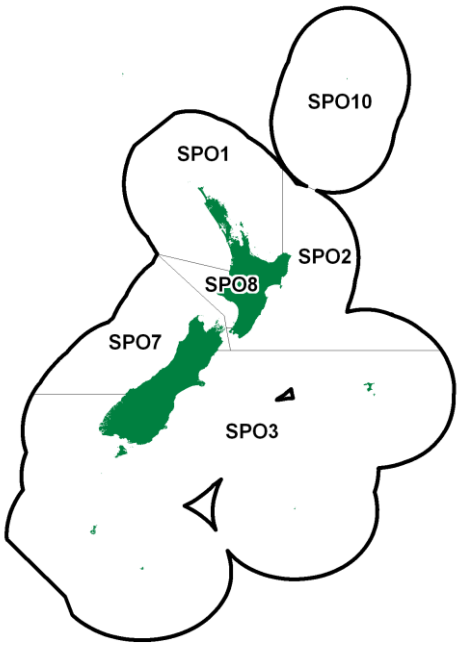
RIG (SPO)

(Mustelus lenticulatus)
Pioke, Makoo



1. FISHERIES SUMMARY

Rig was introduced into the Quota Management System on 1 October 1986. Table 1 gives the TACs, TACCs and allowances that were applicable to the 2015–16 fishing year.

Table 1: TACs (t), TACCs (t) and allowances (t) for rig in 2015–16.

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	33	15	12	246	306
SPO 8	-	-	-	310	401
SPO 10				10	10
Total	124	60	57	1 941	2 273

1.1 Commercial fisheries

Rig are caught in coastal waters throughout New Zealand. Most of the setnet 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, Table 3). 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. The TACC for SPO 7 was decreased to 221 t on 1 October 2006, resulting from a stock assessment based on a declining CPUE. SPO was introduced into the 6th Schedule on the 1st 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.

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 into the QMS in 1986, landings declined to less than half those of the previous decade in response to TACCs which were set at levels that were lower than previous catches. 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. All AMP programmes ended on 30 September 2009. The TACC for SPO 2 was increased from 72 t to 86 t from 1 October 2004 under the low knowledge bycatch framework (Table 4). In 2011–12 the SPO 2 TACC was further increased to 108 t. The SPO 7 TACC was raised to 246 t for 1 October 2015 based on increased abundance.

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 in the accompanying tables.

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 for the entire year 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 three 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. The west coast North Island setnet closure to 7 nautical miles was extended around Cape Egmont to Hawera in 2012, with fishing allowed between 2 and 7 nautical miles if an MPI observer was on board the vessel.

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 of the South Island west coast, 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. Both sides of Farewell Spit were voluntarily closed to setnets, beginning in October 2006, to protect large females in a known pupping area. The net effect of the setnet area closures was to considerably reduce the importance of the rig setnet fishery, which only took 56% of the annual coastwide catch between 2010–11 and 2014–15. The remainder was taken by bottom trawl (35%), Danish seine (6%) and a few other capture methods.

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

Year	SPO 1	SPO 2	SPO 3	SPO 7	SPO 8	Year	SPO 1	SPO 2	SPO 3	SPO 7	SPO 8
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 2014–15. QMS data from 1986–present.

Fishstock	SPO 1		SPO 2		SPO 3		SPO 7		SPO 8	
FMA (s)	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
1994–95	666	829	88	86	402	454	341	350	273	370
1995–96	603	829	107	86	408	454	400	350	330	370

Fishstock	SPO 1		SPO 2		SPO 3		SPO 7		SPO 8	
FMA (s)	1 & 9		2		3,4,5, & 6		7		8	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
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
2014–15	324	692	117	108	556	600	235	221	181	310

	SPO 10			
FMA (s)	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
2014–15	0	10	1 413	1 941

*FSU data.

§Includes landings from unknown areas before 1986–87

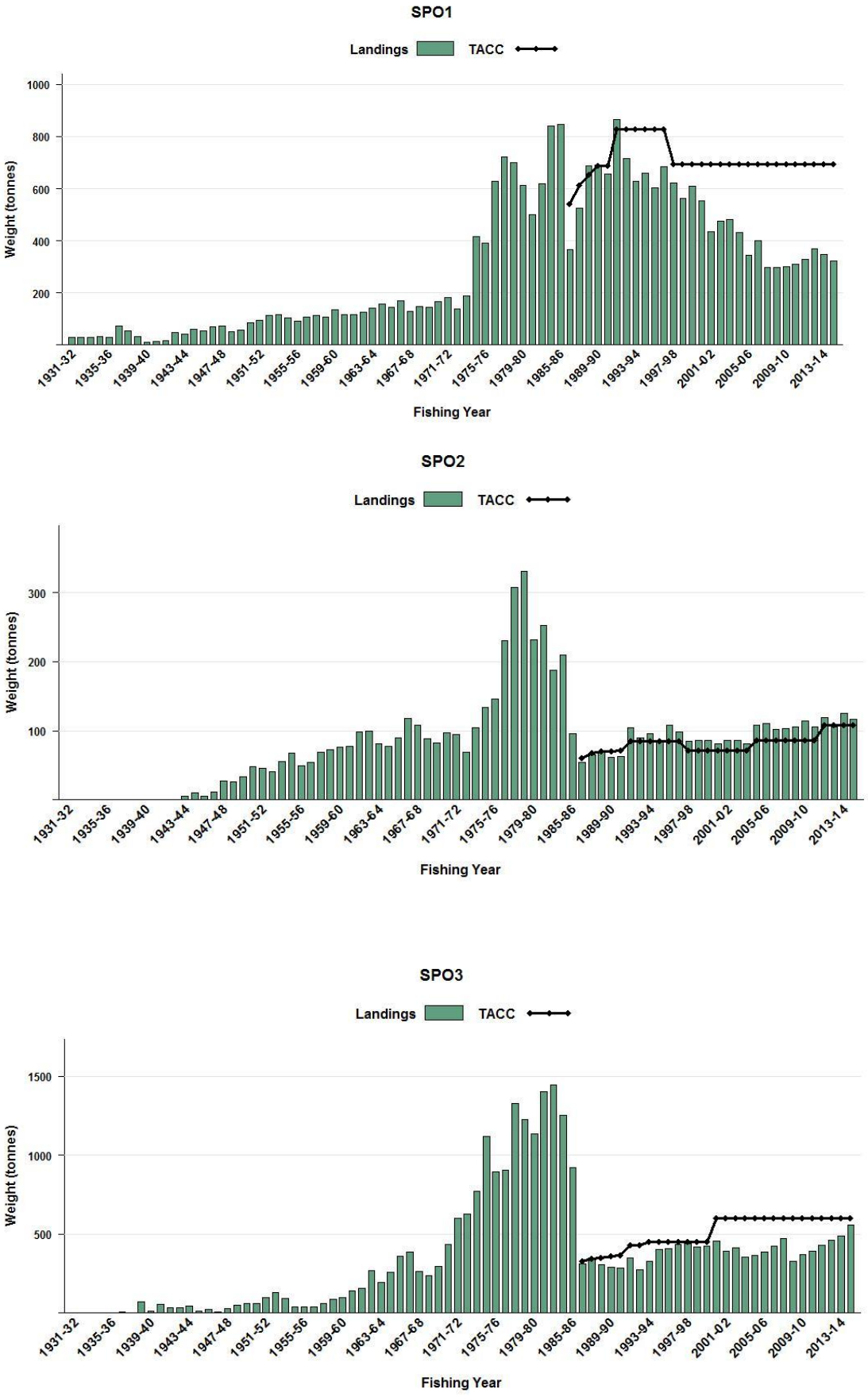


Figure 1: Historical landings and TACCs for the five main SPO stocks. From top to bottom: SPO 1 (Auckland East), SPO 2 (Central East) and SPO 3 (South East Coast).

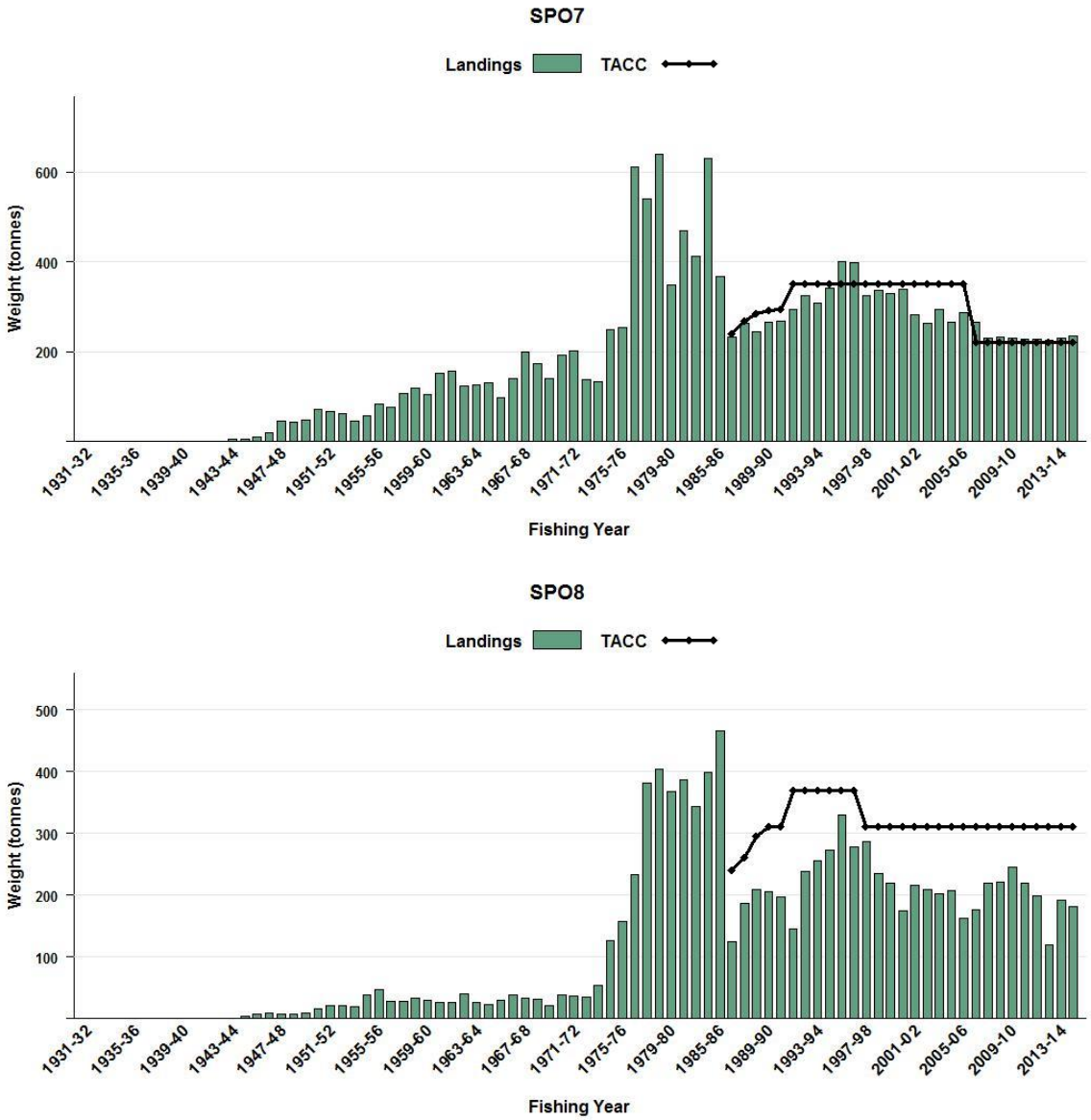


Figure 1 [Continued]: Historical landings and TACCs for the five main SPO stocks. From top to bottom: SPO 7 (Challenger) and SPO 8 (Central Egmont).

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-based fishers

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 2002). 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

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.

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 yr (about 85 cm) and 7–8 yr (about 100 cm), respectively (Francis & Ó Maolagáin 2000). Rig in the Hauraki Gulf mature earlier – 4 yr for males and 5 yr 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 an average 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 the North and South Islands. They grow rapidly during their first summer, and then disappear as water temperatures drop in autumn–winter when they presumably move into deeper water.

Rig make extensive coastal migrations, with one tagged female moving at 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 6.

Table 6: 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 g, length in cm fork 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	$3.85 \times 10^{-}$	3.01	Blackwell (unpubl. data)
3. von Bertalanffy growth parameters					
	Both Sexes				
	L	k	t_o		
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 had 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

New Zealand rig stock status has been assessed based on standardised CPUE analyses of the setnet and bottom trawl fisheries in SPO 3 and SPO 7 since the early 2000s. A comprehensive CPUE analysis of the SPO 1 setnet and bottom trawl fisheries was done in 2011 by Kendrick & Bentley (2012). Starr & Kendrick (2016) did an EEZ-wide CPUE analysis of all five rig QMAs in 2013 and this extensive analysis was repeated in 2016 (Starr & Kendrick, in prep.).

All CPUE analyses presented here are based on commercial catch and effort data reported by fishers using compulsory statutory forms. These forms have changed over the period covered by these analyses, most notably in 2006–07 for setnet and 2007–08 for trawl, when the form changed from a daily report to an "event" report, where an event is defined as a net set or a tow made. In order to derive continuous series of relative abundance, the catch and effort data collected with the new event-based forms needed to be converted into the equivalent daily form to create a series that spanned the change in form type. However, in the old system a fisher only needed to report as estimated catch the top 5 species (by weight) in a day, while the equivalent reporting on the event-based forms is the top 8 species for the event.

It is furthermore necessary to base the rig CPUE analysis on landed rather than estimated weight, because this species is processed at sea and many fishers report the estimated catch as processed weight instead of green [whole] weight. This is achieved by allocating the trip landings proportionately to each fishing day, based on the reported estimated catch, so the explanatory information associated with each day can be incorporated into the CPUE analysis. In the cases when rig are landed and sold at the end of a trip, but there is no estimated rig catch information for the trip, the procedure defaults to using the effort to make the allocation. When this happens, it means that the CPUE for the trip is directly proportional to the effort expended, not where rig are caught. This is not usually a problem when only a small proportion (less than 10%) of the trips fall into this category, but can introduce bias when 50–80% of trips have no estimated catches, as is the case for rig in bottom trawl fisheries. The Plenary agreed in 2016 to use data amalgamated to the level of a complete trip for the rig bottom trawl CPUE analyses. The auxiliary information on location of capture and intended target species was retained by assigning each trip with the value of the most frequent statistical area occupied and the most common target species.

The setnet CPUE data were prepared by amalgamating the effort data and other associated information (month, year, target species, vessel, statistical area) to represent a day of fishing. The procedure assigns

the most frequent statistical area and target species for that day of fishing to the trip/date record. All estimated catches for the day were summed and the five species with the greatest catch were assigned to the date. Landings were then assigned to each daily record in one of two ways: 1) by allocating the landings for the trip proportionately to the estimated catch for each day of fishing; or 2) calculating a "vessel correction factor" (*vcf*) for each vessel in a year (Kendrick & Bentley 2012). This factor is then applied to all estimated catches for that vessel in that year. Only *vcf* values in a specified range (0.75 to 2.0) were used, dropping all remaining vessels.

The setnet and bottom trawl CPUE analyses were conducted in a similar manner and included: a) identification of core vessels which participated consistently in the fishery for a reasonably long period so that the analysis could be confined to these vessels; b) a stepwise selection of explanatory variables, with each step selecting the variable with the greatest remaining explanatory power, after forcing fishing year (the abundance variable) as the first variable. The available explanatory variables 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 had 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 2016). Three standardised analyses were conducted for all bottom trawl fisheries: a) a lognormal non-zero catch model; b) a binomial presence/absence catch model; and c) a delta-lognormal model that combines the two series, using the method of Vignaux (1994). Both Inshore Working Groups have agreed to use the combined delta-lognormal standardised CPUE series as the basis for monitoring all bottom trawl species, especially those for species taken predominantly as bycatch. Simulation work has shown that the use of the combined series accounts for reporting trends as well as trends in the incidence of capture (Langley 2016).

SPO 1

Standardised CPUE indices were calculated for five SPO 1 setnet fisheries by modelling (GLM) non-zero catches by core vessels targeting rig and other shark species. Two coastal bottom trawl fisheries targeting a range of species were analysed by combining a non-zero catch series with a binomial presence/absence series. The SPO 1 setnet 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. This problem was solved by applying a "vessel correction factor" (*vcf*), calculated for each vessel and year, to correct the estimated catch observations (see above).

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 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(coast) and BT(coast) series showing strong declines in the early portion of the series while the SN(007) series shows no trend (Figure 2). The SN(coast) series declines from 2010–11 while the combined BT(coast) series shows a strong upturn from 2012–13, which is consistent among all rig BT CPUE analyses (see below).

The Southern Inshore Working Group and Plenary gave the SN(007) series a research rating of 2 because although this fishery targets mature female rig and the diagnostics were considered credible, it provides an index of abundance for only a portion of the total area. The Plenary gave the BT(coast) and SN(coast) series research ratings of 3 because annual catches were unacceptably low and, in the case of the set net index, the fishing locations were widely dispersed and occupied sporadically.

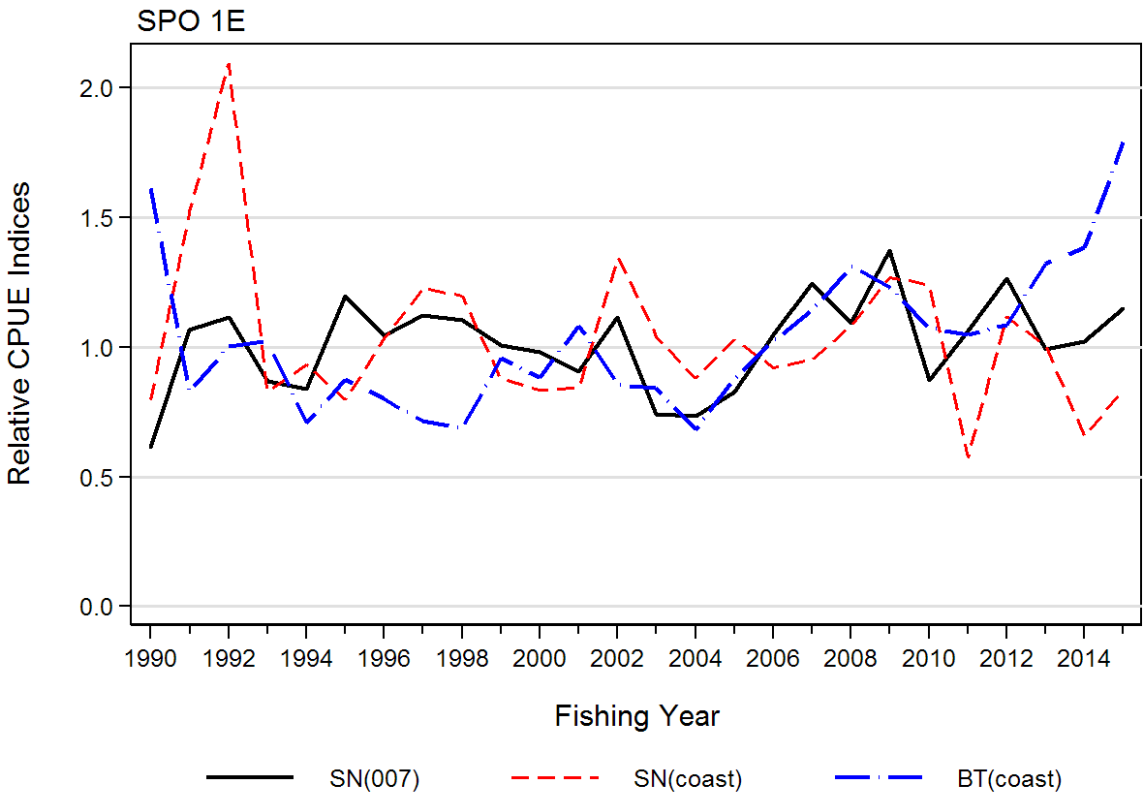


Figure 2: Comparison of standardised CPUE for SPO 1E in three fisheries: a) target shark setnet in the Firth of Thames (Area 007) [SN(007)]; b) target shark (SPO, SCH, SPD or NSD) setnet in remaining SPO 1E statistical areas [SN(coast)]; c) mixed target species bottom trawl in Statistical Areas 002 to 010 [BT(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) plus the most northerly SPO 8 statistical area (041) [SN(41–47)]; 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 plus the most northerly SPO 8 statistical area (041).

The Plenary assigned the BT index a quality ranking of 1, but noted that while the analysis was credible the method of capture does not representatively sample large female rig. The two harbour based set net indices were given a ranking of 2 (medium or mixed quality) because they are probably indexing localised abundance. The Plenary rejected the coastal set-net index as an index of abundance on account of the considerable impact the dolphin closures have had on this fishery. The coastal BT series is relatively flat from 1990 to the late 2000s, but shows a strong upturn since about 2008; the SN(043 Manukau harbour) series shows a strong decline in the early portion of the series while the SN(044 Kaipara harbour) series showed no trend throughout the 1990s. Both set net indices show a slowly declining trend since the late 1990s (Figure 3).

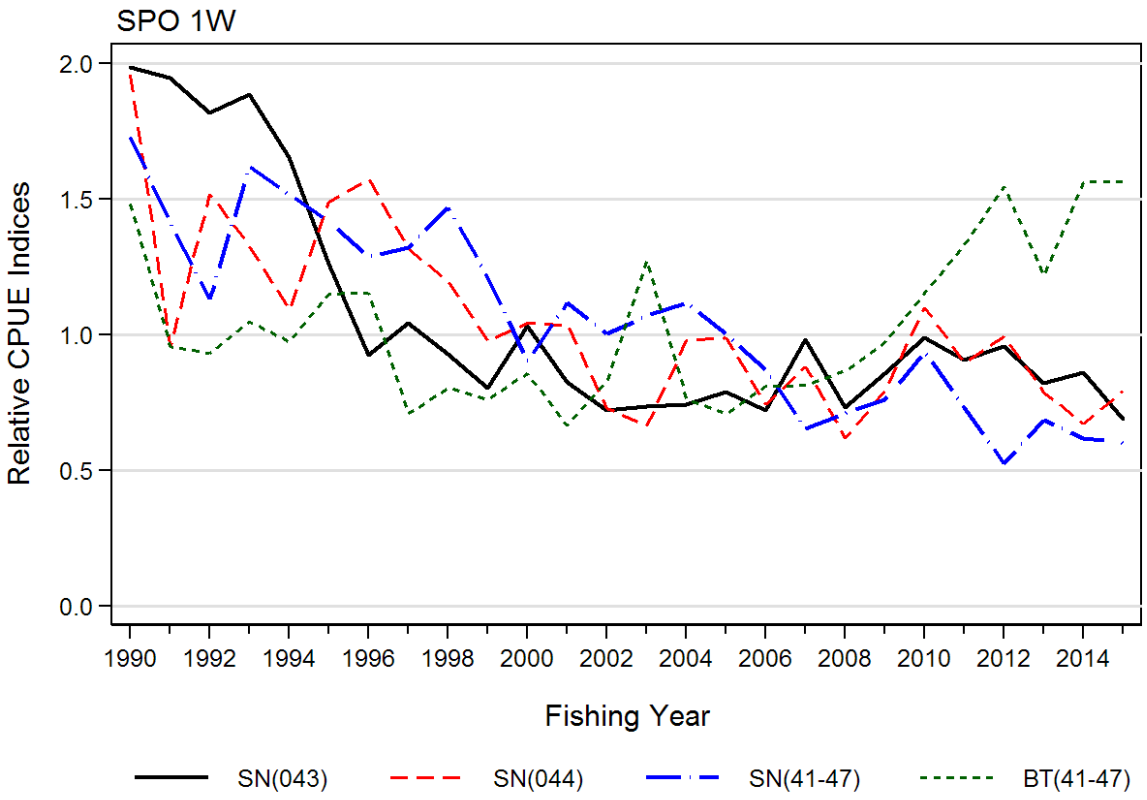


Figure 3: Comparison of standardised CPUE for SPO 1W in four fisheries: a) target shark setnet in Manukau Harbour (Area 043) [SN(043)]; b) target shark setnet in Kaipara Harbour (Area 044) [SN(044)]; c) target shark setnet on outer coast north of Cape Egmont [SN(41-47)]; d) coastal bottom trawl north of Cape Egmont [BT(41-47)].

SPO 2

A trip-based bottom trawl series was used to index SPO 2 relative abundance from 1989–90 to 2014–15. The corresponding setnet analysis was not repeated as part of this update due to the small amount of available data. 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. Only one SPO 2 (BT) analysis was conducted in 2016, which defined the data set by selecting trips which fished exclusively in the Areas 011–015 and targeted flatfish, gurnard or tarakihi. Equivalent analyses which selected trips on the basis of the reported QMA had shown no difference in the derived CPUE trends.

The trip-based combined SPO 2 series constructed from bottom trawl data shows a gradually increasing trend from 1989–90 to 2002–03, after which the series drops to a nadir in 2009–10 (Figure 4). This is followed by an increasing trend, culminating in 2013–14, the highest level in the series and double the 2009–10 index. The 2014–15 index dropped 15% relative to the 2013–14 index. The Plenary 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.

Establishing B_{MSY} compatible reference points

The Plenary agreed to use a Proxy for B_{MSY} based on the average CPUE during the period 2005–2015, a period of relatively stable CPUE and catches.

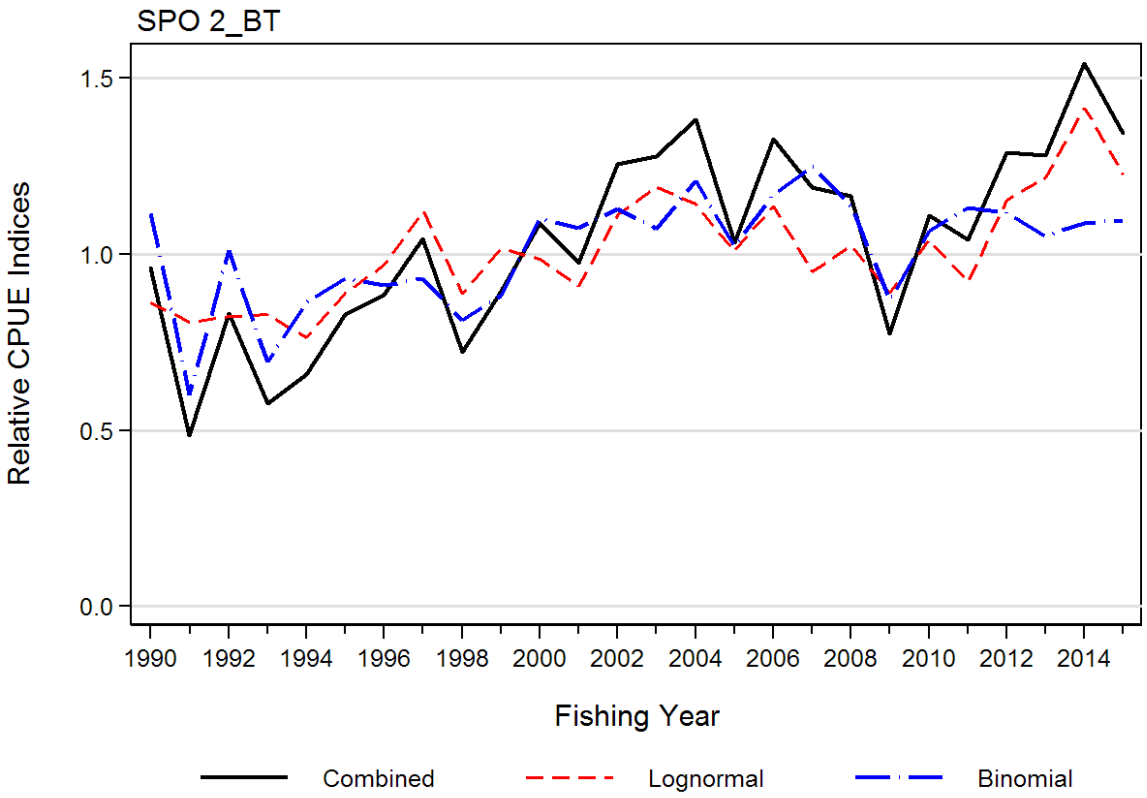


Figure 4: Standardised lognormal, binomial and combined delta-lognormal CPUE series for SPO 2 bottom trawl based on trips which landed rig from Statistical Areas 011 to 015 and targeted flatfish, gurnard or tarakihi up to 2014–15.

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. Two CPUE standardisations were accepted by the Working Group, one based on a shark target setnet fishery (SN[SHK]) and the other based on a mixed target species (flatfish, barracouta, red cod, tarakihi, stargazer, elephant fish, and gurnard) bottom trawl fishery (BT[All]). Two bottom trawl series had previously been constructed from the bottom trawl data, separating the target flatfish data from the target species that are taken at deeper depths. However, the switch to daily catch records for each trip showed that the two SPO 3 bottom trawl fisheries (FLA and MIX) had very similar CPUE trends for rig. The SINSWG agreed that it would be advisable to perform a single analysis on the full suite of bottom trawl target species. The final two fisheries (setnet and trawl) will have different selectivities, harvesting a different size range of rig, with the setnet fishery taking larger fish and the trawl fishery taking juveniles and 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.

The trawl series shows an increasing trend (1989–90 to 2014–15), while the SN(SHK) series fluctuates without trend. (Figure 5). The point estimates for rig from the east coast South Island winter trawl survey largely follow the pattern of the BT(All) series. The 2016 Plenary assigned all three indices of abundance (SN(SHK), BT(ALL) and ECSI Trawl Survey) a quality ranking of 1, but noted that the method of capture used for the BT(All) analysis does not representatively sample large female rig.

Establishing B_{MSY} compatible reference points

The Working Group agreed to average the four lowest survey biomass values (1992–96: see Table 7) as a proxy for the SPO 3 Soft Limit. This definition establishes the B_{MSY} proxy target reference point as twice the average 1992–96 biomass level and the Hard Limit as one-half the average 1992–1996

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.

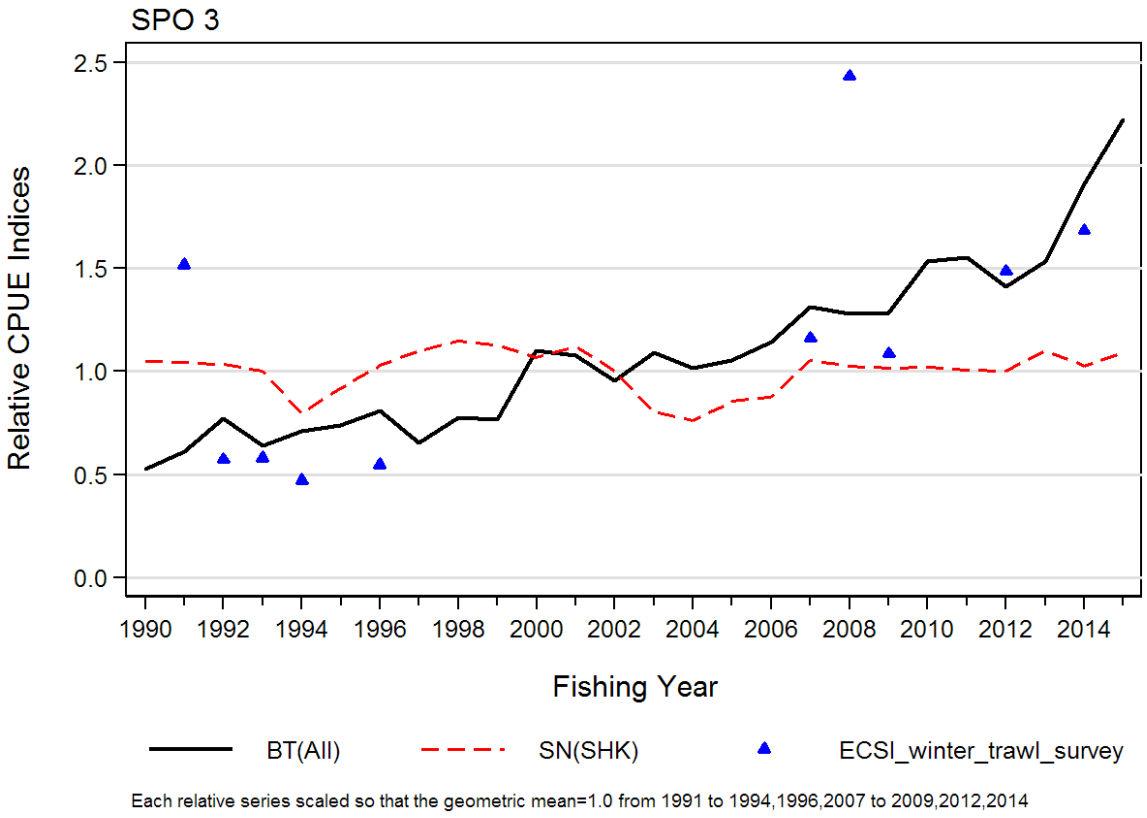


Figure 5: Comparison of the standardised indices from the two CPUE series for SPO 3: a) BT(All): mixed target species (including flatfish) bottom trawl fishery; b) SN(SHK): target shark species setnet fishery; also shown are 10 index values collected for rig from the East Coast South Island winter trawl survey.

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.

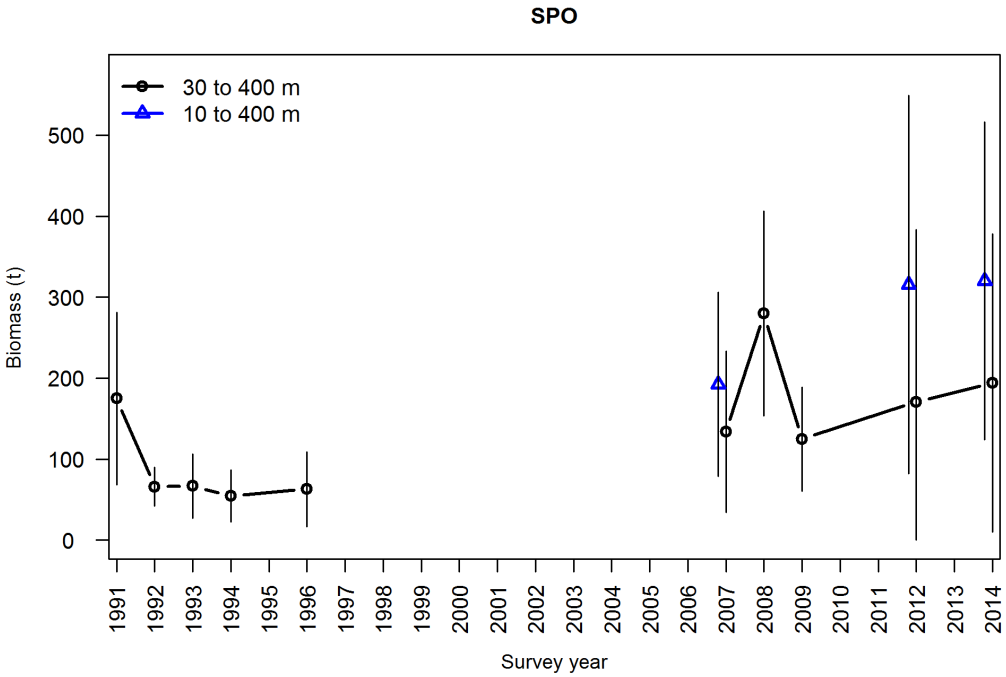


Figure 6: Rig total biomass and 95% confidence intervals for the all ECSI winter surveys in core strata (30–400 m), and core plus shallow strata (10–400 m) in 2007, 2012 and 2014.

Table 7: Relative biomass indices (t) and coefficients of variation (CV) for rigfor 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	CV (%) 30–400m	Total Biomass estimate	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 over 1 m 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 under 70 cm in the survey catch. High numbers of rig under 70 cm in both core and inshore strata in the 2012 and 2014 surveys is indicative of strong recruitment in recent years.

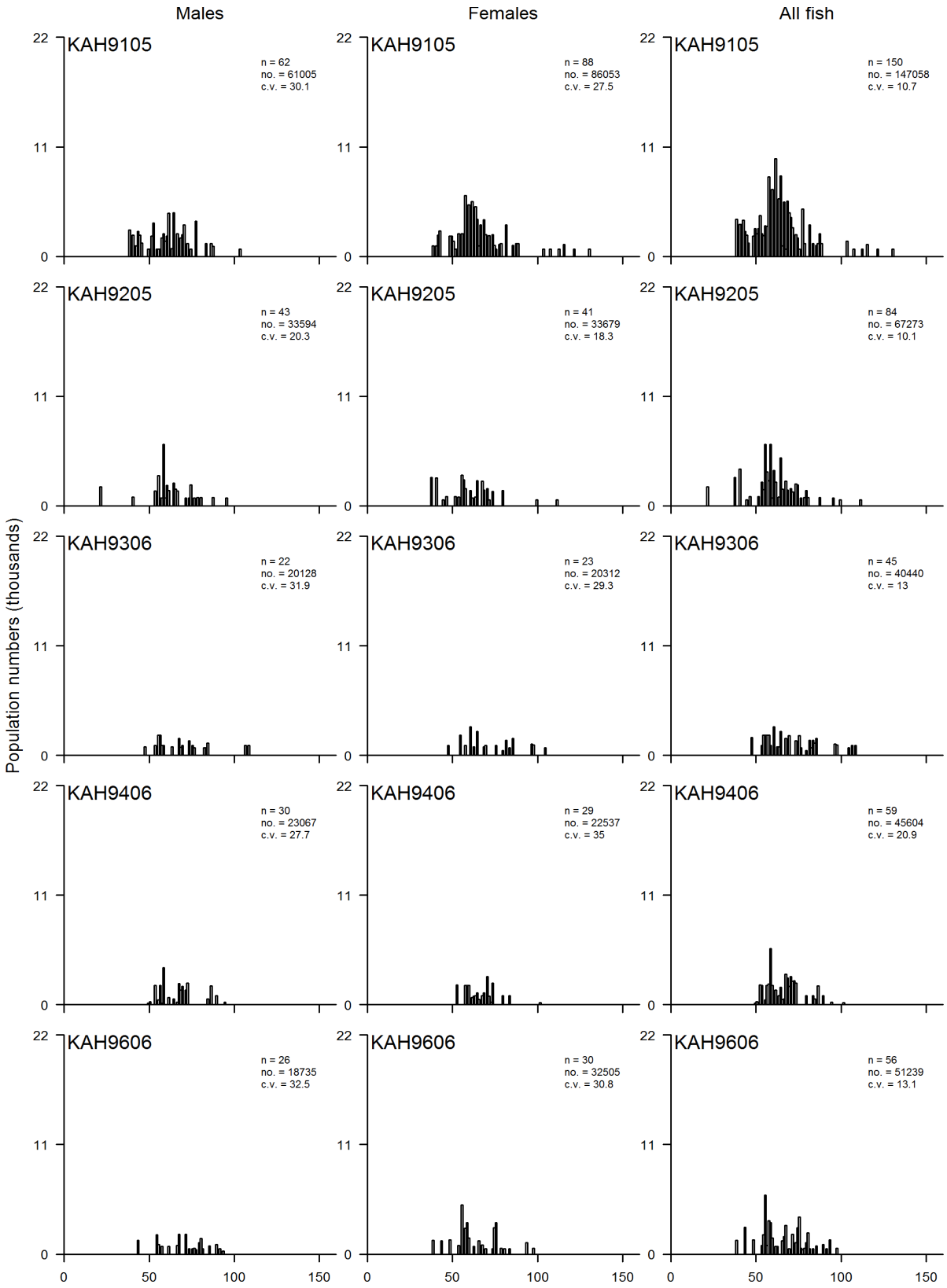


Figure 7: **Scaled length frequency distributions for rig in core strata (30–400 m) for all ten ECSI winter surveys. The length distribution is also shown in the 10–30 m depth strata for the 2007, 2012, and 2014 surveys overlaid in red (not stacked). Population estimates are for the core strata only.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

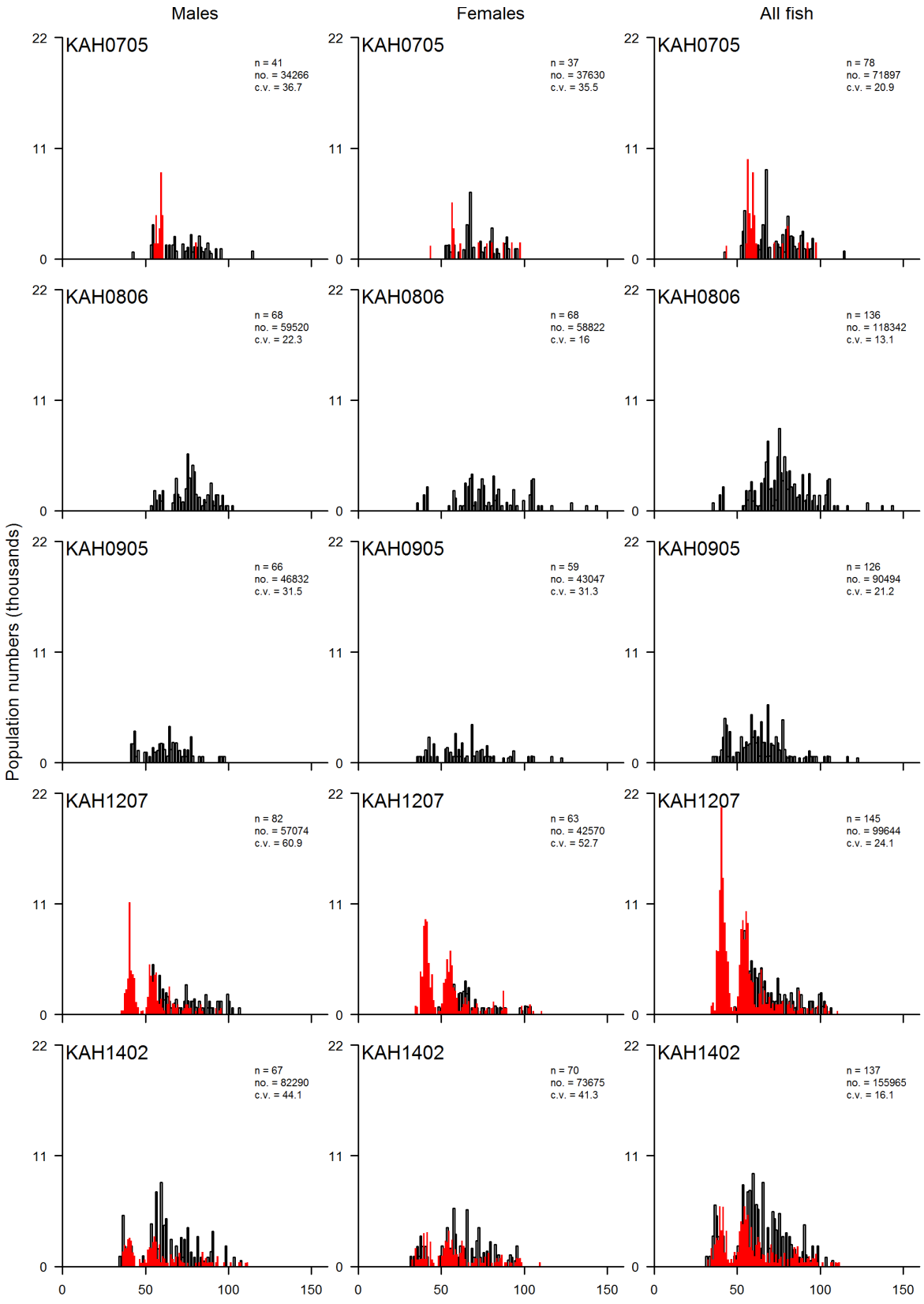


Figure 7 [Continued] Scaled length frequency distributions for rig in core strata (30–400 m) for all ten ECSI winter surveys. The length distribution is also shown in the 10–30 m depth strata for the 2007, 2012, and 2014 surveys overlaid in red (not stacked). Population estimates are for the core strata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

SPO 7

CPUE analyses standardising setnet and bottom trawl catches for core vessels were undertaken in 2016 to assess relative abundance of rig in SPO 7. Two of these analyses were updates of analyses previously accepted by the Working Group: 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, gurnard, snapper, blue warehou and trevally [BT(ALL)]. An analysis of the 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 possibly the management regulations imposed to protect Hector's dolphins. Examination of the distribution of setnet effort on the west coast of the South Island showed that there had been a substantial decline in the number of vessels operating in these statistical areas since 2005–06. A new setnet fishery which targeted shark species was added, covering the statistical areas of the South Taranaki Bight (037, 039 and 040). This was done after examining the fine scale spatial distribution of catches in these three statistical areas, showing that most of the catch came from the coastal section of South Taranaki Bight. This analysis also showed there was catch in Area 037 on the line separating Areas 037 and 038 (between D'Urville Island and Farewell Spit) which may belong more logically to the Area 038 analysis. However, spatial data at this level of detail are not available before October 2006 from the earlier daily forms. 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 new SN(STB) series was rejected by the Plenary (quality ranking of 3) on account of the impact the dolphin closures have had on this fishery. The SN(038) index, which was assigned a quality ranking of 1, 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 2010–11, after which the series began to drop, with the 2014–15 index 30% lower than the peak 2010–11 index (Figure 8).

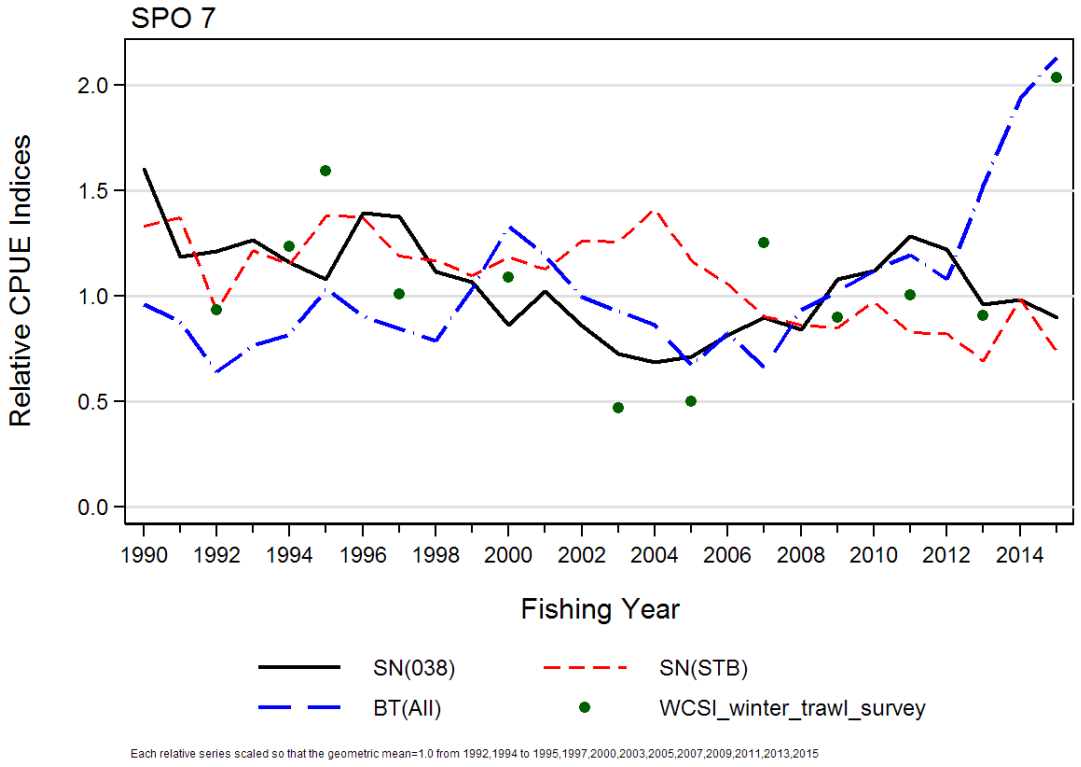


Figure 8: Comparison of three SPO 7 standardised CPUE series: a) shark target setnet fishery in Tasman/Golden Bays [SN(038)]; b) shark target setnet fishery in South Taranaki Bight [SN(STB)]; c) bottom trawl fishery (mix of targets in all SPO 7) [BT(ALL)]; also shown are rig index values from the west coast South Island winter trawl survey: 1992–2015.

The BT (ALL) series (also with a quality ranking of 1) shows an increasing trend since the mid-2000s, with low points observed in both 2004–05 and 2006–07, but has since more than doubled to reach the highest point in the series in 2014–15. The Plenary noted that the BT(All) index will not adequately sample large female rig.

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, it subsequently increased, and was stable at around the target level from 2007 to 2013, and then increased sharply in 2015. (Figure 9, Table 8).

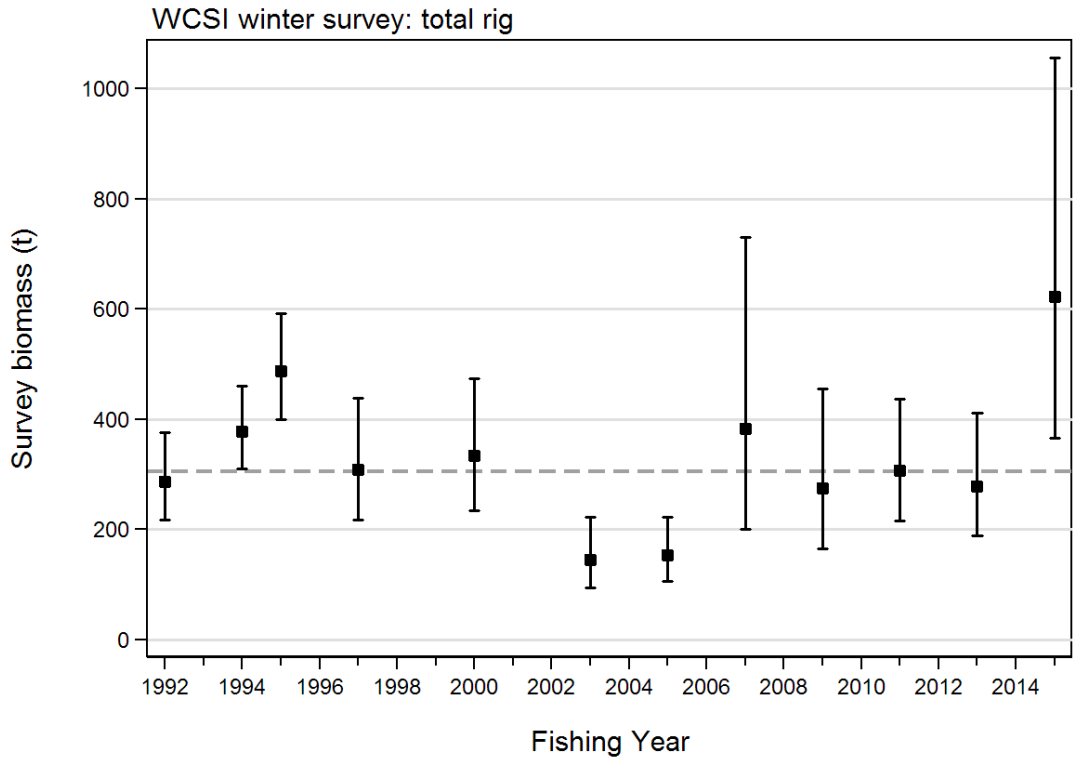


Figure 9: Plots of biomass estimates (t) for rig from the west coast South Island trawl survey by year. Error bars are approximated from the CVs assuming a lognormal distribution and 1.96*CV. The dashed line is the series geometric mean (306 t).

Table 8: 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	286	14
		1994	KAH9404	378	10
		1995	KAH9504	487	10
		1997	KAH9701	308	18
		2000	KAH0004	333	18
		2003	KAH0304	144	22
		2005	KAH0503	153	19
		2007	KAH0704	383	33
		2009	KAH0904	274	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 a 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 over 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 under 80cm in 2011, 2013 and 2015, than in previous surveys, suggests strong recruitment in recent years.

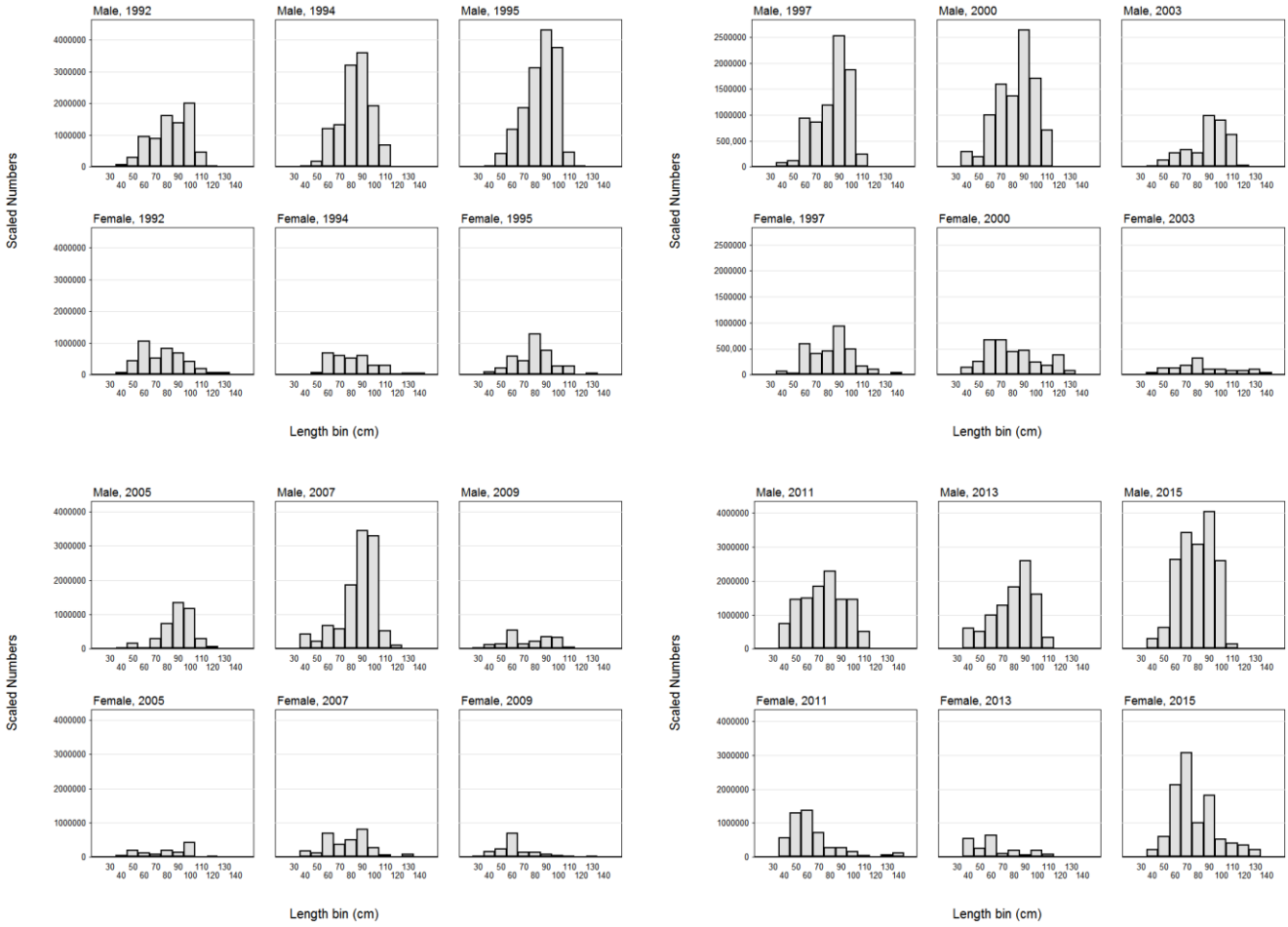


Figure 10: Scaled length frequency distributions by survey year for rig for all twelve WCSI winter surveys, showing distributions as scaled male and female numbers of rig.

Establishing B_{MSY} compatible reference points

The Working Group agreed to use the two lowest survey biomass values (2003 and 2005: see Table 8) 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 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.

The CPUE analyses that had been previously done for SPO 8 have been discontinued by agreement in the SINSWG. The SPO 8 BT analysis consisted of four statistical areas (037, 039, 040 and 041), three of which were also used in the SPO 7_BT(All) analysis. Examination of the spatial distributions of the Area 041 setnet and bottom trawl catches indicated that rig catches in this statistical area merge seamlessly with the equivalent catches in Area 042, immediately to the north of Area 041. As a result, it was decided that Area 041 should be amalgamated with the SPO 1W coastal bottom trawl and setnet fisheries, adding much needed data to these analyses. A new fishery to monitor the South Taranaki Bight was constructed from the remaining statistical areas that were included in the discontinued SPO 8_SN fishery. All the statistical areas included in the previous SPO 8_SN and SPO 8_BT CPUE analysis have been included in other CPUE analyses.

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 when undertaking CPUE analyses, this has not been done for total landings reported in this Working Group Report. These changes reduce the relative 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 based on those historic catches (e.g. *MCY*).

A data informed qualitative risk assessment was completed on all chondrichthyans (sharks, skates, rays and chimaeras) at the New Zealand scale in 2014 (Ford et al 2015). Rig was ranked fifth highest in terms of risk of the eleven QMS chondrichthyan species. Data were described as existing and sound for the purposes of the assessment and consensus over this risk score was achieved by the expert panel. This risk assessment does not replace a stock assessment for this species but may influence research priorities across species.

5. STATUS OF THE STOCKS

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).

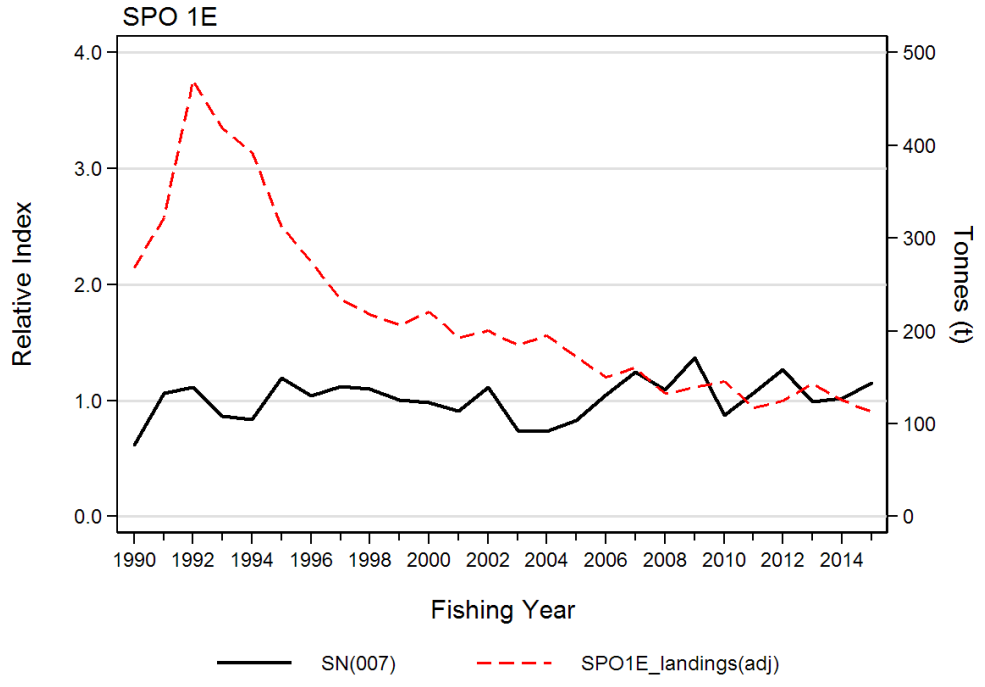
- **SPO 1**

Stock Structure Assumption

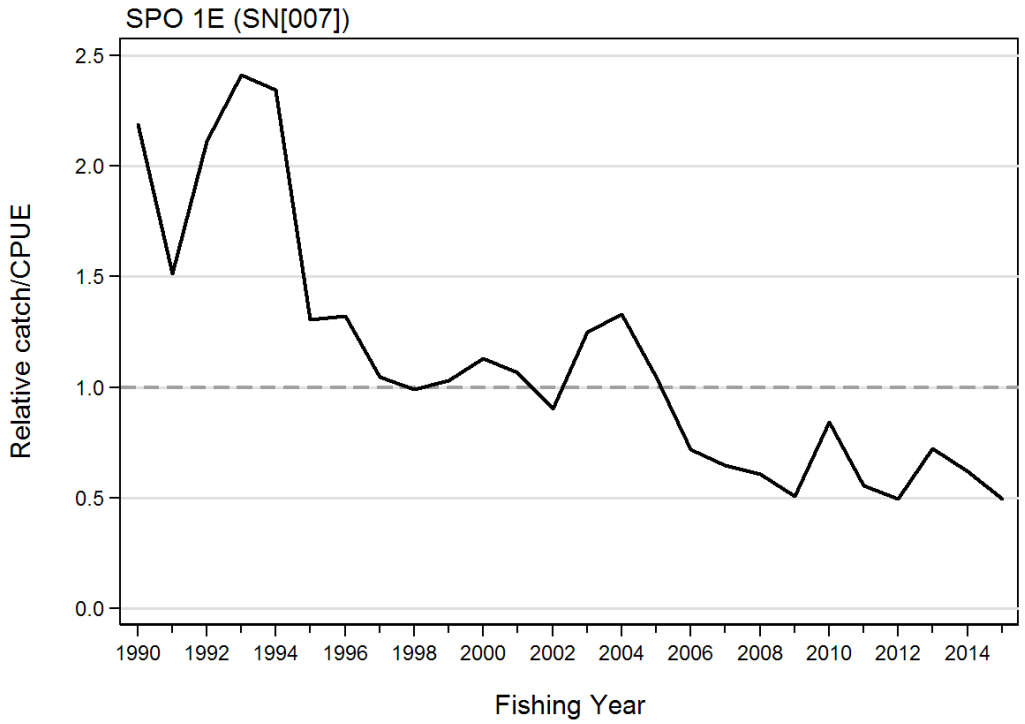
For the purposes of this summary SPO 1E is defined as the sum of Statistical Areas 002 to 010 and is treated as a discrete stock. SPO 1W is defined as the sum of Statistical Areas 041 to 048 and is treated as a discrete stock. It is not known if the rig stocks on the west and east coasts of the North Island are separate.

Stock Status	
Year of Most Recent Assessment	2016
Assessment Runs Presented	Standardised CPUE index: SPO 1E: SN(007) SPO 1W: BT(41-47), SN(043), SN(044)
Reference Points	Target (1E and W): 40% B_0 Soft Limit: 20% B_0 Hard Limit: 10% B_0 Overfishing threshold: F_{MSY}
Status in relation to Target	1E and 1W: Unknown
Status in relation to Limits	1E and 1W Soft Limit: Unknown Hard Limit: Unknown
Status in relation to Overfishing	1E and 1W: Unknown

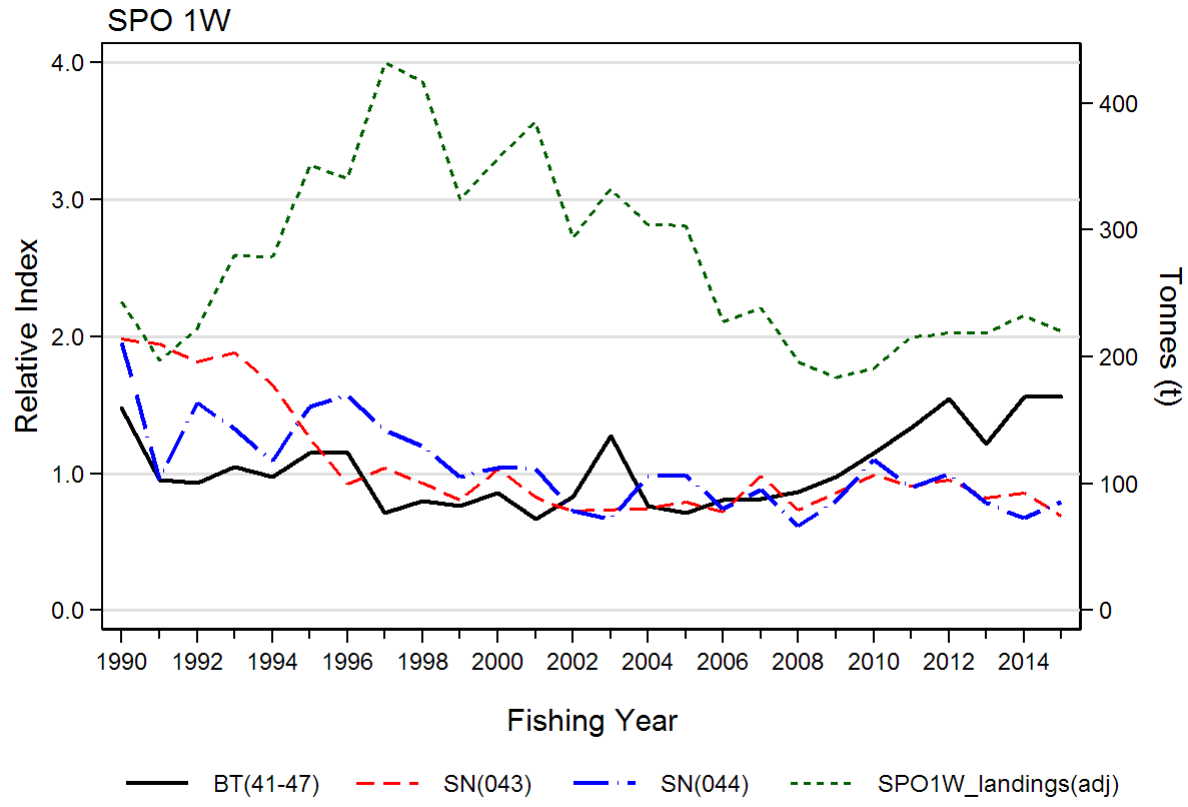
Historical Stock Status Trajectory and Current Status



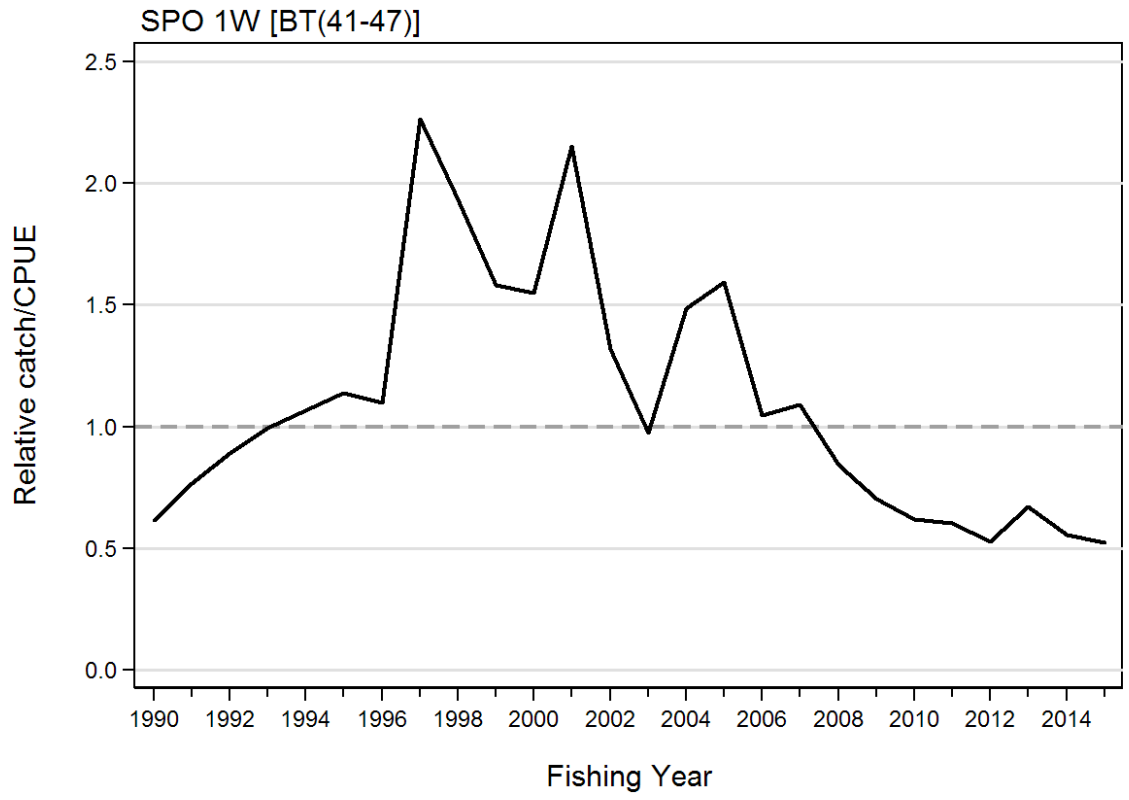
Accepted CPUE indices for SN(007) with the adjusted QMR/MHR landings for SPO 1E. Adjustments were made to ensure that all values in every year are based on a common conversion factor.



Relative fishing pressure for SPO 1E based on the ratio of QMR/MHR (adj) landings relative to the SN(007) CPUE series. Each series has been normalised so that its geometric mean=1.0 for all common years.



Comparison of three accepted CPUE indices [SN(043), SN(044), BT(41-47)] with the adjusted QMR/MHR landings for SPO 1W. Adjustments were made to ensure that all values in every year are based on a common conversion factor.



Relative fishing pressure for SPO 1W based on the ratio of QMR/MHR (adj) landings relative to three CPUE series: BT(41-47). 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	1E: Adult biomass (as indexed by the set net fishery in Statistical Area 007) has fluctuated without trend since 1990. 1W: The coastal BT series is relatively flat from 1990 to the late 2000s, but shows a strong upturn since about 2008; the SN(043 Manukau harbour) series shows a strong decline in the early portion of the series while the SN(044 Kaipara harbour) series showed no trend throughout the 1990s. Both set net indices show a slowly declining trend since the late 1990s.
Recent Trend in Fishing Intensity or Proxy	1E: Fishing intensity (as indexed by the set net fishery in area 007) appears to have been declining since the mid-1990s. 1W: The coastal BT series indicates that fishing intensity increased to relatively high levels from the late 1990s to the early 2000s and has been declining to relatively low levels since
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	Unknown
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

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Fishery characterisation and standardised CPUE analysis	
Assessment Dates	Latest assessment: 2016	Next assessment: 2019
Overall assessment quality rank	1E: 2 – Medium or mixed quality: decline in catch should have resulted in an increase in CPUE 1W: 1 – High Quality	
Main data inputs (rank)	1E: Set net CPUE series: target shark in Area 007 (Firth of Thames) 1W: Bottom trawl CPUE series: mixed target species (Areas 042, 045–048) Setnet CPUE series: target shark in Area 043 (Manukau Harbour) Setnet CPUE series: target shark in Area 044 (Kaipara Harbour)	2 – Medium or mixed quality: series only indexes a small proportion of area 1E 1 – High Quality 2 – Medium or Mixed Quality: series only indexes a small proportion of area 1W 2 – Medium or Mixed Quality: series only indexes a small proportion of area 1W
Data not used (rank)	1E: Bottom trawl CPUE series: mixed target species (Areas 002–010) Setnet CPUE series: target shark (Areas 002–006 and 008–010) 1W: Setnet CPUE series: shark target species (Areas 041–047)	3 – Low Quality: few data 3 – Low Quality: few data 3 – Low Quality: regulatory changes appear to have had significant impact
Changes to Model Structure and Assumptions	- added Statistical Area 041 to the coastal setnet and bottom trawl analyses	
Major Sources of Uncertainty	- Contradictory trends in the bottom trawl and setnet CPUE indices - Lack of historical information relating to stock abundance during the 1970s–1980s when the stock was believed to have been heavily fished means that the current relative stock status is difficult to determine - BT CPUE series may not index large mature females	

Qualifying Comments
The accepted BT(coast) CPUE series (SPO 1E) and BT(41-47) (SPO 1W) do not sample large mature females in the rig population.

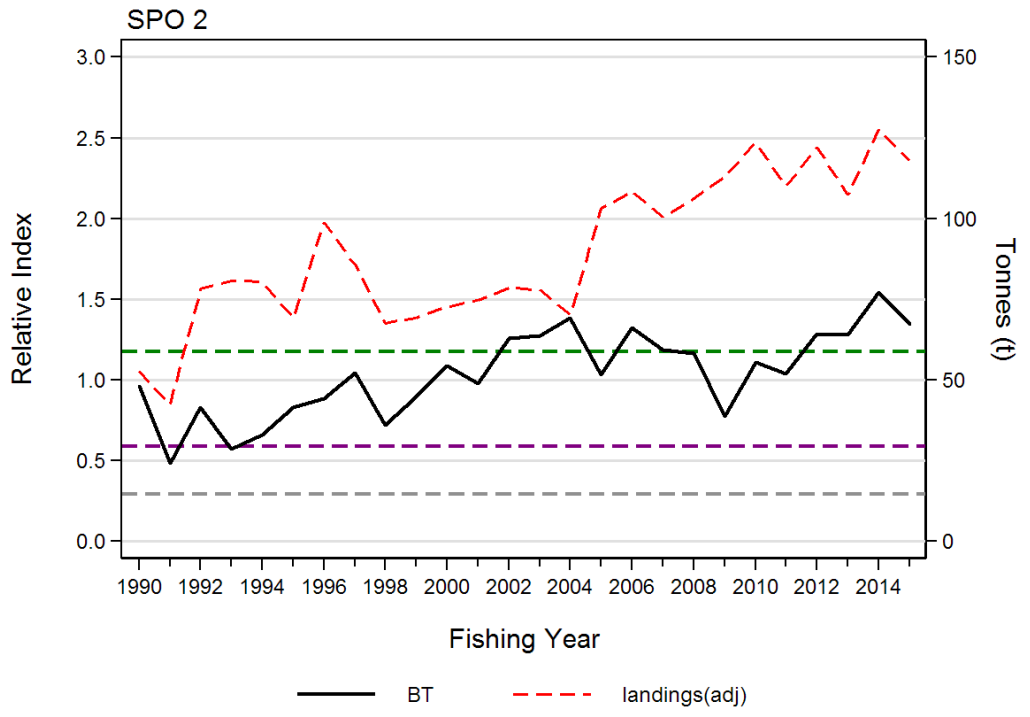
Fishery Interactions
Rig are taken as a bycatch in bottom trawl fisheries targeted mainly at snapper, tarakihi, gurnard, John dory, barracouta, trevally (SPO 1E) while the setnet fisheries are almost exclusively targeted at rig in both SPO 1E and SPO 1W. In the setnet fisheries there is a risk of incidental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

- **SPO 2**

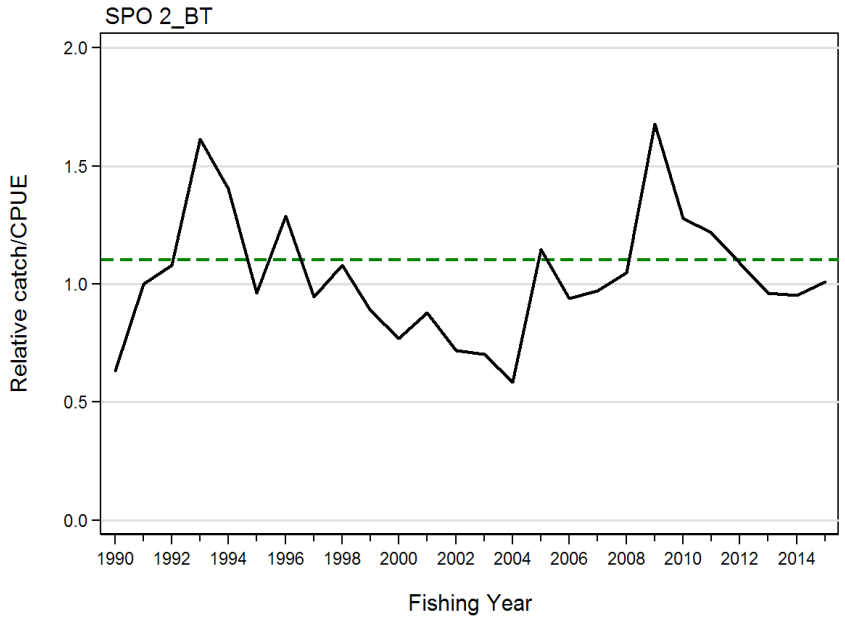
Stock Structure Assumption
For the purposes of this summary SPO 2 is defined as the sum of Statistical Areas 011 to 015 and is treated as a discrete stock.

Stock Status	
Year of Most Recent Assessment	2016
Assessment Runs Presented	Standardised CPUE: BT(stat area)
Reference Points	Target: Proxy for B_{MSY} based on the average CPUE during the period 2005–2015, a period of relatively stable CPUE and catches Soft Limit: 50% of the target Hard Limit: 50% of the soft limit Overfishing threshold: F_{MSY}; assumed to be the average fishing intensity over the period 2005–2015
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 the soft limit Hard Limit: Very Unlikely (< 10%) to be below the hard limit
Status in relation to Overfishing	Overfishing is Unlikely (< 40%) to be occurring

Historical Stock Status Trajectory and Current Status



Comparison of the accepted CPUE index[BT] with the adjusted QMR/MHR landings for SPO 2. Adjustments were made to ensure that all values in every year are based on a common conversion factor. The agreed B_{MSY} proxy (average: 2005–2015) target is shown as a green line, the Soft Limit is shown as a purple line, and the Hard Limit is shown as a grey line.



Relative fishing pressure for SPO 2 based on the ratio of QMR/MHR (adj) landings relative to the [BT] 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 has trended upward from the beginning of the series to about 2010, and since then has fluctuated without trend.
Recent Trend in Fishing Intensity or Proxy	Relative fishing intensity increased from 1990 to 1993, declined to 2004, increased to 2009 and has since declined to near the series average in 2013–14 and 2014–15.
Other Abundance Indices	A set net CPUE series was developed in 2011, but was not repeated in 2013 or 2015 as the Working Group concluded that this series was not credible as an index of abundance due to the small quantity of data available.
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
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	Current catches are Unlikely (< 40%) to cause the stock to decline below the soft or hard limits 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	About as Likely as Not (40–60%)

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Fishery characterisation and standardised CPUE analysis	
Assessment Dates	Latest assessment: 2016	Next assessment: 2019
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 set net CPUE analysis up to 2009–10	3 – Low Quality: 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	- dropped Statistical Area 016 because of overlap with the SPO 7 BT(All) analysis. Rig catches in this statistical area are minor	
Major Sources of Uncertainty	- Lack of historical information relating to stock abundance during the 1970s–1980s when the stock was believed to have been heavily fished means that the current relative stock status is difficult to determine - BT CPUE series may not index large mature fish	

Qualifying Comments
The accepted BT(statarea) CPUE series does not adequately sample large 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.
Fishery Interactions
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.

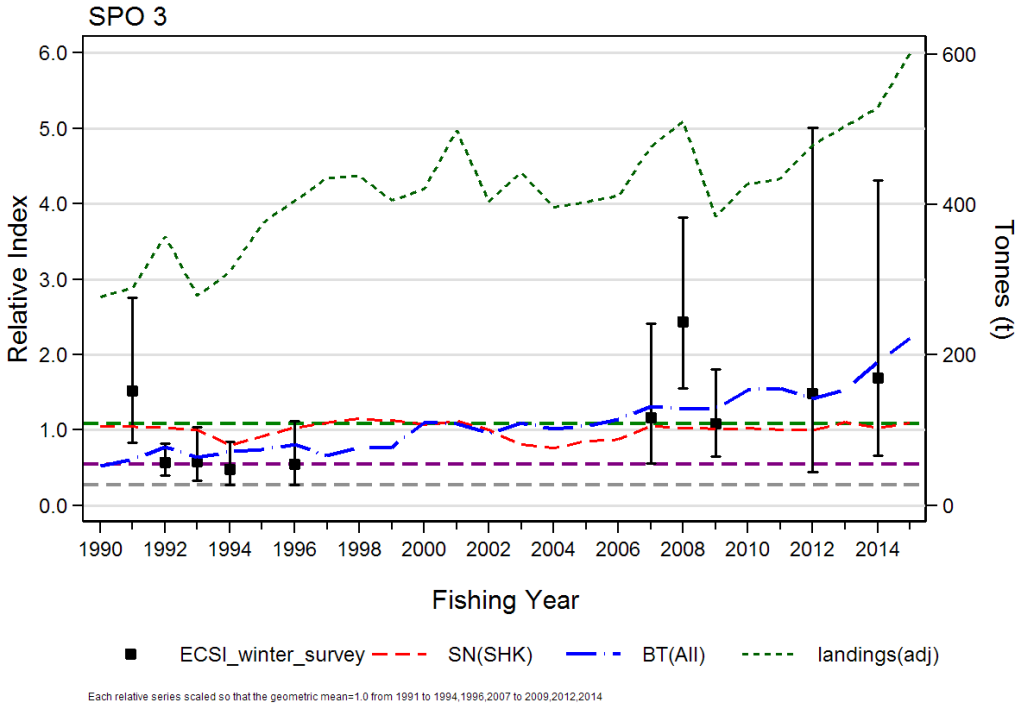
- **SPO 3**

Stock Structure Assumption

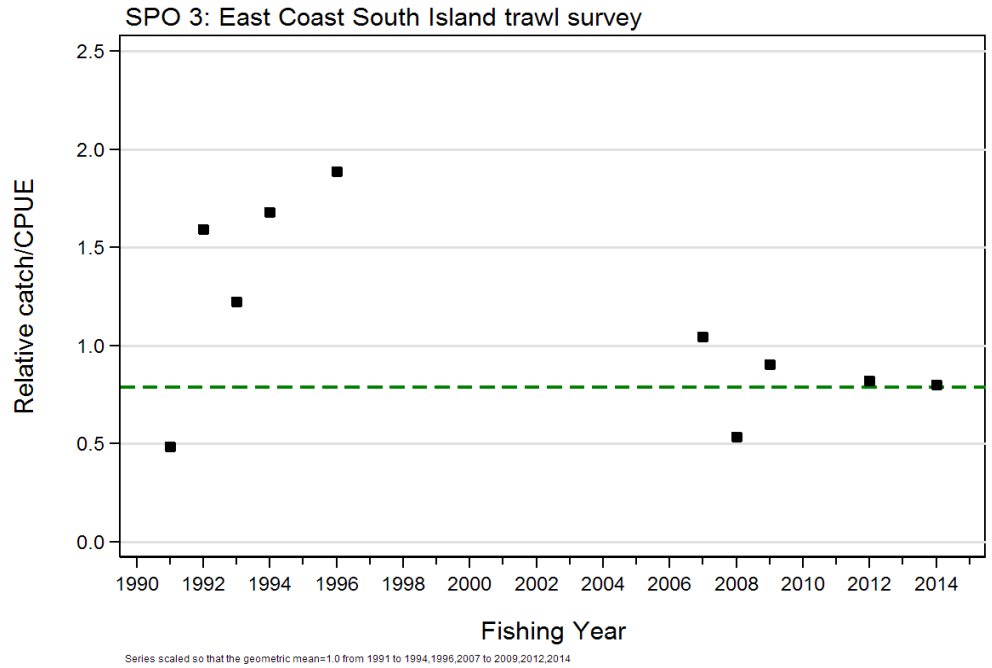
For the purposes of this summary SPO 3 is defined as the sum of Statistical Areas 018 to 032 and areas 049 to 052 and is treated as a discrete stock.

Stock Status	
Year of Most Recent Assessment	2016
Assessment Runs Presented	ECSI trawl survey and two standardised CPUE indices: SN(SHK) and BT(All)
Reference Points	Target: Proxy for B_{MSY} based on twice the soft limit Soft Limit: Average of the 1992–1996 survey indices Hard Limit: 50% of the soft limit Overfishing threshold: F_{MSY}; assumed to be the average fishing intensity for the 1992–1996 survey indices
Status in relation to Target	Likely (> 40%) to be at or above the target
Status in relation to Limits	Soft Limit: Very Unlikely (< 10%) to be below the soft limit Hard Limit: Very Unlikely (< 10%) to be below the hard limit
Status in relation to Overfishing	Overfishing is About as Likely as Not (40–60%) to be occurring

Historical Stock Status Trajectory and Current Status



Comparison of the East Coast South Island (ECSI) trawl survey and two accepted CPUE indices [BT(All) and SN(SHK)] with the adjusted QMR/MHR landings for SPO 3. Adjustments were made to ensure that all values in every year are based on a common conversion factor. The agreed Soft Limit (average: 1992–1994, 1996 ECSI survey biomass estimates=0.54) is shown as a purple line, and the calculated B_{MSY} proxy (=2×Soft Limit) is shown as a green line and the calculated Hard Limit (=0.5×Soft Limit) is shown as a grey line.



Relative fishing pressure for SPO 3 based on the ratio of QMR/MHR (adj) landings relative to the ECSI which has been normalised so that its geometric mean=1.0.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Biomass estimates from the most recent four survey years of the ECSI trawl survey series suggest that biomass has increased relative to the 1990s. There has been a strong increasing trend in the bottom trawl CPUE series dating from the late 2000s, but the set net CPUE series has been relatively flat.
Recent Trend in Fishing Intensity or Proxy	Fishing intensity has dropped to near the overfishing threshold
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
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	Current catches are Unlikely (< 40%) to cause the stock to decline below the soft or hard limits. 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	About as Likely as Not (40–60%)

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Fishery characterisation, trawl survey biomass and standardised CPUE analysis	
Assessment Dates	Latest assessment: 2016	Next assessment: 2019
Overall assessment quality rank	1 – High Quality	

Main data inputs (rank)	- East coast South Island winter trawl survey - Bottom trawl CPUE series: mixed target species - Setnet CPUE series: target shark	1 – High quality 1 – High Quality 1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	- combined two separate bottom trawl analyses (flatfish target and offshore finfish target) into a single bottom trawl series	
Major Sources of Uncertainty	- The increasing trend in the trawl survey and bottom trawl CPUE data is not corroborated by the setnet CPUE series - Lack of historical information relating to stock abundance during the 1970s–1980s when the stock was believed to have been heavily fished means that the current relative stock status is difficult to determine - In some years the ECSI trawl survey indices have high CVs - ECSI trawl survey and bottom trawl CPUE do not adequately sample large mature females	

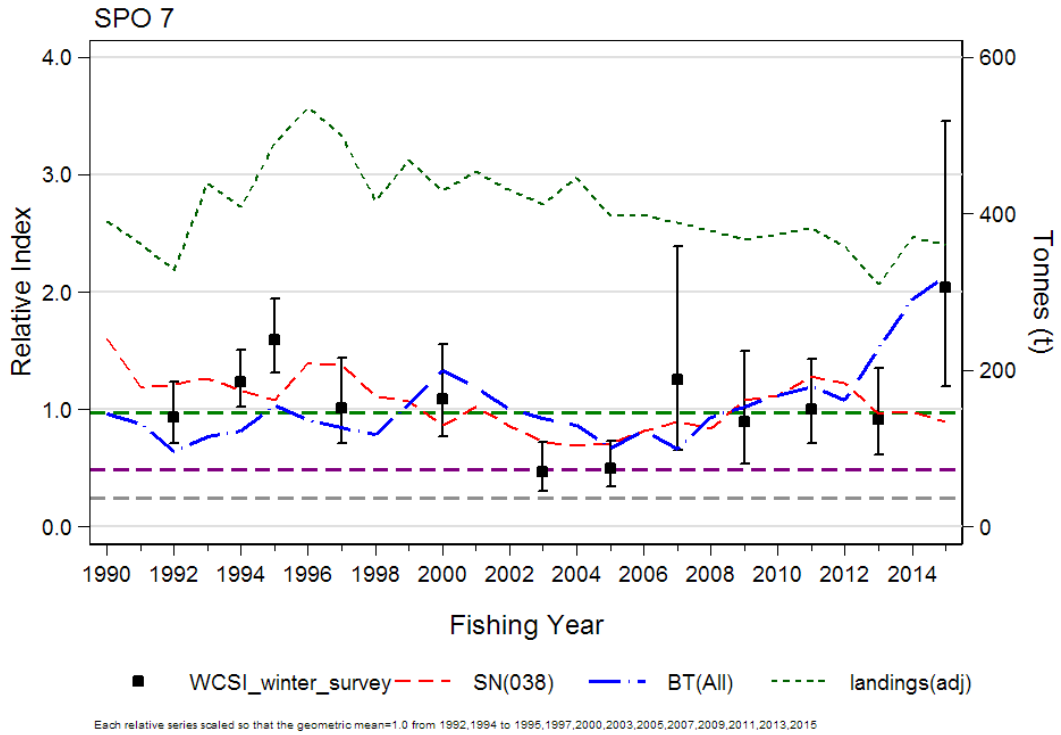
Qualifying Comments
The accepted ECSI trawl survey and the BT(All) CPUE series do not representatively sample large mature female rig.
Fishery Interactions
A 4 nautical mile setnet closure has been in place since October 2008 for the entire area to reduce the bycatch of Hector's dolphins. Rig are largely 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

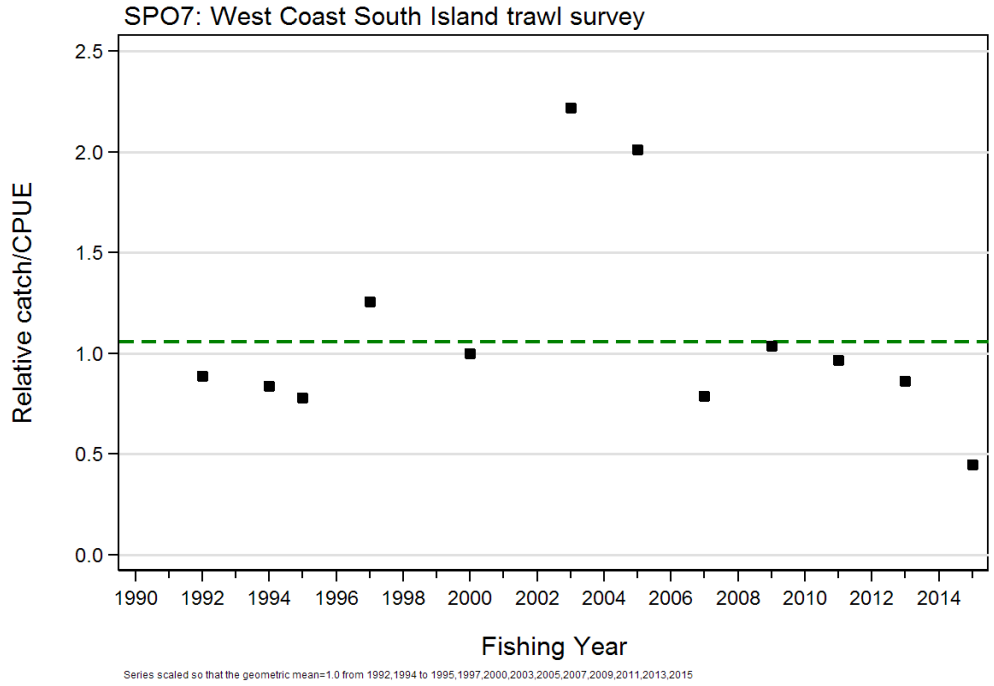
Stock Structure Assumption
For the purposes of this summary SPO 7 is defined as the sum of Statistical Areas 016, 017, 033 to 040 and is treated as a discrete stock.

Stock Status	
Year of Most Recent Assessment	2016
Assessment Runs Presented	WCSI trawl survey series and two standardised CPUE series: BT (All) and SN (038)
Reference Points	Interim Target: Proxy for B_{MSY} based on twice the soft limit 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	Likely (> 40%) to be at or above the target
Status in relation to Limits	Soft Limit: Very Unlikely (< 10%) to be below the soft limit Hard Limit: Very Unlikely (< 10%) to be below the hard limit
Status in relation to Overfishing	Overfishing is Very Unlikely (< 10%) to be occurring

Historical Stock Status Trajectory and Current Status



Comparison of the West Coast South Island (WCSI) trawl survey and two accepted CPUE indices BT(All) and SN(038) with the adjusted QMR/MHR landings for SPO 7. Adjustments were made to ensure that all values in every year are based on a common conversion factor. The agreed Soft Limit (average: 2003 and 2005 WCSI survey biomass estimates=0.49) is shown as a purple line, and the calculated B_{MSY} proxy (=2×Soft Limit) is shown as a green line and the calculated Hard Limit (=0.5×Soft 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 which has been normalised so that its geometric mean=1.0.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Relative biomass from the WCSI trawl survey was stable, at around the target level, from 2007 to 2013, but increased 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 has been declining since the early 2000s and is currently well below the overfishing threshold.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	Size composition data from the WCSI trawl survey catches suggests strong recruitment in recent years.

Projections and Prognosis	
Stock Projections or Prognosis	Unlikely (< 40%) to decline at current catches or the 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	Very Unlikely (< 10%)

Assessment Methodology and Evaluation		
Assessment Type	Level 1: 2006 Quantitative stock assessment Level 2: 2016 WCSI trawl survey and two standardised CPUE abundance indices	
Assessment Method	2006: Bayesian statistical catch-at-age model 2016: Partial Quantitative assessment based on WCSI trawl survey series and standardised CPUE	
Assessment Dates	Latest assessment: 2016	Next assessment: 2019
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	2016: - West Coast South Island trawl survey index - Setnet CPUE series: target shark in Area 038 - Bottom trawl CPUE series: mixed target species (all statistical areas)	 1 – High Quality 1 – High Quality 1 – High Quality
Data not used (rank)	- SN(STB) CPUE series	3 – Low Quality: affected by dolphin management regulations
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 2016, only trawl survey and CPUE indices were considered.	
Major Sources of Uncertainty	- The increasing trend in the bottom trawl CPUE data is not corroborated in the set net CPUE series - Lack of historical information relating to stock abundance during the 1970s–1980s when the stock was believed to have been heavily fished means that the current relative stock status is difficult to determine - WCSI trawl survey and bottom trawl CPUE do not adequately sample large mature females	

Qualifying Comments
The WCSI trawl survey and the accepted BT(all) CPUE series do not representatively sample large mature female rig, but they cover most of SPO 7; while the set net index (which does provide an index of mature rig abundance) only provides an index of abundance for SPO 7 in Statistical Area 038.

Fishery Interactions
SPO 7 is caught in a targeted set net 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 set net fisheries there is a risk of incidental capture of seabirds, white pointer sharks, Hector's dolphins, other dolphins and New Zealand fur seals.

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