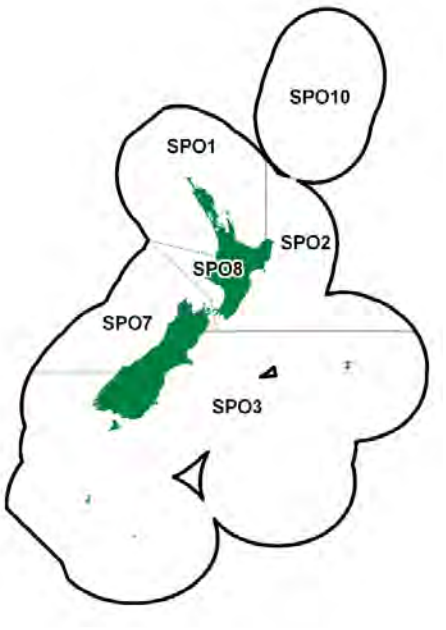
RIG (SPO)

(Mustelus lenticulatus)
Pioke, Makō



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 2021–21 fishing year.

Table 1: TACs (t), TACCs (t), and allowances (t) for rig as at 1 October 2021.

Fishstock	Recreational allowance	Customary non-commercial allowance	Other sources of mortality	TACC	TAC
SPO 1	25	20	15	692	752
SPO 2	10	5	12	119	146
SPO 3	20	20	66	660	766
SPO 7	33	15	27	298	373
SPO 8	60	31	0	310	401
SPO 10	–	–	–	10	10

1.1 Commercial fisheries

Rig are caught in coastal waters throughout New Zealand. Most of the set net 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 set net 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 set net fisheries are at Ninety Mile Beach, Kaipara Harbour, Manukau Harbour, South Taranaki Bight–Tasman Bay/Golden Bay, Canterbury Bight, Kaikōura, and Hauraki Gulf. There is also an active set net fishery in Foveaux Strait where SPO is taken as a bycatch in the target SCH set net fishery.

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. The total TACCs were subsequently increased to a maximum of 2098 t from 1994–95 to 1996–97, allowing landings to rise to 1888 t in 1996–97. Total landings subsequently declined steadily to a minimum of 1186 t during the fishing year 2008–09, before increasing to between 1300 t and 1450 t per year beginning in 2014–15 (Table 4). From 2006–07, the total TACC has been under 2000 t until 2019–20 and 2020–21 when it was increased to 2018 t and 2089 t, respectively.

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		

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	1 118	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	1 327	541	382
1952	115	41	132	63	21	1978	701	330	1 225	638	404
1953	117	56	95	45	20	1979	614	232	1 138	349	368
1954	103	68	40	58	39	1980	499	252	2 667	470	387
1955	93	49	42	84	47	1981	618	188	1 443	413	343
1956	106	54	38	77	29	1982	840	210	1 255	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 include both foreign and domestic landings. Data were aggregated to FMA using methods and assumptions described by Francis & Paul (2013).

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 and to 119 t in 2020–21. The TACC for SPO 7 was decreased to 221 t on 1 October 2006, as a result of a stock assessment based on a declining CPUE. The SPO 7 TACC was raised to 246 t for 1 October 2015 based on increased abundance and has since been raised to 271 t in 2018–19 and 298 t in 2019–20. The SPO 3 TACC was raised to 660 t in 2020–21 in response to increasing BT CPUE and increased ECSI survey indices.

SPO was introduced into Schedule 6 on 1 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.

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.

Table 4: Reported landings (t) of rig by Fishstock from 1985–86 to present and actual TACCs (t) from 1986–87 to present. QMS data from 1986–present. [Continued on next page]

Fishstock	SPO 1		SPO 2		SPO 3		SPO 7		SPO 8	
FMA (s)	1 & 9		2		3,4,5, & 6		7		8	
	Landing	TACC	Landing	TACC	Landing	TACC	Landing	TACC	Landing	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
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
2015–16	316	692	106	108	557	600	248	246	180	310
2016–17	318	692	101	108	543	600	258	246	197	310
2017–18	317	692	89	108	648	600	247	246	159	310
2018–19	238	692	105	108	615	600	265	271	142	310
2019–20	218	692	117	108	651	600	273	298	118	310
2020–21	234	692	109	119	632	660	284	298	47	310

Fishstock	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

Table 4 [continued]

Fishstock	SPO 10			Total
FMA (s)	10			
	Landings	TACC	Landings§	TACC
2014–15	0	10	1 413	1 941
2015–16	0	10	1 406	1 966
2016–17	0	10	1 417	1 966
2017–18	0	10	1 459	1 966
2018–19	0	10	1 364	1 991
2019–20	0	10	1 376	2 018
2020–21	0	10	1 306	2 089

*FSU data.
§Includes landings from unknown areas before

Within SPO 3, 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 extended 4 nautical miles offshore from the coast from Sumner Head in the north to the Rakaia River mouth in the south. Before 1 October 2008, no set nets were allowed within the sanctuary from 1 November to the end of February. For the remainder of the year, set nets 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 set net closures were implemented by the South East Fisheries Management Company (SEFMC) from 1 October 2000 to protect nursery grounds for rig and elephant fish and to reduce interactions between commercial set nets 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 out to 1 nautical mile offshore and out to 4 nautical miles offshore for the period 1 October to 31 January.

From 1 October 2008, a suite of fisheries regulations intended to protect Māui and Hector's dolphins was implemented around the South Island and off the west coast of the North Island by the Minister of Fisheries. At the same time the Minister of Conservation established four new Marine Mammal Sanctuaries for Māui and Hector's dolphins (west coast North Island, Clifford Bay and Cloudy Bay, Catlins Coast, and Te Waewae Bay), and extended the Banks Peninsula Marine Mammal Sanctuary north to the Waipara River and to 12 nautical miles offshore.

For SPO 1 and SPO 8, there have been six changes to the management regulations affecting set net fisheries that target school shark or rig off the west coast of the North Island.

- The first was a closure to set net fishing from Maunganui Bluff to Pariokariwa Point out to 4 nautical miles offshore on 1 October 2003.
- Secondly, this closure was extended by the Minister of Fisheries to 7 nautical miles offshore on 1 October 2008 and in the entrances of the Kaipara Harbour, Manukau Harbour, Waikato River, and Raglan Harbour. An appeal was made by affected commercial fishers who were granted interim relief by the High Court, allowing commercial set net fishing (for rig and school shark) between 4 and 7 nautical miles offshore during daylight hours between 1 October and 24 December for three consecutive years: 2008–2010. The full closure (out to 7 nautical miles offshore all year round) was reinstated in March 2011.
- Thirdly, the west coast North Island set net closure to 7 nautical miles offshore was extended from Pariokariwa Point around Cape Egmont to Hawera in 2012, with commercial set net fishing only allowed between 2 and 7 nautical miles if an Observer was on board the vessel.
- In 2013, the Minister of Conservation varied the West Coast North Island Marine Mammal Sanctuary to prohibit commercial and recreational set net fishing from Pariokariwa Point to the Waiwhakaiho River (New Plymouth) between 2 and 7 nautical miles offshore.
- On 1 October 2020, new commercial and recreational set net fishing closures out to 4 nautical miles offshore took effect from Cape Reinga to Maunganui Bluff, and Hawera to Wellington. Set net fishing closures were also extended from Maunganui Bluff to the Waiwhakaiho River from 7 nautical miles to 12 nautical miles offshore, as well as from the Waiwhakaiho River to Hawera between 2 and 7 nautical miles offshore. Set net fishing closures within the Manukau Harbour were extended to Taumatarea Point in the north and Matakawau Point in the south within the harbour.

For SPO 1 and SPO 8, there have been three changes to management regulations affecting trawl fisheries off the west coast of the North Island.

- In October 2003, trawling was prohibited from Maunganui Bluff and Pariokariwa Point out to 1 nautical mile offshore, with the prohibition extending to 2 nautical miles offshore in areas adjacent to harbours and river mouths.
- In October 2008, trawling was prohibited from Maunganui Bluff to Pariokariwa Point out to 2 nautical miles, and within that area between the Manukau Harbour and Port Waikato out to 4 nautical miles offshore.
- In October 2020, there was an extension to commercial trawl closures from Maunganui Bluff south to the Waiwhakaiho River and to 4 nautical miles offshore.

For SPO 3, commercial and recreational set netting was banned on 1 October 2008 to 4 nautical miles offshore along the east coast of the South Island, 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 Kaikōura Canyon, and permitting set netting in most harbours, estuaries, river mouths, lagoons, and inlets except for the Avon-Heathcote Estuary, Lyttelton Harbour, Akaroa Harbour, and Timaru Harbour. A seasonal exemption applies around Banks Peninsula allowing the use of commercial and recreational flatfish set nets between 1 April and 30 September in the inner portions of Akaroa Harbour, Lyttelton Harbour, Port Levy, and Pigeon Bay. In addition, trawl gear within 2 nautical miles of shore was restricted to flatfish nets with defined low headline heights. In the south, commercial and recreational set netting was banned to 4 nautical miles offshore, extending from Slope Point in the Catlins to Sand Hill Point east of Fiordland and in Te Waewae Bay. An exemption permitted set netting in harbours, estuaries, and inlets. In addition, trawl gear within 2 nautical miles of shore from Slope Point to Sand Hill Point (Te Waewae Bay) was restricted to flatfish nets with defined low headline heights.

On 1 October 2020, the commercial set net fishing closures off Kaikōura were extended slightly offshore but no change was made to the 4 nautical miles recreational closure. Commercial and recreational set net fishing closures were extended off the east coast to encompass Pegasus Bay (north of Banks Peninsula), approximately 19 nautical miles offshore southeast from the headland east of Motunau Beach offshore and then southwest to a point 7 nautical miles offshore from Goat Point. Commercial and recreational set net fishing closures were also extended from Snuffle Nose southwest to 12 nautical miles offshore across the Canterbury Bight to just south of Timaru to the existing 4 nautical miles offshore boundary. In the south, commercial and recreational set net fishing closures were extended within Te Waewae Bay (between Sand Hill Point and Wakaputa Point) to 10 nautical miles offshore.

For SPO 7, both commercial and recreational set netting were banned to 2 nautical miles offshore from 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 set nets, beginning in October 2006, to protect large females in a known pupping area. The net effect of these set net area closures was to greatly reduce the importance of the SPO 7 set net fishery, particularly off the west coast. Fifty-six percent of the average 2000–01 to 2002–03 annual set net catch came from the combined west coast statistical areas, and 36% came from Tasman Bay/Golden Bay. The equivalent percentages from 2015–16 to 2017–18 are 3% for the west coast areas and 96% from Tasman Bay/Golden Bay. Over the same period, the overall set net catch has declined from 64% of the catch to 31%, with the balance taken up by bottom trawl and (in the most recent three years) Danish seine nets.

On 1 October 2020, new commercial and recreational set net fishing closures out to 4 nautical miles offshore took effect within Golden Bay and Tasman Bay, from Farewell Spit to Cape Soucis (Raetihi).

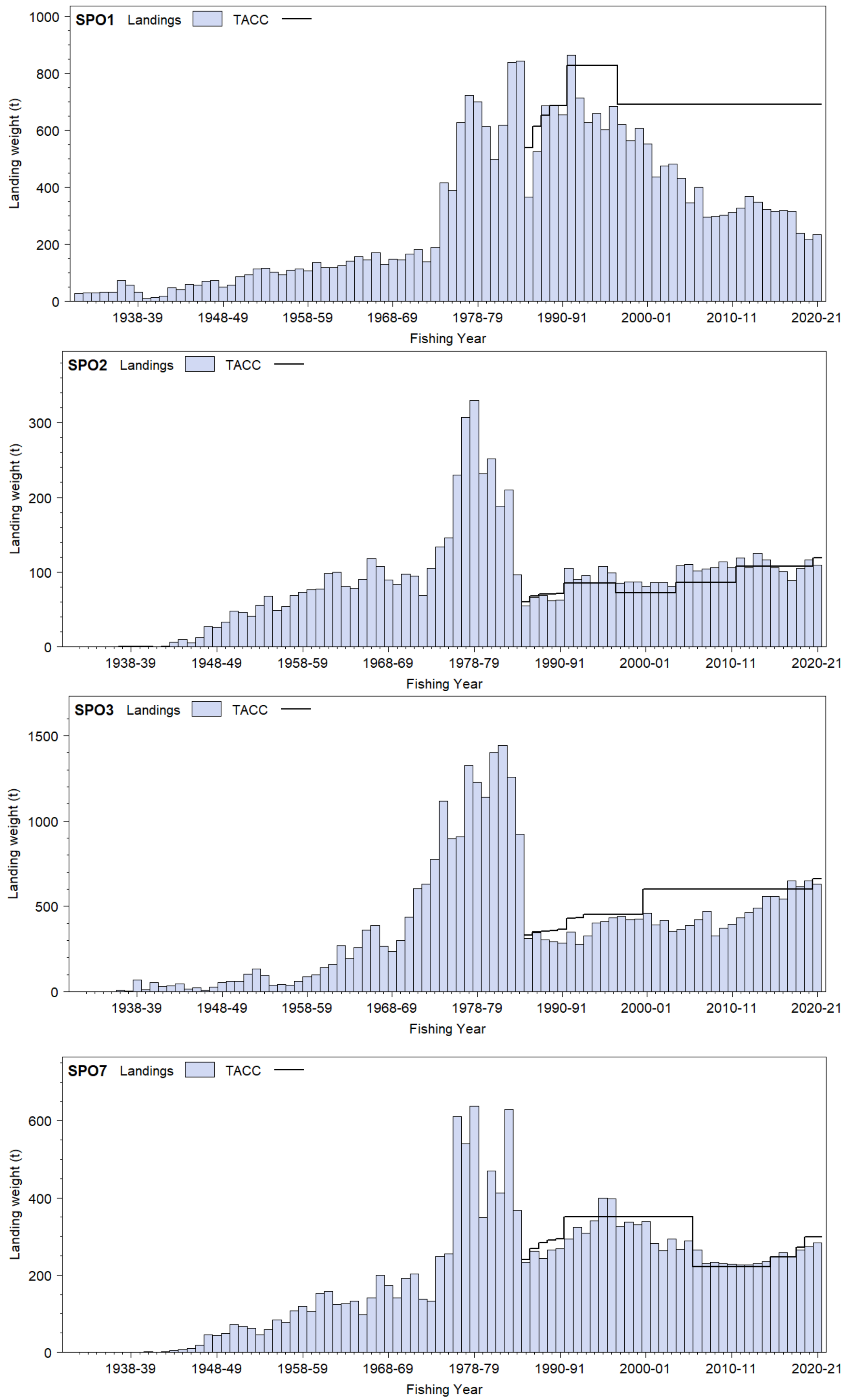


Figure 1: Historical landings and TACCs for the five main SPO stocks. From top to bottom: SPO 1 (Auckland East), SPO 2 (Central East), SPO 3 (South East Coast), and SPO 7 (Challenger). **[Continued on next page]**

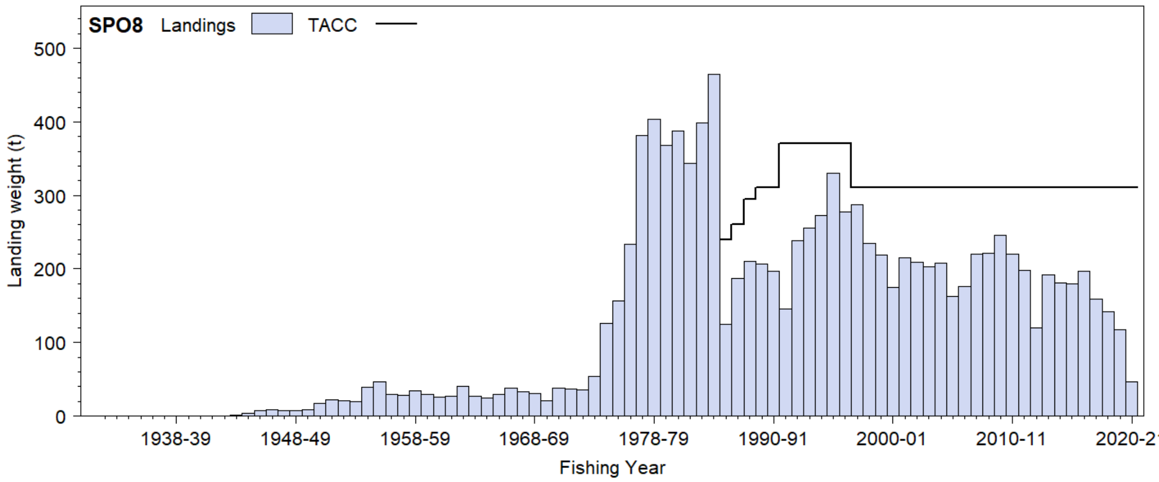


Figure 1 [Continued]: Historical landings and TACCs for the five main SPO stocks. SPO 8 (Central Egmont).

1.2 Recreational fisheries

Rig is the most commonly caught shark species by recreational fishers in New Zealand (Wynne-Jones et al 2014, 2019). Rig are caught by recreational fishers throughout New Zealand. From the 2011–12 national panel survey they were predominantly taken by rod and reel (75.2%) with some taken by longline (16.6%) and less in set net (7.2%). The rod and reel catch was taken predominantly from land (57.5%) and trailer boat (29.6%), highlighting the importance of this species to land-based fishers. In the 2017–18 national panel survey no set net catch was reported, with 76% of the catch taken by land-based fishers (Wynne-Jones et al 2019).

1.2.1 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 Kaikōura 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 2004). 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 in standardised phone interviews. Estimated catches in numbers of fish were converted to weights using mean weights estimated from boat ramp surveys (Hartill & Davey 2015). The national panel survey was repeated during the 2017–18 fishing year using very similar methods to produce directly

comparable results (Wynne-Jones et al 2019, Davey et al 2019). Recreational catch estimates from the two national panel surveys are given in Table 5. Note that national panel survey estimates do not include recreational harvest taken under s111 general approvals.

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, and North in 1993–94. Early survey harvests are presented as a range to reflect the considerable uncertainty in the estimates. The telephone/diary surveys were conducted from December to November but are denoted by the January calendar year. National panel surveys were conducted throughout the October to September fishing year but are 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	0.25
	2018	Panel survey	3 830	6.1	0.34
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
	2018	Panel survey	3 044	4.8	0.32
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	0.24
	2018	Panel survey	9 372	14.9	0.26
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
	2018	Panel survey	11 688	18.6	0.27
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	0.45
	2018	Panel survey	7 435	11.8	0.41

1.3 Customary non-commercial fisheries

Māori 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 set nets 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. Off the South Island male and female rig attain maturity at 5–6 y (about 85 cm) and 7–8 y (about 100 cm), respectively (Francis & Ó Maolagáin 2000). Rig in the Hauraki Gulf mature earlier (4 y for males and 5 y 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. 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, around the North Island and South Island. They grow rapidly during their first summer and then disappear as water temperatures drop in autumn, 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						Source
1. Natural mortality (M)						
All					0.2–0.3	Francis & Francis (1992a)
2. Weight = a(length)^b (Weight in g, length in cm total length).						
	Females			Males		
	a	b		a	b	
SPO 3	3.67×10^{-7}	3.54		1.46×10^{-6}	3.22	Francis (1979)
SPO 7&8	9.86×10^{-7}	3.32		$3.85 \times 10^{-}$	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 occur 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 Trawl surveys

Indices of relative biomass for rig are available from *Kaharoa* trawl surveys of the west coast North Island, east coast South Island, and west coast South Island.

West coast North Island (WCNI) inshore trawl survey

The west coast North Island trawl survey was reinstated in 2018 after a 19 year hiatus from the last previous survey in 1999, with the restored surveys conducted in three consecutive years from 2018. The decision to reinstate this survey was driven by the concern that it was not sufficient to rely on the analysis of commercial catch and effort for snapper in this region and that there was a requirement for a fishery independent biomass survey. However, the success of this reinstatement relied on the ability to define a consistent set of surveyed strata across all survey years, given that strata definitions have changed over the history of the survey as well as the imposition of new regulations that barred access to parts of the inner coast for the protection of Māui dolphins from incidental capture by trawl.

A review completed in 2021 (Jones et al in prep) identified eight surveys which covered a 'core' set of consistently surveyed strata that ranged from 10 to 100 m and extended from the central part of the North Taranaki Bight to Ninety Mile Beach. Two early surveys were dropped when the depth range was extended to 200 m in an 'extended core' series. Jones et al (in prep) determined that three species were adequately represented by these strata in terms of obtaining acceptable CVs while covering a representative spatial and depth range. These species were snapper, red gurnard, and John dory. Although tarakihi were considered well covered by the survey series, parts of the known tarakihi habitat in the southern region of the WCNI have never been covered by any WCNI survey. Rig were thought to have reasonable coverage with a caveat of: "restricted access to the inshore areas, and relatively low numbers caught". Biomass estimates for rig for each of the above stratum definitions are given in Figure 2 and Table 7.

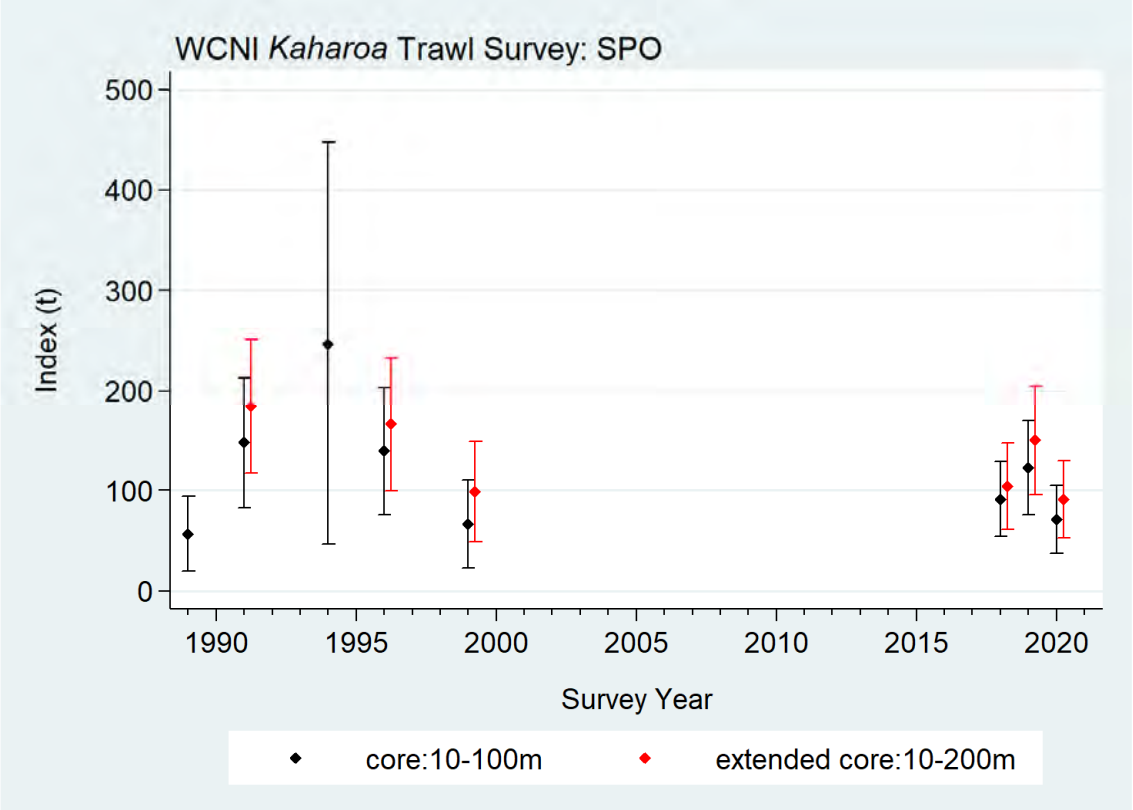


Figure 2: Total rig biomass indices (t) for the 'core' and 'extended core' stratum definitions adopted by Jones et al (in prep). Index values and CVs are given in Table 7.

The annual sample numbers by sex, survey year, and survey core type are given in Table 8. Length frequency distributions for the 10–100 n core strata, scaled by the survey CPUE and stratum area, are plotted by sex and survey year in Figure 3.

Table 7: Rig biomass estimates (t) and CVs for the ‘core’ and ‘extended core’ stratum definitions used for the restratified WCNI trawl survey. ‘–’: not available.

Survey	Core (10–100 m)				Extended Core (10–200 m)			
year	Total	Males	Females	CV	Total	Males	Females	CV
1989	56.7	22.3	32.7	0.33	–	–	–	–
1991	147.9	95.1	52.8	0.22	183.9	111.0	72.9	0.18
1994	246.9	66.4	178.8	0.41	–	–	–	–
1996	139.1	72.0	66.7	0.23	165.9	78.3	87.2	0.20
1999	66.6	24.9	40.0	0.33	98.7	28.7	63.1	0.25
2018	91.1	–	–	0.20	104.0	–	–	0.21
2019	122.6	63.8	58.8	0.19	149.9	63.8	86.1	0.18
2020	70.9	40.9	30.0	0.24	90.9	40.9	50.0	0.21

Table 8: Number of unscaled rig captured and resulting scaled estimates of rig in numbers for the ‘core’ and ‘extended core’ stratum definitions used for the restratified WCNI trawl survey. ‘–’: not available.

	Core (10–100 m)				Extended Core (10–200 m)			
Survey		Males		Females		Males		Females
year	Unscaled	Scaled	Unscaled	Scaled	Unscaled	Scaled	Unscaled	Scaled
1989	16	14 497	21	19 912	–	–	–	–
1991	52	65 475	62	28 934	55	75 166	64	35 755
1994	40	42 303	74	104 150	–	–	–	–
1996	75	42 252	83	40 587	78	47 948	87	48 882
1999	20	22 908	30	20 648	23	25 593	38	29 150
2018	25	37 402	21	8 755	25	38 449	24	14 083
2019	55	36 476	45	26 603	55	36 726	50	36 226
2020	33	26 762	46	17 884	33	26 997	51	25 398

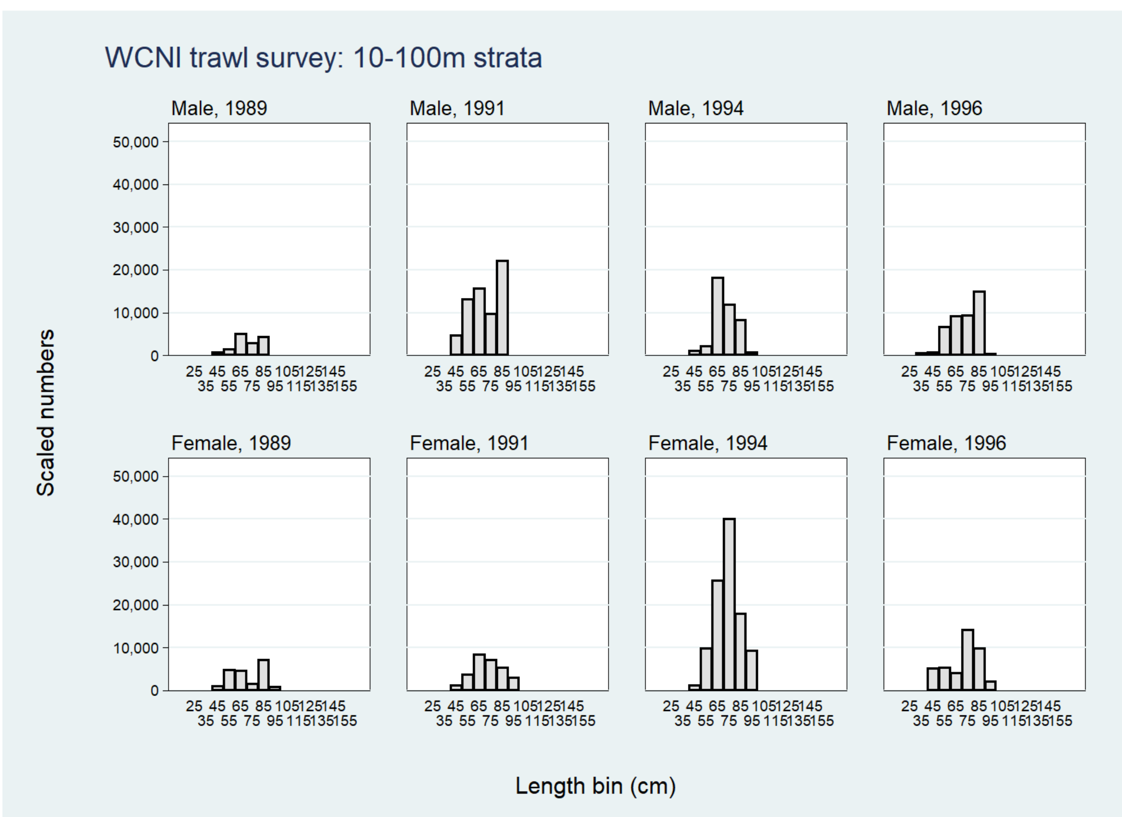


Figure 3: Scaled rig length frequency distributions by survey year for the eight core WCNI trawl surveys. Number of observations by sex are given in Table 8. [Continued on next page]

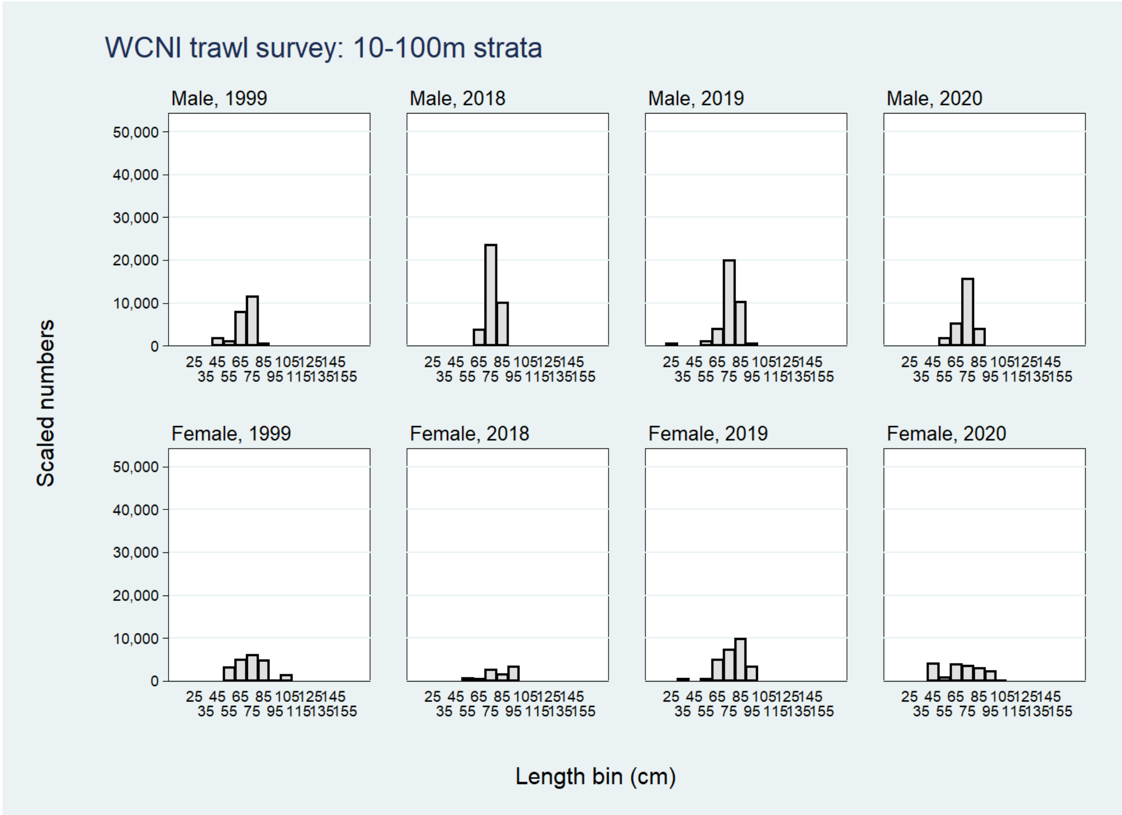


Figure 3: [Continued]. Scaled rig length frequency distributions by survey year for the eight core WCNI trawl surveys. Number of observations by sex are given in Table 8.

East coast South Island (ECSI) inshore trawl survey

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, particularly in 2021 when the biomass estimate increased enormously but was associated with a very high CV (Table 9, Figure 4). The 10–30 m depth range accounts for a relatively large, but variable, proportion of the total rig biomass, ranging from 29% to 66% of the total survey biomass, indicating that these additional shallow strata are important for monitoring rig in this area. The 2018 survey illustrates this point, with the 2018 SPO estimate in the core strata dropping nearly 50% relative to the 2016 estimate, whereas the total 2018 estimate, which includes the shallow strata, was greater than the equivalent 2016 estimate (Table 9, Figure 4). The core strata (30–400 m) of the ECSI winter trawl survey are not fully representative of the rig population because there is a large and variable proportion of the rig biomass inside the 30 m depth contour.

Table 9: 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.

Fishstock	Survey year	Trip number	Total biomass estimate	CV (%)	Total biomass estimate	CV (%)
			30–400m		10–400m	
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
	2016	KAH1605	181	39	255	29
	2018	KAH1803	98	28	287	29
	2021	KAH2104	506	90	728	63

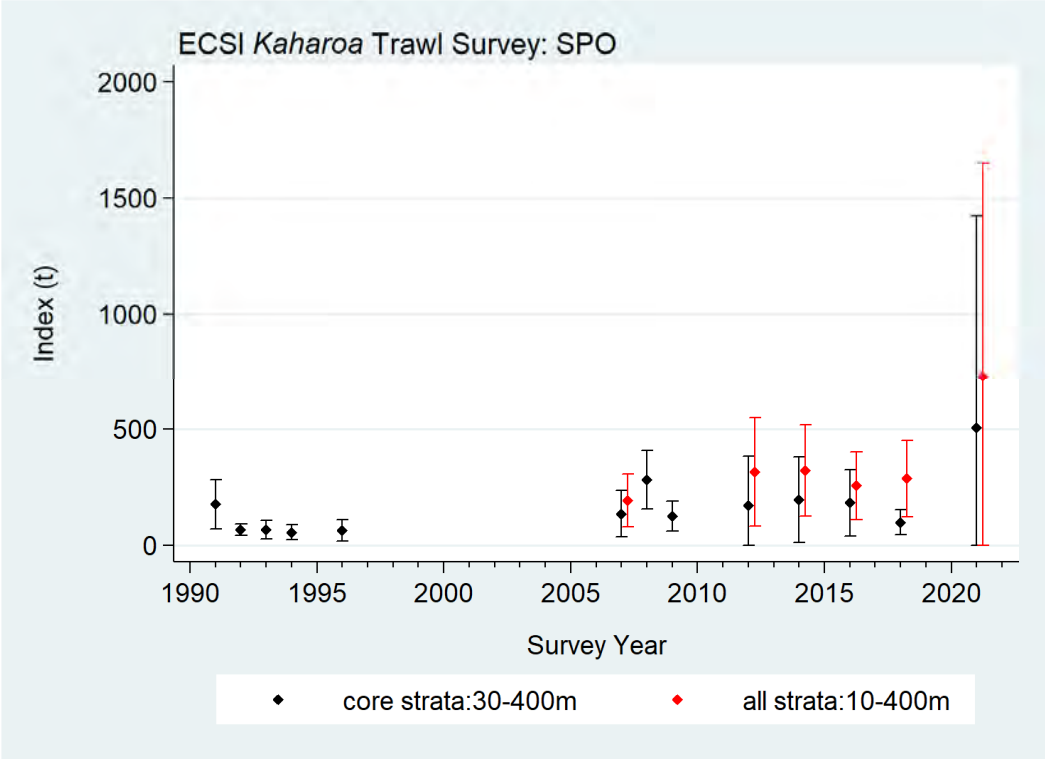


Figure 4: Rig total biomass (t) and 95% confidence intervals for all ECSI winter surveys in core strata (30–400 m), and core plus shallow strata (10–400 m) in 2007, 2012, 2014, 2016, 2018, and 2021.

Length frequency distributions: ECSI

The annual sample numbers by sex, survey year, and depth zone are given in Table 10. The length frequency distributions for the east coast South Island winter trawl surveys often have modes centred round 40 cm and 60 cm, most pronounced in the shallow 10–30 m depth range (Figure 5a, Figure 5b). These two modes correspond to pre-recruit rig of ages 1+ and 2+. Rig tended to be larger overall in the 30–400 m depth range in first four of the six survey years that covered 10–30 m strata (Figure 6). However, in 2018, rig were approximately the same size in the two strata and in 2021, rig were much larger in the 10–30 m strata than in the 30–400 m core strata definition (Figure 6). This survey appears to be monitoring pre-recruited cohorts (1+ and 2+) reasonably well, but probably not the full extent of the recruited (> 90 cm) size distribution, because the proportion of rig over 1 m long in the survey catch is low (Figure 5a, Figure 5b). Time series plots of 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 changed the shape of the length frequency distribution, by increasing the proportion of fish under 70 cm in the survey catch. Figure 6 demonstrates that catches from the shallow (10–30 m) strata included a higher proportion of smaller rig than those in the core (30–400 m) strata in the first four surveys. High numbers of rig under 70 cm in both core and inshore strata in the 2012, 2014, and 2016 surveys were indicative of strong recruitment in recent years (Starr & Kendrick 2020).

Table 10: Number of unscaled rig captured and resulting scaled estimates of rig in numbers for the 30–400 m core and 10–30 m shallow stratum definitions used for the ECSI trawl survey. Only years with valid survey coverage in both stratum definitions are shown.

	Core (30–400 m)				Shallow (10–30 m)			
Survey		Males		Females		Males		Females
year	Unscaled	Scaled	Unscaled	Scaled	Unscaled	Scaled	Unscaled	Scaled
2007	41	34 266	37	37 630	17	24 868	14	21 076
2012	82	57 074	63	42 570	176	78 393	221	107 109
2014	67	82 290	70	73 675	121	52 841	145	59 709
2016	68	63 209	55	50 441	98	57 318	106	61 071
2018	60	49 559	54	43 953	105	91 437	77	70 596
2021	244	149 113	216	124 452	82	111 184	76	101 502

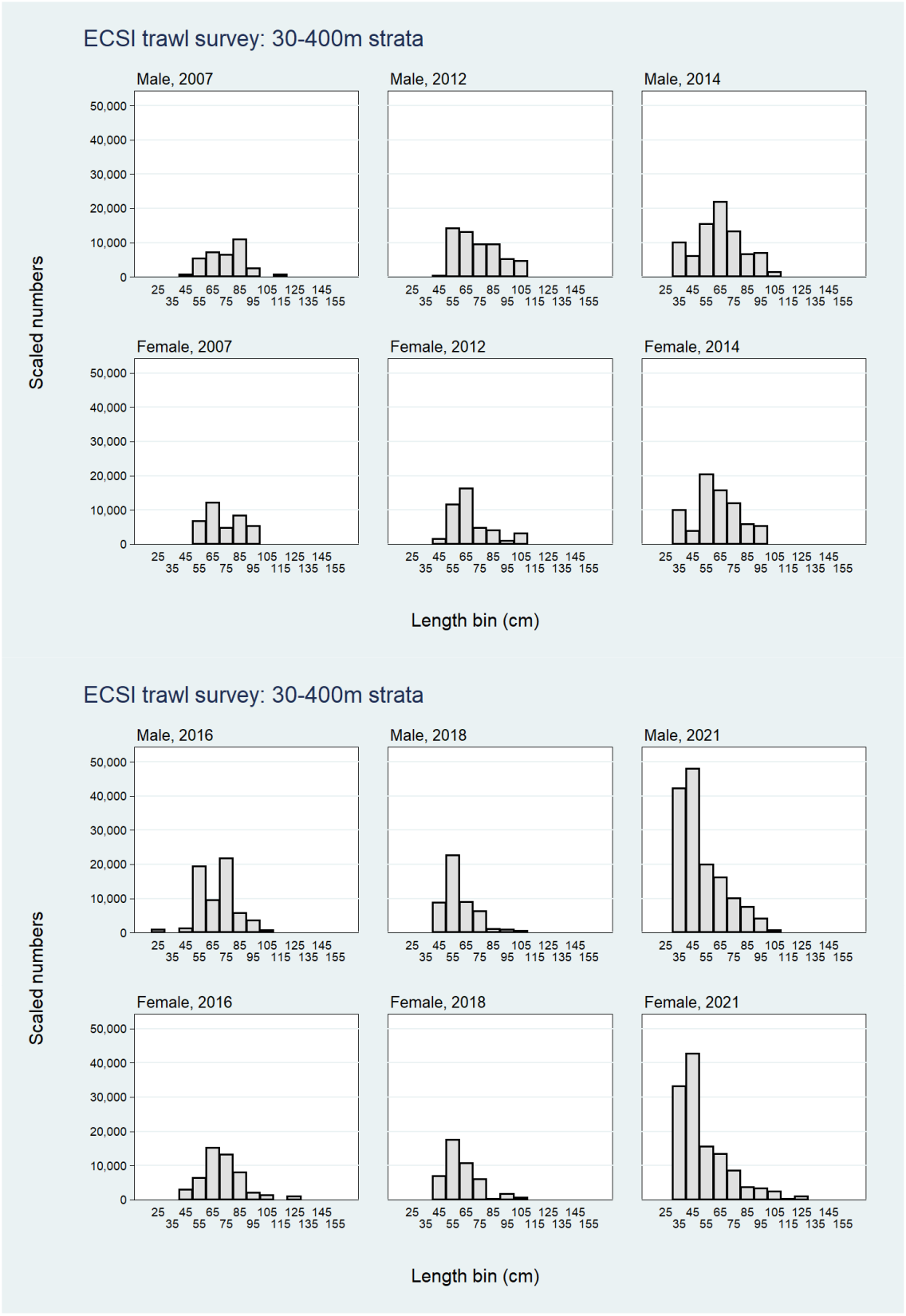


Figure 5a: Length frequency distributions for the total 30–400 m core strata for the 2007, 2012, 2014, 2016, 2018, and 2021 surveys. Number of observations by sex are given in Table 10.

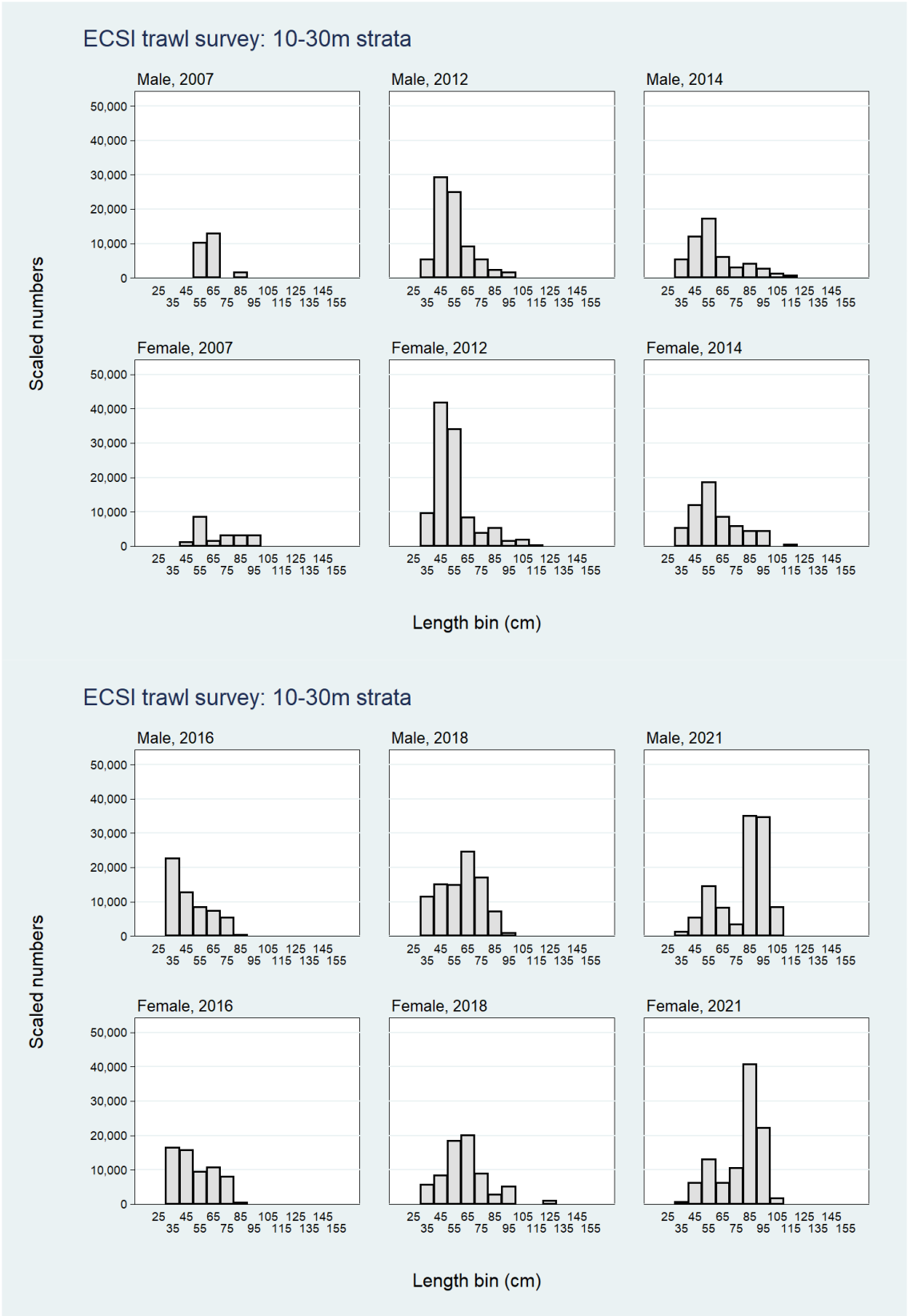


Figure 5b: Length frequency distributions for the total 10–30 m core strata for the 2007, 2012, 2014, 2016, 2018, and 2021 surveys. Number of observations by sex are given in Table 10.

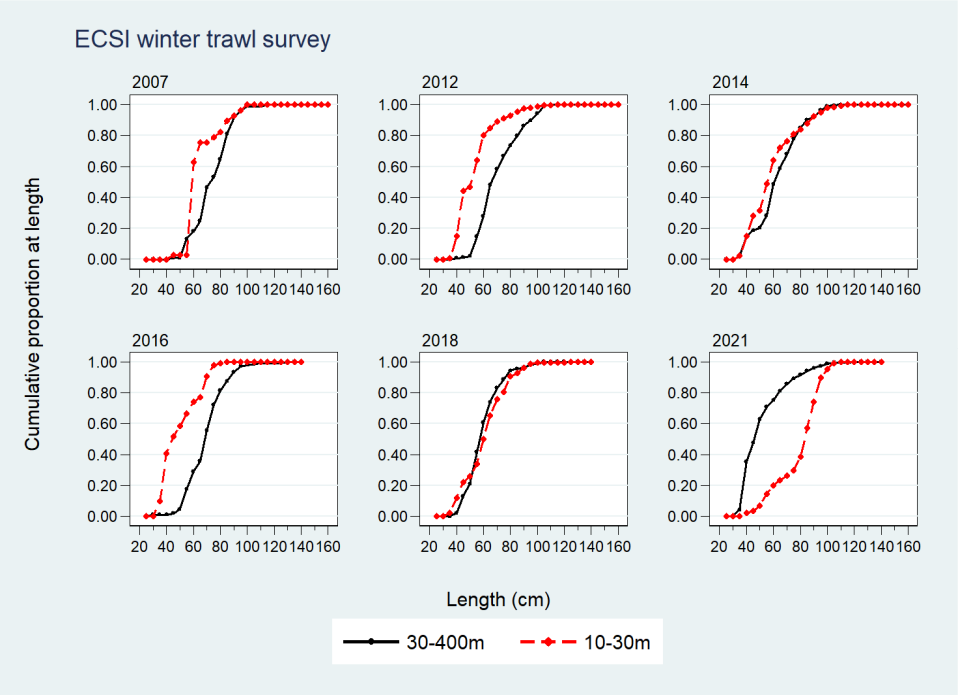


Figure 6: Empirical cumulative frequency plots for combined male and female rig comparing the cumulative length frequencies by year for the core (30–400 m) and shallow (10–30 m) strata across the six years (2007, 2012, 2014, 2016, 2018, 2021) with valid surveys in the shallow (10–30 m) strata.

West coast South Island (WCSI) inshore trawl survey

Although not optimised for rig, the west coast South Island inshore trawl survey provides useful abundance indices (Table 11, Figure 7). Stevenson & Hanchet (2000) reported that the survey is likely to provide a reasonable index of abundance for juveniles and pre-recruits less than 90 cm (Stevenson 2007). The depth range of the core survey (20–400 m) is suitable for rig but the lack of larger female rig in the length frequency distribution from the trawl survey suggests they may not be well sampled as noted by Stevenson & Hanchet (2000), but that pre-recruit and adult males are well sampled.

Total biomass has been relatively steady over time but has increased in the years up to 2015, after which the survey index values have dropped considerably with the 2021 estimate among the lowest in the series.

Length frequency distributions of rig show that distinct modes can be present in some years particularly for 0+ fish under 40 cm (e.g., 2007, 2011, 2013, and 2019) (Figure 8). Several distinct year classes are visible in some years (e.g., 2011). The distributions show that 0+ fish are relatively common in Tasman Bay and Golden Bay (e.g., 2007, 2009, 2017), but these fish are present in some years in strong numbers off the west coast as well (e.g., 2011, 2019).

Table 11: 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 (t)	CV (%)
WCSI	SPO 7				
		1992	KAH9204	288	14
		1994	KAH9404	380	10
		1995	KAH9504	490	11
		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
		2017	KAH1703	506	33
		2019	KAH1902	467	14
		2021	KAH2103	273	14

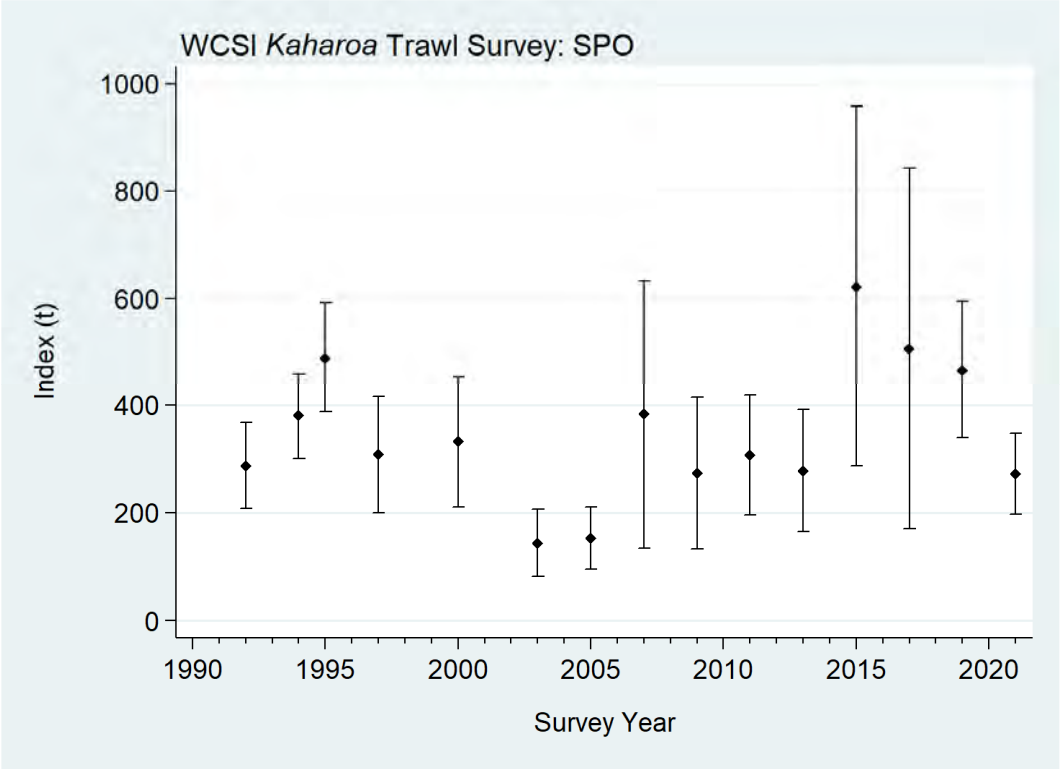


Figure 7: Plots of biomass estimates (t) for rig from the west coast South Island trawl survey by year. Error bars are ± two standard deviations.

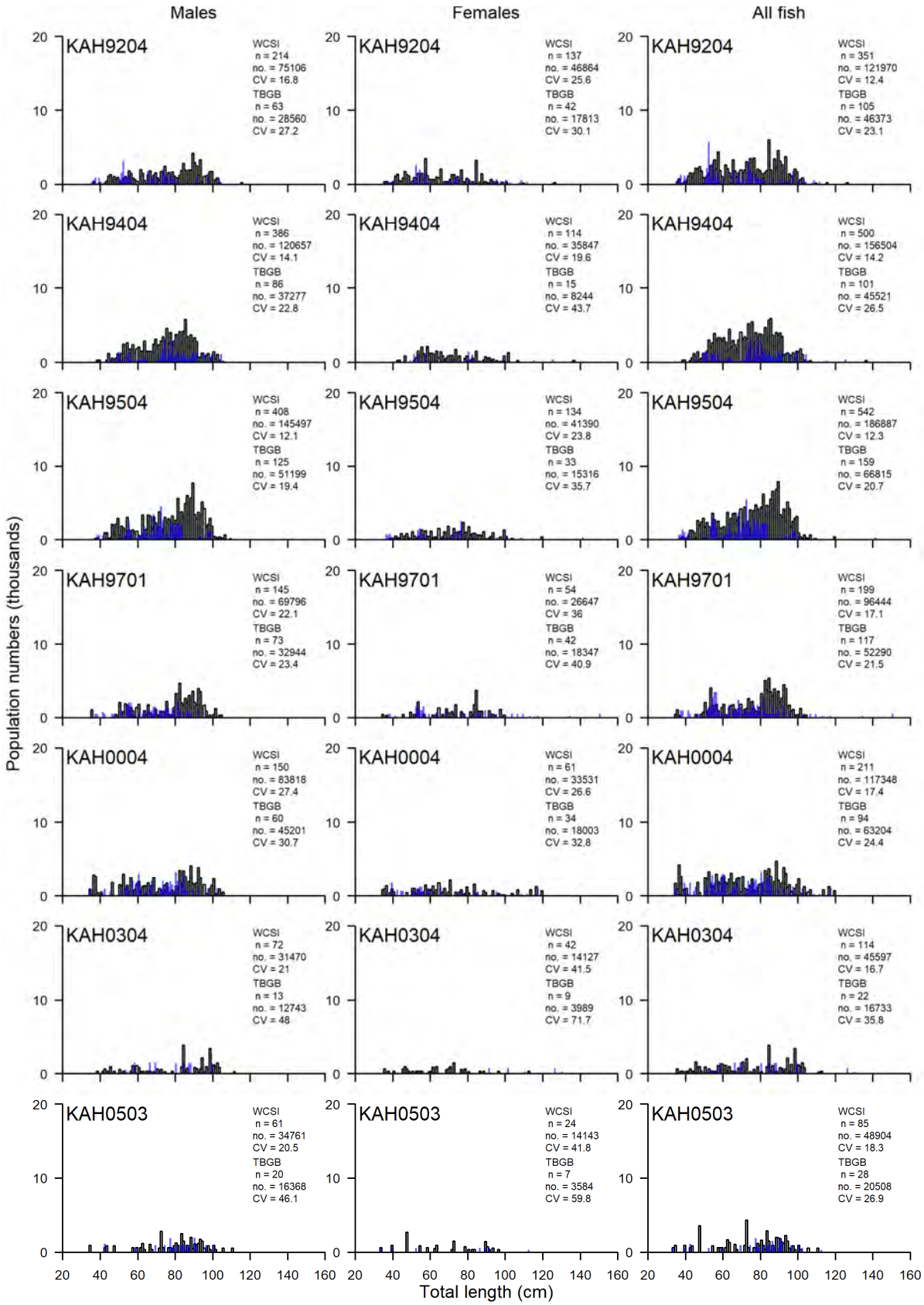


Figure 8: Scaled population length frequency distributions for rig from the west coast South Island inshore trawl survey time series core strata (20–400 m). Blue bars represent strata from Tasman Bay and Golden Bay; black bars represent the west coast of the South Island strata.

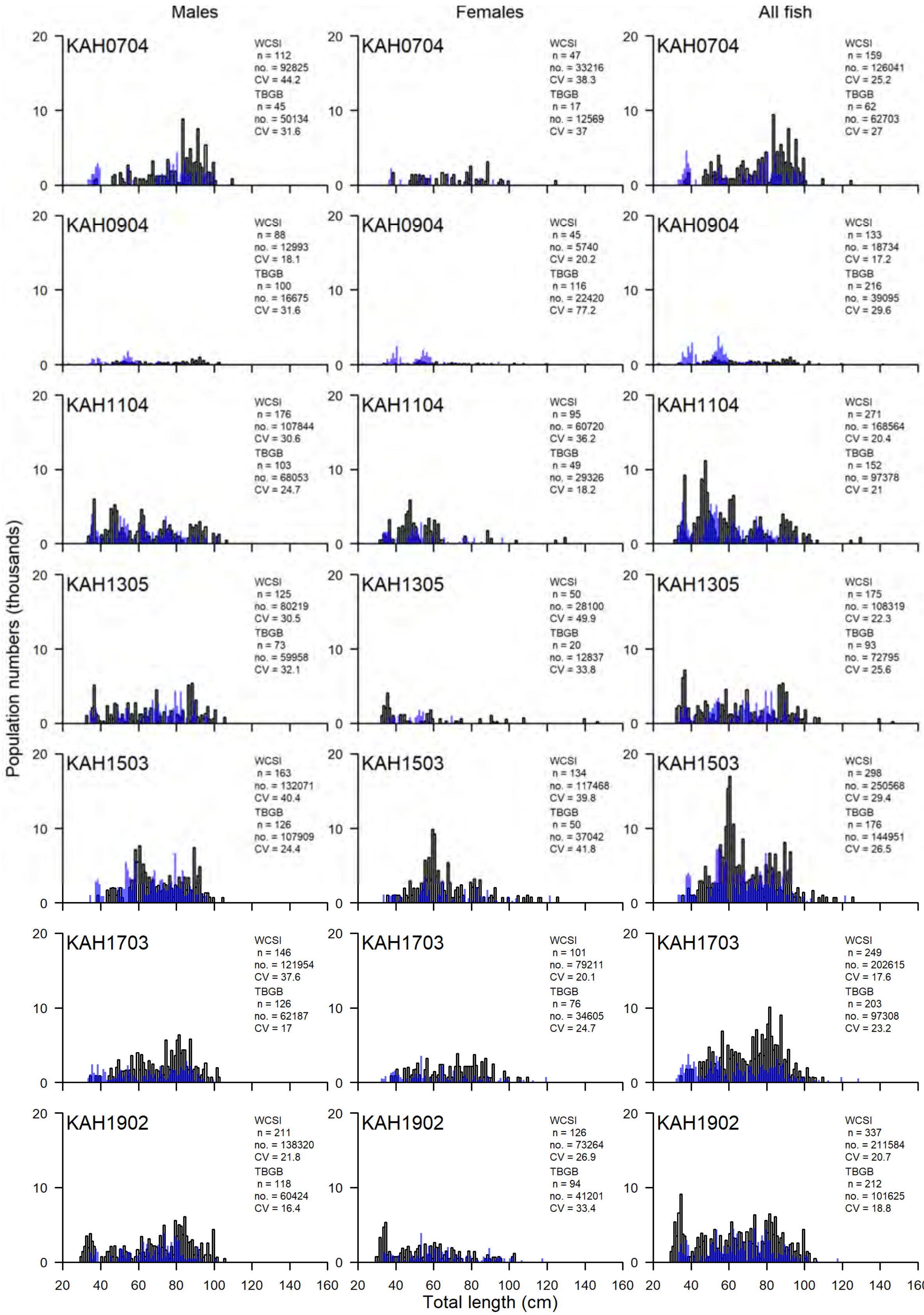


Figure 8 [Continued]

4.2 Estimates of fishery parameters and abundance

New Zealand rig stock status has been assessed based on standardised CPUE analyses of the set net and bottom trawl fisheries in SPO 3 and SPO 7 since the early 2000s. More recently, stock status for the east coast and west coast South Island rig have been evaluated against target definitions based the appropriate fishery independent trawl survey. A comprehensive CPUE analysis of the SPO 1 set net 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. This review was repeated in 2016 (Starr & Kendrick 2017), in 2019 (Starr & Kendrick 2020), and in 2022 (Starr et al 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, notably in 2006–07 for set net 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 or a collection of nets or a tow. Reporting changed again in 2019 with the introduction of electronic reporting of catch and effort. Paper forms were replaced with software installed on tablets or cell phones that controlled the recording of catch and effort data, based on specifications provided by Fisheries New Zealand. To derive a continuous series of relative abundance over these substantial changes in data collection protocols, the catch and effort data collected at an event-based level needed to be converted back into the equivalent daily form to create a series that adjusted for changes in reporting protocol. This procedure has become standard in New Zealand inshore fisheries CPUE analyses and is documented in an appendix of Starr et al (in prep).

A further complication in rig CPUE analyses is the requirement to use landed rather than estimated catch 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 by vessel, so the explanatory information associated with each day can be incorporated into the CPUE analysis. For trips 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. This occurs because fishers are only required to report the top five or eight species by weight per event or day (depending on the reporting format) and rig often do not reach this threshold. 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 occurs for rig caught in bottom trawl fisheries. Because of this problem, the 2016 Plenary agreed to use data amalgamated to the level of a complete trip for all 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 set net CPUE data were prepared by amalgamating the estimated catch and 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. This latter procedure is required in SPO 1 because fishers in that QMA tend to hold back their catch rather than deliver it to a Licensed Fish Receiver (LFR), thus breaking the link between the effort part of the form which holds the effort, location of catch, and the catch estimate and the landing part of the form which holds the verified catch information. The ERS protocol introduced a new QL code for fish held in temporary holding facilities on land; this is a final destination code and fishers can update their original landing records for a trip when deferred landings are sold to an LFR. However, this analysis treated deferred landing data from the paper and ERS systems in the same manner by scaling estimated catches using an annual vessel-specific ratio.

The set net 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 set net analysis) or number of tows (for the bottom trawl analysis). For the set net fishery, it was considered appropriate to sum the length of net set to move from an event report to a daily report because of how the instructions were given for NCELR and ERS reporting. However, it was determined that it was not appropriate to sum the duration of time that multiple nets were in the water when amalgamating this variable to a daily event. Instead a 'soak time' variable was implemented which calculated the time the first net was set in a day of fishing to the time when the last net was pulled. This 'soak time' variable returned better model diagnostics when compared with the same model using a summed duration variable or with dropping the duration variable.

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). The Inshore Working Group agreed to use combined models which integrate the signal from the tows with positive catch with the signal from presence/absence models based on the same data. These methods are preferred for use as the basis for monitoring species that are taken by bottom trawl, 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 2019). Only standardised models based on positive catch records were used for the SPO 1 set net CPUE analyses. This is because zero catch records are relatively rare (less than 5% in most instances and only rarely >10%). Experience has shown that models which combine positive and zero catch information are nearly indistinguishable from the positive catch model when the zero catch records are less than 10% of the total records. Combined models were introduced for the SPO 3 and SPO 7 set net analyses in 2022 because of a higher incidence of zero effort records than seen in SPO 1.

SPO 1

Standardised CPUE indices were calculated for five SPO 1 set net fisheries by modelling (GLM) non-zero catches by core vessels targeting rig and other shark species when this species was reviewed in 2016. 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 set net analyses were complicated by the fact that up to 50% of the set net landings were accumulated 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

In 2016, three CPUE analyses for SPO 1E were presented to the Working Group: a) a target shark (NSD, SPO, SHK, SPD) set net fishery operating in the Firth of Thames (Statistical Area 007) [SN(007)]; b) a target shark set net 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)].

The Southern Inshore Working Group (SINSWG) 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. The latter two series were not updated in 2019 or in 2022 (Starr & Kendrick 2019,

Starr et al in prep) because of their low research rating. The SN(007) analysis was updated, showing a relatively strong upturn from the 2013 to 2019, followed by a decline in 2020 and 2021 (Figure 9).

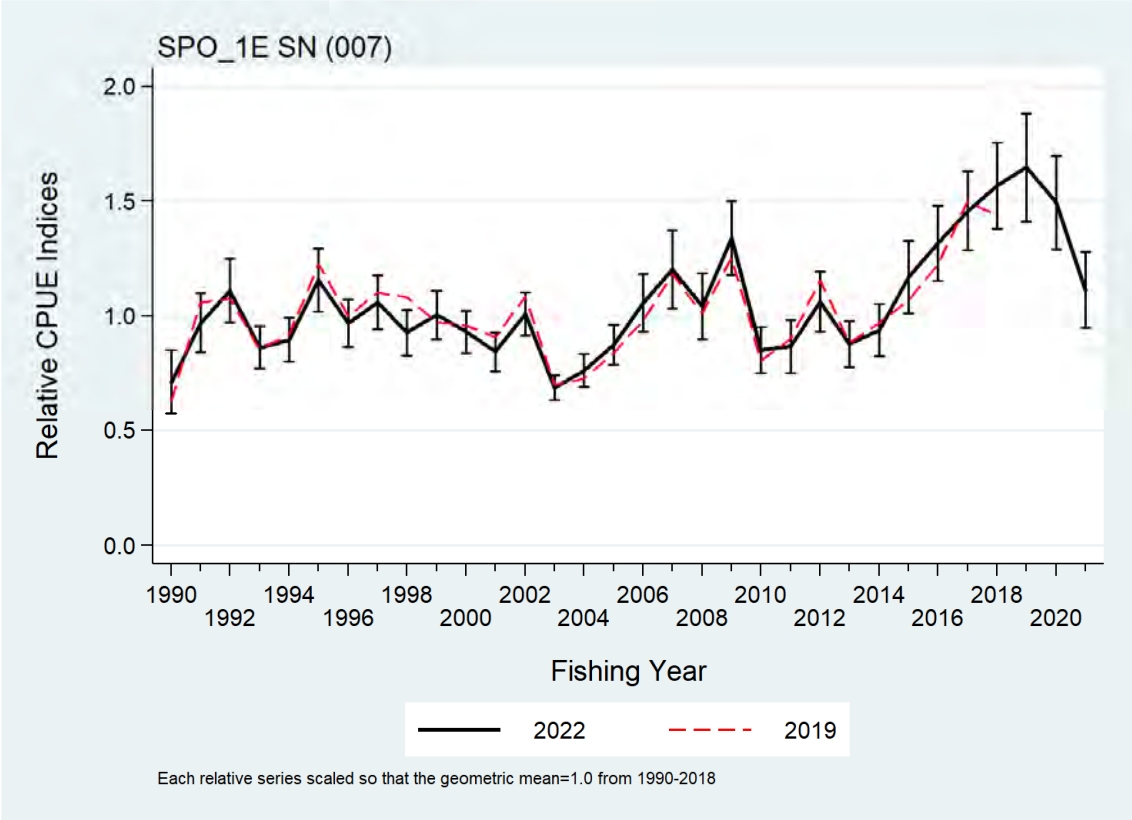


Figure 9: Standardised CPUE for SPO 1E in the target shark set net in the Firth of Thames (Statistical Area 007) [SN(007)]. Error bars show 95% confidence interval on the prediction.

SPO 1W

In 2016, four CPUE analyses for SPO 1W were presented to the Working Group: a) a target shark (NSD, SPO, SHK, SPD) set net fishery operating in Manukau Harbour (Statistical Area 043) [SN(043)]; b) a target shark set net fishery operating in Kaipara Harbour (Statistical Area 044) [SN(044)]; c) a target shark set net fishery operating in all the remaining SPO 1W Statistical Areas (042, 045–048) plus the most northerly SPO 8 Statistical Area (041) [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, 045–048) [BT(coast)] outside the harbours plus the most northerly SPO 8 Statistical Area (041).

The 2016 Plenary assigned the BT index a quality ranking of '1', but noted that, although 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 set net index series was not updated in 2019 or in 2022 (Starr & Kendrick 2019, Starr et al in prep) because of its rejection in 2016. The other three series were updated in 2022. The coastal BT series has shown a slow increasing trend since the mid-2000s to about 2012, followed by a period of relative stability extending to 2021. The SN(043 Manukau Harbour) series showed a strong decline in the early part of the series while the SN(044 Kaipara Harbour) series declined in the first one or two years in the series. Both set net indices showed a slowly declining trend into the early 2000s, followed by a period of relative stability (Figure 10). The Manukau series has trended upward beginning in 2019 while the Kaipara series has remained stable.

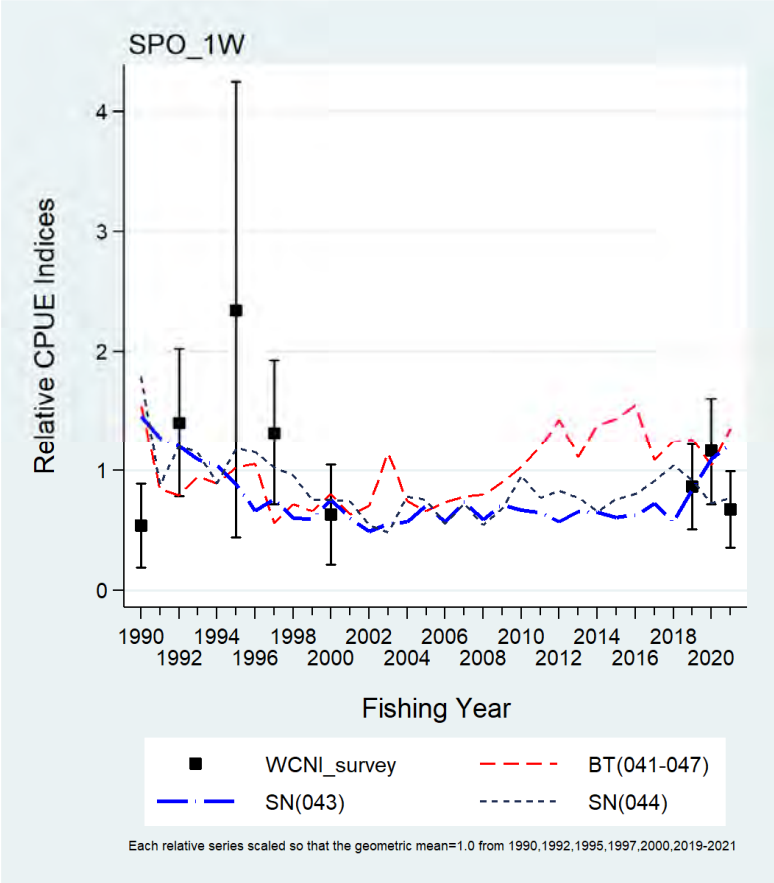


Figure 10: Comparison of standardised CPUE for SPO 1W in three fisheries: a) target shark set net in Manukau Harbour (Statistical Area 043) [SN(043)]; b) target shark set net in Kaipara Harbour (Statistical Area 044) [SN(044)]; c) coastal bottom trawl north of Cape Egmont [BT(041-047)]. Also shown are the WCNI trawl survey core 10–100 m biomass indices offset by one year to match the fishing year definition. Error bars are ±2 standard errors.

SPO 2

As done in 2016 and 2019, a trip-based bottom trawl series was used to index SPO 2 relative abundance from 1989–90 to 2020–21 (Starr et al in prep). The corresponding set net analysis was not repeated 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 2022; with this analysis defined by selecting trips which fished exclusively in the Statistical Areas 011–015 and targeted flatfish, red gurnard, or tarakihi.

The trip-based combined SPO 2 series constructed from bottom trawl data showed a gradually increasing trend from 1989–90 to 2011–12, after which the series showed an increasing trend to the end of the series (Figure 11). There was some year-to-year variability beginning around 2014, but the overall trajectory appeared to be upward. The Plenary gave the BT(trip) series an overall assessment quality rank of '1' but noted that, though the analysis was credible, the method of capture does not representatively sample large female rig. An event based (tow-by-tow) standardised analysis was introduced in 2022 as a diagnostic to test whether amalgamating the data to the level of a complete trip was introducing bias. This analysis determined that this series agreed well in the overlapping years.

Establishing B_{MSY} compatible reference points

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

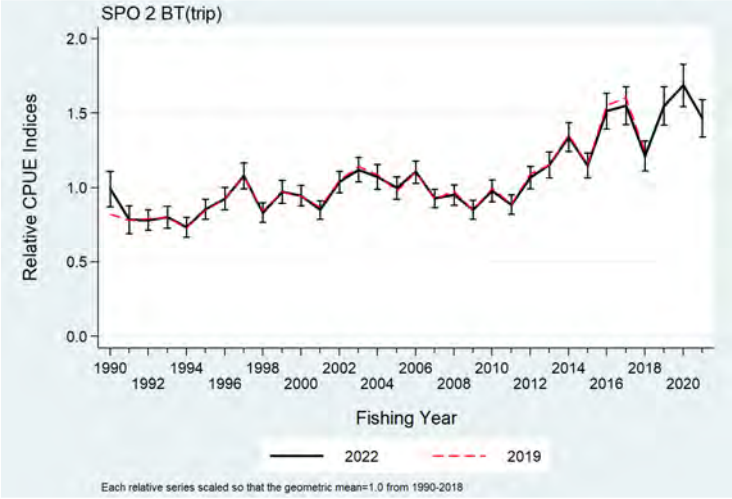


Figure 11: Standardised combined delta-lognormal CPUE series for SPO 2 bottom trawl based on trips which landed rig from Statistical Areas 011 to 015 and targeted flatfish, red gurnard, or tarakihi up to 2020–21. Also plotted is the equivalent series from the 2019 SPO 2 review. Error bars are ±2 standard errors.

SPO 3

Rig in SPO 3 are mostly landed in the shark set net 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 in 2016, one based on a shark target set net fishery (SN[SHK]) and the other based on a mixed target species (flatfish, barracouta, red cod, tarakihi, stargazer, elephantfish, and red 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 other target species that are taken at deeper depths. However, the switch to a trip-based analysis 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, amalgamated at the level of a trip. The final two fisheries (set net and trawl) will have different selectivities, harvesting a different size range of rig, with the set net 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.

While the 2019 review (Starr & Kendrick 2020) repeated the BT(All) and SN(SHK) analyses, the INSWG requested in 2022 to split the SPO 3 QMA into two parts: a) east coast, incorporating Statistical Areas 018 (Kaikōura/Motunau), 020 (Pegasus Bay), 022 (Canterbury Bight), 024 (Oamaru/Timaru), and 026 (Catlins) and b) Foveaux Strait, incorporating Statistical Areas 025 (eastern Foveaux St), 027 (south east side Stewart Island), 028 (south end Stewart Island), 029 (west side Stewart Island), 030 (western Foveaux St), and 031/032 (Fiordland). This decision was prompted by the diagnostics, with the implied residuals from the full SPO 3 SN (daily) model showing poor correlations for most of the statistical areas compared with the overall annual model trend. The same was true for the SCH and SPO target species, again showing low correlation with the overall annual model trend. Implied residual correlations between statistical areas and target species with the overall model annual trend were much better for the SPO 3 BT (trip) model. However, there were several anomalies which suggested that a split region model should be explored for this series as well.

The split SPO 3 BT east coast (trip) and the SPO 3 BT Foveaux St (trip) models showed implied residual correlations for all statistical areas that were equivalent to the full SPO 3 BT (trip) model, except for Statistical Area 025, which was improved under the split SPO 3 BT Foveaux St (trip) model. Similarly, the two split SPO 3 BT models and the full SPO 3 BT model had similar implied target species residuals, except for STA target, which again were better under the SPO 3 BT Foveaux St model because the majority of STA targeting was in the more southerly statistical areas. Figure 12 (top panel) shows that the SPO 3 BT east coast (trip) model closely resembles the full SPO 3 BT (trip) model while

the SPO 3 BT Foveaux St (trip) model is more variable (likely due to limited data for this model) but still provides good corroboration with the SPO 3 BT east coast (trip) model.

The implied residual comparisons were more problematic for the SPO 3 SN (daily) model, with none of the statistical areas in the full model showing strong correlations with the overall annual model trend, While the statistical area implied residual correlations were weaker for the SPO 3 SN split models than for the corresponding split SPO 3 BT models, they were nevertheless better in the spatially split models than in the full SPO 3 SN model. The INSWG accepted the two spatially split SPO 3 SN models over the full SPO 3 SN model, reasoning that the relatively poor implied residual statistical area correlations in all these models were likely to be evidence that there is spatial heterogeneity among mature rig in SPO 3 at a finer scale than the available data. As for the target species implied residuals in the spatially split SPO 3 SN models, the correlation was considerably improved for SPO (the dominant target species) in the SPO 3 SN east coast model while the SCH (again the dominant target species) correlation was much better in the SPO 3 SN Foveaux St model. As seen for the SPO 3 BT models, all three of the SPO 3 SN models resemble each other, with the SPO 3 SN east coast model (which has the majority of the data) closer to the full SPO 3 SN model while the SPO 3 SN Foveaux St model is more variable than the other two models (Figure 12, lower panel). The three SN models have similar relative levels in 2020 and 2021 even though they have different intermediate trajectories (Figure 12).

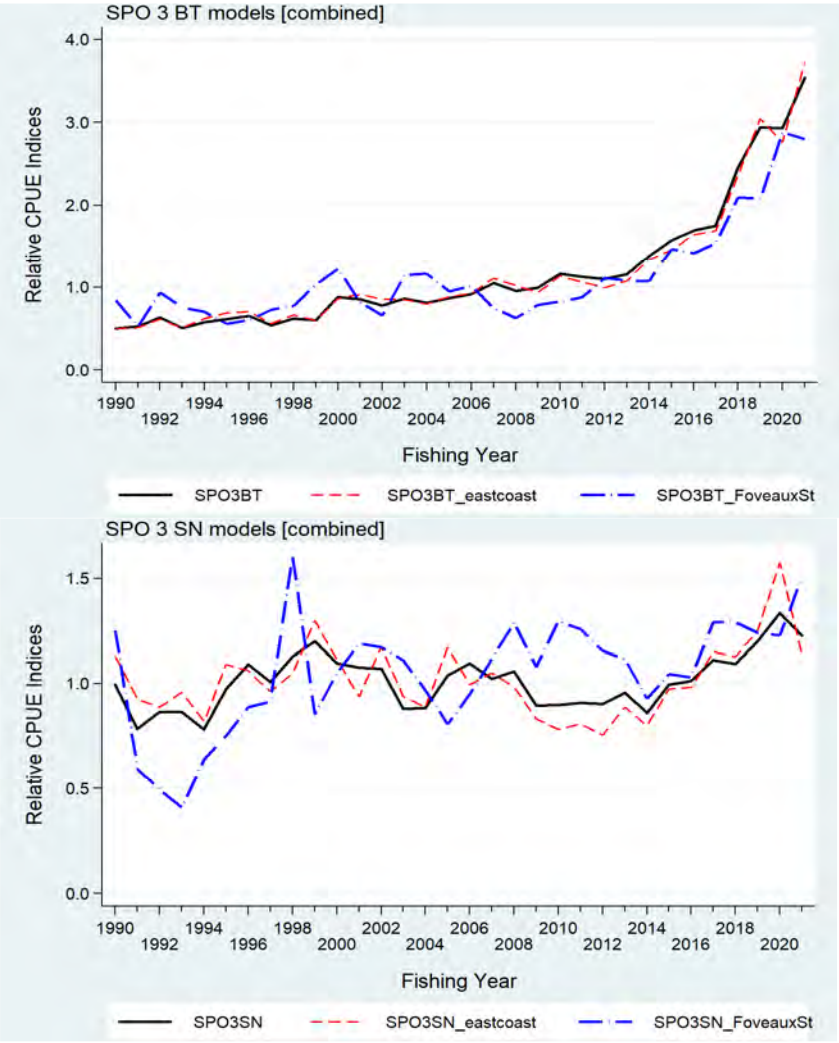


Figure 12: Comparison of the standardised combined indices for three SPO 3 BT CPUE series (top panel) and three combined SPO 3 SN CPUE series (bottom panel). For both BT and SN, the three models were defined in terms of the contributing statistical areas, with the 'full' SPO 3 model incorporating all the inshore Statistical Areas (018, 020, 022, 024, 026, 025, 027, 028, 029, 030, 031) while the 'east coast' models use Statistical Areas 018, 020, 022, 024, and 026 and the Foveaux St models use Statistical Areas 025, 027, 028, 029, 030, and 031.

SPO 3 east coast

The SPO 3 BT east coast (trip) series showed an increasing trend from 1989–90 to 2016–17, after which the trend accelerated, more than doubling the relative CPUE between 2018 and 2021 (Figure 13). The SPO 3 SN east coast (daily) series fluctuated without trend over the same period (Figure 13). The point estimates for rig from the east coast South Island (ECSI) winter trawl survey all strata (10–400 m) largely followed the pattern of the SPO 3 BT east coast (trip) series, except for the 2007 observation which doesn't match the equivalent SPO 3 BT east coast (trip) index very well. The 2021 ECSI point index value mirrors the large increase for the same year in the SPO 3 BT east coast series. Unfortunately, the associated CV for this index value (63%) was so large that this index must be considered unreliable.

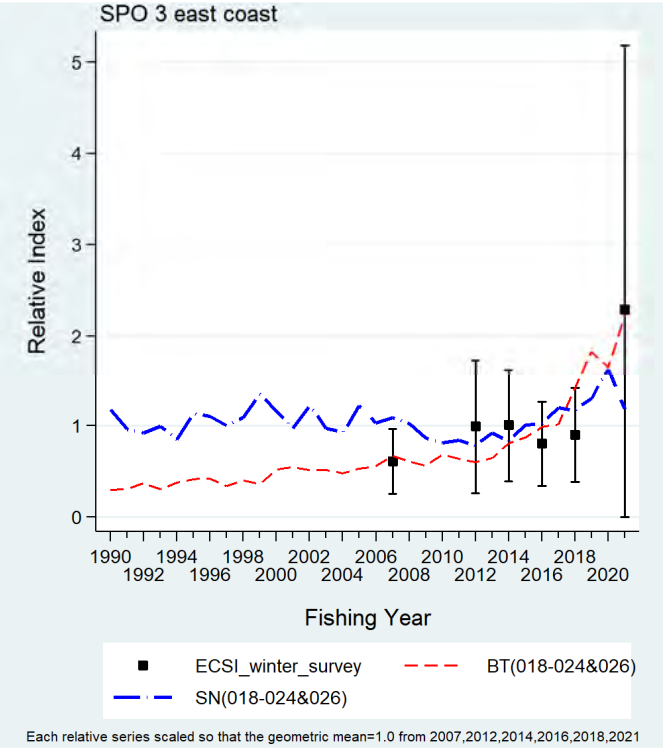


Figure 13: Comparison of two SPO 3 east coast (Statistical Areas 018, 020, 022, 024, and 026) standardised CPUE series: a) bottom trawl fishery (mix of targets in SPO 3 east coast statistical areas) [BT(018-024&026)]; b) shark target set net fishery [SN(018-024&026)]. Also shown are rig index values from the east coast South Island (ECSI) trawl survey (all strata, 10–400 m): 2007, 2012, 2014, 2016, 2018, and 2021, with error bars ± 2 standard errors.

By combining length frequency (LF) distributions across years to overcome small sample sizes, Figure 14 shows there were substantial differences in the mean LF distributions between the ECSI trawl survey, the SPO 3 BT east coast fishery, and the SPO 3 SN east coast fishery, with the set net LF distributions lying to the right of the bottom trawl LF distributions which are again to the right of the survey LF distributions. There is also a suggestion that the female set net LF distributions lie to the right of the equivalent male SN LF distributions, while the corresponding bottom trawl and survey LF distributions are reasonably similar between the two sexes.

Establishing B_{MSY} compatible reference points

The conclusion that the core strata (30–400 m) of the ECSI winter trawl survey were not fully representative of the rig population rendered the previously selected B_{MSY} proxy target reference point invalid because it was based on the core strata (see Figure 6 for comparative LFs by year and stratum definition). The INSWG agreed to revise the definition of the B_{MSY} proxy target reference point to be the geometric average of the five survey years which adequately covered the 10–30 m strata (2007, 2012, 2014, 2016, and 2018). It is not possible to use the 2021 index value in this definition given the very large CV (63%) associated with this index. The rationale for choosing this period was that abundance was stable and catches were relatively high, indicating high surplus production. The Soft Limit will be one-half of the B_{MSY} proxy and the Hard Limit will be one-quarter of the B_{MSY} proxy.

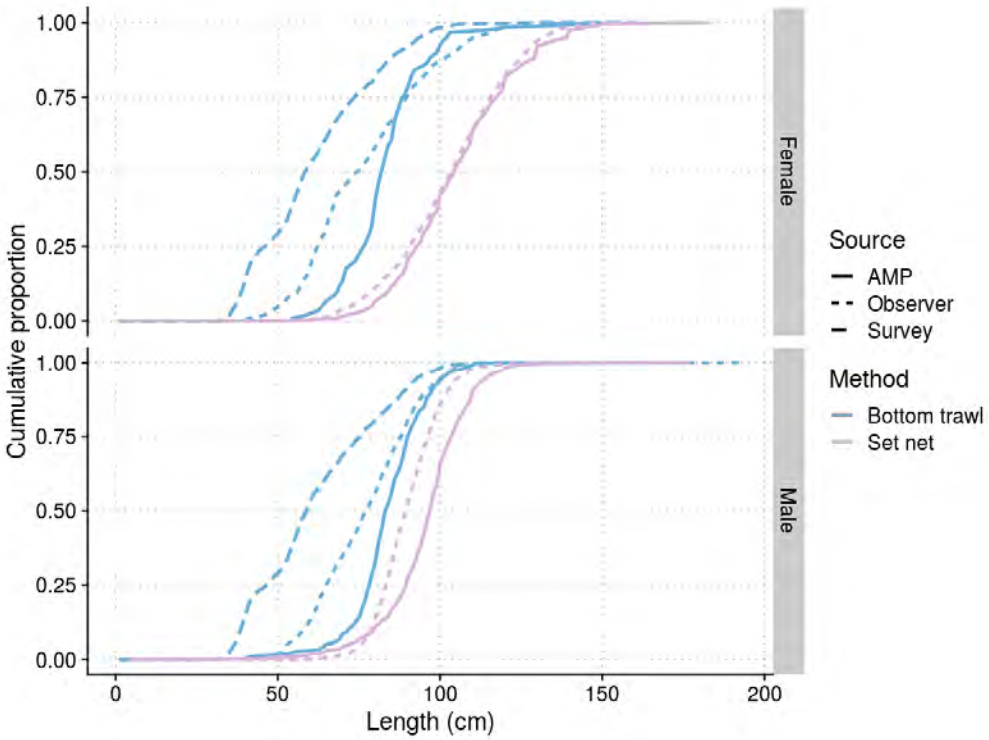


Figure 14: Empirical cumulative length frequencies for male and female rig from ECSI trawl surveys (2007, 2012, 2014, 2016, 2018, 2021; 10–400 m strata), observer sampling, and AMP data from Statistical Areas 018–024 and 026. The AMP data were collected in the 1995–2008 fishing years and the observer data in the 2008, 2010–2021 fishing years.

SPO 3 Foveaux Strait

The SPO 3 BT Foveaux St (trip) series showed a slow increasing trend from 1989–90 to 2013–14, after which the trend accelerated, doubling the relative CPUE between 2015 and 2021 (Figure 15). The SPO 3 SN Foveaux St (daily) series showed a slowly increasing trend over the same period (Figure 15). This difference in trends may be due to the different nature of the fisheries, with the set net fishery being primarily composed of the bycatch of rig when targeting school shark whereas the bottom trawl fishery is a mix of target flatfish and target stargazer fishing. It is likely that the set net fishery is capturing mature rig while the bottom trawl fishery will be taking immature and sub-adult rig.

By combining length distributions across years to overcome small sample sizes, Figure 16 shows there were substantial differences in the mean length frequency (LF) distributions between the SPO 3 BT Foveaux Strait fishery and the SPO 3 SN Foveaux Strait fishery, with the set net LF distributions lying to the right of the bottom trawl LF distributions. There is also a suggestion that the female LF distributions lie to the right of the equivalent male LF distributions for AMP SN and BT as well as the observer BT distributions.

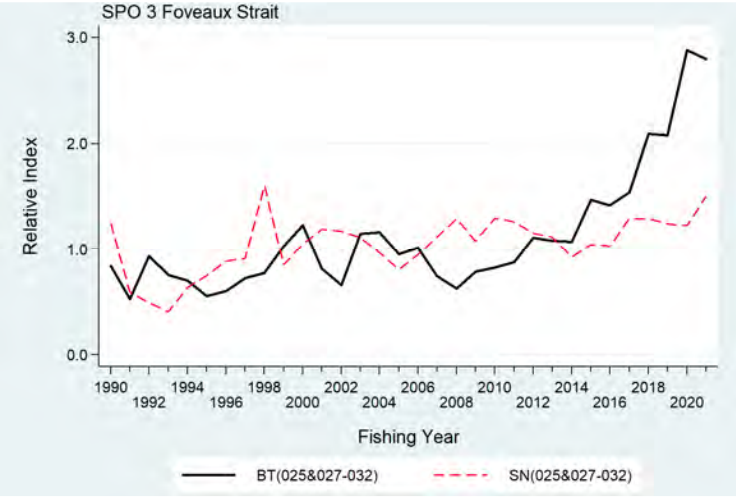


Figure 15: Comparison of two SPO 3 Foveaux Strait (Statistical Areas 025, 027, 028, 029. 030, 031, and 032) standardised CPUE series: a) bottom trawl fishery (mix of targets in SPO 3 east coast statistical areas) [BT(025&027–032)]; b) shark target set net fishery [SN(025&027–032)].

Establishing B_{MSY} compatible reference points

In 2022, the Inshore Working Group adopted the geometric mean CPUE from the SN(025&027–032) series for the period 2002–2012 as the target reference point for SPO 3 Foveaux Strait. This was a period with stable CPUE indices and relatively stable catch. The INSWG agreed that during this period the stock was likely to be between the 40% B_0 target and the 20% B_0 soft limit, leading to the conclusion that the average CPUE in this period nominally represented 30% B_0. Incorporating this biomass definition into the default Harvest Strategy Standard results in a 40% B_0 target that is 4/3 times (1.333) the defined reference period level, and two-thirds and one-third of the reference period level for the Soft (20% B_0) and Hard (10% B_0) Limits, respectively.

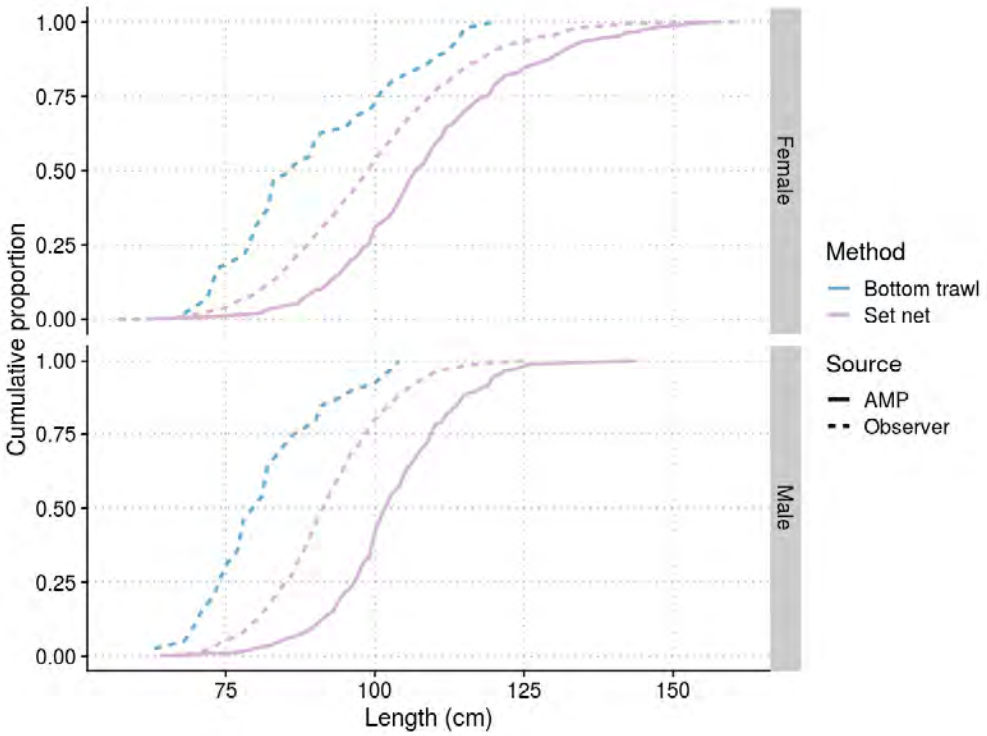


Figure 16: Empirical cumulative length frequencies for male and female rig from observer sampling and AMP data from Statistical Areas 025 and 027–031. The AMP data were collected in the 1996, 1997, 1999–2001, 2004 fishing years and the observer data in the 2008, 2010, 2012, 2015–2021 fishing years.

SPO 7

CPUE analyses standardising set net 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) set net 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, red gurnard, snapper, blue warehou, and trevally [BT(ALL)]. An analysis of the set net fishery in Statistical Areas 032–037 was rejected by the SINSWG in 2016 (after being accepted in the 2006–2013 analyses) because of lack of sufficient data to create a reliable index. This lack was attributed to the movement of ACE to other SPO 7 fisheries and the management regulations imposed to protect Hector's dolphins. Examination of the distribution of set net effort off 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, with less than 2% of the set net fishery catches originating from statistical areas other than Statistical Area 038 during 2015–16 to 2017–18. In 2016, an alternative set net fishery analysis was trialled (SN[STB]), 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 Statistical Area 037 on the line separating Statistical Areas 037 and 038 (between D'Urville Island and Farewell Spit) which may belong more logically to the Statistical Area 038 analysis. However, spatial data at this level of detail are not available before October 2007 from the earlier daily forms. The SN(STB) series was rejected by the 2016 Plenary (quality ranking of '3') on account of the impact the dolphin closures have had on this fishery.

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 2019 and 2022 reviews (Starr & Kendrick 2019, Starr et al in prep) repeated the BT(All) and SN(038) analyses. 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 was followed by an increasing trend to a peak in 2010–11, after which the series varied about the series mean up to 2018–19 when it trebled over the next two years (Figure 17). However, these increases are unreliable, given that only two vessels participated in this fishery in 2019–20, and just a single vessel in 2020–21. It is now likely this series will have to be abandoned from lack of supporting data.

The BT(ALL) series (with a quality ranking of '1') showed an increasing trend since the mid-2000s, with low points observed in both 2004–05 and 2006–07, but has since shown a generally increasing trend which, like the SPO 3 BT series, has accelerated in 2019–20 and 2020–21 to three and four times the long-term average index. The Plenary noted that the BT(All) index does not adequately sample large female rig. Event based (tow-by-tow) standardised analyses were undertaken in both 2019 and 2022 as diagnostics to test whether amalgamating the data to the level of a complete trip was introducing bias. These analyses determined that the series agreed well in the overlapping years.

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, and subsequently increased to a stable level from 2007 to 2013. It then increased sharply in 2015, with total biomass remaining high in the 2017 survey, but then dropping relative to the 2015 index in 2019 and even more in 2021 (Figure 7, Table 11). The 2021 WCSI survey rig biomass index contradicts the strong increase in CPUE observed in the BT(All) series.

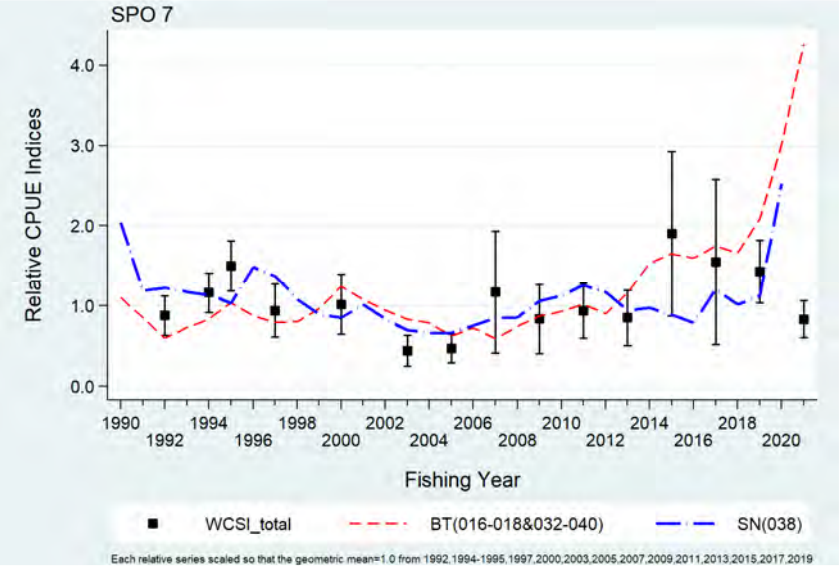


Figure 17: Comparison of two SPO 7 standardised CPUE series: a) bottom trawl fishery (mix of targets in all SPO 7) [BT(016-018&032-040)]; b) shark target set net fishery in Tasman Bay/Golden Bay [SN(038)]. Also shown are rig index values from the west coast South Island (WCSI) trawl survey: 1992–2021. The 2021 index value for the SN(038) analysis was dropped because it was based on a single vessel.

By combining length frequency (LF) distributions across years to overcome small sample sizes, Figure 18 shows there were substantial differences in the mean LF distributions between the WCSI trawl survey, the SPO 7 BT fishery, and the SPO 7 SN fishery, with the female set net LF distributions lying to the right of the bottom trawl LF distributions (AMP and observer) which are again to the right of the survey LF distributions. However, the male LF distributions from both the SN and BT fisheries are very similar while the survey distribution lies to the left of the commercial fishery LFs.

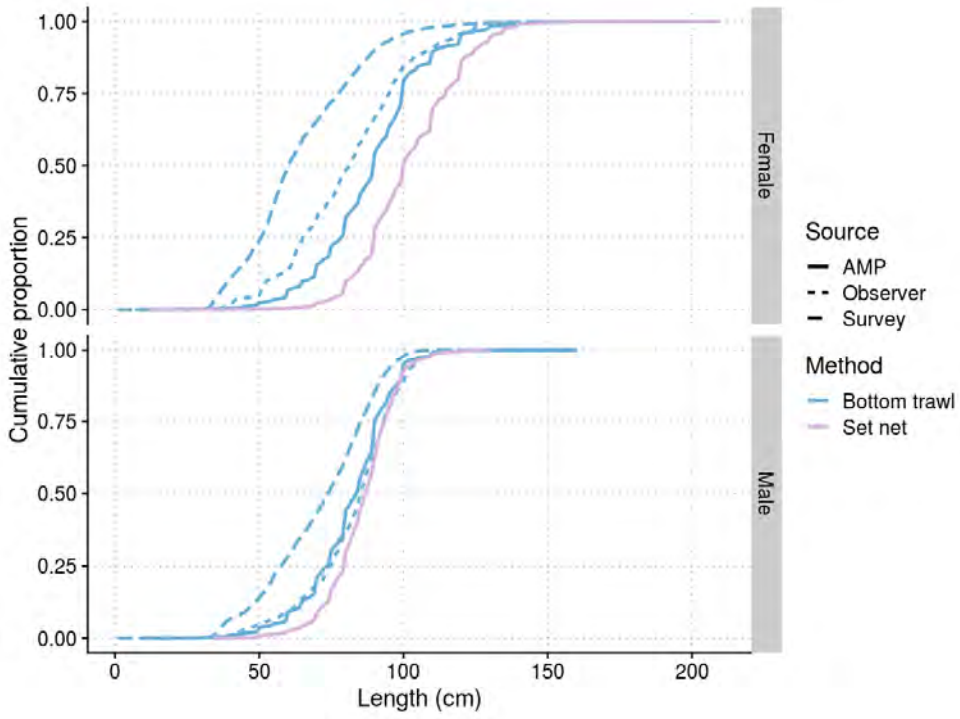


Figure 18: Empirical cumulative length frequencies for male and female rig from WCSI trawl surveys (1992, 1994, 1995, 1997, 2000, 2003, 2005, 2007, 2009, 2011, 2013, 2015, 2017, 2019, 2021), observer sampling and AMP data from Statistical Areas 032–-038. The AMP data were collected in the 1996, 1997, 2001–2012, and 2014 fishing years and the observer data in the 1995, 2005, 2010-2013, 2016, and 2017 fishing years.

Establishing B_{MSY} compatible reference points

The Inshore Working Group agreed to use the two lowest survey biomass values (2003 and 2005: see Table 11) 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 from a set net 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 tarakihi, snapper, and red gurnard. Recent average set net landings in SPO 8 have been between 150 and 200 t per year, whereas bottom trawl landings average between 10 and 30 t per 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 previously completed for SPO 8 have been discontinued by agreement of 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 Statistical Area 041 set net and bottom trawl catches indicated that rig catches in this area merge seamlessly with the equivalent catches in Statistical Area 042, immediately to the north of Statistical Area 041. As a result, it was decided that Statistical Area 041 should be amalgamated with the SPO 1W coastal bottom fishery, 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, but this analysis was not accepted by the 2016 Plenary because of the disappearance of the set net fishery in all statistical areas other than Statistical Area 038 (Tasman Bay/Golden Bay).

4.3 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. This means that biological stock boundaries do not necessarily coincide with QMA boundaries. Consequently, management by quota within Fishstocks may be sub-optimal for individual stocks.

The use of small mesh commercials set nets (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. Although researchers correct catches for these changes when undertaking CPUE analyses, this has not been done for total landings reported in this Plenary chapter. These changes reduce the relative effect of catches in recent years compared with early years, e.g., if actual catch had been constant it would appear to be declining.

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).

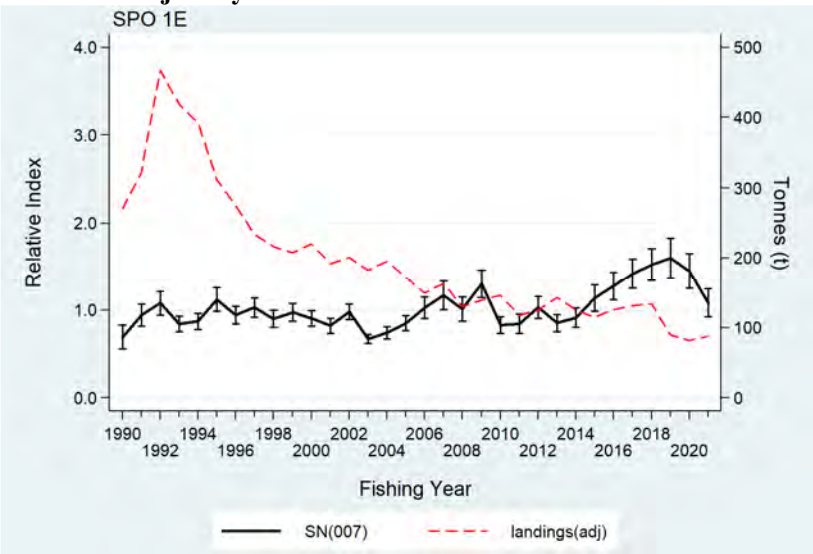
- **SPO 1 & SPO 8N**

Stock Structure Assumption

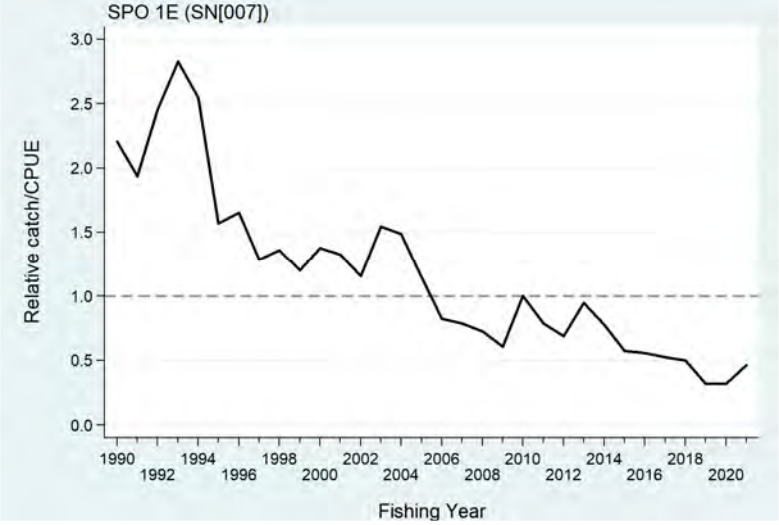
For the purposes of this summary SPO 1E is defined as the sum of Statistical Areas 002 to 010 and is treated as a discrete stock. SPO 1W is defined as the sum of Statistical Areas 041 to 048 and is treated as a discrete stock. Note that part of Statistical Area 041 is also in SPO 8. It is not known if the rig stocks on the west and east coasts of the North Island are separate.

Stock Status	
Year of Most Recent Assessment	2022
Assessment Runs Presented	Standardised CPUE indices: SPO 1E: SN(007) SPO 1W: BT(041-047), 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: Unlikely to be overfishing 1W: Unlikely to be overfishing

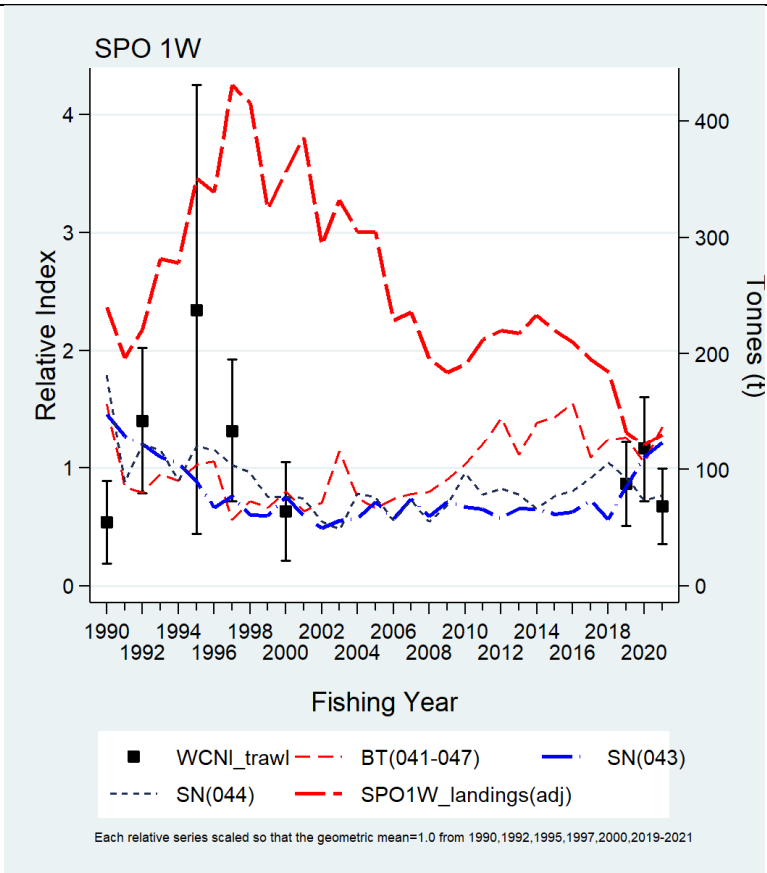
Historical Stock Status Trajectory and Current Status



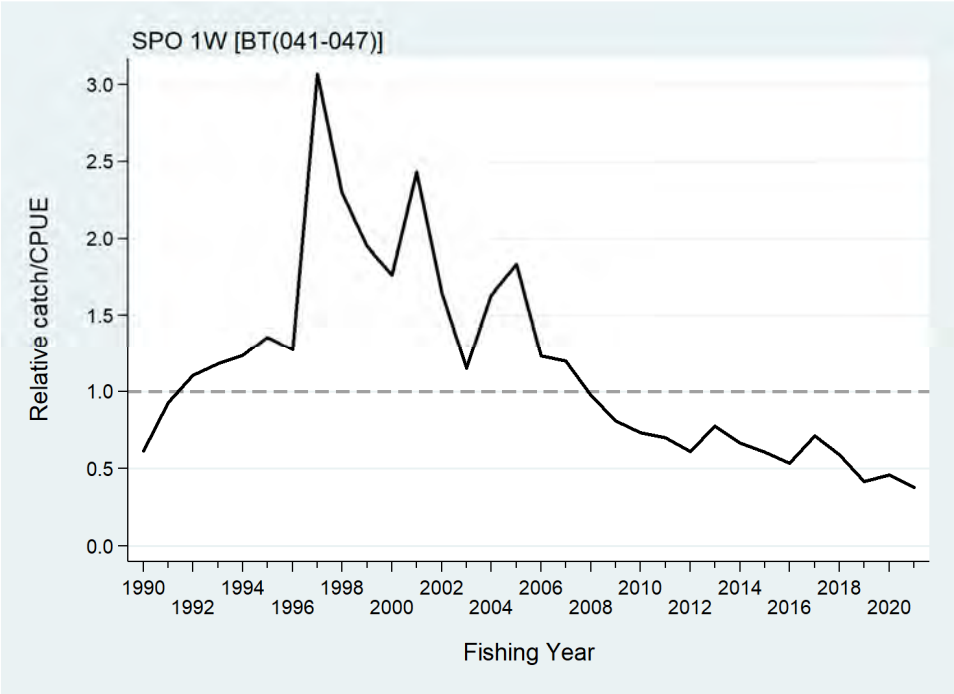
Accepted CPUE indices for SN(007) with the adjusted QMR/MHR landings for SPO 1E. Adjustments were made to ensure that all catch values in every year are based on a common conversion factor. Error bars are ±2 standard errors.



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(041-047)] with the adjusted QMR/MHR landings for SPO 1W. Index values for 8 comparable WCNI trawl survey indices (10-100 m core) are also shown. Adjustments were made to ensure that all catch 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 the BT(041-047) CPUE series.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	- 1E: Adult biomass (as indexed by the set net fishery in Statistical Area 007) showed a relatively strong upturn from 2013 to 2019 followed by a decline in 2020 and 2021 but remains near the long-term series average. - 1W: The coastal BT series has been relatively stable from 2012 to 2021 but is above the long-term average index in 2021; both the SN(043 Manukau Harbour) series and the SN(044 Kaipara Harbour) series have been stable from the early 2000s to 2018, whereafter the Manukau series has shown an increase while the Kaipara has remained stable. Both set net series are near their long-term average in 2021.
Recent Trend in Fishing Intensity or Proxy	- 1E: Fishing intensity (as indexed by the set net fishery in Statistical Area 007) appears to have been declining since the mid-1990s and is well below the long-term average. - 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 and is now well below the long-term average.
Other Abundance Indices	- WCNI trawl survey (re-stratified) is reasonably consistent with all three WCNI CPUE series.
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	Unlikely (< 40%) for current catch (1E and 1W)

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Fishery characterisation and standardised CPUE analysis	
Assessment Dates	Latest assessment: 2022	Next assessment: 2025
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 Statistical Area 007 (Firth of Thames)	2 – Medium or Mixed Quality: series only indexes a small proportion of area 1E
	- 1W: Bottom trawl CPUE series: mixed target species (Statistical Areas 042, 045–048)	1 – High Quality
	- Set net CPUE series: target shark in Statistical Area 043 (Manukau Harbour)	2 – Medium or Mixed Quality: series only indexes a small proportion of area 1W

	- Set net CPUE series: target shark in Area 044 (Kaipara Harbour)	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) - Set net CPUE series: target shark (Areas 002–006 and 008–010) - 1W: Set net 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 a significant impact
Changes to Model Structure and Assumptions	-	
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 - SPO1W BT CPUE series does not index large mature females	

Qualifying Comments
-

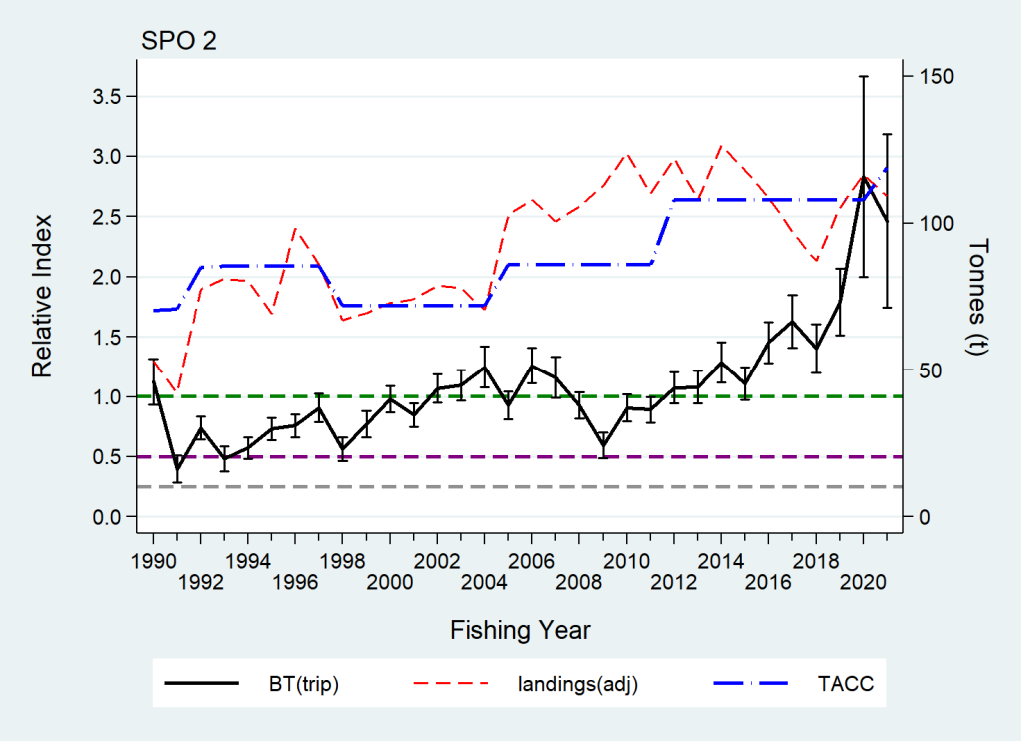
Fishery Interactions
Rig are taken as a bycatch in bottom trawl fisheries targeting mainly snapper, tarakihi, red gurnard, John dory, barracouta, and trevally (SPO 1E) while the set net fisheries almost exclusively target rig in both SPO 1E and SPO 1W.

- **SPO 2**

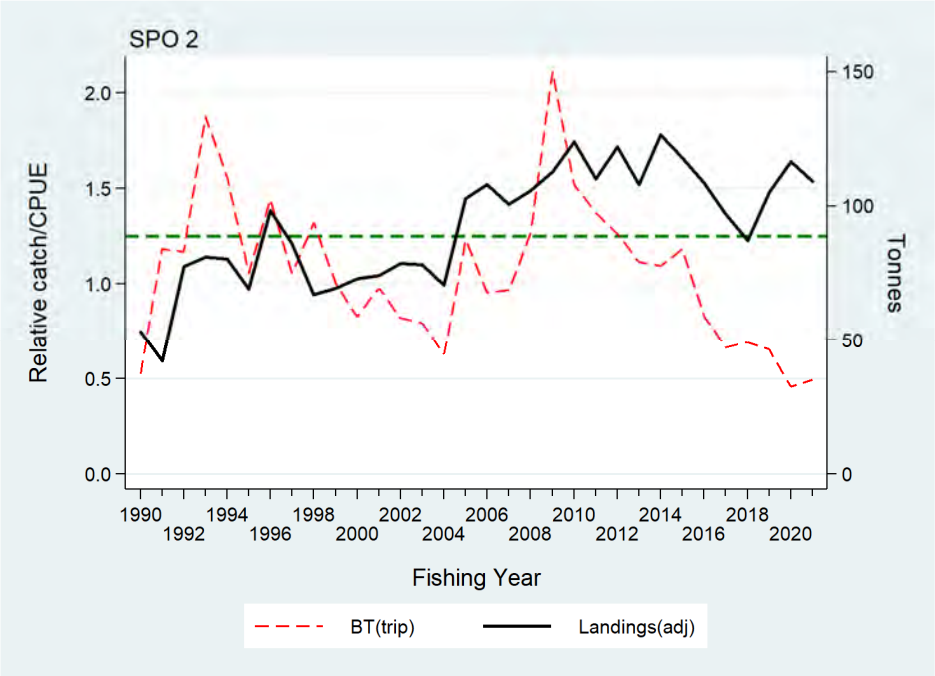
Stock Structure Assumption
For the purposes of this summary SPO 2 is defined as the sum of Statistical Areas 011 to 015 and is treated as a discrete stock.

Stock Status	
Year of Most Recent Assessment	2022
Assessment Runs Presented	Standardised CPUE: BT(stat area)
Reference Points	Target: Proxy for B_{MSY} based on the geometric mean 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 geometric mean fishing intensity over the period 2005–2015
Status in relation to Target	Very Likely (> 90%) 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 Unlikely (< 40%) to be occurring

Historical Stock Status Trajectory and Current Status



Comparison of the accepted CPUE index[BT(trip)] with the adjusted QMR/MHR landings and TACC for SPO 2. Adjustments were made to ensure that all catch values in every year are based on a common conversion factor. The agreed B_{MSY} proxy (geometric 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. Error bars are ±2 standard errors.



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

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Biomass has increased strongly since 2009, with some interannual variability. Biomass in 2021 was 2.5 times the B_{MSY} proxy target.

Recent Trend in Fishing Intensity or Proxy	Relative fishing intensity has been steadily decreasing from a peak in 2009 and was well below the threshold in 2021.
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
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Current catches are Very Unlikely (< 10%) to cause the stock to decline below the soft or hard limits
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unlikely (< 40%) for both

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Fishery characterisation and standardised CPUE analysis	
Assessment Dates	Latest assessment: 2022	Next assessment: 2025
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Bottom trawl standardised CPUE series: trip-based analysis	1 – High Quality
Data not used (rank)	- Set net standardised CPUE analysis	3 – Low Quality: This series was not updated in 2016 (not ranked in 2011) because there were 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 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(trip) CPUE series does not adequately sample large mature fish in the rig population; the Working Group agreed that the set net 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 flatfish, tarakihi, and red gurnard while the set net fisheries target rig, school shark, flatfish, blue warehou, and blue moki.

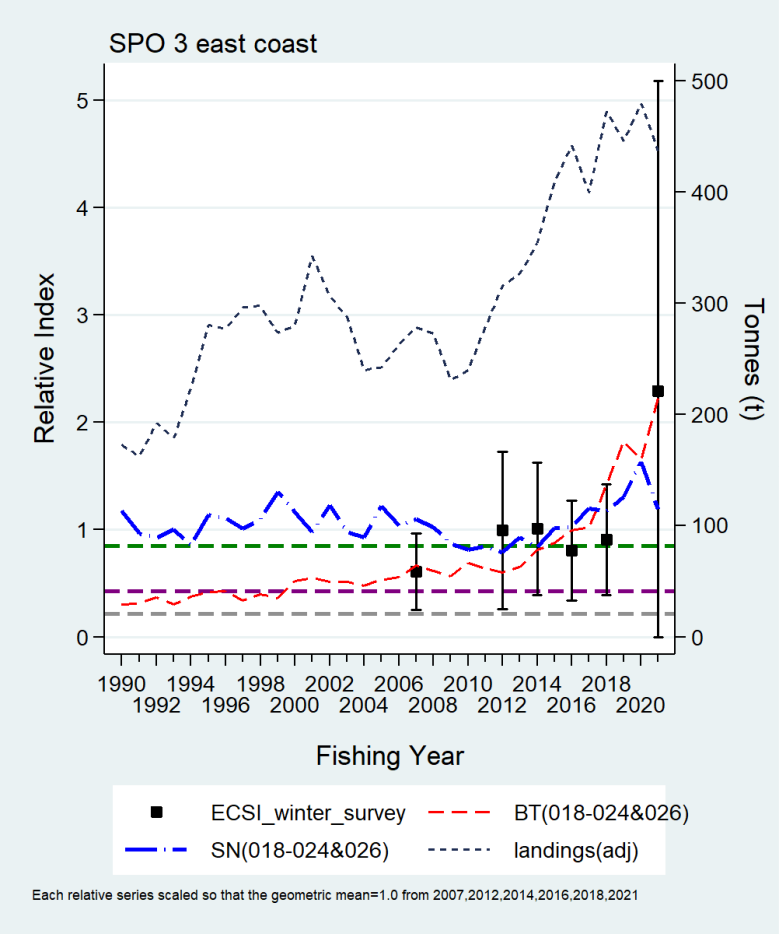
- **SPO 3 east coast**

Stock Structure Assumption

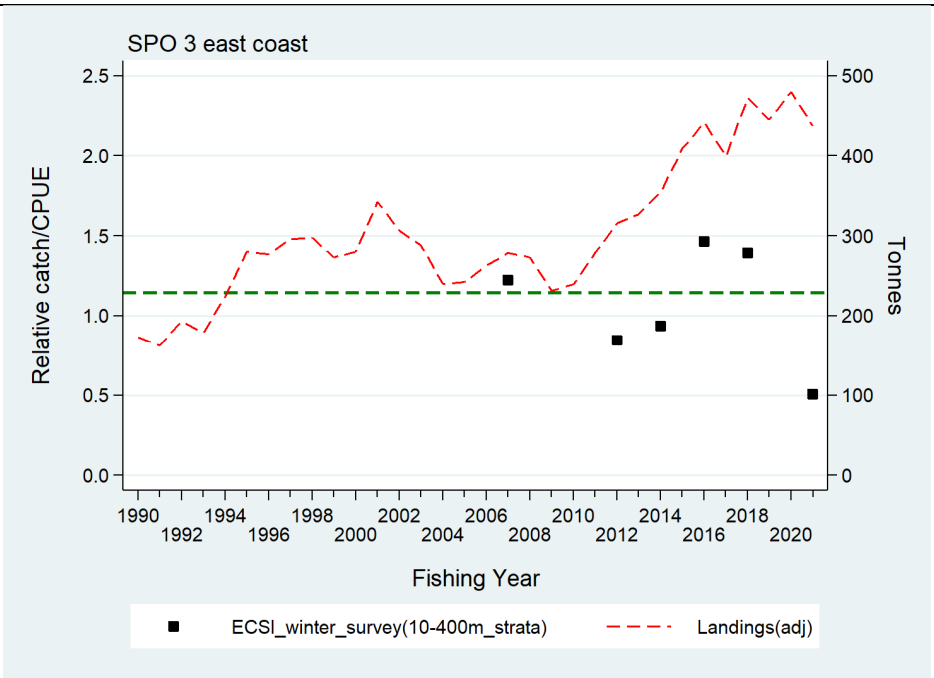
For the purposes of this summary, SPO 3 east coast is defined as the sum of Statistical Areas 018 to 024, 026, plus Statistical Areas 049 to 052 and is treated as a discrete stock.

Stock Status	
Year of Most Recent Assessment	2022
Assessment Runs Presented	ECSI trawl survey and two standardised CPUE indices: SN(east coast) and BT(east coast)
Reference Points	Target: Proxy for B_{MSY} based on geometric average ECSI trawl survey (all strata) indices for the period 2007–2018 Soft Limit: Half the B_{MSY} proxy Hard Limit: 25% of the B_{MSY} proxy Overfishing threshold: F_{MSY}; assumed to be the geometric average fishing intensity for the 2007–2018 survey indices
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: 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 (all strata) with two accepted east coast CPUE indices [BT(018-024&026) and SN(018-024&026)] and with the adjusted QMR/MHR landings for SPO 3. Adjustments were made to ensure that all catch values in every year are based on a common conversion factor. The B_{MSY} proxy (geometric average: 2007, 2012, 2014, 2016, 2018 ECSI total 10-400 m survey biomass estimates) is shown as a green line, and the calculated Soft Limit (= 0.5 x B_{MSY} proxy) is shown as a purple line and the calculated Hard Limit (= 0.25 x B_{MSY} proxy) is shown as a grey line.



Relative fishing pressure for east coast SPO 3 based on the ratio of QMR/MHR (adj) landings (areas 018–024,026) relative to the ECSI trawl survey which has been normalised so that its geometric mean=1.0. Indicated threshold is the geometric mean of the 2007, 2012, 2014, 2016, 2018 fishing pressure estimates.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Core strata biomass estimates from survey years 2012 to 2016 of the ECSI winter trawl survey series suggest that biomass has increased relative to the 1990s. Biomass in 2021 showed a very strong increase which must be considered unreliable, given the large associated CV (63%). However, this large increase, coupled with the increasing BT CPUE trend, likely indicates that current biomass has increased from 2017 to 2021.
Recent Trend in Fishing Intensity or Proxy	Fishing intensity has fluctuated around the overfishing threshold, and has possibly dropped in 2021.
Other Abundance Indices	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 increased more slowly up to 2020, followed by a 28% drop between 2020 and 2021.
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	It is not known if the stock will continue to increase at current catch levels
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.
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: 2022	Next assessment: 2025
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- East coast South Island winter trawl survey	1 – High quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	- Split SPO 3 into SPO 3 east coast and SPO 3 Foveaux St	
Major Sources of Uncertainty	- The increasing trend in the trawl survey (core strata) and bottom trawl CPUE since 1990 are not well corroborated by the set net CPUE series, which has increased more slowly. - Lack of historical information relating to stock abundance during the 1970s–1980s when the stock was believed to have been heavily fished means that stock status relative to early levels of abundance 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 set net CPUE series is likely to be affected by the management measures introduced to protect Hector's dolphins and a consequent attenuation of the fleet.

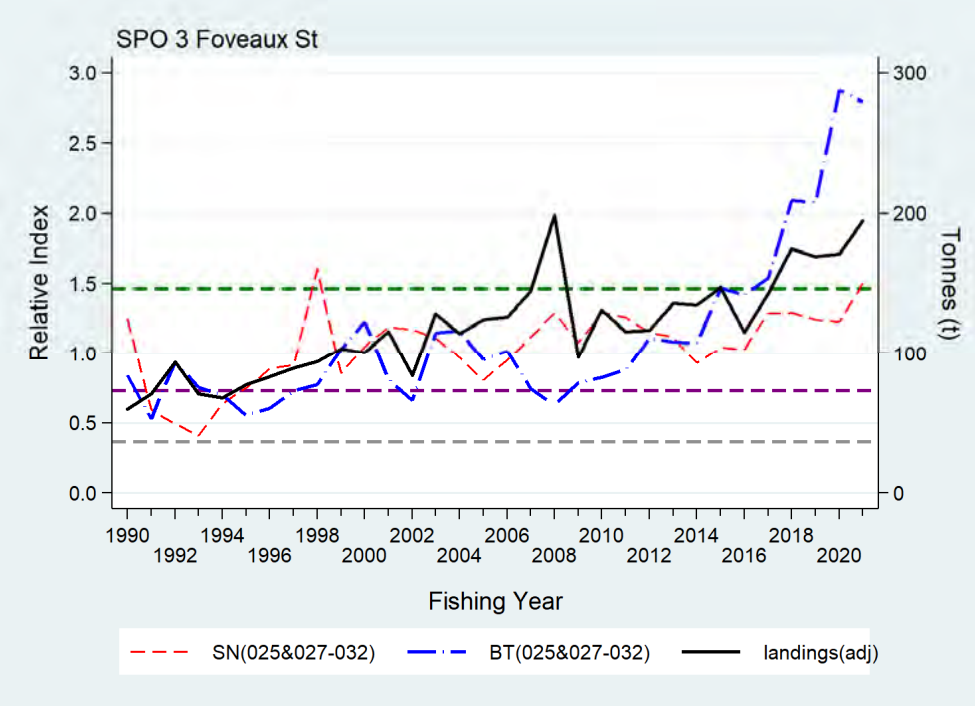
Fishery Interactions
A 4 nautical mile set net closure has been in place since October 2008 for the entire area to reduce the bycatch of Hector's dolphins. Rig are largely targeted by set net but they are also caught as bycatch in target fisheries for school shark, flatfish, red cod, spiny dogfish, and elephantfish in set net, bottom trawl, and bottom longline fisheries.

- **SPO 3 Foveaux Strait**

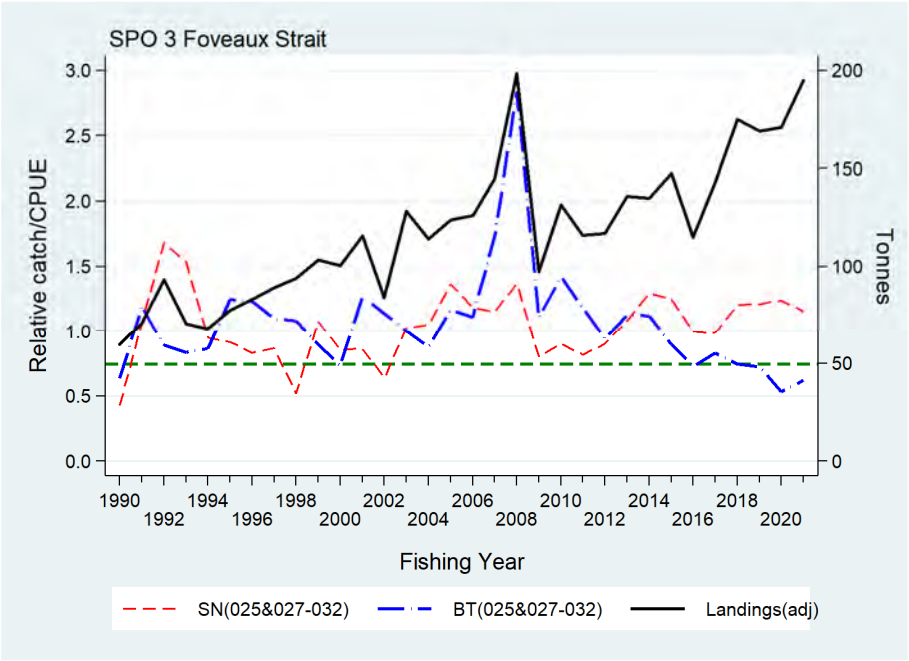
Stock Structure Assumption
For the purposes of this summary, SPO 3 Foveaux Strait is defined as the sum of Statistical Areas 025, 027–031 and is treated as a discrete stock.

Stock Status	
Year of Most Recent Assessment	2022
Assessment Runs Presented	Standardised SN CPUE (025,027–032) index series
Reference Points	A 30% B_0 proxy was based on the geometric mean SN(025,027–032) indices for the period 2002–2012 and then scaled up or down for the targets and limits Target (40% B_0): 1.333 x 30% B_0 proxy Soft Limit (20% B_0): 0.667 x 30% B_0 proxy Hard Limit (10% B_0): 0.333 x 30% B_0 proxy Overfishing threshold: F_{MSY}; assumed to be the geometric mean fishing intensity for the 2002–2012 SN (025,027–032) indices divided by 1.333
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%) Hard Limit: Very Unlikely (< 10%)
Status in relation to Overfishing	Overfishing is Likely (> 60%) to be occurring

Historical Stock Status Trajectory and Current Status



Comparison of two accepted Foveaux Strait CPUE indices [BT(025&027–032) and SN(025&027–032)] with the adjusted QMR/MHR landings for SPO 3 Foveaux St. Adjustments were made to ensure that all catch values in every year are based on a common conversion factor. The agreed B_{MSY} proxy of 1.33 x 30% B_0 proxy [=geometric average from 2002 to 2012 for the SN(025&027–032 series) is shown as a green line, and the calculated Soft Limit (= 0.67 x 30% B_0 proxy) is shown as a purple line and the calculated Hard Limit (=0.33 x 30% B_0 proxy) is shown as a grey line.



Relative fishing pressure for Foveaux Strait SPO 3 based on the ratio of QMR/MHR (adj) landings (sum of areas 025&027–032) relative to the SN(025&027–032) and BT(025&027–032) CPUE series which have been normalised so that the geometric mean=1.0. The indicated threshold (green dashed line) is geometric average fishing pressure from 2002 to 2012 for the SN(025&027–032) series divided by 1.333.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	The SN CPUE series has increased gradually, rising 20% between 2015 and 2020 and another 20% between 2020 and 2021. The BT CPUE series has been increasing since 2008, nearly doubling between 2015 and 2021.
Recent Trend in Fishing Intensity or Proxy	Fishing intensity has fluctuated above the overfishing threshold.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	Catches and CPUE have increased since the late 2000s. It is not known if the stock will continue to increase at current catch levels.
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.
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Likely (> 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: 2022	Next assessment: 2025
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Bottom trawl CPUE series: mixed target species - Set net CPUE series: target shark	1 – High Quality 1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	- Split SPO 3 into SPO 3 east coast and SPO 3 Foveaux St	
Major Sources of Uncertainty	- The greater than threefold increase in the bottom trawl CPUE since the late 2000s is not matched by the set net CPUE series, which has only increased about 80% since 2005. - Lack of historical information relating to stock abundance during the 1970s–1980s when the stock was believed to have been heavily fished means that stock status relative to early levels of abundance is difficult to determine. - Bottom trawl CPUE do not adequately sample large mature females.	

Qualifying Comments
-

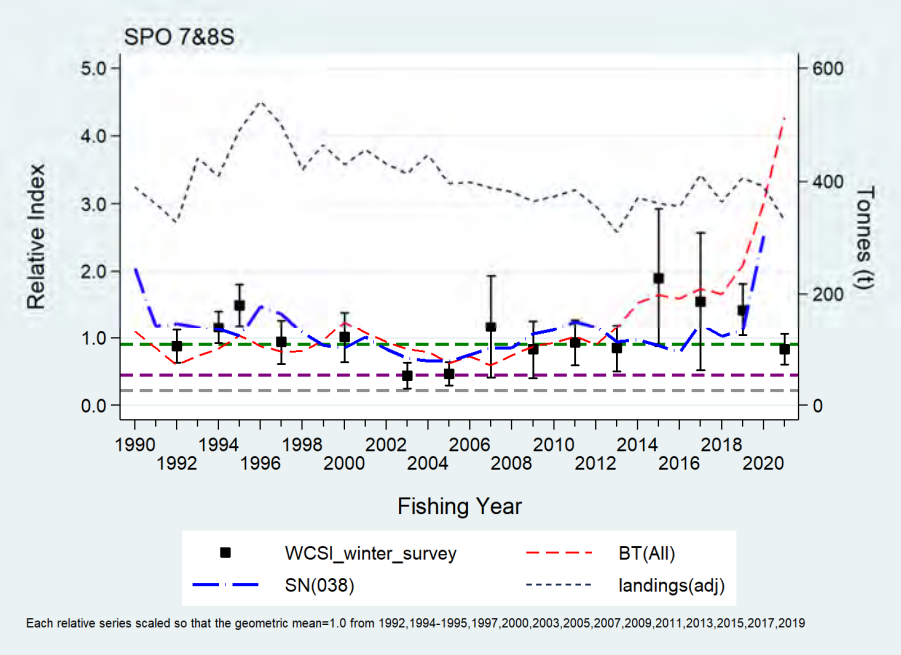
Fishery Interactions
A 4 nautical mile set net closure has been in place since October 2008 for the entire area to reduce the bycatch of Hector's dolphins. Rig are largely targeted by set net but they are also caught as bycatch in target fisheries for school shark, flatfish, red cod, spiny dogfish, and elephantfish in set net, bottom trawl, and bottom longline fisheries.

- **SPO 7 & SPO 8S**

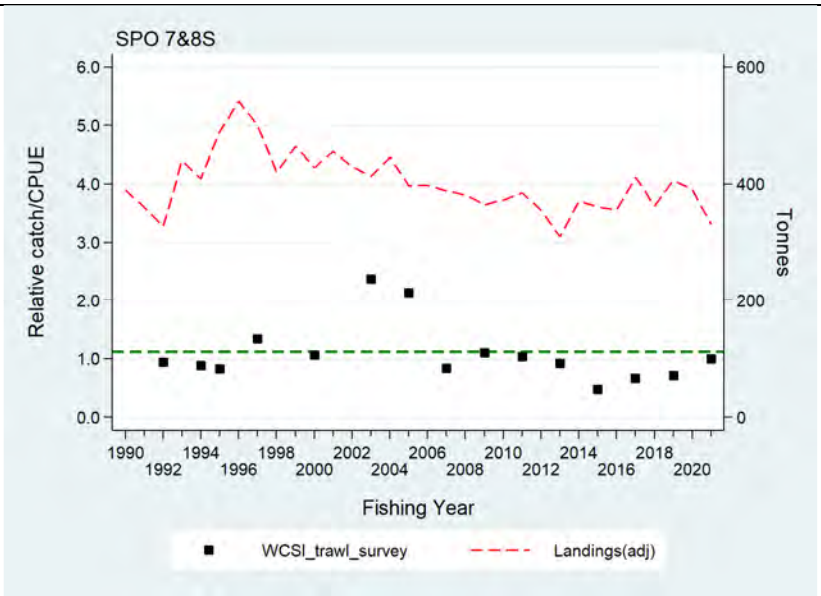
Stock Structure Assumption
For the purposes of this summary SPO 7 is defined as the sum of Statistical Areas 016, 017, 033 to 040 and is treated as a discrete stock. Note that Statistical Area 040 is shared with SPO 8.

Stock Status	
Year of Most Recent Assessment	2022
Assessment Runs Presented	WCSI trawl survey series and two standardised CPUE series: BT (All) and SN (038)
Reference Points	Target: Proxy for B_{MSY} based on twice the soft limit Soft Limit: Geometric 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 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 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 catch 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. The 2021 index value for the SN(038) analysis was dropped because it was based on a single vessel.



Relative fishing pressure for SPO 7 based on the ratio of QMR/MHR (adj) landings relative to the WCSI trawl survey which has been normalised so that its geometric mean=1.0. Target fishing pressure (1.10) is one-half of the fishing pressure associated with the low level of biomass observed in the 2003 and 2005 trawl survey indices.

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 and has since declined in three successive surveys.
Recent Trend in Fishing Intensity or Proxy	Relative fishing intensity has been declining since the early 2000s and has been increasing towards the overfishing threshold since 2015.
Other Abundance Indices	- The SPO 7_BT(All) CPUE series shows a strong increasing trend in recent years from a low point in 2004–05. The SPO 7 SN(038) series has also been recently increasing but is hampered by a lack of data.
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: Unlikely (< 40%) Hard Limit: Unlikely (< 40%)
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unlikely (< 40%)

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	WCSI trawl survey series and two standardised CPUE abundance indices	
Assessment Dates	Latest assessment: 2022	Next assessment: 2025
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	2016: - West Coast South Island trawl survey index	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	-	
Major Sources of Uncertainty	- The drop in the 2021 WCSI survey index is in conflict with the increasing trend seen in the BT and SN CPUE series. - There is a lack of historical information relating to stock abundance during the 1970s–1980s when the stock was believed to have been heavily fished means that stock status relative to early levels of abundance is difficult to determine. - WCSI trawl survey and bottom trawl CPUE do not adequately sample large mature females.	

Qualifying Comments
The Statistical Area 038 SN fishery had nearly disappeared in 2020 and 2021 and may no longer provide information for this QMA.

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 Bay and Golden Bay).

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