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New Zealand Fisheries Assessment Research Document 88/22

Red cod

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This series documents the scientific basis for stock assessments and fisheries management advice in New Zealand. It addresses the issues of the day in the current legislative context and in the time frames required. The documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

RED COD
(*Pseudophycis bacchus*)

I. INTRODUCTION

Red cod, until the mid 1970's considered an undesirable bycatch of demersal trawling around the east and west coasts of South Island, has in the last decade been specifically targeted by the domestic fleet. Substantial quantities are also taken as bycatch by the deepwater fleet (foreign licensed and N.Z. chartered). A TAC was first estimated for this species in 1983/84 but not introduced under the ITQ system until the most recent fishing year 1987/88 when it was set at 15 290 t (Annala, 1987). The management areas of concern are 1 (EEZ area B north and H north), 2 (EEZ area B east and H Central), 3 (EEZ areas C, D, E and F), and 7 (EEZ areas G and H South). This document briefly summarises the available biological and fisheries data relevant to reviewing the current TAC.

II. REVIEW OF THE FISHERY

(a) Variation in landings

(i) Annual landings

Total annual landings of red cod caught by the domestic and deepwater (foreign licensed and NZ chartered) fishing fleet from 1936 to 1985-86 are summarised in Fig. 1. This fishery is characterised by two different periods. First a long period of very low domestic landings, generally less than 1000 t y^{-1} from 1936 to 1976. This was followed by a decade of relatively high but fluctuating landings from 1977 to 1986. The deepwater

catch of red cod grew from less than 1000 t in 1968, peaked at 11 500 t in 1977, fell almost to zero in 1978 but subsequently rose to near 4000 t in 1984 and 1985. Prior to 1976 the only foreign nation to record substantial quantities of red cod was Japan while Korean and Russian boats which did not record by species probably caught red cod (Table 1). Russian and particularly Korean boats have since 1977 taken several hundred tons each year. In addition, since the declaration of the EEZ NZ chartered vessels have taken an increasing catch of red cod.

The total catch of red cod (Fig. 1) increased through the 1970's to a peak in 1977. Catches declined after the declaration of the EEZ, when foreign boats were excluded from the trawl grounds on the east and west coasts of the South Island, and reached their lowest in 1980. Catch of red cod subsequently rose to a record peak of 18 000 t in 1985. However, preliminary estimates drawn from Quota Management Reports indicate that in the 1986-87 fishing year the total catch of red cod was about 4000 t, the lowest since 1981. This catch is only 26% of the 1986-87 TAC.

(ii) Landings by area and month

Domestic

Table 2 summarises the landings of red cod by domestic fishing area and month for 1983-84 to 1985-86. Although red cod occur around the entire New Zealand coast (Paul, 1986) between 40 and 50% of the total NZ domestic catch is fished from area 22, Canterbury Bight. Also important are areas 20 (Pegasus Bay) and areas 34 and 35 (northern Westland and Buller). These 4 areas accounted for between 67 and 79% of the domestic catch in the 3 fishing years summarised in Table 1. A significant proportion of the catch (12-14%) in each year is fished from unspecified areas.

Between 74 and 80% of all red cod caught by the domestic fleet is fished in summer and autumn from January to June (see Table 2). There is a north-south progression of peak catches along both the east and west coasts of South Island. Peak catch occurs as early as November off Kaikoura and as late as September around Southland (Table 3). However, this does not indicate major stock movement as catches are much higher in areas 20 and 22 for almost all months every year.

Deepwater (NZ chartered and foreign licensed)

The majority of the deepwater catch of red cod comes from 4 areas, EA, FE, FW and C- (see Table 4). Since 1978-79 area C- has declined in importance while in both area FE and FW catch has increased. Catches tend to be slightly higher in late summer and autumn and again early in spring with winter minimums but this varies among years (see Table 5). There is no northern-southern trend in month of peak catch by the deepwater fleet.

(iii) Source of variation in landings

Annual, area and monthly fluctuations in catch of red cod by both the domestic and deepwater fleet highlight the complex and unpredictable nature of this fishery. Changes in fishing practice are a major cause of the increase in red cod landed by the domestic fleets since 1977. Prior to this year the landed value of red cod was very low and consequently much of what was caught by the domestic fleet as bycatch while fishing for more valuable species was dumped at sea (Fenaughty and Bagley, 1981). Since 1977 the value of red cod has increased and the entire catch is probably landed. Thus no attempt has been made to assess variations in domestic catch in relation to effort in this paper. In addition the changing area of operation of the foreign fleet since the declaration of the EEZ has had a significant impact on the east and west coast fisheries.

Longshore and inshore-offshore migrations may affect the availability of red cod to the domestic fleet. However, there is little evidence for this. For example, in years of poor fishing by the inshore domestic vessels there is no corresponding increase in the catch of the offshore deepwater vessels. Hence the large annual fluctuations in catch since 1977 could be caused by real changes in abundance, perhaps a consequence of variable recruitment, coupled with relatively high growth rates and high fishing or natural mortality.

(b) Size and age composition of the catch

There is no information compiled on the size or age of the commercial catch of red cod.

Red cod were caught with 'commercial' gear during a ground fish trawl survey off the east coast of the South Island (Paul and Kucerans, 1984). These fish ranged from 22 to 70 cm TL but most were between 40 and 60 cm TL. Habib (1975) used length frequency distributions to study age and growth and suggested that 40 cm TL may be reached by the end of the second year.

(c) Maori and recreational fishing

There are no data on the extent of Maori or recreational fishing for red cod. Both activities are likely to be most extensive around Banks Peninsula, in the Canterbury Bight and off the west coast of South Island but are probably insignificant compared to commercial landings.

III. STOCK ASSESSMENT

(a) Stock structure

There is no data on stock structure of red cod around New Zealand. However, for quota management purposes the New Zealand stock has been broken into four groups: Stock 1 (Auckland East and West), Stock 2 (Central East and West), Stock 3 (Chatham Rise, SE coast, Sub-Antarctic and Southland) and Stock 7 (Challenger).

(b) Resource surveys

No surveys have been specifically designed to estimate the structure or biomass of red cod populations. Red cod were caught as bycatch in a number of trawl surveys carried out around the South Island (see Hurst and Fenaughty 1985 for a summary). However, the coefficients of variation are often very high (median 43%, range 9-99%) and, therefore, of little use in determining absolute biomass. TACs were originally based on the highest recorded catch (July 1983-June 1984). Stock 3 TAC was later increased because of even higher levels of reported catch.

(c) Age and growth

Red cod can grow to about 80 cm TL (Paul, 1986). Habib (1975) examined size frequency distributions of red cod caught from the Canterbury Bight and suggested that this species grows to 40 cm in two years after hatching. No data is available on growth of older larger fishes. Neither otoliths or scales have been studied to confirm these growth rates. In addition otoliths from red cod appear difficult to read. Maturity is reached at 28-36 cm for fish from East Cape but not until 52 cm TL in the Canterbury Bight (Habib, 1975).

(d) Estimation of MCY

The only data on which to base stock assessment are commercial catch data - for all Fishstock areas the average of the 1983-84 to 1986-87 catches has been used, assuming relatively constant effort (N.B. the 1986-87 catch was included as the TAC introduced that year was not a limiting factor on the level of catch). The catch unrecorded by area has been attributed to Fishstocks 3 and 7 using a 10:1 ratio (the average of the ratio of the reported catches over this time). Due to the apparent large annual variability, MCY has been calculated as 0.6 (1.0 for Fishstocks 1+2) of the average catch. Biomass data are not included as the areas surveyed do not encompass the main red cod fishery areas and the coefficients of variation are usually high.

Fishstocks 1+2

MCY = cY, where c = 1.0, Y = average of the reported catch 1983-84 to 1986-87.

Hence: MCY = 110 t.

This represents the average of the 4 most recent years catches (Table 6), but has not been reduced as described above (i.e. c = 1.0) because the amounts are small and the unreported catch by area has not been apportioned to these areas.

Fishstock 3

MCY = cY, where c = 0.6, Y = average of the estimated catch 1983-84 to 1986-87.

Hence: MCY = 6300 t.

This represents the average of the 4 most recent years catches (Table 6), with an allowance for catch not recorded by area, based on the average ratio

of Fishstock area 3:area 7 of 10:1) x 0.6, because of the large (5 fold from 1984-85 to 1986-87) fluctuation in annual catches. The recent drop in catches has been interpreted as a fluctuation rather than a continuing decline. Although there may be natural fluctuations in abundance (presumably related to fast growth), the heavy fishing pressure in 1977 and 1984-85 may be exacerbating these fluctuations. There is little evidence for them being fluctuations in availability rather than abundance.

Fishstock 7

MCY = cY, where c = 0.6, Y = average of the estimated catch 1983-84 to 1986-87

Hence: MCY = 900 t.

This represents the same approach as for Fishstock 3; i.e. the average of the 4 most recent years catches (apportioned as described) x 0.6, again because of the large (5 fold from 1983-84 to 1986-87) fluctuation in annual catches. The interpretation of this fluctuation is also the same as for Fishstock 3.

IV. MANAGEMENT IMPLICATIONS

Large fluctuations in red cod stocks are a problem, particularly on the east coast of the South Island. This is not only a problem for the fishermen who rely on red cod, but creates additional pressures for the bycatch trade-off system, and leads to increased targeting on other species. The high level of fishing pressure in recent years may have been exacerbating natural fluctuations and lowering the TAC to a more average yield should help to lessen the extremes.

There are a range of species associations which are potential bycatch problems in the mixed fishery of which red cod is a part; in particular, salmon and elephant fish.

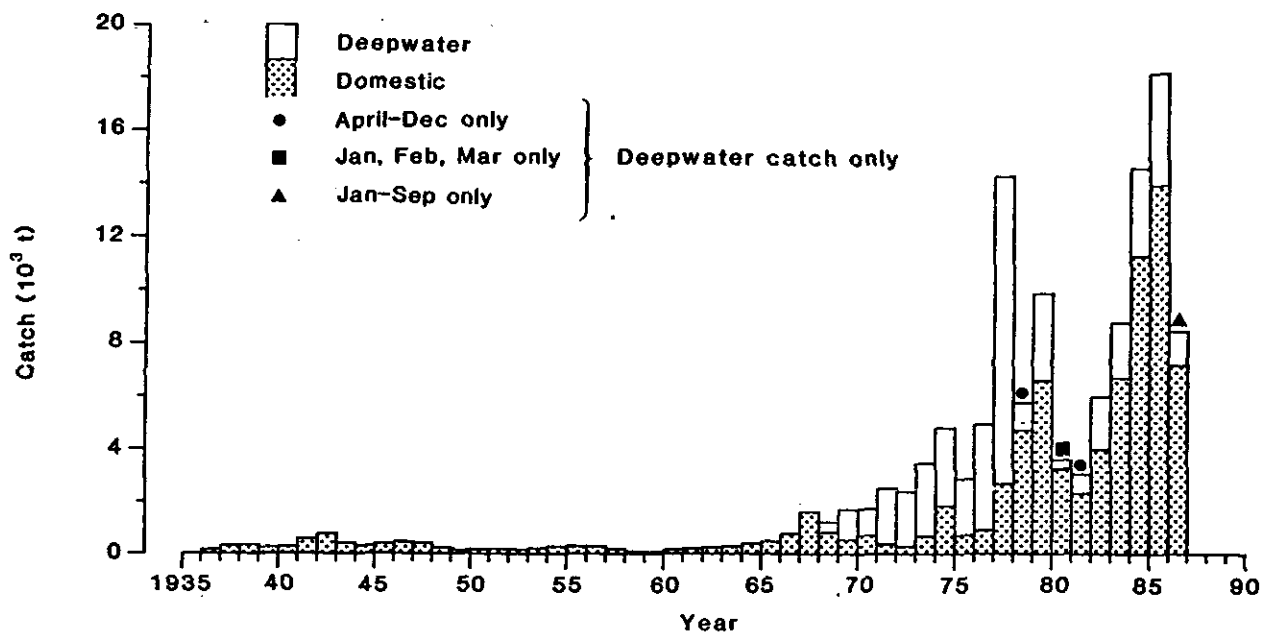
Dumping of red cod has occurred in the past but has probably been minimal in recent years and should not affect the data used for the estimation of average yields.

Dumping of bycatch species has been occurring in the last 2 seasons. The reduced abundance of red cod has resulted in a different catch mix for which some fishermen do not have the correct quota; there appears to be a problem this season with barracouta in particular.

This is one species where research effort could impact significantly on our understanding of the large fluctuations in the fishery, and lead to more informed yield recommendations and management. Particular research areas which should make an impact are: growth (E.C.S.I. catch sampling?), a continuous survey of the distribution and abundance on the E.C.S.I. and Stewart/Snares Is. shelf, and stock relationships. It may also be possible to predict good and bad years by estimating year class strength of pre-recruits. The use of CPUE data as a predictive tool could be investigated, but may only be useful if combined with catch sampling of length frequencies.

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Data sources
 1936-73, Habib 1975
 1974-82, King 1985
 1983, King 1986
 1983-86 (Domestic), FSU summary data sheets
 1978-86 (Foreign), Deepwater trawl summaries

Fig. 1. Annual domestic and deep-water (NZ chartered and foreign licensed) landings (t) of red cod 1936-1986.

TABLE 1: Reported catch (t) of red cod by nation 1970-1986/87

	NEW ZEALAND		FOREIGN LICENSED				TOTAL
	Domestic	Chartered	Japan	Korea	U.S.S.R.	Total	
1970 ¹	760	-	995	-	-	995	1 755
1971 ¹	393	-	2 140	-	-	2 140	2 533
1972 ¹	301	-	2 082	-	<100	2 182	2 483
1973 ¹	736	-	2 747	-	<100	2 847	3 583
1974 ¹	1 876	-	2 950	-	<100	3 050	4 926
1975 ¹	721	-	2 131	-	<100	2 231	2 952
1976 ¹	948	-	4 001	-	600	4 601	5 549
1977 ¹	2 690	-	8 001	1 358 ⁶	2 200	11 559	14 249
1978/79 ²	5 343	124	2 560	151	51	2 762	8 229
1979/80 ^{2,3}	5 638	883	537	259	116	912	7 433
1981/82 ²	3 210	387	474	70	102	646	4 243
1982/83 ²	4 342	406	764	675	52	1 493	6 241
1983/83 ⁴	3 751	390	149	401	3	553	4 694
1983/84 ⁵	10 189	1 764	1 364	480	49	1 893	13 846
1984/85 ⁵	14 097	2 381	978	829	7	1 814	18 292
1985/86 ⁵	9 035	1 014	739	147	5	891	10 940
1986/87 ⁵	?	?	?	?	?	?	3 941 ⁷

- 1 Calendar Year.
- 2 1 April-31 March.
- 3 Fishing returns not processed 1980-81.
- 4 1 April-30 Sept.
- 5 1 Oct.-30 Sept.
- 6 Principally red cod and ribaldo.
- 7 From QMS - may be underestimated.

TABLE 2: Catch (t) of red cod by the domestic fleet by area and month for 1983-84 to 1985-86
(49-52 No significant catch)

	Domestic Fishing Areas											Total	%
	1-15	18-19	20-21	22-23	24	25-30	33	34	35	16-17 and 36-48	Undefined		
1983/84													
Oct	6	50	33	6	0	11	9	68	12	16	31	244	2%
Nov	13	56	34	22	0	7	9	49	12	13	17	232	2%
Dec	10	26	112	159	1	11	7	55	9	8	51	449	4%
Jan	10	40	198	551	1	12	15	59	93	11	87	1 077	11%
Feb	4	24	257	646	5	28	21	72	126	20	274	1 477	15%
Mar	6	28	134	816	4	44	58	157	37	25	124	1 433	14%
Apr	12	24	198	457	8	23	18	94	59	77	173	1 143	11%
May	9	18	129	412	11	38	9	99	56	54	166	1 401	14%
Jun	8	15	97	741	13	49	6	120	70	05	198	1 522	15%
Jul	16	18	28	66	12	8	20	55	71	15	67	476	5%
Aug	14	11	14	6	2	12	90	196	9	34	11	399	4%
Sep	10	12	32	7	0	42	30	128	2	26	32	321	3%
Total	118	322	1 266	3 889	57	285	292	1 152	544	1 005	1 231	10 161	
%	1%	3%	12%	38%	0.6%	3%	3%	11%	5%	10%	12%		
1984/85													
Oct	15	39	50	13	2	35	4	26	15	41	19	259	2%
Nov	22	98	128	336	3	29	1	39	32	32	45	765	5%
Dec	3	44	474	271	21	36	1	13	20	31	92	1 006	7%
Jan	7	56	343	643	8	31	0	3	17	19	150	1 277	9%
Feb	5	36	257	469	6	25	2	20	52	18	67	957	7%
Mar	3	26	425	1 035	15	14	4	30	90	90	204	1 936	14%
Apr	1	15	311	1 186	6	16	2	54	46	114	241	1 992	14%
May	5	25	145	1 735	35	15	5	55	41	104	550	2 737	19%
Jun	5	2	128	1 108	56	18	0	84	42	72	275	1 790	13%
Jul	2	1	34	546	4	12	1	17	5	43	176	841	6%
Aug	6	0	18	4	3	58	10	24	3	57	68	251	2%
Sep	9	0	21	3	1	140	14	24	0	20	68	300	2%
Total	83	342	2 334	7 349	160	429	44	389	363	641	1 955	14 089	
%	0.6%	2%	17%	52%	1%	3%	0.3%	3%	3%	5%	14%		
1985/86													
Oct	3	5	43	57	3	17	1	7	0	9	12	157	2%
Nov	8	21	282	420	6	18	6	8	0	10	34	813	9%
Dec	4	30	257	390	8	19	0	3	0	7	209	927	10%
Jan	1	5	463	1 274	1	10	5	0	0	16	237	2 012	22%
Feb	1	34	647	718	4	33	5	0	0	23	139	1 604	18%
Mar	2	13	248	385	7	41	1	0	1	6	65	769	9%
Apr	1	1	153	686	11	40	2	0	1	14	129	1 038	12%
May	1	1	78	454	79	32	0	2	0	14	103	764	8%
Jun	1	1	39	294	20	8	0	2	0	12	120	497	6%
Jul	1	1	31	58	18	18	1	3	0	9	49	189	2%
Aug	1	1	17	43	3	2	23	30	0	11	25	156	2%
Sep	1	1	46	17	3	7	4	2	0	6	12	99	1%
Total	25	114	2 304	4 796	163	245	48	57	2	137	1 134	9 025	
%	0.3%	1%	26%	53%	2%	3%	0.5%	0.6%	0.02%	2%	13%		

TABLE 3: Month of peak red cod catch by area on the east and west coast South Island. Data summarised from Table 2.

Fishing year	Domestic Fishing Area							
	East Coast					West Coast		
	18	20	22	24	25-30	35	34	33
1983/84	Nov	Feb	Mar	Jun	Jun	Feb	Aug	Aug
1984/85	Nov	Dec	May	Jun	Sep	Mar	Jun	Sep
1985/86	Feb	Feb	Jan	May	Mar	Apr	Aug	Aug

TABLE 4: Summary of red cod catch (t) by deep water trawl (NZ chartered and foreign licensed)
1978/79-1985/86

EEZ Area	1978-79 ¹	1979-80 ¹	1980-81 ²	1981-82 ¹	1982-83 ¹	1983-83 ³	1983-84 ⁴	1984-85 ⁴	1985-86 ⁴
A	0	0	-	0	0	0	0	0	0
B	6	0	-	0	0	0	0	0	0
CM	20	47	-	22	91	69	34	43	10
C-	1 142	523	-	58	7	28	55	114	96
D	34	320	-	114	89	97	507	149	86
EA	738	343	-	522	1 291	431	1 100	854	321
EB	0	24	-	0	0	0	20	6	0
EC	1	28	-	30	4	14	12	3	14
EP	0	0	-	7	25	0	6	128	46
FE	202	110	-	35	230	20	212	1 213	532
FW	367	331	-	209	140	260	1 579	1 624	619
G	122	21	-	16	8	15	33	3	174
H	259	47	-	27	15	10	101	49	7
Undefined	6	0	-	0	0	1	0	11	
Total	2 887	1 794	-	1 040	1 900	945	3 659	4 197	1 905

1 Fishing year 1 Apr-31 March.

2 No data for entire year.

3 Fishing year 1 Apr-30 Sept.

4 Fishing year 1 Oct-30 Sept.

TABLE 5: Catch (t) of red cod by the deepwater vessels (NZ chartered and foreign licensed) by Fisheries Management Area and month 1983-84 to 1985-86. Areas A and B not included because no catch of red cod

	Fisheries Management Area											Total	%
	CM	C-	D	EA	EB	EC	EP	FE	FW	G	H		
1983/84													
Oct	6.9	0.8	23	42	0	0	0	34	337	0.2	1.9	446	12%
Nov	2.9	6.8	3	0	6.8	0	0	1.3	287	0	9.5	317	9%
Dec	0	11	2	85	0	0	0	15	63	0.2	20	197	5%
Jan	0.4	1.7	34	82	0	0	0	4.4	66	0.1	22	210	6%
Feb	0	0	366	54	0	2.7	0.5	8.8	7.6	0	18	457	12%
Mar	0	0	0.4	202	0	0	3.6	32	3	0	17	258	7%
Apr	1.2	3.7	4.4	204	0	0	0.9	76	229	0	1.7	520	14%
May	0.1	0.1	0.3	255	3.4	0	0	15	182	0	2.3	459	13%
Jun	1.4	28	10	50	0	0	0	21	41	0	6.7	158	4%
Jul	0.6	0	40	96	0	0.2	0	0.7	23	0.2	0	160	4%
Aug	12	0.7	20	28	10	2.7	1	3	322	9.3	0.2	409	11%
Sep	8.1	1.6	3.8	1.8	0.3	5.7	0	2.3	19	23	1.7	67	2%
Total	34	55	507	1 099	20	12	6	212	1 579	33	101	3 658	
%	1%	1.5%	14%	30%	1%	0.3%	0.2%	6%	43%	1%	3%		
1984-85													
Oct	4.3	19.5	2.4	0	0	0.1	0.4	0.9	74	0	2.2	104	2%
Nov	1.9	9.8	11	31	0	0	0.9	8.0	63	0	3.1	130	3%
Dec	0	0.3	31	180	0	0	1.6	55	81	0	15	363	9%
Jan	0	5.6	9.2	114	0	0	11	45	144	0	23	351	8%
Feb	0	0	4.8	180	0	0	14	61	211	0	0	471	11%
Mar	1.5	1.0	10	80	2.2	0	0.8	44	134	0	0	274	7%
Apr	0	0	7.5	147	2.4	0	3.3	72	136	0	1.4	369	9%
May	0	0.4	3.8	72	0.4	0	19	130	36	0	1.3	263	6%
Jun	0.1	1.9	29	29	0.6	0	0	267	16	0	1.2	344	8%
Jul	0.1	3	22	5	0.8	0	77	519	10	0	1.5	639	15%
Aug	22	43	1.9	8	0	0.8	0	10	154	2.2	0.1	242	5%
Sep	13	30	15	6.5	0	1.8	0.4	1.4	565	0.6	0	633	15%
Total	43	114	149	854	6.3	2.7	128	1 213	1 624	2.8	4.9	4 184	
%	1.0%	3%	4%	20%	0.2%	0.1%	3%	29%	39%	0.1%	1%		
1985-86													
Oct	0.6	20	0.3	1.6	0	0.6	0.1	4.5	359	0	0	387	20%
Nov	0.8	13	2.9	14	0	0.1	0	31	44	0	1.4	107	6%
Dec	0.3	3.0	16	28	0	0.7	20	48	19	0	0.2	135	7%
Jan	0.1	3.8	0.6	20	0	0	26	155	14	0	0	219	11%
Feb	0	0	1.6	94	0	0	0	108	39	0	0	242	13%
Mar	0	0.1	8.0	69	0	0	0	103	28	0	0	208	11%
Apr	2.2	13	13	53	0	0	0	36	27	0	0	144	8%
May	0.5	13	30	29	0	0	0	41	9	0	2.4	125	7%
Jun	1.4	0	12	3.8	0	0	0	0.8	0.6	0	0.4	19	1%
Jul	0	0	0.1	7.9	0	0	0	0	2	0.3	0	10	0.5%
Aug	0.1	0	0	0.9	0	2.1	0	1.5	10	117	0	132	7%
Sep	3.4	30	1.0	1.1	0	10	0.2	4.9	66	68	2.7	178	9%
Total	9.5	96	86	321	0	14	46	532	619	174	7.2	1 905	
%	0.5%	5%	5%	17%	0%	0.7%	2%	28%	32%	9%	0.4%		

TABLE 6: Estimated total catch of red cod, by red cod fishstock area, for the fishing years 1983-84 to 1986-87

Fishstock code/area	Catch (t)				TAC 1986-87
	1983-84	1984-85	1985-86	1986-87**	
1 Auckland	12	9	6	5	30
2 Central	197	126	48	46	350
3 South East, Chatham, Southland, Sub-Antarctic	9 357	14 751	9 346	3 271	11 960
7 Challenger	3 051	1 442	408	619	2 940
Not Specified	1 231	2 318	2 124	?	

** From QMS - may be underestimated.