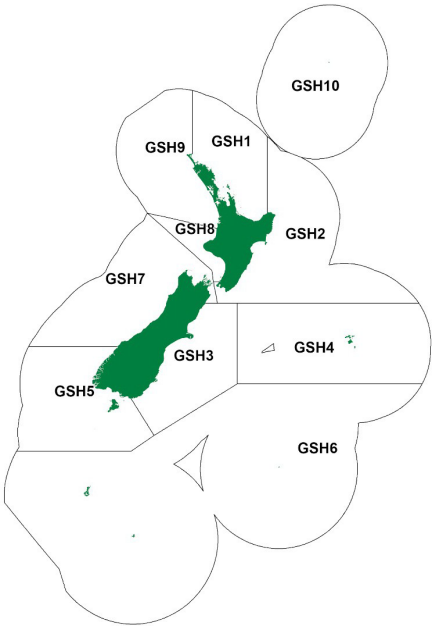
DARK GHOST SHARK (GSH)

(*Hydrolagus novaezealandiae*)



1. FISHERY SUMMARY

Allowances, TACCs, and TACs are shown in Table 1.

Table 1: Recreational and Customary non-commercial allowances, other mortality, TACCs, and TACs (t) for ghost shark by Fishstock.

Fishstock	Recreational allowance	Customary non-commercial allowance	Other sources of mortality	TACC	TAC
GSH 1	1	1	3	30	35
GSH 2	1	0	10	89	100
GSH 3	0	0	–	1 185	1 185
GSH 4	0	0	–	370	370
GSH 5	0	0	–	109	109
GSH 6	0	0	–	95	95
GSH 7	0	0	–	1 121	1 121
GSH 8	1	0	4	34	39
GSH 9	0	0	–	22	22
GSH 10	0	0	–	0	0

1.1 Commercial fisheries

Two species (dark and pale ghost sharks) make up virtually all commercial ghost shark landings. Dark ghost shark (*Hydrolagus novaezealandiae*) was introduced into the QMS from the beginning of the 1998–99 fishing year for the 10 FMAs shown above. Catches of six other ghost shark (Chimaeridae) species known from New Zealand waters have been negligible.

Both ghost shark species are taken almost exclusively as a bycatch of other target trawl fisheries. In the 1990s, about 43% of ghost sharks were landed as a bycatch of the hoki fishery, with fisheries for silver warehou, arrow squid, and barracouta combining to land a further 36%. The two ghost shark species were seldom differentiated on catch landing returns prior to the start of the 1998–99 fishing year. Estimated landings of both species by foreign licensed and joint venture vessels over the period 1 April 1978 to 30 September 1983 are presented in Table 2. Landings by domestic (inshore) vessels would have been negligible during this time. The unknown quantities of ghost sharks that were discarded and not recorded will have resulted in an under-reported total, particularly before their inclusion in the QMS.

In the early to mid-1980s about half of reported ghost shark landings were from FMA 3. Virtually all the additional catch was spread over FMAs 4–7. In 1988–89, landings from west coast South Island (FMA 7) began to increase, almost certainly associated with the development of the hoki fishery. In

1990–91, significant landing increases were apparent on the Chatham Rise, off southeast South Island and on the Campbell Plateau. The development of fisheries for non-spawning hoki were probably responsible for these increases.

Table 2: Reported landings (t) of both ghost shark species by fishing year and EEZ area, taken by foreign licensed and joint venture vessels. An approximation of these areas with respect to current QMA boundaries is used to assign catches to QMAs. No data are available for the 1980–81 fishing year.

Year	EEZ Area												
	B	C(M)	C(1)	D	E(B)	E(P)	E(C)	E(A)	F(E)	F(W)	G	H	Total
QMA	1&2	3	4	6	5	7	8						
1978–79*	1	37	99	26	3	16	11	88	90	8	68	17	465
1979–80*	1	55	54	426	10	4	28	138	183	7	1	5	912
1980–81*													-
1981–82*	0	84	28	117	0	2	6	29	71	9	4	0	350
1982–83*	0	108	35	84	0	2	17	98	99	29	1	1	474
1983–83#	0	84	41	73	0	0	17	5	16	17	0	0	253

* 1 April to 31 March # 1 April to 30 Sept.

Estimated landings of dark ghost shark by QMA are shown in Table 3 and Table 4, and the historical landings and TACC for the main GSH stocks are depicted in Figure 1.

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

Year	GSH 1	GSH 2	GSH 3	GSH 4	GSH 5	GSH 6	GSH 7	GSH 8
1931–32	0	0	0	0	0	0	0	0
1932–33	0	0	0	0	0	0	0	0
1933–34	0	0	0	0	0	0	0	0
1934–35	0	0	0	0	0	0	0	0
1935–36	0	0	0	0	0	0	0	0
1936–37	0	0	0	0	0	0	0	0
1937–38	0	0	0	0	0	0	0	0
1938–39	0	0	0	0	0	0	0	0
1939–40	0	0	0	0	0	0	0	0
1940–41	0	0	0	0	0	0	0	0
1941–42	0	0	0	0	0	0	0	0
1942–43	0	0	0	0	0	0	0	0
1943–44	0	0	0	0	0	0	0	0
1944	0	0	0	0	0	0	0	0
1945	0	0	0	0	0	0	0	0
1946	0	0	0	0	0	0	0	0
1947	0	0	0	0	0	0	0	0
1948	0	0	0	0	0	0	0	0
1949	0	0	0	0	0	0	0	0
1950	0	0	0	0	0	0	0	0
1951	0	0	0	0	0	0	0	0
1952	0	0	0	0	0	0	0	0
1953	0	0	0	0	0	0	0	0
1954	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	0	0	0
1957	0	0	0	0	0	0	0	0
1958	0	0	0	0	0	0	0	0
1959	0	0	0	0	0	0	0	0
1960	0	0	0	0	0	0	0	0
1961	0	0	0	0	0	0	0	0
1962	0	0	0	0	0	0	0	0
1963	0	0	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	0	0	0
1966	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0
1972	0	0	103	0	11	0	0	0
1973	0	0	0	0	0	0	0	0
1974	0	0	7	0	1	0	0	0
1975	0	0	8	0	1	0	0	0
1976	0	0	19	0	2	0	0	1
1977	0	0	2	0	0	0	0	0
1978	0	0	54	0	100	30	15	2
1979	0	2	486	383	178	131	268	2
1980	0	0	150	230	92	144	144	28
1981	0	0	233	243	111	35	17	17
1982	0	0	320	97	223	29	11	7

Notes: The 1931–1943 years are April–March but from 1944 onwards are calendar years. Data up to 1985 are from fishing returns; data from 1986 to 1990 are from Quota Management Reports. 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).

Landings from 1983–84 to 1994–95 were derived by splitting all reported ghost shark landings into depth and area bins and allocating to species based on distribution data derived from trawl surveys (see Section 2). Landings from 1995–96 to 1998–99 were estimated assuming dark ghost shark made up 70% of the total ghost shark catch in FMAs 5 and 6, and 75% in all other FMAs. However, this approach assumes that the proportion that each species contributes to the whole is consistent from year to year and does not change in response to various sources of mortality, fishing-induced or otherwise. As such, the data covered by this time period should be treated with caution. Catches from the 1999–00 fishing year are more reliable, when pale ghost shark had also been included in the QMS, bringing both under the system.

Table 4: Estimated landings (t) of dark ghost shark by Fishstock from 1982–83 to present, based on reported landings of both ghost shark species combined, and actual TACCs set from 1998–99. * - FSU data. [Continued on next page]

Fishstock	GSH 1		GSH 2		GSH 3		GSH 4		GSH 5	
FMA (s)	1		2		3		4		5	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1982–83*	1	–	< 1	–	151	–	65	–	35	–
1983–84*	0	–	< 1	–	185	–	65	–	42	–
1984–85*	< 1	–	4	–	136	–	95	–	50	–
1985–86*	< 1	–	1	–	276	–	60	–	30	–
1986–87	3	–	13	–	472	–	97	–	34	–
1987–88	4	–	< 1	–	539	–	53	–	49	–
1988–89	9	–	27	–	460	–	21	–	67	–
1989–90	1	–	14	–	383	–	29	–	78	–
1990–91	1	–	40	–	665	–	271	–	70	–
1991–92	4	–	7	–	444	–	179	–	81	–
1992–93	8	–	5	–	399	–	151	–	76	–
1993–94	7	–	7	–	569	–	144	–	51	–
1994–95	3	–	2	–	737	–	187	–	63	–
1995–96	13	–	37	–	678	–	253	–	71	–
1996–97	17	–	66	–	817	–	402	–	94	–
1997–98	17	–	17	–	767	–	262	–	70	–
1998–99	18	15	60	37	950	1 187	318	373	64	109
1999–00	15	15	51	37	938	1 187	173	373	71	109
2000–01	15	10	50	33	1 111	1 185	179	370	85	109
2001–02	22	10	52	33	1 068	1 185	241	370	76	109
2002–03	17	10	58	33	1 371	1 185	265	370	93	109
2003–04	21	10	84	33	894	1 185	157	370	45	109
2004–05	14	10	74	33	880	1 185	282	370	80	109
2005–06	20	10	57	33	583	1 185	318	370	61	109
2006–07	20	22	60	66	654	1 185	396	370	115	109
2007–08	19	22	100	66	484	1 185	562	370	67	109
2008–09	14	22	71	66	490	1 185	251	370	61	109
2009–10	13	22	64	66	520	1 185	233	370	108	109
2010–11	17	22	95	66	640	1 185	311	370	73	109
2011–12	11	22	57	66	497	1 185	482	370	72	109
2012–13	12	22	51	66	420	1 185	210	370	111	109
2013–14	15	22	83	89	667	1 185	201	370	53	109
2014–15	16	22	44	89	406	1 185	217	370	42	109
2015–16	21	22	38	89	547	1 185	217	370	56	109
2016–17	21	22	47	89	493	1 185	223	370	83	109
2017–18	21	22	53	89	584	1 185	198	370	63	109
2018–19	28	22	40	89	528	1 185	166	370	51	109
2019–20	26	22	44	89	349	1 185	147	370	55	109
2020–21	28	22	61	89	419	1 185	191	370	54	109
2021–22	18	30	33	89	389	1 185	125	370	51	109
2022–23	21	30	23	89	472	1 185	137	370	47	109
2023–24	17	30	43	89	505	1 185	137	370	65	109

Fishstock	GSH 6		GSH 7		GSH 8		GSH 9		Total	
FMA (s)	6		7		8		9			
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1982–83*	19	–	10	–	< 1	–	0	–	282	–
1983–84*	56	–	38	–	< 1	–	0	–	387	–
1984–85*	61	–	63	–	< 1	–	0	–	409	–
1985–86*	41	–	31	–	3	–	0	–	442	–
1986–87	36	–	71	–	4	–	0	–	729	–
1987–88	6	–	68	–	1	–	0	–	720	–
1988–89	6	–	133	–	2	–	0	–	725	–
1989–90	9	–	180	–	27	–	0	–	722	–
1990–91	94	–	217	–	3	–	0	–	1 361	–
1991–92	80	–	124	–	3	–	1	–	923	–
1992–93	68	–	221	–	11	–	0	–	938	–
1993–94	53	–	513	–	14	–	0	–	1 357	–
1994–95	61	–	703	–	3	–	0	–	1 778	–

Table 4 [Continued]:

Fishstock	GSH 6		GSH 7		GSH 8		GSH 9		Total	
FMA (s)	6		7		8		9			
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1995–96	68	–	548	–	8	–	3	–	1 679	–
1996–97	135	–	926	–	9	–	11	–	2 477	–
1997–98	136	–	170	–	3	–	12	–	1 454	–
1998–99	110	95	409	1 121	7	12	22	14	1 958	2 963
1999–00	117	95	466	1 121	19	12	25	14	1 875	2 963
2000–01	76	95	475	1 121	22	12	31	8	2 043	2 943
2001–02	94	95	463	1 121	22	12	25	8	2 063	2 943
2002–03	99	95	593	1 121	15	12	20	8	2 531	2 943
2003–04	72	95	652	1 121	27	12	12	8	1 964	2 943
2004–05	53	95	694	1 121	31	12	10	8	2 118	2 943
2005–06	31	95	625	1 121	22	12	8	8	1 725	2 943
2006–07	43	95	696	1 121	16	22	6	22	2 006	3 012
2007–08	36	95	601	1 121	29	22	13	22	1 911	3 012
2008–09	49	95	991	1 121	24	22	16	22	1 967	3 012
2009–10	19	95	1 037	1 121	29	22	6	22	2 028	3 012
2010–11	38	95	1 129	1 121	33	22	6	22	2 341	3 012
2011–12	37	95	1 041	1 121	37	22	6	22	2 240	3 012
2012–13	70	95	767	1 121	32	22	10	22	1 683	3 012
2013–14	72	95	691	1 121	27	34	9	22	1 817	3 047
2014–15	72	95	458	1 121	20	34	7	22	1 283	3 047
2015–16	64	95	400	1 121	19	34	6	22	1 368	3 047
2016–17	59	95	423	1 121	19	34	14	22	1 382	3 047
2017–18	71	95	329	1 121	18	34	25	22	1 363	3 047
2018–19	68	95	485	1 121	20	34	19	22	1 406	3 047
2019–20	35	95	333	1 121	28	34	24	22	1 039	3 047
2020–21	49	95	345	1 121	16	34	14	22	1 177	3 047
2021–22	39	95	266	1 121	17	34	18	22	956	3 055
2022–23	78	95	228	1 121	21	34	11	22	1 039	3 055
2023–24	37	95	223	1 121	20	34	7	22	1 052	3 055

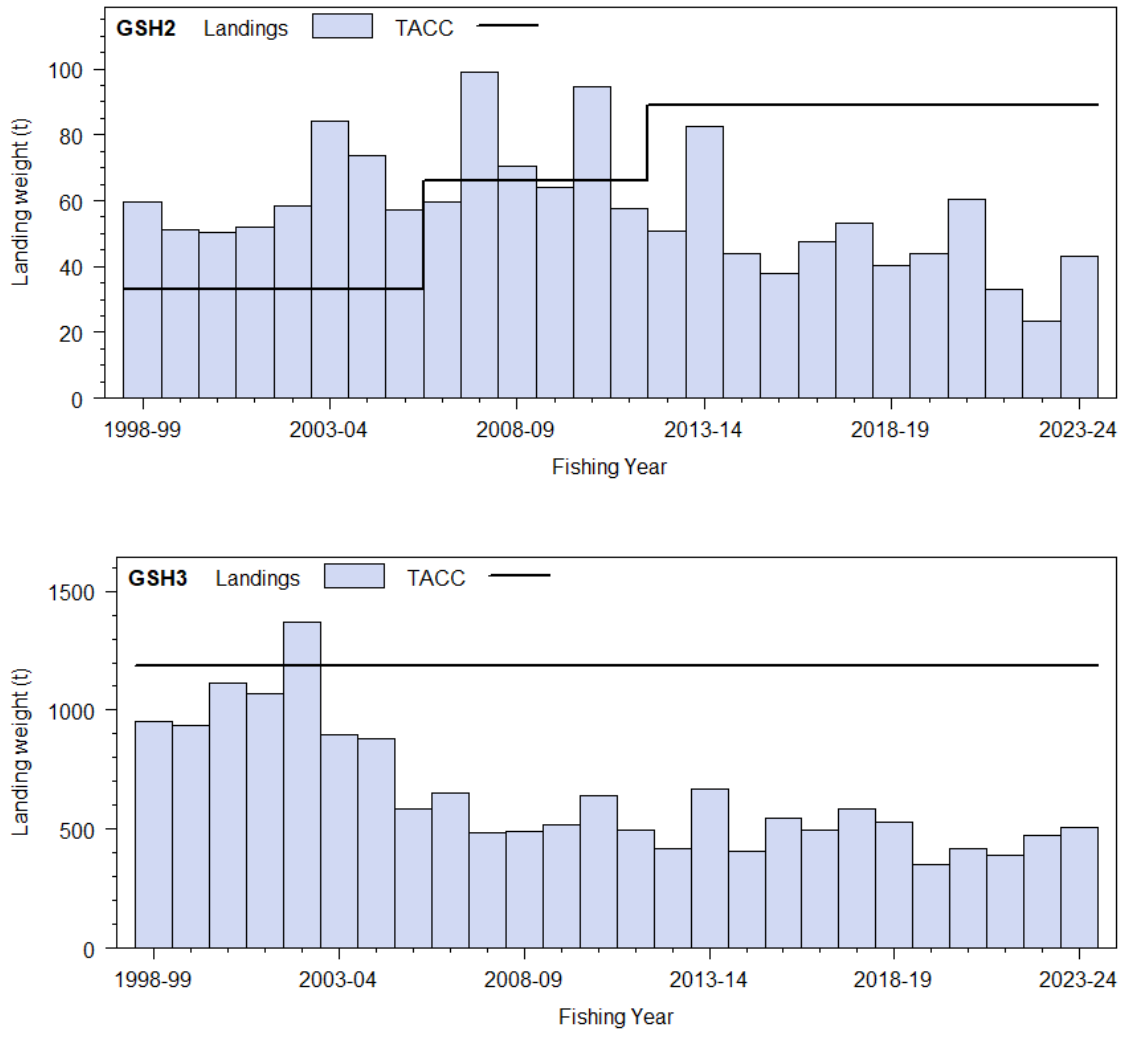


Figure 1: Reported commercial landings and TACC for GSH stocks. From top GSH 2 (Central East) and GSH 3 (South East Coast). [Continued on next page]

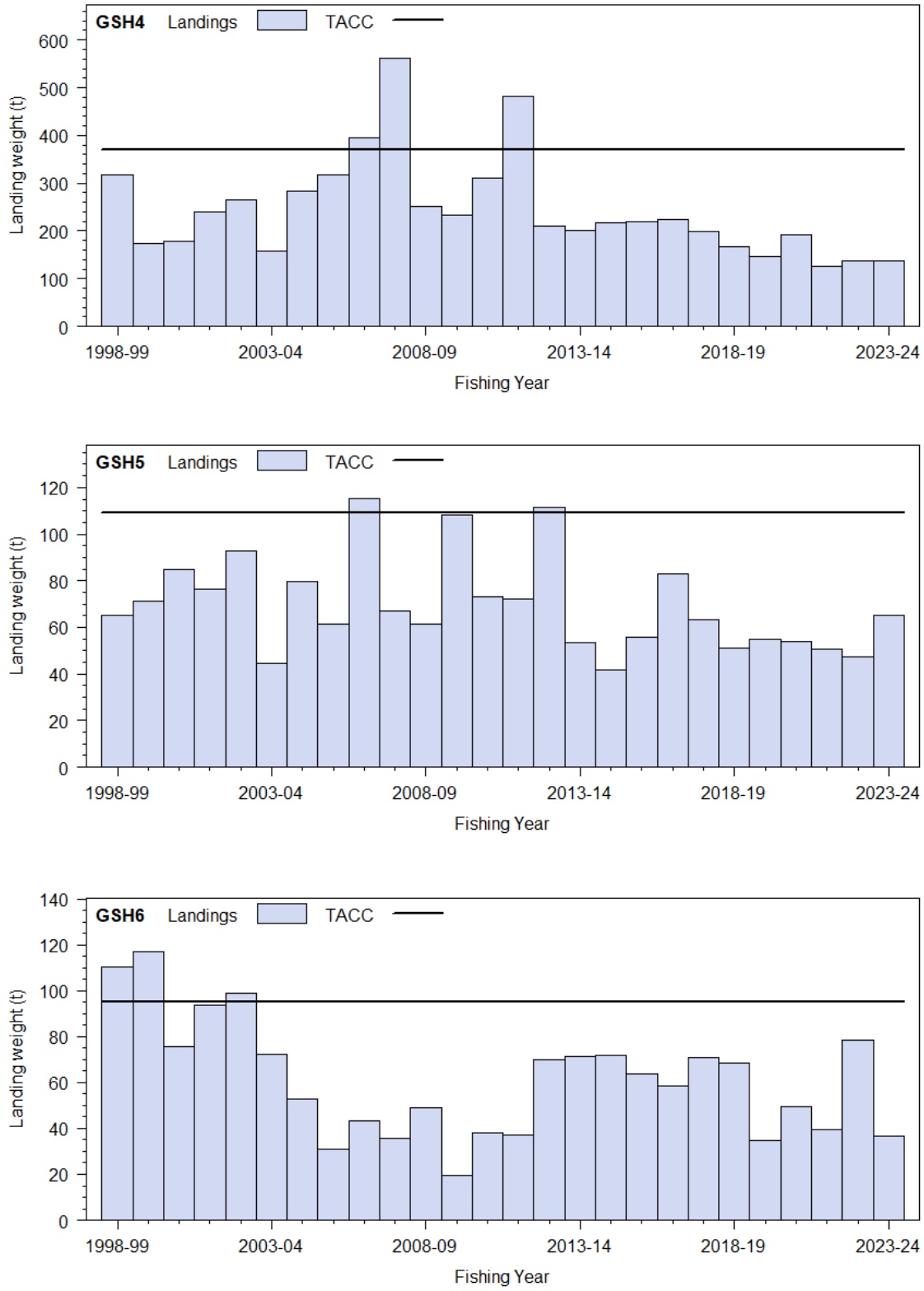


Figure 1 [Continued]: Reported commercial landings and TACC for GSH stocks. From top GSH 4 (South East Chatham Rise), GSH 5 (Southland), GSH 6 (Sub-Antarctic), and GSH 7 (west coast South Island).

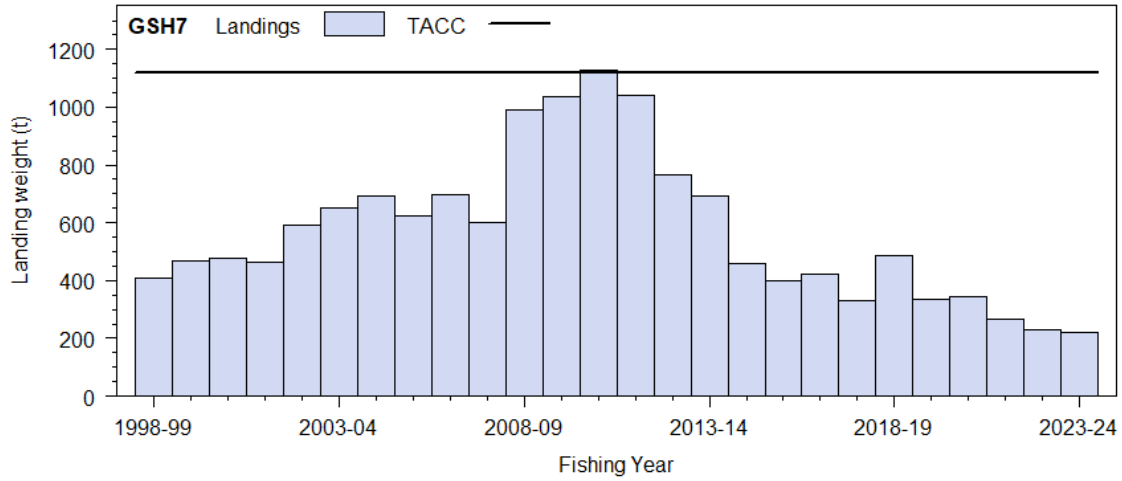


Figure 1 [Continued]: Reported commercial landings and TACC for GSH stocks. GSH 7 (west coast South Island).

The TACs currently applied to dark ghost shark were initially intended to apply to a combined fishery for both species, based on the average catch of both species over various periods (see the "Review of Sustainability Measures and Other Management Controls for the 1998–99 Fishing Year - Final Advice Paper" dated 6 August 1998). No allowance for non-commercial interests was included in the final allocation because recreational and customary non-commercial catches are likely to be very small due to the depth distribution of this species.

TACCs were increased from 1 October 2006 in GSH 1 to 22 t, in GSH 2 to 66 t, in GSH 8 to 22 t, and in GSH 9 to 22 t. In these stocks landings had been above the TACC for a number of years and the TACCs were increased to the average of the previous 7 years plus an additional 10%. In GSH 2 and 8 landings continued to consistently exceed the TACCs after 2006. Consequently, the TACCs were further increased to 89 t in GSH 2 and 34 t in GSH 8 in 2013. Landings have remained below the TACCs for all GSH stocks since 2013.

1.2 Recreational fisheries

Current catches of dark ghost sharks by recreational fishers are believed to be negligible in all areas.

1.3 Customary non-commercial fisheries

Quantitative information on the current level of customary non-commercial catch is not available but is likely to be negligible.

1.4 Illegal catch

Quantitative information on the level of illegal catch is not available. In 1998–99 (when dark ghost shark were in the QMS, but pale ghost shark were not), a quantity of dark ghost shark was reported as pale ghost shark.

1.5 Other sources of mortality

Ghost sharks have been dumped and not reported in the past by commercial fishers in QMAs 1 and 2. Similar behaviour is believed to occur in all other QMAs. The extent of the unreported dumping is unknown in all areas.

2. BIOLOGY

Dark ghost sharks (*Hydrolagus novaezelandiae*) occur throughout much of the New Zealand EEZ in depths from 30 to 850 m, and bottom water temperatures of about 7–15 °C, but they are sparse north of 40° S and have not been recorded from the Bounty Plateau. They are most abundant in waters 150–500 m deep off the west coast South Island and on the Chatham Rise, and in depths of 150–700 m on

the Stewart-Snares shelf and in Southland/sub-Antarctic waters. Smaller sharks (under 40 cm chimaera length) are more abundant in waters shallower than 200 m, particularly in the Canterbury Bight. There have been no notable changes in the dark ghost shark spatial catch distribution over the last 30 years.

Trawl surveys show that dark and pale ghost sharks exhibit niche differentiation, with depth being the most influential factor, although there is some overlap of habitat. On the Chatham Rise, the main overlap range appears quite compact (from about 340 to 540 m). In the Southland/sub-Antarctic region, the overlap range is wider (about 350 to 770 m). Stomach contents indicate that both species are predominantly benthic feeders. Dark ghost sharks may occasionally be caught in densities of 50–60 fish per km^2, being the highest density amongst the common chimaera species. Larger catches have included both adults and juveniles, but with the proportion of juveniles increasing with catch size, suggesting that nursery grounds may occur. Dark ghost sharks of < 40 cm chimaera length have been frequently caught in research surveys, but nursery grounds have not yet been described. Mating and egg laying grounds have not yet been identified.

A research report by Francis & Ó Maolagáin (2001) found that eye lens diameter showed potential as an ageing technique, but further work was needed. They calculated von Bertalanffy parameters (Table 5) from trawl survey-caught fish and found that growth rates were similar and moderately rapid for males and females, with both sexes reaching 50 cm in 5–9 years. They cautioned the use of these parameters, however, as ageing of dark ghost sharks had not been validated. Length-frequency histograms indicate that females grow to a larger size than males. Without population age structures or confident estimates of longevity, it is not possible to estimate natural or total mortalities. Preliminary studies of the related *Hydrolagus colliei* found ages up to 21 years, and of *Chimaera monstrosa* found ages of up 30 years.

On the Chatham Rise, the estimated size at 50% sexual maturity for dark ghost sharks is 52–53 cm for males and 62–63 cm for females. As for most other elasmobranchs, ghost shark fecundity is likely to be low. Maturity has been associated with a detectable change in growth form in males. Mature and gravid female dark ghost sharks have been caught in small numbers on Chatham Rise, sub-Antarctic, and west coast South Island *Tangaroa* surveys, and at a higher relative abundance in the east coast South Island *Kaharoa* survey. Maturity data for other surveyed areas are lacking. Predators of ghost sharks are known to include ling, stargazer, and red cod. Length-weight parameters are shown in Table 6.

Table 5: Proposed von Bertalanffy growth parameters for dark ghost shark. Source: Francis & Ó Maolagáin (2001).

		von Bertalanffy growth parameters		
Region	**Sex**	L_∞	K	t_0
East coast South Island	Female	135.3	0.052	–0.94
	Male	89.0	0.091	–0.61
West coast South Island	Female	123.0	0.065	–1.15
	Male	123.4	0.044	–1.43
Stewart–Snares shelf	Female	122.1	0.087	–1.01
	Male	108.0	0.073	–1.34
Chatham Rise	Female	97.0	0.090	–1.17
	Male	–	–	–

Table 6: Length-weight parameters for dark ghost shark.

1. Weight = a (length)^b (Weight in g, length in cm chimaera length)

	Estimate		
Area	a	b	Source
Chatham Rise	0.002986	3.170546	O'Driscoll et al (2011)
Sub-Antarctic	0.001653	3.3256	Bagley et al (2013)

3. STOCKS AND AREAS

The only information which may indicate a stock boundary is an apparent difference in maximum size of dark ghost sharks, with both males and females from the Chatham Rise attaining a maximum size 3–4 cm greater than those in Southland/sub-Antarctic waters.

Horn (1997) proposed that ghost sharks be managed as three Fishstocks, i.e., east coast New Zealand (FMAs 1–4), Stewart-Snares shelf and Campbell Plateau (FMAs 5 and 6), and west coast New Zealand (FMAs 7, 8, and 9). Areas of narrow continental shelf separate these FMA groupings, so they could well provide barriers to stock mixing for pale ghost shark which prefer deeper water. This would be less influential for dark ghost shark, however, which are found much shallower. Pale ghost shark were allocated to the QMAs following the recommendation by Horn when introduced into the QMS, but dark ghost shark were already allocated on the basis of the generic FMAs.

4. STOCK ASSESSMENT

East coast (FMAs 1, 2, 3, & 4)

East coast South Island winter trawl surveys

Total biomass in the east coast South Island winter survey core strata (30–400 m) increased 16-fold between 1992 and 2016, before a 57% decline in 2018, and an 85% increase in 2021, after which biomass has remained around 12 000 t (Figure 2, Table 7). All surveys had a large component of juvenile biomass (based upon the assumed length of first maturity) ranging from 30 to 61% and in 2024 it was 35%.

The spatial distribution of dark ghost shark has been similar over the time series of surveys and confined to the outer continental shelf and slope edge, with the largest catch rates more often off Timaru. Over the fifteen core strata surveys, dark ghost shark were present in 27–58% of tows, with higher occurrence after 1996, and they show a variable but generally increasing trend of occurrence.

The dark ghost shark size distributions in each of the surveys from 1993 to 2009 were similar and generally bimodal. The 2012, 2014, and 2016 length frequency distributions were distinct from previous years, with the appearance of relatively larger numbers of adults or mature fish, commensurate with the large biomass increase over this period. These larger fish still accounted for a high proportion of the total biomass in 2018, and particularly in 2021 and 2022, and good recruitment (under 40 cm) in 2021 was observed in the 2022 and 2024 distributions.

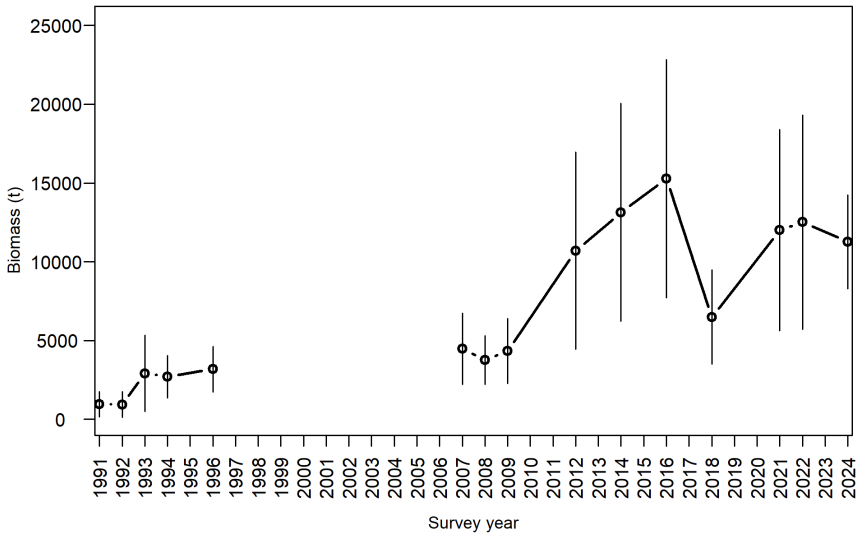


Figure 2: Biomass for dark ghost shark from the east coast South Island winter trawl surveys in core strata (30–400 m). Error bars are ±2 standard errors.

Table 7: Biomass indices (t) and coefficients of variation (CV). Estimates for the Chatham Rise and sub-Antarctic summer surveys on *Tangaroa* are for core strata only (200–800 and 300–800 m respectively). [Continued on next page]

FMA	Area	Vessel	Trip code	Date	Biomass (t)	% CV
3 & 4	Chatham Rise	*Tangaroa*	TAN9106	Jan-Feb 1992	6 700	11.1
			TAN9212	Jan-Feb 1993	5 950	9.2
			TAN9401	Jan 1994	10 360	15.3
			TAN9501	Jan 1995	3 490	11.2
			TAN9601	Jan 1996	6 170	12.4
			TAN9701	Jan 1997	6 240	11.7
			TAN9801	Jan 1998	6 720	14.1
			TAN9901	Jan 1999	12 125	23.4
			TAN0001	Jan 2000	9 154	25.2
			TAN0101	Jan 2001	10 356	11.7
			TAN0201	Jan 2002	9 997	11.1
			TAN0301	Jan 2003	10 341	9.1
			TAN0401	Jan 2004	10 471	15.0
			TAN0501	Jan 2005	11 885	16.3
			TAN0601	Jan 2006	11 502	11.9
			TAN0701	Jan 2007	7 852	10.6
			TAN0801	Jan 2008	9 391	10.9
			TAN0901	Jan 2009	8 445	13.7
			TAN1001	Jan 2010	11 596	16.8
			TAN1101	Jan 2011	6 588	16.6
			TAN1201	Jan 2012	13 162	20.6
			TAN1301	Jan 2013	11 723	11.6
			TAN1401	Jan 2014	9 050	17.5
			TAN1601	Jan 2016	12 129	12.2
			TAN1801	Jan 2018	5 580	17.5
			TAN2001	Jan 2020	8 101	19.6
			TAN2201	Jan 2022	8 995	17.9
5 & 6	Southland & Sub-Antarctic	*Tangaroa* (summer)	TAN9105	Nov-Dec 1991	1 030	25.4
			TAN9211	Nov-Dec 1992	710	43.2
			TAN9310	Nov-Dec 1993	1 060	33.6
			TAN0012	Nov-Dec 2000	1 459	89.6
			TAN0118	Nov-Dec 2001	1 391	35.7
			TAN0219	Nov-Dec 2002	175	37.7
			TAN0317	Nov-Dec 2003	382	48.9
			TAN0414	Nov-Dec 2004	843	41.7
			TAN0515	Nov-Dec 2005	517	40.2
			TAN0617	Nov-Dec 2006	354	32.0
			TAN0714	Nov-Dec 2007	659	37.2
			TAN0813	Nov-Dec 2008	1 128	32.1
			TAN0911	Nov-Dec 2009	433	43.1
			TAN1117	Nov-Dec 2011	3 709	75.0
			TAN1215	Nov-Dec 2012	1 794	68.3
			TAN1412	Nov-Dec 2014	1 400	46.7
			TAN1614	Nov-Dec 2016	808	69.0
			TAN1811	Nov-Dec 2018	2 299	50.1
			TAN2014	Nov-Dec 2020	1 623	64.9
		Tangaroa (autumn)	TAN9204	Mar-Apr 1992	3 740	48.6
			TAN9304	Apr-May 1993	750	44.7
			TAN9605	Mar-Apr 1996	3 080	47.6
			TAN9805	Apr-May 1998	2 490	44
5	Stewart-Snares	*Tangaroa*	TAN9301	Feb-Mar 1993	120	44
			TAN9402	Feb-Mar 1994	490	43
			TAN9502	Feb-Mar 1995	790	71
			TAN9604	Feb-Mar 1996	1 870	63
7	West coast South Island	*Tangaroa*	TAN0007	Jun-Aug 2000	77	26.9
			TAN1210	Jul-Aug 2012	106	70.4
			TAN1308	Jul-Aug 2013	75	43.0
			TAN1609	Jul-Aug 2016	39	26.3
			TAN1807	Jul-Aug 2018	46	29.6
			TAN2107	Jul-Aug 2021	42	21.3
7	West coast South Island	*Kaharoa*	KAH9204	Mar-Apr 1992	375	20.1
			KAH9404	Mar-Apr 1994	722	14.3
			KAH9504	Mar-Apr 1995	767	23.7
			KAH9701	Mar-Apr 1997	1 591	21.2
			KAH0004	Mar-Apr 2000	2 259	8.8
			KAH0304	Mar-Apr 2003	554	15.1
			KAH0503	Mar-Apr 2005	832	21.5
			KAH0704	Mar-Apr 2007	2 215	20.7
			KAH0904	Mar-Apr 2009	900	17.3
			KAH1104	Mar-Apr 2011	2 363	22.6
			KAH1305	Mar-Apr 2013	981	22.6
			KAH1503	Mar-Apr 2015	1 211	54.6
			KAH1703	Mar-Apr 2017	772	36.8
			KAH1902	Mar-Apr 2019	518	27.2
			KAH2103	Mar-Apr 2021	258	29.3

Table 7 [Continued]

FMA	Area	Vessel	Trip code	Date	Biomass (t)	% CV
2	East coast North Island	*Kaharoa*	KAH9304	Mar-Apr 1993	450	61.5
			KAH9402	Feb-Mar 1994	40	41.3
			KAH9502	Feb-Mar 1995	10	48.6
			KAH9602	Feb-Mar 1996	80	33.5
3	East coast South Island winter surveys (core strata 30–40 m)	*Kaharoa*	KAH9105	May 1991	962	42
			KAH9205	May 1992	934	44
			KAH9306	May 1993	2 911	42
			KAH9406	May 1994	2 702	25
			KAH9606	May 1996	3 176	23
			KAH0705	May 2007	4 483	25
			KAH0806	May-Jun 2008	3 763	20
			KAH0905	May-Jun 2009	4 330	24
			KAH1207	Apr-Jun 2013	10 704	29
			KAH1402	Apr-Jun 2014	13 137	26
			KAH1605	Apr-Jun 2016	15 271	26
			KAH1803	Apr-Jun 2018	6 485	23
			KAH2104	Apr-Jun 2021	12 004	27
			KAH2204	May-Jun 2022	12 519	27
			KAH2402	May-Jun 2024	11 257	13
3	East coast South Island summer surveys	*Kaharoa*	KAH9618	Dec '96-Jan '97	3 066	18
			KAH9704	Dec '97-Jan '98	5 870	33
			KAH9809	Dec '98-Jan '99	7 416	27
			KAH9917	Dec '99-Jan '00	2 512	19
			KAH0014	Dec '00-Jan '01	2 950	18

Chatham Rise winter trawl surveys

The Chatham Rise trawl survey time series is not optimised for dark ghost shark, but biomass estimates were relatively precise (Figure 3, Table 7). This time series may provide a reasonable index of abundance for that part of the eastern fishery covered by GSH 4. However, the survey extends into GSH 3 where commercial catches of dark ghost shark are significant but shallower than the survey's starting depth of 200 m. The length composition of the catches has been unimodal except during 2004–2010 when it was more bimodal, with most males 40–60 cm and females 40–70 cm.

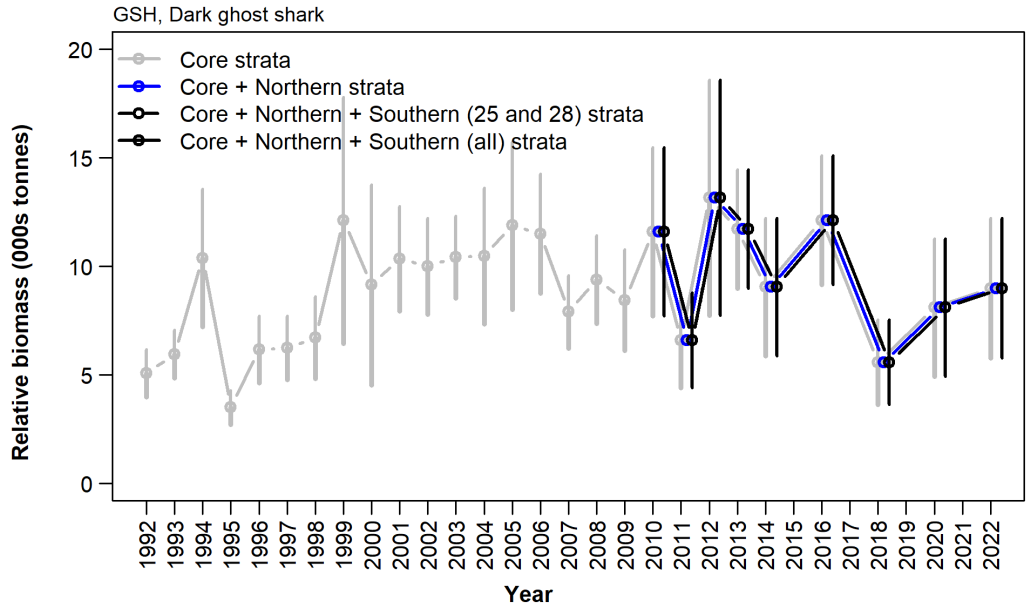


Figure 3: Biomass for dark ghost shark from the Chatham Rise trawl survey. Error bars are ± 2 standard errors.

Stewart-Snares shelf and Campbell Plateau (FMAs 5 and 6)

Sub-Antarctic winter trawl surveys

Biomass indices from the sub-Antarctic trawl survey time series are significantly lower than those for the east coast South Island and Chatham Rise surveys. Indices have fluctuated somewhat often with relatively high CVs (Figure 4, Table 7). The large spike seen in 2011 was due to randomly allocated stations within stratum 6 (300–600 m) that were located at the shallower, northern end of the stratum

where dark ghost shark were more likely to be encountered. The starting depth of 300 m and the high CVs mean that this survey is unlikely to be a reliable index of abundance.

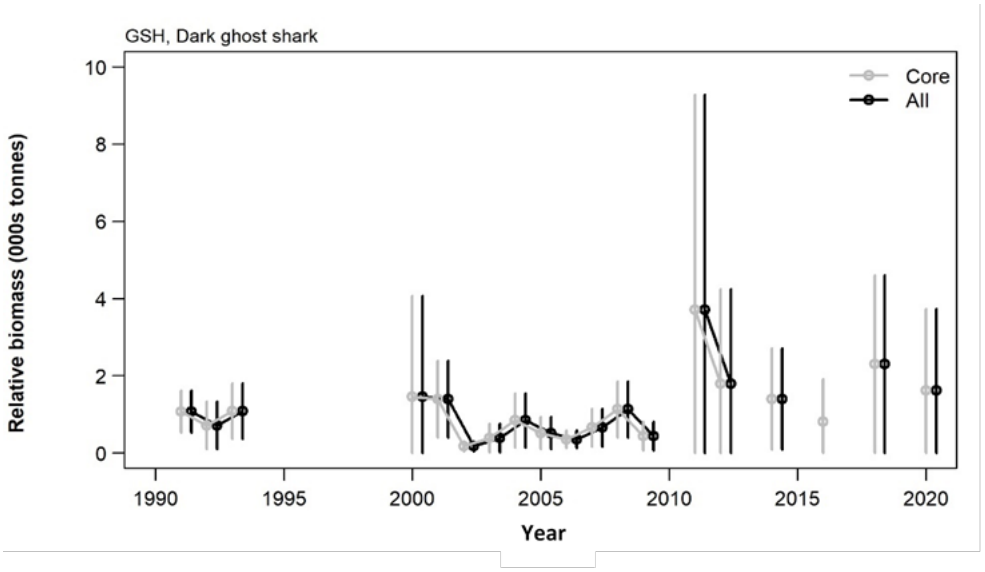


Figure 4: Biomass trends ±95% CI (estimated from survey CVs assuming a lognormal distribution) from the Sub- Antarctic trawl survey.

West coast New Zealand (FMAs 7, 8, and 9)

West coast South Island winter trawl surveys

Biomass estimates from the west coast South Island inshore trawl survey declined to a series low in 2021 but have fluctuated considerably and seem unlikely to reflect real changes in abundance (Figure 5).

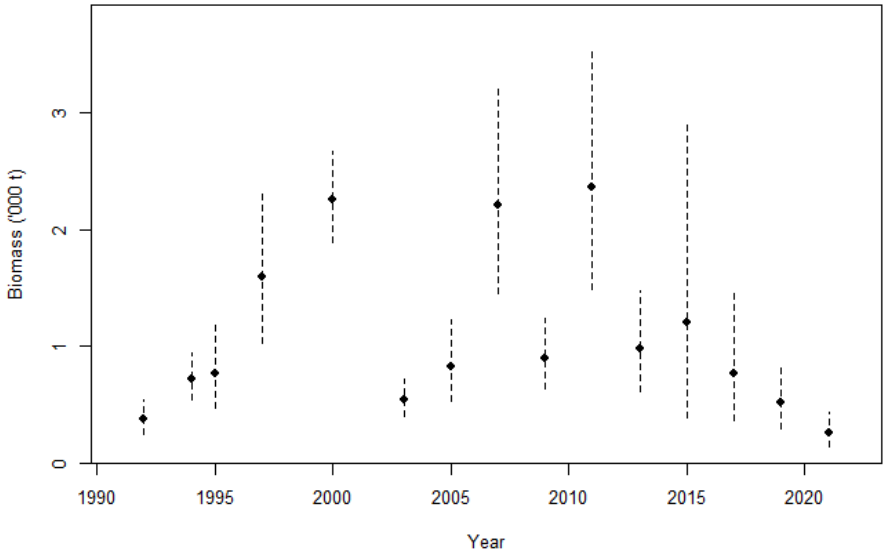


Figure 5: Biomass trends ±95% CI (estimated from survey CVs assuming a lognormal distribution) from the west coast South Island *Kaharoa* trawl survey core strata.

Biomass estimates from the west coast South Island offshore trawl survey have declined after a higher biomass in 2012 and then been similar in 2016, 2018, and 2021 (Figure 6, Table 7). The survey has caught both juvenile and mature dark ghost shark, with most males 30–60 cm and most females 30–70 cm. Although the biomass in 2021 was similar to 2018 and 2016, the distribution in 2021 was substantially different and further north, with no dark ghost shark captured south of 41.5° S.

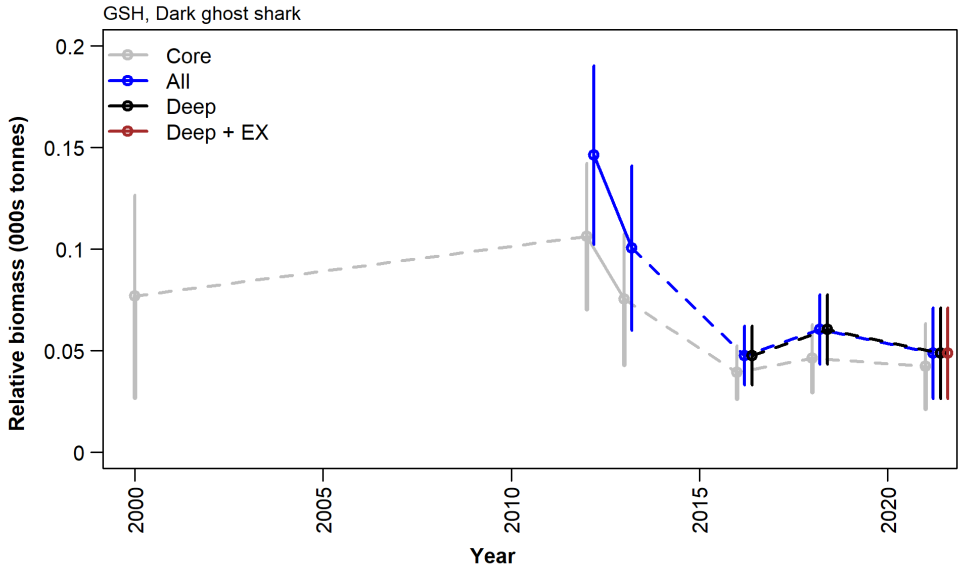


Figure 6: Biomass trends ±95% CI (estimated from survey CVs assuming a lognormal distribution) from the west coast South Island *Tangaroa* trawl survey.

Establishing interim B_{MSY}-compatible reference points

In 2022 the Working Group discussed establishing interim B_{MSY}-compatible reference levels. The trawl survey series were accepted as valid estimates of relative stock biomass, albeit with some reservations (see Future Research Considerations). However, it was agreed that further knowledge of the fisheries exploitation patterns was needed to credibly evaluate the trawl survey series in relation to catches.

4.1 Other factors

Elasmobranchs are believed to have a strong stock-recruit relationship; the number of young born is related directly to the number of adult females. Ghost shark fecundity is unknown but is probably low.

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) and 2018 (Ford et al 2018). Dark ghost shark was ranked equal first (with five other species) in terms of risk for the eleven QMS chondrichthyan species, with a risk score of 18 (scoring 6/6 for fishing intensity and 3/6 for consequence). Data were described as existing but poor 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. FUTURE RESEARCH CONSIDERATIONS

- The fishery characterisation should be updated. The last characterisation covered the period to 2010–11. The characterisation should evaluate standardised CPUE (in particular from the hoki fishery) as a further potential biomass index and compare catches by length for the fisheries and trawl surveys.
- Stock structure should be reviewed for all New Zealand simultaneously using all available data. This should include evaluating hypotheses for apparently contradictory trends in catch and biomass series within areas currently assumed to contain a single stock (e.g., GSH 1–4).

6. STATUS OF THE STOCKS

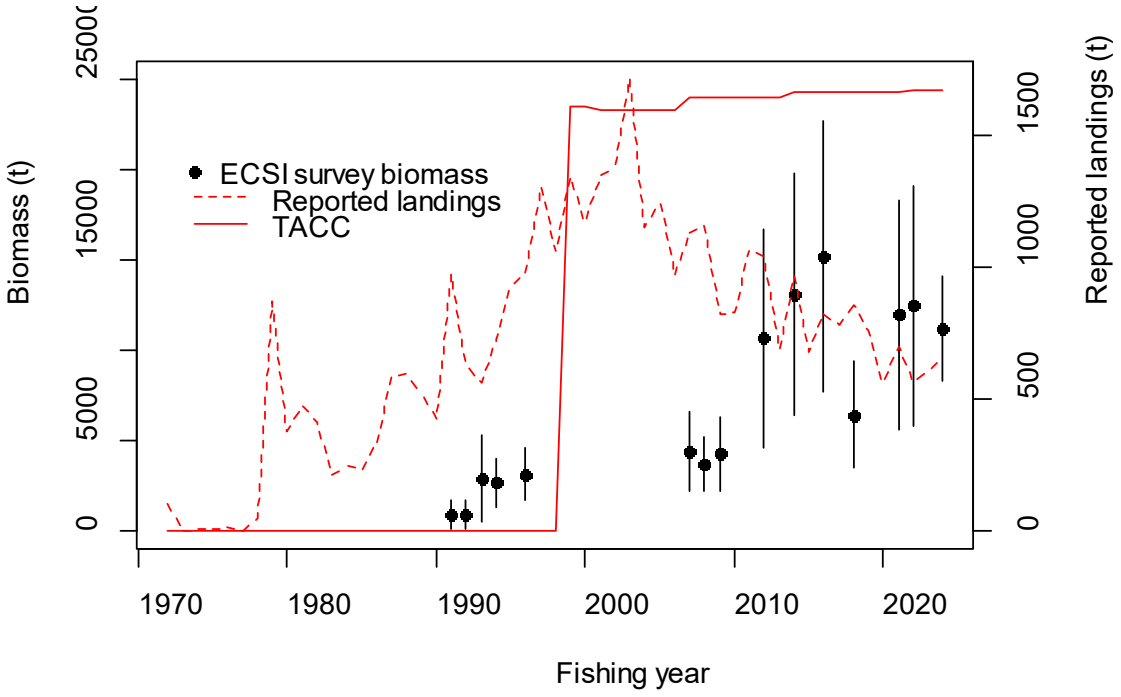
Stock structure assumptions

Three Fishstocks have been assumed: the east coast New Zealand (FMAs 1–4), Stewart-Snares shelf and sub-Antarctic (FMAs 5 and 6), and west coast New Zealand (FMAs 7, 8, and 9).

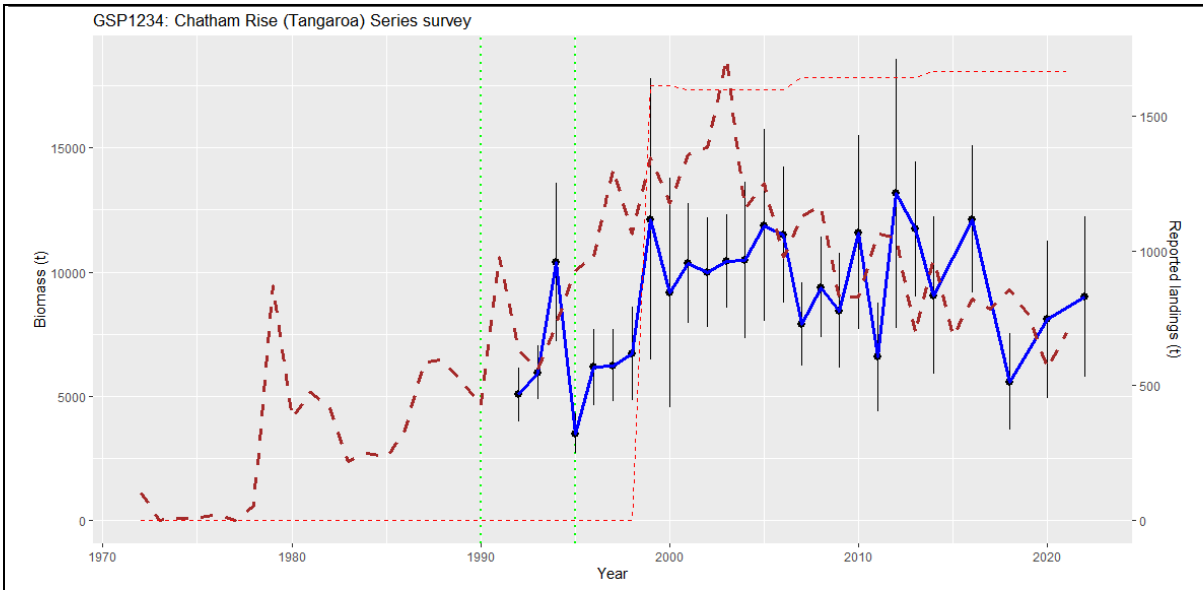
- **Chatham Rise and ECSI (GSH 1–4)**

Stock Status		
Most Recent Assessment Plenary Publication Year	2023	
Intrinsic Productivity Level	Medium	
Catch in most recent year of assessment	Year: 2021–22	Catch: 653 t
Assessment Runs Presented	Abundance indices based upon the Chatham Rise and east coast South Island trawl surveys	
Reference Points	Management Target: 40% B_0 Soft Limit: 20% B_0 Hard Limit: 10% B_0 Overfishing threshold: Not defined	
Status in relation to Target	Unknown	
Status in relation to Limits	Unknown	
Status in relation to Overfishing	Unknown	

Historical Stock Status Trajectory and Current Status



GSH 1–4: Relative biomass from east coast South Island (ECSI) *Kaharoa* winter trawl surveys. Black circles and vertical lines are ± 2 s.e.; dashed red line, reported QMR/MHR landings (right axis); solid red line, TACC for GSH 1–4 (right axis).



GSH 1–4: Relative biomass from Chatham Rise *Tangaroa* trawl survey. Blue line for Chatham Rise plus vertical lines showing ± 2 s.d. (left axis); dashed line, reported QMR/MHR landings (right axis); red dotted line, TACC for GSH 1–4 (right axis).

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Biomass indices from the east coast South Island inshore trawl survey time series remained relatively high, and biomass indices from Chatham Rise have fluctuated and remained stable.
Recent Trend in Fishing Intensity or Proxy	Unknown
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	-

Assessment Methodology		
Assessment Type	Level 2 – Partial Quantitative Stock Assessment	
Assessment Method	Evaluation of survey abundance index and length frequencies	
Assessment Dates	Latest assessment Plenary publication year: 2022	Next assessment: Unknown
Overall assessment quality rank	1 – High Quality	
Main data inputs	Survey abundance index Survey length frequency	1 – High Quality 1 – High Quality
Data not used (rank)	-	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	-	

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 Hard Limit: Unknown
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown

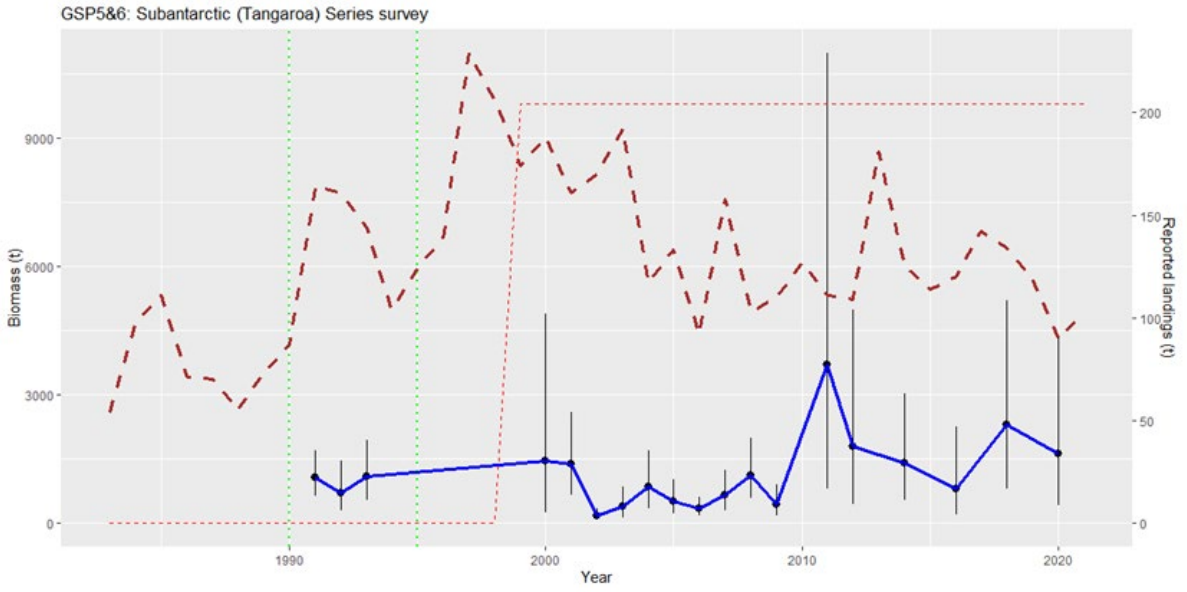
Qualifying Comments
-

Fishery Interactions
Dark ghost shark in the eastern fishery is caught exclusively as bycatch in other target fisheries with the two most important ones being hoki followed by arrow squid. For both target fisheries, incidental interactions and associated mortalities are noted for New Zealand fur seals and seabirds,and low productivity species taken in the fisheries include one basking shark in 2019–20 and deepsea skates.

- **Stewart-Snares shelf and Campbell Plateau (GSH 5 & 6)**

Stock Status		
Year of Most Recent Assessment	2023	
Intrinsic Productivity Level	Medium	
Catch in most recent year of assessment	Year: 2021–22	Catch: 90 t
Assessment Runs Presented	-	
Reference Points	Management Target: 40% B_0 Soft Limit: 20% B_0 Hard Limit: 10% B_0 Overfishing threshold: Not defined	
Status in relation to Target	Unknown	
Status in relation to Limits	Unknown	
Status in relation to Overfishing	Unknown	

Historical Stock Status Trajectory and Current Status



GSH 5 & 6: Relative biomass from Sub-Antarctic *Tangaroa* survey: blue line plus vertical lines showing ± 2 s.d. (left axis); dashed line, reported QMR/MHR landings (right axis); red dotted line, TACC for GSH 5 & 6 (right axis).

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Biomass indices from the summer sub-Antarctic trawl survey time series have been relatively high but uncertainty is high.
Recent Trend in Fishing Intensity or Proxy	Unknown
Other Abundance Indices	-
Trends in Other Relevant Indicators orVariables	-

Assessment Methodology		
Assessment Type	Level 2 – Partial Quantitative Stock Assessment	
Assessment Method	Evaluation of survey abundance index and length frequencies	
Assessment Dates	Latest assessment Plenary publication year: 2023	Next assessment: Unknown
Overall assessment quality rank	1 – High Quality	
Main data inputs	Survey abundance index Survey length frequency	1 – High Quality 1 – High Quality
Data not used (rank)	-	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	-	

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 Hard Limit: Unknown
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown

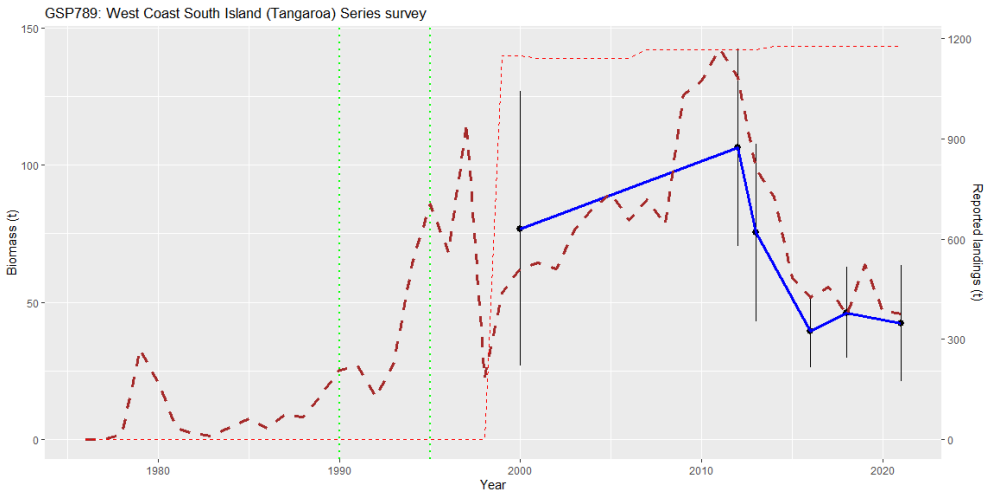
Qualifying Comments
-

Fishery Interactions
Dark ghost shark in the southern fishery is caught exclusively as bycatch in other target fisheries with the two most important ones being arrow squid followed by hoki. For both target fisheries, incidental interactions and associated mortalities have been recorded for New Zealand fur seals and seabirds, and low productivity species taken in the fisheries include one basking shark and deepsea skates.

- **Western stock (GSH 7, 8, & 9)**

Stock Status		
Most Recent Assessment Plenary Publication Year	2023	
Intrinsic Productivity Level	Medium	
Catch in most recent year of assessment	Year: 2021–22	Catch: 301 t
Assessment Runs Presented	Abundance index based on west coast South Island *Tangaroa* research trawl survey	
Reference Points	Management Target: 40% B_0 Soft Limit: 20% B_0 Hard Limit: 10% B_0 Overfishing threshold: Not defined	
Status in relation to Target	Unknown	
Status in relation to Limits	Unknown	
Status in relation to Overfishing	Unknown	

Historical Stock Status Trajectory and Current Status



GSH 7–9: Relative biomass from west coast South Island *Tangaroa* survey: blue line plus vertical lines showing ± 2 s.d. (left axis); dashed line, reported QMR/MHR landings (right axis); red dotted line, TACC for GSH 7–9 (right axis).

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Biomass has been stable for the last 5 years following a period of decline.
Recent Trend in Fishing Intensity or Proxy	Unknown
Other Abundance Indices	-
Trends in other relevant indicators or variables	-

Assessment Methodology		
Assessment Type	Level 2 – Partial Quantitative Stock Assessment	
Assessment Method	Evaluation of survey abundance index and length frequencies	
Assessment Dates	Latest assessment Plenary publication year: 2022	Next assessment: Unknown
Overall assessment quality rank	1 – High Quality	
Main data inputs	Survey abundance index Survey length frequency	1 – High Quality 1 – High Quality
Data not used (rank)	-	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	-	

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 Hard Limit: Unknown
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown

Qualifying Comments
-

Fishery Interactions
-

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