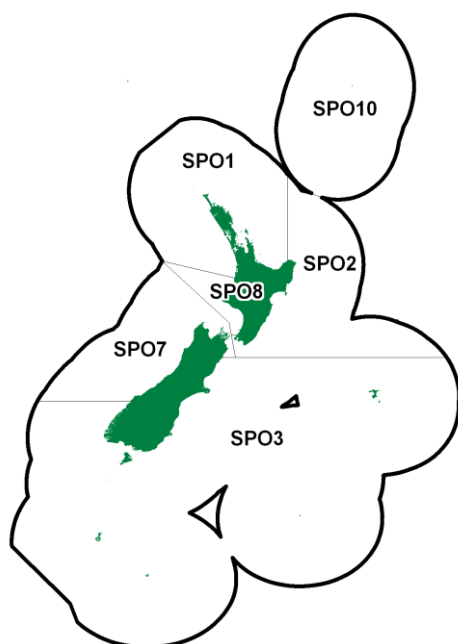


**RIG (SPO)**

(*Mustelus lenticulatus*)  
Pioke, Makoo



## 1. FISHERIES SUMMARY

Rig was introduced into the Quota Management System on 1 October 2004 with the following TACs, TACCs and allowances (Table 1).

**Table 1: TACs (t), TACCs (t) and allowances (t) for rig.**

Fishstock	Recreational Allowance	Customary non-commercial Allowance	Other sources of mortality	TACC	TAC
SPO 1	25	20	15	692	752
SPO 2	10	5	7	108	130
SPO 3	60	20	30	600	710
SPO 7	29	15	5	221	270
SPO 8	-	-	-	310	401
SPO 10	-	-	-	10	10
Total	124	60	57	1941	2273

### 1.1 Commercial fisheries

Rig are caught in coastal waters throughout New Zealand. Most of the catch is taken in 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. 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 2). Since then, a larger proportion has been taken by trawlers as bycatch. 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 1 October 2006. SPO was introduced into the 6<sup>th</sup> Schedule on the 1<sup>st</sup> of May 2012, which means that rig that are alive and likely to survive can be released (but must be reported as Destination “X”). Figure 1 shows the historical landings and TACC values for the main SPO stocks.

## RIG (SPO)

**Table 2: 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	Year	Landings
1965	723	1970	930	1975	1 841	1980	3 000	1985	3 222
1966	850	1971	1 120	1976	2 610	1981	3 006		
1967	737	1972	1 011	1977	3 281	1982	3 425		
1968	677	1973	–	1978	3 300	1983	3 826		
1969	690	1974	2 040	1979	2 701	1984	3 562		

Following the introduction of rig to the QMS in 1986, landings declined to less than half those of the previous decade in response to the TACCs. Since 1986–87, landings have generally increased in response to TACC increases (Table 4). 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 in 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 (Table 6). In 2011-12 the SPO 2 TACC was further increased to 108 t.

In October 1992, the conversion factors for headed and gutted, and dressed, rig were both reduced from 2.00 to 1.75. They were each further reduced to 1.55 in 2000–01. Landings and TACCs prior to 2000–01 have not been adjusted for the changes in the conversion factor. All AMP programmes ended on 30 September 2009.

Commercial landings of rig in SPO 1 have declined consistently since 1991–92. Although changes to the conversion factors mean that landings prior to 2000–01 are overestimated, catches since that time have continued to decline.

The Banks Peninsula Marine Mammal Sanctuary was established in 1988 by the Department of Conservation under the Marine Mammal Protection Act 1978, for the purpose of protecting Hector's dolphins. The sanctuary extends 4 nautical miles from the coast from Sumner Head in the north to the Rakaia River mouth in the south. Prior to 1 October 2008, no setnets were allowed within the sanctuary from 1 November to the end of February. For the remainder of the year, setnets were allowed; but could only be set from an hour after sunrise to an hour before sunset, be no more than 30 metres long, with only one net per boat which was required to remain tied to the net while it was set.

Voluntary setnet closures were implemented by the SEFMC from 1 October 2000 to protect nursery grounds for rig and elephantfish and to reduce interactions between commercial setnets and Hector's dolphins in shallow waters. The closed area extended from the southernmost end of the Banks Peninsula Marine Mammal Sanctuary to the northern bank of the mouth of the Waitaki River. This area was closed permanently for a distance of 1 nautical mile offshore and for 4 nautical miles offshore for the period 1 October to 31 January.

From 1 October 2008, a suite of regulations intended to protect Maui's and Hector's dolphins was implemented for all of New Zealand by the Minister of Fisheries.

For SPO 1, there have been two changes to the management regulations affecting setnet fisheries which target school shark off the west coast of the North Island. The first was a closure to setnet fishing from Maunganui Bluff to Pariokariwa Point for a distance of 4 nautical miles on 1 October 2003. This closure was extended by the Minister to 7 nautical miles on 1 October 2008. An appeal was made by affected fishers who were granted interim relief by the High Court, allowing setnet fishing beyond 4 nautical miles during daylight hours between 1 October and 24 December during three consecutive years: 2008-2010.

For SPO 3, commercial and recreational set netting was banned in most areas from 1 October 2008 to 4 nautical miles offshore of the east coast of the South Island, extending from Cape Jackson in the Marlborough Sounds to Slope Point in the Catlins. Some exceptions were allowed, including an exemption for commercial and recreational set netting to only one nautical mile offshore around the

Kaikoura Canyon, and permitting setnetting in most harbours, estuaries, river mouths, lagoons and inlets except for the Avon-Heathcote Estuary, Lyttelton Harbour, Akaroa Harbour and Timaru Harbour. In addition, trawl gear within 2 nautical miles of shore was restricted to flatfish nets with defined low headline heights. Commercial and recreational setnetting was banned in most areas to 4 nautical miles offshore, extending from Slope Point in the Catlins to Sandhill Point east of Fiordland and in all of Te Waewae Bay. An exemption permitted setnetting in harbours, estuaries and inlets. In addition, trawl gear within 2 nautical miles of shore was restricted to flatfish nets with defined low headline heights.

For SPO 7, both commercial and recreational setnetting were banned to 2 nautical miles offshore, with the recreational closure effective for the entire year and the commercial closure restricted to the period 1 December to the end of February. The closed area extends from Awarua Point north of Fiordland to the tip of Cape Farewell at the top of the South Island. There is no equivalent closure in SPO 8, with the southern limit of the Maui's dolphin closure beginning north of New Plymouth at Pariokariwa Point. There have been two recent changes to the management regulations affecting setnet fisheries which take school shark off the west coast of the North Island.

**Table 3: Reported landings (t) for the main QMAs from 1931 to 1982.**

Year	SPO1	SPO 2	SPO 3	SPO 7	SPO8	Year	SPO 1	SPO 2	SPO 3	SPO 7	SPO8
1931-32	28	0	0	0	0	1957	115	69	60	108	28
1932-33	30	0	0	0	0	1958	106	73	87	119	34
1933-34	29	0	0	0	0	1959	136	76	98	105	30
1934-35	33	0	0	0	0	1960	118	77	141	153	26
1935-36	31	0	0	0	0	1961	118	98	160	158	27
1936-37	73	0	8	0	0	1962	126	100	269	124	40
1937-38	56	1	5	0	0	1963	142	81	193	126	27
1938-39	32	1	70	0	0	1964	157	78	243	132	24
1939-40	10	1	12	0	0	1965	145	90	360	98	30
1940-41	13	1	54	1	0	1966	171	118	386	141	38
1941-42	18	0	32	0	0	1967	129	108	266	200	33
1942-43	49	1	33	1	0	1968	147	89	236	173	31
1943-44	42	6	44	5	1	1969	145	83	299	141	21
1944	60	10	14	7	4	1970	167	97	436	192	38
1945	56	5	24	10	8	1971	183	95	603	203	37
1946	71	12	8	19	9	1972	139	69	629	138	36
1947	73	27	28	45	7	1973	189	105	775	133	54
1948	51	26	51	43	7	1974	417	134	1118	249	126
1949	57	33	60	49	9	1975	390	146	896	255	157
1950	87	48	62	73	17	1976	629	230	906	610	233
1951	94	46	101	68	22	1977	723	307	1327	541	382
1952	115	41	132	63	21	1978	701	330	1225	638	404
1953	117	56	95	45	20	1979	614	232	1138	349	368
1954	103	68	40	58	39	1980	499	252	2667	470	387
1955	93	49	42	84	47	1981	618	188	1443	413	343
1956	106	54	38	77	29	1982	840	210	1255	629	399

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 4: Reported landings (t) of rig by Fishstock from 1985–86 to 2013–14 and actual TACCs (t) from 1986–87 to 2012–13. QMS data from 1986–present.**

Fishstock FMA (s)	SPO 1		SPO 2		SPO 3		SPO 7		SPO 8	
	1 & 9		2		3,4,5, & 6		7		8	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1985–86*	845	–	96	–	921	–	367	–	465	–
1986–87	366	540	55	60	312	330	233	240	125	240
1987–88	525	614	66	68	355	347	262	269	187	261
1988–89	687	653	68	70	307	352	239	284	212	295
1989–90	689	687	61	70	292	359	266	291	206	310
1990–91	656	688	63	71	284	364	268	294	196	310
1991–92	878	825	105	85	352	430	290	350	145	370
1992–93	719	825	90	86	278	432	324	350	239	370
1993–94	631	829	96	86	327	452	310	350	255	370

**RIG (SPO)**

**Table 4 [Continued]**

Fishstock FMA (s)	SPO 1		SPO 2		SPO 3		SPO 7		SPO 8	
	1 & 9		2		3,4,5, & 6		7		8	
1995-96	603	829	107	86	408	454	400	350	330	370
1996-97	681	829	99	86	434	454	397	350	277	370
1997-98	621	692	85	72	442	454	325	350	287	310
1998-99	553	692	86	72	426	454	336	350	235	310
1999-00	608	692	86	72	427	454	330	350	219	310
2000-01	554	692	81	72	458	600	338	350	174	310
2001-02	436	692	86	72	391	600	282	350	216	310
2002-03	477	692	86	72	417	600	264	350	209	310
2003-04	481	692	81	72	354	600	293	350	203	310
2004-05	429	692	108	86	366	600	266	350	208	310
2005-06	345	692	110	86	389	600	288	350	163	310
2006-07	400	692	101	86	423	600	265	221	176	310
2007-08	297	692	104	86	472	600	231	221	220	310
2008-09	297	692	106	86	328	600	233	221	222	310
2009-10	302	692	114	86	371	600	229	221	246	310
2010-11	311	692	106	86	395	600	229	221	220	310
2011-12	328	692	119	108	433	600	227	221	198	310
2012-13	369	692	106	108	463	600	226	221	120	310
2013-14	349	692	125	108	489	600	230	221	192	310

FMA (s)	SPO 10		Total	
	Landings	TACC	Landings§	TACC
1985-86*	0	-	2 906	-
1986-87	0	10	1 091	1 420
1987-88	0	10	1 395	1 569
1988-89	0	10	1 513	1 664
1989-90	0	10	1 514	1 727
1990-91	0	10	1 467	1 737
1991-92	0	10	1 770	2 070
1992-93	< 1	10	1 650	2 072
1993-94	0	10	1 619	2 097
1994-95	0	10	1 769	2 098
1995-96	0	10	1 848	2 098
1996-97	0	10	1 888	2 098
1997-98	0	10	1 760	1 888
1998-99	0	10	1 635	1 888
1999-00	0	10	1 670	1 888
2000-01	0	10	1 607	2 034
2001-02	0	10	1 411	2 034
2002-03	0	10	1 453	2 034
2003-04	0	10	1 412	2 034
2004-05	0	10	1 377	2 048
2005-06	0	10	1 295	2 048
2006-07	0	10	1 365	1 919
2007-08	0	10	1 324	1 919
2008-09	0	10	1 186	1 919
2009-10	0	10	1 262	1 919
2010-11	0	10	1 260	1 919
2011-12	0	10	1 305	1 941
2012-13	0	10	1 283	1 941
2013-14	0	10	1 386	1 941

\*FSU data.

§Includes landings from unknown areas before 1986-87



Figure 1: Historical landings and TACCs for the five main SPO stocks. From top to bottom: SPO 1 (Auckland East), SPO 2 (Central East) and SPO 3 (South East Coast).

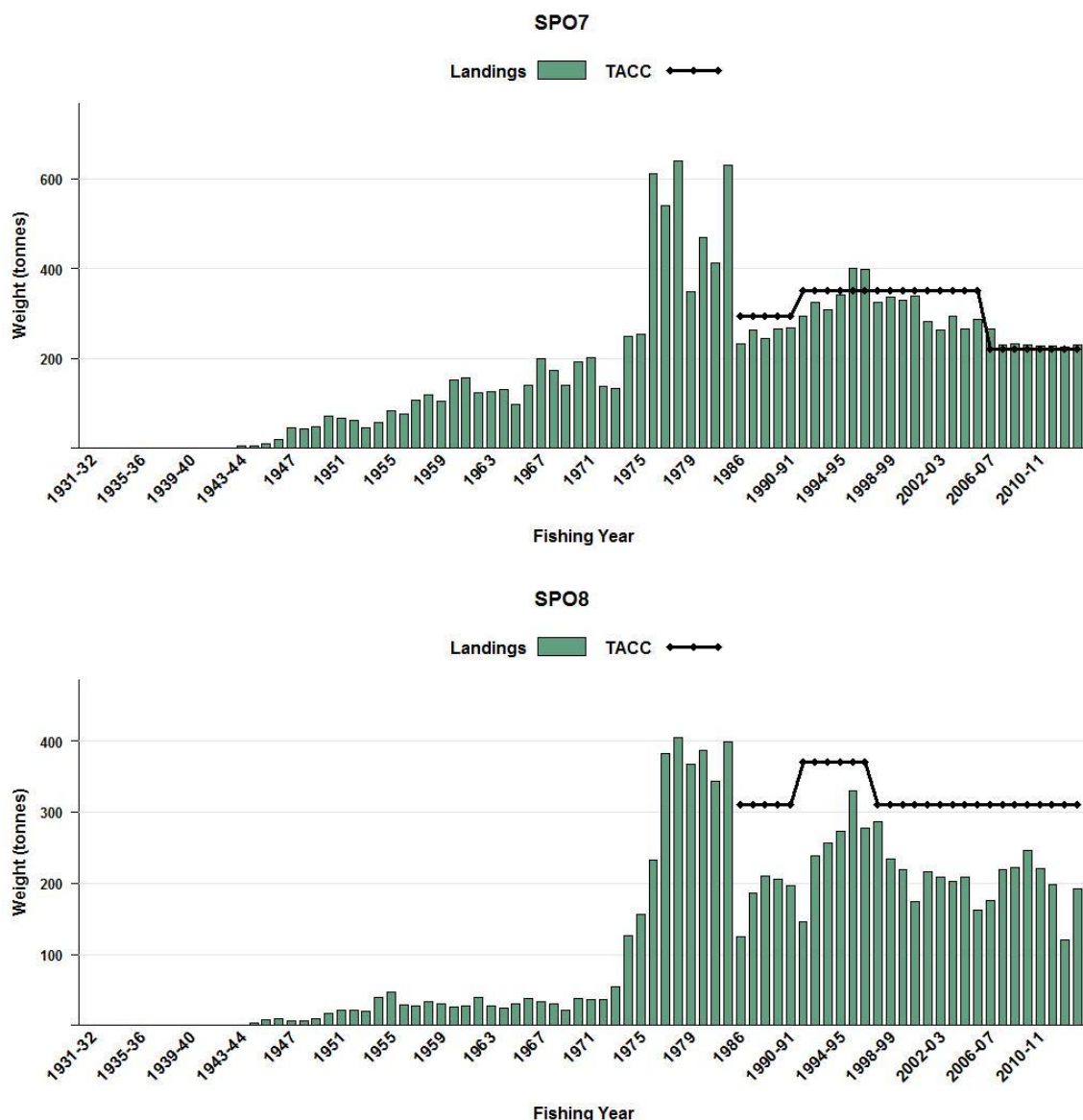


Figure 1 [Continued]: Historical landings and TACCs for the five main SPO stocks. From top to bottom: SPO 7 (Challenger) and SPO 8 (Central Egmont).

SPO 7 is managed under a stakeholder led fisheries plan. This fisheries plan was developed by the Challenger Finfisheries Management Company Limited on behalf of quota owners and includes details of rebuild goals and objectives for the rig fishery in Quota Management Area 7 (SPO 7). It represents part of the commitment made by 93% of the rig quota owners towards improving the value of their property rights and ensuring the future utilisation of the fishery for future generations. This plan was submitted to the Minister of Fisheries for approval pursuant to Section 11(a) of the Fisheries Act 1996. The plan seeks to improve the productivity of the SPO 7 fishstock through implementing area closures and catch reductions.

## 1.2 Recreational fisheries

Rig are the most commonly recreationally caught shark in New Zealand (Wynne-Jones et al 2014). Rig are caught by recreational fishers throughout New Zealand. They are predominantly taken on rod and reel (75.2%) with some taken on longline (16.6%) and less in set net (7.2%). The rod and reel catch is taken predominantly from land (57.5%) and trailer boat (29.6%), highlighting the importance of this species to land

## 1.21 Management Controls

The main method used to manage recreational harvests of rig is daily bag limits. Spatial and method restrictions also apply. Fishers can take up to 20 rig as part of their combined daily bag limit in the Auckland and Kermadec, Central, and Challenger Fishery Management Areas. Fishers can take up to 5 rig as part of their combined daily bag limit in the Fiordland and South-East Fishery Management Areas. Fishers can take up to 3 rig as part of their combined daily bag limit in the Kaikoura Fishery Management Area. Spatial closures for set netting and minimum mesh sizes for rig are also in place in all areas. There is currently no bag limit in place for the Southland Fishery Management Area.

### 1.2.2 Estimates of recreational harvest

There are two broad approaches to estimating recreational fisheries harvest: the use of onsite or access point methods where fishers are surveyed or counted at the point of fishing or access to their fishing activity; and, offsite methods where some form of post-event interview and/or diary are used to collect data from fishers.

The first estimates of recreational harvest for rig were calculated using an offsite approach, the offsite regional telephone and diary survey approach. Estimates for 1996 came from a national telephone and diary survey (Bradford 1998). Another national telephone and diary survey was carried out in 2000 (Boyd & Reilly 2005). The harvest estimates provided by these telephone diary surveys (Table 5) are no longer considered reliable.

In response to the cost and scale challenges associated with onsite methods, in particular the difficulties in sampling other than trailer boat fisheries, offsite approaches to estimating recreational fisheries harvest have been revisited. This led to the development and implementation of a national panel survey for the 2011–12 fishing year (Wynne-Jones et al 2014). The panel survey used face-to-face interviews of a random sample of New Zealand households to recruit a panel of fishers and non-fishers for a full year. The panel members were contacted regularly about their fishing activities and catch information collected in standardised phone interviews. Note that the national panel survey estimate does not include recreational harvest taken under s111 general approvals. Recreational catch estimates from the national panel survey are given in Table 5.

**Table 5: Recreational harvest estimates for rig stocks. Early surveys were carried out in different years in the regions: South in 1991–92, Central in 1992–93, North in 1993–94 (Teirney et al 1997). Early survey harvests are presented as a range to reflect the considerable uncertainty in the estimates. The telephone/diary surveys ran from December to November but are denoted by the January calendar year. The national panel survey ran through the October to September fishing year but is denoted by the January calendar year.**

Stock	Year	Method	Number of fish	Total weight (t)	CV
SPO 1	1994	Telephone/diary	11 000	5-25	-
	1996	Telephone/diary	28 000	35	0.31
	2000	Telephone/diary	13 000	17	0.30
	2012	Panel survey	7 780	8.5	-
SPO 2	1993	Telephone/diary	5 000	5-15	-
	1996	Telephone/diary	4 000	-	-
	2000	Telephone/diary	16 000	21	0.58
	2012	Panel survey	7 172	7.8	0.26
SPO 3	1992	Telephone/diary	12 000	15-30	0.22
	1996	Telephone/diary	12 000	15	0.20
	2000	Telephone/diary	43 000	57	0.32
	2012	Panel survey	8 142	8.9	0.33
SPO 7	1993	Telephone/diary	8 000	10-25	0.39
	1996	Telephone/diary	19 000	24	0.20
	2000	Telephone/diary	33 000	33	0.38
	2012	Panel survey	19 126	20.9	0.25
SPO 8	1993	Telephone/diary	18 000	20-60	0.43
	1994	Telephone/diary	1 000	0-5	-
	1996	Telephone/diary	7 000	-	-
	2000	Telephone/diary	7 000	9	0.48
	2012	Panel survey	5 499	6	0.45

## RIG (SPO)

### 1.3 Customary non-commercial fisheries

Maori fishers traditionally caught large numbers of "dogfish" during the last century and early this century. Rig was probably an important species, although spiny dogfish and school shark were also taken. The historical practice of having regular annual fishing expeditions, during which thousands of dogfish were sun-dried on wooden frames, is no longer prevalent. However, rig are still caught in small quantities by customary non-commercial fishers in parts of the North Island, especially the harbours of the Auckland region. Quantitative information on the current level of customary non-commercial take is not available.

### 1.4 Illegal Catch

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

### 1.5 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.

**Table 6: Total Allowable Catch (TAC, t), Total Allowable Commercial Catch (TACC, t), and recreational, non-commercial customary, and other fishing mortality allowances (t) declared for SPO as of October 2012.**

Fishstock	TAC	TACC	Customary Non-Commercial Catch	Recreational	Other Mortality
SPO 1 (FMA 1 & 9)	752	692	20	25	15
SPO 2	144	108	20	10	6
SPO 3 (FMA 3–6)	710	600	20	60	30
SPO 7	270	221	15	29	5
SPO 8	401	310	0	0	0
SPO 10	10	10	0	0	0

## 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 5–6 yrs (about 85 cm) and 7–8 yrs (about 100 cm), respectively (Francis & O'Maolagain 2000). Rig in the Hauraki Gulf mature earlier – 4 yrs for males and 5 yrs for females – and at smaller sizes (Francis & Francis 1992 a & b). 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 7.



**Table 7: Estimates of biological parameters for rig.**

Fishstock	Estimate				Source
<u>1. Natural mortality (<math>M</math>)</u>					
All	0.2–0.3				Francis & Francis (1992a)
<u>2. Weight = <math>a(\text{length})^b</math> (Weight in g, length in cm fork length).</u>					
	Females		Males		
	a	b	a	b	
SPO 3	$3.67 \times 10^{-7}$	3.54	$1.46 \times 10^{-6}$	3.22	Francis (1979)
SPO 7&8	$9.86 \times 10^{-7}$	3.32	$3.85 \times 10^{-6}$	3.01	Blackwell (unpubl. data)
<u>3. von Bertalanffy growth parameters</u>					
	Both Sexes				
	L	k	$t_0$		
SPO 3 & 7	147.2	0.119	-2.35		Francis & Ó Maolagáin (2000)

### 3. STOCKS AND AREAS

Information relevant to determining rig stock structure in New Zealand was reviewed in 2009 (Smith 2009, Blackwell & Francis 2010, Francis 2010). These reviews concluded that the existing QMAs are a suitable size for rig management, although the boundaries between biological stocks are poorly defined, especially in the Cook Strait region. Insufficient tagging occurred in SPO 1 to determine whether division of that stock into separate 1E and 1W stocks is warranted.

Genetic, biological, fishery and tagging data were all considered, but the evidence available for the existence and geographical distribution of biological stocks is poor. Some differences were found in CPUE trends at a small spatial scale but stock separation at the indicated spatial scales seems unlikely, and the CPUE differences may have resulted from processes acting below the stock level, such as localised exploitation of different sexes or different size classes of sharks. Genetic and morphological evidence indicate that a separate undescribed species of *Mustelus* occurs at the Kermadec Islands, but it is not known if rig also occurs there.

The most useful source of information was a tagging programme undertaken mainly in 1982–84 (Francis 1988a). However, most tag releases were made around the South Island, so little information was available for North Island rig. Male rig rarely moved outside the release QMA, even after more than five years at liberty. Female rig were more mobile than male rig, with about 30% of recaptures reported beyond the release QMA boundaries within 2–5 years of release. The proportion reported beyond the release QMA increased steadily with time. However, few females moved more than one QMA away from the release point. Because males move shorter distances than females, a conservative management approach is to set rig QMAs at a size appropriate for male stock ranges.

### 4. STOCK ASSESSMENT

#### 4.1 Estimates of fishery parameters and abundance

##### SPO 1

Standardised CPUE indices were calculated for SPO 1 by modelling (GLM) non-zero catches by core vessels targeting rig with setnets and bottom trawl between 1989–90 and 2011–12 (Starr & Kendrick In Prep). This analysis was an update of a similar analysis undertaken by Kendrick & Bentley in 2012. (Kendrick & Bentley 2012). The SPO 1 analyses were complicated by the fact that up to 50% of the setnet landings were accumulated ashore using intermediate destination codes for subsequent landing to a Licensed Fish Receiver, thus breaking the link between effort and landing within a trip. Estimated catches are unreliable in rig fisheries because many fishers report the processed weight rather than the equivalent green weight. Data preparation for the bottom trawl CPUE analyses was performed using the same procedure as used for all other SPO QMAs. However, Kendrick & Bentley (2012) adopted an alternative data preparation procedure for the setnet fishery analyses, in which a “vessel correction factor” ( $vcf$ ), calculated for each vessel and year, is used to correct the estimated

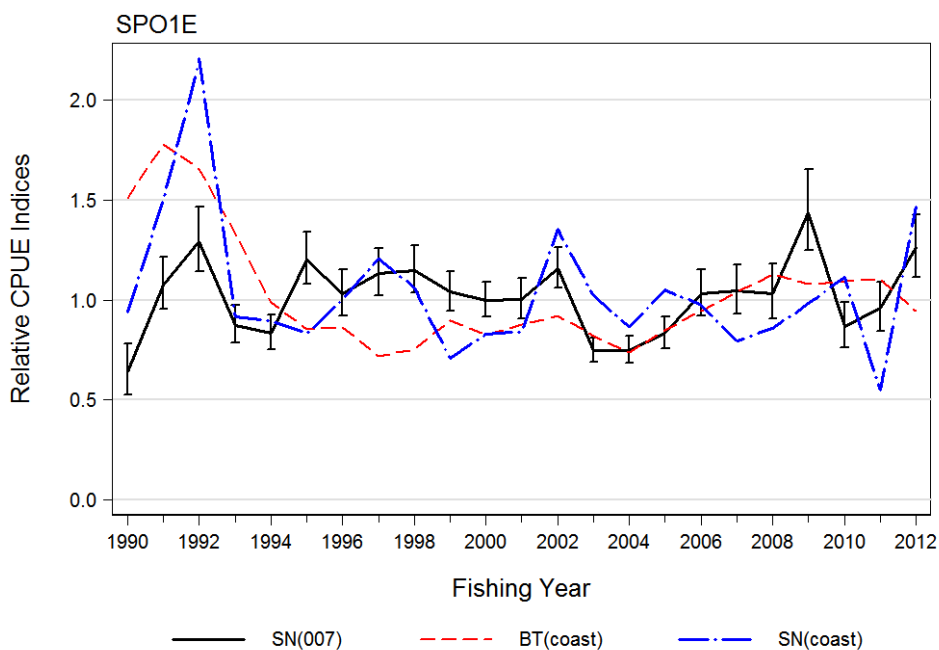
## RIG (SPO)

catch observations. This approach was not accepted by the Northern Inshore Working Group in 2011, because the new methodology required further investigation. However, this approach, also recently adopted for rock lobster, was accepted by the Working Group for SPO 1 in 2013.

### SPO 1E

Three CPUE analyses for SPO 1E were accepted by the Working Group: a) a target shark (NSD, SPO, SHK, SPD) setnet fishery operating in the Firth of Thames (Area 007) [SN(007)]; b) a target shark setnet fishery operating in all the remaining SPO 1E statistical areas (002 to 006 and 008 to 010) [SN(coast)]; and c) a mixed target species (SNA, TRE, GUR, JDO, BAR, TAR) bottom trawl fishery operating in all SPO 1E statistical areas (002 to 010) [BT(coast)]. These three series show broadly similar trends from the mid-1990s, but differ in the early period, with the SN(007) series showing a strong decline in the early portion of the series while the other two series show no trend (Figure 2).

The Southern Inshore Working Group gave the SN(007) series a research rating of 1 because this fishery targets mature female rig and the diagnostics were considered credible. The Working Group gave the BT(coast) series a research rating of 1 because the diagnostics were credible but cautioned that this index does not representatively sample large female rig. The SN(coast) series was given an overall assessment quality rank of 2 because this series was more variable than the other two series and the Working Group noted that the fishing locations were widely dispersed, occupied sporadically and may not be representative of the wider population.



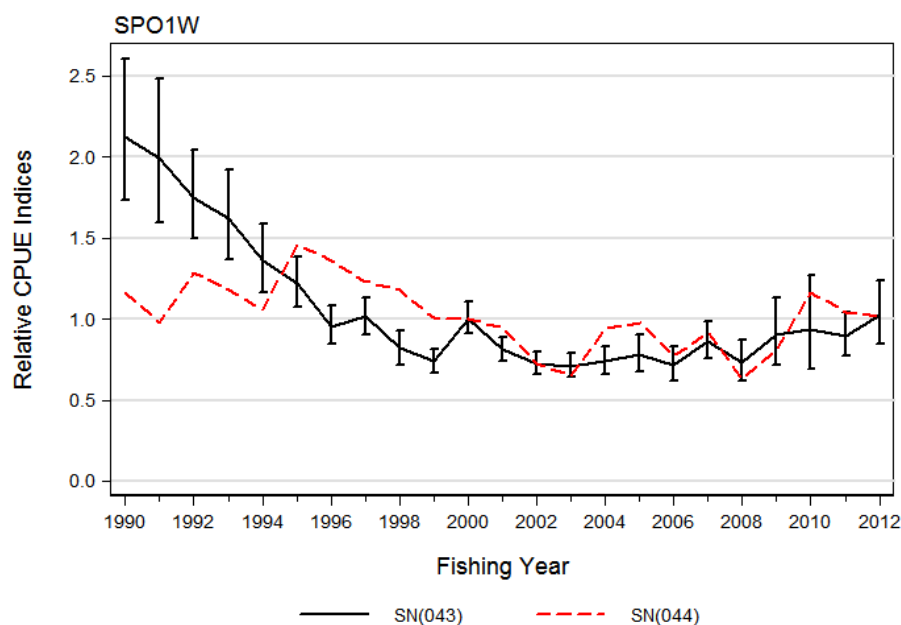
**Figure 2: Comparison of standardised CPUE for SPO 1E in three fisheries: a) target shark setnet in the Firth of Thames (Area 007) [SN(007)]; b) mixed target species bottom trawl in statistical areas 002 to 010 [BT(coast)]; c) target shark (SPO, SCH, SPD or NSD) setnet in all remaining SPO 1E statistical areas [SN(coast)].**

### SPO 1W

Four CPUE analyses for SPO 1W were presented to the Working Group: a) a target shark (NSD, SPO, SHK, SPD) setnet fishery operating in Manukau Harbour (Area 043) [SN(043)]; b) a target shark setnet fishery operating in Kaipara Harbour (044) [SN(044)]; c) a target shark setnet fishery operating in all the remaining SPO 1W statistical areas (042, 045 to 048) [SN(coast)]; and d) a mixed target species (SNA, TRE, GUR, JDO, BAR, TAR) bottom trawl fishery operating in all SPO 1W statistical areas (042, 045 to 048) [BT(coast)] outside the harbours. Only two of these series were accepted by the Working Group, with the two coastal series rejected because of small amounts of data (recent years had the core vessel data sets for SN(coast) with less than 10 t of landed rig while the BT(coast) core data set showed between 15 t and 35 t of rig landed). The two remaining series showed similar

trends from the mid-1990s, but differed in the early period, with the SN(043) series showing a strong decline in the early portion of the series while the SN(044) series showed no trend throughout the 1990s (Figure 3).

The Working Group gave the SN(043) and SN(044) series research ratings of 1 because catches from these fisheries include mature female rig and the diagnostics were considered credible. The Working Group gave the SN(coast) and BT(coast) series overall assessment quality rank of 3 because there were few data, particularly in recent years. The BT(coast) series also showed a doubling and halving of CPUE between 2002 and 2004, a jump that the Working Group did not consider credible.



**Figure 3: Comparison of standardised CPUE for SPO 1W in two fisheries: a) target shark setnet in Manukau Harbour (Area 043) [SN(043)]; b) target shark setnet in Kaipara Harbour (Area 044) [SN(044)].**

## SPO 2

The standardised trip-based bottom trawl CPUE analysis used to monitor the SPO 2 Fishstock in 2009 (Starr & Kendrick 2009, 2011; Bentley & Kendrick in Prep) and 2013 (Starr & Kendrick in prep) was extended by two years in 2015. As done in the previous analyses, the extended analysis was based on complete trips which landed SPO 2 using the bottom trawl method from 1989–90 to 2013–14, adjusted for changes in conversion factors. As noted since 2009, the corresponding setnet analysis was not repeated as part of this update due to the small amounts of available data. The use of complete trips was necessary because of the large proportion of trips which landed SPO 2 but did not report any estimated catch (ranging from 56% to 13% by number of trips and 39% to 2% by weight). Such a strong trend in this statistic means that CPUE analyses reliant on the estimated catches to distribute the landings within a trip will be unreliable. In addition, estimated catches severely underestimated landings (median estimated catch by trip was 71% the landed catch). The use of complete trips limited the number of explanatory factors that could be applied in the analysis.

However, previous analyses found no difference when adjusting for zone of capture or target species category compared to the analyses which only corrected for year, month and vessel. The trip-based indices are presented here as they include the largest amount of data should not be affected by the strong trend in the reporting of estimated catches. The SPO 2 landing data, regardless of the method of capture, did not exhibit the behaviour observed in SPO 1 of landing to temporary holding receptacles. Two SPO 2 (BT) analyses were conducted in 2015, one which defined the data set by only selecting trips which fished exclusively in the Areas 011–016 (designated “statarea”) and the other restricted to trips which exclusively landed SPO 2 (designated “Fishstock”). There was no difference in the CPUE trends estimated by these two data sets.

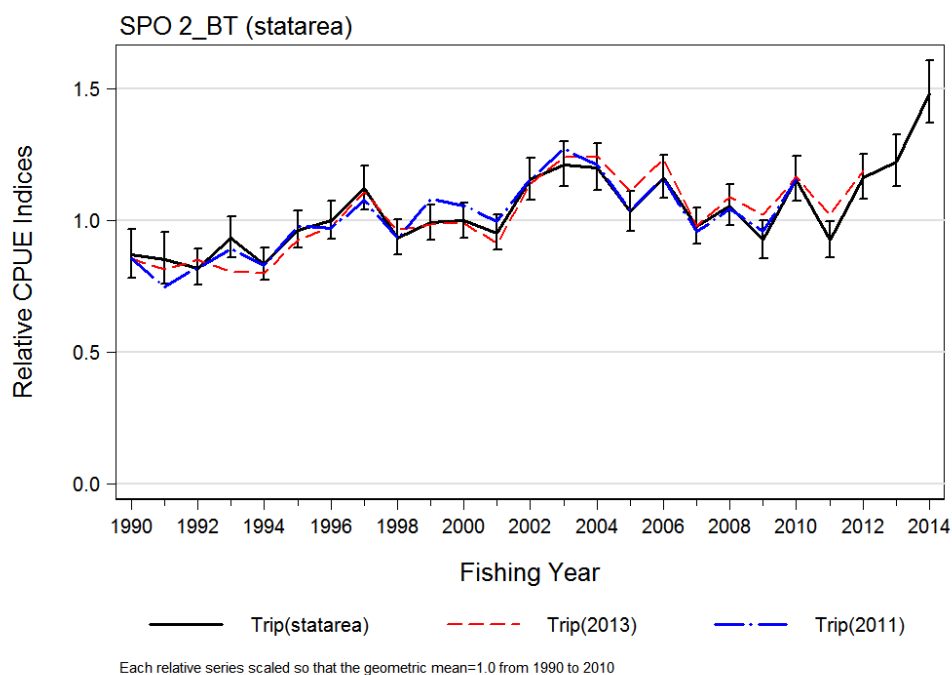
## RIG (SPO)

The trip-based SPO 2 series constructed from bottom trawl data shows a gradually increasing trend from 1989–90 to 2002–03 after which the series drops slowly to 2011–12, where it reaches an apparent nadir (Figure 4). This is followed by three successive years of increase, culminating in 2013–14, the highest level in the series and 60% higher than 2011–12. The 2013 Southern Inshore Working Group (SIWG) gave the BT(trip) series an overall assessment quality rank of 1 but noted that, while the analysis was credible, the method of capture does not representatively sample large female rig.

### Research recommendations

In 2013, the recommendation was made that “the next update should include the setnet index (SPO 2) and the trip stratum analysis for BT and SN, because the SN index is more likely to monitor the large females”. This option was investigated in 2015, but the SIWG agreed that there were insufficient data to conduct such an analysis.

The 2015 SPO 2 analysis was not able to implement the recommendation that “historic catch and CPUE trends should be integrated with the current analyses”, but has implemented the recommendation that “the catch/CPUE ratio should be included as an indication of trends in relative fishing intensity” in the Status of Stocks section of this report.



**Figure 4: Lognormal standardised CPUE series and associated 95% error bars for SPO 2 based on the “statarea” definition to identify valid bottom trawl setnet trips which landed to SPO 2 up to 2013–14. Also shown for comparison are the equivalent SPO 2 BT CPUE series calculated in 2011 (Kendrick & Bentley in prep) and 2013 (Starr & Kendrick in prep).**

## SPO 3

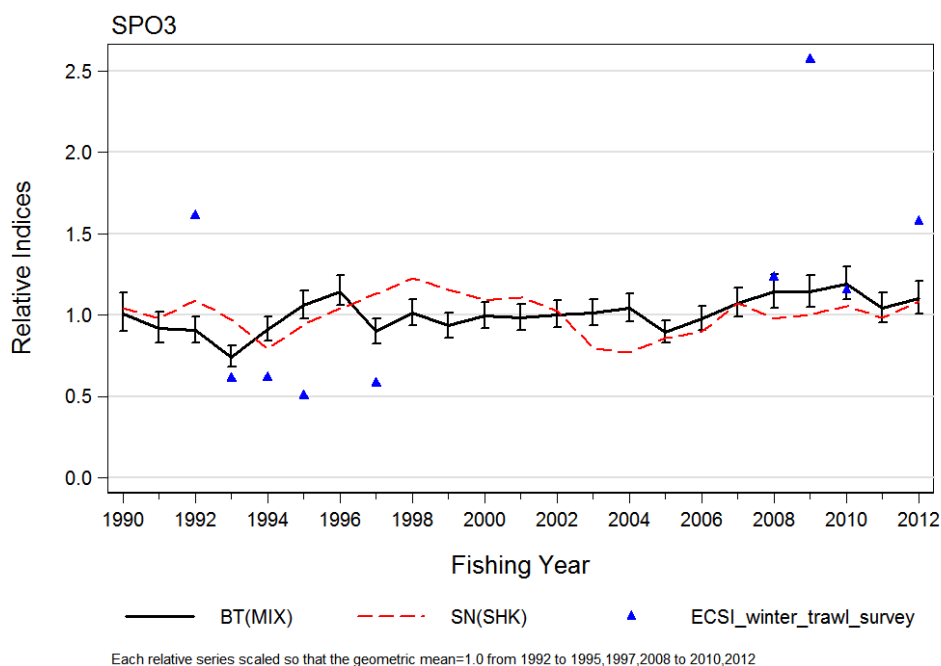
Rig in SPO 3 are mostly landed in the shark setnet and bottom trawl fisheries directed at a range of species, with additional small amounts landed by Danish seine vessels. The commercial catch in SPO 3 has never reached the TACC. Two CPUE standardisations were accepted by the Working Group, one based on a shark target setnet fishery and the other based on a mixed target species (barracouta, red cod, tarakihi, stargazer, elephantfish, and gurnard) bottom trawl fishery. Both CPUE analyses are extensions of equivalent analyses which have been previously reviewed by the Working Group (SeaFIC 2005a; Starr et al 2008, Starr & Kendrick 2011), although gurnard and elephantfish were added to the target species list for the bottom trawl analysis. These two fisheries are modelled separately because they operate at different depth ranges, with rig in the trawl fishery taken strictly as a bycatch while the species is targeted by the setnet fishery. These fisheries will clearly have different selectivities, harvesting a different size range of rig, with the setnet fishery taking larger fish while the

trawl fishery takes sub-adults. The SPO 3 landing data, regardless of the method of capture, did not exhibit the behaviour observed in SPO 1 of landing to temporary holding receptacles.

Each CPUE analysis was performed in the same manner. The effort data were matched with the landing data at the trip level to avoid relying on the estimated catch information in the effort part of the form and the resulting biases that exist in the reporting of estimated catches of rig. Core vessels which participated consistently in the fishery for a reasonably long period were identified within each data set so that the analysis could be confined to these vessels. The standardised analysis used a stepwise selection of explanatory variables based on the statistical distribution that gave the best fit to the data when performing a regression on non-zero catch records by trip stratum. The explanatory variables offered included fishing year (forced), month, vessel, statistical area, target species, duration of fishing, and length of net set (for the setnet analysis) or number of tows (for the bottom trawl analysis). The landing information used in this CPUE analysis has been corrected for changes in conversion factors that have occurred over the history of the dataset as well as to eliminate trips with unreasonably large landings (Starr & Kendrick in press).

The two series fluctuate about the long-term mean over the full period of each series (Figure 5). The Working Group accepted these series as indices of abundance and, although the trend based on the SN(SHK) data should be more reliable because it should be indexing adult fish, the Working Group downweighted this series because the setnet fishery on the east coast of the South Island has been considerably curtailed to reduce the bycatch of protected species. Given the known vulnerability of shark species, these analyses should be repeated regularly.

The Southern Inshore Working Group gave the BT(MIX) series a research rating of 1 because of the credibility of the analysis and the wide range of target species involved, but noted that the method of capture does not monitor the full size range of the population. The SN(SHK) series was given an overall assessment quality rank of 2 because the Working Group was concerned that the measures implemented to reduce the capacity of this fishery to intercept protected species would also affect the comparability of the series when capturing rig. The BT(FLA) series was given a research rating of 3 because the Working Group felt that the low headline height nets often used in this fishery would considerably reduce the catchability of rig. Bottom trawl nets more suitable for deeper water species are also used in this fishery but net type is not reported on the catch/effort forms, further reducing the ability of data from this fishery to monitor rig abundance.



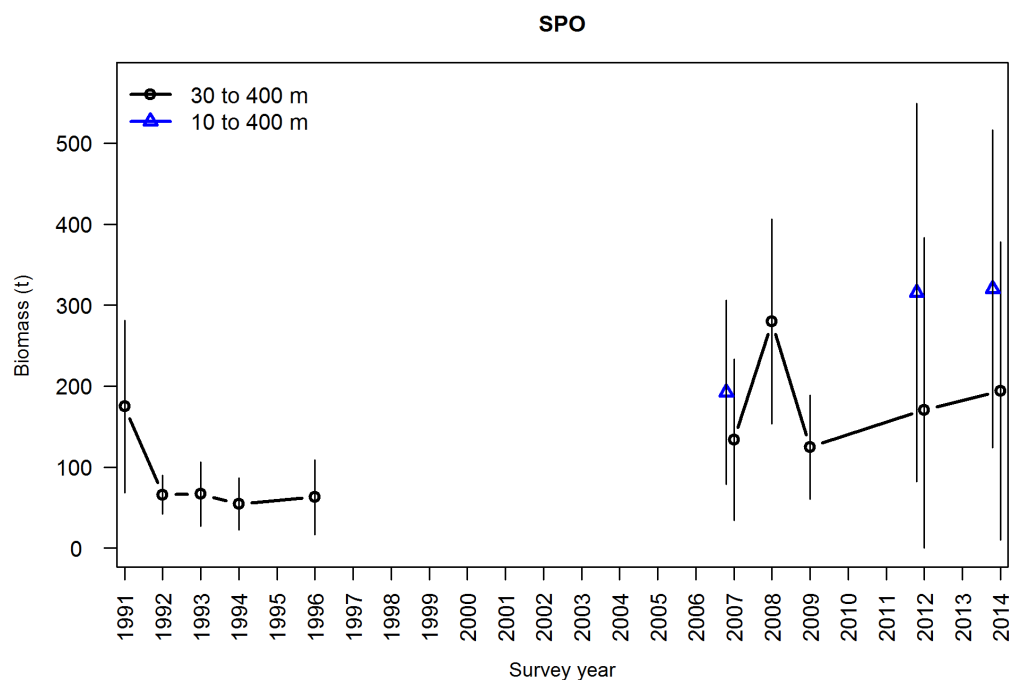
**Figure 5:** Comparison of the lognormal indices from the two CPUE series for SPO 3: a) BT[MIX]: mixed target species bottom trawl fishery; b) SN[SHK]: target shark species setnet fishery; also shown are nine index values collected for rig from the East Coast South Island winter trawl survey.

## RIG (SPO)

### Biomass estimates

#### ECSI

Rig biomass estimates in the east coast South Island winter trawl survey core strata (30–400 m) are generally higher in recent years compared with the 1990s (Figure 6). The additional biomass captured in the 10–30 m depth range accounts for 30% and 46% and 64% of the biomass in the core plus shallow strata (10–400 m) for 2007, 2012, and 2014 respectively, indicating that it is necessary to monitor the shallower strata as well as the core area for this species.



**Figure 6: Rig 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.**

**Table 8: Relative biomass indices (t) and coefficients of variation (CV) for rig for the east coast South Island (ECSI) - winter, survey area\*. 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). -, not measured; NA, not applicable.**

Region	Fishstock	Year	Trip number	Total Biomass estimate		Total Biomass estimate	
				CV (%)	30–400m	CV (%)	10–400m
ECSI (winter)	SPO 3	1991	KAH9105	175	30	-	-
		1992	KAH9205	66	18	-	-
		1993	KAH9306	67	30	-	-
		1994	KAH9406	54	29	-	-
		1996	KAH9608	63	37	-	-
		2007	KAH0705	134	37	192	30
		2008	KAH0806	280	23	-	-
		2009	KAH0905	125	26	-	-
		2012	KAH1207	171	62	315	37
		2014	KAH1402	194	48	320	21

### Length frequency distributions

#### ECSI

The length distributions for the east coast South Island trawl surveys have two clear modes centred round 40 cm and 60 cm, most pronounced in the shallow 10 to 30 m depth range (Figure 7). These two modes correspond to pre-recruit rig of ages 1+ and 2+. Rig tends to be larger overall in the 30 to 100 m depth range. The survey appears to be monitoring pre-recruited cohorts (1+ and 2+) reasonably well, but probably not the full extent of the recruited size distribution, as the proportion of rig >1m long in the survey catch is low. Plots of time series length frequency distributions are spiky because of the low numbers caught, but the size range is reasonably consistent among surveys. The addition of the 10–30 m depth range has changed the shape of the length frequency distribution, by increasing the

proportion of fish < 70cm in the survey catch. High numbers of rig < 70cm in both core and inshore strata in the 2012 and 2014 surveys is indicative of strong recruitment in recent years.

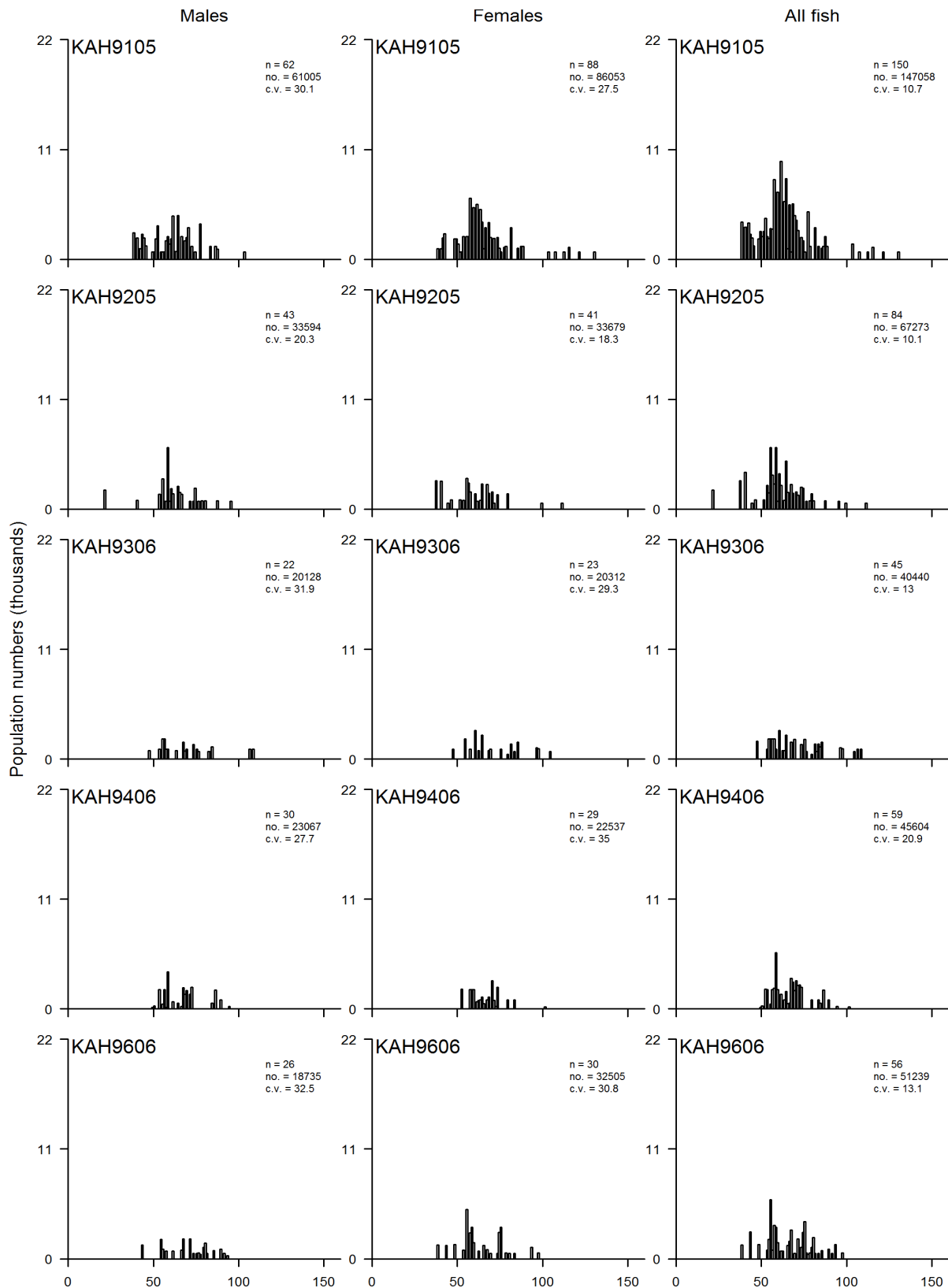
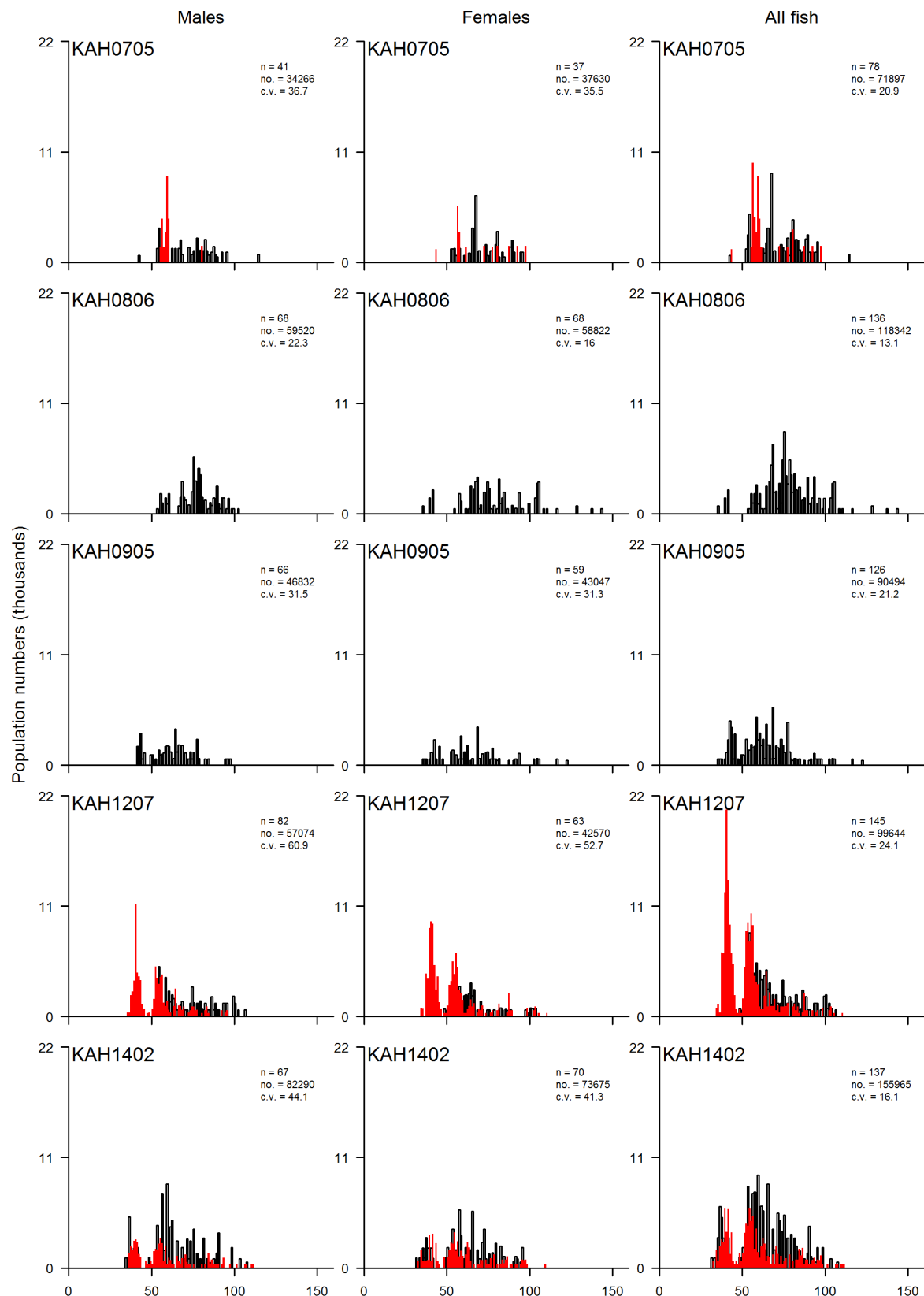


Figure 7: Scaled length frequency distributions for rig in core strata (30–400 m) for all ten ECSI winter surveys. The length distribution is also shown in the 10–30 m depth strata for the 2007, 2012, and 2014 surveys overlaid in red (not stacked). Population estimates are for the core strata only. n, number of fish measured; no., population number; CV, coefficient of variation.

**RIG (SPO)**



**Figure 7 [Continued]**

**SPO 7**

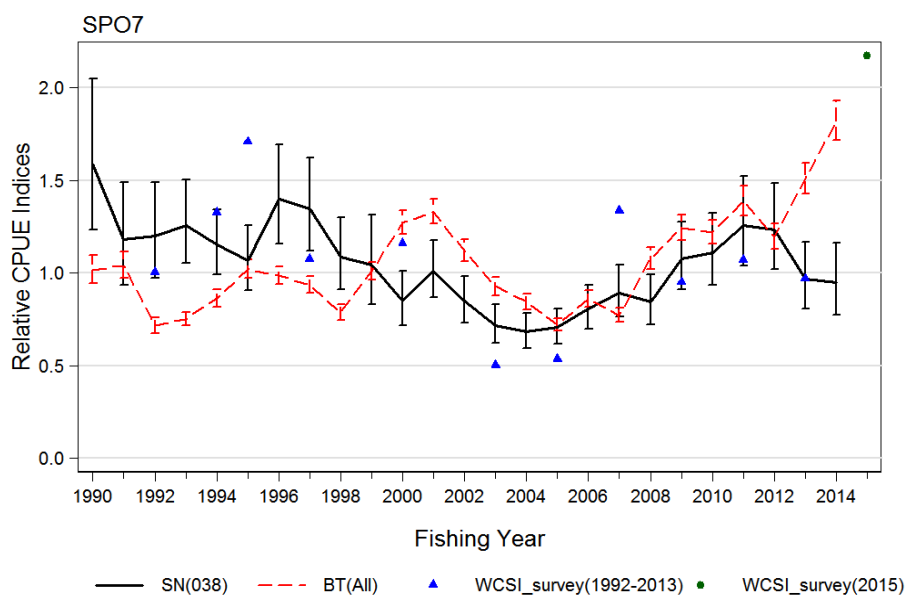
CPUE analyses standardising non-zero setnet and bottom trawl catches for core vessels were undertaken in 2015 to assess relative abundance of rig in SPO 7. Most of these analyses were updates of analyses previously accepted by the Working Group in 2006 (Starr et al 2006), 2010 (Starr et al 2010) and in 2013 (Starr & Kendrick in prep). The 2015 analyses used two of the same fishery definitions as the previous analyses: 1) setnet fishery in Statistical Area 038 targeting rig, spiny



dogfish and school shark [SN(038)]; and 2) bottom trawl fishery in Statistical Areas 016–018, 032–037, 038, 039 and 040 targeting flatfish, red cod, rig, barracouta, tarakihi, and gurnard [BT(ALL)]. A third analysis (setnet fishery in Areas 032–037) was rejected by the SIWG in 2015 (after being accepted in the 2006–2013 analyses) because of lack of sufficient data to create a reliable index. This lack is attributable to the movement of ACE to other SPO 7 fisheries and likely the management regulations imposed to protect Hector’s dolphins. Examination of the distribution of setnet effort on the west coast of the South Island shows that there has been a substantial decline in the number of vessels operating in these statistical areas since 2005–06. The SPO 7 landing data, regardless of the method of capture, did not exhibit the behaviour of landing to temporary holding receptacles observed in SPO 1.

The CPUE data were prepared by matching the landing data for a trip with effort data from the same trip that had been amalgamated to represent a day of fishing. The procedure assigns the modal statistical area and modal target species (defined as the observation with the greatest effort) to the trip/date record. All estimated catches for the day were summed and the five top species with the greatest catch were assigned to the date. This “daily-effort stratum” preparation method was followed so that the event-based data collected on forms presently used in these fisheries can be matched as well as possible with the data collected on earlier daily forms, to create a continuous CPUE series. Each analysis was confined to a set of core vessels which had participated consistently in the fishery for a reasonably long period (SN[038]: 3 trips for at least 3 years (for 17 vessels representing 96% of the catch); BT[All]: 5 trips for at least 10 years (for 94 vessels representing 78% of the catch)). The explanatory variables offered to each model included fishing year (forced), month, vessel, statistical area, target species, duration of fishing, and length of net set (for the setnet analysis) or number of tows (for the bottom trawl analysis). The Working Group had previously concluded that the SN(038) index was the more credible of the two available series (Area 038 accounts for 44% of the total rig landings over 25 years, 72% of which were taken by setnet gear [i.e. 72%=32%/44%]).

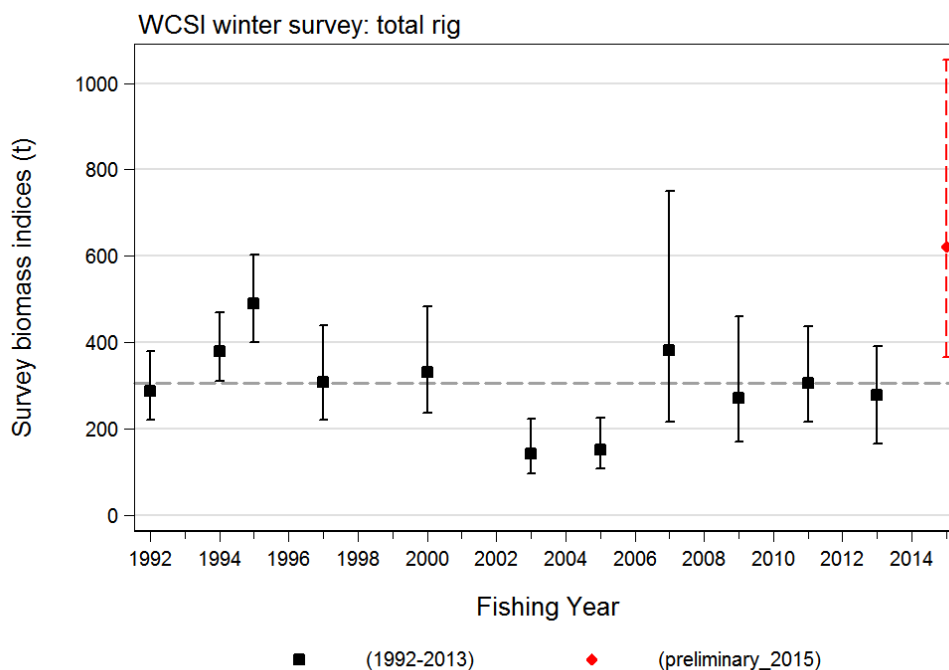
The SN(038) index showed a continuous declining trend from the beginning of the series to a low in the mid-2000s, approximately coincident with the lowering of the SPO 7 TACC. This low point is followed by an increasing trend to a peak in 2009–10, after which the series levels off and possibly dropped in 2012–13 and 2013–14 (Figure 8). It is this series which led to the decision to reduce the SPO 7 TACC to 221 t in 2006–07. The BT (ALL) series has shown an increasing trend since the mid-2000s but does not show the initial strong decline seen in the Tasman/Golden Bay series, possibly because SN(038) is the only fishery that takes mature females.



**Figure 8: Comparison of two SPO 7 standardised CPUE series: i) setnet fishery (shark target in Tasman/Golden Bays) [SN(038)]; ii) bottom trawl fishery (mix target in all SPO 7) [BT(ALL)]; also shown are nine index values collected for rig from the West Coast South Island winter trawl survey: 1992–2013 plus a preliminary WCSI rig biomass estimate for 2015 (in green because not yet reviewed by WG).**

## RIG (SPO)

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 declined by more than 50% between 1995 and 2005 but has since increased toward the series mean (Figure 9, Table 9). A preliminary 2015 WCSI survey value was more than double the 2013 index value (from 278 t to 622 t) (Figure 9, Table 9).



**Figure 9: 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 and  $1.96*CV$ . The dashed line is the series geometric mean (306 t). The 2015 biomass estimate is preliminary.**

The Southern Inshore Working Group gave the SN (038) series an overall assessment quality rank of 1 because this fishery targets mature female rig and there have been relatively few restrictions for the protection of Hector's dolphins because of their low abundance in this area. However, the Working Group was concerned that there were relatively few data in this analysis. If this trend of diminishing data continues, the utility of this series in future years may be compromised.

**Table 9: Relative biomass indices (t) and coefficients of variation (CV) for rig for the west coast South Island (WCSI) trawl survey.**

Survey	Fishstock	Year	Trip number	Total Biomass estimate (t)	CV (%)
WCSI	SPO 7	1992	KAH9204	288	13
		1994	KAH9404	380	10
		1995	KAH9504	490	10
		1997	KAH9701	308	18
		2000	KAH0004	333	18
		2003	KAH0304	144	22
		2005	KAH0503	153	19
		2007	KAH0704	383	13
		2009	KAH0904	272	26
		2011	KAH1104	307	18
		2013	KAH1305	278	20
		2015	KAH1503	622	27

### Length frequency distributions: WCSI trawl survey

Unlike the ECSI survey, the length distributions for the west coast South Island trawl surveys have no modes centred around 40 cm and the 60 cm mode is not present in every year (Figure 10). The 60 cm mode corresponds to pre-recruit rig of age 2+ and is present for both males and females in 2009 and shows up for females in most years from 2007 onwards. There is suggestion that there may be a 40 cm female mode in 2013. The male length distributions tend to be larger than for females in most years, with both distributions having low proportions >110 cm, indicating that this survey does not monitor the full range of rig sizes. The length distributions for the recently completed 2015 survey indicate good abundance across the 60–100 cm size bins for males and the 60–70 cm size bins for females. Higher numbers of fish < 80cm in 2011, 2013 and 2015, than in previous surveys, suggests strong recruitment in recent years.

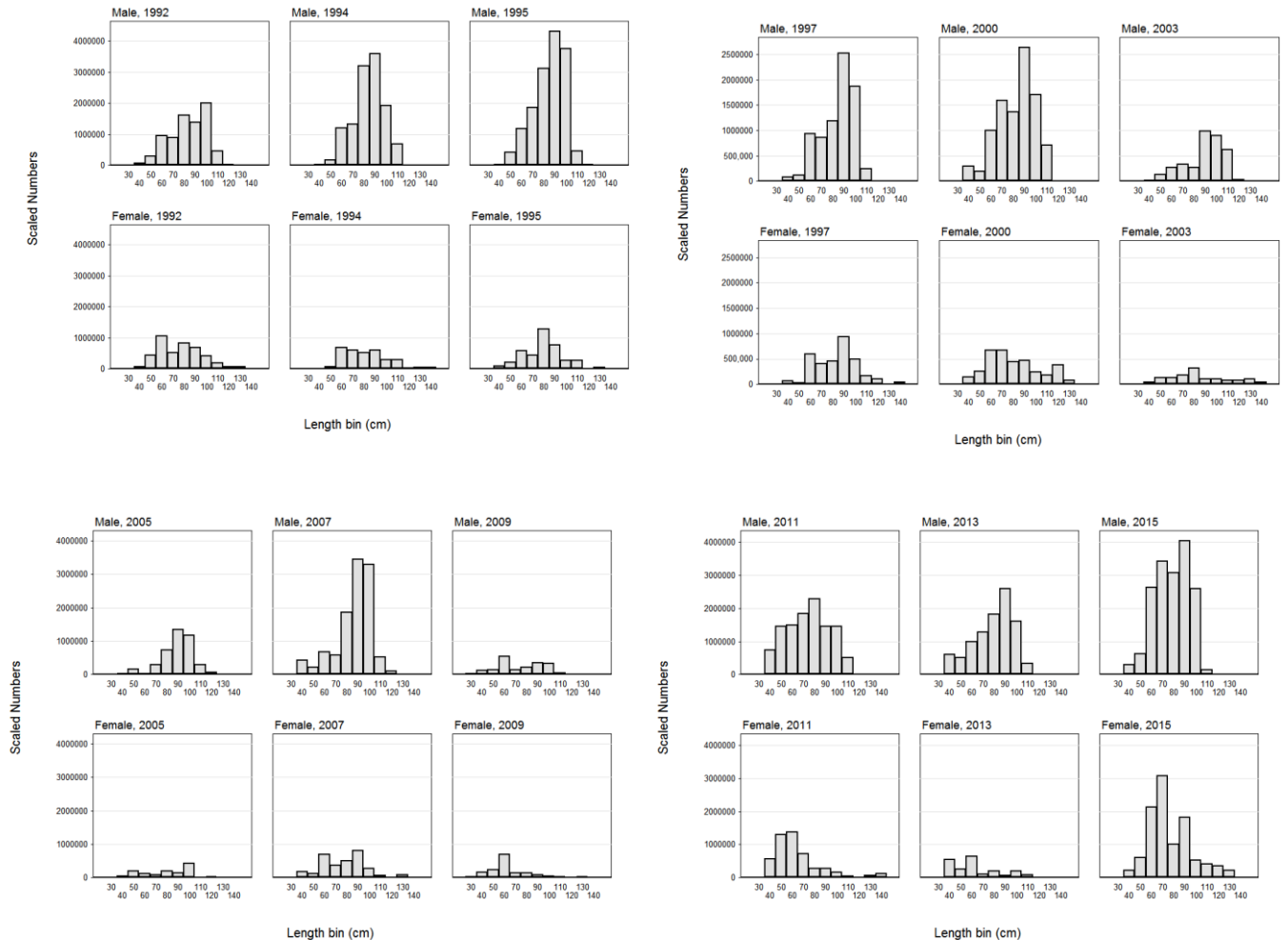


Figure 10 [Continued]: Scaled length frequency distributions by survey year for rig for all twelve WCSI winter surveys, showing distributions as scaled male and female numbers of rig.

### Establishing $B_{MSY}$ compatible reference points

The Working Group agreed to use the two lowest survey biomass values (2003 and 2005; see Table 9) as a proxy for the SPO 7 Soft Limit. This definition establishes the  $B_{MSY}$  proxy target reference point as twice the average 2003–2005 biomass level and the Hard Limit as one-half the average 2003–2005 biomass level. These are based on the definitions from the default Harvest Strategy Standard where the Soft and Hard Limits are one-half and one-quarter the target, respectively.

### SPO 7 Stock Assessment

A stock assessment for SPO 7 was presented to the AMP Working Group in 2006 (AMP-WG-06/24, AMP-WG-06/25). This assessment was an age-structured model fitted to setnet CPUE indices from two areas: Tasman/Golden Bays (Statistical Area 038) and the west coast South Island biomass

## RIG (SPO)

indices from the WCSI survey (Figure 9), commercial length frequency data (setnet and trawl fisheries), length frequency data from the WCSI survey, and age-length data (for estimating the growth model). Historical catches were reconstructed back to 1965, which was assumed to be the beginning of the model, starting with an unfished biomass at equilibrium. The model had two sexes, with growth parameters for each sex estimated in the model and a plus group at age 23 to accommodate the largest females in the length frequency data. Sex-specific commercial and survey selectivities were estimated. Descending right-hand limbs were allowed in the commercial trawl and survey selectivity functions to account for an assumed reduction in catchability for large rig taken by trawl nets. Natural mortality ( $M$ ) was fixed at 0.25 and steepness ( $h$ ) at 0.5 (Francis & Francis 1992a). This latter value was consistent with values used for low productivity shark species. Bayesian methods were used to estimate uncertainty.

The Working Group noted that this assessment was the first stock assessment completed within an AMP programme and was also the first chondrichthyan assessment completed in New Zealand. The Working Group accepted the methods, including data preparation steps and model structure and considered the results satisfactory.

The Working Group made the following conclusions based on this stock assessment:

- The SPO 7 stock was almost certainly below  $B_{MSY}$ . There was however some uncertainty as to where the stock was in relation to  $B_0$ . It was therefore not possible to produce reliable stock projections necessary to derive an assessment based TACC.
- Based on declining indices of abundance, current catches and the TACC (which had been substantially undercaught for the last five years) were not sustainable.

The Working Group requested that the stock assessment should be repeated in 2008. The next assessment should include the following:

- sensitivity runs based on larger historical catches prior to 1975 to account for probable dumping by trawlers;
- additional length-age data, particularly for large females; more rig would therefore need to be aged;
- new length composition data from the commercial catch (trawl and setnet);
- appropriate stock recruit relationships for sharks;
- 5-year stock projections;
- an understanding of the relationship of rig stocks between areas: what is the appropriate relationship of sub-areas within SPO 7 or with SPO 3 or SPO 8? The Working Group agreed that there was uncertainty in this issue and that information should be collected to address this problem.

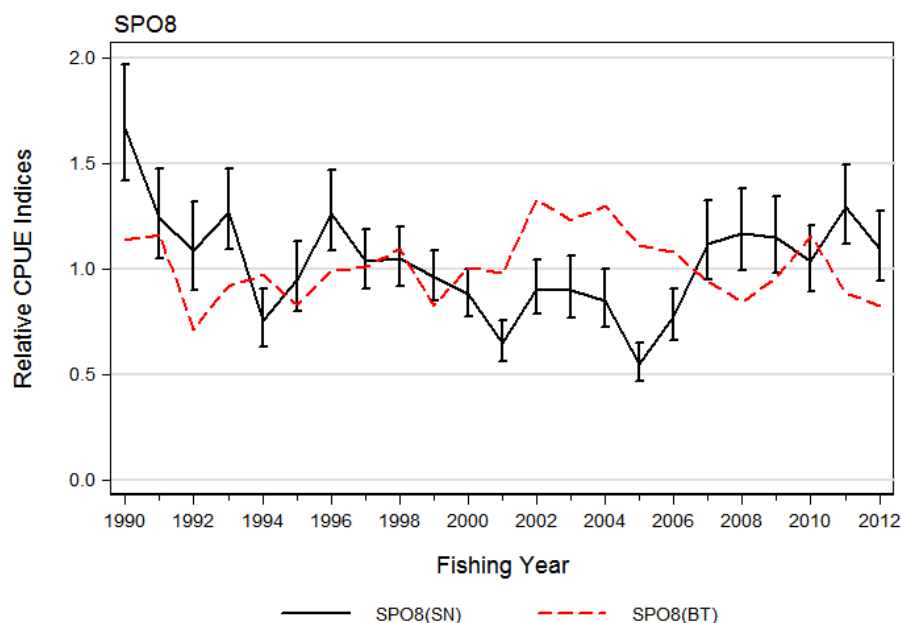
## SPO 8

SPO 8 landings are primarily by a setnet fishery that operates along the coast from Kapiti to beyond New Plymouth. The SPO 8 bottom trawl fishery operates further offshore in the North and South Taranaki Bights and takes rig as a bycatch in fisheries targeted at gurnard, tarakihi, snapper and gurnard. Recent average setnet landings in SPO 8 have been between 150–200 t/year while bottom trawl landings average between 10–30 t/year. The SPO 8 landing data, regardless of the method of capture, did not exhibit the behaviour of landing to temporary holding receptacles.

Standardised CPUE series were developed for both the SPO 8 setnet and bottom trawl fisheries, with each analysis confined to a set of core vessels which had participated consistently in the fishery for a reasonably long period. These analyses were performed on the non-zero trip-strata, regressing  $\ln(\text{catch})$  against the usual range of explanatory variables, including fishing year (forced), month, vessel, statistical area, target species, duration of fishing, and length of net (for the setnet analysis) or number of tows (for the bottom trawl analysis). One problem with the SPO 8 analyses was the large overlap with other SPO QMAs, with all of the SPO 8 coastal statistical areas being shared with other QMAs. The approach of dropping trips which reported multiple QMA landings while fishing in an ambiguous statistical area was discarded for these analyses. Instead, all trips fishing in Areas 039, 040 and 041 were deemed to have fished in SPO 8 (for both the setnet and bottom trawl analysis),

resulting in the adjustment of estimated catches to landings without regard for the QMA and avoiding the problem of discarding over 30% of the catch from the analysis.

The SPO 8(SN) CPUE analysis was variable with relatively large coefficients of variation (Figure 10). The overall pattern was one of gradual decline to the mid-2000s, followed by a recovery to the present. The SPO 8(BT) CPUE series showed no trend (Figure 10). The WG gave the SPO 8(SN) series a research rating of 1, noting that the year trend was similar in all three statistical areas and that a setnet fishery should provide information from a wider range of the rig population. The Working Group gave the SPO 8(BT) CPUE series an overall assessment quality rank of 2, noting that the indices were based on very small amounts of data in any year, with landings from the core data set ranging from 5 to 20 t of rig per year and that trawl gear does not representatively sample large female rig.



**Figure 11: Comparison of two standardised CPUE series from three SPO 8 statistical areas: 039, 040 and 041**  
i) setnet fishery (shark target) [SPO 8(SN)]; ii) bottom trawl fishery (mixed target) [SPO 8(BT)].

## 4.2 Other factors

Stock mixing occurs in the South Taranaki Bight to the Cook Strait and South Westland regions, and probably elsewhere. 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.

There have been several changes to the rig conversion factors over the period that SPO has been managed within the QMS. The trend has been towards lower conversion factors. While researchers correct catches for these changes in undertaking CPUE analyses, this has not been done for total landings reported in this Working Group Report. These changes have the effect of reducing the effect of catches in recent years compared to early years, e.g. if actual catch had been constant it would appear to be declining. This has implications for historically set TACCs and any yield estimates (e.g. *MCY*).

## 5. STATUS OF THE STOCKS

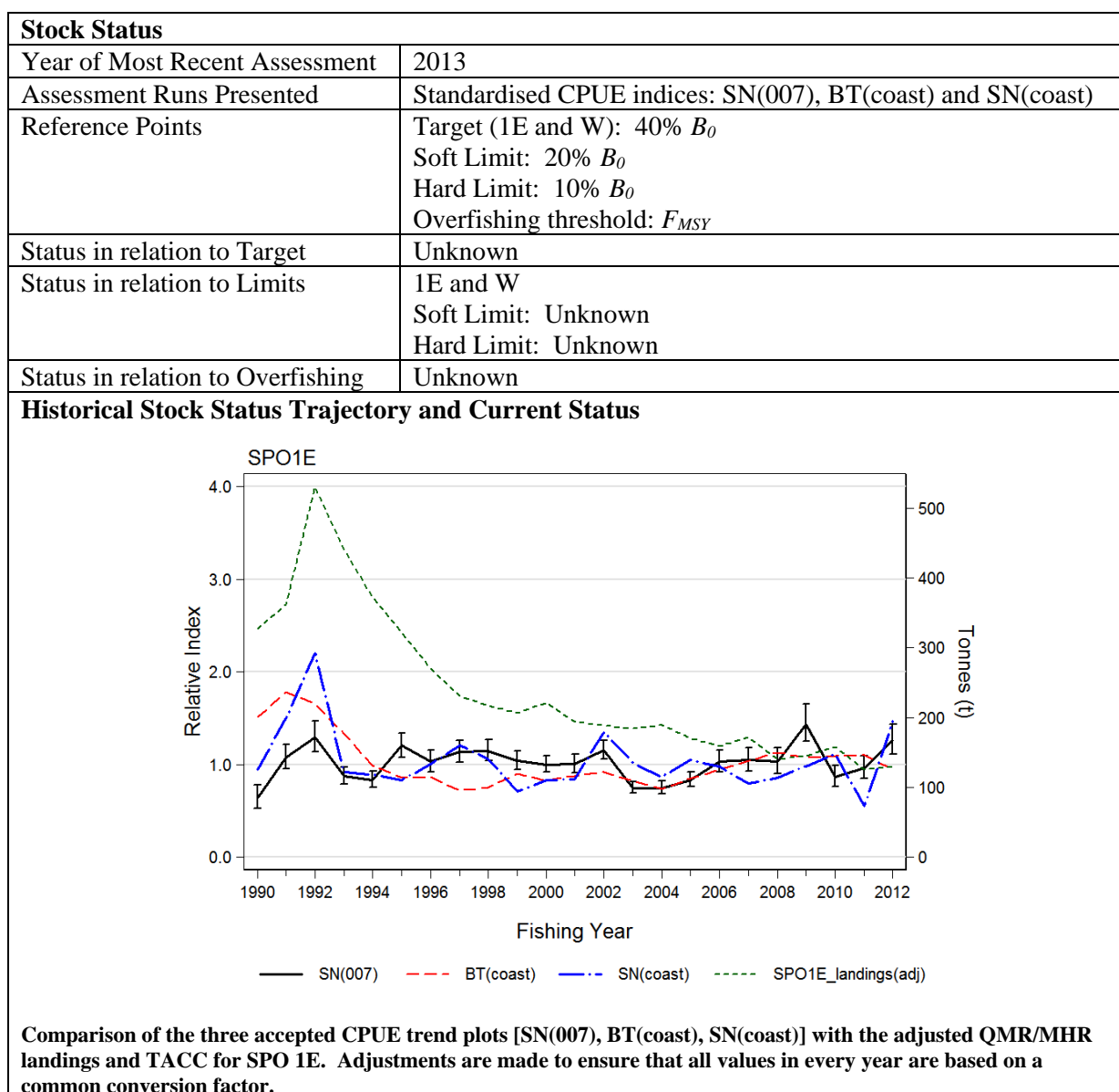
No estimates of current and reference biomass are available.

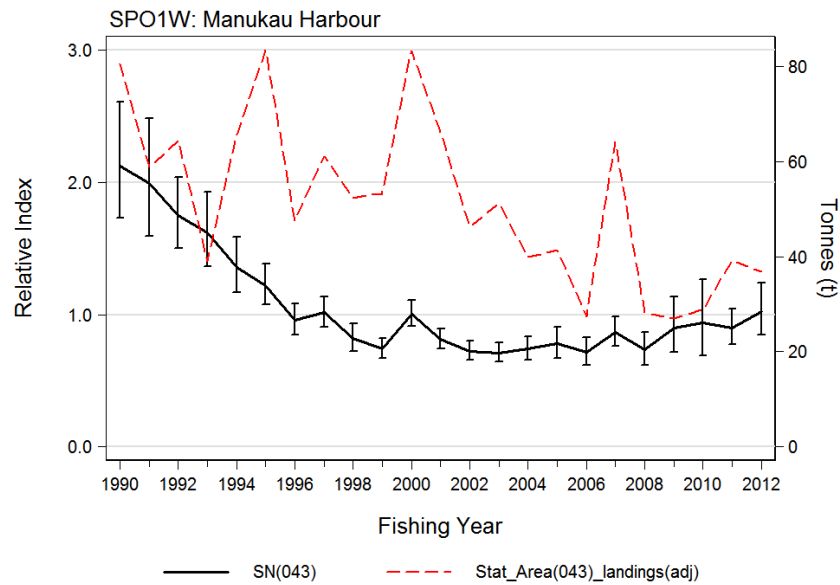
A review of stock structure in 2009 concluded that the existing QMAs were suitable for rig management, although the boundaries between biological stocks were poorly defined, especially in the Cook Strait region (Francis 2010).

- **SPO 1**

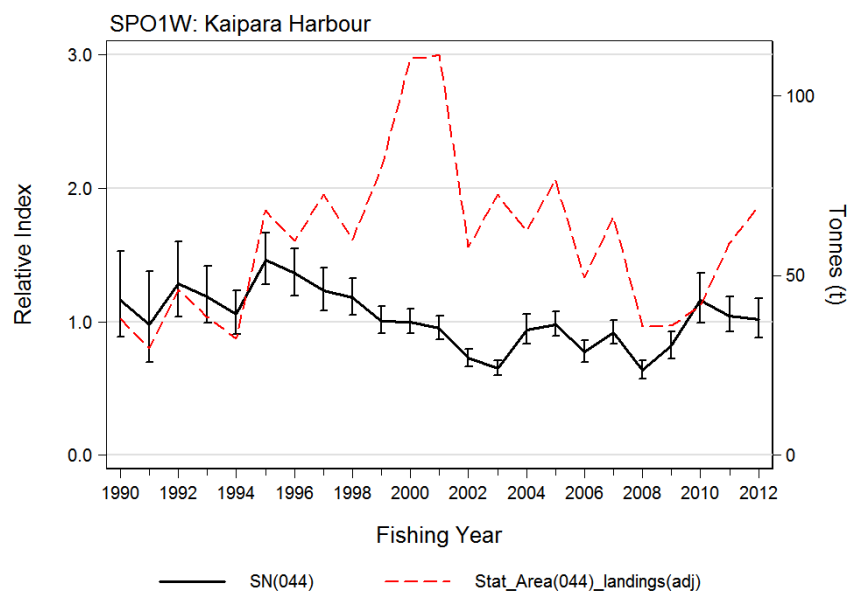
### Stock Structure Assumption

For the purposes of this summary SPO 1 is treated as a discrete stock. It is not known if the rig stocks on the west and east coasts of the North Island are separate.





Comparison of the accepted CPUE trend plot for SN(043) with the adjusted total SPO landings in Statistical Area 043 (Manukau Harbour). Adjustments are made to ensure that all values in every year are based on a common conversion factor.



Comparison of the accepted CPUE trend plot for SN(044) with the adjusted total SPO landings in Statistical Area 044 (Kaipara Harbour). Adjustments are made to ensure that all values in every year are based on a common conversion factor.

**Fishery and Stock Trends**

Recent Trend in Biomass or Proxy	(1E) Adult biomass has fluctuated without trend, sub-adult biomass declined in the early 1990s after which it has fluctuated without trend. (1W) the SN(043 –Manukau harbour) series showed a strong decline in the early portion of the series while the SN(044 Kaipara harbour) series showed no trend throughout the 1990s, both have fluctuated without trend since the late 1990s.
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Recent Trend in Fishing Intensity or Proxy	Unknown
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Other Abundance Indices	-
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Trends in Other Relevant Indicators or Variables	-
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**RIG (SPO)**

<b>Projections and Prognosis</b>	
Stock Projections or Prognosis	Current catches are Unlikely (< 40%) to cause the stock to decline.
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Unknown (Catch) Hard Limit: Unknown (Catch) Since current catches are well below the TACC, it is Unknown if the TACC will cause the stock to decline.
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown

<b>Assessment Methodology and Evaluation</b>		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Fishery characterisation and standardised CPUE analysis	
Assessment Dates	Latest assessment: 2013	Next assessment: 2016
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	SPO 1E: Setnet CPUE series: target shark in Area 007 (Firth of Thames) Bottom trawl CPUE series: mixed target species (Areas 002–010) Setnet CPUE series: target shark (Areas 002–006 and 008–010)  SPO 1W: Setnet CPUE series: target shark in Area 043 (Manakau Harbour) Setnet CPUE series: target shark in Area 043 (Manakau Harbour)	1 – High Quality  1 – High Quality 2 – Medium Quality  1 – High Quality 1 – High Quality
Data not used (rank)	SPO 1W Bottom trawl CPUE series: mixed target species (Areas 042, 045–048) Setnet CPUE series: shark target species (Areas 042, 045–048)	3 – Low Quality: few data and poor diagnostics 3 – Low Quality: few data and poor diagnostics
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	Lack of historical information relating to stock abundance	

**Qualifying Comments**

The accepted BT(coast) CPUE series (SPO 1E) does not sample mature fish in the rig population.

**Fishery Interactions**

Rig are taken as a bycatch in bottom trawl fisheries targeted mainly at snapper, tarakihi, gurnard, John dory, barracouta, trevally (SPO 1E) while the setnet fisheries are almost exclusively targeted at rig in both SPO 1E and SPO 1W. In the setnet fisheries there is a risk of incidental capture of seabirds, Maui's dolphins on the west coast, other dolphins and New Zealand fur seals.

- **SPO 2**

**Stock Structure Assumption**

For the purposes of this summary SPO 2 is treated as a discrete stock.

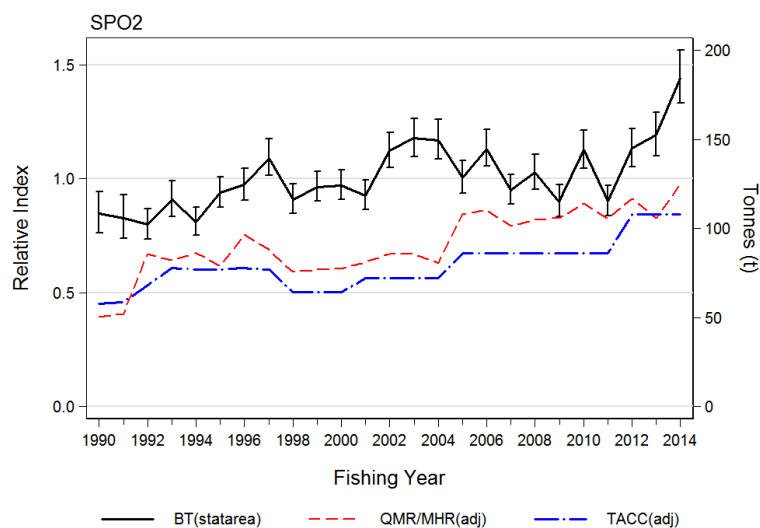
**Stock Status**

Year of Most Recent Assessment	2015
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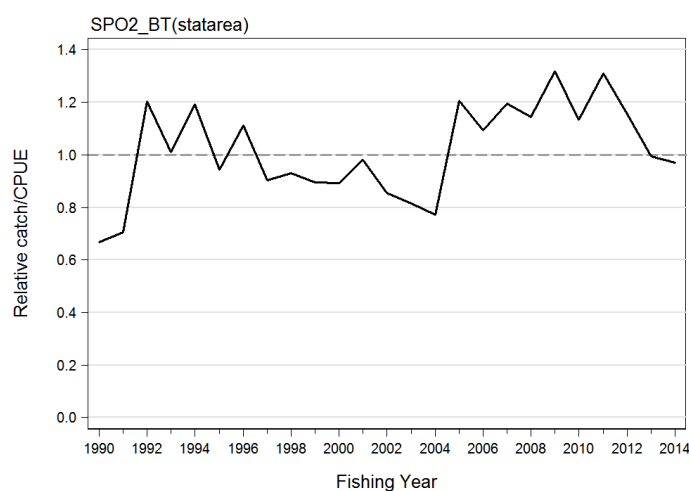


Assessment Runs Presented	Standardised CPUE: BT(stat area)
Reference Points	Target: 40% $B_0$ Soft Limit: 20% $B_0$ Hard Limit: 10% $B_0$ Overfishing threshold: $F_{MSY}$
Status in relation to Target	Unknown
Status in relation to Limits	Soft Limit: Unknown Hard Limit: Unlikely (< 40%)
Status in relation to Overfishing	Unknown

### Historical Stock Status Trajectory and Current Status



Comparison of the accepted CPUE trend plot [BT(statarea)] with the adjusted QMR/MHR landings and TACC for SPO 2. Adjustments are made to ensure that all values in every year are based on a common conversion factor.



Relative fishing pressure for SPO 2 based on the ratio of QMR/MHR (adj) landings relative to the BT(statarea) CPUE series. This series has been normalised so that its geometric mean=1.0.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Biomass had an upward trend from the beginning of the series to the early 2000s, after which biomass fluctuated to a low in 2010–11 followed by three successive years of increase.
Recent Trend in Fishing Intensity or Proxy	Relative fishing intensity has declined since 2009–10 and in 2013–14 was just below the series average.
Other Abundance Indices	A setnet CPUE series was developed in 2011, but was not repeated in 2013 or 2015 as the Working Group conclude that this series was not credible as an index of abundance because

**RIG (SPO)**

	of the small quantity of available data.
Trends in Other Relevant Indicators or Variables	-

<b>Projections and Prognosis</b>	
Stock Projections or Prognosis	Current catches are Unlikely (< 40%) to cause the stock to decline.
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Unknown Hard Limit: Current catches are Unlikely (< 40%) to cause the stock to decline below the hard limit. Since current catches are above the TACC, it is Unlikely (< 40%) that the TACC will cause the stock to decline.
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown

<b>Assessment Methodology and Evaluation</b>		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Fishery characterisation and standardised CPUE analysis	
Assessment Dates	Latest assessment: 2015	Next assessment: 2016
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	Bottom trawl CPUE series: trip-based analysis	1 – High Quality
Data not used (rank)	The setnet CPUE analysis up to 2009–10.	3- This series was not updated in 2015 (not ranked in 2011) as there was insufficient data to produce a reliable index of abundance
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- Lack of historical information relating to stock abundance	

<b>Qualifying Comments</b>
The accepted BT(statarea) CPUE series does not sample mature fish in the rig population; the Working Group agreed that the setnet series was not credible due to lack of data, poor vessel overlap, and the fact that the set net fishery targets a mixed group of species, including blue moki and blue warehou.
<b>Fishery Interactions</b>
Rig are taken as a bycatch in bottom trawl fisheries targeted mainly at flatfish, tarakihi and gurnard while the setnet fisheries target rig, school shark, flatfish, blue warehou and blue moki. There is a risk of incidental capture of seabirds, dolphins and New Zealand fur seals. There is a risk of incidental capture of Hector’s dolphins at the southern end of the QMA.

● **SPO 3**

**Stock Structure Assumption**

For the purposes of this summary SPO 3 is treated as a discrete stock.

<b>Stock Status</b>	
Year of Most Recent Assessment	2013
Assessment Runs Presented	None
Reference Points	Target: 40% $B_0$ Soft Limit: 20% $B_0$ Hard Limit: 10% $B_0$

	Overfishing threshold: $F_{MSY}$
Status in relation to Target	Unknown
Status in relation to Limits	Soft Limit: Unknown Hard Limit: Unknown
Status in relation to Overfishing	Unknown
<b>Historical Stock Status Trajectory and Current Status</b>	
<p>Each relative series scaled so that the geometric mean=1.0 from 1992 to 1995, 1997, 2008 to 2010, 2012</p>	
<p><b>Comparison of the two accepted CPUE trend plots [BT(MIX) and SN(SHK)] with the adjusted QMR/MHR landings and TACC for SPO 3. Adjustments are made to ensure that all values in every year are based on a common conversion factor. Also shown are the nine index values for the East Coast South Island winter trawl survey.</b></p>	

<b>Fishery and Stock Trends</b>	
Recent Trend in Biomass or Proxy	Biomass trends have been relatively flat for both accepted CPUE series. Biomass estimates from the most recent four survey years of the ECSI trawl survey series suggest that biomass has increased relative to the 1990s.
Recent Trend in Fishing Intensity or Proxy	Unknown
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	-

<b>Projections and Prognosis</b>	
Stock Projections or Prognosis	Current catches are Unlikely (< 40%) to cause the stock to decline. Since current catches are below the TACC, it is Unknown if the TACC will cause the stock to decline.
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Unknown Hard Limit: Unknown Since current catches are below the TACC, it is Unknown if the TACC will cause the stock to decline below either limit.
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown

<b>Assessment Methodology and Evaluation</b>		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Fishery characterisation and standardised CPUE analysis and trawl survey biomass	
Assessment Dates	Latest assessment: 2013	Next assessment: 2016
Overall assessment quality rank	1 – High Quality	

**RIG (SPO)**

Main data inputs (rank)	-Bottom trawl CPUE series: mixed target species -Setnet CPUE series: target shark -East coast South Island winter trawl survey	1 – High Quality 2 – Medium Quality  1 – High quality
Data not used (rank)	Bottom trawl CPUE series: flatfish target species	3 – Low Quality: gear from this fishery is poor at catching rig
Changes to Model Structure and Assumptions	- Dropped the bottom trawl flatfish CPUE analysis	
Major Sources of Uncertainty	- Lack of historical information relating to stock abundance. - In some years the ECSI trawl survey indices have high CVs.	

**Qualifying Comments**

The accepted BT(MIX) CPUE series and the ECSI trawl survey do not representatively sample large female rig. The SN(SHK) CPUE series has been downgraded to level 2 because there are concerns that recent management restrictions to protect Hector’s dolphins will reduce the comparability of this series with earlier indices.

**Fishery Interactions**

A 4 nautical mile setnet closure has been in place since October 2008 for the entire area to reduce the bycatch of Hector’s dolphins. Rig are largely targeted by setnet but they are also caught as bycatch in target fisheries for school shark, flatfish, red cod, spiny dogfish and elephant fish in setnet, bottom trawl and bottom longline fisheries. In the setnet fisheries there is a risk of incidental capture of seabirds, Hector’s dolphins, other dolphins and New Zealand fur seals. There is a risk of incidental capture of sea lions from Otago Peninsula south.

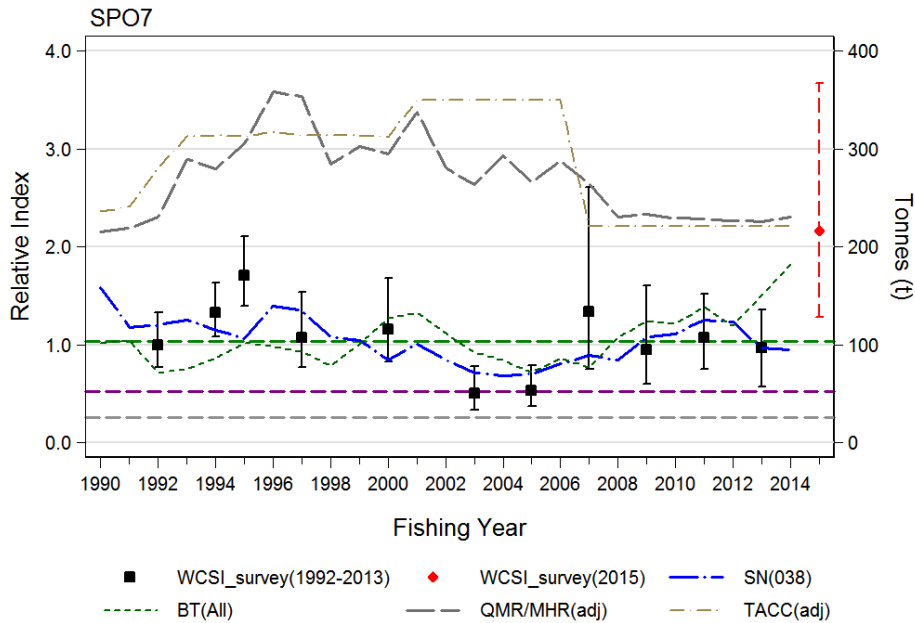
• **SPO 7**

**Stock Structure Assumption**

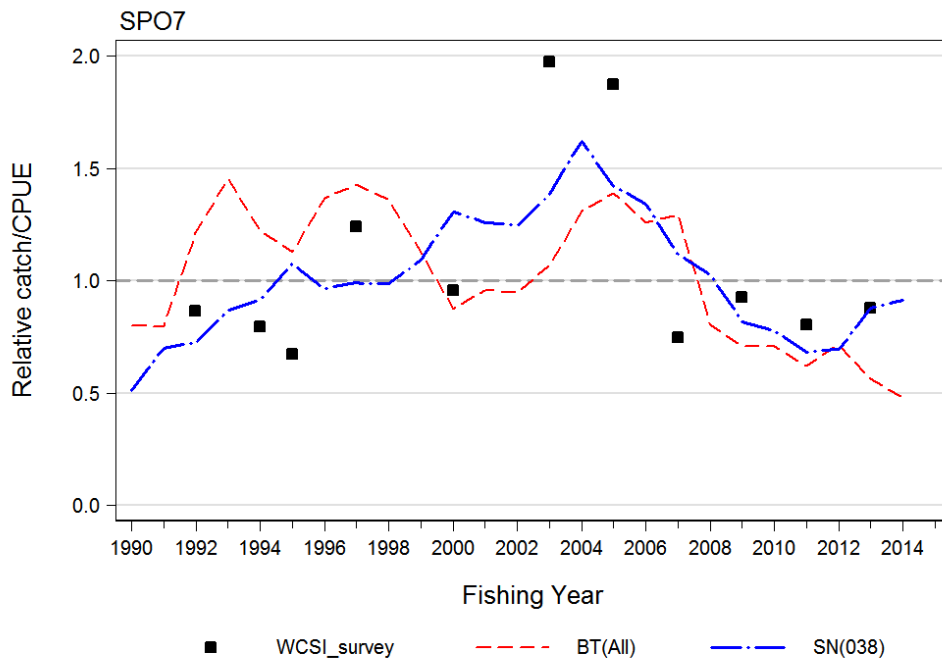
For the purposes of this summary SPO 7 is treated as a discrete stock.

<b>Stock Status</b>	
Year of Most Recent Assessment	2015
Assessment Runs Presented	WCSI trawl survey series BT (All) CPUE series SN (038) CPUE series
Reference Points	Interim Target: Proxy for Bmsy based on 2x soft limit (297.2 t) Soft Limit: Mean WCSI trawl survey biomass estimates for 2003 and 2005 (148.6 t) Hard Limit: 50% of soft limit Overfishing threshold: $F_{MSY}$
Status in relation to Target	About as Likely as Not (40-60%) to be at or above the target.
Status in relation to Limits	Soft Limit: Unlikely (< 40%) to be below Hard Limit: Very Unlikely (< 10%) to be below
Status in relation to Overfishing	Overfishing is Unlikely (< 40%) to be occurring

**Historical Stock Status Trajectory and Current Status**



Comparison of the two accepted CPUE trend plots [SN(038) and BT(ALL)] with the adjusted QMR/MHR landings and TACC for SPO 7. Adjustments are made to ensure that all values in every year are based on a common conversion factor. Also shown are 12 index values for the West Coast South Island trawl survey. The most recent WCSI survey value is indicated in red because it is preliminary. The agreed Soft Limit is shown as a purple line, the *B<sub>MSY</sub>* proxy target is shown as a green line and the Hard Limit is shown as a grey line.



Relative fishing pressure for SPO 7 based on the ratio of QMR/MHR (adj) landings relative to the WCSI survey and two CPUE series: BT(All) and SN(038). Each series has been normalised so that its geometric mean=1.0 for all common years.

**Fishery and Stock Trends**

Recent Trend in Biomass or Proxy	Relative biomass (WCSI trawl survey) was stable, at around the target level, from 2007 to 2013, but increase sharply in 2015. The SPO 7_BT(All) CPUE [series shows an increasing trend in recent years from a low point in 2004–05]. The SPO 7_SN(038) series has flattened out after showing an increase from 2006–07.
Recent Trend in Fishing Intensity or Proxy	Relative fishing intensity, based on all three indices of abundance, is well below the series means and is declining

**RIG (SPO)**

Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	Size composition of the WCSI trawl survey catches suggests strong recruitment in recent years.

<b>Projections and Prognosis</b>	
Stock Projections or Prognosis	The stock is Unlikely (< 40%) to decline under current catch and TACC.
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Unlikely (< 40%) Hard Limit: Very Unlikely (< 10%)
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown

<b>Assessment Methodology and Evaluation</b>		
Assessment Type	Level 1: 2006 Quantitative stock assessment Level 2: 2015 Two Standardised CPUE abundance indices and West Coast South Island trawl survey index	
Assessment Method	2006: Bayesian statistical catch-at-age model 2015: Partial Quantitative assessment based on standardised CPUE and WCSI trawl survey series	
Assessment Dates	Latest assessment: 2015	Next assessment: 2016
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	2006: - West Coast South Island trawl survey index - Setnet CPUE from area 038 and the west coast - Length data from SN (038), SN(WC) and bottom trawl(WC) - Age/length data 2015: - Setnet CPUE series: target shark in Area 038 - Bottom trawl CPUE series: mixed target species (all statistical areas) - West Coast South Island trawl survey	1 – High Quality 1 – High Quality 1 – High Quality 1 – High Quality 1 – High Quality 1 – High Quality 1 – High Quality
Data not used (rank)	-WCSI SN CPUE series	3– Low Quality: insufficient data
Changes to Model Structure and Assumptions	In 2006: SPO 7 stock status was evaluated using an age-structured model fitted to setnet CPUE indices, biomass indices from the WCSI survey, length frequency data and age-length data.  In 2015, the WCSI SN series, previously also used to assess SPO7, was dropped due to data scarcity	
Major Sources of Uncertainty	- Lack of historical information relating to stock abundance.	

<b>Qualifying Comments</b>
The accepted BT(all) CPUE series and the WCSI trawl survey do not representatively sample large female rig, but they cover most of SPO7; while the set net index (which does provide an index of mature female abundance) only provides an index of abundance for SPO7 in statistical area 038. As the WCSI trawl survey biomass estimate for 2015 is preliminary, it was given lower weight than the other data points in the series.

**Fishery Interactions**

SPO 7 is caught in a targeted setnet fishery, which also targets school shark and spiny dogfish and in a bottom trawl fishery targeting flatfish, barracouta, red cod and tarakihi. The set net fishery has historically been focused in statistical area 038 (Tasman and Golden Bays). In the setnet fisheries there is a risk of incidental capture of seabirds, white pointer sharks, Hector's dolphins, other dolphins and New Zealand fur seals.

- **SPO 8**

**Stock Structure Assumption**

For the purposes of this summary SPO 8 is treated as a discrete stock.

<b>Stock Status</b>	
Year of Most Recent Assessment	2013
Assessment Runs Presented	Standardised CPUE: SPO 8(SN) and SPO 8(BT)
Reference Points	Target: 40% $B_0$ Soft Limit: 20% $B_0$ Hard Limit: 10% $B_0$ Overfishing threshold: $F_{MSY}$
Status in relation to Target	Unknown
Status in relation to Limits	Soft Limit: Unknown Hard Limit: Unknown
Status in relation to Overfishing	Unknown
<b>Historical Stock Status Trajectory and Current Status</b>	
<p style="text-align: center;">SPO8</p> <p style="text-align: center;">Fishing Year</p> <p style="text-align: center;">— SPO8(SN)    - - - SPO8(BT)    - - - QMR/MHR(adj)    - - - TACC(adj)</p>	
<p>Comparison of the two accepted CPUE trend plots [SPO 8(SN) and SPO 8(BT)] with the adjusted QMR/MHR landings and TACC for SPO 8. Adjustments are made to ensure that all values in every year are based on a common conversion factor.</p>	
<b>Fishery and Stock Trends</b>	
Recent Trend in Biomass or Proxy	Setnet CPUE shows a long gradual descent to the mid-2000s followed by a recovery to initial levels by the end of the series; the SPO 8(BT) CPUE series fluctuates without trend.
Recent Trend in Fishing Intensity or Proxy	Unknown
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	-

## RIG (SPO)

<b>Projections and Prognosis</b>	
Stock Projections or Prognosis	Current catches are Unlikely (< 40%) to cause the stock to decline. Since current catches are below the TACC, it is Unknown if the TACC will cause the stock to decline.
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Unknown Hard Limit: Unknown Since current catches are below the TACC, it is Unknown if the TACC will cause the stock to decline below the soft or hard limits.
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown

<b>Assessment Methodology and Evaluation</b>		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Fishery characterisation and standardised CPUE analysis	
Assessment Dates	Latest assessment: 2013   Next assessment: 2016	
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	Setnet CPUE series: target shark in Areas 039, 040, and 041 Bottom trawl CPUE series: mixed target species (Areas 039, 040, and 041)	1 – High Quality 2 – Medium or Mixed Quality: few data
Data not used (rank)	N/A	-
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	Lack of historical information relating to stock abundance.	

<b>Qualifying Comments</b>
The independence of this QMA between SPO 1W to the north and SPO 7 to the south is unclear because Statistical Areas straddle QMA boundaries. In order to avoid double counting, Statistical areas 039, 040 and 014 were deemed to be SPO 8 and were excluded from the SPO 1W and SPO 7 analyses.

<b>Fishery Interactions</b>
SPO 8 are mainly caught in a targeted setnet fishery which also targets school shark and spiny dogfish. The remaining catch is taken by a bottom trawl fishery targeting snapper, gurnard, trevally and tarakihi. In the setnet fisheries there is a risk of incidental capture of seabirds, Maui's dolphins other dolphins and New Zealand fur seals.

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