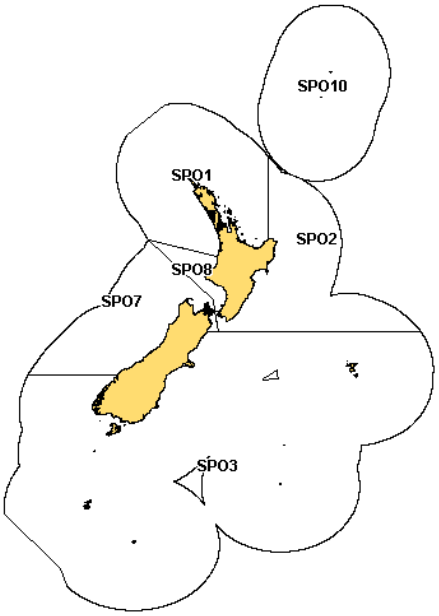
RIG (SPO)

(Mustelus lenticulatus)



1. FISHERIES SUMMARY

(a) Commercial fisheries

Rig are caught in coastal waters throughout New Zealand. Most of the catch is taken from water less than 50 m deep during spring and summer, when rig aggregate inshore. Before the introduction of the QMS in 1986, 80% of the commercial catch was taken by bottom setnet, and most of the remainder by trawl. Since then, a larger proportion has been taken by trawlers as bycatch, but the exact split by method is unknown (because method data were available only for a portion of the rig catch in the CELR database). The most important bottom setnet fisheries are at 90-Mile Beach, Kaipara Harbour, Manukau Harbour, South Taranaki Bight – Tasman/Golden Bay, Canterbury Bight, Kaikoura and Hauraki Gulf. Due to a decline in CPUE the TACC for SPO 7 was decreased to 221 t on the 1st October 2006. Total reported landings of rig increased rapidly during the 1970s, and averaged about 3200 t per year during the late 1970s and early 1980s (Table 1).

Table 1: Reported total New Zealand landings (t) of rig for the calendar years 1965 to 1985. Sources: MAF and FSU data.

Year	Landings	Year	Landings	Year	Landings	Year	Landings
1965	723	1971	1120	1977	3281	1983	3826
1966	850	1972	1011	1978	3300	1984	3562
1967	737	1973	–	1979	2701	1985	3222
1968	677	1974	2040	1980	3000		
1969	690	1975	1841	1981	3006		
1970	930	1976	2610	1982	3425		

Following the introduction of the QMS, landings declined to less than half those of the previous decade. Since 1986–87, landings have generally increased in response to TAC increases (Table 2). TACCs for all Fishstocks except SPO 10 were increased by 20% for the 1991–92 fishing year under the Adaptive Management Programme (AMP). Another TACC increase (from 454 t to 600 t) was implemented in SPO 3 for the 2000–01 fishing year. The TACCs for SPO 1, SPO 2 and SPO 8 reverted to the pre-AMP levels for the 1997–98 fishing year, when these Fishstocks were removed from the AMP in July 1997. The TACC for SPO 2 was increased from 72 t to 86 t from 1 October 2004 under the low knowledge bycatch framework.

In October 1992, the conversion factors for headed and gutted, and dressed, rig were reduced from 2.00 to 1.75. Since most rig are landed in these states, this reduction would have produced a

maximum increase in removals of about 14% for the same nominal TACC. Landings prior to 1992–93 have not been adjusted for the change in the conversion factor. The combined effect of adaptive management and conversion factor changes was a 37% increase in allowable commercial removals from all main stocks between 1991 and 1993.

Table 2: Reported landings (t) of rig by Fishstock from 1985–86 to 2005–06 and actual TACs (t) from 1986–87 to 2005–06.

Fishstock	SPO 1		SPO 2		SPO 3		SPO 7		SPO 8		SPO 10			
FMA (s)	1 & 9		2		3,4,5, & 6		7		8		10		Total	
	Landings	TAC	Landings	TAC	Landings	TAC	Landings	TAC	Landings	TAC	Landings	TAC	Landings§	TAC
1985–86*	845	–	96	–	921	–	367	–	465	–	0	–	2906	–
1986–87†	366	540	55	60	312	330	233	240	125	240	0	10	1091	1420
1987–88†	525	614	66	68	355	347	262	269	187	261	0	10	1395	1569
1988–89†	687	653	68	70	307	352	239	284	212	295	0	10	1513	1664
1989–90†	689	687	61	70	292	359	266	291	206	310	0	10	1514	1727
1990–91†	656	688	63	71	284	364	268	294	196	310	0	10	1467	1737
1991–92†	878	825	105	85	352	430	290	350	145	370	0	10	1770	2070
1992–93†	719	825	90	86	278	432	324	350	239	370	0	10	1650	2072
1993–94†	631	829	96	86	327	452	310	350	255	370	0	10	1619	2097
1994–95†	666	829	88	86	402	454	341	350	273	370	0	10	1769	2098
1995–96†	603	829	107	86	408	454	400	350	330	370	0	10	1848	2098
1996–97†	681	829	99	86	434	454	397	350	277	370	0	10	1888	2098
1997–98†	621	692	85	72	442	454	325	350	287	310	0	10	1760	1888
1998–99†	553	692	86	72	426	454	336	350	235	310	0	10	1635	1888
1999–00†	608	692	86	72	427	454	330	350	219	310	0	10	1670	1888
2000–01†	554	692	81	72	458	600	338	350	174	310	0	10	1607	2034
2001–02†	436	692	86	72	391	600	282	350	216	310	0	10	1411	2034
2002–03†	477	692	86	72	417	600	264	350	209	310	0	10	1453	2034
2003–04†	481	692	81	72	354	600	293	350	203	310	0	10	1412	2034
2004–05†	429	692	108	86	366	600	266	350	208	310	0	10	1377	2048
2005–06†	345	692	110	86	389	600	288	350	163	310	0	10	1295	2048

* FSU data.
† QMS data.
§ Includes landings from unknown areas before 1986–87.

(b) Recreational fisheries

Rig are caught by recreational fishers throughout New Zealand. Less that 3% of the recaptures of rig tagged around the South Island and Manawatu coasts in 1982–84 were returned by recreational fishers. Estimates of recreational landings obtained from three surveys, 1991–92 to 1993–94, 1996 and 1999-00 are given in Table 3. Recreational landings between 1991 and 1994 comprised only a small proportion (<15%) of the total rig harvest in all Fishstocks.

Table 3: Estimated number and weight of rig harvested by recreational fishers by Fishstock and survey. Surveys were carried out in different years in the Ministry of 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 harvests are presented as a range to reflect the uncertainty in the estimates.

Fishstock	Survey	Number	*CV%*	Harvest Range (t)	Point estimate (t)
1991-92					
SPO 3	South	12 000	22	15-30	-
1992-93					
SPO 2	Central	5000	-	5-15	-
SPO 7	Central	8000	39	10-25	
SPO 8	Central	18 000	43	20-60	-
1993-94					
SPO 1	North	11 000	21	5-25	-
SPO 8	North	1000	-	0-5	
1996					
SPO 1	National	28 000	31	25-45	35
SPO 2	National	4000	-	-	-
SPO 3	National	12 000	20	10-20	15
SPO 7	National	19 000	20	20-30	24
SPO 8	National	7000	-	-	-

Table 3: (*continued*)

Fishstock	Survey	Number	*CV%*	Harvest Range (t)	Point estimate (t)

1999-00					
SPO 1	National	13 000	30	12-23	-
SPO 2	National	16 000	58	9-33	-
SPO 3	National	43 000	32	39-75	-
SPO 7	National	33 000	38	21-46	-
SPO 8	National	7000	48	5-13	-

A key component of estimating recreational harvest from diary surveys is determining the proportion of the population that fish. The Recreational Working Group has concluded that the methodological framework used for telephone interviews produced incorrect eligibility figures for the 1996 and previous surveys. Consequently the harvest estimates derived from these surveys are considered to be considerably underestimated and not reliable. However, relative comparisons can be made between stocks within these surveys. The Recreational Working Group considered that the 2000 survey using face-to-face interviews better estimated eligibility and that the derived recreational harvest estimates are believed to be more accurate. FMA2 catches are nevertheless considered to be over-estimated, probably because of an unrepresentative diarist sample. The 1999/2000 Harvest estimates for each Fishstock should be evaluated with reference to the coefficient of variation.

(c) Maori traditional fisheries

Maori fishers traditionally caught large numbers of "dogfish" during the last century and early this century. Rig was probably an important species, though spiny dogfish and school shark were also taken. The early practice of having regular annual fishing expeditions, during which thousands of dogfish were sun-dried on wooden frames, has died out. However, rig are still caught in small quantities by Maori in parts of the North Island, especially the harbours of the Auckland region. Quantitative information on the current level of Maori customary take is not available.

(d) Illegal Catch

Quantitative information on the level of illegal catch is not available.

(e) Other sources of mortality

Unknown quantities of juvenile rig are caught by setnets placed in harbours and shallow bays. Quantitative information on the level of other sources of mortality is not available.

2. BIOLOGY

Rig are born at a total length (TL) of 25–30 cm. On the South Island male and female rig attain maturity at 5-6yrs (~85cm) and 7/8yrs (~100 cm), respectively (Francis & O'Maolagain, 2000). Rig in the Hauraki Gulf mature earlier – 4yrs for males and 5 yrs for females - and at smaller sizes (Francis & Francis, 1992). Longevity is not known because few large fish have been aged, however, a male rig that was mature at tagging was recaptured after nearly 14 years of liberty, suggesting a longevity of 20 years or longer. Females reach a maximum length of 151 cm and males 126 cm TL.

Rig give birth to young during spring and summer following a 10–11 month gestation period. Most females begin a new pregnancy immediately after parturition, and therefore breed annually. The number of young produced increases exponentially with the length of the mother, and ranges from 2 to 37 (mean about 11). Young are generally born in shallow coastal waters, especially in harbours and estuaries, throughout North and South Islands. They grow rapidly during their first summer, and then disappear as water temperatures drop in autumn-winter. They presumably move into deeper water.

Rig make extensive coastal migrations, with one tagged female moving a least 1160 km. Over half of the tagged rig that were recaptured had moved over 50 km, and over half of the females had moved more than 200 km. Females travel further than males, and mature females travel further than immature females.

Biological parameters relevant to stock assessment are shown in Table 4.

Table 4: Estimates of biological parameters for rig.

Fishstock	Estimate						Source
1. Natural mortality (M)							
All	0.2–0.3						Francis & Francis (1992a)
2. Weight = a (length)^b (Weight in kg, length in cm total length)							
	Females			**Males**			
	a	**b**		**a**	**b**		
SPO 3	3.67×10^{-7}	3.54		1.46×10^{-6}	3.22		Francis (1979)
SPO 7 & 8	9.86×10^{-7}	3.32		3.85×10^{-6}	3.01		Blackwell (unpubl. data)
3. von Bertalanffy growth parameters*							
	Females			**Males**			
	K	**t_0**	**L**	**K**	**t_0**	**L**	
SPO 1	0.42	-0.77	90.7	0.16	-2.02	118.7	Francis & Francis (1992a)
SPO 3	0.40	-0.68	87.0	0.11	-1.91	161.1	Francis & Francis (1992a)
	Males and females combined						
	K	**t_0**	**L**				
SPO 3 & 7	0.119	-2.35	147.2				Francis & Ó Maolagáin (2000)

3. STOCKS AND AREAS

There are no new data that alter the stock boundaries given in previous assessment documents.

Five biological rig stocks are recognised: northeast coast North Island (NECNI), statistical areas 1–11; southeast coast North Island (SECNI), 12–15; east coast South Island (ECSI), 18–30; west coast South Island (WCSI), 17, 31–36, 38; west coast North Island (WCNI), 16, 37, 39–48. ECSI and WCSI boundaries were determined from tagging studies; NECNI and SECNI were separated on the basis of differing CPUE trends before 1986; and WCNI was arbitrarily defined to be similar in size to the South Island stocks.

Fishstocks SPO 2, SPO 3 and SPO 7 correspond closely with SECNI, ECSI and WCSI biological stocks respectively. SPO 8 consists of part of the WCNI stock, and SPO 1 consists of part of the WCNI stock and the NECNI stock.

4. STOCK ASSESSMENT

There are no new data which would alter the yield estimates given in the 1997 Plenary Report. The yield estimates are based on commercial landings data only.

(a) Estimates of fishery parameters and abundance

Standardised CPUE (kg/km net) indices were calculated for SPO 8 and for five sub-areas in SPO 1 by modelling (GLM) non-zero catches by core vessels targeting rig with setnets between 1989-90 and 2003-04 (Blackwell et al., 2006). Catches were adjusted prior to the analysis to account for changes in conversion factors over this period. Standardized CPUE series in SPO 8 and all sub-areas in SPO 1, apart from Manakau Harbour, were flat, suggesting no sustainability concern and that the current catches were sustainable (Figures 1 & 2). Although standardized CPUE in the Manakau harbour declined, rig in this harbour do not comprise a separate population; this observation is therefore more likely to reflect changes in local conditions than a decline in the abundance of the SPO 1 west coast stock.

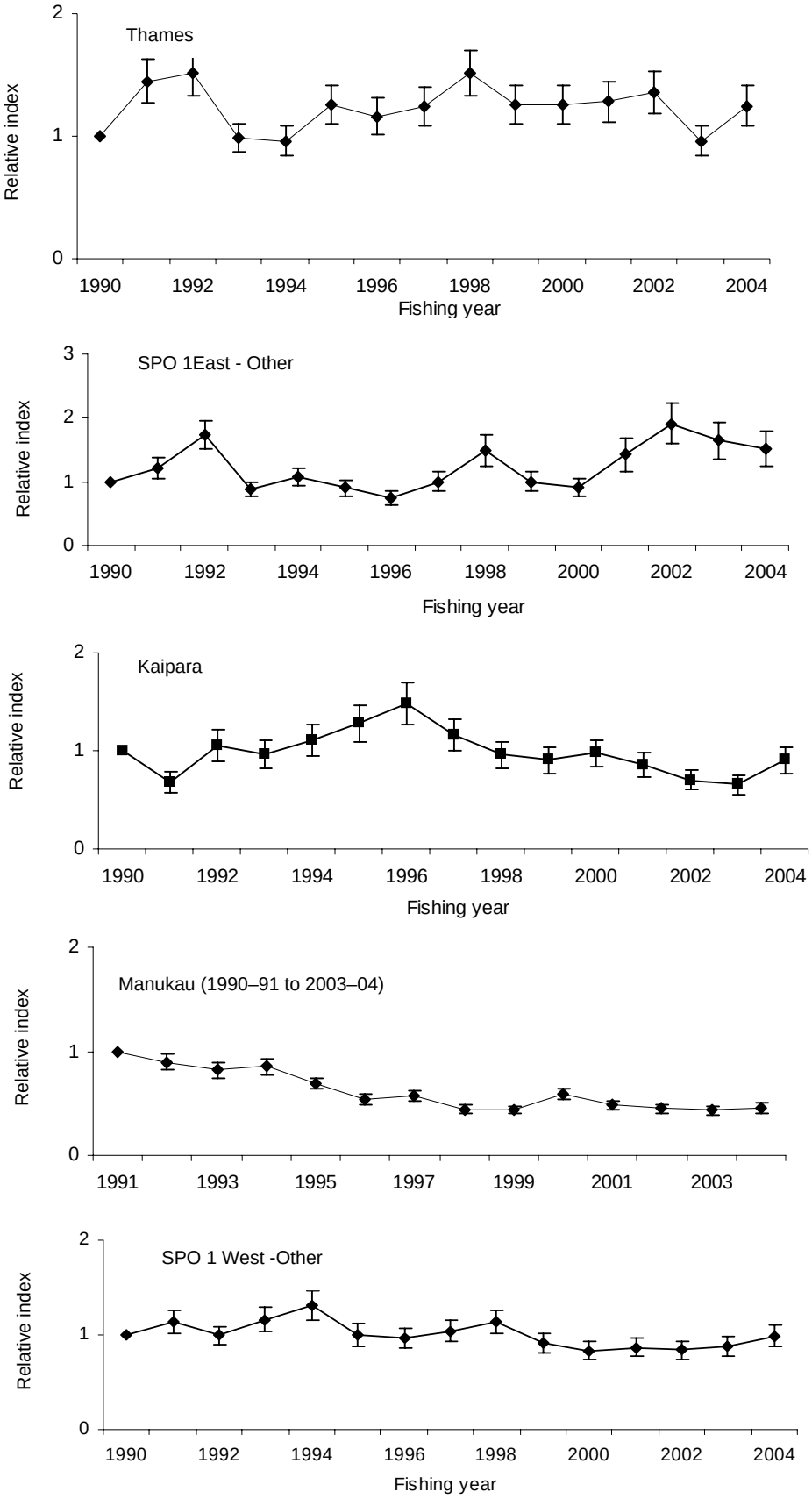


Figure 1: CPUE series, based on lognormal standardization of non-zero, core vessel, setnet catches (calculated green weight), for five sub-regions in SPO 1 (1989/90 – 2003/04). Error bars represent 1 s.e. (Blackwell et al., 2006).

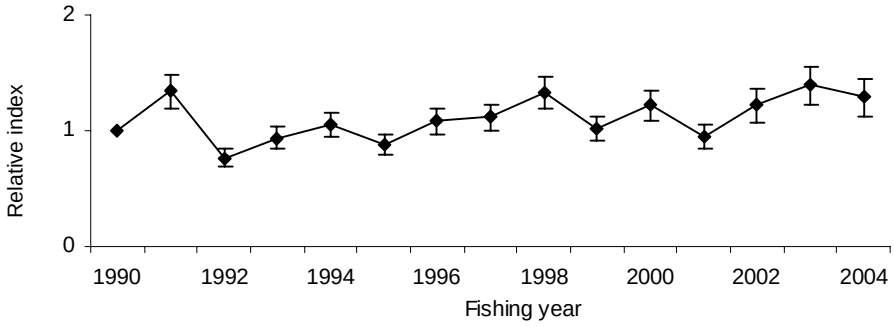


Figure 2: Standardized CPUE indices, based on non-zero, core-vessel setnet catches (calculated green weight) for SPO 8 (Blackwell et al., 2006). Error bars represent 1 s.e.

Revised indices of abundance for SPO 3 (1989/90 to 2003/04) and SPO 7 (1989/90 – 2004/05) stocks were reported as part of the AMP (SeaFIC, 2005a; Starr et al., 2006), using standardised CPUE data from rig target setnet fisheries. The analyses assumed that setnet mesh selectivity had remained the same over the whole time period. Although there was no overall trend in CPUE indices for SPO 3 (Figure 3), the AMP WG concluded (in 2005) that recent declines in CPUE, annual landings and mean size of males and females suggest that abundance of SPO 3 may have declined over the last six years.

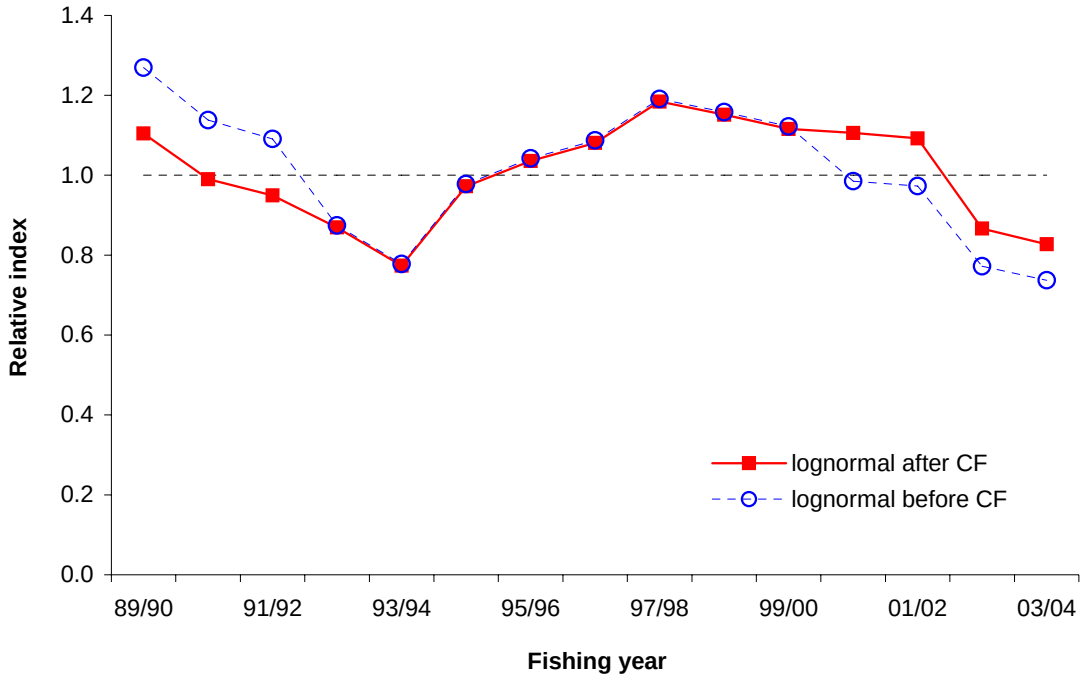


Figure 3: Lognormal standardization of non-zero setnet catches of SPO 3, both with and without conversion factor (CF) correction (see full-term review of SPO 3 AMP for more details). A line indicating the geometric mean of both series is provided for reference.

Lognormal standardisation of non-zero setnet catches for core vessels on the west coast of the South Island (SPO 7) produced an annual index that peaked in 1995/96 and although fluctuating depicted no clear trend since then. A similar index for Tasman and Golden Bays (area 038), where about half of the annual SPO 7 catch is taken, produced an annual index that declined consistently since 1989/90 (Figure 4). Nominal CPUE (kg/100m of setnet) for core vessels in area 038 declined by approximately 66% between 1976/77 and

1984/85 (Francis & Smith, 1988), suggesting that there had been substantial decline in abundance in Tasman and Golden Bays prior to the current analysis. Although large rig are not effectively targeted with bottom trawl gear, the WCSI trawl survey is believed to provide reliable indices of the relative biomass of males and younger females in SPO 7. Relative biomass indices declined by more than 50% between 1995 and 2005 (Figure 5).

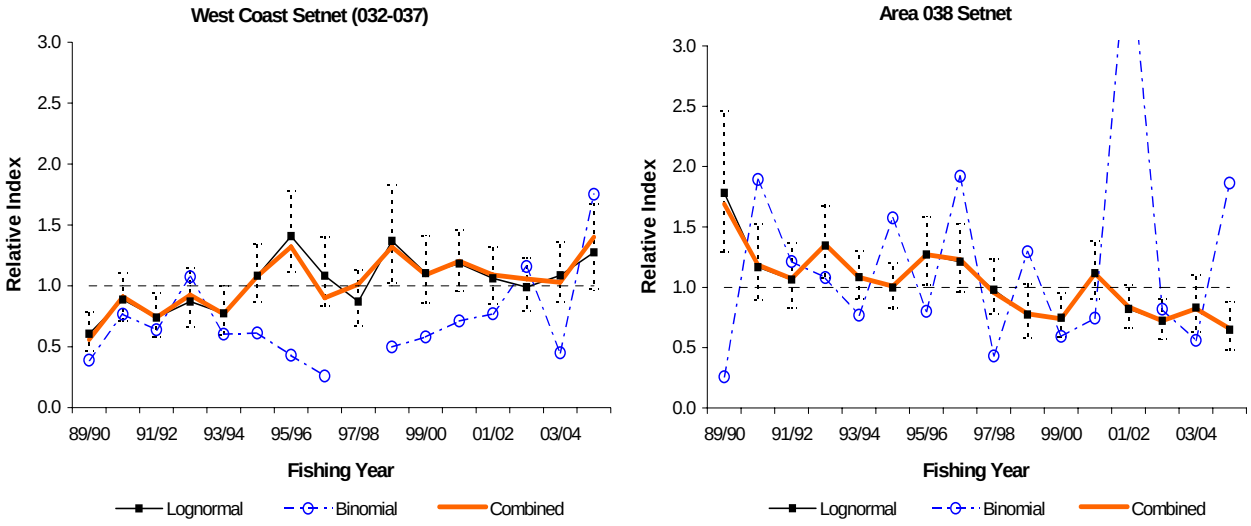


Figure 4. Plot of three standardised CPUE models: [left panel] the west coast South Island setnet fishery and [right panel] the Area 038 setnet fishery. a) a lognormal model using non-zero landings as the dependent variable (with associated 95% lognormal error bars); b) a binomial (logistic) model using a binary variable indicating a successful or zero catch of rig and c) a combined model which summarises the two sets of indices into a single trajectory.

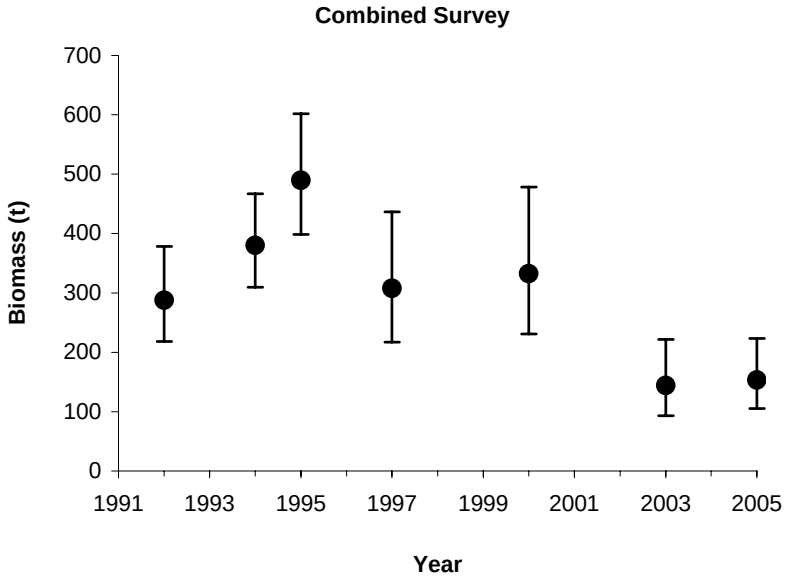


Figure 5. Plots of biomass estimates (t) for rig from the west coast South Island trawl survey by year. Error bars are approximated from the CVs assuming a lognormal distribution.

(b) Biomass estimates

ECSI and WCSI biomass estimates were calculated by dividing the mean reported commercial landings for the period 1981–83 by estimates of the exploitation rates in 1982–84 obtained from tagging studies. Biomass estimates were 4700–5600 t for ECSI and 3250 t for WCSI. While these estimates are out of date now estimates of current biomass are not available.

(c) Estimation of Maximum Constant Yield (MCY)

(i) ECSI and WCSI stocks

MCY was previously estimated using the equation MCY = $0.5*M*B_{av}$ (Method 2). However, recent work has shown that populations fished at this level have a high probability of stock collapse (i.e., falling below 20% virgin biomass) if their recruitment steepness is less than or equal to 0.5 (Francis & Francis, 1992a). Rig, like all elasmobranchs, have very low fecundity. In addition, fecundity declines with the size of the mother. Therefore, it is likely that rig have a close relationship between recruitment and spawning stock biomass. It is therefore unsafe to use Method 2 for estimating MCY for rig. MCY can only be estimated using this method if an estimate of virgin biomass becomes available (in which case MCY can be determined as a percentage of B_0 as described by Francis & Francis 1992a).

No estimates of MCY are available for these stocks. This conclusion has not changed since the 1992 Plenary Report.

(ii) WCNI Stock

MCY was estimated using the equation MCY = cYav (Method 4). The period 1977–78 to 1981–82 appeared to have relatively constant effort (± 30%) and no trend in landings, so landings during these years were averaged to estimate Y_{av}. M lies in the range 0.2–0.3, leading to a value of 0.7 or 0.8 for c (the natural variability factor). However, natural variability in year class strength is probably low in view of very low fecundity, so c was set at 0.9.

MCY = 0.9* 680 t = 612 t (rounded to 610 t).

Targeted setnet CPUE declined in 3 of the 4 statistical areas examined over the period used for MCY estimation, indicating that landings or effort or both varied. Therefore, this method may be inappropriate, and MCY may be less than 610 t.

The estimate of MCY has not changed since the 1989 Plenary Report.

(iii) NECNI Stock

MCY was estimated using the equation MCY = cY_{av} (Method 4). The period 1977–78 to 1980–81 had relatively constant effort (± 15%) and no trend in landings in the Hauraki Gulf (the part of the stock range that accounts for most of the catch), so landings during these years were averaged to estimate Y_{av} c was set equal to 0.9.

MCY = 0.9 * 318 t = 286 t (rounded to 290 t).

The estimate of MCY has not changed since the 1988 Plenary Report.

(iv) SECNI Stock

MCY cannot be estimated explicitly. However, based on the catch history for this stock before the introduction of the QMS, the MCY is likely to be less that 70 t.

MCY < 70 t.

The estimate of MCY has not changed since the 1992 Plenary Report.

The level of risk to the stock by harvesting the population at the estimated MCY value cannot be determined.

(d) Estimation of Current Annual Yield (CAY)

CAY can not be determined with available data.

Yield estimates are summarised in Table 5.

Table 5: Yield estimates (t) of rig by stock.

Parameter	Fishstock	Estimates
MCY	SPO 1 (WCNI + NECNI)	630*
	SPO 2 (SECNI)	< 70
	SPO 3 (ECSI)	Cannot be determined
	SPO 7 (WCSI)	Cannot be determined
	SPO 8 (WCNI)	270*
	SPO 10	Cannot be determined
CAY	All	Cannot be determined

* MCY estimate for the WCNI stock was apportioned pro-rata between SPO 1 and SPO 8 Fishstocks on the basis of historical catches.

(e) Other factors

Stock mixing occurs in the South Taranaki Bight – Cook Strait and South Westland regions, and probably elsewhere as well. Some regional fisheries therefore exploit more than one stock. Also, biological stock boundaries do not always coincide with Fishstock boundaries. Consequently, management by quota within Fishstocks is likely to be sub optimal for individual stocks.

The use of small mesh commercials setnets (125 mm) in the Auckland FMA probably results in a large proportion of the rig catch being immature fish. Elsewhere, the minimum size is 150 mm.

Greenweight landings prior to 1992–93 were estimated using an old and incorrect conversion factor (2.00). The currently accepted conversion factor (1.75) has been applied since 1992–93. Therefore, landings prior to 1992–93 (see Table 2), and the MCY estimates for SPO 1, 2 and 8 (Table 5), have been overestimated. The actual values are 87.5% of the reported values.

5. ANALYSIS OF ADAPTIVE MANAGEMENT PROGRAMMES (AMP)

The Ministry of Fisheries revised the AMP framework in December 2000. The AMP framework is intended to apply to all proposals for a TAC or TACC increase, with the exception of fisheries for which there is a robust stock assessment. In March 2002, the first meeting of the new AMP Working Group was held. Two changes to the AMP were adopted:

- a new checklist was implemented with more attention being made to the environmental impacts of any new proposal;
- the annual review process was replaced with an annual review of the monitoring requirements only. Full analysis of information is required a minimum of twice during the 5 year AMP.

SPO 3

The first SPO 3 TACC increase (from 364 t to 430 t) took effect in the 1991–92 fishing year under the AMP. A subsequent increase to 600 t was granted in 2000 for the 2000–01 fishing year. The SPO 3 AMP (and 600 t TACC) was extended for an additional year i.e. 2004/05 when the previous 5-year term ended.

Full-term Review of SPO 3 AMP in 2007

In 2007 the AMP FAWG reviewed the performance of the AMP after 6 years at the higher TACC level (Starr et al., 2007). The WG noted:

Effects of Conversion Factors

- The WG noted that the conversion factors used for raising DRE and HGU weight to greenweight for SPO 3 have changed twice in the past, from 2 (60 to 91/92), to 1.75 (92/93 to 99/00) to 1.55 (00/01 to present).
- Correcting past catch estimates using the current conversion factors has resulted in a reduction in estimates of past catch for SPO across the time series, more so than for other species (e.g. SCH) for which conversion factors have changed. As a result, revised past catch estimates are below TACC levels throughout the period fished, and substantially below current AMP TACC levels, since these were increased in 99/00.

Fishery Characterization

- SPO 3 was one of the first stocks to enter an AMP, when the TACC was raised from 364 t to 430 t for 1991/92. The TACC was raised again following the 2000 review to 600 t on 1 Oct 2000. After the last full-term review in 2005, the AMP was extended for two more years under existing conditions, until 2006/07.
- After correction of past estimated catches using the latest conversion factors for dressed weight to green weight, estimated catches have been well below the TACC levels throughout the history of the fishery under the QMS. Catches reached their highest level of 458 t in 2000/01, approximately the previous TACC level, but well below the increased TACC. Catches have since declined and remained below 400 t.
- 75% of the SPO 3 catch is taken in the setnet fishery, 25% is taken as bycatch in bottom trawls, and minor catches are taken by bottom longline and mid-water trawl.
- Rig are caught over a wide area, from statistical areas 18 to 32, with minor catches on the Chatham Rise and in the Sub-Antarctic. Setnet and trawl catches are mainly made in the Canterbury Bight. Setnet catches have always been high off Kaikoura as a result of the tarakihi targeted setnet fishery there, but have declined in that area since 2002/03. Substantial trawl catches are also made in Pegasus Bay and from Foveaux Strait to Fiordland. Longlining makes the minor catches in the Chatham Rise and Sub-Antarctic.
- The setnet fishery is strongly seasonal, with catches being taken mainly from Oct - Mar. Bottom trawl bycatches are fairly evenly spread across the year.
- Rig is the dominant species, and contributes 90% of the SPO3 catch, in the SPO / SCH / ELE / SPD shark-targeted setnet fishery. Rig targeting dominates the ECSI setnet fishery, but is mainly a bycatch in the SCH targeted southern South Island fishery.
- Rig contribute bycatches to a wide range of trawl target fisheries, but are mainly caught in the red cod (central east coast), flatfish (Timaru southward) and stargazer (Stewart Island - Fiordland) fisheries.
- The strong shifts in the setnet fishery where effort moved into Pegasus Bay from the Kaikoura in the late 1990s, and the Canterbury Bight 2001/03, have reversed. The Canterbury Bight was again the most important fishing area in 2005/06. The three year decline in landings noted in 2005 has also reversed, with catches increasing over 2004/06.
- There seems to be an increasing trend to target rig in trawls, and a corresponding decline in the SCH targeted rig bycatch, coinciding with the increased AMP TACC and decline in ACE values in 2000/01.
- Despite the wide geographic range of trawl fisheries catching rig, rig are generally only caught in near-shore trawls shallower than 100 m.

CPUE Analysis

- The main fishery used in rig CPUE analysis is the shark-targeted setnet fishery. This fishery, which mainly catches adults, has been used in previous analyses. Noting the increased targeting of rig in trawl fisheries, two additional trawl bycatch indices were investigated: a red cod / barracouta / stargazer / tarakihi targeted fishery; and the flatfish targeted fishery. These trawl caught rig are thought to mainly consist of juveniles.

- CPUE for these fisheries definitions were standardised using a lognormal model based on non-zero catches. In additional, a binomial model was used to investigate the effect of changing proportion of zero catches.
- The standardised setnet index suggests that the fishery has operated at two levels: one above the long-term average from the start of the series until about 1997/98, followed by a 20% - 30% drop to a lower level which has remained stable, or slightly increased, since then. This contrasts markedly with the unstandardised index in which current levels are near the earliest CPUE levels.
- Substantially lower catch rates over 1992/93 - 1995/96 were followed by particularly high catch rates from 1997/98 - 2000/01. Standardisation has markedly flattened the nominal trends, although there is closer agreement over the most recent few years. The effects of standardisation are the result of changes in vessel, month, target and net-length, and appear to relate principally to changes in targeting and large differences between performance by specific vessels.
- The two standardised trawl indices remain highly stable at close to the long-term average catch rate across the entire period, with perhaps a gradual decline in the flatfish targeted fishery.
- The binomial model for the setnet fishery shows high inter-annual variation, and combination with the lognormal setnet model has little effect. Binomial models for the two trawl fisheries show strongly increasing proportions of non-zero catches, and combination with the lognormal models results in overall more optimistic, increasing trends. The binomial model is difficult to interpret because trends in reporting rate appear to be confounded with biomass trends.

Logbook Programme

- The logbook programme introduced in 94/95 to cover rig, school shark and elephantfish, was primarily designed to monitor rig catches.
- After initial problems, coverage (of rig catch) has been fairly good, averaging 23.6% from 1998/99 to 2003/04. Coverage has since declined to 10.6%. The number of participating vessels shows less of a decline, having decreased from a peak of 14 in 2000/01 to 8 vessels at present, and there has been a slight increase in 2005/06 in number of vessels, sets and net-length covered.
- 2034 sharks were sampled in 1995/96 just after programme inception, and remained high (between 1166 and 1950) up to 2003/04. Numbers sampled have about halved since then, although there was a sight increase in the number sampled in 2005/06.
- Logbooks have tended to oversample the Canterbury Bight and have failed to cover the small target fishery off Kaikoura. Coverage did capture the shift from Kaikoura to Pegasus Bay in 2001/02, but coverage has been lost in Pegasus Bay. Seasonal coverage has been fairly good.
- While the sex ratio in catches was close to 50:50 at the start of the programme, the proportion of males has increased to about 70% in recent years. There has been no change in mean length of males caught, but the there has been a decline in the proportion of large females, and a decrease in female mean length, particularly since 2001/02 after rig targeting increased.
- Proportion of mature males by size suggests a size at 50% maturity of about 80 cm.
- The WG noted the general decline in coverage of all shark fisheries under this logbook programme and emphasized that effective measures or incentives needed to be implemented to improve coverage to representative levels again.

Effects of Fishing

Setnet Fisheries

- 73% of the SPO 3 catch is taken in near-shore setnets, and the main environmental concern relates to possible mortalities of the endangered Hector's dolphins, which usually occur within 4 nm of the shore.
- Hector's dolphin abundance off the ECSI has been estimated at 1880 animals (C.I. 1384 - 2554, CV 15.7%), and high densities occur in Akaroa Harbour, between Banks Peninsula and Rakaia River, the east coast of the Banks Peninsula and between Cape Campbell and Motunau.
- In response, a maximum allowable fishing mortality of 3 dolphins / year was set for the Canterbury setnet area (Waiau to Waitaki Rivers) from 2002 onwards. Setnet users have also agreed to the voluntary use of pingers on nets, and use is increasing as suitable pingers become available on the market.

- Setnet fishing has been specifically prohibited between 1 November to the end of February, and setnet fishing may not be conducted at night during the rest of the year, in the Banks Peninsula Marine Mammal Sanctuary.
- Setnet fishers have also adopted a Code of Practice that includes staying away from penguin colonies, setting over 20 m deep, avoid fishing in murky water <30 m deep and not setting when Hectors dolphins or yellow-eyed penguins are active in the vicinity. South East Finfish Management Ltd has also implemented additional voluntary area closures.
- Diving seabirds (penguins, shearwaters, shags and gannets) are also occasionally caught in setnets. The SPO 3 fishery overlaps with distributions of the vulnerable yellow-eyed penguin and the white flippered penguin. These birds are particularly vulnerable to setnetting near breeding colonies.

Trawl Fisheries

- One Hector's dolphin capture was reported in the red cod trawl fishery in 97/98, but none have been reported since, and none were observed in 187 observed trawls in 99/00. Trawlers have been advised not to haul when dolphins are active in the vicinity, and to keep sonar on when hauling.
- To minimise warp-strikes by seabirds trawlers >28 m length have been required since 12 January 2006 to deploy mitigation devices while trawling.
- Increased TACCs under the AMP have not resulted in any increases or significant changes in SCH trawl fishing areas or effort. The ECSI inshore trawl areas have been trawled for decades and benthic impacts of these trawlers have not increased as a result of the AMP.

Conclusions

- Catches dropped below 400 t after introduction into the QMS, and have been between 400 t and 450 t since the mid-1990s. Noting the consistent and increasing CPUE at the time, the WG concluded in 1998 that those catch levels were likely to be sustainable.
- Current setnet CPUE analyses suggest a stable CPUE up until ~2000/01, followed by a drop in CPUE to a lower level, after which CPUE has remained stable, or increased slowly in the last 2 - 3 years. Mixed and flatfish trawl CPUE series have remained stable throughout the fishery, and the proportion of non-zero rig catches has steadily increased in all three fisheries.
- The rig stock probably increased from low levels after the reduction in catches upon introduction into the QMS, and subsequent stable CPUEs suggest some stability in abundance up until 2000/01.
- A subsequent drop in CPUE to a lower level may be related to an increase in targeting at that time. However, the drop in CPUE from 2001/02 - 2002/03 seems too large to have resulted from a decline in abundance. Shifts in fishing patterns between areas, and continued catches below the TACC despite stable (or increasing) catch rates, in recent years, suggest that factors other than abundance may be influencing recent CPUE trends.

6. STATUS OF THE STOCKS

No estimates of current and reference biomass are available.

SPO 1
For SPO 1, landings have generally declined since 1991–92. This decline may be partially due to quota distribution problems. Patterns in relative abundance suggest that recent catch levels are probably sustainable. However, it is unknown whether the current TACC is sustainable, or whether the recent catch levels and the current TACC are at levels that will allow the stock to move towards a size that would support the maximum sustainable yield.

SPO 2
For SPO 2, landings have exceeded the TACC every year since 1991–92. In 1997, agreement could not be reached on whether recent catch levels or the current TACC are sustainable. It is not known whether recent catches and the current TACC are at levels that will allow the stock to move towards a size that would support the maximum sustainable yield.

SPO 3
SPO 3 is being managed within an AMP (the TACC was increased to 600 t in 2000–01) with a decision rule relating to CPUE. Recent catch levels and the current TACC are thought to be sustainable, but it is unknown if they are at levels that will allow the stock to move towards a size that would support the maximum sustainable yield.

SPO 7
SPO 7 is being managed within an AMP (TACC increased from 294 to 350 t in 1991/92). The AMP FAWG concluded based on a stock assessment, and trends in abundance indices, that SPO7 was below B_{MSY} and that neither current catches nor the TACC were sustainable.

SPO 8
For SPO 8, landings increased until 1995–96 and then have declined steadily; the current catch was 216 t in 2001–02. All recorded landings have been less than the TACC. Recent catch levels are probably sustainable. However, it is unknown whether the current TACC is sustainable, or whether the recent catch levels and the current TACC are at levels that will allow the stock to move towards a size that would support the maximum sustainable yield.

Yield estimates, TACCs and reported landings of rig are summarised in Table 6.

Table 6: Summary of yield estimates (t), TACCs (t) and reported landings (t) of rig for the most recent fishing year.

Fishstocks		FMA	MCY	2005–06 Actual TACC	2005–06 Reported landings
SPO 1	Auckland (East) (West)	1 & 9	630	692	345
SPO 2	Central (East)	2	< 70	86	110
SPO 3	South-East (Coast) (Chatham), Southland and Sub-Antarctic	3, 4, 5 & 6	–	600	389
SPO 7	Challenger	7	–	350	288
SPO 8	Central (West)	8	270	310	163
SPO 10	Kermadec	10	–	10	0
Total				2048	1295

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