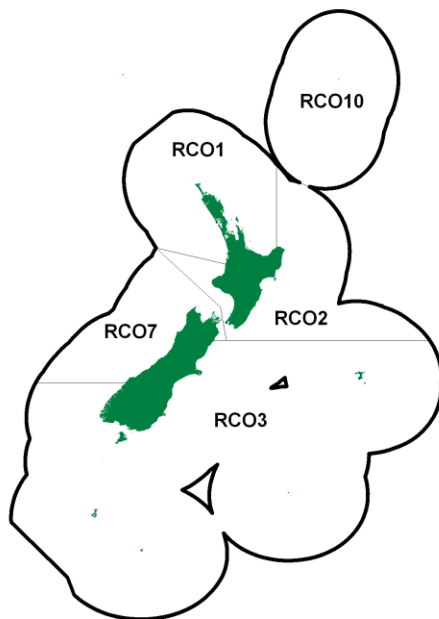


RED COD (RCO)*(Pseudophycis bachus)*

Hoka

**1. FISHERY SUMMARY****1.1 Commercial fisheries**

Red cod are targeted primarily by domestic trawlers in the depth range between 30 and 200 m and are also a bycatch of deepwater fisheries off the southeast and southwest coasts of the South Island. The domestic red cod fishery is seasonal, usually beginning in November and continuing to May or June, with peak catches around January and May. During spring and summer, red cod are caught inshore before the fishery moves into deeper water during winter. RCO entered the QMS in 1986.

Reported annual catches by nation from 1970 to 1986–87 are given in Table 1. Foreign vessel catches declined and were negligible by 1987–88.

Table 1: Reported annual catch (t) of red cod by nation from 1970 to 1986–87.

Fishing year	New Zealand		Foreign licensed				Combined Total
	Domestic	Chartered	Japan	Korea	USSR	Total	
1970*	760	-	995	-	-	995	1 755
1971*	393	-	2 140	-	-	2 140	2 533
1972*	301	-	2 082	-	< 100	2 182	2 483
1973*	736	-	2 747	-	< 100	2 847	3 583
1974*	1 876	-	2 950	-	< 100	3 050	4 926
1975*	721	-	2 131	-	< 100	2 231	2 952
1976*	948	-	4 001	-	600	4 601	5 549
1977*	2 690	-	8 001	1 358	\$2 200	11 559	14 249
1978–79*	5 343	124	2 560	151	51	2 762	8 229
1979–80*	5 638	883	537	259	116	912	7 433
1981–82*	3 210	387	474	70	102	646	4 243
1982–83*	4 342	406	764	675	52	1 493	6 241
1983–83†	3 751	390	149	401	3	553	4 694
1983–84†	10 189	1 764	1 364	480	49	1 893	13 846
1984–85†	14 097	2 381	978	829	7	1 814	18 292
1985–86†	9 035	1 014	739	147	5	891	10 940
1986–87‡	2 620	1 089	197	4	59	261	3 969

1970–1977 = calendar years; 1978–79 to 1982–83 = 1 April–31 March; 1980–1981=no fishing returns processed this year; 1983–1983 - 1 April–30 September; 1983–84 to 1986–87 - 1 October–30 September; * MAF data; † FSU data; ‡ QMS data § mainly ribaldo and red cod.

Recent reported landings and TACCs of red cod by Fishstock are shown in Table 3, while Figure 1 depicts historical landings and TACC values for the three main RCO stocks.

RED COD (RCO)

Table 2: Reported landings (t) for the main QMAs from 1931 to 1982.

Year	RCO 1	RCO 2	RCO 3	RCO 7	Year	RCO 1	RCO 2	RCO 3	RCO 7
1931–32	0	0	16	6	1957	0	5	189	6
1932–33	0	51	41	67	1958	0	8	84	6
1933–34	0	0	28	21	1959	0	15	95	23
1934–35	0	0	18	0	1960	0	16	165	46
1935–36	0	0	12	0	1961	0	16	184	41
1936–37	0	13	35	14	1962	0	48	193	60
1937–38	0	27	143	32	1963	0	27	248	46
1938–39	0	19	279	27	1964	0	29	377	49
1939–40	5	24	213	19	1965	0	65	339	120
1940–41	0	41	213	50	1966	0	91	500	234
1941–42	0	12	539	61	1967	0	54	1358	243
1942–43	1	4	728	54	1968	0	13	1124	87
1943–44	0	3	362	34	1969	0	35	1645	69
1944	0	2	287	5	1970	0	34	1536	184
1945	0	5	423	5	1971	0	8	2453	72
1946	0	13	434	51	1972	1	10	274	19
1947	3	18	322	74	1973	1	44	475	219
1948	9	8	202	17	1974	1	37	6788	949
1949	0	4	123	19	1975	0	37	4798	233
1950	0	3	199	13	1976	0	20	10960	535
1951	0	13	198	23	1977	0	242	12379	2666
1952	0	11	133	35	1978	4	224	7069	2296
1953	0	19	205	41	1979	5	76	7921	1936
1954	0	59	233	48	1980	2	41	3644	628
1955	0	28	247	37	1981	0	42	2478	705
1956	0	11	297	18	1982	9	125	5088	787

Notes:

1. The 1931–1943 years are April–March but from 1944 onwards are calendar years.
2. Data up to 1985 are from fishing returns; Data from 1986 to 1990 are from Quota Management Reports.
3. Data for the period 1931 to 1982 are based on reported landings by harbour and are likely to be underestimated as a result of under-reporting and discarding practices. Data includes both foreign and domestic landings. Data were aggregated to FMA using methods and assumptions described by Francis & Paul (2013).

Table 3: Reported landings (t) of red cod by Fishstock from 1983–84 to 2014–15, and actual TACCs (t) for 1986–87 to 2014–15. The QMS data is from 1986–present.

Fishstock FMA (s)	RCO 1		RCO 2		RCO 3		RCO 7		RCO 10	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1983–84*	12	-	197	-	9 357	-	3051	-	0	-
1984–85*	9	-	126	-	14 751	-	1 442	-	0	-
1985–86*	6	-	48	-	9 346	-	408	-	0	-
1986–87	5	30	46	350	3 300	11 960	619	2 940	0	10
1987–88	8	40	81	357	2 878	12 182	1 605	2 982	0	10
1988–89	9	40	85	359	7 732	12 362	1 345	3 057	0	10
1989–90	8	42	105	362	6 589	13 018	800	3 105	0	10
1990–91	12	42	68	364	4 630	12 299	839	3 125	0	10
1991–92	26	42	358	364	6 500	12 299	2 220	3 125	0	10
1992–93	46	42	441	364	9 633	12 389	4 083	3 125	0	10
1993–94	44	42	477	364	7 977	12 389	2 992	3 125	0	10
1994–95	63	42	762	364	12 603	12 389	3 569	3 125	0	10
1995–96	28	42	584	500	11 038	12 389	3 728	3 125	0	10
1996–97	42	42	396	500	10 056	12 389	3 710	3 125	0	10
1997–98	22	42	192	500	9 972	12 389	2 700	3 125	0	10
1998–99	10	42	282	500	13 926	12 389	2 055	3 125	0	10
1999–00	3	42	130	500	4 824	12 389	633	3 125	0	10
2000–01	5	42	112	500	2 776	12 389	1 538	3 125	0	10
2001–02	6	42	150	500	2 862	12 389	1 409	3 126	0	10
2002–03	8	42	144	500	5 107	12 389	1 657	3 126	0	10
2003–04	11	42	225	500	7 724	12 389	2 358	3 126	0	10
2004–05	21	42	423	500	4 212	12 389	3 052	3 126	0	10
2005–06	24	42	372	500	3 222	12 389	3 061	3 126	0	10
2006–07	25	42	256	500	1 877	12 389	3 409	3 126	0	10
2007–08	12	42	225	500	3 236	4 600	2 984	3 126	0	10
2008–09	12	42	212	500	2 542	4 600	2 131	3 126	0	10
2009–10	14	42	364	500	2 994	4 600	1 864	3 126	0	10
2010–11	19	42	501	500	4 567	4 600	1 603	3 126	0	10
2011–12	8	42	549	500	5 389	4 600	1 608	3 126	0	10
2012–13	6	42	300	500	5 292	4 600	1 282	3 126	0	10
2013–14	6	42	167	500	4 411	5 391	1 272	3 126	0	10
2014–15	7	42	142	500	2173	4 600	1482	3 126	0	10

Table 3 [continued]

Fishstock FMA (s)	Total	
	Landings§	TACC
1983–84*	13 848	-
1984–85*	18 292	-
1985–86*	10 940	-
1986–87	3 970	15 290
1987–88	4 506	15 571
1988–89	9 171	15 828
1989–90	7 502	16 537
1990–91	5 549	15 840
1991–92	9 104	15 840
1992–93	14 203	15 930
1993–94	11 491	15 930
1994–95	16 997	15 930
1995–96	15 350	16 066
1996–97	14 204	16 066
1997–98	12 886	16 066
1998–99	16 273	16 066
1999–00	5 590	16 066
2000–01	4 432	16 066
2001–02	4 427	16 067
2002–03	6 916	16 067
2003–04	10 318	16 067
2004–05	7 708	16 067
2005–06	6 679	16 067
2006–07	5 567	16 067
2007–08	6 457	8 278
2008–09	4 897	8 278
2009–10	5 236	8 278
2010–11	6 691	8 278
2011–12	7 627	8 278
2012–13	6 881	8 278
2013–14	5 855	9 069
2014–15	3 804	8 278

*FSU data.

§ Includes landings from unknown areas before 1986–87.

The bulk of reported landings are taken from RCO 3, in particular the Canterbury Bight and Banks Peninsula areas. The red cod fishery is characterised by large variations in catches between years. Research indicates that this interannual variation in catch is due to varied recruitment causing biomass fluctuations rather than a change in catchability. The RCO 3 TACC was reduced by 63% from the 1 October 2007 to 4600 t, with the TAC being set at 4930 t (customary, recreational and other sources of mortality were allocated 5, 95 and 230 t respectively). All RCO stocks fisheries have been put on to Schedule 2 of the Fisheries Act 1996. Schedule 2 allows that for certain “highly variable” stocks, the Total Annual Catch (TAC) can be increased within a fishing season. The base TAC is not changed by this process and the “in-season” TAC reverts to the original level at the end of each season. No RCO stocks have yet had an in-season increase.

RED COD (RCO)

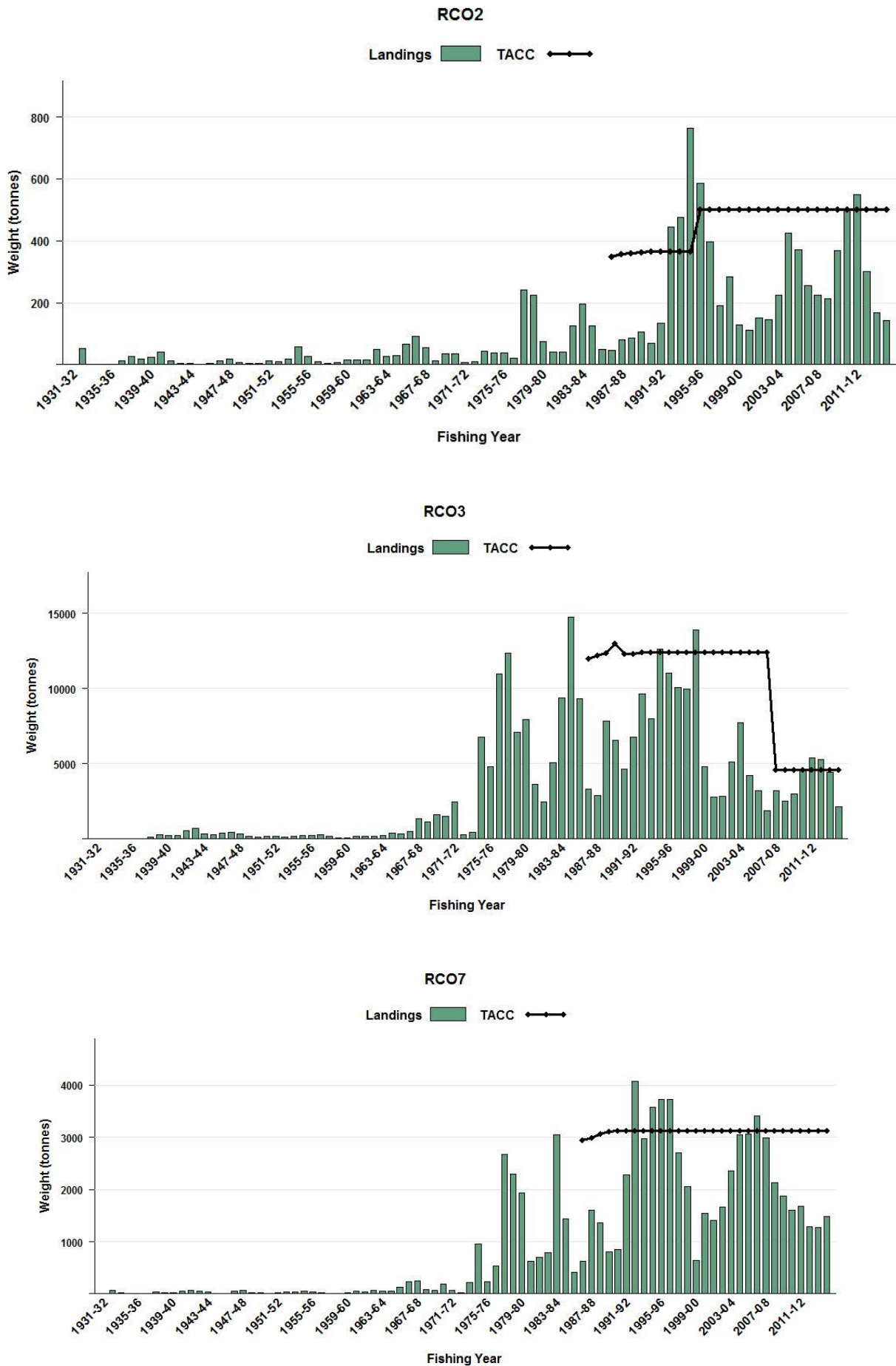


Figure 1: Reported commercial landings and TACC for the three main RCO stocks. Top to bottom: RCO 2 (Central East), RCO 3 (South East Coast), RCO 7 (Challenger).

1.2 Recreational fisheries

Recreational fishers take red cod, particularly on the east coast of the South Island. Results of five separate recreational fishing surveys are shown in Table 4.

Table 4: Estimated number and weight of red cod harvested by recreational fishers, by Fishstock and survey. Surveys were carried out in different years in the MAF Fisheries regions: South in 1991–92, Central in 1992–93, North in 1993–94 (Teirney et al 1997) and nationally in 1996 (Bradford 1998) and 1999–00 (Boyd & Reilly 2002). Survey harvest is presented as a range to reflect the uncertainty in the estimates.

Fishstock	Survey	Number	CV %	Estimated harvest range (t)	Estimated point estimate (t)
1991–92					
RCO 3	South	104 000	16	90–120	-
RCO 7	South	1 000	-	0–5	-
1992–93					
RCO 2	Central	151 000	19	105–155	-
RCO 7	Central	1 100	34	5–15	-
1993–94					
RCO 1	North	9000	34	5–15	-
1996					
RCO 1	National	11 000	18	5–15	11
RCO 2	National	88 000	11	80–105	92
RCO 3	National	99 000	10	90–115	103
RCO 7	National	38 000	15	30–50	40
1999–00					
RCO 1	National	21 000	36	5–11	8
RCO 2	National	39 000	25	8–14	11
RCO 3	National	207 000	25	210–349	280
RCO 7	National	23 000	50	5–14	9

A key component of the process of estimating recreational harvest from diary surveys is determining the proportion of the population that fish. The Recreational Technical Working Group concluded that the harvest estimates from the diary surveys should be used only with the following qualifications: a) they may be very inaccurate; b) the 1996 and earlier surveys contain a methodological error; and c) the 2000 and 2001 estimates are implausibly high for many important fisheries. The 1999–00 harvest estimates for each Fishstock should be evaluated with reference to the coefficient of variation.

1.3 Customary non-commercial fisheries

Quantitative estimates of the current level of customary non-commercial catch are not available.

1.4 Illegal catch

Quantitative estimates of the level of illegal catch are not available.

1.5 Other sources of mortality

Processing limits on red cod are sometimes imposed to discourage fishers from landing red cod when the species cannot be processed or when markets are poor. This practice has encouraged dumping. Processing limits are currently less of a problem than in earlier years.

2. BIOLOGY

Red cod are a fast-growing, short-lived species with few fish in the commercial fishery older than six years. Red cod grow to about 25 cm total length (TL) in the first year, followed by annual growth increments of around 15, 10 and 5 cm. Growth of sexes is similar for the first two years, after which females tend to grow faster than males and reach a larger overall length. Sexual maturity ranges from 45 to 55 cm TL with a mean value of 52 cm TL for both sexes at an age of 2–3 years. *M* has been estimated to equal 0.76 for both sexes. In 1995, ageing of red cod was validated using marginal zone analysis.

RED COD (RCO)

In the 1989–90 to 1992–93 fishing years, 80% of the landings in RCO 3 were 2+ and 3+ fish (50–57 cm TL). The sex ratio of the commercial catch during this period was skewed towards females during November (F:M ratio of 3.4:1) with the ratio tending to even out by May. Schools are generally comprised of single age cohorts rather than a mix of age classes.

Spawning in red cod varies with latitude, with spawning occurring later at higher latitudes. In the Canterbury Bight, spawning occurs from August to October. No definite spawning grounds have been identified on the southeast coast, but there is some evidence that red cod spawn in deeper water (300–750 m). Running ripe fish were caught on the Puysegur Bank in 600 m during the Southland trawl survey in February 1994. Juvenile red cod are found in offshore waters after the spawning period; however, no nursery grounds are known for this species.

Red cod are seasonally abundant, with schools appearing in the Canterbury Bight and Banks Peninsula area around November. These schools are feeding aggregations and are not found in these waters after about June. Catch data indicates that they move into deeper water after this time. Recruitment is highly variable resulting in large variations in catches between years.

Biological parameters relevant to the stock assessment are shown in Table 5.

Table 5: Estimates of biological parameters for red cod.

Fishstock	Estimate						Source
<u>1. Natural mortality (M)</u>							
RCO 3	0.76						Beentjes (1992)
<u>2. Weight = a(length)^b (Weight in g, length in cm fork length).</u>							
	Females			Males			
	a	b		a	b		
RCO 3	0.0074	3.059		0.0145	2.892		Beentjes (1992)
RCO 3 combined sexes	0.009249	3.001					Beentjes (1992)
<u>3. von Bertalanffy growth parameters</u>							
	Females			Males			
	L_{∞}	k	t_0	L_{∞}	k	t_0	
RCO 3	76.5	0.41	-0.03	68.5	0.47	0.06	Horn (1995)
RCO 7	79.6	0.49	0.20	68.2	0.53	0.22	Beentjes (2001)

3. STOCKS AND AREAS

The number of red cod stocks is unknown. There is no information about stock structure, recruitment patterns, or other biological characteristics that would indicate stock boundaries.

4. STOCK ASSESSMENT

No recent stock assessments have been carried out on any red cod stocks. Previous assessments were undertaken, however, these are now outdated. Details appear in previous versions of the Plenary report.

Trawl survey biomass estimates are available from one *Tangaroa* survey, and five summer and twelve winter *Kaharoa* surveys (Table 6, Figures 2, 3 and 4). In 2001, the Inshore FAWG recommended that the summer east coast South Island trawl survey be discontinued due to the extreme variability in the catchability of the target species. The winter surveys were reinstated in 2007 and this time included additional 10–30 m strata in an attempt to index elephant fish and red gurnard which were included in the list of target species. Only 2007, 2012, and 2014 surveys provide full coverage of the 10–30 m depth range. The winter surveys are currently conducted on a biennial cycle.

4.1 Biomass estimates

ECSI

Biomass for red cod from 2007 to 2009 ECSI trawl survey core strata (30–400 m) was largely unchanged and remained low relative to the period between 1991 and 1994. In contrast the biomass in 2012 was more than six-fold greater than in 2009, followed by a drop of similar magnitude in 2014 (Table 6, Figure 3). The relatively high biomass in 1994 and the low biomass in 2007–09 are consistent with commercial landings in RCO 3, a fishery in which cyclical fluctuating catches are characteristic. The large biomass in 2012 consisted predominantly of 1+ year fish. The proportion of pre-recruit biomass varied greatly among surveys ranging from 7 to 59% of the total biomass and in 2014 it was 49%, reflecting relatively low numbers of adult fish rather than a strong 1+ cohort. The proportion of juvenile biomass (based on the length-at-50% maturity) also varied greatly among surveys, from 27 to 80%, and in 2014 it was 70% (Figure 4).

The additional red cod biomass captured in the shallow strata (10–30 m) accounted for only 4% and 2% of the biomass in the core plus shallow strata (10–400 m) for 2007 and 2012 respectively, but in 2014 it was 44%, indicating that in terms of biomass, it is important to monitor the shallow strata for red cod (Table 6, Figure 3). The addition of the 10–30 m depth range had little effect on the shape of the length frequency distributions in 2007 and 2012, but in 2014 the largest fish were in 10–30 m (Beentjes et al 2015).

The distribution of red cod hot spots within the ECSI survey area varies, but overall this species is consistently well represented over the entire survey area, most commonly from 30 m to about 300 m, but is also found in waters shallower than 30 m.

WCSI

Total biomass estimates were fairly stable for the first four surveys, varying from 2546 t to 3169 t. There was a sharp decline in 2000 to 414 t, but the biomass gradually recovered to 2782 t in 2009. The biomass estimate of 989 t from the 2015 survey was the third lowest in the series, down from 1247 t in 2013 (the fourth lowest estimate in the time series) and continues a declining trend since 2009. The decline in biomass has come from both the west coast South Island and Tasman Bay/Golden Bay, but has been more pronounced in recent years from the west coast.

Population numbers also declined in 2015 by almost 50% from 2013 after dropping around 40% from 2011 to 2013, with fewer fish over 20 cm. The lack of 1+ fish (25–40 cm) from this survey may be significant for the commercial fishery in 2015–16, given the dependence on recruitment (Beentjes 2000). While biomass has declined in all strata of the survey area, it appears the decrease has been most pronounced in the northern areas, particularly in Tasman Bay and Golden Bay, but also the northern parts of the west coast.

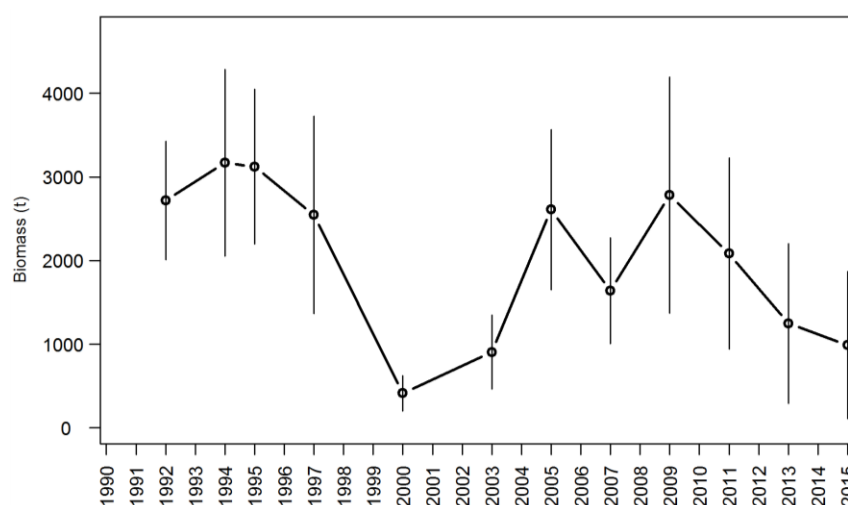


Figure 2: Biomass trends from the West Coast South Island inshore trawl survey. Error bars are \pm two standard deviations.

RED COD (RCO)

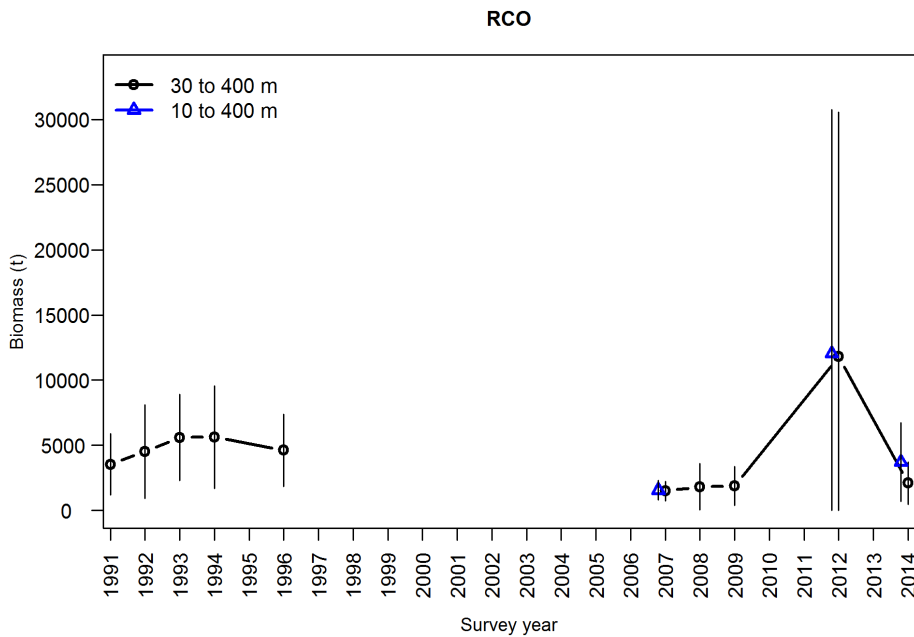


Figure 3: Red cod total biomass and 95% confidence intervals for the all ECSI winter surveys in core strata (30–400 m), and core plus shallow strata (10–400 m) in 2007, 2012, and 2014.

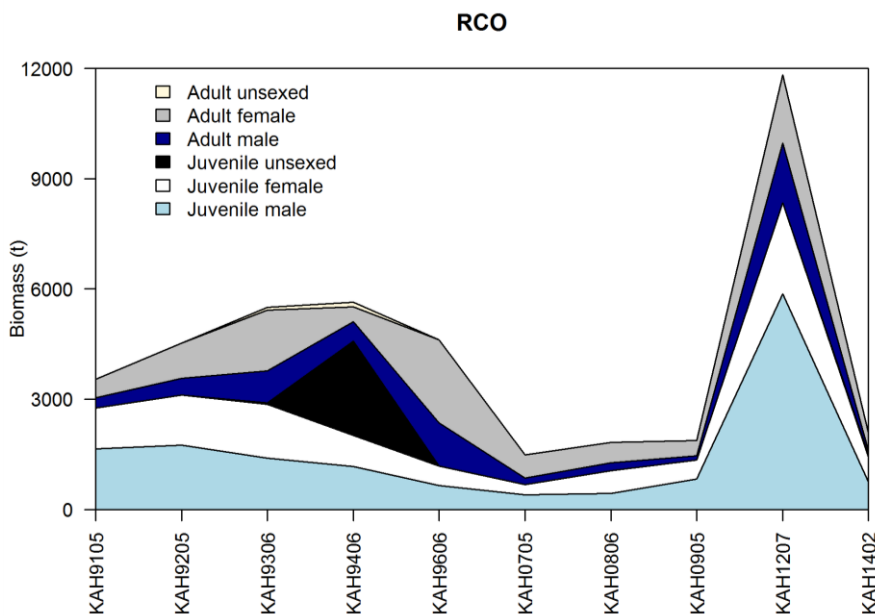


Figure 4: Red cod juvenile and adult biomass for ECSI winter surveys in core strata (30–400 m), where juvenile is below and adult is equal to or above length at which 50% of fish are mature.

4.2 Length frequency distributions

The size distributions of red cod in each of the ten core strata (30–400 m) ECSI surveys were similar and generally characterised by a 0+ mode (10–20 cm), 1+ mode (30–40 cm), and a less defined right hand tail comprised predominantly of 2+ and 3+ fish (Beentjes et al 2015). The 1996 to 2009 surveys showed poor recruitment of 1+ fish compared to earlier surveys, whereas the 1+ cohort was the largest of all ten surveys in 2012 and only average in 2014. Red cod on the ECSI, sampled during these surveys, were generally smaller than those from Southland, suggesting that this area may be an important nursery ground for juvenile red cod. The addition of the 10–30 m depth range had little effect on the shape of the length frequency distributions in 2007 and 2012, but in 2014 the largest fish were in 10–30 m (Beentjes et al 2015).

Table 6: Relative biomass indices (t) and coefficients of variation (CV) for red cod for east coast South Island (ECSI) - summer and winter, west coast South Island (WCSI), and Southland survey areas*. Biomass estimates for ECSI in 1991 have been adjusted to allow for non-sampled strata (7 & 9 equivalent to current strata 13, 16 and 17). The sum of pre-recruit and recruited biomass values do not always match the total biomass for the earlier surveys because at several stations length frequencies were not measured, affecting the biomass calculations for length intervals. -, not measured; NA, not applicable. Recruited is defined as the size-at-recruitment to the fishery (40 cm).

Region	Fishstock	Year	Trip number	Total	CV (%)	Total	CV (%)	Pre-	CV (%)	Recruited	CV (%)
				Biomass estimate		Biomass estimate		recruit			
ECSI(winter)	RCO 3				30-400m		10-400m		30-400m		30-400m
		1991	KAH 9105	3 760	40	-	-	1 823	45	2 054	37
		1992	KAH 9205	4 527	40	-	-	2 089	50	2 438	33
		1993	KAH 9306	5 601	30	-	-	1 025	51	4 469	27
		1994	KAH 9406	5 637	35	-	-	3 338	40	2 299	36
		1996	KAH 9606	4 619	30	-	-	590	31	4 029	34
		2007	KAH0705	1 486	25	1 552	24	190	33	1 295	25
		2008	KAH0806	1 824	49	-	-	129	36	1 695	50
		2009	KAH0905	1 871	40	-	-	833	50	1 038	41
		2012	KAH1207	11 821	79	12 032	78	7 015	97	4 806	55
		2014	KAH1402	2 096	39	3 714	41	409	45	1 654	23
ECSI(summer)	RCO 3	1996-97	KAH 9618	10 634	23	-	-	4 101	23	-	-
		1997-98	KAH 9704	7 536	23	-	-	4 426	24	-	-
		1998-99	KAH 9809	12 823	17	-	-	3 770	15	-	-
		1999-00	KAH 9917	6 690	30	-	-	2 728	41	-	-
		2000-01	KAH 0014	1 402	82	-	-	1 283	89	-	-
ECNI	RCO 2	1993	KAH 9304	913	52			197	31		
		1994	KAH 9402	1 298	50			547	52		
		1995	KAH 9502	469	36			47	34		
WCSI	RCO 7	1992	KAH 9204	2 719	13	-	-			-	-
		1994	KAH 9404	3 169	18	-	-			-	-
		1995	KAH 9504	3 123	15	-	-			-	-
		1997	KAH 9701	2 546	23	-	-			-	-
		2000	KAH0004	414	26						
		2003	KAH 0304	906	24	-	-			-	-
		2005	KAH0503	2610	18	-	-			-	-
		2007	KAH0704	1638	19	-	-			-	-
		2009	KAH0904	2 782	25	-	-			-	-
		2011	KAH1104	2 055	28						
		2013	KAH1305	1 247	38	-	-				
		2015	KAH1503	988	45						
Southland	RCO 3	1993	TAN 9301	100	68	-	-	-	-	-	-
		1994	TAN 9402	707	68	-	-	-	-	-	-
		1995	TAN 9502	2 554	49	-	-	182	66	-	-
		1996	TAN 9604	33 390	94	-	-	736	99	-	-

*Assuming areal availability, vertical availability and vulnerability equal 1.0. Biomass is only estimated outside 10 m depth except for COM9901 and CMP0001. Note: because trawl survey biomass estimates are indices, comparisons between different seasons (e.g., summer and winter ECSI) are not valid

5. STATUS OF THE STOCKS

Yearly fluctuations in red cod catch reflect changes in recruitment. Trawl surveys and catch sampling of red cod have shown that the fishery is based almost exclusively on two and three year old fish and is highly dependent on recruitment success. RCO 2 and 3 are presently managed using in-season adjustments based on a decision rule and associated management procedure.

RCO 3

Stock Status	
Year of Most Recent Assessment	2009
Assessment Runs Presented	-
Reference Points	Target: <i>MSY</i> -compatible proxy based on the East Coast South Island trawl survey (to be determined) Soft Limit: 50% of target Hard Limit: 25% of target Overfishing threshold: -
Status in relation to Target	Unknown
Status in relation to Limits	Soft limit: Unknown Hard Limit: Unknown
Status in relation to Overfishing	-
Historical Stock Status Trajectory and Current Status	
<p>The graph displays three data series over time. The left y-axis represents Survey Biomass (t) from 0 to 10,000. The right y-axis represents Catch or TACC (t) from 0 to 15,000. The x-axis represents Fishing Year from 89/90 to 07/08. WCSI_Survey is shown as black dots with vertical error bars. QMR/MHR is a red dashed line. TACC is a blue dash-dot line. A horizontal dashed line at approximately 3,800 t indicates the mean biomass index from 1992 to 2009. Both biomass and catch show a general decline from the mid-1990s onwards.</p>	
<p>East Coast South Island survey biomass (points) commercial catch (red dashed line) and TACC (blue dashed line) for the period 1990 to 2009. Horizontal line dashed is the mean biomass index, 1992–2009.</p>	
Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Both catch and survey biomass have declined substantially since the mid 1990s.
Recent Trend in Fishing Mortality or Proxy	Unknown
Other Abundance Indices	-

Trends in Other Relevant Indicators or Variables	From 1991 to 1994 large recruitment pulses were seen in the survey catch. The most recent three surveys (2007, 2008 and 2009) have not detected any significant recruitment.
Projections and Prognosis	
Stock Projections or Prognosis	Biomass estimates from the recently reinstated winter East Coast South Island since 2007 confirm that biomass is low relative to the 1990s.
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Unknown Hard Limit: Unknown
Probability of Current Catch or TACC causing Overfishing to continue or to commence	-

Assessment Methodology and Evaluation		
Assessment Type	Level 2: Trawl survey	
Assessment Method	Accepted biomass index	
Assessment Dates	Latest assessment: 2011	Next assessment: Unknown
Overall assessment quality rank	1 – High Quality. The Southern Inshore Working Group agreed that the East Coast South Island index was a credible measure of red cod biomass.	
Main data inputs (rank)	Trawl survey biomass estimates and length frequency analysis	1 – High Quality
Data not used (rank)	-	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	-	

Qualifying Comments
-

Fishery Interactions
Red cod are landed as bycatch in barracouta, flatfish, squid and tarakihi bottom trawl fisheries and ling, school shark, spiny dogfish, rig, tarakihi and moki setnet fisheries. Incidental captures of seabirds occur.

RCO 7

Stock Structure Assumptions

Stock boundaries are unknown, but for the purpose of this summary RCO 7 is considered to be a single management unit.

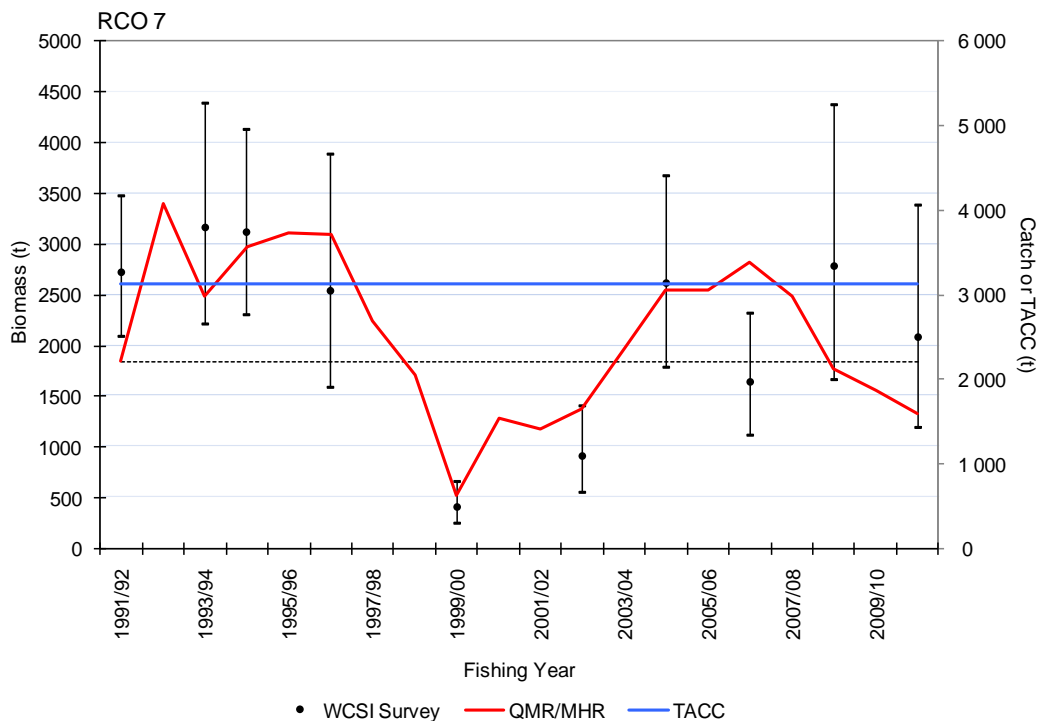
Stock Status	
Year of Most Recent Assessment	2015 West Coast South Island trawl survey
Reference Points	Target: <i>MSY</i> -compatible proxy based on the West Coast South Island trawl survey (to be determined) Soft Limit: 50% of target Hard Limit: 25% of target Overfishing threshold: -
Status in relation to Target	Unknown
Status in relation to Limits	Soft limit: Unknown Hard Limit: Unlikely (< 40%) to be below
Status in relation to Overfishing	-

RED COD (RCO)

Fishery and Stock Trends

Trend in Biomass or Proxy	The 2015 biomass index is the third lowest in the time series and continues an overall declining trend since 2009, although it is associated with a relatively high CV (45%).
Trend in Fishing Mortality or Proxy	Unknown

Historical survey biomass, Catch and TACC Trajectories



West Coast South Island survey biomass (points) commercial catch (red line) and TACC (blue line) for the period 1990 to 2009. Horizontal line dashed represents the mean biomass index, 1992–2011.

Other Abundance Indices	-
Trends in Other Relevant Indicator or Variables	Decline in the number of 1+ fish (25–40 cm), record number of 0+ fish (10–20 cm) in 2015.

Projections and Prognosis

Stock Projections or Prognosis	The lack of 1+ fish in 2015 is of concern for a recruitment-driven fishery. The record number of 0+ fish in the 2015 survey may help sustain the fishery in the short term.
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Unknown Hard Limit: Unknown
Probability of Current catch or TACC causing Overfishing to continue or to commence	-

Assessment Methodology and Evaluation		
Assessment Type	Level 2: Partial Quantitative Stock Assessment	
Assessment Method	Evaluation of survey biomass trends and length frequencies.	
Assessment Date	Latest assessment: 2015	Next assessment: 2017
Overall assessment quality rank	1 – High Quality. The Southern Inshore Working Group agreed that the West Coast South Island survey was a credible measure of biomass.	
Main data inputs (rank)	West Coast South Island survey biomass length frequency	1 – High Quality
Data not used (rank)	-	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	-	
Qualifying Comments		
-		

Fishery Interactions

Red cod are primarily taken in conjunction with the following QMS species: stargazer, red gurnard, tarakihi and various other species in the West Coast South Island target bottom trawl fishery. Smooth skates are caught as a bycatch in this fishery, and the biomass index for smooth skates in the west coast trawl survey has declined substantially since 1997. There may be similar concerns for rough skates but the evidence is less conclusive. Incidental captures of seabirds occur.

Yield estimates, TACCs and reported landings for the 2014–15 fishing year are summarised in Table 7.

Table 7: Summary of yield estimates (t), TACCs (t) and reported landings (t) of red cod for the most recent fishing year. MCY(1) from eY_{AV} method, MCY(2) from MIAEL method (range only given).

Fishstock	FMA		MCY(1)	MCY(2)	2014–15 Actual TACC	2014–15 Reported landings
RCO 1	Auckland (East) (West)	1 & 9	60		42	7
RCO 2	Central (East) (West)	2 & 8		500	500	142
RCO 3	South-East, Southland and Sub-Antarctic	3, 4, 5, & 6	4 400	2 418–13 330	4 600	2 173
RCO 7	Challenger	7	800	2 568–3 452	3 126	1 482
RCO 10	Kermadec	10	-		10	0
Total			5 260		8 273	3 804

6. FOR FURTHER INFORMATION

- Annala, J H; Sullivan, K J; O'Brien, C; Iball, S (Comps.) (1998) Report from the Fishery Assessment Plenary, May 1998: Stock assessments and yield estimates. 409 p. (Unpublished report held in NIWA library, Wellington.)
- Beentjes, M P (1992) Assessment of red cod based on recent trawl survey and catch sampling data. New Zealand Fisheries Assessment Research Document 1992/16. 41 p. (Unpublished report held in NIWA library, Wellington.)
- Beentjes, M P (1995a) Inshore trawl survey of the Canterbury Bight and Pegasus Bay, May–June 1992 (KAH9205). *New Zealand Fisheries Data Report* No: 55.
- Beentjes, M P (1995b) Inshore trawl survey of the Canterbury Bight and Pegasus Bay, May–June 1993 (KAH9306). *New Zealand Fisheries Data Report* No: 56.
- Beentjes, M P (2000) Assessment of red stocks (RCO 3 and RCO 7) for 1999. *New Zealand Fisheries Assessment Report 2000/25*. 78 p.
- Beentjes, M P; MacGibbon, D; Lyon, W S (2015) Inshore trawl survey of Canterbury Bight and Pegasus Bay, April–June 2014 (KAH1402). *New Zealand Fisheries Assessment Report 2015/14*. 136 p.
- Beentjes, M P; Renwick, J A (2001) The relationship between red cod, *Pseudophycis bachus*, recruitment and environmental variables in New Zealand. *Environmental biology of fishes*, 61(3), 315–328.
- Beentjes, M P; Wass, R (1994) Inshore trawl survey of the Canterbury Bight and Pegasus Bay, May–June 1991 (KAH9105). *New Zealand Fisheries Data Report* No: 48.
- Boyd, R O; Reilly, J L (2005) 1999/2000 National marine recreational fishing survey: harvest estimates. Final Research Report for Ministry of Fisheries Research Project REC9803. (Unpublished report held by Ministry for Primary Industries, Wellington.)
- Bradford, E (1998) Harvest estimates from the 1996 national recreational fishing surveys. New Zealand Fisheries Assessment Research Document 1998/16. 27 p. (Unpublished report held in NIWA library, Wellington.)
- Cordue, P L (1998a) An evaluation of alternative stock reduction estimators of virgin biomass and the information content of various research survey scenarios. New Zealand Fisheries Assessment Research Document 1998/22. 35 p. (Unpublished report held in NIWA library, Wellington.)

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- Cordue, P L (1998b) Designing optimal estimators for fish stock assessment. *Canadian Journal of Fisheries and Aquatic Science* 55: 376–386.
- Francis, R I C C (1992) Recommendations concerning the calculation of maximum constant yield (*MCY*) and current annual yield (*CAY*). New Zealand Fisheries Assessment Research Document 1992/8. (Unpublished report held in NIWA library, Wellington.)
- Habib, G (1975) Aspects of biology of red cod (*Pseudophycis bachus*). (Unpublished Ph.D thesis, University of Canterbury.) 203 p.
- Horn, P (1995) A validated ageing methodology, and growth parameters for red cod (*Pseudophycis bachus*) off the southeast coast of the South Island, New Zealand. New Zealand Fisheries Assessment Research Document 1995/6. 15 p. (Unpublished report held in NIWA library, Wellington.)
- Stevenson, M L (2007) Inshore trawl surveys of the west coast of the South Island and Tasman and Golden Bays, March–April 2007 (KAH0704). New Zealand Fisheries Assessment Research Document 2007/41. 64 p. (Unpublished report held in NIWA library, Wellington.)
- Stevenson, M L (2012) Inshore trawl survey of the west coast South Island and Tasman and Golden Bays, March–April 2011 (KAH1104). *New Zealand Fisheries Assessment Report 2012/50*. 77 p.
- Stevenson, M L; Beentjes, M P (1999) Inshore trawl survey of the Canterbury Bight and Pegasus Bay, December 1998–January 1999 (KAH9809). *NIWA Technical Report* No 63. 66 p.
- Teirney, L D; Kilner, A R; Millar, R E; Bradford, E; Bell, J D (1997) Estimation of recreational catch from 1991/92 to 1993/94. New Zealand Fisheries Assessment Research Document 1997/15. 43 p. (Unpublished report held in NIWA library, Wellington.)