	122	1.6	19	34	–

In the Tuaheni High fishery, the length of vessels in the black cardinalfish target fishery has shown no clear trend (Table 13). Targeted effort increased steadily from 1991–92 to 1996–97, then dropped to about the starting level the following year, and then increased steadily again to 2002–03, when effort was the highest recorded. Despite the increasing trend in effort, catches remained relatively stable between 1991–92 and 1996–97, then dropped in 1997–98, after which they have shown an increasing trend, similar to effort. Catch and effort in the fisheries targeting other species have been highly variable, and relatively low with the exception of catches in 1993–94. Insufficient data are available to describe catch rates in the non-target fishery. Catch rates in the target fishery showed a steady decline from 1991–92 to a low in 1997–98, and then increased to a level about half the starting level for the period 1999–2000 to 2002–03.

Table 13: Estimated catch (t), number of tows, and catch rate (t/tow) by fishing year for vessels targeting black cardinalfish, or targeting other species, for the Tuaheni High fishery, with the number of vessels and vessel length statistics for the black cardinalfish target fishery. Catch rate calculated for a minimum of 20 tows. \* missing data; “-” not applicable.

Fishing year	Black cardinalfish target							Other-target		
	No. vessels	Vessel length (m)			No. tows	Catch (t)	t/tow	No. tows	Catch (t)	t/tow
		min	mean	max						
1984-85	0	-	-	-	-	-	-	1	10	-
1985-86	0	-	-	-	-	-	-	-	-	-
1986-87	0	-	-	-	-	-	-	1	0.1	-
1987-88	5	-	-	-	34	359	10.6	28	278	9.9
1988-89*	-	-	-	-	-	-	-	-	-	-
1989-90*	-	-	-	-	-	-	-	-	-	-
1990-91	7	27.2	33.6	35.6	221	1 661	7.5	14	125	8.9
1991-92	5	29.3	33.2	35.6	47	407	8.7	3	61	-
1992-93	9	18.3	33.8	42.4	55	329	6.0	6	18	-
1993-94	6	27.2	34.6	42.4	102	453	4.4	27	618	22.9
1994-95	8	27.2	36.3	42.7	95	579	6.1	8	100	-
1995-96	9	25.4	34.7	42.7	156	366	2.3	15	121	-
1996-97	9	27.2	32.7	42.7	186	448	2.4	24	236	9.8
1997-98	7	27.2	36.0	42.7	46	9	0.2	8	12	-
1998-99	10	27.2	32.4	42.0	104	198	1.9	8	50	-
1999-2000	11	27.2	32.0	43.7	150	441	2.9	26	217	8.4
2000-01	10	26.0	31.1	43.7	135	346	2.6	21	54	2.6
2001-02	11	27.0	32.0	42.7	143	495	3.5	6	0.2	-
2002-03	10	27.6	34.8	42.7	274	777	2.8	4	0.1	-

Table 14: Estimated catch (t), number of tows, and catch rate (t/tow) by fishing year for vessels targeting black cardinalfish, or targeting other species, for the Ritchie Hill and Rockgarden fishery, with the number of vessels and vessel length statistics for the black cardinalfish target fishery. Catch rate calculated for a minimum of 20 tows. \* missing data; “-” not applicable.

Fishing year	Black cardinalfish target							Other-target		
	No. vessels	Vessel length (m)			No. tows	Catch (t)	t/tow	No. tows	Catch (t)	t/tow
		min	mean	max						
1984-85	0	-	-	-	-	-	-	3	13	-
1985-86	0	-	-	-	-	-	-	2	1	-
1986-87	3	-	-	-	6	21	-	36	12	0.3
1987-88	1	-	-	-	1	38	-	27	24	0.9
1988-89*	-	-	-	-	-	-	-	-	-	-
1989-90*	-	-	-	-	-	-	-	-	-	-
1990-91	6	29.3	34.3	42.4	53	100	1.9	133	421	3.2
1991-92	8	18.1	30.8	42.4	65	186	2.9	120	375	3.1
1992-93	8	27.2	32.3	42.8	69	253	3.7	80	448	5.6
1993-94	8	27.2	36.4	42.4	52	61	1.2	89	437	4.9
1994-95	7	27.2	36.3	42.7	32	30	0.9	76	196	2.6
1995-96	10	25.4	42.2	104.5	96	188	2.0	28	71	2.5
1996-97	7	27.2	33.5	42.7	90	232	2.6	38	134	3.5
1997-98	11	26.0	35.0	43.0	198	562	2.8	65	147	2.3
1998-99	13	26.0	32.8	43.7	201	235	1.2	121	165	1.4
1999-2000	13	26.0	38.6	43.0	203	463	2.3	110	186	1.7
2000-01	10	26.0	39.3	44.7	170	379	2.2	35	50	1.4
2001-02	7	27.0	39.8	42.7	285	863	3.0	20	13	0.7
2002-03	8	27.6	40.8	42.7	249	406	1.6	37	22	0.6

In the Ritchie Hill and Rockgarden fishery, the length of vessels in the black cardinalfish target fishery has been relatively high since 1999–2000, but this is not associated with changes to the minimum or maximum size of vessels (Table 14). Both targeted effort and catches have increased steadily from 1994–95 to 2001–02, and remained relatively high in 2002–03. Conversely, the effort in the fisheries targeting other species has shown a decreasing overall trend, although effort was relatively high in 1998–99 and 1999–2000. Catches have shown a similar overall decline, but do not increase with effort in 1998–99 and 1999–2000. The catch rates in the target fishery have been variable, and shown no clear trend. The catch rates in the fisheries targeting other species have shown a steady decrease from 1992–93 to 2002–03.

### 3.6 Bay of Plenty

#### 3.6.1 The fishery

In the following description three subareas were defined, Mercury-Colville, White Island, and North Colville (see Section 3.2). The fishery in the Bay of Plenty was the most recent to develop, with the first catches taken as a bycatch in the orange roughy target fishery in 1993–94 (Table 15). The first targeted fishing was reported the following year in the Mercury-Colville hills area, then in 1996–97 in White Island, and then in 1998–99 in North Colville. Mercury-Colville has consistently supported the largest fishery. In Mercury-Colville and White Island, catches from both the target fishery and as bycatch in the orange roughy fishery were relatively high from the mid to late 1990s, but relatively low since 2000–01. In North Colville, catches have been smaller than in other areas, but the largest catches were taken in 2002–03.

**Table 15: Estimated trawl catches (t) of black cardinalfish by target species for the Bay of Plenty fisheries.**

Fishing year	Mercury-Colville			White Island			North Colville		
	Black cardinalfish	Orange roughy	Other <sup>1</sup>	Black cardinalfish	Orange roughy	Other <sup>2</sup>	Black cardinalfish	Orange roughy	Other <sup>3</sup>
1993–94	0	98	0	0	<0.1	0	0	0	0
1994–95	938	25	44	0	0	0	0	0	0
1995–96	647	618	0	0	0	0	0	<0.1	0
1996–97	796	1 063	0	0.1	0.1	0	0	1	0
1997–98	401	475	<0.1	85	105	0	0	1	0
1998–99	149	182	0	187	98	0	<0.1	3	0
1999–2000	511	25	0	134	85	0.1	88	11	0
2000–01	193	1	0	9	1	0	5	<0.1	0
2001–02	240	102	0	17	1	0	4	4	0
2002–03	243	32	0	48	4	<0.1	158	5	<0.1

1. Other includes bluenose, alfonsino, and ruby fish.

2. Other includes bluenose and alfonsino.

3. Other includes alfonsino.

#### 3.6.2 Location

In the Mercury-Colville black cardinalfish target fishery, the peak effort and catch rate were in the depth class 800–899 m (Figure 16), with a similar pattern of catch rates in the orange roughy target fishery. In the White Island black cardinalfish target fishery, the peak catch rates were in depth classes 600–699 m and 800–999 m (Figure 17). Most effort was directed slightly shallower than peak catch rates, with a maximum at 700–799 m. A clear peak in catch rate at 800–899 m was present in the orange roughy target fishery. In the North Colville black cardinalfish target fishery, peak effort and catch rates were in the depth class 800–899 m (Figure 18). A peak in catch rates at 800–899 m was also seen in the orange roughy target fishery.

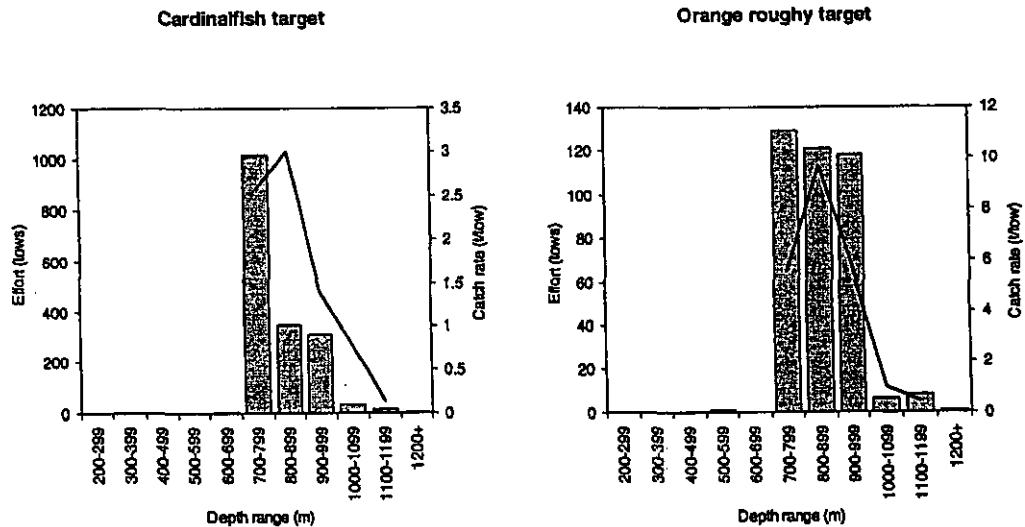


Figure 16: Total estimated effort (no. tows; bars) and catch rates (t/tow; lines) by depth class and target species for the Mercury-Colville fishery.

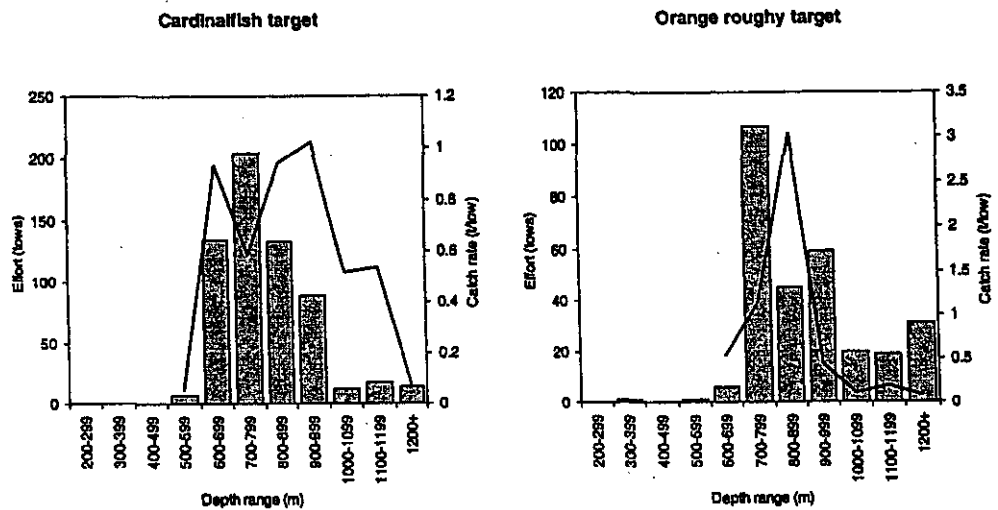


Figure 17: Total estimated effort (no. tows; bars) and catch rates (t/tow; lines) by depth class and target species for the White Island fishery.

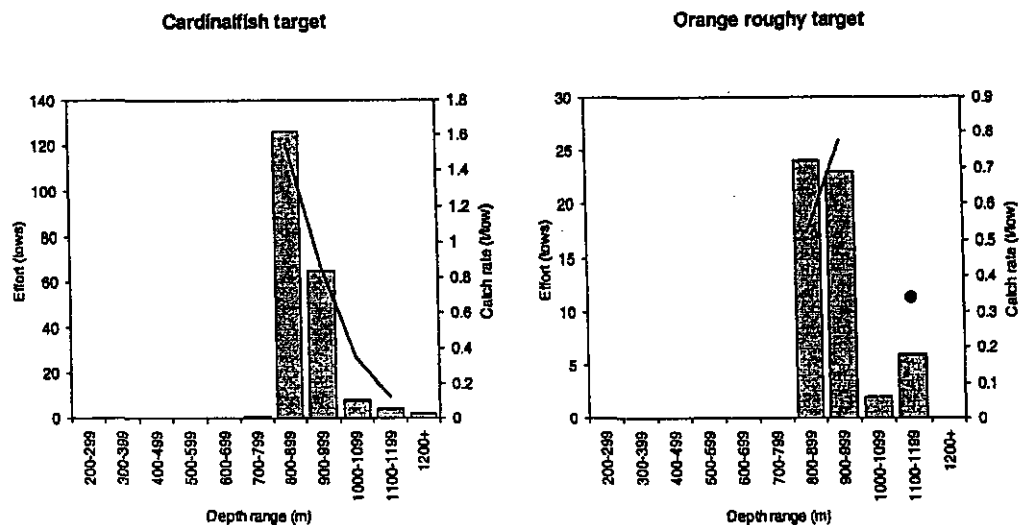


Figure 18: Total estimated effort (no. tows; bars) and catch rates (t/tow; lines) by depth class and target species for the North Colville fishery.

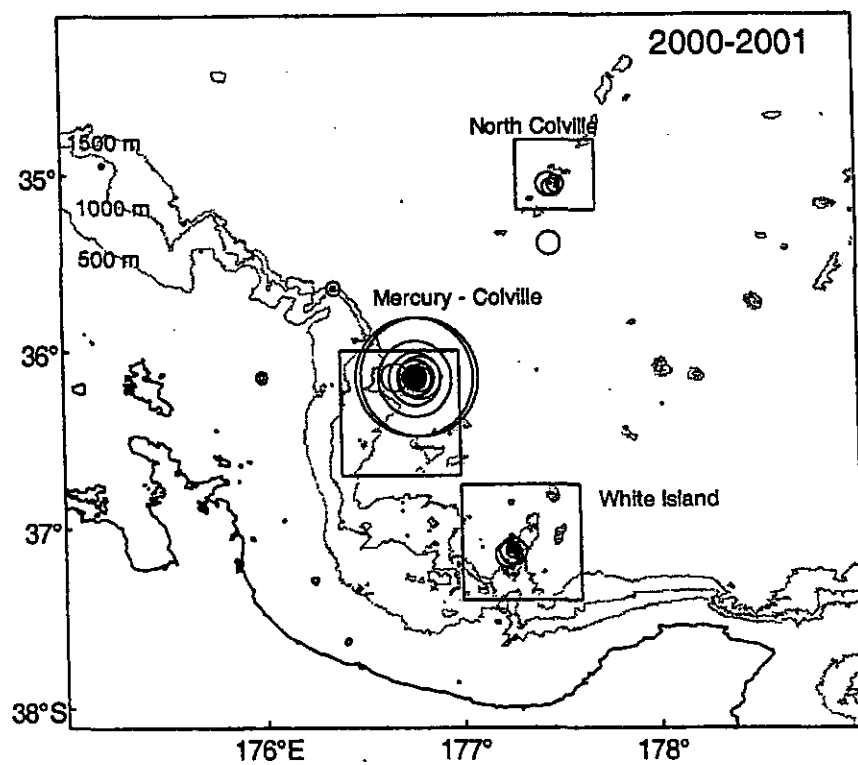
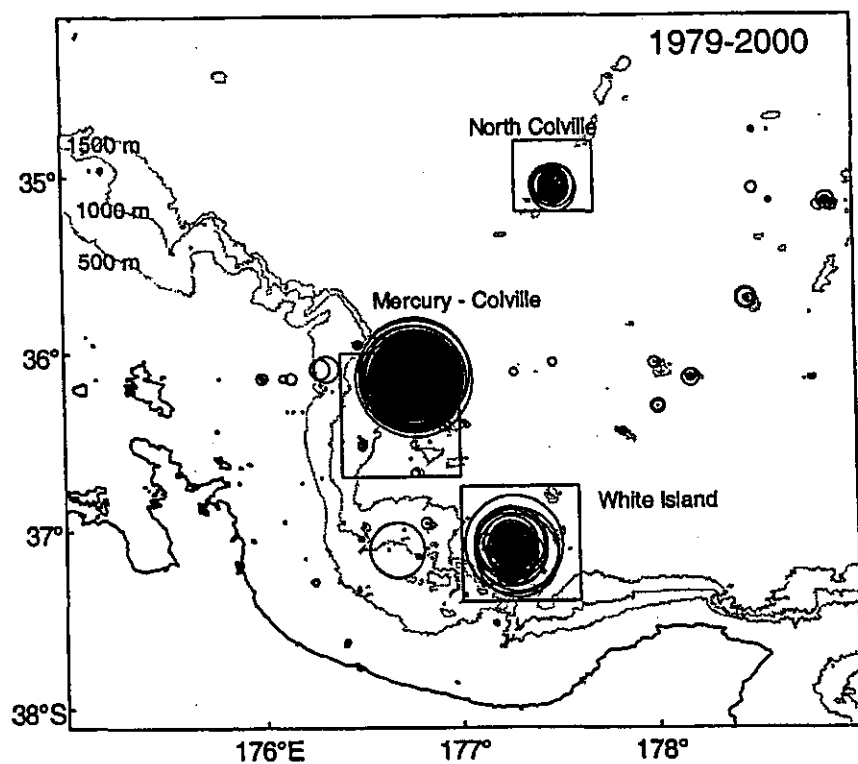


Figure 19: Estimated trawl catch rate (t/tow) of black cardinalfish by fishing position and fishing year for the Bay of Plenty fishery. Catch rate proportional to circle area (maximum 85 t).

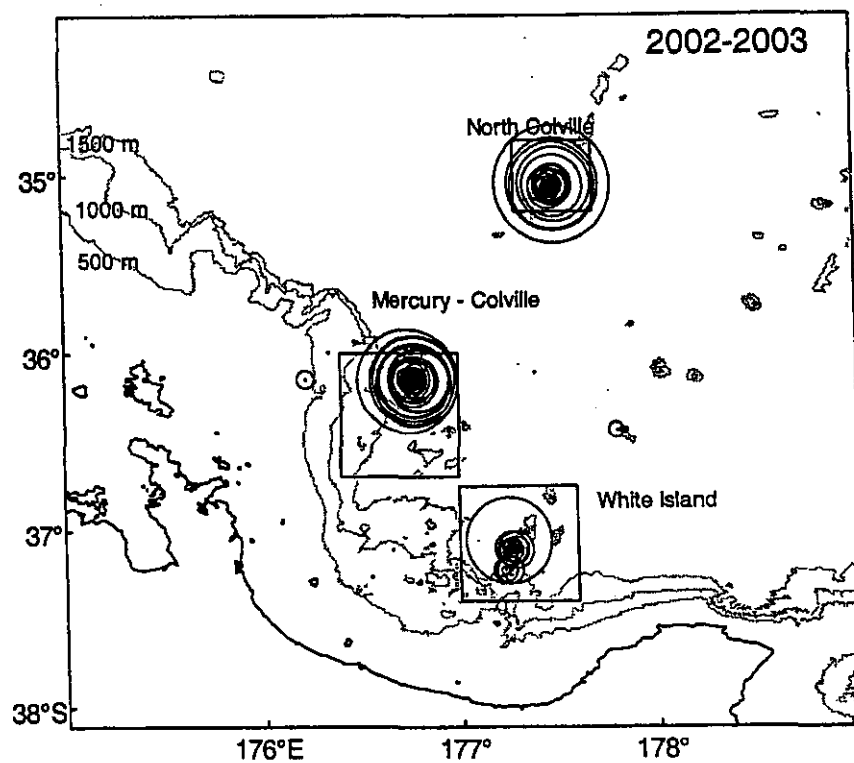
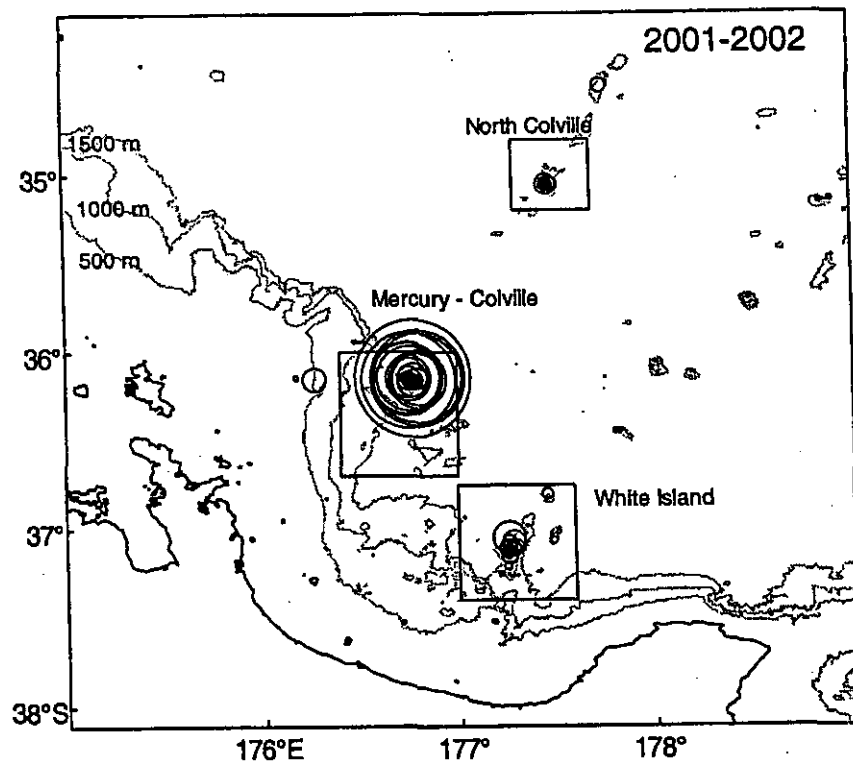


Figure 19 (cont.): Estimated trawl catch rate (t/tow) of black cardinalfish by fishing position and fishing year for the Bay of Plenty fishery. Catch rate proportional to circle area (maximum 85 t).

In the Mercury-Colville fishery, most of the black cardinalfish catches have consistently been taken in a single area known as the "Colville Knolls", at about 176° 50' E and 36° 10' S (Figure 19).

In the White Island fishery, catches have been taken in two main areas, the first known as "Waitotahi", at about 177° 15' E and 37° 05' S, and the second known as "Nukuhou" just south of this area, at about 177° 15' E and 37° 15' S (Figure 19). The higher catch rates have been taken from Waitotahi.

In the North Colville fishery, almost all catches have been taken from a single area at about 177° 30' E and 35° 05' S (Figure 19).

A number of small catches have been taken in other areas of the Bay of Plenty, most notably on the chain of seamounts extending northeast from White Island, primarily before 2000–01 (Figure 19).

### 3.6.3 Seasonality

Catches of black cardinalfish in the Mercury-Colville target fishery have been made throughout the year, although since 1998 most of catches were between February and September (Figure 20). In the orange roughy target fishery, most of catches were taken between May and October.

Catches of black cardinalfish in the White Island target fishery and also orange roughy target fishery have been concentrated between January and May, with smaller catches also taken between September and November (Figure 21).

Catches of black cardinalfish in the North Colville target fishery show no clear pattern, with relatively large catches in March, August, and November and December (Figure 22). Catches in the orange roughy target fishery have been relatively low, and since 1999 almost entirely taken in June.

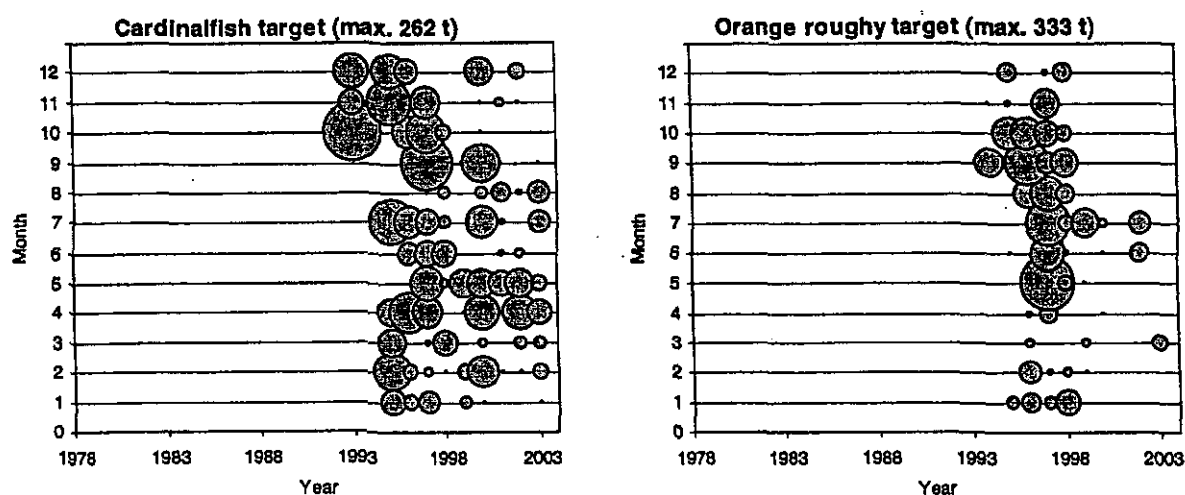


Figure 20: Bubble plots showing normalised estimated catches of black cardinalfish by month and year, for different target species for the Mercury-Colville fishery, with the maximum catch value shown in brackets (t).

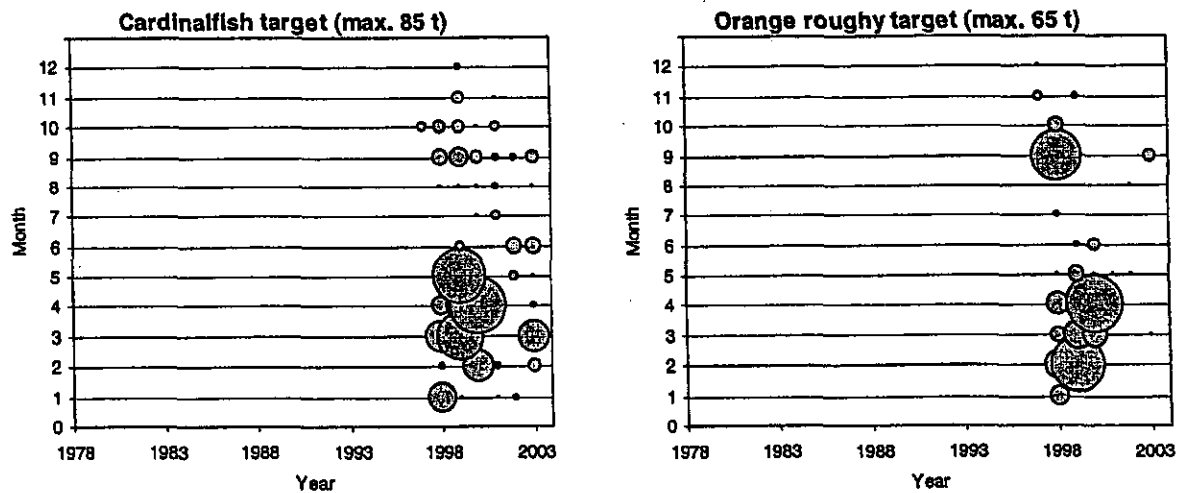


Figure 21: Bubble plots showing normalised estimated catches of black cardinalfish by month and year, for different target species for the White Island fishery, with the maximum catch value shown in brackets (t).

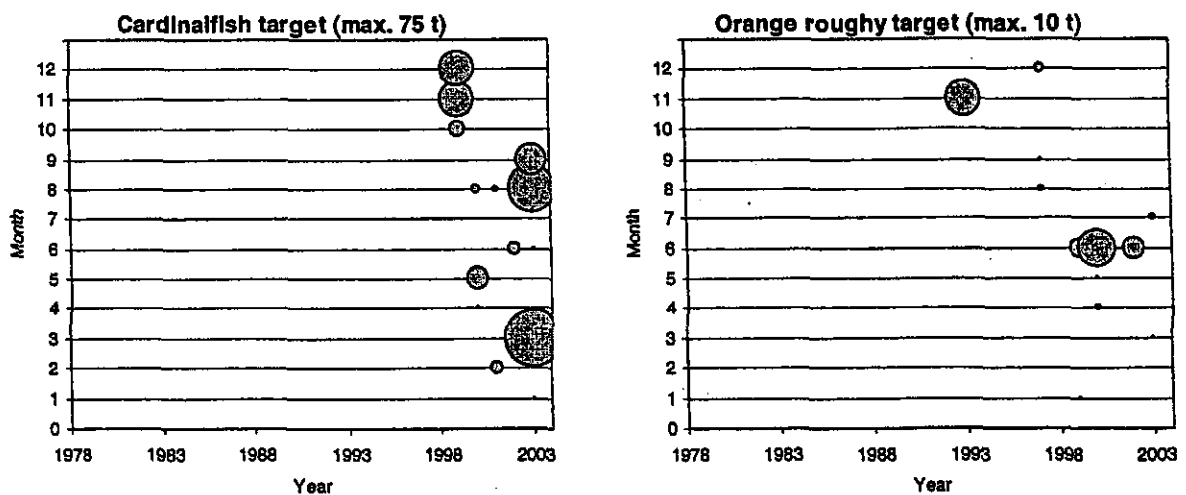


Figure 22: Bubble plots showing normalised estimated catches of black cardinalfish by month and year, for different target species for the North Colville fishery, with the maximum catch value shown in brackets (t).

### 3.6.4 Catch and effort trends

In the Mercury-Colville fishery, the mean length of vessels in the black cardinalfish target fishery showed no trend until 1995–96, then increased to a peak in 1999–2000, and then decreased to a mean length comparable to pre-1995–96 by 2001–02 (Table 16). The targeted effort increased to reach a peak in 1996–97, then declined until 1998–99, after which effort has remained relatively constant. Overall, catches decreased from almost the start of the fishery, in 1994–95, to a low in 1998–99, but after a relatively high catch in 1999–2000, have shown a slow increase. Effort in the fisheries targeting other species was relatively high in the mid 1990s, but then declined rapidly, and has been low since 2000–01. Catch rates in the target fishery have shown a relatively steady decline since the start of the fishery in 1993–94, although there was a relatively high catch rate in 1999–2000. In the fisheries targeting other species, effort has decreased since 1995–96, and catch and catch rates peaked around 1996–97.



**Table 16: Estimated catch (t), number of tows, and catch rate (t/tow) by fishing year for vessels targeting black cardinalfish, or targeting other species, for the Mercury-Colville fishery, with the number of vessels and vessel length statistics for the black cardinalfish target fishery. Catch rate calculated for a minimum of 20 tows.**

Fishing year	Black cardinalfish target							Other-target		
	No. vessels	Vessel length (m)			No. tows	Catch (t)	t/tow	No. tows	Catch (t)	t/tow
		min	mean	max						
1993-94	1	29.8	29.8	29.8	1	0.0	—	12	98.5	—
1994-95	4	29.8	30.8	42.8	225	937.6	4.17	13	69.3	—
1995-96	9	25.4	29.2	42.8	279	647.3	2.32	108	618.0	5.72
1996-97	4	29.6	32.9	41.5	367	796.1	2.17	94	1 062.7	11.31
1997-98	5	26.0	33.9	43.7	202	400.7	1.98	95	475.4	5.00
1998-99	3	29.6	38.6	43.7	111	148.8	1.34	38	182.0	4.79
1999-2000	4	26.0	43.1	43.7	158	510.7	3.23	19	25.3	—
2000-01	3	26.0	39.4	43.7	113	193.4	1.71	1	1.0	—
2001-02	4	26.0	31.1	43.7	127	239.8	1.89	7	101.8	—
2002-03	7	25.4	29.9	43.7	163	242.5	1.49	8	32.3	—

In the White Island fishery, the mean length of vessels in the black cardinalfish target fishery showed no clear trend, although it was relatively high in 1999-2000 and relatively low in 2001-02 (Table 17). The targeted effort increased rapidly to reach a peak in 1998-99, then declined until 2000-01, after which effort has remained relatively constant. The overall trend in catches has been similar, except that catches show an increase after 2000-01. Effort in the fisheries targeting other species has been low, and catches peaked in the late 1990s. Catch rates in the target fishery have been broadly similar to catch and effort, with relatively high catch rates in the late 1990s, a low in 2000-01, and an increase in 2001-02 and 2002-03. However, the relative increase in catch rate in 2002-03 was much greater than shown by catch or effort. Too few data are available to make conclusions from catch rates in the fisheries targeting other species.

**Table 17: Estimated catch (t), number of tows, and catch rate (t/tow) by fishing year for vessels targeting black cardinalfish, or targeting other species, for the White Island fishery, with the number of vessels and vessel length statistics for the black cardinalfish target fishery. Catch rate calculated for a minimum of 20 tows.**

Fishing year	Black cardinalfish target							Other-target		
	No. vessels	Vessel length (m)			No. tows	Catch (t)	t/tow	No. tows	Catch (t)	t/tow
		min	mean	max						
1993-94	0	—	—	—	—	—	—	—	—	—
1994-95	1	34.6	34.6	34.6	1	0.0	—	1	0.02	—
1995-96	0	—	—	—	—	—	—	—	—	—
1996-97	2	33.2	33.8	34.6	5	0.1	—	2	0.2	—
1997-98	5	26.0	33.6	41.5	90	84.7	0.94	4	105.4	—
1998-99	4	26.0	33.7	43.7	205	187.5	0.91	5	98.4	—
1999-2000	4	26.0	36.3	43.7	166	133.8	0.81	4	85.3	—
2000-01	4	26.0	31.5	43.7	53	9.0	0.17	1	0.6	—
2001-02	5	26.0	27.8	43.7	46	16.8	0.36	2	1.2	—
2002-03	6	26.0	33.4	42.8	51	47.8	0.94	5	4.4	—

In the North Colville black cardinalfish target fishery, the time series of data is relatively short (five years). The mean length of vessels in this fishery has shown no clear trend (Table 18). The targeted effort was relatively high in 1999-2000, and peaked in 2002-03. Catches have shown a similar trend to effort. Effort in the fisheries targeting other species has been relatively low, but has increased. The catches have also been low and shown no clear trend, although catches were relatively high in 1994-95 and 1999-2000. Insufficient data are available to describe catch rates in either the target or non-target fisheries.

**Table 18: Estimated catch (t), number of tows, and catch rate (t/tow) by fishing year for vessels targeting black cardinalfish, or targeting other species, for the North Colville fishery, with the number of vessels and vessel length statistics for the black cardinalfish target fishery. Catch rates calculated for a minimum of 20 tows.**

Fishing year	No. vessels	Vessel length (m)			Black cardinalfish target			Other-target		
		min	mean	max	No. tows	Catch (t)	t/tow	No. tows	Catch (t)	t/tow
1993-94	0	-	-	-	-	-	-	-	-	-
1994-95	0	-	-	-	-	-	-	2	9.0	-
1995-96	0	-	-	-	-	-	-	1	<0.1	-
1996-97	0	-	-	-	-	-	-	5	0.6	-
1997-98	0	-	-	-	-	-	-	1	1.0	-
1998-99	1	43.7	43.7	43.7	5	0.1	-	7	2.7	-
1999-2000	3	29.6	43.2	43.7	52	87.5	1.68	10	10.7	-
2000-01	1	43.7	43.7	43.7	10	5.1	-	2	<0.1	-
2001-02	1	43.7	43.7	43.7	17	4.2	-	13	4.0	-
2002-03	2	29.6	42.2	43.7	123	157.9	1.28	16	4.8	-

### 3.7 North Challenger and Lord Howe

#### 3.7.1 The fishery

This fishery occurs largely outside the EEZ. Catches of black cardinalfish were first reported as a by-catch in the orange roughy fisheries in 1980-81, again in 1987-88, and from 1991-92 (Table 19). Catches in the black cardinalfish target fishery started in 1992-93, peaked the following year, but have

**Table 19: Estimated trawl catches (t) of black cardinalfish by target species for the Bay of Plenty fisheries.**  
\* data missing; "-" not applicable.

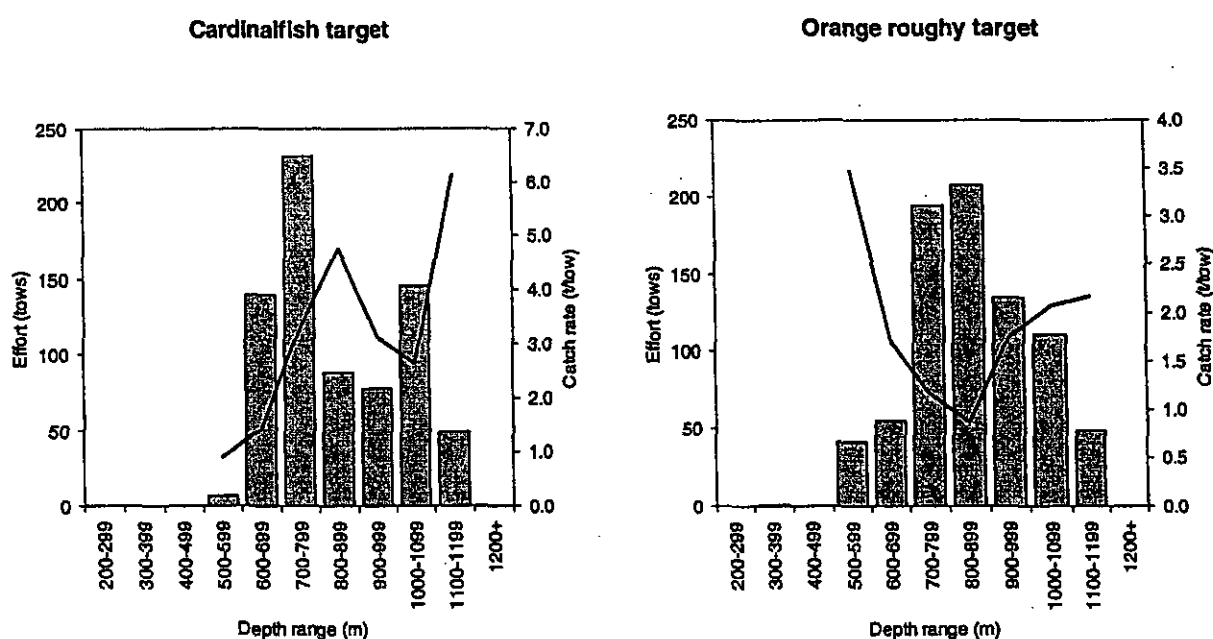
Fishing Year	Alfonsino	Black cardinalfish	Orange roughy	Other <sup>1</sup>
1980-81	0	0	8	0
1981-82	0	0	0	0
1982-83	0	0	0	0
1983-84	0	0	0	0
1984-85	0	0	0	0
1985-86	0	0	0	0
1986-87	0	0	0	0
1987-88	0	0	2	0
1988-89*	-	-	-	-
1989-90*	-	-	-	-
1990-91	0	0	0	0
1991-92	0	0	10	0
1992-93	0	<1	179	<1
1993-94	5	504	533	2
1994-95	<1	118	109	0
1995-96	40	201	3	0
1996-97	3	326	115	<1
1997-98	<1	74	67	0
1998-99	1	279	22	<1
1999-2000	8	138	5	<1
2000-01	0	357	128	0
2001-02	0	133	26	0
2002-03	2	200	22	0

1. Other includes bluenose, hoki, spiky oreo, giant stargazer, and white warehou.

subsequently been variable and show no clear trend. Bycatches from the orange roughy fishery also peaked in 1993–94, but then declined, and then remained at a level at or below about 100 t.

### 3.7.2 Location

In the black cardinalfish target fishery, greatest effort was in the depth class 700–799 m (Figure 23). The peak catch rates in the target fishery were at 800–899 m, and at 1100–1199 m. The catch rates in the orange roughy fishery were inconsistent with this pattern, and were greatest at the shallower and deeper ends of the depth range.



**Figure 23: Total estimated effort (no. tows; bars) and catch rates (t/tow; lines) by depth class and target species for the North Challenger and Lord Howe fishery.**

A number of specific and consistent fishing areas can be identified in the North Challenger and Lord Howe region (Figure 24). The first area is close to the region of shallower ground (less than 1000 m) at the southern end of the Lord Howe Rise, at about 165° 30' E and 36° S. A number of smaller catches have also been taken just to the east of this area and, during the last three fishing years, the small catches have been largely from this area. Two further fishing areas are on the northern end of the Challenger Plateau, one at about 167° 15' E and 37° 20' S, and southeast of this at about 167° 40' E and 37° 30' S. An area further to the south and east also yielded some catches in earlier years, but no large catches have been made in the last three fishing years. Finally, an area to the east has yielded some catches, primarily in the last three fishing years.

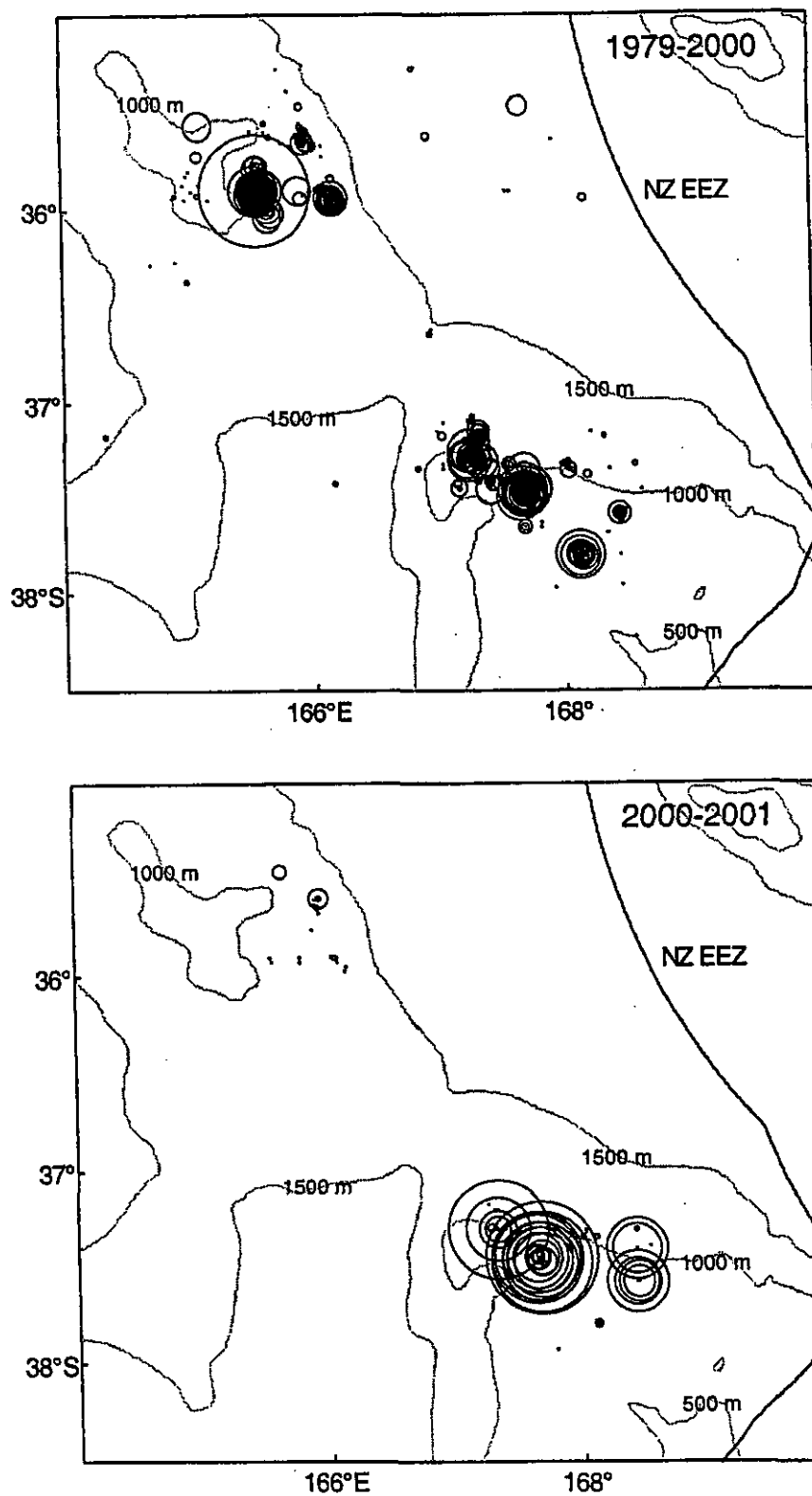


Figure 24: Estimated trawl catch rate (t/tow) of black cardinalfish by fishing position and fishing year for the North Challenger and Lord Howe fishery. Catch rates proportional to circle area (maximum 236 t).

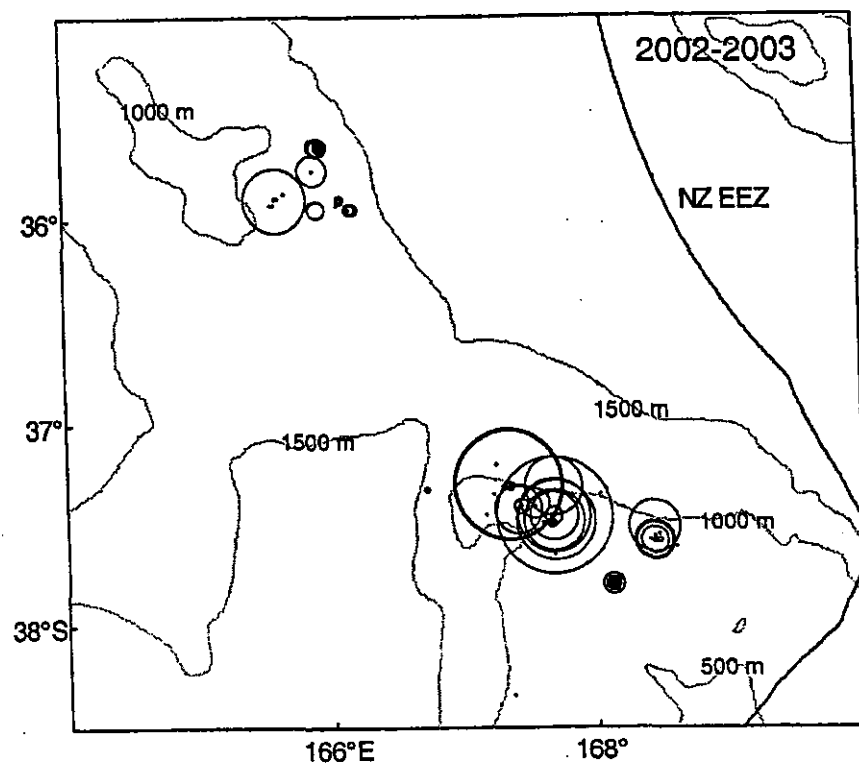
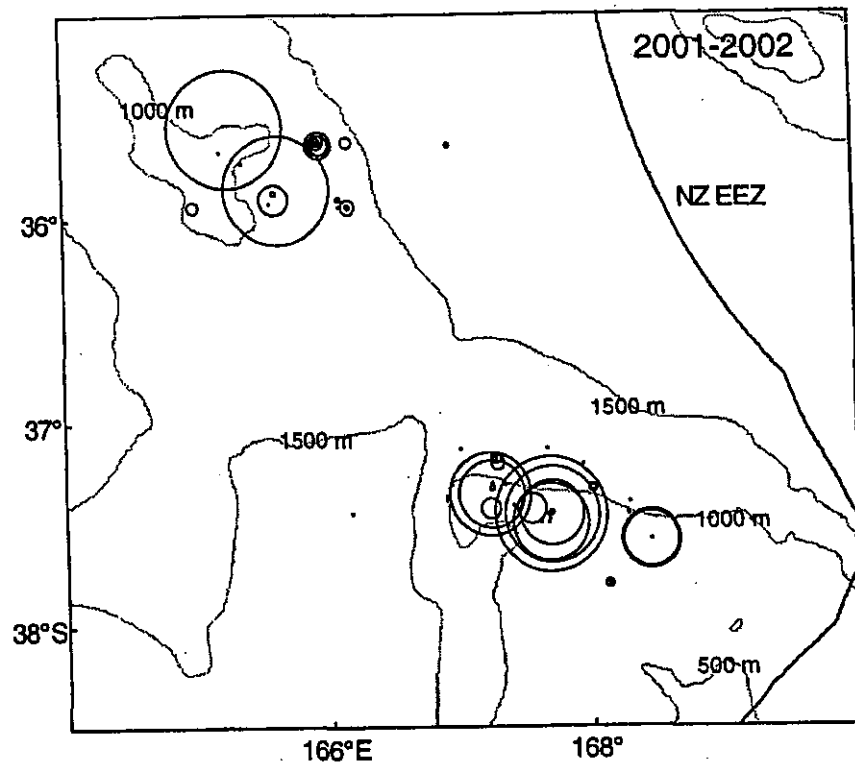


Figure 24 (cont.): Estimated trawl catch rate (t/tow) of black cardinalfish by fishing position and fishing year for the North Challenger and Lord Howe fishery. Catch rates proportional to circle area (maximum 236 t).

### 3.7.3 Seasonality

Catches of black cardinalfish in the target fishery have been made primarily between January and May, although some catches were also taken between October and December between 1994 and 1996 (Figure 25). The seasonal pattern of catches in the orange roughy target fishery is generally similar, but with some catches also taken in June.

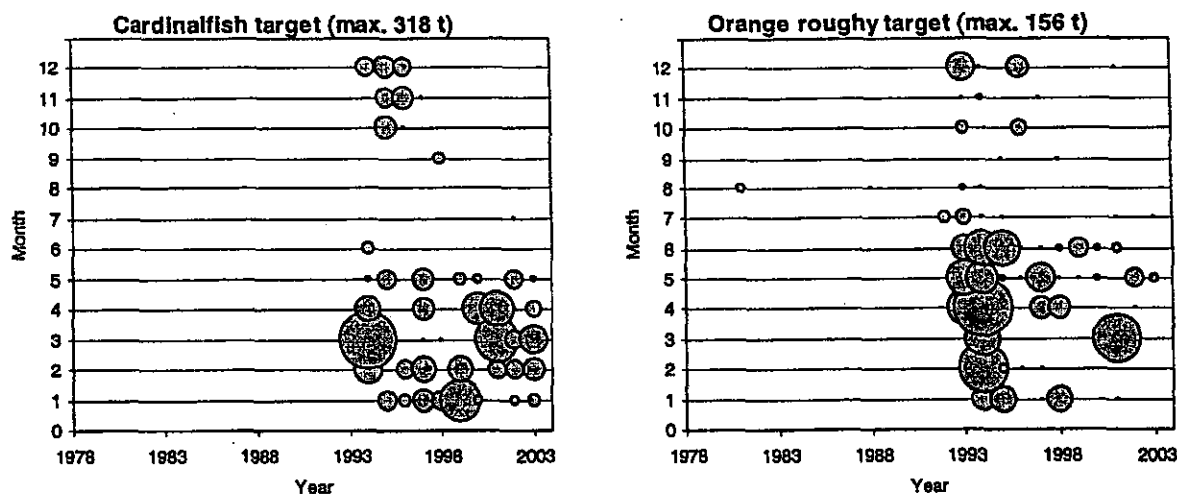


Figure 25: Bubble plots showing normalised estimated catches of black cardinalfish by month and year, for different target species for the North Challenger and Lord Howe fishery, with the maximum catch value shown in brackets (t).

### 3.7.4 Catch and effort trends

The mean length of vessels in the black cardinalfish target fishery increased to 1995–96, and then remained high, but in recent years mean length has decreased steadily (Table 20). The targeted effort has been variable, with no clear trend. The patterns of catch do not clearly follow effort, and have also been variable and without a clear trend. Both catch and effort in the fisheries targeting other species were relatively high in 1992–93 and 1993–94, but subsequently no clear trends are present. Catch rates in both the target and non-target fishery are also variable, and do not show clear trends.

## 4. DISCUSSION

In previous reports, a clear association was made between fishing for black cardinalfish and fishing for orange roughy (Field et al. 1997, Field & Clark 2001). However, since the mid 1990s the relative incidence of black cardinalfish as a bycatch in the orange roughy fishery has generally decreased (Phillips 2002). The present analysis supports a continuation of the decline of the black cardinalfish bycatch in the orange roughy fisheries. A major factor causing this decline is the increasingly restrictive TACCs on orange roughy (Annala et al. 2004). The orange roughy TACCs and fisheries peaked during the early and mid 1990s, and then experienced large declines. Although targeting of black cardinalfish has increased, the present analysis does not generally support a switch from targeting orange roughy to targeting black cardinalfish, as the effort targeting black cardinalfish did not show a clear and associated increase in any areas except for Ritchie and Rockgarden.

Table 20: Estimated catch (t), number of tows, and catch rate (t/tow) by fishing year for vessels targeting black cardinalfish, or targeting other species, for the North Challenger and Lord Howe fishery, with the number of vessels and vessel length statistics for the black cardinalfish target fishery. Catch rates calculated for a minimum of 20 tows. \* missing data; “-” not applicable.

Fishing year	Black cardinalfish target			Other-target		
	No. vessels	Vessel length (m)			No. tows	Catch (t) t/tow
		min	mean	max		
1980-81	0	-	-	-	-	-
1981-82	0	-	-	-	-	-
1982-83	0	-	-	-	-	-
1983-84	0	-	-	-	-	-
1984-85	0	-	-	-	-	-
1985-86	0	-	-	-	-	-
1986-87	0	-	-	-	-	-
1987-88	0	-	-	-	3	1.9
1988-89*	-	-	-	-	-	-
1989-90*	-	-	-	-	-	-
1990-91	0	-	-	-	-	-
1991-92	0	-	-	-	5	10.3
1992-93	2	23.6	34.8	65.7	15	0.3
1993-94	9	24.8	46.8	61.5	83	503.8
1994-95	4	27.6	31.6	41.7	54	117.8
1995-96	2	41.7	49.9	53.6	65	200.8
1996-97	4	41.4	50.0	53.6	89	326.2
1997-98	3	41.7	49.8	53.6	25	74.1
1998-99	6	38.0	42.0	53.6	96	278.7
1999-2000	6	41.7	46.3	57.4	92	137.7
2000-01	3	41.7	42.8	43.7	89	357.3
2001-02	5	36.6	42.5	43.7	58	133.3
2002-03	6	27.0	40.6	43.7	82	199.7

The depth range for black cardinalfish was consistently shallower than for orange roughy, and somewhat shallower in Wairarapa than in other areas. The second peak in catch rates between 900 m and 1199 m could be an artefact caused by the orange roughy fishery, which is predominant at these depths. Catches of black cardinalfish from the target fishery have been reported over a wider period of the year than bycatches from the orange roughy fisheries. Clear similarities in seasonality to the orange roughy fisheries remain only for East Cape, Ritchie and Rockgarden, White Island, and North Challenger and Lord Howe.

Although not directly comparable because of the use of new subareas, the general pattern of catches and effort for QMA 1 in this study are similar to those given by Field & Clark (2001). Field & Clark (2001) indicated an exceptionally large bycatch in 1993-94 associated with the development of the East Cape orange roughy fishery, but the present analysis indicates that this bycatch was taken in Tuaheni High. The decrease in catch rates identified by Field & Clark (2001) has subsequently reversed, with relatively high or increasing unstandardised catch rates after 1998-99. This report indicates that the black cardinalfish bycatch in the alfonso fishery, as identified by Field & Clark (2001), was restricted almost entirely to Ritchie Hill and Rockgarden.

The patterns in the QMA 2 fishery identified in this study show good correspondence with the patterns in 2000-01 reported by Phillips (2002). The decline in catch rates at Mercury-Colville identified by Phillips (2002) appears to have slowed or stabilised according to the unstandardised catch rates. Phillips did not analyse the White Island area.

Previous reports have concluded that catch per unit effort was not a reliable index of abundance for black cardinalfish (Field & Clark 2001, Phillips 2002). The present analysis indicated changes in fleet

composition occurred in most fisheries, and that the number of vessels and effort in the target fisheries have been relatively low (i.e. less than 200 tows per year per area). In this analysis, the coverage of the fishery was also poor for years before 1990–91. It is still not clear whether the poor coverage of the fishery is a reality for these data, or whether data were still incomplete following revision of the fsu database. Further, the catch rates were generally higher in the fisheries targeting other species than in the target fishery, which may indicate that the reported target species has limited or unclear meaning for black cardinalfish. According to Field & Clark (2001), there have also been market value changes over time, catches have been influenced by TACCs on other species, and also influenced by the introduction of the TACC on black cardinalfish itself. However, there was no clear and large increase in black cardinalfish catches associated with the entry to the QMS in 1998, as seen in some other deepwater bycatch species such as ribaldo (authors unpublished data). Catch per unit effort has therefore not yet been shown to be a reliable indicator of abundance trends for black cardinalfish.

## 5. ACKNOWLEDGMENTS

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