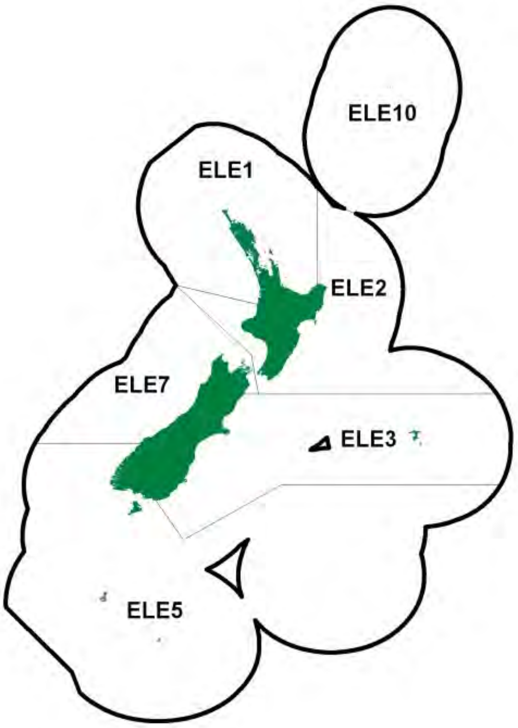
ELEPHANT FISH (ELE)

(*Callorhinchus milii*)
Reperepe



1. FISHERY SUMMARY

1.1 Commercial fisheries

From the mid-1950s to the 1980s, landings of elephant fish of around 1000 t/year were common. Most of these landings were from the area now encompassed by ELE 3, but fisheries for elephant fish also developed on the south and west coasts of the South Island in the late 1950s and early 1960s, with average catches of around 70 t per year in the south (in the 1960s to the early 1980s) and 10–30 t per year on the west coast. Total annual landings of elephant fish dropped considerably in the early 1980s (between 1982–83 and 1994–95 they ranged between 500 and 750 t) but later increased to the point that they have annually exceeded 1 000 t since the 1997–98 fishing season. Reported landings since 1931 are shown in Tables 1 and 2, while an historical record of landings and TACC values for the three main ELE stocks are depicted in Figure 1. ELE 3 has customary, recreational and other mortality allowances of 5 t, 5 t, and 50 t respectively, and ELE 5 has allowances 5 t, 5 t, and 7 t respectively.

Table 1: Reported total landings of elephant fish for calendar years 1936 to 1982. Sources: MAF and FSU data.

Year	Landings (t)	Year	Landings (t)	Year	Landings (t)	Year	Landings (t)	Year	Landings (t)
1936	116	1946	235	1956	980	1966	1 112	1976	705
1937	184	1947	188	1957	1 069	1967	934	1977	704
1938	201	1948	230	1958	1 238	1968	862	1978	596
1939	193	1949	310	1959	1 148	1969	934	1979	719
1940	259	1950	550	1960	1 163	1970	1 128	1980	906
1941	222	1951	602	1961	983	1971	1 401	1981	690
1942	171	1952	459	1962	1 156	1972	1 019	1982	661
1943	220	1953	530	1963	1 095	1973	957		
1944	270	1954	853	1964	1 235	1974	848		
1945	217	1955	802	1965	1 111	1975	602		

The TACC for ELE 3 has, with the exception of 2002–03 and 2018-19, been consistently exceeded since 1986–87. The ELE 3 TACC was increased to 500 t for the 1995–96 fishing year, and then increased twice more under an Adaptive Management Programme (AMP): initially to 825 t in October 2000 and then to 950 t in October 2002. This new TACC combined with the allowances for customary and recreational fisheries (5 t each), increased the new TAC for the 2002–03 fishing year in ELE 3 to 960 t. For the 2009– 10 fishing year, the TACC was increased from 960 t to 1 000 t. This was followed by a further increase to 1 150 t for the fishing year 2018-19. ELE 3 fishing is seasonal, mostly occurring in spring and summer in inshore waters. Most of the increase in catch from the early 2000s in the ELE 3 trawl fishery has been taken as a bycatch of the flatfish target fishery and an emerging target ELE fishery (Starr & Kendrick 2013). During the 1990s, the level of elephant fish bycatch from the RCO 3 trawl fishery increased from around 80 t/year to greater than 400 t in 2000–01 (Starr & Kendrick 2013). There was a steady increase in the level of ELE 3 bycatch from the FLA 3 trawl fishery, with catches increasing from around 70 t in 1994–95 to 300 t in 1999–00. There is also a significant setnet fishery in ELE 3, largely directed at rig and elephant fish.

The fishery in ELE 5 is mainly a trawl fishery targeted at flatfish and to a lesser extent giant stargazer. Very little catch in ELE 5 is taken by target setnet fisheries. Catches increased consistently from 1992–93 (39 t) to 2008-09 (208 t), before decreasing again. The TACCs were exceeded in most years from 1995–96 to 2011-12. The ELE 5 TACC was increased from 71 t to 100 t under an AMP in October 2001. The TACC was further increased under the AMP to 120 t in October 2004 and catches have exceeded this TACC by 70% in 2007–08 and 2008–09. For the 2009–10 fishing season, the TACC was increased by 17% up from 120 t to 140 t. All AMP programmes ended on 30 September 2009. The ELE 5 TACC was further increased to 170 t in 2012–13; landings have repeatedly remained below the TACC since, including in 2018-19 when just 104 t of elephant fish were landed.

From 1 October 2008, a suite of regulations intended to protect Maui's and Hector's dolphins was implemented for all of New Zealand by the Minister of Fisheries. For ELE 3, commercial and recreational set netting was banned in most areas to 4 nautical miles offshore of the east coast of the South Island, extending from Cape Jackson in the Marlborough Sounds to Slope Point in the Catlins. Some exceptions were allowed, including an exemption for commercial and recreational set netting to only one nautical mile offshore around the Kaikoura Canyon, and permitting setnetting in most harbours, estuaries, river mouths, lagoons and inlets except for the Avon-Heathcote Estuary, Lyttelton Harbour, Akaroa Harbour and Timaru Harbour. In addition, trawl gear within 2 nautical miles of shore was restricted to flatfish nets with defined low headline heights. For ELE 7, both commercial and recreational setnetting were banned to 2 nautical miles offshore, with the recreational closure effective for the entire year and the commercial closure restricted to the period 1 December to the end of February. The closed area extends from Awarua Point north of Fiordland to the tip of Cape Farewell at the top of the South Island. Some interim relief to these regulations was provided in ELE 5 from 1 October 2008 to 24 December 2009.

Table 2: Reported landings (t) for the main QMAs from 1931 to 1990. [Continued on next page]

Year	ELE 1	ELE 2	ELE 3	ELE 5	ELE 7
1931–32	0	0	0	0	0
1932–33	0	0	0	0	0
1933–34	0	0	0	0	0
1934–35	0	0	0	0	0
1935–36	0	0	0	0	0
1936–37	0	0	79	0	1
1937–38	0	0	183	0	0
1938–39	0	0	194	1	2
1939–40	0	1	190	1	1
1940–41	0	1	243	8	1
1941–42	0	0	220	1	0
1942–43	0	0	163	6	0
1943–44	0	0	219	1	0
1944	0	0	251	10	0
1945	0	2	205	3	3
1946	0	0	228	3	4
1947	0	2	176	0	10
1948	0	2	227	0	9
1949	0	1	296	2	13
1950	0	1	522	14	13
1951	0	2	585	6	10
1952	0	0	440	9	5
1953	0	3	514	13	3
1954	0	2	839	5	7
1955	0	3	771	4	25
1956	0	1	933	16	29
1957	0	2	992	28	46
1958	0	0	1 140	47	51
1959	0	0	1 066	37	44
1960	0	1	1 099	38	27
1961	0	0	913	43	27
1962	0	4	1 066	73	14

Table 2: [Continued]

Year	ELE 1	ELE 2	ELE 3	ELE 5	ELE 7
1963	0	2	976	111	8
1964	0	3	1 109	107	16
1965	0	7	983	88	34
1966	0	1	985	99	27
1967	0	1	812	77	45
1968	0	1	757	54	52
1969	0	1	824	75	33
1970	0	3	987	87	53
1971	0	0	1 243	103	37
1972	0	0	928	70	15
1973	0	0	864	73	21
1974	0	0	766	97	41
1975	0	1	557	55	28
1976	0	0	622	91	52
1977	0	0	601	114	45
1978	0	0	552	49	26
1979	0	0	661	63	18
1980	0	0	794	129	34
1981	0	1	543	114	16
1982	0	0	584	85	34

Notes:

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

Table 3: Reported landings (t) of elephant fish by Fishstock from 1983–84 to 2018–19 and actual TACCs (t) from 1986–87 to 2018–19. QMR data from 1986 – present. No landings have been reported from ELE 10.

Fishstock	ELE 1		ELE 2		ELE 3		ELE 5		ELE 7			
FMA (s)	1 & 9		2 & 8		3 & 4		5 & 6		7		Total	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1983–84*	< 1	-	5	-	605	-	94	-	60	-	765	-
1984–85*	< 1	-	3	-	517	-	134	-	50	-	704	-
1985–86*	< 1	-	4	-	574	-	57	-	46	-	681	-
1986–87	< 1	10	2	20	506	280	48	60	29	90	584	470
1987–88	< 1	10	3	20	499	280	64	60	44	90	610	470
1988–89	< 1	10	1	22	450	415	49	62	43	100	543	619
1989–90	< 1	10	3	22	422	418	32	62	55	101	510	623
1990–91	< 1	10	5	22	434	422	55	71	59	101	553	636
1991–92	< 1	10	11	22	450	422	58	71	78	101	597	636
1992–93	< 1	10	5	22	501	423	39	71	61	102	606	638
1993–94	< 1	10	6	22	475	424	46	71	41	102	568	639
1994–95	< 1	10	5	22	580	424	60	71	39	102	684	639
1995–96	< 1	10	7	22	688	500	72	71	93	102	862	715
1996–97	< 1	10	9	22	734	500	74	71	94	102	912	715
1997–98	< 1	10	12	22	910	500	95	71	66	102	1 082	715
1998–99	< 1	10	9	22	842	500	129	71	117	102	1 098	715
1999–00	< 1	10	6	22	950	500	105	71	87	102	1 148	715
2000–01	2	10	7	22	956	825	153	71	90	102	1 207	1 040
2001–02	< 1	10	9	22	852	825	105	100	88	102	1 053	1 057
2002–03	1	10	9	22	950	950	106	100	59	102	1 125	1 194
2003–04	< 1	10	10	22	984	950	102	100	42	102	1 139	1 194
2004–05	< 1	10	13	22	972	950	125	120	74	102	1 184	1 214
2005–06	< 1	10	14	22	1 023	950	147	120	76	102	1 260	1 214
2006–07	< 1	10	17	22	960	950	158	120	116	102	1 251	1 214
2007–08	< 1	10	16	22	1 092	950	202	120	125	102	1 435	1 214
2008–09	1	10	21	22	1 063	950	208	120	91	102	1 384	1 214
2009–10	< 1	10	21	22	1 089	1 000	176	140	86	102	1 372	1 274
2010–11	< 1	10	14	22	1 123	1 000	153	140	93	102	1 384	1 283
2011–12	< 1	10	16	22	1 074	1 000	157	140	130	102	1 377	1 283
2012–13	< 1	10	16	22	1 140	1 000	157	170	123	102	1 436	1 304
2013–14	< 1	10	16	22	1 110	1 000	173	170	96	102	1 394	1 304
2014–15	< 1	10	11	22	1 048	1 000	179	170	102	102	1 340	1 304
2015–16	< 1	10	9	22	1 159	1 000	137	170	95	102	1 400	1 304
2016–17	< 1	10	12	22	1 051	1 000	182	170	81	102	1 326	1 304
2017–18	< 1	10	8	22	1 098	1 000	126	170	113	102	1 346	1 304
2018–19	< 1	10	9	22	1 142	1 150	104	170	100	102	1 464	1 304

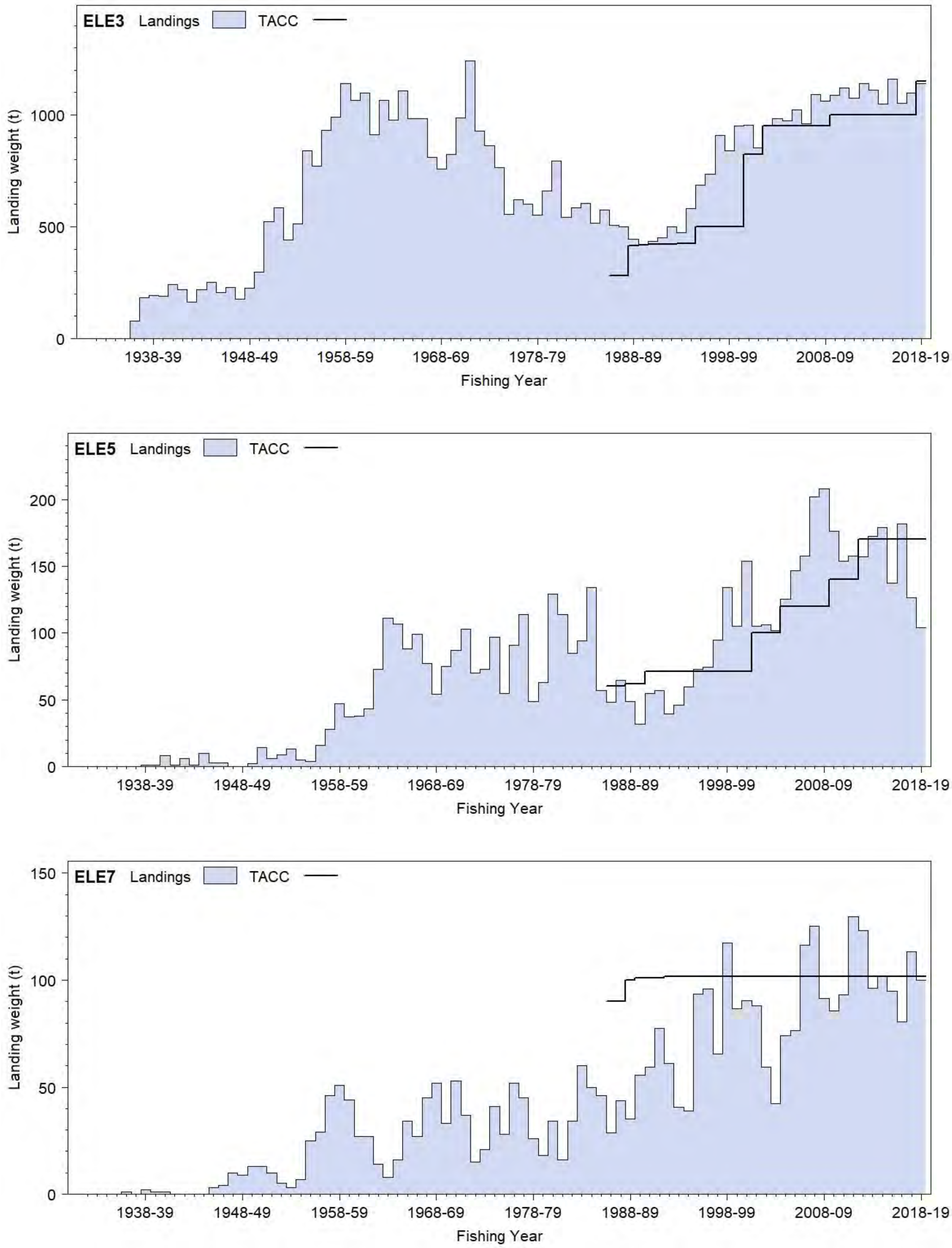


Figure 1: Reported commercial landings and TACC for the three main ELE stocks. From top: ELE 3 (South East Coast and Chatham Rise), ELE 5 (Southland and Sub-Antarctic), and ELE 7 (Challenger).

1.2 Recreational fisheries

Catches of elephant fish by recreational fishers are low compared with those of the commercial sector. Catches estimated using National Panel Surveys (NPS) in 2011–12 and 2017–18 (Wynne-Jones et al 2014, 2019) are shown in Table 4. Recreational catch exceeded 1000 fish only in ELE 3 in the two surveys and all estimates are quite uncertain. Regional surveys in the early 1990s (Teirney et al 1997) and national surveys in 1996, 1999, and 2000 (Bradford 1998, Boyd & Reilly 2002) showed similarly low number of fish harvested and similar geographical patterns. No estimates of mean weight are available to convert these estimates of harvested fish to harvested weights.

Table 4: Recreational harvest estimates for elephantfish stocks (Wynne-Jones et al 2014, 2019). In sufficient data on mean fish weights are available from boat ramp surveys to convert numbers to catch weights.

Stock	Year	Method	Number of fish	Total weight (t)	CV
ELE 2	2011/12	Panel survey	183	-	-
	2017/18	Panel survey	339	-	0.72
ELE 3	2011/12	Panel survey	4 853	-	-
	2017/18	Panel survey	2 458	-	0.36
ELE 5	2011/12	Panel survey	202	-	-
	2017/18	Panel survey	60	-	1.00
ELE 7	2011/12	Panel survey	960	-	-
	2017/18	Panel survey	189	-	0.39

1.3 Customary non-commercial fisheries
Quantitative information on the current level of customary non-commercial catch is not available.

1.4 Illegal catch
There are reports of discards of juvenile elephant fish by trawlers from some areas. However, no quantitative estimates of discards are available.

1.5 Other sources of mortality
The significance of other sources of mortality has not been documented.

2. BIOLOGY

Elephant fish are uncommon off the North Island and occur south of East Cape on the east coast and south of Kaipara on the west coast. They are most plentiful around the east coast of the South Island.

Males mature at a length of 50 cm fork length (FL) at an age of 3 years, females at 70 cm FL at 4 to 5 years of age. The maximum age of elephant fish is unknown. However a tagged, 73 cm total length, Australian male was at liberty for 16 years, suggesting a longevity for males of at least 20 years (Coutin 1992, Francis 1997). Females probably also live to at least 20 years. A longevity of 20 years suggests that M is about 0.23. This results from use of the equation $M = \log_e 100/\text{maximum age}$, where maximum age is the age to which 1% of the population survives in an unexploited stock.

Mature elephant fish migrate to shallow inshore waters in spring and aggregate for mating. Eggs are laid on sand or mud bottoms, often in very shallow areas. They are laid in pairs in large yellow-brown egg cases. The period of incubation is at least 5–8 months, and juveniles hatch at a length of about 10 cm FL. Females are known to spawn multiple times per season. After egg laying the adults are thought to disperse and are difficult to catch; however, juveniles remain in shallow waters for up to 3 years. During this time juveniles are vulnerable to incidental trawl capture, but are of little commercial value.

Von Bertalanffy growth curves based on MULTIFAN analysis of length-frequency data are available for Pegasus Bay and Canterbury Bight in 1966–68 and 1983–88. However, the ages of the larger fish were probably underestimated and the growth curves are only reliable to about 4–5 years (Francis 1997). New empirical growth curves were developed by fitting a Von Bertalanffy growth function to a dataset consisting of (a) the first six length-frequency modes from the study by Francis (1997) and (b) an approximate maximum size and age for male and female elephant fish. The latter points ‘anchor’ the curves at the right hand ends and generate more plausible curve shapes, L_∞ estimates, and therefore length-at-age. The largest measured fish in the ELE 3 samples from 1966–68 and 1983–88 (i.e. 76 cm FL for males and 97 cm FL for females) were considered to be reasonable estimates of the mean maximum lengths of elephant fish in an unfished population. The following data points were therefore used in fitting the growth curves: 76 cm and 20 years for males, and 97 cm and 20 years for females. The best fitting growth model had separate male and female coefficients for K and L_∞ and a common coefficient for t_0 (M. Francis, unpubl. data).

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

Table 5: Estimates of biological parameters for elephant fish.

Fishstock	Estimate						Source
1. Natural mortality (*M*)							
All	0.23						See text
2. Weight = a (length)^b (Weight in g, length in cm fork length)							
	Both sexes						
	a	b					
ELE 3	0.0091	3.02					Gorman (1963)
3. von Bertalanffy Growth Function							
	Females			Males			
	$L\infty$	*k*	*t0*	$L\infty$	*k*	*t0*	
ELE 3	97.88	0.26	-0.55	75.03	0.34	-0.55	See text

3. STOCKS AND AREAS

There are no data that would alter the current stock boundaries. Results from tagging studies conducted during 1966–69 indicate that elephant fish tagged in the Canterbury Bight remained in ELE 3. Separate spawning grounds to maintain each ‘stock’ have not been identified. The boundaries used are related to the historical fishing pattern when this was a target fishery.

4. STOCK ASSESSMENT

4.1 Estimates of fishery parameters and abundance

4.1.1 Trawl survey biomass indices

ECSI Trawl Survey

The ECSI winter surveys from 1991 to 1996 in 30–400 m were replaced by summer trawl surveys (1996–97 to 2000–01) which also included the 10–30 m depth range, but these were discontinued after the fifth in the annual time series because of the extreme fluctuations in catchability between surveys (Francis et al 2001). The winter surveys were reinstated in 2007 and this time included additional 10–30 m strata in an attempt to index elephant fish and red gurnard which were officially included in the target species in 2012. Only the 2007, 2012, 2014, 2016, and 2018 surveys provide full coverage of the 10–30 m depth range (Figure 2).

Total biomass in the core strata increased markedly in 1996 and although it has fluctuated since then it has remained high with the post-1994 average (including 2014, but not 2016) about three-fold greater than that of the early 1990s (Figure 2). The 2016 biomass was more than six-fold greater than this average, but the CV around the estimate was 68%, very high compared to previous surveys. The 2018 core strata estimate of 807 t is similar to the post-1994 average. In the core plus shallow strata, biomass followed the same trend as the core strata biomass. The additional elephant fish biomass captured in the 10–30 m depth range accounted for 44%, 64%, 41%, 7% and 28% of the biomass in the core plus shallow strata (10–400 m) for 2007, 2012, 2014, 2016 and 2018 respectively, indicating the importance of shallow strata for elephant fish biomass (Table 6, Figure 2). Further, the addition of the 10–30 m depth range had a significant effect on the shape of the length frequency distributions with the appearance of strong 1+ and 2+ cohorts, otherwise poorly represented in the core strata, particularly in 2007 and 2012. The proportion of pre-recruit biomass in the core plus shallow strata was also generally greater than that of the core strata alone, indicating that younger fish are more common in shallow water (Table 6). For the five core plus shallow strata surveys, the juvenile biomass (based on the length-at-50% maturity) varied from about one third to three quarters of the total biomass in the first three surveys, to 9% in 2016, and back up to 47% in 2018. . The distribution of elephant fish hot spots varies, but overall this species is consistently well represented over the entire survey area from 10 to 100 m, but is most abundant in the shallow 10 to 30 m.

WCSI Trawl Survey

For WCSI Trawl Surveys, elephant fish (ELE 7) total biomass estimates are variable between successive surveys and the biomass estimates are frequently imprecise, particularly for the higher biomass estimates (Table 6). The last three trawl surveys (2009, 2011 and 2013) have estimated relatively high levels of recruited biomass compared to the biomass estimates from the earlier surveys (Figure 3). However, of the three recent surveys, only the 2013 survey provided a biomass estimate with a reasonable level of precision (CV 26%). The survey estimates of pre-recruit biomass are also poorly determined.

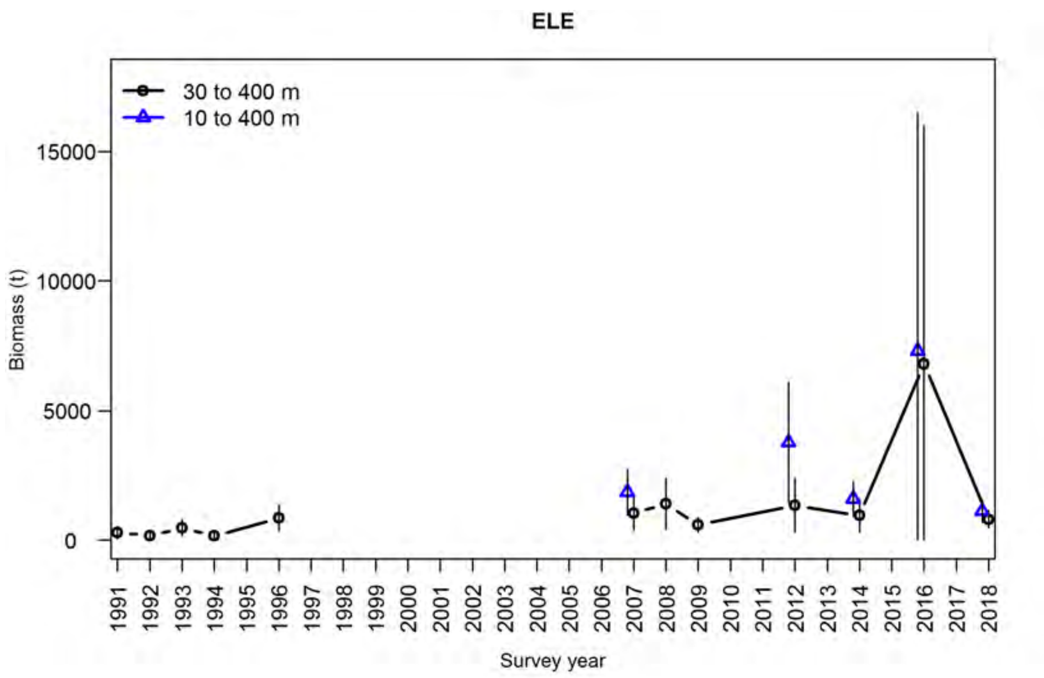


Figure 2: Elephant fish total biomass and 95% confidence intervals for all ECSI winter surveys in core strata (30–400 m), and core plus shallow strata (10–400 m) in 2007, 2012, 2014, 2016 and 2018.

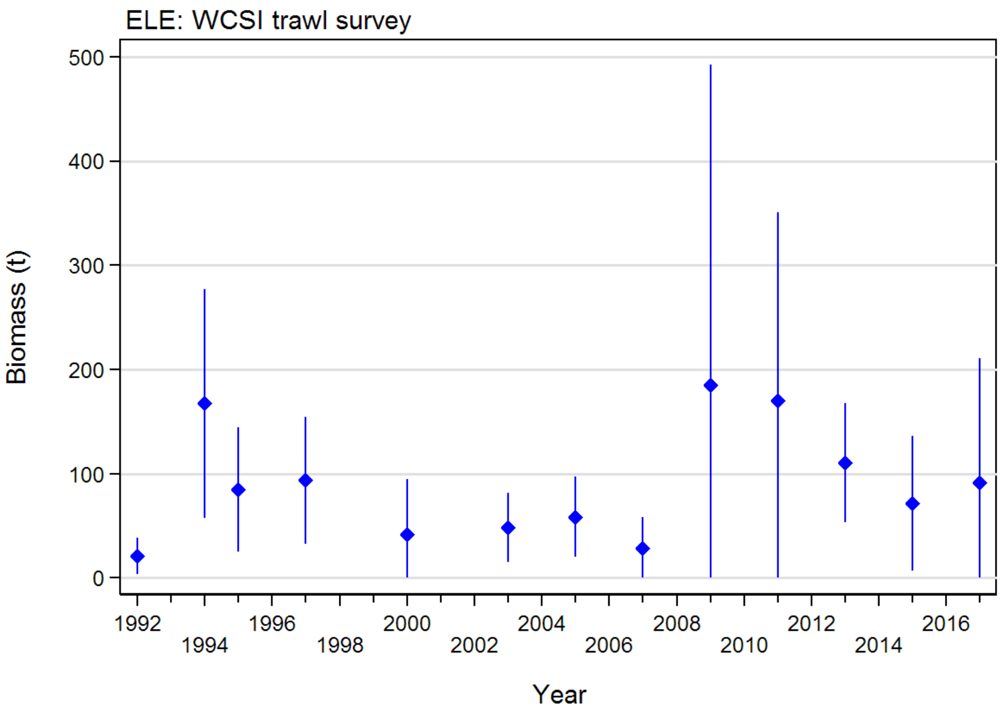


Figure 3: Elephant fish trawl survey total biomass estimates for the west coast South Island survey, with associated 95% confidence intervals.

Table 6: Relative biomass indices (t) and coefficients of variation (CV) for elephant fish for east coast South Island (ECSI) - summer and winter, west coast South Island (WCSI) and the Stewart-Snares Island survey areas*. Biomass estimates for ECSI in 1991 have been adjusted to allow for non-sampled strata (7 and 9 equivalent to current strata 13, 16 and 17). The sum of pre-recruit and recruited biomass values do not always match the total biomass for the earlier surveys because at several stations length frequencies were not measured, affecting the biomass calculations for length intervals. – , not measured; NA, not applicable. Recruited is defined as the size-at-recruitment to the fishery (50 cm).

Region	Fishstock	Year	Trip number	Total Biomass estimate	CV (%)	Total Biomass estimate	CV (%)	Pre-recruit	CV (%)	Pre-recruit	CV (%)	Recruited	CV (%)	Recruited	CV (%)
ECSI(winter)	ELE 3			30–400 m		10–400 m		30–400 m		10–400 m		30–400 m		10–400 m	
		1991	KAH9105	300	40	-	-	NA	NA	-	-	NA	NA	-	-
		1992	KAH9205	176	32	-	-	54	83	-	-	122	28	-	-
		1993	KAH9306	481	33	-	-	60	56	-	-	421	34	-	-
		1994	KAH9406	152	33	-	-	22	51	-	-	142	34	-	-
		1996	KAH9606	858	30	-	-	338	40	-	-	520	26	-	-
		2007	KAH0705	1 034	32	1 859	24	516	59	1 201	36	518	21	658	20
		2008	KAH0806	1404	35	-	-	627	57	-	-	777	27	-	-
		2009	KAH0905	596	23	-	-	210	38	-	-	387	25	-	-
		2012	KAH1207	1 351	39	3 781	31	66	46	581	25	1 285	39	3 199	36
		2014	KAH1402	951	34	1600	21	174	32	429	25	777	40	1 171	28
		2016	KAH1605	6 812	68	7 299	63	62	43	167	30	6 750	68	7 132	64
		2018	KAH1803	807	21	1118	20	266	34	356	28	541	23	761	24
ECSI(summer)	ELE 3	1996–97	KAH9618	21	42	-	-	-	-	-	-	-	-	-	-
		1997–98	KAH9704	167	33	-	-	-	-	-	-	-	-	-	-
		1998–99	KAH9809	85	35	-	-	-	-	-	-	-	-	-	-
		1999–00	KAH9917	94	33	-	-	-	-	-	-	-	-	-	-
		2000–01	KAH0014	42	63	-	-	-	-	-	-	-	-	-	-
				49	34										
WCSI	ELE 7	1992	KAH9204	59	33	-	-	-	-	-	-	-	-	-	-
		1994	KAH9404	28	53	-	-	-	-	-	-	-	-	-	-
		1995	KAH9504	185	83	-	-	-	-	-	-	-	-	-	-
		1997	KAH9701	170	53	-	-	-	-	-	-	-	-	-	-
		2000	KAH0004	110	26	-	-	-	-	-	-	-	-	-	-
		2003	KAH0304	72	45	-	-	-	-	-	-	-	-	-	-
		2005	KAH0503	92	65	-	-	-	-	-	-	-	-	-	-
		2007	KAH0704	21	42	-	-	-	-	-	-	-	-	-	-
		2009	KAH0904	167	33	-	-	-	-	-	-	-	-	-	-
		2011	KAH1104	85	35	-	-	-	-	-	-	-	-	-	-
		2013	KAH1305	94	33										
		2015	KAH1503	42	63										
		2017	KAH1703	49	34										
Stewart-Snares	ELE 5	1993	TAN9301	219	33	-	-	-	-	-	-	-	-	-	-
		1994	TAN9402	177	47	-	-	-	-	-	-	-	-	-	-
		1995	TAN9502	69	49	-	-	-	-	-	-	-	-	-	-
		1996	TAN9604	137	46	-	-	-	-	-	-	-	-	-	-

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

4.1.2 CPUE biomass indices

ELE 3 and ELE 5

Three standardised CPUE series for ELE 3 were prepared for 2012, with each series based on the bycatch of elephant fish in bottom trawl fisheries defined by different target species combinations. Initially, the Working Group accepted a series based solely on the bycatch of elephant fish when targeting red cod. It then requested two further analyses: one [ELE 3(MIX)] where the target species definition was expanded to include STA, BAR, TAR, and ELE, as well as RCO, to investigate the effect of target species switching by explicitly standardising for target species effects. The second analysis [ELE 3(MIX)-trip] was done on all trips that targeted RCO, STA, BAR, TAR, and ELE at least once, then amalgamating all data to the level of a trip. This removed the differences between the TCEPR, TCER and CELR forms, but loses all targeting information.

The three sets of ELE 3 CPUE indices (ELE 3(RCO), ELE 3(MIX) and ELE 3(MIX)-trip) were very similar for the 1989–90 to 2010–11 years. The Working Group agreed in 2009 to drop the ELE 3-SN(SHK) and ELE 5-SN(SHK) (setnet with shark target species) indices because the setnet fisheries in these two QMAs have been substantially affected by management interventions (including measures to reduce the bycatch of Hector's dolphins) and no longer appeared to be an appropriate index of ELE abundance in either QMA.

In 2014, the ELE 3(MIX) CPUE model was updated to include additional data from 2011–12 and 2012–13 (Langley 2014). The resulting CPUE indices were very similar to the previous analysis for the comparable period. The indices were updated again in 2016, extending the time-series to 2014–15. Standardised CPUE has fluctuated without trend since 2009–10 and the 2014–15 data point is near the interim target (see below) (Figure 4).

An analysis of recent CPUE data suggested that bottom trawl fishing operations may be attempting to avoid larger catches of elephant fish. During 2012–13 to 2014–15, there was a lower probability of successive larger catches of elephant fish. This may have negatively biased the CPUE indices from 2012–13 to 2014–15 (Langley 2016 - presentation).

***B_{MSY}* conceptual proxy:** The Working Group proposed using the average of the ELE 3(MIX) series from 1998–99 to 2010–11 to represent a "B_{MSY} conceptual proxy" for the ELE 3 Fishstock. This period was selected because of its relative stability following a period of continuous increase. However, the Working Group has concerns about the reliability of this as a proxy and suggested that it only be used on an interim basis.

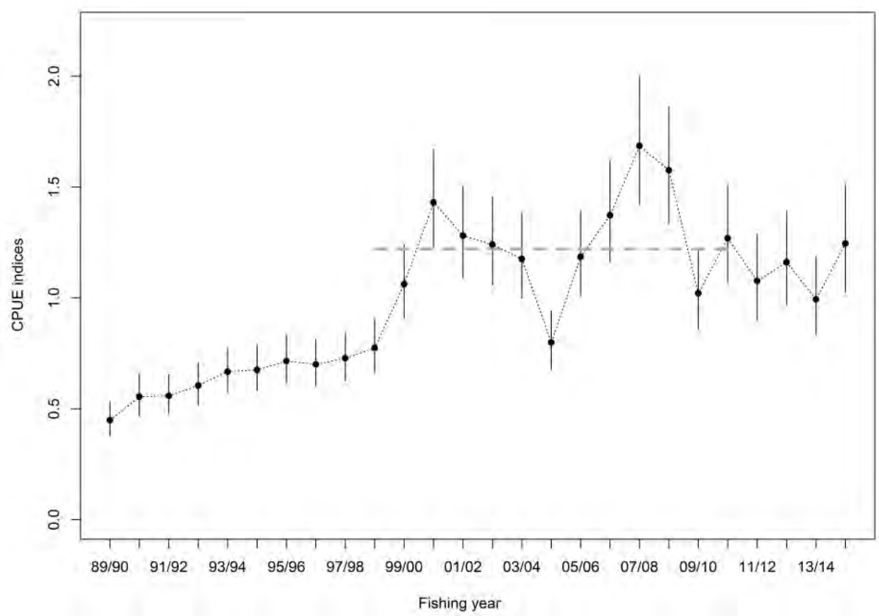


Figure 4: Standardised CPUE indices for the ELE 3 bottom trawl fisheries [ELE 3(MIX)]. The horizontal grey line is the mean of ELE 3(MIX) from 1998–99 to 2010–11 (B_{MSY} conceptual proxy). The CPUE series has been normalised to a geometric mean of 1.0. Error bars show 95% confidence intervals.

ELEPHANT FISH (ELE)

Two standardised CPUE series for ELE 5 were prepared for 2012 with each series based on the bycatch of elephant fish in the bottom trawl fisheries defined by target species combinations (Starr & Kendrick 2013). One of these series [ELE 5 BT(MIX)] is analogous to the MIX series developed for ELE 3, with the series defined by six target species in all valid ELE 5 statistical areas. The second ELE 5 analysis [ELE 5 BT(MIX)-trip] was a trip- based analysis using the same target species selection method as described for ELE 3-BT(MIX)-trip series. The two sets of indices were very similar.

In 2014, the ELE 5-BT(MIX) CPUE model was updated to include data from 2011–12 to 2012–13 (Langley 2014). This model used the "daily effort" method to prepare the data, whereby every record was reduced to a day of fishing, with the predominant statistical area and target species for the day assigned to the record. This method was accepted by the WG as the best procedure to follow when reducing event-based forms to match earlier daily forms. The two most recent indices were lower than the peak CPUE from 2008–09 to 2010–11, although CPUE has been maintained at a relatively high level compared to the 1990s–early 2000s (Figure 5). The ELE 5-BT(MIX) model was again updated in 2017, with data current to the end of 2015–16. Although the fishery definition and data preparation methods were unchanged, a binomial presence/absence series was added because of a declining trend in the proportion of days with zero catch. The Plenary accepted a revised index which combined the binomial and lognormal series using the delta-lognormal method (Starr & Kendrick, in prep). This was done because the Inshore WGs have adopted the standard of combining positive catch and fishing success models when there is a trend in the proportion zero catch. As well, simulation work has indicated that calculating a combined index may reduce bias when reporting small catch amounts (Langley 2015). Recent indices estimated by this updated series are lower than the peak observed at the end of the 2010 decade, but these indices remain above the long-term average CPUE (Figure 5).

***B_{MSY}* conceptual proxy:** The Plenary agreed in 2017 to use the mean combined ELE5-BT(MIX) CPUE for the period 2005–06 to 2015–16 as a "BMSY conceptual proxy" for ELE 5. This period was selected because a plot of CPUE against catch (yield curve) appeared to have levelled out and is assumed to represent a stochastic equilibrium (Figure 6).

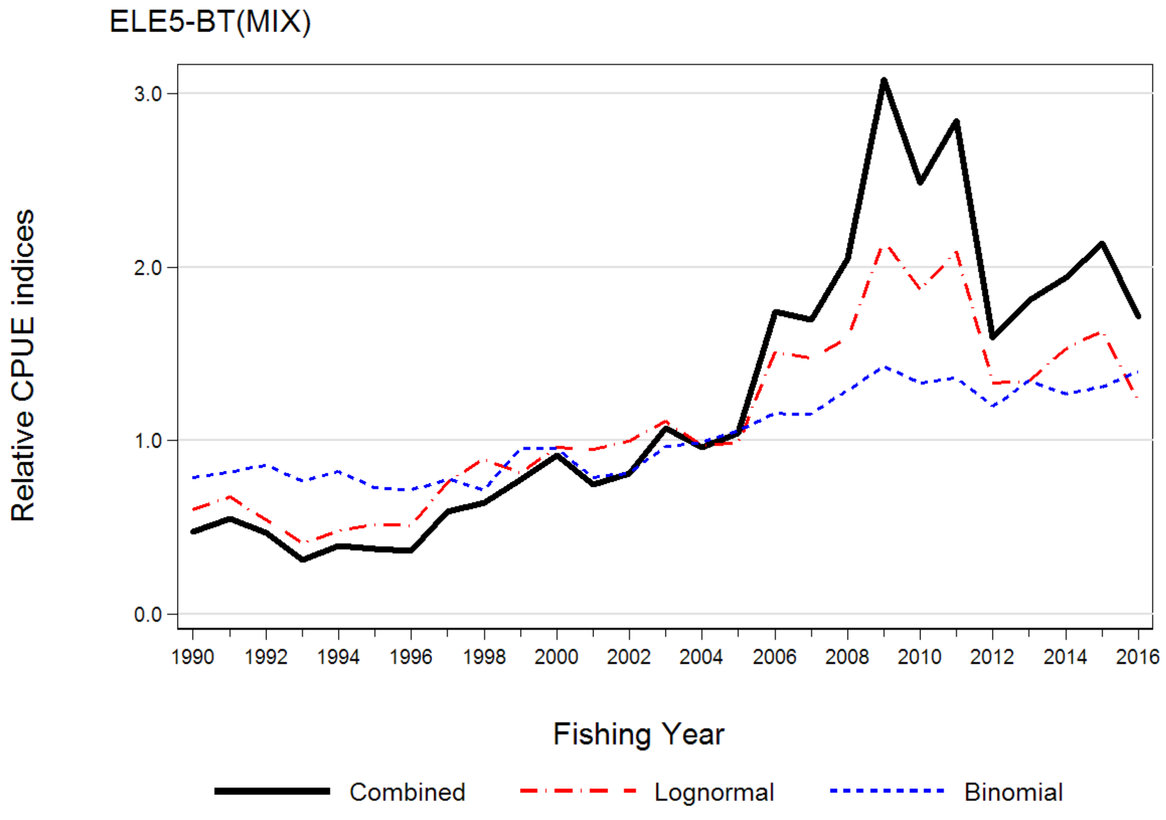


Figure 5: Plots of three ELE5-BT(MIX) CPUE series: a) positive catch (lognormal); b) presence/absence (binomial) and c) combined series using the delta-lognormal method.

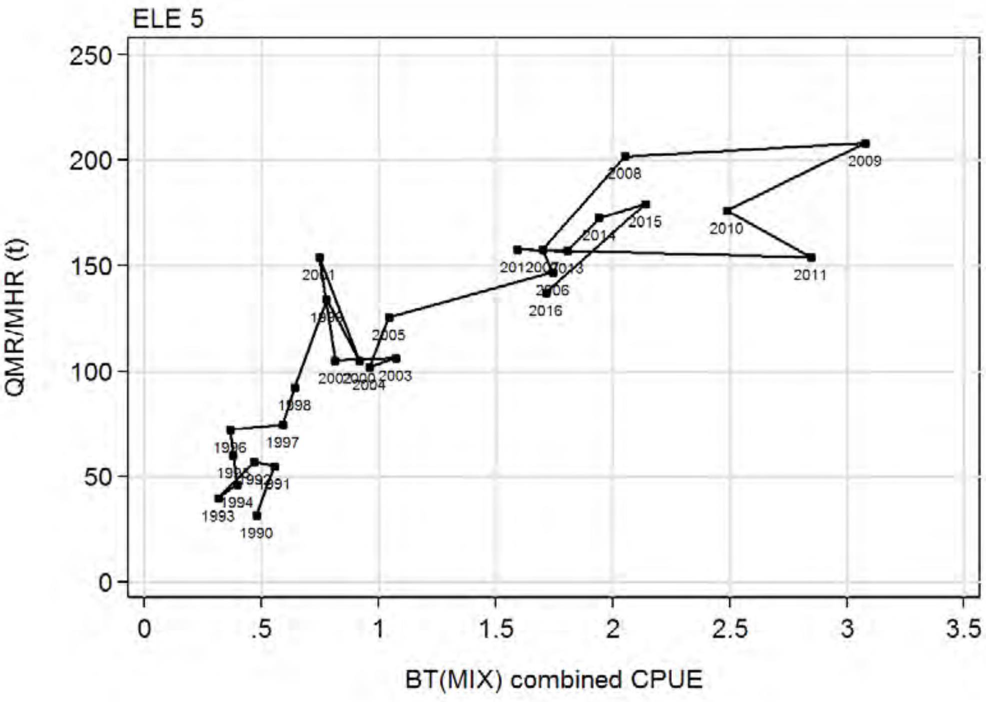


Figure 6: Trace yield plot for ELE 5, showing CPUE and QMR/MHR landings plotted sequentially by fishing year.

ELE 7

A preliminary CPUE analysis of the catch of elephant fish from the WCSI inshore trawl fishery was conducted in 2013 and updated in 2014 (Langley 2014). The analysis included all bottom trawl catch and effort data targeting either flatfish, red gurnard, red cod or elephant fish. These target trawl fisheries encompass almost all the trawl fishing effort within the depth range that encompasses most of the catch of elephant fish off the west coast of the South Island (5–80 m). The primary analysis was conducted based on catch and effort data from 1989–90 to 2012–13 aggregated in a format that was consistent with the CELR reporting format. The landed catch of elephant fish from each trip was apportioned to the effort records either based on the associated level of estimated catch or, where estimated catches were not recorded, in proportion to the number of trawls in each aggregated effort record.

The data set included a significant proportion of trip and effort records with no elephant fish catch, although the proportion of nil catch records decreased steadily over the study period. Thus, the overall CPUE for the fishery was modelled in two components: the binomial model of the proportion of positive catches and the lognormal model of the magnitude of the positive catch. The two components were combined to generate a time series of delta-lognormal CPUE indices. The sensitivity of the catch threshold used to define a positive catch (i.e. 0, 1 kg, 2 kg and 5 kg) was investigated. The resulting binomial and lognormal CPUE indices were sensitive to the applied catch threshold; however, the compensatory changes in the two sets of indices resulted in delta-lognormal indices that were relatively insensitive to the applied catch threshold.

The resulting CPUE indices fluctuated over the study period with a marked peak in CPUE in 1999–2000 and 2000–01 and low CPUE in 1997–98 and 2003–04 (Figure 7). The CPUE indices remained stable during 2007–08 to 2009–10, increased in 2010–11, increased markedly in 2011–12 and remained at the higher level in 2012–13. In 2014, the SINS WG concluded that the CPUE indices were unlikely to be a reliable index of stock abundance, primarily on the basis that the large inter-annual variations in the CPUE indices especially during the late 1990s and early 2000s were not consistent with the dynamics of the stock and may be attributable to changes in the operation of the WCSI trawl fishery at that time.

A separate delta-lognormal CPUE analysis was conducted for the location based TCER catch and effort data from 2007–08 to 2012–13 (Langley 2014). The resulting CPUE models incorporated a number of additional explanatory variables available in the high resolution data format. The TCER delta-lognormal CPUE indices were broadly similar to the CELR format CPUE indices for the comparative period The TCER indices exhibited a comparable increase in CPUE from 2009–10 to 2011–12, although the TCER indices were higher in 2007–08 to 2008–09 than the CELR format indices. In 2015, the TCER CPUE indices were updated to include the 2013–14 fishing year. The SINS WG concluded that the TCER CPUE indices represented the best available information for monitoring trends in ELE 7 stock abundance.

A "rapid update" of the ELE 7 tow-by-tow standardised CPUE analysis was reviewed and accepted by the SINS WG in 2019 (Starr & Kendrick 2019). This analysis duplicated the Langley (2014) analysis reported above, extending the analysis by four years as well as providing additional diagnostics supporting the standardisation procedure (Figure 7). The SINS WG agreed that this series indexed ELE 7 abundance, with the 2017–18 index near the series mean (Figure 7). In addition, the SINS WG agreed that the mean (2007–08 to 2017–18) index of this series could serve as a B_{msy} proxy target for this stock.

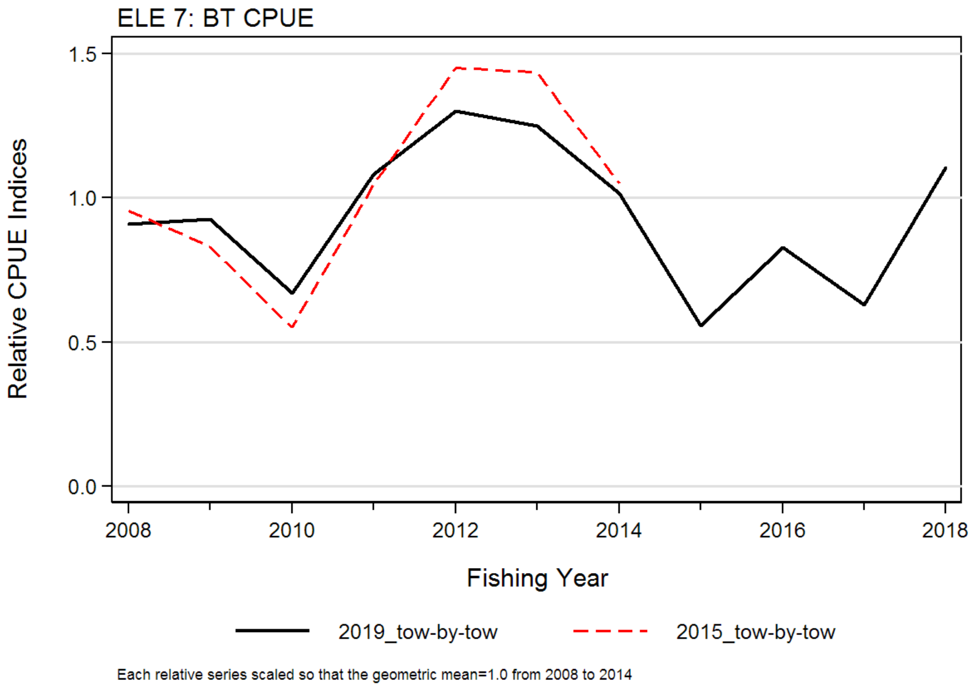


Figure 7. Standardised delta-lognormal CPUE indices for the ELE 7 inshore WCSI trawl fishery based on tow-by-tow TCER data. Two index series are presented: the updated 2019 series and the previously accepted 2015 series. Both sets of indices are normalised to the comparable time period (2007–08 to 2013–14).

4.2 Stock Assessment models

A preliminary stock assessment model was developed for ELE 3. Estimates of current and reference absolute biomass are not available for the other elephant fish stocks.

ELE 3

A stock assessment model was developed for ELE 3 in 2016 using the Stock Synthesis (3.24f) software to implement an age-structured population model. The data sets available for inclusion in the assessment model are, as follows.

- Annual reported catch of elephant fish (1931–2015). The historical catches were derived from Francis & Paul (2013). Additional unreported landed catches were included for the period prior to the introduction of the QMS. The level of unreported landed catch was assumed to represent a third of the reported catch. The magnitude of unreported landed catch was based on discussions with commercial operators in the ELE 3 fishery.
- A time-series of estimates of the magnitude of the discarded catch (unreported but not landed) of elephant fish (1931–2015). Based on the discussions with commercial operators it was assumed that the discarded (and unreported catch) represented 25% of total landed catch (reported and unreported combined). The discarded catch is comprised of smaller elephant fish, usually less than 50 cm FL.
- BT MIX CPUE indices 1989–90 to 2014–15 (26 observations).
- ECSI trawl survey pre-recruit (< 50 cm), recruited (50+ cm) and total biomass estimates from the time series of winter surveys, 30–400 m depth (11 observations).
- ECSI trawl survey length compositions (male and female); winter surveys, 30–400 m depth (11 observations).

- Aggregated length compositions (male and female) of the commercial trawl catch sampled by Scientific Observers during 2009–10.

Additional data are available from the summer ECSI trawl surveys. These data were not included in the analysis as it has previously been concluded that the summer survey series does not represent a reliable index of abundance for elephant fish. In recent years, the winter trawl survey has been extended to include the shallower areas of Canterbury Bight and Pegasus Bay (10–30 m), partly to improve the monitoring of the abundance of elephant fish. However, the time-series of surveys that includes this area is limited (four surveys).

Initial modelling results revealed that the scaled length compositions derived from the winter trawl surveys were highly variable (amongst surveys) and inconsistent with the other key input data sets. Further examination of the length composition data revealed that few elephant fish were caught and sampled during each survey and the scaled length compositions were typically dominated by the sampled catch from a limited number of trawls. The length and sex compositions of these larger catches were highly variable.

On that basis, it was concluded that the survey length compositions were unlikely to be representative of the length composition of the elephant fish population and these data were excluded from the final set of model options. Further, the estimates of trawl survey biomass for pre-recruit (<50 cm) fish are relatively imprecise (CVs 32–83%) and preliminary modelling indicated that these indices were not consistent with the other abundance indices (especially the CPUE indices). Thus, the pre-recruit trawl survey biomass indices were also excluded from the final set of model options.

<u>Model configuration</u>
The final assessment model was configured, as follows.

- Model period 1931–2015, terminal year represents 2014–15 fishing year.
- Age classes 0–19 and 20+ years, two sexes.
- Initial (1931) population age structure assumes equilibrium, unexploited conditions.
- Annual recruitment derived from Beverton and Holt stock-recruitment relationship; R0 parameter estimated (uninformative beta prior) and steepness fixed at 0.6 (base model option), recruitment deviates from SRR estimated for 1989–2013 assuming a SigmaR of 0.6.
- Sexual maturity (female fish) at 70 cm (FL).
- Two commercial fisheries: discard and retained catch. The selectivity of the commercial catch is assumed to be equivalent for the two main fishing methods (BT and SN).
- Commercial length composition data from 2009–10 are partitioned at 50 cm to characterise the length composition of discard (<50 cm) and retained (50+ cm) commercial catches. Both length compositions are assigned a relatively high weighting (ESS 100) to ensure that the model approximates these observations.
- The length-based selectivity of discard commercial fishery is parameterised using a double normal selectivity function (equivalent for both sexes). Selectivity is effectively truncated at about 50 cm (FL).
- Two alternative length-based selectivity options were adopted for the retained commercial fishery with selectivity parameterised using either a logistic or double normal function. Selectivity was allowed to vary by sex.
- The CPUE indices are assumed to represent the relative abundance of the component of the population that is vulnerable to the retained commercial fishery. The CPUE indices were assigned a CV of 20%.
- The ECSI recruited (50+ cm) total biomass estimates were assigned the native CVs from individual surveys. The length-based selectivity of the survey was assumed to be knife edge at 50 cm (FL) with full selectivity for all the larger length intervals.

Model options that assumed a logistic selectivity function for the (retained) commercial fishery resulted in a poor fit to the (retained) commercial length composition for male and female fish (from 2009–10). These models consistently over-estimated the number of larger male (>68 cm FL) and female (>90 cm FL) elephant fish in the commercial catch.

The alternative model option with selectivity parameterised by a double normal function resulted in a substantial improvement in the fit to the commercial length compositions (relative to the logistic selectivity model). The double normal selectivity model estimated selectivity for male and female fish started to rapidly decline above 70 cm and 85 cm FL, respectively. The lower selectivity of larger female fish meant that approximately 40–50% of the mature female population (by weight) is estimated to be invulnerable to the commercial fishery and, consequently, not monitored by the CPUE indices.

Separate model runs were conducted for the two selectivity options, each with three assumed values of SRR steepness: a base level of 0.6 bracketed by values of 0.5 and 0.7. MCMCs were conducted for the six model options. However, the results of the MCMCs were not satisfactory for the model options with the lowest value of steepness and, consequently, only MCMC results for the 0.6 steepness options are reported.

Model results

The overall fit to the CPUE indices was acceptable for all model options. The CPUE indices exhibit a general increase with marked peaks in the early and late 2000s. The models account for these trends by estimating higher recruitments for 1996–1998, 2004, and 2009. As previously noted, the double normal selectivity parameterisation substantially improved the fit to the retained commercial length composition data (compared to logistic selectivity). There was also a marginal improvement in the fit to the CPUE indices with the double normal selectivity.

All model options also estimated an increase in stock abundance that was consistent with the overall increase in the ECSI trawl survey recruited biomass estimates between the 1990s and the more recent period, although the fit to the individual biomass estimates is poor. The quality of the fit is consistent with the relatively low precision of the biomass estimates and the likelihood that the survey vulnerability of elephant fish varies amongst survey years (as indicated by the variability in the length composition of the survey catches).

Two indicators of stock status were derived from the assessment models: current (2014–15) female spawning (=mature) biomass relative to unexploited spawning biomass (SB_{2015}/SB_0), and current spawning biomass relative to the spawning biomass in 1985 (SB_{2015}/SB_{1985}). The latter metric provides an indication of the extent of the stock recovery from the period when the stock was estimated to be at the lowest level.

The MPD results indicate that stock abundance has increased considerably from a low level (approx. 10–20% SB_0) in 1985. The double normal selectivity model runs represent a somewhat more optimistic estimate of the current stock status relative to both SB_0 and SB_{1985}. MPD estimates of stock status tended to be near the lower bound of the MCMC confidence intervals, indicating that the MPD estimates are likely to represent minimum biomass levels consistent with the catch history.

Table 7: Estimates of stock status for the range of commercial selectivity and SRR steepness options (MPD estimates). McMC estimates (median value and 95% confidence interval) are also presented for the two selectivity options with SRR steepness of 0.60.

Selectivity	Steepness		SB_{2015}/SB_0	SB_{2015}/SB_{1985}
Double normal				
	0.6	MPD	0.390	2.99
		MCMC	0.471 (0.266–0.872)	2.86 (2.08–3.97)
	0.7	MPD	0.321	3.77
Logistic				
	0.6	MPD	0.279	2.50
		MCMC	0.386 (0.217–0.651)	2.63 (1.86–3.61)
	0.7	MPD	0.229	3.03

The results are also sensitive to the assumptions regarding SRR steepness. Higher values of steepness correspond to lower estimates of SB_0 and a higher level of depletion by 1985, and while the relative level of recovery from 1985 is higher than for lower steepness options, the current level of stock biomass relative to SB_0 is lower.

The median estimates of SB_{2015}/SB_0 stock status from the MCMCs are more optimistic than the corresponding MPD results for the SRR steepness 0.60 model runs. The MCMC results also reveal that there is considerable uncertainty associated with the estimates of stock status, although the confidence intervals derived from the MCMCs suggest that current biomass is Likely to be above the default soft limit (20% SB_0) and About As Likely as Not to be at or above the default target biomass level (40% SB_0). However, the preliminary nature of the model precludes definitive statements about stock status.

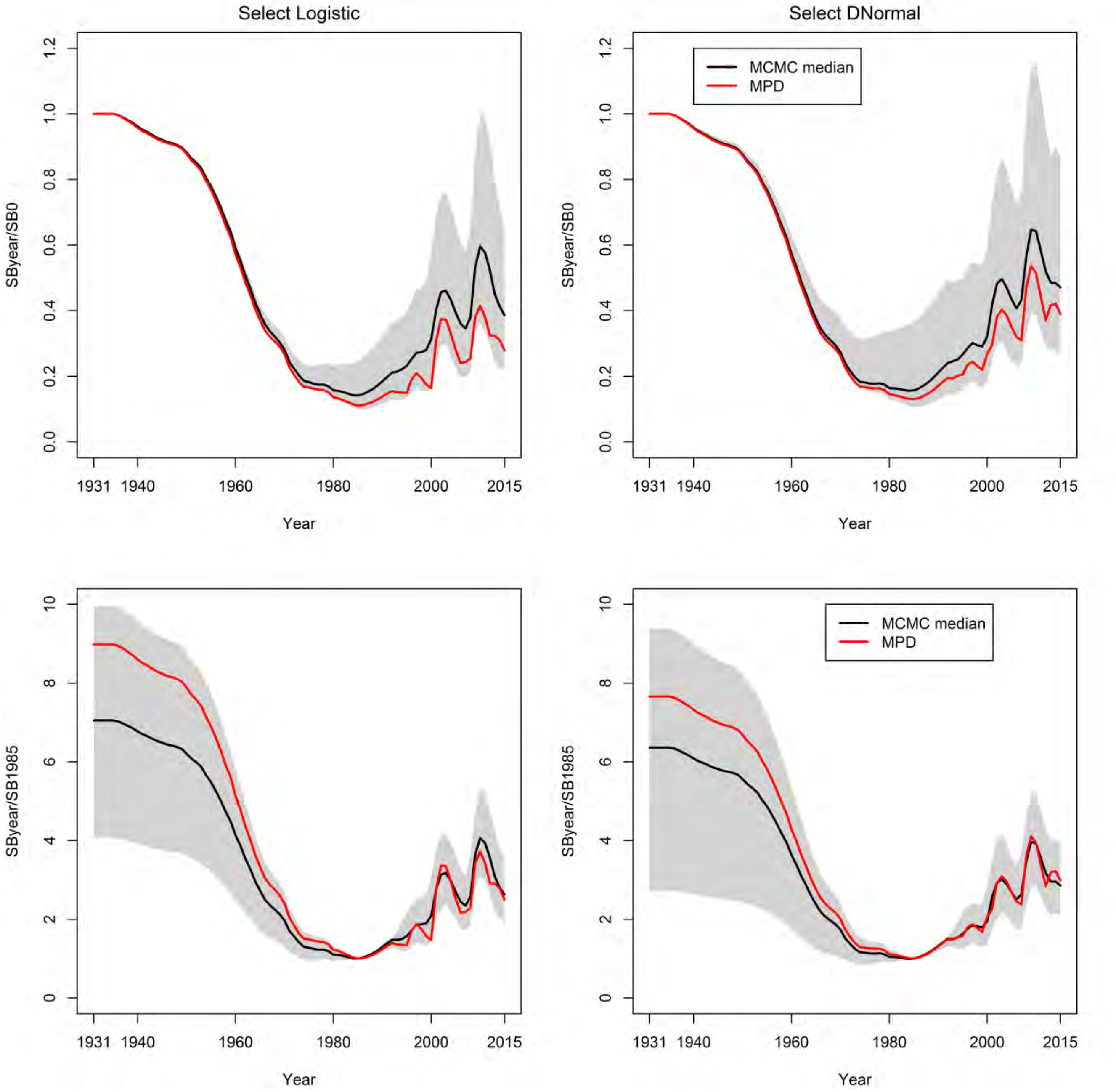


Figure 8: Stock trajectories for the spawning biomass relative to SB_0 (upper panels) and SB_{1985} (lower panels) for logistic (left panels) and double normal (right panels) selectivity options with SRR steepness 0.6. The black line represents the median of the McMCs (with 95% confidence interval) and the red line represents the MPD.

The Southern Inshore Working Group concluded that this preliminary model produced plausible biomass trajectories, but uncertainty about productivity and fits to commercial length data precluded acceptance of the model as a reliable estimator of current stock status.

These conclusions need to be tempered by the possibility that the models may be over-estimating recruitment in the more recent years. This may provide an explanation for the apparent over-estimation of the proportion of larger, older fish in the population in the late 2000s (that were not apparent in the commercial length composition). Conversely, the recent CPUE indices may be biased low (due to apparent avoidance behaviour) and consequently the model may under-estimate the current level of biomass.

Estimates of SB_{2015}/SB_0 stock status are also highly uncertain (and potentially biased) due to the assumptions associated with the estimation of historical, unexploited biomass.

4.3 Yield estimates and projections
No other yield estimates are available.

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

5. STATUS OF THE STOCKS

- **ELE 1**

No estimates of current and reference biomass are available.

- **ELE 2**

It is not known if recent catch levels or the current TACC are sustainable. The state of the stock in relation to B_{MSY} is unknown.

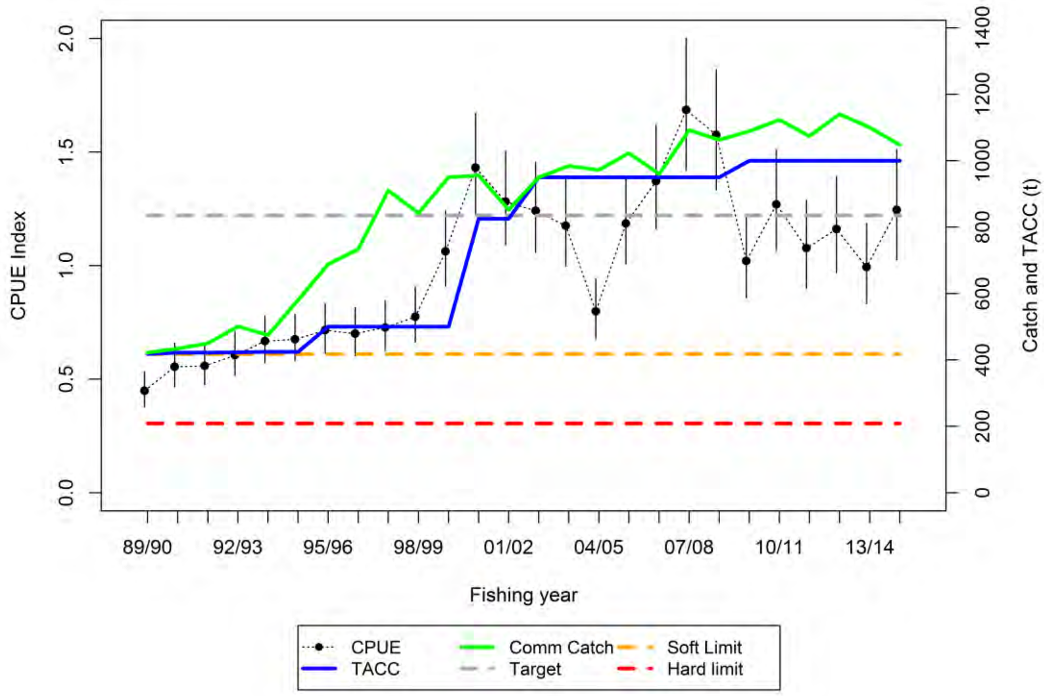
- **ELE 3**

Stock Structure Assumptions
No information is available on the stock separation of elephant fish. The Fishstock ELE 3 is treated in this summary as a unit stock.

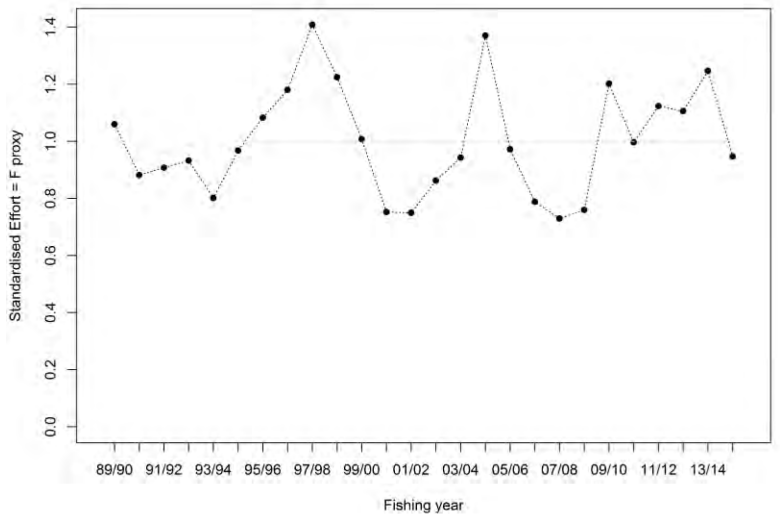
Stock Status	
Year of Most Recent Assessment	2016
Assessment Runs Presented	Update ELE 3 (MIX) CPUE series
Reference Points	Interim target: B_{MSY}-compatible proxy based on CPUE (average from 1998–99 to 2010–11 of the ELE 3(MIX) model as defined in Starr & Kendrick 2013) Soft Limit: 50% of target Hard Limit:25% of target
Status in relation to Target	About as Likely as Not (40–60%) to be at or above the target
Status in relation to Limits	Soft Limit: Unlikely (< 40%) to be below Hard Limit: Very Unlikely (< 10%) to be below
Status in relation to Overfishing	Overfishing is About as Likely as Not (40–60%) to be occurring

Historical Stock Status Trajectory and Current Status

CPUE, Catch and TACC Trajectories



Comparison of the mixed target species bottom trawl CPUE series (ELE 3(MIX)) with the trajectories of catch (ELE 3(QMR/MHR)) and TACCs from 1989–90 to 2014–15. The dashed lines represent the interim target and corresponding soft limit and hard limit.

Fishery and Stock Trends	
Recent trend in Biomass or Proxy	The ELE 3(MIX) CPUE series, which is considered to be an index of stock abundance, showed a generally increasing trend from the beginning to reach a peak in 2007–08. CPUE indices have remained relatively stable below the peak level since 2009–10, remaining near the proposed target.
Recent trend in Fishing Intensity or Proxy	 **Fishing mortality proxy is Standardised Fishing Effort = Total catch/CPUE (normalised). Fishing mortality proxy has fluctuated about the average level and was at about the average in the most recent year.**

Other Abundance Indices	- Although there is high inter-annual variation, the winter ECSI trawl survey index shows a trend that is consistent with the ELE 3(MIX) CPUE index. - Preliminary stock assessment modelling for ELE 3 estimates that the stock abundance has increased substantially from a low level in the 1980s. The assessment models indicate that current biomass levels are probably at or about the default target biomass levels.
Trends in Other Relevant Indicator or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	Quantitative stock projections are unavailable.
Probability of Current Catch or TACC causing decline Biomass to remain below or to decline below Limits	Soft Limit: Unlikely (< 40%) Hard Limit: Very Unlikely (< 10%)
Probability of Current Catch or TACC causing Overfishing to continue or to commence	The TACC and current reported catches are About as Likely as Not (40–60%) to cause overfishing.

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Evaluation of agreed standardised CPUE indices which reflect changes in abundance.	
Assessment Dates	Latest assessment: 2016	Next assessment: Unknown
Overall assessment quality rank	1 – High Quality. The Southern Inshore Working Group agreed that the ELE 3(MIX) CPUE index was a credible measure of abundance.	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	- Compass Rose trawl survey data - Summer ECSI trawl survey data and winter ECSI trawl survey data - Set net CPUE (shark)	3 – Low Quality: insufficient data 2 – Medium or Mixed Quality: variable catchability / selectivity between years 3 – Low Quality: Index compromised by area closures
Changes to Model Structure and Assumptions	None since 2012 assessment	
Major Sources of Uncertainty	- It is possible that fisher avoidance and discarding have biased (low) the CPUE trends reported for this fishery.	

Qualifying Comments
- Elephant fish have shown good recovery since apparently being at low biomass levels in the mid-1980s. - Preliminary stock assessment modelling results are consistent with assumed level of stock rebuilding, primarily reflecting the increase in the CPUE abundance indices. However, there are considerable uncertainties associated with key biological parameters (natural mortality and growth) and conflict amongst the main input data sets. The modelling results are not considered to be amply reliable to estimate current stock status (relative to MSY levels) and potential yields for the stock. With respect to the conceptual B_{msy} proxy, the Plenary had concerns about the reliability of this as a proxy and advised that it only be used in the interim. - Historical catches may be poorly estimated. Both current and historical estimates of landings exclude fish discarded at sea and the quantum of discards is unknown. Management interventions since the stock was introduced into the QMS may have influenced the rate of discarding and therefore the reliability of CPUE as a measure of relative abundance.

Fishery Interactions
Elephant fish in ELE 3 are taken as bycatch by bottom trawl fisheries targeting red cod, flatfish and barracouta. Targeting elephant fish in the bottom trawl fishery has increased to around 40% of the landings since 2004–05 when the deemed value regime changed. Around 15% of the ELE 3 landings are taken by setnet in a fishery targeted at a number of shark species, including rig, elephant fish, spiny dogfish and school shark. Both the trawl and setnet fisheries have been subject to management measures designed to reduce interactions with endemic Hector's dolphins. Bottom trawl fishers also have not trawled within one nautical mile of the coast (since 2001) in an effort to preserve ELE egg cases. This may have reduced juvenile and egg mortality in shallow water. Interactions with other species are currently being characterised.

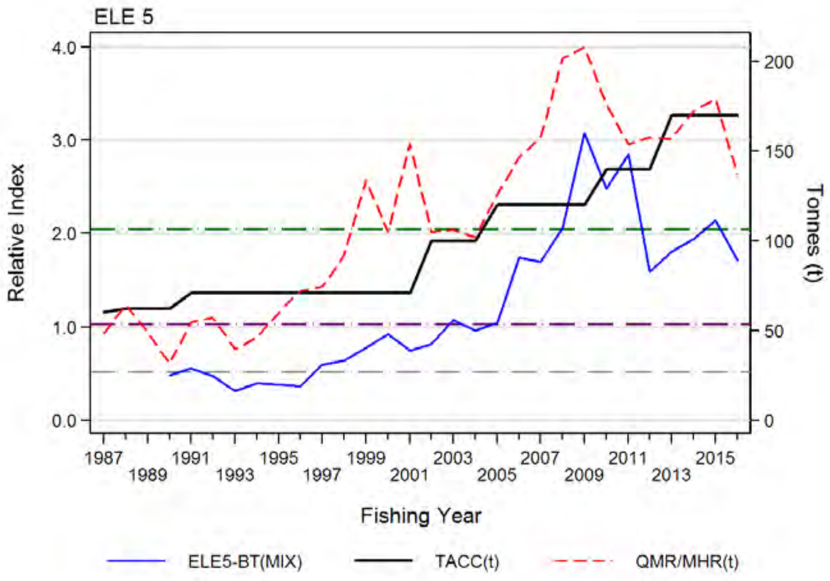
- **ELE 5**

Stock Structure Assumptions

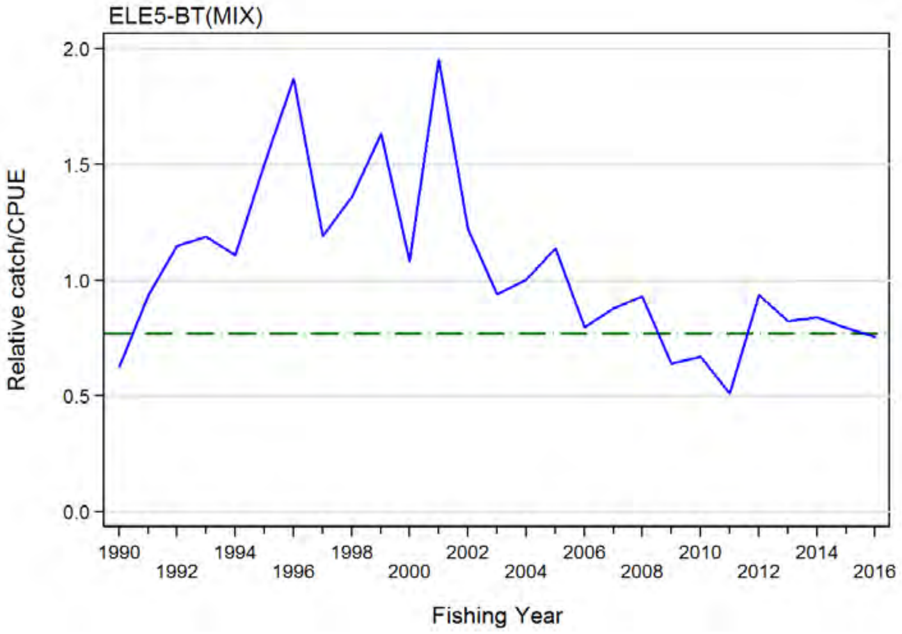
No information is available on the stock separation of elephant fish. The Fishstock ELE 5 is treated in this summary as a unit stock.

Stock Status	
Year of Most Recent Assessment	2017
Assessment Runs Presented	Standardised bottom trawl CPUE series based on mixed target species: combined delta-lognormal series
Reference Points	Target: B_{MSY}-compatible proxy based on mean ELE5-BT(MIX) standardised CPUE: 2005–06 to 2015–16 Soft Limit: 50% of Bmsy proxy Hard Limit: 25% of Bmsy proxy Overfishing threshold: Mean annual relative exploitation rate for the period: 2005–06 to 2015–16
Status in relation to Target	About as Likely as Not (40-60%) to be at or above Bmsy
Status in relation to Limits	Soft Limit: Unlikely (< 40%) to be below Hard Limit: Very Unlikely (< 10%) to be below
Status in relation to Overfishing	Overfishing is About as Likely as Not (40–60%) to be occurring

Historical Abundance and Catch Trajectories



Comparison of the ELE 5-BT(MIX) CPUE series with the TACC and QMR/MHR landings for ELE 5 The agreed B_{MSY} proxy (geometric average: 2006–2016 ELE 5-BT(MIX) CPUE indices=2.051) is shown as a green line; the calculated Soft Limit (=0.5xB_{MSY} proxy) is shown as a purple line; the calculated Hard Limit (=0.25xB_{MSY} proxy) is shown as a grey line.



Relative fishing pressure for ELE 5 based on the ratio of QMR/MHR landings relative to the ELE5-BT(MIX) CPUE series which has been normalised so that its geometric mean=1.0. Horizontal green line is the geometric mean fishing pressure from 2006 to 2016.

Fishery and Stock Trends	
Recent trend in Biomass or Proxy	The ELE 5 (MIX) CPUE series increased up to a peak in 2008–09, dropped sharply in 2011–12 and has fluctuated without trend close to the target since then.
Recent Trend in Fishing Mortality or Proxy	Fishing mortality proxy has remained relatively stable or declining over the last 10 years.
Other Abundance Indices	-
Trends in Other Relevant Indicator or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	Unknown
Probability of Current Catch and TACC causing biomass to remain below or to decline below Limits	Soft Limit: Unlikely (< 40%) Hard Limit: Very Unlikely (< 10%)
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Current Catch: About as Likely as Not (40–60%) TACC: About as Likely as Not (40–60%)

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Evaluation of agreed standardised CPUE indices	
Assessment Dates	Latest assessment: 2017	Next assessment: 2020
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- ELE 5 BT(MIX) CPUE series	1 – High Quality
Data not used (rank)	- Length frequency data summarised from setnet logbooks compiled under the industry Adaptive Management Programme	3 – Low Quality: data sparse and outdated
Changes to Model Structure and Assumptions	Addition of a binomial index to produce a combined CPUE series	

Major Sources of Uncertainty	It is possible that discarding and management changes (including changes in deemed values) in this fishery has affected CPUE estimates.

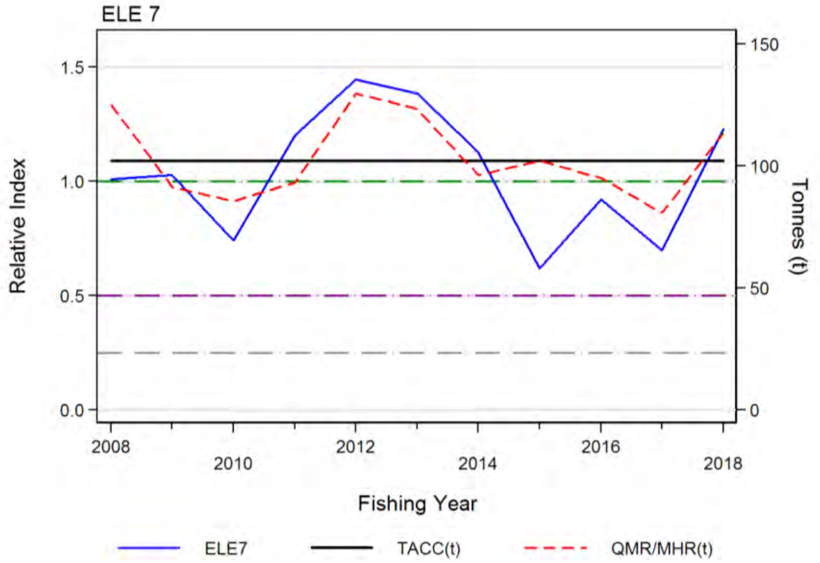
Qualifying Comments
Elephant fish have shown strong recovery since apparently being at low biomass levels in the mid-1980s. The historical catches may be poorly estimated. Both current and historical estimates of landings exclude fish discarded at sea and the quantum of discards is unknown. Confidence intervals for combined CPUE indices are not available.

Fishery Interactions
Elephant fish in ELE 5 are taken by bottom trawl in fisheries targeted at flatfish and stargazer. Targeting elephant fish in the bottom trawl fishery was low (average 14% from 1989–90 to 2015–16) but has increased to 19% of the landings since 2002–03. Around 12% of the ELE 5 landings are taken by setnet in a fishery targeted at rig and school shark. Incidental captures of seabirds and great white sharks occur, and there is a possibility of incidental capture of Hector's dolphins. However, both the trawl and setnet fisheries have been subject to management measures designed to reduce interactions with endemic Hector's dolphins. Interactions with other species are currently being characterised.

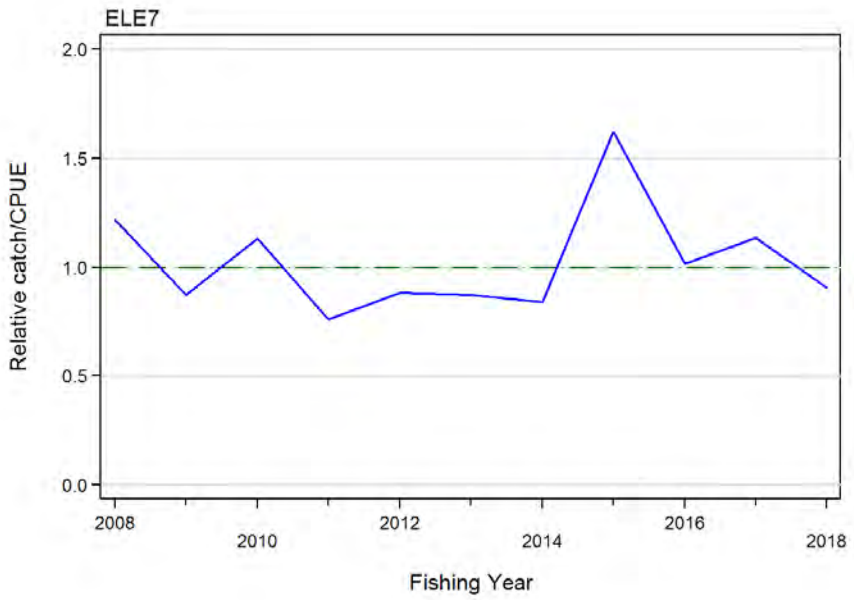
- **ELE 7**

Stock Status	
Year of Most Recent Assessment	2019
Assessment Runs Presented	ELE 7 tow-by-tow bottom trawl mixed target species standardised CPUE
Reference Points	Interim target: B_{MSY} proxy based on the mean of the CPUE series for the period: 2007–08 to 2017–18 Soft Limit: 50% of target Hard Limit: 25% of target Overfishing threshold: : Mean annual relative exploitation rate for the period: 2007–08 to 2017–18
Status in relation to Target	About as Likely as Not (40-60%) to be at or above B_{MSY}
Status in relation to Limits	Soft Limit: Unlikely (< 40%) Hard Limit: Very Unlikely (< 10%)
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 ELE 7-BT(tow-by-tow) CPUE series with the TACC and QMR/MHR landings for ELE 7. The agreed B_{MSY} proxy (geometric average: 2008–2018 ELE 7-BT(tow-by-tow) CPUE indices=1.0) is shown as a green line; the calculated Soft Limit (=0.5xB_{MSY} proxy) is shown as a purple line; the calculated Hard Limit (=0.25xB_{MSY} proxy) is shown as a grey line.



Relative fishing pressure for ELE 7 based on the ratio of QMR/MHR landings relative to the ELE7-BT(tow-by-tow) CPUE series which has been normalised so that its geometric mean=1.0. Horizontal green line is the geometric mean fishing pressure from 2007–08 to 2017–18.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	CPUE was high from 2010–11 to 2012–13 followed by a period of low CPUE from 2014–15 to 2016–17. The 2017–18 CPUE was above the series mean.
Recent Trend in Fishing Intensity or Proxy	Relative exploitation rate has fluctuated about the series mean and in 2017-18 was lower than the overfishing threshold.
Other Abundance Indices	Trawl survey biomass trends for this stock are unreliably estimated by the West Coast South Island survey. However, recent biomass estimates have been relatively high compared to the long term average.
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	Relative biomass is predicted to continue to fluctuate around the target level at the current catch.
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	Current catches and the current TACC are About as Likely as Not (40–60%) to cause overfishing.

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE index and relative biomass estimates from inshore WCSI trawl survey	
Assessment dates	Latest assessment: 2019	Next assessment: Unknown
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Standardised CPUE (tow-by-tow) (from 2007–08)	1 – High Quality: The SINSWG had confidence in this part of the CPUE index as a credible measure of abundance 2 – Medium or Mixed

	- Standardised CPUE (MIX) (pre 2007–08)	Quality: less catch (data) and lack of spatial resolution
Data not used (rank)	- Biomass estimates from inshore WCSI trawl survey	2 – Medium or Mixed Quality: low precision and high variability
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	- It is possible that discarding and management changes in this fishery have biased the CPUE trends to be low.	

Qualifying Comments
The pre-QMS catches are not well reported. Both current and historical estimates of landings exclude fish discarded at sea and the quantum of discards is unknown.

Fishery Interactions
Trawl target sets for ELE 7 tend to be in shallow water mostly around 25 m. Elephant fish are landed with rig, school shark and spiny dogfish in setnets and in bottom trawls as bycatch in flatfish and red cod target sets. Incidental captures of seabirds occur and there is a possibility of incidental capture of Hector's dolphins. Interactions with other species are currently being characterised.

7. FOR FURTHER INFORMATION

Beentjes, M P; MacGibbon, D; Lyon, W S (2015) Inshore trawl survey of Canterbury Bight and Pegasus Bay, April–June 2014 (KAH1402). *New Zealand Fisheries Assessment Report 2015/14*. 136 p.

Beentjes, M.P.; MacGibbon, D.; Parkinson, D. (2016). Inshore trawl survey of Canterbury Bight and Pegasus Bay, April–June 2016 (KAH1605). *New Zealand Fisheries Assessment Report 2016/61*. 135 p.

Boyd, R O; Reilly, J L (2002) 1999/2000 national marine recreational fishing survey: harvest estimates. Draft New Zealand Fisheries Assessment Report. (Unpublished report held by Fisheries New Zealand, Wellington.)

Bradford, E (1998) Harvest estimates from the 1996 national recreational fishing surveys. New Zealand Fisheries Assessment Research Document 1998/16. 27 p. (Unpublished report held by NIWA library, Wellington.)

Coakley, A (1971) The biological and commercial aspects of the elephantfish. *Fisheries Technical Report* No: 76. 29 p.

Coutin, P (1992) Sharks... and more sharks. *Australian fisheries* June 1992: 41–42.

Ford, R B; Galland, A; Clark, M R; Crozier, P; Duffy, C A J; Dunn, M R; Francis, M P; Wells, R (2015) Qualitative (Level 1) Risk Assessment of the impact of commercial fishing on New Zealand Chondrichthyans. New Zealand Aquatic Environment and Biodiversity Report No. 157. 111 p.

Francis, M P (1996) Productivity of elephantfish - has it increased? *Seafood New Zealand* February 96: 22–25.

Francis, M P (1997) Spatial and temporal variation in the growth rate of elephantfish (*Callorhinchus milii*). *New Zealand Journal of Marine and Freshwater Research* 31: 9–23.

Francis, R I C C; Hurst, R J; Renwick, J A (2001) An evaluation of catchability assumptions in New Zealand stock assessments. *New Zealand Fisheries Assessment Report 2001/1*. 37 p.

Francis, M P; Paul, L J (2013) New Zealand inshore finfish and shellfish commercial landings, 1931–82. *New Zealand Fisheries Assessment Report 2013/55.* 136 p.

Gorman, T B S (1963) Biological and economic aspects of the elephantfish, *Callorhynchus milii* Bory, in Pegasus Bay and the Canterbury Bight. *Fisheries Technical Report No: 8*. 54 p.

Langley, A D (2001) The analysis of ELE 3 catch and effort data from the RCO 3 target trawl fishery, 1989–90 to 1999–2000. *New Zealand Fisheries Assessment Report 2001/66*. 33 p.

Langley. A D (2014) Updated CPUE analyses for selected South Island inshore finfish stocks. *New Zealand Fisheries Assessment Report 2014/40.* 116 p.

Langley, A D (2015) Fishery characterisation and Catch-Per-Unit-Effort indices for John dory in JDO 1. *New Zealand Fisheries Assessment Report 2015/47*. 76 p.

Lydon, G J; Middleton, D A J; Starr, P J (2006) Performance of the ELE 3 and ELE 5 Logbook Programmes. AMP-WG-06/18. (Unpublished manuscript available from the NZ Seafood Industry Council, Wellington.)

MacGibbon, D J; Stevenson, M L (2013) Inshore trawl survey of the west coast South Island and Tasman and Golden Bays, March-April 2013 (KAH1305). *New Zealand Fisheries Assessment Report 2013/66.* 115 p.

MacGibbon, D.J.; Beentjes, M.P.; Lyon, W.L.; Ladroit, Y. (2019). Inshore trawl survey of Canterbury Bight and Pegasus Bay, April–June 2018 (KAH1803). *New Zealand Fisheries Assessment Report 2019/03.* 136 p.

McClatchie, S; Lester, P (1994) Stock assessment of the elephantfish (*Callorhinchus milii).* New Zealand Fisheries Assessment Research Document 1994/6. 17 p. (Unpublished report held by NIWA library, Wellington.)

Raj, L; Voller, R (1999) Characterisation of the south-east elephantfish fishery-1998. 55 p. (Unpublished report available at NIWA library, Wellington)

Seafood Industry Council (SeaFIC) (2000) Proposal to the Inshore Fishery Assessment Working Group. Placement of the ELE 3 into Adaptive Management Programme dated 23 March 2000 (presented to the Inshore Fishery Assessment Working Group 28 March 2000). (Unpublished report held by Fisheries New Zealand, Wellington)

Seafood Industry Council (SeaFIC) (2002) Report to the Inshore Fishery Assessment Working Group: Performance of the ELE 3 Adaptive Management Programme (dated 25 February 2002). (Unpublished report held by Fisheries New Zealand, Wellington)

Seafood Industry Council (SeaFIC) (2003a) 2003 performance report: ELE 3 Adaptive Management Programme. AMP-WG-2003/06. 3 p. (Unpublished report held by Fisheries New Zealand, Wellington)

Seafood Industry Council (SeaFIC) (2003b) Report to the Adaptive Management Fishery Assessment Working Group: Performance of the ELE 5 Adaptive Management Programme and request for an additional increase in ELE 5. AMP-WG-2003/07. 39 p. (Unpublished report held

by Fisheries New Zealand, Wellington)
Seafood Industry Council (SeaFIC) (2005a) 2005 Report to the Adaptive Management Programme Fishery Assessment Working Group: Performance of the ELE 3 Adaptive Management Programme. AMP-WG-2005/16. (Unpublished report held by Fisheries New Zealand, Wellington)
Seafood Industry Council (SeaFIC) (2005b) 2005 Report to the Adaptive Management Programme Fishery Assessment Working Group: Performance of the ELE 5 Logbook Programme. AMP-WG-05/23. (Unpublished report held by Fisheries New Zealand, Wellington)
Southeast Finfish Management Company (SEFMC) (2002a) 2002 Report to the Inshore Fishery Assessment Working Group. Performance of the ELE 3 Adaptive Management Programme (dated 25 February 2002). (Unpublished report held by Fisheries New Zealand, Wellington)
Southeast Finfish Management Company (SEFMC) (2002b) 2002 Report to the Inshore Fishery Assessment Working Group. Performance of the ELE 5 Adaptive Management Programme (dated 25 February 2002). (Unpublished report held by Fisheries New Zealand, Wellington)
Southeast Finfish Management Company (SEFMC) (2003) 2003 Report to the Inshore Fishery Assessment Working Group. Performance of the ELE 5 Adaptive Management Programme and request for an increase in ELE 5 (dated 13 Nov 2003). (Unpublished report held by Fisheries New Zealand, Wellington)
Starr, P J; Kendrick, T H (2013) ELE 3&5 Fishery Characterisation and CPUE. *New Zealand Fisheries Assessment Report 2013/38*. 95 p.
Starr, P.J.; Kendrick, T.H. (2017). ELE 5 Fishery Characterisation and CPUE Report. *New Zealand Fisheries Assessment Report 2017/50*. 63 p.
Starr, P.J.; Kendrick, T.H. (2019). ELE 7 Characterisation & Rapid CPUE update. SINSWG 2019-16. 78 p. (Unpublished report held by Fisheries New Zealand, Wellington)
Starr, P J; Kendrick, T H; Lydon, G J; Bentley, N (2007a) Report to the Adaptive Management Programme Fishery Assessment Working Group: Full-term review of the ELE 3 Adaptive Management Programme. AMP-WG-07/07. 104 p. (Unpublished report held by Fisheries New Zealand, Wellington.)
Starr, P J; Kendrick, T H; Lydon, G J; Bentley, N (2007b) Report to the Adaptive Management Programme Fishery Assessment Working Group: Two-year review of the ELE 5 Adaptive Management Programme. AMP-WG-07/10. 89 p. (Unpublished report held by Fisheries New Zealand, Wellington.)
Sullivan, K J (1977) Age and growth of the elephantfish *Callorhinchus milii* (Elasmobranchii: Callorhynchidae). *New Zealand Journal of Marine and Freshwater Research* 11: 745–753.
Teirney, L D; Kilner, A R; Millar, R E; Bradford, E; Bell, J D (1997) Estimation of recreational catch from 1991/92 to 1993/94. New Zealand Fisheries Assessment Research Document 1997/15. 43 p. (Unpublished report held by NIWA library, Wellington.)
Wynne-Jones, J; Gray, A; Heinemann, A; Hill, L; Walton, L (2019). National Panel Survey of Marine Recreational Fishers 2017–2018. Draft New Zealand Fisheries Assessment Report held by Fisheries New Zealand.
Wynne-Jones, J; Gray, A; Hill, L; Heinemann, A (2014) National Panel Survey of Marine Recreational Fishers 2011–12: Harvest Estimates. *New Zealand Fisheries Assessment Report 2014/67*. 145 p.