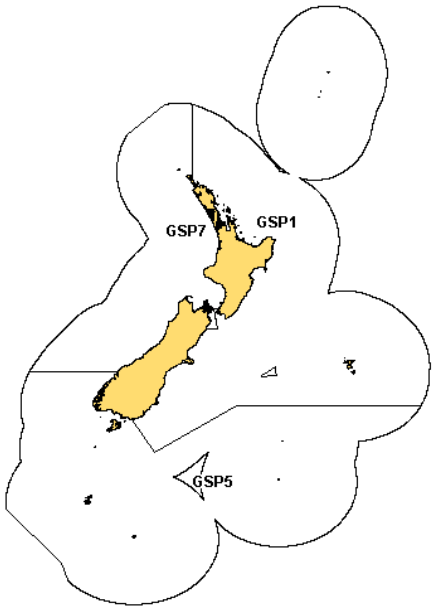
PALE GHOST SHARK (GSP)

(*Hydrolagus bemisi*)



1. FISHERY SUMMARY

1.1 Commercial fisheries

Two species (dark and pale ghost sharks) make up virtually all the commercial ghost shark landings. Pale ghost shark (*Hydrolagus bemisi*) was introduced into the QMS from the beginning of the 1999–00 fishing year as 3 Fishstocks: GSP 1 - QMAs 1 to 4, and 10; GSP 5 - QMAs 5 and 6 and GSP 7 - QMAs 7, 8 and 9.

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 QMA 3. Virtually all the additional catch was spread over QMAs 4–7. In 1988–89, landings from west coast South Island (QMA 7) began to increase, this is almost certainly associated with the development of the hoki fishery. In 1990–91, significant landings increases were apparent on the Chatham Rise, off southeast South Island, and on the Campbell Plateau. The development of fisheries for non-spawning hoki was probably responsible for these increases.

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	
1978–79*	1	37	99	26	3	16	11	88	90	8	68	17	465
				42					18				
1979–80*	1	55	54	6	10	4	28	138	3	7	1	5	912
1980–81*													–
				11									
1981–82*	0	84	28	7	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

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

Estimated landings of pale 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 pale ghost shark made up 30% of the total ghost shark catch in QMAs 5 and 6, and 25% in all other QMAs.

From 1 Oct 1999 TACCs were set for pale ghost shark fishstocks as follows: GSP 1 - 509 t, GSP 5 - 118 t and GSP 7 - 176 t. The TAC in each case was set equal to the TACC. Estimated and reported landings for this period are shown in Table 3. The fisheries in GSP1 and GSP5 exceeded the TACC by large amounts, possibly as a result of better reporting of catches. From 1 October 2004 the TACCs for GSP 1 and GSP 5 were increased to 1150 t and 454 t respectively, the level of catch being reported from the fisheries. Catches have since declined to well below the TACC levels.

In GSP 1, catches are mainly taken on the Chatham Rise while in GSP 5 catches are mainly taken in the sub-Antarctic area; both as bycatch of the hoki trawl fisheries. Estimated catches appear to have been under-reported both before and after the introduction to the QMS. The original TACCs were based on estimated catches, but these are likely to have been much lower than the actual catches. Estimated catches on TCEPR forms since 1999–00 were only 25–30% of the QMR totals.

Table 2: Estimated landings (t) of pale ghost shark by fishery management area for fishing years 1982–83 to 1998–99 based on the reported landings of both species combined. The estimated landings up to 1994–95 are based on data in the 1997 Plenary Report. Landings from 1995–96 to 1998–99 were estimated assuming pale ghost shark made up 30% of the total ghost shark catch in QMAs 5 and 6, and 25% in all other QMAs.

	QMA										
	1	2	3	4	5	6	7	8	9	10	Total
1982–83	1	1	74	35	21	13	2	1	0	0	148
1983–84	0	1	63	24	11	15	7	1	0	0	122
1984–85	1	1	60	49	16	19	12	0	0	0	158
1985–86	1	1	96	23	10	14	7	1	0	0	153
1986–87	1	2	110	27	11	12	13	1	0	0	177
1987–88	1	1	138	21	13	2	15	1	0	0	192
1988–89	2	7	124	9	19	2	34	1	0	0	198
1989–90	1	3	86	8	41	5	33	5	0	0	182
1990–91	1	7	148	63	61	82	39	1	0	0	402
1991–92	1	2	218	95	64	54	35	2	1	0	472
1992–93	2	1	227	99	77	55	53	7	0	0	521
1993–94	1	2	173	42	36	32	99	4	0	0	389
1994–95	1	1	246	62	27	26	234	1	0	0	598
1995–96	4	12	226	84	30	29	183	3	1	0	572
1996–97	6	22	272	134	40	58	309	3	3	0	847
1997–98	6	6	256	87	30	58	57	1	4	0	505
1998–99	6	20	315	107	27	47	136	2	7	0	667

Table 3: Estimated landings (t) of pale ghost shark by Fishstock for 1999–00 to 2006–07 and actual TACs set from 1999–00 (QMR data).

Fishstock	GSP 1		GSP 5		GSP 7			
QMA (s)	1,2,3,4,10		5,6		7,8,9		Total	
	Landings	TAC	Landings	TAC	Landings	TAC	Landings	TAC
1999–00	577	509	216	118	35	176	828	803
2000–01	1 142	509	454	118	16	176	1 613	803
2001–02	1 033	509	545	118	71	176	1 649	803
2002–03	1 277	509	602	118	16	176	1 895	803
2003–04	1 009	509	529	118	15	176	1 553	803
2004–05	635	1 150	247	454	5	176	887	1 780
2005–06	565	1 150	134	454	9	176	708	1 780
2006–07	553	1 150	226	454	15	176	794	1 780

1.2 Recreational fisheries

Current catches of 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 take 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

Pale ghost shark occur throughout the EEZ and have been recorded in depths ranging from 270 to 1200 m. They are most abundant in depths of 400–1000 m on the Chatham Rise and Southland/sub-Antarctic, but are uncommon north of 40° S and appear to inhabit a narrower depth range in that region (600–950 m).

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. Hard parts of pale ghost shark have not yet been examined to check the existence of any banding pattern that may represent annual growth zones. Without population age structures or confident estimates of longevity it is not possible to estimate natural or total mortalities. A recent 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 pale ghost sharks is 59–60 cm for males and 69–70 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 4.

Table 4: Estimates of biological parameters for pale ghost shark, from Horn (1997).

FMA	Estimate	
1. Weight = a (length)b (Weight in g, length in cm chimaera length)		
Pale ghost shark	a	b
3 & 4	0.00512	3.037
5 & 6	0.00946	2.883

3. STOCKS AND AREAS

Horn (1997) proposed that ghost sharks be managed as three Fishstocks, i.e., east coast New Zealand (QMAs 1–4), Stewart-Snares shelf and Campbell Plateau (QMAs 5 and 6), and west coast New Zealand (QMAs 7, 8, and 9). Areas of narrow continental shelf separate these QMA groupings, so they could well provide barriers to stock mixing, particularly for the pale ghost shark. The deep water separating the Bounty Platform from the Campbell Plateau may also provide a barrier to mixing, and these areas may hold separate stocks.

4. STOCK ASSESSMENT

No assessment of any stocks of 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 ghost sharks. Several time series of relative biomass estimates are available from trawl surveys (Table 5), but wide fluctuations between years suggest the need for caution in using these as indicators of relative abundance.

In 2004, the Plenary agreed that the trawl survey series for both GSP 1 and GSP 5 indicated that previous catch levels have had no impact on the biomass of pale ghost shark, however, the actual level of catch is not known. The recorded catch history for this species is likely to underestimate actual catches. A revised catch history could be reconstructed based on assumptions concerning bycatch rates in the hoki fishery

Table 5: Biomass indices (t) and coefficients of variation (CV)

					Pale ghost shark	
GSP	Area	Vessel	Trip code	Date	Biomass	% CV
1	Chatham Rise	*Tangaroa*	TAN9106	Jan–Feb 1992	6 060	5.7
			TAN9212	Jan–Feb 1993	3 570	7
			TAN9401	Jan–94	5 900	8.6
			TAN9501	Jan–95	2 750	8.4
			TAN9601	Jan–96	7 900	10
			TAN9701	Jan–97	2 870	12.2
			TAN9801	Jan–98	4 052	9.3
			TAN9901	Jan–99	5 272	9.7
			TAN0001	Jan–00	4 892	7.6
			TAN0101	Jan–01	7 094	9
			TAN0201	Jan–02	4 896	10
			TAN0301	Jan–03	4 653	12.1
			TAN0401	Jan–04	3 627	8.6
			TAN0501	Jan–05	4 061	9.2
			TAN0601	Jan–06	3 237	11
			TAN0701	Jan–07	4 766	9
			TAN0801	Jan–08	3 235	6.1

Table 5 *(Continued)*:

GSP	Area	Vessel	Trip code	Date	Biomass	% CV
5	Southland	*Tangaroa*	TAN9105	Nov–Dec 1991	11 210	6.1
	Sub-Antarctic		TAN9211	Nov–Dec 1992	4 750	7.2
			TAN9310	Nov–Dec 1993	11 670	9.4
			TAN0012	Nov–Dec 2000	17 823	12.4
			TAN0118	Nov–Dec 2001	11 219	8.8
			TAN0219	Nov–Dec 2002	9 297	9.3
			TAN0317	Nov–Dec 2003	10 360	8.7
			TAN0414	Nov–Dec 2004	8 549	10.3
			TAN0515	Nov–Dec 2005	9 416	10
			TAN0617	Nov–Dec 2006	12 619	10
			TAN0714	Nov–Dec 2007	13 107	11
5	Southland	*Tangaroa*	TAN9204	Mar–Apr 1992	10 530	6.1
	Sub-Antarctic		TAN9304	Apr–May 1993	14 640	9.5
			TAN9605	Mar–Apr 1996	16 380	9.9
			TAN9805	Apr–May 1998	15 758	10

4.2 Biomass estimates

No biomass estimates are available for ghost shark.

4.3 Estimation of Maximum Constant Yield (MCY)

As no estimate of biomass or harvest rate are available, 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 pale ghost shark.

For all Fishstocks it is not known if recent catch levels are sustainable or at levels that will allow the stocks to move towards a size that will support the MSY. TACCs were increased from 1 October 2004, in GSP 1 and GSP 5, to the approximate average of the previous four year catches. However catches have since declined to well below these levels. Information from trawl surveys indicates that recent catch levels have had no impact on the biomass and there is good recruitment of small pale ghost sharks on the Chatham Rise and in the sub-Antarctic area.

TACCs and reported landings for the 2006–07 fishing year are summarised in Table 6.

Table 6: Summary of TACCs (t) and reported landings (t) of pale ghost shark for the most recent fishing year.

Fishstock		QMA	2006–07 Actual TACC	2006–07 Estimated landings
GSP 1	Auckland (East), Central (East) South-East (Coast) (Chatham), Kermadec	1, 2, 3, 4, 10	1 150	553
GSP 5	Southland, Sub-antarctic	5, 6	454	226
GSP 7	Challenger, Central (West), Auckland (West)	7, 8, 9	176	15
Total			1 780	794

6. FOR FURTHER INFORMATION

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

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Horn PL. 1997. A summary of biology and commercial landings, and a stock assessment of ghost sharks (*Hydrolagus* spp.) in New Zealand waters. New Zealand Fisheries Assessment Research Document 1997/3. 36p.

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. 13p.