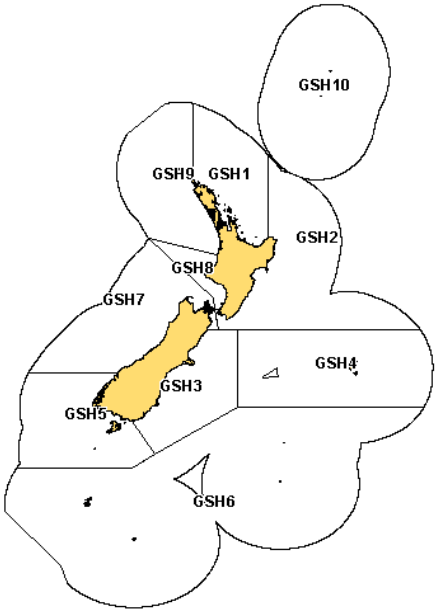
DARK GHOST SHARK (GSH)

(*Hydrolagus novaezealandiae*)



1. FISHERY SUMMARY

1.1 Commercial fisheries

Two species (dark and pale ghost sharks) make up effectively all the 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.

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 1. Landings by domestic (inshore) vessels would have been negligible during this time period. The unknown quantities of ghost sharks that were discarded and not recorded are likely to have resulted in under-reported total catches over the full period for which data are available.

In the early to mid 1980s about half of the 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 this is 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.

Estimated landings of dark ghost shark by QMA are shown in Table 2. 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.

Table 1: 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						
78–79*	1	37	99	26	3	16	11	88	90	8	68	17	465
79–80*	1	55	54	426	10	4	28	138	183	7	1	5	912
80–81*													–
81–82*	0	84	28	117	0	2	6	29	71	9	4	0	350
82–83*	0	108	35	84	0	2	17	98	99	29	1	1	474
83–83#	0	84	41	73	0	0	17	5	16	17	0	0	253

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

Table 2: Estimated landings (t) of dark ghost shark by Fishstock from 1982–83 to 2005–06, based on reported landings of both ghost shark species combined, and actual TACCs set from 1998–99. No landings have been recorded from FMA 10, and no TACC has been set for this area.

Fishstock	GSH 1		GSH 2		GSH 3		GSH 4		GSH 5	
FMA (s)	1		2		3		4		5	
	Landings	TAC	Landings	TAC	Landings	TAC	Landings	TAC	Landings	TAC
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

Fishstock	GSH 6		GSH 7		GSH 8		GSH 9			
FMA (s)	6		7		8		9		Total	
	Landings	TAC	Landings	TAC	Landings	TAC	Landings	TAC	Landings	TAC
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	–
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

Table 2 (*Continued*):

Fishstock	GSH 6		GSH 7		GSH 8		GSH 9			
	6		7		8		9		Total	
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#	46	95	695	1 121	16	22	6	22	2 006	3 012

* FSU data. # QMS data.

The TACs currently applied to dark ghost shark were initially intended to apply to a combined fishery for both species, and were 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 were 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 were above the TACC for a number of years and the TACCs have been increased to the average of the previous 7 years plus an additional 10%.

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.

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 were 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 shark (*Hydrolagus novaezelandiae*) occur through much of the New Zealand EEZ in depths from 30 to 850 m, but they are sparse north of 40° S and have not been recorded from the Bounty Platform. They are most abundant in waters 150–500 m deep on the west coast of the South Island and the Chatham Rise, and in depths of 150–700 m on the Stewart-Snares shelf and Southland/sub-Antarctic. Smaller sharks (< 40 cm CL) are more abundant in waters shallower than 200 m, particularly in the Canterbury Bight.

Trawl surveys show that dark and pale ghost shark exhibit niche differentiation, with water 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.

No published information is available on the age or growth rate of any *Hydrolagus* species, or even any species in the family Chimaeridae. Length-frequency histograms indicate that females grow to a larger size (and presumably have a faster growth rate) than males. Without population age structures or confident estimates of longevity, it is not possible to estimate natural or total mortalities. A recent (year?) study has shown that eye lens measurements and spine band counts are potentially useful

ageing techniques for dark ghost sharks (Francis & Ó Maolagáin 2001). However, these techniques have yet to be validated.

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.

Biological parameters relevant to the stock assessment are shown in Table 3.

Table 3: Estimates of biological parameters for dark ghost shark, from Horn (1997).

FMA	Estimate	
1. Weight = a (length)^b (Weight in g, length in cm chimaera length)		
	a	b
Dark ghost shark		
3 & 4	0.00202	3.274
5 & 6	0.00192	3.297

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 dark 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.

4. STOCK ASSESSMENT

No assessment of any stocks of dark ghost shark has been completed. Therefore, no estimates of yield are available.

4.1 Estimates of fishery parameters and abundance

Estimates of fishery parameters are not available for dark ghost sharks. Several time series of relative biomass estimates are available from fishery independent trawl surveys (Table 4, Figure 1), but wide fluctuations between years suggest the need for caution in using these as indicators of relative abundance. Longer time series may ultimately prove useful, as a recent (2008) study suggest that the West Coast South Island trawl survey is probably monitoring adult abundance.

Table 4: Biomass indices (t) and coefficients of variation (CV).

FMA	Area	Vessel	Trip code	Date	Biomass	% CV
3 & 4	Chatham Rise	*Tangaroa*	TAN9106	Jan-Feb 1992	6700	11.1
			TAN9212	Jan-Feb 1993	5950	9.2
			TAN9401	Jan-94	10360	15.3
			TAN9501	Jan-95	3490	11.2
			TAN9601	Jan-96	6170	12.4
			TAN9701	Jan-97	6240	11.7
			TAN9801	Jan-98	6720	14.1
			TAN9901	Jan-99	12125	23.4
			TAN0001	Jan-00	9154	25.2
			TAN0101	Jan-01	10356	12
			TAN0201	Jan-02	9997	11.1
			TAN0301	Jan-03	10341	9.1
			TAN0401	Jan-04	10471	15
			TAN0501	Jan-05	11885	16.3
			TAN0601	Jan-06	11502	12
			TAN0701	Jan-07	7852	11
			TAN0714	Jan-08	9391	10.9
5 & 6	Southland	*Tangaroa*	TAN9105	Nov-Dec 1991	1030	25.4
	Sub-Antarctic		TAN9211	Nov-Dec 1992	710	43.2
			TAN9310	Nov-Dec 1993	1060	33.6
			TAN0012	Nov-Dec 2000	1459	89.6
			TAN0118	Nov-Dec 2001	1391	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
			TAN0617	Nov-Dec 2006	354	32
			TAN9204	Mar-Apr 1992	3740	48.6
			TAN9304	Apr-May 1993	750	44.7
			TAN9605	Mar-Apr 1996	3080	47.6
			TAN9805	Apr-May 1998	2490	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	1870	63
2	East coast	*Kaharoa*	KAH9304	Mar-Apr 1993	450	61.5
	North Island		KAH9402	Feb-Mar 1994	40	41.3
			KAH9502	Feb-Mar 1995	10	48.6
			KAH9602	Feb-Mar 1996	80	33.5
3	East coast	*Kaharoa*	KAH9105	May-91	770	41.5
	South Island		KAH9205	May-92	930	43.6
			KAH9306	May-93	2910	41.5
			KAH9406	May-94	2700	25.1
			KAH9606	May-96	3180	22.7
			KAH0705	May-07	4483	25
3	East coast	*Kaharoa*	KAH9618	Dec ’96 - Jan ’97	3070	18
	South Island		KAH9704	Dec ’97 - Jan ’98	5870	33
			KAH9809	Dec ’98 - Jan ’99	7420	27
7	Northwest coast	*Kaharoa*	KAH9204	Mar-Apr 1992	380	20
	South Island		KAH9404	Mar-Apr 1994	720	14.3
			KAH9504	Mar-Apr 1995	770	23.7
			KAH9701	Mar-Apr 1997	1590	21.2
			KAH0004	Mar-Apr 2000	2260	9
			KAH0304	Mar-Apr 2003	540	15
			KAH0503	Mar-Apr 2005	830	22
			KAH0704	Mar-Apr 2007	2215	21

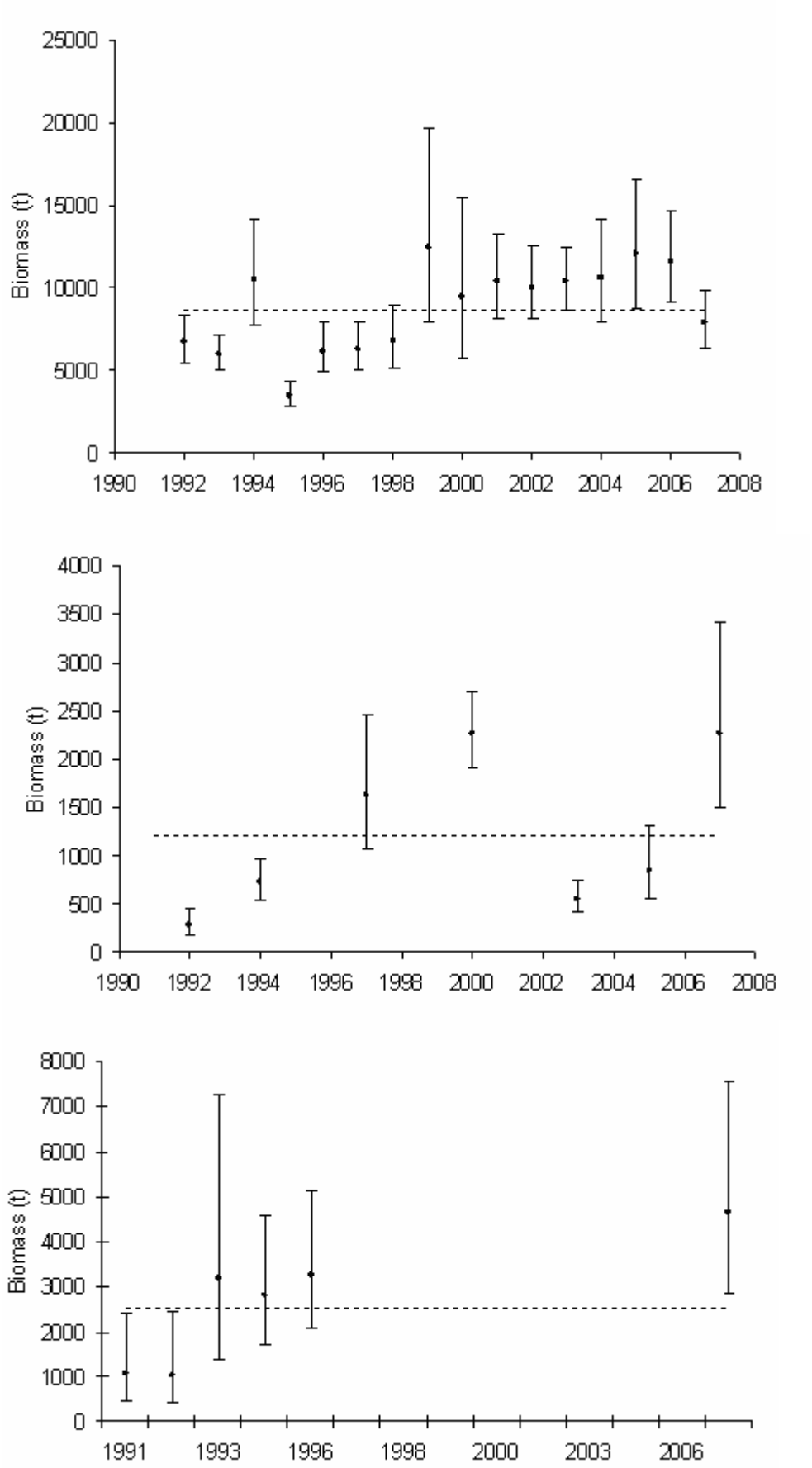


Figure 1: Biomass trends ±95% CI (estimated from survey CV's assuming a lognormal distribution) and the time series mean (dotted line) from the Chatham rise (top), West (middle) and East (bottom) Coast South Island trawl surveys.

4.2 Biomass estimates

No biomass estimates are available for dark ghost shark.

4.3 Estimation of Maximum Constant Yield (MCY)

As there are no available estimates of biomass or harvest rates, the only possible method of calculating maximum constant yield is MCY = cY_{AV} (Method 4). However, it was decided that no estimates of MCY would be presented because:

i. *M* (and hence, the natural variability factor *c*) is unknown,

ii. the level of discarding is unknown and may have been considerable, and

iii. no sufficiently long period of catches was available where there were no systematic changes in catch or effort (noting that the period of catches from which Y_{AV} is derived should be at least half the exploited life span of the fish).

4.4 Estimation of Current Annual Yield (CAY)

In the absence of estimates of current biomass, CAY has not been estimated.

4.5 Other yield estimates and stock assessment results

No other yield estimates are available.

4.6 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. Assuming a strong stock-recruit relationship, Francis & Francis (1992) showed that the estimates of MCY obtained using the equations in current use in New Zealand stock assessments were overly optimistic for rig, and it is likely that they are also unsuitable for ghost sharks.

5. STATUS OF THE STOCKS

No estimates of current and reference biomass are available for dark ghost shark.

Reported landings from the two major fisheries (GSH 3 and 7) have been well below the TACCs in recent years. However for all stocks, it is not known if recent catch levels or current TACCs are sustainable in the long term or whether they will allow the stocks to move towards a size that will support the maximum sustainable yield.

TACCs and reported landings are summarised in Table 5.

Table 5: Summary of TACCs (t) and reported landings (t) for dark ghost shark for the most recent fishing year.

Fishstock		QMA	2006–07 Actual TACC	2006–07 Estimated landings
GSH 1	Auckland (East)	1	22	20
GSH 2	Central (East)	2	66	60
GSH 3	South-east (Coast)	3	1 185	654
GSH 4	South-east (Chatham)	4	370	396
GSH 5	Southland	5	109	115
GSH 6	Sub-Antarctic	6	95	43
GSH 7	Challenger	7	1 121	695
GSH 8	Central (West)	8	22	16
GSH 9	Auckland (West)	9	22	6
GSH 10	Kermadec	10	0	0
Total			3 012	2 006

6. FOR FURTHER INFORMATION

Francis MP., Francis RICC. 1992. Growth, mortality, and yield estimates for rig (*Mustelus lenticulatus*). New Zealand Fisheries Assessment Research Document 92/5. 32 p.

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Stevens D., Livingston M., Bagley N. 2001. Trawl survey of hoki and middle depth species on the Chatham Rise, January 2001 (TAN0101). Final Research Report for Ministry of Fisheries Research Project HOK2000/02 Objectives 1 and 2. 13 p.