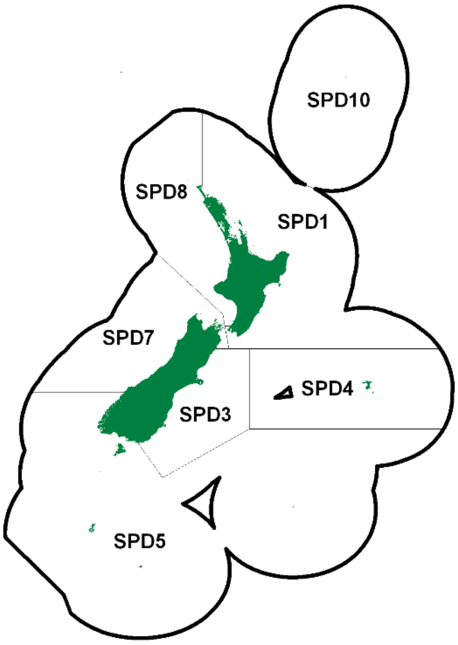
SPINY DOGFISH (SPD)

(*Squalus acanthias*)
Makohuarau, Pioke, Kāraerae



1. FISHERY SUMMARY

1.1 Commercial fisheries

Spiny dogfish are found throughout the southern half of New Zealand, extending to East Cape and Manakau Harbour on the east and west coasts of the North Island respectively. A related species, the northern spiny dogfish (*Squalus mitsukurii*), is mainly restricted to North Island waters, overlapping with its conspecific in the central west coast area and around the Chatham Islands. Although they have different species codes for reporting purposes it is probable that some misidentification and misreporting occurs - particularly in FMAs 1, 8 and 9.

The best estimate of reported catch from the fishery is shown in the final column in Table 1. For the period 1980–81 to 1986–87 the best estimate of landings is the sum of the FSU data. For the period 1987–88 to 1996–97 this is the sum of the LFRR and the discards from the CELR and CLR. It has been assumed here that all the fish which have been caught and discarded will die, and that all the discarded fish have been recorded. Although neither assumption is likely to be true, and the biases they produce will at least partially cancel each other out, it is likely that the true level of discards is considerably higher. However, these figures are currently the best estimates of total removals from the fishery.

Before 1980–81 landings of rig and both *Squalus* species were included together and catches of the latter were probably small. Since then the reported catch of spiny dogfish has fluctuated between about 3000 and 7000 t. The reported catch by the deepwater fleet has remained fairly constant during most of the period, averaging 2000–4000 t, with a slight decrease in recent years. Reported catch by the inshore fleet has shown a steady increase throughout the period and is now at a similar level to the catch from the deepwater fleet.

Most of the spiny dogfish caught by the deepwater fleet are taken as a bycatch in the jack mackerel, barracouta, hoki, red cod, and arrow squid fisheries, in depths from 100 to 500 m. Some are packed whole but most are trunked and exported to markets in Asia and Europe.

Table 1: Reported catches of spiny dogfish (t) by fishing year. FSU (Fisheries Statistics Unit), LFRR (Licensed Fish Receiver Return). Discards reported from CELR (Catch Effort Landing Return), and CLR (Catch Landing Return). Numbers in brackets are probably underestimates. (- no data).

	FSU				Best
	Inshore	Deepwater	LFRR	Discards	Estimate
1980–81	-	(196)	-	-	196
1981–82	-	1 881	-	-	1 881
1982–83	(107)	2 568	-	-	2 675
1983–84	309	2 949	-	-	3 258
1984–85	303	3 266	-	-	3 569
1985–86	311	2 802	-	-	3 113
1986–87	870	2 277	2 608	-	3 147
1987–88	834	3 877	4 823	-	4 823
1988–89	(351)	(500)	3 573	(16)	3 589
1989–90	(14)	0	2 952	321	3 273
1990–91	-	-	5 983	333	6 316
1991–92	-	-	3 274	521	3 795
1992–93	-	-	4 157	616	4 773
1993–94	-	-	6 150	1 063	7 213
1994–95	-	-	4 793	628	5 421
1995–96	-	-	6 230	1 920	8 150
1996–97	-	-	4 887	2 572	7 459

Spiny dogfish are also taken as bycatch by inshore trawlers, setnetters and longliners targeting flatfish, snapper, tarakihi and gurnard. Because of processing problems due to their spines, sandpaper-like skin, and short shelf life, and their low economic value, many inshore fishers are not interested in processing and landing them. Furthermore, because of their sheer abundance they can at times severely hamper fishing operations for other commercial species and they are regarded by many fishers as a major nuisance. Trawlers working off Otago during the summer months often reduce towing times and headline heights, and at times leave the area altogether to avoid having to spend hours pulling hundreds of meshed dogfish out of trawl nets. Setnetters and longliners off the Otago coast, and in Tasman Bay and the south Taranaki Bight have also complained about spiny dogfish taking longline baits, attacking commercial fish caught in the nets or lines, and rolling up nets.

The catch by FMA from the FSU, CELR and CLR databases is shown in Table 3. Large catches have been made from FMAs 3, 5, 6, and 7 since 1982–83. Catches from FMA 4 have increased substantially since the mid-1990s. Landings from FMA 5 and 6 were most important in the early 1980s, with 1000–2000 t taken annually by factory trawlers. In more recent years FMA 3, and to a lesser extent, FMA 7 have become more important. The catch in both these areas is taken equally by factory trawlers and inshore fleets. The catch in FMA 1 is unlikely to be spiny dogfish which is considered to be virtually absent from the area, and so these catches should probably be attributed to *S. mitsukurii*.

Competitive quotas of 4075 t for FMA 3, and of 3600 t for FMAs 5 and 6, were introduced for the first time in the 1992–93 fishing year. These quotas were based on yields derived from trawl surveys using a method that is now considered obsolete, and harvest levels which are now considered unreliable. The reported catches exceeded the FMA 3 quota in 1997–98, 2000–01 and 2001–02 and the FMA 5/6 quota in 2001–02.

Spiny dogfish was introduced into the QMS in October 2004. Catches and TACCs are shown in Table 4, while Figure 1 depicts historical landings and TACC values for the main SPD stocks.

Prior to their introduction into the QMS spiny dogfish were legally discarded at sea (provided that total catch was reported). Although discard rates increased dramatically through the 1990s (Table 5), this is believed to reflect a change in reporting practise rather than an increase in the proportion of catch discarded.

Table 2: Reported landings (t) for the main QMAs from 1931 to 1982.

Year	SPD 1	SPD 3	SPD 4	SPD 5	Year	SPD 1	SPD 3	SPD 4	SPD 5
1931	0	0	0	0	1957	0	0	0	0
1932	0	0	0	0	1958	0	0	0	0
1933	0	0	0	0	1959	0	0	0	0
1934	0	0	0	0	1960	0	0	0	0
1935	0	0	0	0	1961	0	0	0	0
1936	0	0	0	0	1962	0	0	0	0
1937	0	0	0	0	1963	0	0	0	0
1938	0	0	0	0	1964	0	0	0	0
1939	0	0	0	0	1965	0	0	0	0
1940	0	0	0	0	1966	0	0	0	0
1941	0	0	0	0	1967	0	0	0	0
1942	0	0	0	0	1968	0	0	0	0
1943	0	0	0	0	1969	0	0	0	0
1944	0	0	0	0	1970	0	0	0	0
1945	0	0	0	0	1971	0	0	0	0
1946	0	0	0	0	1972	0	0	0	0
1947	0	0	0	0	1973	0	0	0	0
1948	0	0	0	0	1974	0	0	0	0
1949	0	0	0	0	1975	0	0	0	0
1950	0	0	0	0	1976	0	0	0	0
1951	0	0	0	0	1977	0	0	0	0
1952	0	0	0	0	1978	1	20	0	38
1953	0	0	0	0	1979	2	130	67	74
1954	0	0	0	0	1980	0	39	13	149
1955	0	0	0	0	1981	2	123	92	203
1956	0	0	0	0	1982	20	291	31	2228

Year	SPD 7	SPD 8	Year	SPD 7	SPD 8
1931	0	0	1957	0	0
1932	0	0	1958	0	0
1933	0	0	1959	0	0
1934	0	0	1960	0	0
1935	0	0	1961	0	0
1936	0	0	1962	0	0
1937	0	0	1963	0	0
1938	0	0	1964	0	0
1939	0	0	1965	0	0
1940	0	0	1966	0	0
1941	0	0	1967	0	0
1942	0	0	1968	0	0
1943	0	0	1969	0	0
1944	0	0	1970	0	0
1945	0	0	1971	0	0
1946	0	0	1972	0	0
1947	0	0	1973	0	0
1948	0	0	1974	0	0
1949	0	0	1975	0	0
1950	0	0	1976	0	0
1951	0	0	1977	0	0
1952	0	0	1978	124	41
1953	0	0	1979	128	40
1954	0	0	1980	11	31
1955	0	0	1981	73	150
1956	0	0	1982	113	84

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 of spiny dogfish by FMA. Proportions by area have been taken from CELR and CLR and pro-rated to the best estimate from Table 1. Competitive quotas of 4075 t for FMA 3, and of 3600 t for FMAs 5 and 6, were introduced for the first time in the 1992–93 fishing year.

Year	FMA 1	FMA 2	FMA 3	FMA 4	FMA 5	FMA 6	FMA 7	FMA 8	FMA 9	FMA 10	Other	Total
1982–83	4	0	151	131	2 089	81	145	66	7			2 675
1983–84	22	18	409	347	565	1 700	119	63	16			3 258
1984–85	21	12	557	481	451	1 899	90	48	10			3 569
1985–86	13	11	892	411	537	1 017	120	92	20			3 113
1986–87	64	18	1 048	162	1 002	29	501	296	27			3 147
1987–88	50	9	1 664	172	642	16	1 402	841	27			4 823
1988–89	341	16	1 510	168	771	7	633	132	11			3 589
1989–90	36	14	2 243	136	241	2	521	80	0			3 273
1990–91	129	14	2 987	513	1 708	14	883	67	0			6 316
1991–92	54	23	1 801	66	538	33	1 031	249	0			3 795
1992–93	50	9	2 128	218	817	22	1 163	366	0			4 773
1993–94	51	34	3 165	358	1 158	21	2 212	214	0			7 213
1994–95	84	47	2 883	363	606	37	1 205	196	0			5 421
1995–96	68	177	2 558	969	1 147	152	1 205	186	15			7 052
1996–97	30	159	2 428	1 287	764	120	1 517	235	7	1	1	6 555
1997–98	52	165	5 042	917	428	223	2 389	1 172	34	0	11	10 433
1998–99	45	488	3 148	1 048	1 996	154	1 902	74	< 1	0	< 1	8 424
1999–00	15	328	3 309	994	1 163	189	1 505	25	7	0	5	7 540
2000–01	38	336	4 355	1 075	1 389	212	1 310	54	16	0	28	8 811
2001–02	12	222	4 249	1 788	3 734	487	961	71	12	0	-	11 530
2002–03	10	245	3 553	1 010	2 621	413	772	85	19	0	0	8 727
2003–04	12	91	2 077	516	1 032	302	423	20	5	0	0	4 477

Table 4: Reported domestic landings (t) of spiny dogfish by Fishstock and TACC from 2004–05 to 2015–16.

Fishstock		SPD 1		SPD 3		SPD 4		SPD 5		SPD 7
FMA		1&2		3		4		5&6		7
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
2004–05	234	331	2 707	4 794	839	1 626	2 479	3 700	842	1 902
2005–06	186	331	3 831	4 794	1 055	1 626	2 298	3 700	832	1 902
2006–07	239	331	2 712	4 794	822	1 626	2 165	3 700	1 125	1 902
2007–08	156	331	2 082	4 794	1 397	1 626	1 501	3 700	928	1 902
2008–09	229	331	1 981	4 794	866	1 626	2 071	3 700	929	1 902
2009–10	128	331	1 855	4 794	667	1 626	2 205	3 700	1 116	1 902
2010–11	176	331	1 976	4 794	825	1 626	1 443	3 700	1 436	1 902
2011–12	187	331	1 607	4 794	740	1 626	1 390	3 700	1 704	1 902
2012–13	193	331	1 302	4 794	442	1 626	1 547	3 700	1 298	1 902
2013–14	226	331	1 411	4 794	1 090	1 626	2 068	3 700	914	1 902
2014–15	212	331	1 860	4 794	1 380	1 626	1 715	3 700	1 022	1 902
2015–16	178	331	1284	4 794	866	1 626	1 092	3 700	857	1 902

Fishstock		SPD 8		
FMA		8&9		Total
	Landings	TACC	Landings	TACC
2004–05	121	307	7 222	12 660
2005–06	108	307	8 311	12 660
2006–07	118	307	7 181	12 660
2007–08	124	307	6 188	12 660
2008–09	150	307	6 226	12 660
2009–10	194	307	6 166	12 660
2010–11	221	307	6 077	12 660
2011–12	252	307	5 880	12 660
2012–13	182	307	4 965	12 660
2013–14	122	307	5 831	12 660
2014–15	123	307	6 312	12 660
2015–16	147	307	4 525	12 660

Table 5: Discard rates (% of catch) by FMA and fishing year (after Manning et al 2004).

Fishing year	FMA											
	1	2	3	4	5	6	7	8	9	10	Other	Average
1989–90	11	17	18	4	46	100	13	34	0	0	0	18
1990–91	7	0	6	2	29	11	21	24	0	0	0	11
1991–92	9	3	8	13	34	90	42	18	0	0	0	20
1992–93	13	47	5	51	39	43	20	80	0	0	0	21
1993–94	5	65	13	42	21	34	29	66	0	0	0	23
1994–95	2	52	8	31	20	74	29	64	98	0	5	19
1995–96	7	39	18	55	39	94	45	72	100	0	11	36
1996–97	15	61	26	40	70	68	59	89	93	0	16	44
1997–98	53	83	51	53	72	86	81	92	100	0	16	64
1998–99	20	92	57	60	29	78	82	63	0	0	16	58
1999–00	9	86	60	55	39	68	81	84	35	0	0	62
2000–01	37	70	60	77	57	77	72	56	29	0	87	64
Average	15	74	35	53	42	78	54	68	78	0	16	45

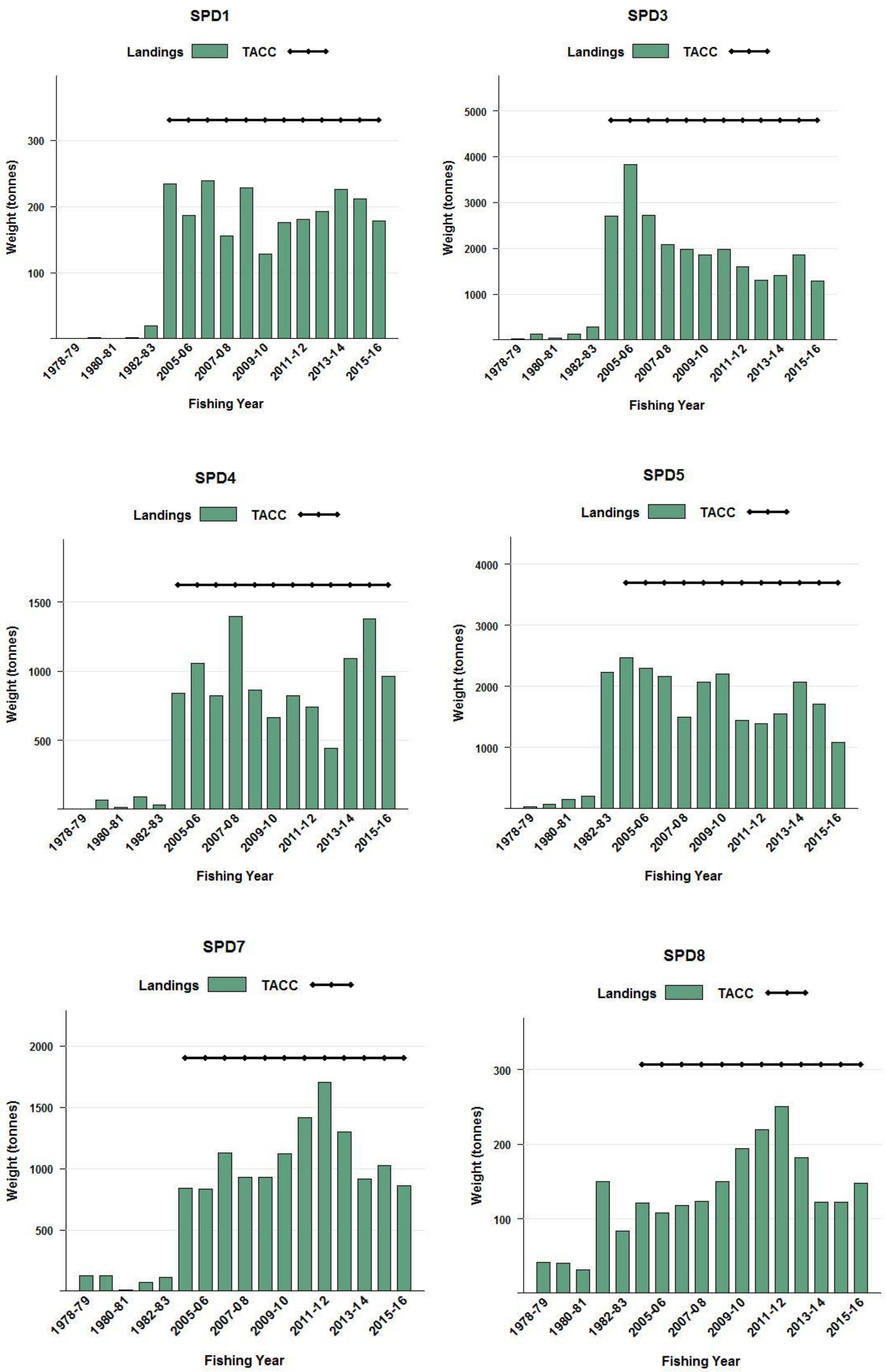


Figure 1 [Continued]: Reported commercial landings and TACCs for the six main SPD stocks SPD 1 (Auckland East, Central East), SPD 3 (South East Coast), SPD 4 (South East Chatham Rise), SPD 5 (Sub-Antarctic, Southland), SPD 7 (Challenger), and SPD 8 (Central Egmont, Auckland West).

1.2 Recreational fisheries

Spiny dogfish are caught by recreational fishers throughout their geographical range in New Zealand. They are mainly taken as bycatch when targeting other more valued species using rod and line and setnet. In many parts of New Zealand, spiny dogfish are regarded by recreational anglers as a pest, often clogging nets and taking baits from hooks. Estimates of recreational landings obtained from three surveys in 1991–92 to 1993–94, 1996 and 1999–00 are given in Table 6. Overall, recreational landings probably comprise only a small proportion (less than 10 %) of the total spiny dogfish catch.

Table 6: Estimated number and weight of spiny dogfish harvested by recreational fishers by Fishstock and survey. Surveys were carried out in different years in the MAF Fisheries regions: South in 1991–92, Central in 1992–93, North in 1993–94 (Teirney et al 1997) and nationally in 1996 (Bradford 1998) and 1999–00 (Boyd & Reilly 2002). Survey harvests are presented as a range to reflect the uncertainty in the estimates.

Fishstock	Survey	Number	CV%	Harvest Range (t)	Point estimate (t)
1991–92					
FMA 3	South		23		120
FMA 5	South		-		2
FMA 7	South		92		11
1992–93					
FMA 2	Central		42		133
FMA 7	Central		35		46
FMA 8	Central		45		143
1993–94					
FMA 1,9	North		-		< 10
1996					
FMA 1	National	1 000	-	-	-
FMA 2	National	5 000	-	-	-
FMA 3	National	21 000	17	25–40	33
FMA 5	National	9 000	-	-	-
FMA 7	National	24 000	21	30–45	37
FMA 9	National	15 000	-	-	-
1999–00					
FMA 1	National	9 000	61	4.4–17.9	11
FMA 2	National	22 000	37	17.3–37.8	28
FMA 3	National	93 000	27	83.2–145.9	115
FMA 5	National	7 000	47	4.4–12.3	8
FMA 7	National	25 000	35	20.4–41.9	31
FMA 8	National	21 000	52	12.7–40.3	27
FMA 9	National	12 000	82	2.7–26.2	14

The Recreational Technical Working Group concluded that the harvest estimates from the diary surveys should be used only with the following qualifications: a) they may be very inaccurate; b) the 1996 and earlier surveys contain a methodological error; and c) the 2000 and 2001 estimates are implausibly high for many important fisheries.

1.3 Customary non-commercial fisheries

Maori fishers traditionally caught large numbers of “dogfish” and this included rig, school shark, and spiny dogfish. Quantitative information on the current level of customary non-commercial fisheries take is not available.

1.4 Illegal catch

It is unlikely that there is an illegal catch of spiny dogfish as the quota for this species has never been reached, and it has low commercial value.

1.5 Other sources of mortality

It is likely that there is a large amount of spiny dogfish discarded by fishers which is never reported on the returns. The level of mortality and any temporal trends from non-reported discards have not been estimated. The introduction of cost recovery charges in 1994–95 may account for the decline in reported discards in that year.

2. BIOLOGY

Spiny dogfish are widely distributed around the South Island and extend as far north as Manukau Harbour and East Cape on the west and east coasts of the North Island respectively. They are most abundant on the east coast of the South Island and the Stewart/Snares Shelf. They are found on the continental shelf and upper slope down to a depth of at least 500 m, but are most common in depths of 50–150 m. Schools are strongly segregated by size and sex. The size of fish in the commercial fishery is not known but will depend to a large extent on the method of capture and the area fished.

Spiny dogfish are born at a size of 18–30 cm total length (TL). They have been aged using fin spines, and early growth has been validated by following modes in length-frequency and eye lens weight frequency data. Males mature at 58 cm TL at age 6, and females mature at 73 cm TL at age 10. The maximum ages and lengths in a study of east coast South Island dogfish were 21 years and 90 cm TL for males, and 26 years and 111 cm TL for females.

M was estimated using the equation $\log_e 100$/maximum age, where maximum age is the age to which 1% of the population survive in an unexploited stock. Using a maximum age of 26 gave an estimate of *M* of 0.18. This has been revised up to 0.2 to reflect the imprecision with which this estimate is known. A similar estimate of *M* was obtained using a survivorship table approach (Hanchet 1986). At an instantaneous mortality rate of 0.2 $year^{-1}$ an initial population of 1000 females would replace themselves over their lifespan (given their length-at-age, length-at-maturity and fecundity-length relationships).

Female spiny dogfish give birth to young over an extended period between April and September, mainly on the shelf edge in depths of 200–300 m. Mating also occurs in deeper water (coincident with a movement of mature males offshore), after which females with young "candled" embryos move into shallower waters of 100 m or less. They remain there for 12 months until the embryos are 15 cm long after which they return to deeper water. Parturition occurs after a gestation period approaching 24 months, and is closely followed by mating and ovulation and the biennial cycle is repeated. Both the number and the size of the young increase linearly with the length of the mother. The number of young per litter ranges from 1 to 19.

Young of the year move inshore into shallower waters shortly after birth. Over the next few years they move steadily into deeper water but remain in size segregated schools comprising up to 2 or 3 age classes. Once maturity is reached both males and females undergo inshore/offshore migrations associated with reproductive activity. A north/south migration along the east coast South Island during autumn/spring has also been postulated but the full extent of this migration is unknown.

Spiny dogfish are found both on the bottom and in mid-water and feed on a very wide range of species, including *Munida*, krill, fish, squid, and crabs.

Biological parameters relevant to the stock assessment are shown in Table 7.

3. STOCKS AND AREAS

No specific research on the stock structure of spiny dogfish has been carried out. Limited tagging has been conducted, so the only available data come from seasonal trawl surveys, and fisheries landings data.

The analysis of *W.J. Scott* and *James Cook* surveys carried out from 1978 to 1983 clearly showed seasonal migrations of spiny dogfish along the east coast of South Island (ECSI). Spiny dogfish were most abundant in the southern part of the coast from October to April, and more abundant to the north in May to September. It is also clear from summer trawl surveys of the area that there is a resident part of the population of spiny dogfish on the Stewart/Snares Shelf over the summer months. However, there have been no comparable series of seasonal surveys there and so it is presently unclear whether the east coast South Island (ECSI) fish migrate south as far as the Stewart/Snares Shelf. Until more data become available fish from the two areas should be treated as separate stocks.

Table 7: Estimates of biological parameters of spiny dogfish for QMA 3 (Hanchet 1986).

1. Natural mortality (*M*)

	0.2

2. Weight = a (length)^b (Weight in g, length in cm fork length)

Males		Females	
a	b	a	b
0.00275	3.05	0.00139	3.25

3. von Bertalanffy growth parameters

Males			Females		
K	t_0	L_∞	K	t_0	L_∞
0.116	-2.88	89.5	0.069	-3.45	120.1

4. Maturity ogive

Age (years)	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	➢ **12**
Males	0.00	0.02	0.21	0.68	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Females	0.00	0.00	0.00	0.00	0.04	0.04	0.23	0.52	0.75	1.00	1.00

Seasonal trawl surveys were also carried out on west coast South Island (WCSI) between June 1981 and April 1983 using the *W.J. Scott*. The catches showed a strong seasonal component being highest in summer and autumn and lowest in winter and spring. It is likely that some fish migrate north in winter, perhaps to the northern and southern Taranaki Bights, and Tasman Bay and Golden Bay. However, it is also clear from summer trawl surveys of the areas that there is a resident part of the population of spiny dogfish in the Taranaki Bights over the summer months. It may therefore be appropriate to treat fish from FMAs 7 and 8 as a single stock.

There is little commercial catch in FMAs 1, 2, 4, and 9, and little data on movement in or between the areas. Until more data have been obtained it would seem appropriate to manage spiny dogfish with the following five Fishstocks:

SPD 1: FMAs 1 & 2
SPD 3: FMA 3
SPD 4: FMA 4
SPD 5: FMAs 5 & 6
SPD 7: FMAs 7, 8 & 9

4. STOCK ASSESSMENT

There are no estimates of current or virgin biomass.

4.1 Estimates of fishery parameters and abundance

Biomass indices of spiny dogfish from recent trawl surveys using *Tangaroa* and *Kaharoa* are summarised in Table 8 and Figures 2–4. Based on a combination of CVs, variability in biomass indices and the time span of each series, it is concluded that surveys provide reliable indices of dogfish abundance off the west coast of the South Island, the east coast of the South Island, and on the Chatham Rise. Relative biomass indices suggest that spiny dogfish became more abundant on the Chatham Rise during the early to mid-1990s. Apart from a temporary increase during the mid-1990s, the abundance of spiny dogfish off the west coast South Island appears to have been fairly stable between 1991 and 2003. On the east coast of the South Island spiny dogfish biomass increased in the early 1990s and has fluctuated without trend since then.

West Coast South Island Inshore Trawl Survey

Biomass estimates of spiny dogfish for the WCSI inshore trawl survey have been relatively stable with the exception of 2013 which was the highest in the time series, although the associated CV is also very high (Figure 2). Most of the biomass is found off the west coast within the 100–200 m strata. Adults usually comprise slightly more of the biomass than juveniles.

Chatham Rise Trawl Survey

The Chatham Rise Trawl Survey was designed primarily for hoki and covers the depth range 200–400 m. It therefore excludes a small portion of SPD habitat around the Mernoo Bank in less than 200 m. The survey biomass estimates for SPD increased from 1991 to 1995, and have cycled around the series mean since then (Figure 2). The Chatham rise SPD survey catch is dominated by mature females (60–100 cm), while that of the ECSI survey consists mostly of males and females < 60 cm (Beentjes et al. 2016; Stevens et al. 2015).

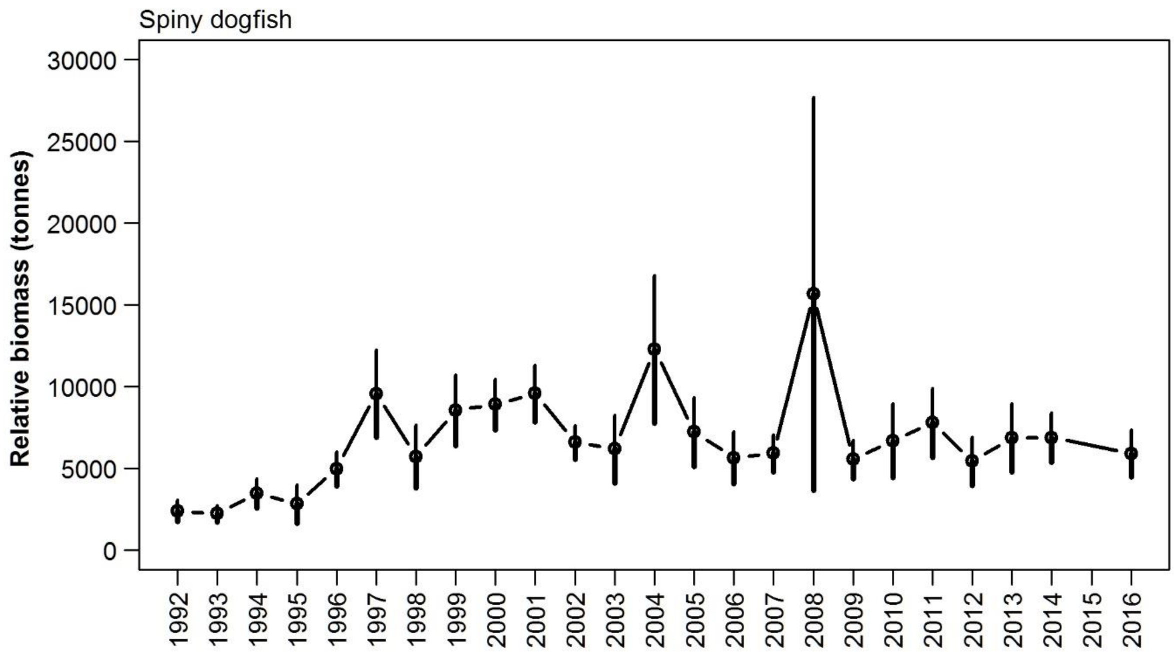
East coast South Island inshore trawl survey

The East Coast South Island winter surveys from 1991 to 1996 (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 were expanded to include the 10–30 m depth range, in order to monitor elephant fish and red gurnard. Prior to 2014, only the 2007 and 2012 surveys provide full coverage of the 10–30 m depth range.

Spiny dogfish biomass in the core strata increased markedly in 1996 and has fluctuated over the last six surveys with indications of a declining trend, although the magnitude of the CVs indicate that this may not be significant (Table 8, Figure 3). Pre-recruited biomass was a small component of the total biomass estimate in the 1992 to 1994 surveys at 1–3% of total biomass, but since 1996 it ranged from 7 to 28%, and in 2016 it was 12% (Table 8, Figure 3). This is also reflected in the biomass of juvenile spiny dogfish (based on the length-at-50% maturity; which increased markedly from about 14% of total biomass before 1996, to between 32 and 57% in the last seven surveys, and in 2016 it was 32% juvenile (Figure 4).

The additional spiny dogfish biomass captured in the 10–30 m depth range accounted for 5%, 8%, 10% and 5% of the biomass in the core plus shallow strata (10–400 m) for 2007, 2012, 2014 and 2016 respectively, indicating that it is useful to monitor the shallow strata for spiny dogfish biomass (Table 8, Figure 3). Further, the addition of the 10–30 m depth range may be important for monitoring the small fish. The spatial distribution of spiny dogfish hotspots varies, but overall this species is consistently well represented over the entire survey area, most commonly from 30 m to about 350 m.

The size distributions of spiny dogfish in the 1992 to 1994 surveys were similar and generally bimodal for males, but less defined for females which are less numerous than males throughout the time series. From 1996 onwards, smaller fish were more abundant, particularly in the last four surveys. The large increase in biomass observed post-1996 is in part a result of the change in the population size composition. Spiny dogfish on the ECSI sampled on these surveys were considerably smaller than those from the Chatham Rise, Southland, and the sub-Antarctic surveys, suggesting that this area may be an important nursery ground for juvenile spiny dogfish and there may be movement in and out of the ECSI survey area.



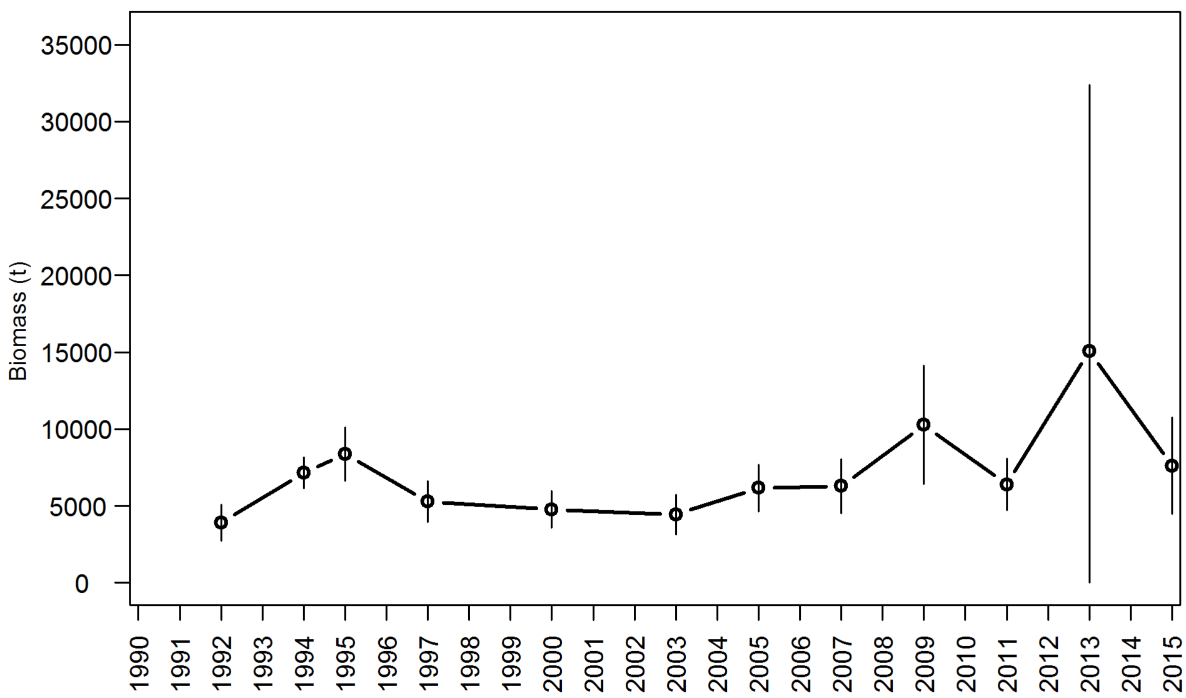


Figure 2: Spiny dogfish biomass for the Chatham Rise (top) and west coast South Island inshore (bottom) trawl survey time series (error bars are ± two standard errors).

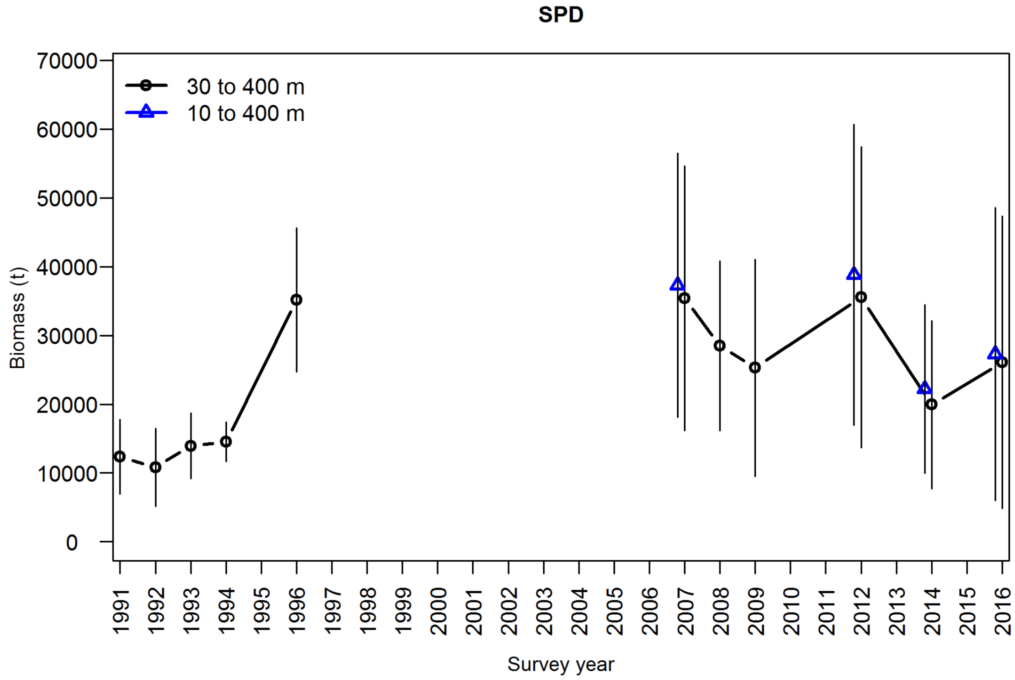


Figure 3: Spiny dogfish total biomass for ECSI winter surveys in core strata (30–400 m), and core plus shallow strata (10–400 m). Error bars are ± two standard errors.

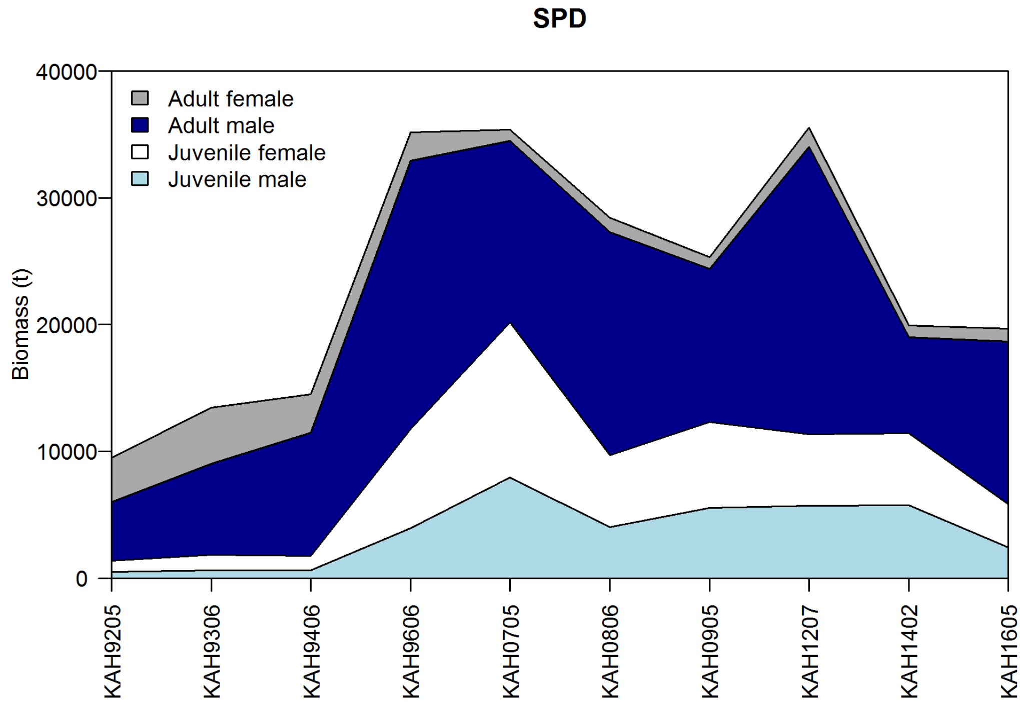


Figure 4: Spiny dogfish juvenile and adult biomass for ECSI winter surveys in core strata (30–400 m), where juvenile is below and adult is equal to or above length at which 50% of fish are mature.

Table 8: Relative biomass indices (t) and coefficients of variation (CV) for spiny dogfish for east coast North Island (ECNI), east coast South Island (ECSI) - summer and winter, Chatham Rise, Stewart-Snares Shelf, Sub-Antarctic, west coast South Island (WCSI) and west coast North Island (WCNI) survey areas*. Biomass estimates for ECSI in 1991 have been adjusted to allow for non-sampled strata (7 & 9 equivalent to current strata 13, 16 and 17). 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 (%)
ECNI	SPD 2	1993	KAH9304	963	78	-	-	-	-	-	-	-	-	-	-
		1994	KAH9402	988	47	-	-	-	-	-	-	-	-	-	-
		1995	KAH9502	658	25	-	-	-	-	-	-	-	-	-	-
		1996	KAH9602	1 026	51	-	-	-	-	-	-	-	-	-	-
ECSI(winter)	SPD 3			30–400 m		10–400 m		30–400 m		10–400 m		30–400 m		10–400 m	
		1991	KAH9105	12 873	22	-	-	-	-	-	-	-	-	-	-
		1992	KAH9205	10 787	26	-	-	266	27	-	-	9 212	31	-	-
		1993	KAH9306	13 949	17	-	-	343	72	-	-	13 122	17	-	-
		1994	KAH9406	14 530	10	-	-	205	49	-	-	14 325	10	-	-
		1996	KAH9606	35 169	15	-	-	3 412	23	-	-	31 757	16	-	-
		2007	KAH0705	35 386	24	37 299	26	5 831	46	-	-	29 554	27	-	-
		2008	KAH0806	28 476	22	-	-	1 886	50	-	-	26 590	22	-	-
		2009	KAH0905	25 311	31	-	-	2 398	30	-	-	22 913	32	-	-
		2012	KAH1207	35 546	31	38 821	28	3 804	58	-	-	31 742	34	-	-
		2014	KAH1402	19 949	31	22 188	28	5 683	34	-	-	14 266	36	-	-
		2016	KAH1605	26 063	41	27 300	39	2 639	34			18 299	50		
ECSI(summer)	SPD 3	1996–97	KAH9618	35 776	28	-	-	-	-	-	-	-	-	-	-
		1997–98	KAH9704	29 765	25	-	-	-	-	-	-	-	-	-	-
		1998–99	KAH9809	22 842	16	-	-	-	-	-	-	-	-	-	-
		1999–00	KAH9917	49 832	37	-	-	-	-	-	-	-	-	-	-
		2000–01	KAH0014	30 508	34	-	-	-	-	-	-	-	-	-	-
Chatham Rise	SPD 4	1991	TAN9106	2 390	14	-	-	-	-	-	-	-	-	-	-
		1992	TAN9212	2 220	11	-	-	-	-	-	-	-	-	-	-
		1994	TAN9401	3 449	13	-	-	-	-	-	-	-	-	-	-
		1995	TAN9501	2 841	21	-	-	-	-	-	-	-	-	-	-
		1996	TAN9601	4 969	11	-	-	-	-	-	-	-	-	-	-
		1997	TAN9701	8 905	9	-	-	-	-	-	-	-	-	-	-
		1998	TAN9801	9 586	9	-	-	-	-	-	-	-	-	-	-
		1999	TAN9901	6 334	8										
		1999–00	TAN0001	6 191	17	-	-	-	-	-	-	-	-	-	-
		2000–01	TAN0101	12 289	18	-	-	-	-	-	-	-	-	-	-
		2001–02	TAN0201	2 390	14	-	-	-	-	-	-	-	-	-	-

*Assuming areal 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.

Table 8 [Continued]: Relative biomass indices (t) and coefficients of variation (CV) for spiny dogfish for east coast North Island (ECNI), east coast South Island (ECSI) - summer and winter, Chatham Rise, Stewart-Snares Shelf, Sub-Antarctic, west coast South Island (WCSI) and west coast North Island (WCNI) survey areas*. Biomass estimates for ECSI in 1991 have been adjusted to allow for non-sampled strata (7 & 9 equivalent to current strata 13, 16 and 17). 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 (%)
Chatham Rise	SPD 4	2002–03	TAN0301	2 220	11	-	-	-	-	-	-	-	-	-	-
		2004	TAN0401	3 449	13	-	-	-	-	-	-	-	-	-	-
		2005	TAN0501	7 227	15	-	-	-	-	-	-	-	-	-	-
		2006	TAN0601	5 650	14	-	-	-	-	-	-	-	-	-	-
		2007	TAN0701	5 906	10	-	-	-	-	-	-	-	-	-	-
		2008	TAN0801	15 674	38	-	-	-	-	-	-	-	-	-	-
		2009	TAN0901	5 548	11	-	-	-	-	-	-	-	-	-	-
		2010	TAN1001	6 698	17	-	-	-	-	-	-	-	-	-	-
		2011	TAN1101	7 794	14	-	-	-	-	-	-	-	-	-	-
		2012	TAN1201	5 438	14	-	-	-	-	-	-	-	-	-	-
		2013	TAN1301	6 884	15	-	-	-	-	-	-	-	-	-	-
		2014	TAN1401	6 886	11										
		2016	TAN1601	5 908	12										
Stewart-Snares Shelf	SPD 5	1993	TAN9301	35 776	28	-	-	-	-	-	-	-	-	-	-
		1994	TAN9402	29 765	25	-	-	-	-	-	-	-	-	-	-
		1995	TAN9502	22 842	16	-	-	-	-	-	-	-	-	-	-
		1996	TAN9604	49 832	37	-	-	-	-	-	-	-	-	-	-
Sub-Antarctic (*Spring*)	SPD 5	1991	TAN9105	8 502	55	-	-	-	-	-	-	-	-	-	-
		1992	TAN9211	1 150	15	-	-	-	-	-	-	-	-	-	-
		1993	TAN9310	1 585	21	-	-	-	-	-	-	-	-	-	-
		2000	TAN0012	4 173	12	-	-	-	-	-	-	-	-	-	-
		2001	TAN0118	8 528	31	-	-	-	-	-	-	-	-	-	-
		2002	TAN0219	3 505	19	-	-	-	-	-	-	-	-	-	-
		2003	TAN0317	2 317	17	-	-	-	-	-	-	-	-	-	-
		2004	TAN0414	3 378	27										
		2005	TAN0515	4 344	19	-	-	-	-	-	-	-	-	-	-
		2006	TAN0617	3 039	19	-	-	-	-	-	-	-	-	-	-
Sub-Antarctic (*Autumn*)	SPD 5	1992	TAN9204	926	30	-	-	-	-	-	-	-	-	-	-
		1993	TAN9304	440	38	-	-	-	-	-	-	-	-	-	-
		1996	TAN9605	207	56	-	-	-	-	-	-	-	-	-	-
		1998	TAN9805	1 532	36	-	-	-	-	-	-	-	-	-	-

*Assuming areal 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.

Table 8 [Continued]: Relative biomass indices (t) and coefficients of variation (CV) for spiny dogfish for east coast North Island (ECNI), east coast South Island (ECSI) - summer and winter, Chatham Rise, Stewart-Snares Shelf, Sub-Antarctic, west coast South Island (WCSI) and west coast North Island (WCNI) survey areas*. Biomass estimates for ECSI in 1991 have been adjusted to allow for non-sampled strata (7 & 9 equivalent to current strata 13, 16 and 17). 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 (%)
WCSI	SPD 7	1992	KAH9204	3 919	15	-	-	-	-	-	-	-	-	-	-
		1994	KAH9404	7 145	7	-	-	-	-	-	-	-	-	-	-
		1995	KAH9504	8 370	10	-	-	-	-	-	-	-	-	-	-
		1997	KAH9701	5 275	13	-	-	-	-	-	-	-	-	-	-
		2000	KAH0004	4 777	12	-	-	-	-	-	-	-	-	-	-
		2003	KAH0304	4 446	15	-	-	-	-	-	-	-	-	-	-
		2005	KAH0503	6 175	12	-	-	-	-	-	-	-	-	-	-
		2007	KAH0704	6 219	14	-	-	-	-	-	-	-	-	-	-
		2009	KAH0904	10 270	19	-	-	-	-	-	-	-	-	-	-
		2011	KAH1104	6 402	13	-	-	-	-	-	-	-	-	-	-
		2013	KAH1305	15 087	57	-	-	-	-	-	-	-	-	-	-
		2015	KAH1503	7 613	21	-	-	-	-	-	-	-	-	-	-
WCNI	SPD 9	1991	KAH9111	443*	34	-	-	-	-	-	-	-	-	-	-
		1994	KAH9410	381*	30	-	-	-	-	-	-	-	-	-	-
		1996	KAH9615	634*	68	-	-	-	-	-	-	-	-	-	-
		1999	KAH9915	106*	15	-	-	-	-	-	-	-	-	-	-

*Assuming areal 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.

Manning et al (2004) evaluated the usefulness of commercial CPUE, commercial length composition, trawl survey relative biomass estimates and trawl-survey-catch length-composition for monitoring all major SPD stocks (Table 9).

Table 9: Catch and effort data sets and analyses evaluated as monitoring tools for major SPD stocks.

QMA	Data set and analysis
SPD 3 - East coast South Island	1. Standardised setnet CPUE for core vessels targeting SPD.
	2. Standardised setnet CPUE for core vessels targeting all species.
	3. Standardised bottom trawl CPUE for core vessels targeting all species.
	4. Relative abundance indices from East Coast South Island trawl surveys (discontinued after 2001)
SPD 4 - Chatham Rise	5. Standardised bottom trawl CPUE for core Korean vessels
	6. Standardised bottom trawl CPUE for core domestic vessels
	7. Standardised bottom longline CPUE for core domestic vessels
	8. Relative abundance indices from Chatham Rise trawl surveys.
SPD 5 - Stewart Snares Shelf	9. Standardised bottom trawl CPUE.
	10. Relative abundance indices from Stewart-Snares shelf surveys (discontinued after 1996)
SPD 7 - West Coast South Island	11. Standardised bottom trawl CPUE for core vessels
	12. Relative abundance indices from West coast South Island Trawl Surveys.

Based on the results of the analyses listed in Table 9, the following methods were recommended for monitoring SPD:

QMA	Recommended Monitoring Tools
SPD 3 - East coast South Island	Standardised setnet CPUE using model 2 (core vessels targeting all species)
SPD 4 - Chatham Rise	Chatham Rise Trawl Survey and length composition of commercial catch
SPD 5 - Stewart Snares Shelf	*Standardised bottom trawl CPUE and length composition of commercial catch.
SPD 7 - West Coast South Island	West coast South Island Trawl survey and length composition of commercial catch

* Information on historical changes in reporting rates is required before this index can be used.

4.2 Biomass estimates

Lack of suitable information has precluded estimation of virgin and current biomass for spiny dogfish. Although most of the necessary biological parameters (Hanchet 1986, 1988, Hanchet & Ingerson 1997), relative indices of abundance and data required to estimate fishing selectivity for most important fisheries (with the exception of FMA 4 bottom longline and FMA 3 setnet fisheries) are now available, robust stock assessments will also require estimates of historical, unreported discarding and discard mortality so that an accurate history of fishery related removals can be constructed.

4.3 Yield estimates and projections

Estimation of Maximum Constant Yield (*MCY*)

MCY cannot be estimated.

Estimation of Current Annual Yield (*CAY*)

CAY cannot be determined.

4.5 Other factors

The ability to withstand harvesting depends on the strength of a number of compensatory mechanisms. For example, under exploitation individuals may grow faster, show increased fecundity, or suffer reduced natural mortality. In elasmobranchs the number of young born is related directly to the number of adult females, and, because of the relatively large size and hence good survival of the young at birth, it is presumed that there is a strong stock recruit relationship for these species.

Several methods of estimating *MCY* involve the multiplication of a harvest level by an estimate of B_0 or B_{av}. Francis & Francis (1992) used Monte Carlo simulation to estimate harvest levels for calculating *MCY* for a rig stock. No stock-recruitment data were available for elasmobranchs at the time and so they used values for the Beverton & Holt steepness parameter ranging from 0.35 to 0.50, and recruitment variability of 0.4. These values were all at the low range of values used for teleost species and which they considered appropriate for rig. The results of their simulation studies showed that the estimates of *MCY* obtained using the harvest levels given in the equations in the Guide to Biological Reference Points were overly optimistic for rig. Given that spiny dogfish have a slower growth rate and are less fecund than rig, it seems reasonable to assume that those harvest levels are also unsuitable for spiny dogfish.

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). Spiny dogfish was ranked 7th 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

No estimates of current or reference biomass are available, but trawl survey estimates of abundance are all at or above the long term average (1991–2011 for Chatham Rise and 1992–2011 for WCSI).

Although reported commercial catches of spiny dogfish were observed to increase in all major FMAs during the 1990s, the extent to which these increases can be attributed to changes in reporting practice (i.e., more accurate reporting of discards in recent times) is uncertain. Trawl surveys, on the other hand, indicate that there was a general increase in the abundance of spiny dogfish, particularly around the South Island, in the mid-1990s.

6. FOR FURTHER INFORMATION

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