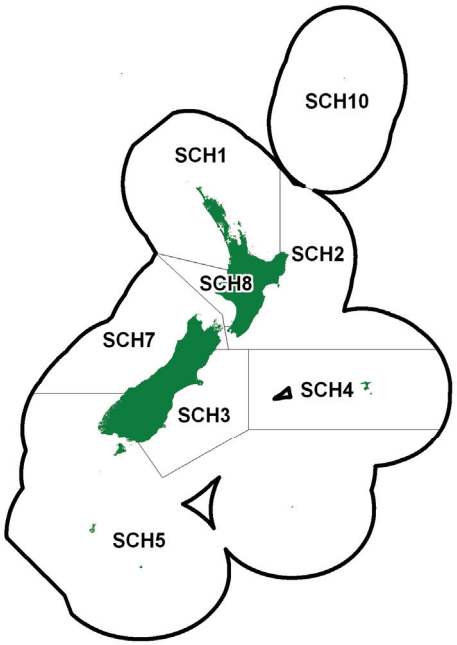
SCHOOL SHARK (SCH)

(*Galeorhinus galeus*)
Tupere, Tope, Makohuarau



1. FISHERY SUMMARY

1.1 Commercial fisheries

This moderate-sized shark has supported a variety of fisheries around New Zealand from the early 1940s onwards. Landings rose steeply from the late 1970s until 1983 (Table 1), with the intensification of setnetting targeting this and other species, and a general decline in availability of other, previously more desirable, coastal species. However, because of the earlier discarding and under-reporting, this recorded rise in landings does not reflect an equal rise in catches. After a small decline in 1984–85, catches decreased by about 50% from 1986 onwards because of reduced quotas within the QMS (Table 2). From 1987–88 to 1991–92 total reported landings were around 2200–2500 t. In 1995–96 total landings increased markedly to 3387 t and the total TACC (3107 t) was exceeded for the first time. Landings have remained around the TACC level since 1995–96. TACCs for SCH 3, 5, 7 & 8 were increased by between 5% (SCH 5) and 20% (the remainder) under AMP management in October 2004. From the 1st October 2007 the TACC for SCH 1 was increased to 689 t, at that time a TAC was set for the first time at 893 t with 102 t, 68 t and 34 t being allocated to customary, recreational and other sources of motility respectively. Figure 1 shows the historical landings and TACC values for the main SCH stocks.

Table 1: Reported domestic landings (t) of school shark from 1948 to 1983.

Year	Landings	Year	Landings	Year	Landings	Year	Landings
1948	75	1957	301	1966	316	1975	518
1949	124	1958	323	1967	376	1976	914
1950	147	1959	304	1968	360	1977	1 231
1951	157	1960	308	1969	390	1978	161
1952	179	1961	362	1970	450	1979	481
1953	142	1962	354	1971	597	1980	1 788
1954	185	1963	380	1972	335	1981	2 716
1955	180	1964	342	1973	400	1982	2 965
1956	164	1965	359	1974	459	1983	3 918

Source: MAF data.

During the period of high landings in the mid 1980s setnetting was the main fishing method, providing about half the total catch, with lining accounting for one-third of the catch, and trawling the remainder. There were large regional variations.

Small amounts of school shark are also caught by the foreign charter tuna longliners fishing offshore in the EEZ to well beyond the shelf edge.

The Banks Peninsula Marine Mammal Sanctuary was established in 1988 by the Department of Conservation under the Marine Mammal Protection Act 1978, for the purpose of protecting Hector's dolphins. The sanctuary extends 4 nautical miles from the coast from Sumner Head in the north to the Rakaia River mouth in the south. Prior to 1 October 2008, no setnets were allowed within the sanctuary between 1 November to the end of February. For the remainder of the year, setnets were allowed; but could only be set from an hour after sunrise to an hour before sunset, be no more than 30 metres long, with only one net per boat which was required to remain tied to the net while it was set.

Voluntary setnet closures were implemented by the SEFMC from 1 October 2000 to protect nursery grounds for rig and elephantfish and to reduce interactions between commercial setnets and Hector's dolphins in shallow waters. The closed area extended from the southern most end of the Banks Peninsula Marine Mammal Sanctuary to the northern bank of the mouth of the Waitaki River. This area was closed permanently for a distance of 1 nautical mile offshore and for 4 nautical miles offshore for the period 1 October to 31 January.

From 1 October 2008, a suite of regulations intended to protect Maui's and Hector's dolphins was implemented for all of New Zealand by the Minister of Fisheries.

For SCH 1, there have been two recent changes to the management regulations affecting setnet fisheries which take school shark off the west coast of the North Island. The first was a closure to setnet fishing from Maunganui Bluff to Pariokariwa Point for a distance of 4 nautical miles on 1 October 2003. This closure was extended by the Minister to 7 nautical miles on 1 October 2008. An appeal was made by affected fishers who were granted interim relief by the High Court, allowing setnet fishing beyond 4 nautical miles during daylight hours between 1 October to 24 December.

For SCH 3, commercial and recreational set netting was banned in most areas to 4 nautical miles offshore of the east coast of the South Island, extending from Cape Jackson in the Marlborough Sounds to Slope Point in the Catlins. Some exceptions were allowed, including an exemption for commercial and recreational set netting to only one nautical mile offshore around the Kaikoura Canyon, and permitting setnetting in most harbours, estuaries, river mouths, lagoons and inlets except for the Avon-Heathcote Estuary, Lyttelton Harbour, Akaroa Harbour and Timaru Harbour. In addition, trawl gear within 2 nautical miles of shore was restricted to flatfish nets with defined low headline heights.

For SCH 5, commercial and recreational setnetting was banned in most areas to 4 nautical miles offshore, extending from Slope Point in the Catlins to Sandhill Point east of Fiordland and in all of Te Waewae Bay. An exemption which permitted setnetting in harbours, estuaries and inlets was allowed. In addition, trawl gear within 2 nautical miles of shore was restricted to flatfish nets with defined low headline heights.

For SCH 7, both commercial and recreational setnetting were banned to 2 nautical miles offshore, with the recreational closure effective for the entire year and the commercial closure restricted to the period 1 December to the end of February. The closed area extends from Awarua Point north of Fiordland to the tip of Cape Farewell at the top of the South Island. There is no equivalent closure in SCH 8, with the southern limit of the Maui's dolphin closure beginning north of New Plymouth at Pariokariwa Point. There have been two recent changes to the management regulations affecting setnet fisheries which take school shark off the west coast of the North Island.

Table 2: Reported landings (t) of school shark by Fishstock from 1983–84 to 2008–09 and actual TACCs (t) from 1986–87 to 2008–09. QMS data from 1986–present.

Fishstock	SCH 1		SCH 2		SCH 3		SCH 4		SCH 5	
FMA (s)	1 & 9		2		3		4		5 & 6	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1983–84*	1 087	–	298	–	630	–	8	–	792	–
1984–85*	861	–	237	–	505	–	12	–	995	–
1985–86*	787	–	214	–	370	–	23	–	647	–
1986–87	418	560	137	160	283	270	19	200	382	610
1987–88	530	604	123	168	320	289	22	200	529	613
1988–89	483	624	134	188	222	294	25	200	494	615
1989–90	585	652	154	197	272	305	27	235	450	635
1990–91	559	664	139	198	227	318	21	239	480	649
1991–92	596	664	161	198	264	318	34	239	612	686
1992–93	820	664	202	199	220	320	38	239	593	686
1993–94	658	667	156	199	202	322	41	239	624	686
1994–95	658	668	159	199	237	322	86	239	656	694
1995–96	804	668	212	199	296	322	229	239	690	694
1996–97	793	668	228	199	290	322	179	239	662	694
1997–98	764	668	214	199	270	322	127	239	623	694
1998–99	783	668	275	199	331	322	100	239	714	694
1999–00	820	668	250	199	341	322	97	239	706	694
2000–01	799	668	178	199	364	322	100	239	724	694
2001–02	691	668	208	199	324	322	93	239	673	708
2002–03	689	668	225	199	410	322	130	239	746	708
2003–04	758	668	187	199	323	322	149	239	727	708
2004–05	694	668	201	199	424	387	206	239	743	743
2005–06	634	668	177	199	325	387	183	239	712	743
2006–07	661	668	200	199	376	387	88	239	738	743
2007–08	708	689	227	199	345	387	133	239	781	743
2008–09	713	689	232	199	364	387	145	239	741	743

Fishstock	SCH 7		SCH 8		SCH 7			
FMA (s)	7		8		10		Total	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings§	TACC
1983–84*	1 039	–	694	–	0	–	4 776	–
1984–85*	1 030	–	698	–	0	–	4 501	–
1985–86*	851	–	652	–	0	–	3 717	–
1986–87	454	470	229	310	0	10	1 946	2 590
1987–88	515	500	374	345	0	10	2 367	2 729
1988–89	532	522	419	433	0	10	2 309	2 886
1989–90	516	524	371	438	0	10	2 377	2 996
1990–91	420	531	369	441	0	10	2 215	3 050
1991–92	431	531	409	441	0	10	2 508	3 086
1992–93	482	531	484	441	0	10	2 839	3 089
1993–94	473	531	448	441	0	10	2 603	3 093
1994–95	370	534	417	441	0	10	2 583	3 105
1995–96	635	534	521	441	0	10	3 387	3 107
1995–96	542	534	459	441	0	10	3 153	3 107
1997–98	471	534	447	441	0	10	2 917	3 107
1998–99	681	534	533	441	0	10	3 421	3 107
1999–00	639	534	469	441	0	10	3 324	3 107
2000–01	576	534	453	441	0	10	3 193	3 107
2001–02	501	534	449	441	0	10	2 913	3 121
2002–03	512	534	448	441	0	10	3 161	3 121
2003–04	574	534	405	441	0	10	3 124	3 121
2004–05	546	641	554	529	0	10	3 368	3 416
2005–06	568	641	503	529	0	10	3 102	3 416
2006–07	583	641	534	529	0	10	3 180	3 416
2007–08	606	641	497	529	0	10	3 299	3 437
2008–09	694	941	588	529	0	10	3 477	3 437

* FSU data. § Includes landings from unknown areas before 1986–87.

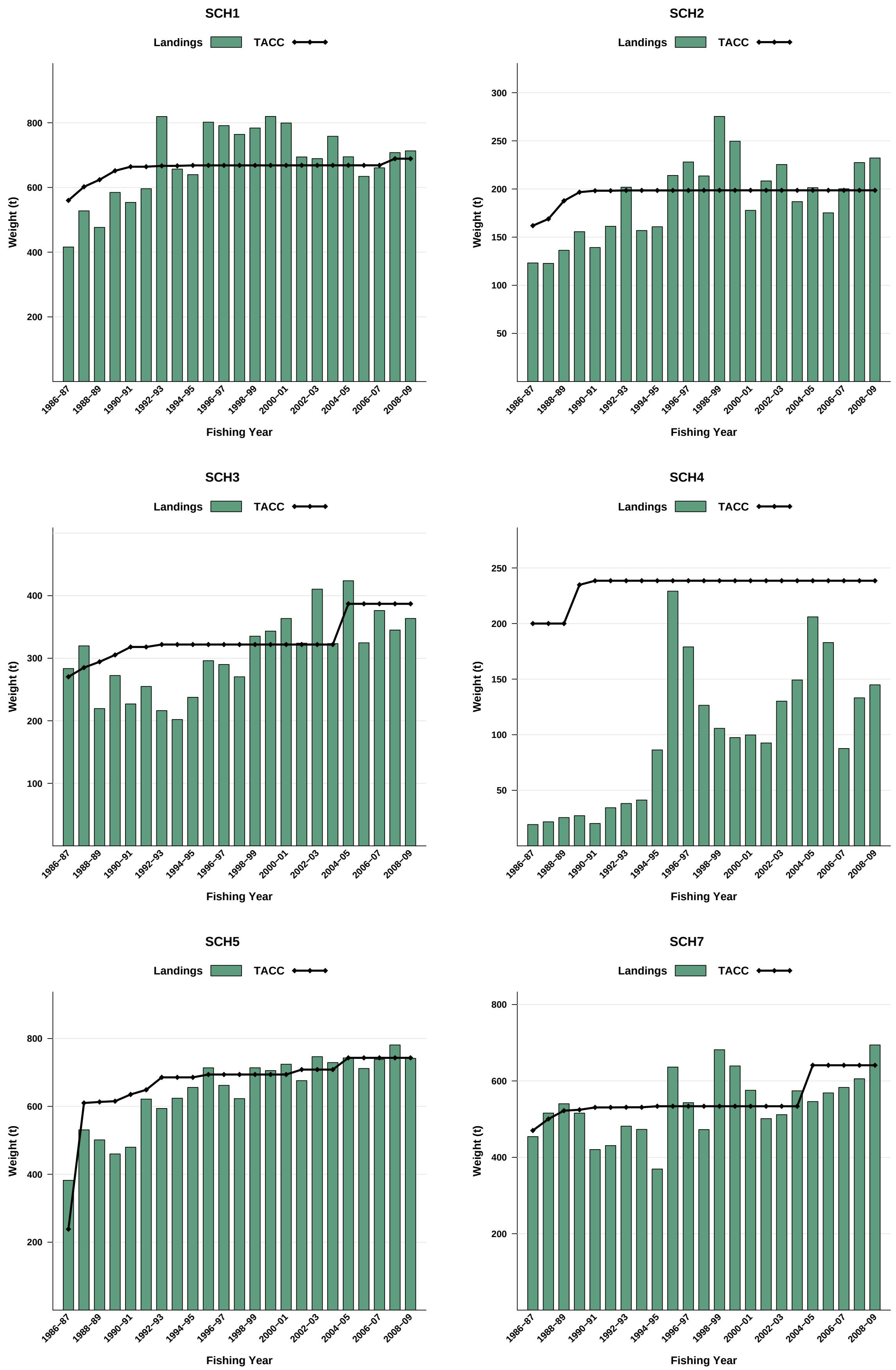


Figure 1: Historical landings and TACC for the seven main SCH stocks. From top left: SCH1 (Auckland East), SCH2 (Central East), SCH3 (South East coast), SCH4 (South East Chatham Rise), SCH5 (Southland), SCH7 (Challenger). [Continued on next page]…

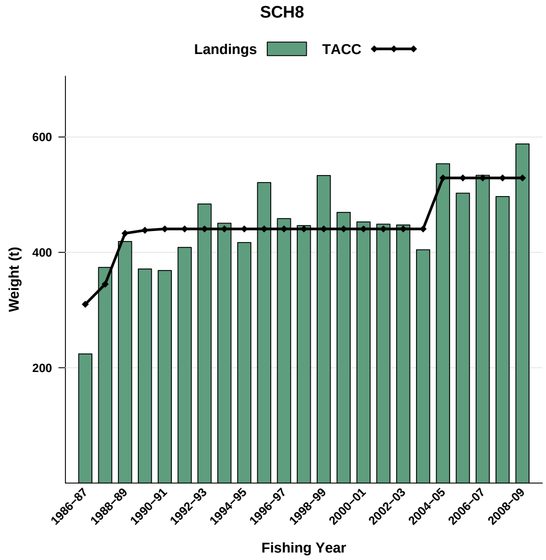


Figure 1 [Continued]: Historical landings and TACC for the seven main SCH stocks. SCH8 (Central Egmont). Note that these figures do not show data prior to entry into the QMS.

1.2 Recreational fisheries

Although school shark is a listed gamefish and is regularly caught by recreational fishers, it is not considered to be a particularly desirable target species at the present time. Recreational catch records have been obtained from diary surveys undertaken in 1991–94, 1996 and 1999–00 (Tables 3 and 4).

The Recreational Technical Working Group recommends 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. Relative comparisons may be possible between stocks within these surveys.

Table 3: Estimated number and weight of school sharks harvested by recreational fishers relative to Fishstock and survey. Surveys were carried out in different years in the Ministry of Fisheries regions: South in 1991–92, Central in 1992–93 and North in 1993–94 (Teirney *et al.* 1997).

		Total		
Fishstock	Survey	Number	CV (%)	Survey harvest (t)
SCH 1	North	17 000	24	10–170
SCH 1	Central	1 000	–	0–10
SCH 2	Central	13 000	27	25–45
SCH 3	South	6 000	33	15–35
SCH 5	South	1 000	–	0–10
SCH 7	Central	9 000	84	10–35
SCH 7	South	3 000	–	5–15
SCH 8	Central	7 000	45	10–30

Table 4: Estimates of annual number and weight of school shark harvested by recreational fishers from national diary surveys in 1996 (Bradford 1998) and Dec1999-Nov 2000 (Boyd & Reilly 2005). The mean weights used to convert numbers to catch weight are considered the best available estimates. Estimated harvest is also presented as a range to reflect the uncertainty in the point estimates.

Fishstock	Number caught	CV (%)	Estimated harvest range (t)	Point estimate (t)
1996				
SCH 1	23 000	17	35–55	46
SCH 2	5 000	–	–	–
SCH 3	3 000	–	–	–
SCH 5	1 000	–	–	–
SCH 7	8 000	24	5–25	16
SCH 8	11 000	22	15–25	21
1999–00				
SCH 1	27 000	42	38-93	66
SCH 2	7 000	30	13-24	18
SCH 3	19 000	46	26-70	48
SCH 5	3 000	66	2-11	7
SCH 7	23 000	56	26-91	58
SCH 8	3 000	55	4-13	8

1.3 Customary non-commercial fisheries

Maori fishers made extensive use of school shark in pre-European times for food, oil, and skin. There is no quantitative information on the current level of customary non-commercial take.

1.4 Illegal catch

There is no quantifiable information on the level of illegal catch. There is an unknown amount of unreported offshore trawl and pelagic longline catch of school shark, either landed (under another name, or in "mixed") or discarded.

1.5 Other sources of mortality

There is an unknown discarded bycatch of juvenile, mainly first-year, school shark taken in harbour and bay setnets. Quantitative information is not available on the level of other sources of mortality.

2. BIOLOGY

School sharks are distributed across the shelf, generally being inshore in summer and offshore in winter. They extend in smaller numbers near the seafloor down the upper continental slope, to at least 600 m. The capture of school sharks by tuna longliners shows that their distribution extends well offshore, up to 180 nm off the South Island, and 400 nm off northern New Zealand towards the Kermadec Islands. They feed predominantly on small fish and cephalopods (octopus and squid).

Growth rates have not been estimated for New Zealand fish, but in Australia and South America school sharks are slow growing and long-lived (Grant *et al.*. 1979, Olsen 1984, Peres & Vooren 1991). They are difficult to age by conventional methods, but up to 45 vertebral rings can be counted. Growth is fastest for the first few years, slows appreciably between 5 and 15 years, and is negligible at older ages, particularly after 20. Results from an Australian long-term tag recovery suggest a maximum age of at least 50 years. Age-at-maturity has been estimated at 12–17 years for males and 13 to 15 years for females (Francis & Mulligan 1998). The size range of commercially caught maturing and adult school shark is 90–170 cm total length (TL), with a broad mode at 110–130 cm TL, which varies with area, season and depth.

Breeding is not annual; it has generally been assumed to be biennial, but recent work on a Brazilian stock suggests that females have a 3-year cycle (Peres & Vooren 1991). Fecundity (pup number) increases from 5–10 in small females to over 40 in the largest. Mating is believed to occur in deep water, probably in winter. Release of pups occurs during spring and early summer (November-January), apparently earlier in the north of the country than in the south. Nursery grounds include harbours, shallow bays and sheltered coasts. The pups remain in the shallow nursery grounds during their first one or two years and subsequently disperse across the shelf. The geographic location of the most important pupping and nursery grounds in New Zealand is not known.

The combination of late maturity, slow growth, and low fecundity gives a low overall productivity. In Australia, M has been estimated as 0.1.

New Zealand tagging studies have shown that school shark may move considerable distances, including trans-Tasman migrations (for details see the 1995 Plenary Report).

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

Table 5: Estimates of biological parameters for school shark.

Fishstock	Estimate		Source
1. Weight = a (length)^b (Weight in g, length in cm fork length)			
	Both sexes combined		
	a	b	
SCH 1	0.0003	3.58	McGregor (unpub.)
SCH 3	0.0035	3.08	McGregor (unpub.)
SCH 5	0.0181	2.72	McGregor (unpub.)
SCH 5	0.0068	2.94	Hurst *et al*. (1990)
SCH 7	0.0061	2.94	Blackwell (unpub.)
SCH 8	0.0104	2.84	Blackwell (unpub.)
2. Estimate of *M* for Australia			
	0.1		Grant *et al*. (1979), Olsen (1984)

3. STOCKS AND AREAS

Information relevant to determining school shark stock structure in New Zealand was reviewed in 2009 (Smith 2009, Blackwell & Francis 2010, Francis 2010). Primarily based on the tagging evidence, there is probably a single biological stock in the New Zealand EEZ. Genetic, biological, fishery and tagging data were all considered, but the evidence for the existence of distinct biological stocks is poor. Some differences were found in CPUE trends between OMAs, but stock separation at the QMA level seems unlikely, and the CPUE differences may have resulted from processes acting below the stock level, such as localised exploitation of different sexes or different size classes of sharks. An apparent lack of juvenile school shark nursery areas in SCH 4 and SCH 5 suggests that these Fishstocks are not distinct, but are instead maintained by recruitment from other QMAs.

The most useful source of information was an opportunistic tagging programme undertaken mainly on research trawlers since 1985 (Hurst et al. 1999). However most tag releases were made around the South Island so little information is provided for North Island school shark. Female school shark were slightly more mobile than males, with higher proportions of the former moving to non-adjacent QMAs and to Australia. About 30% of school shark recaptures were reported from outside the release QMA within a year of release, and this was maintained in the second year after release. After 2–5 years at liberty about 60% of recaptured school sharks (both sexes) were reported from outside the release QMA. After more than 5 years at liberty, 8% of males and 19% of females were recaptured from Australia. A large proportion of tagged school sharks moved outside the QMA of release within 5 years, and a significant proportion eventually moved to Australia. These trends in apparent movement are consistent across two decades of tagging. The relative importance of various breeding grounds around New Zealand (e.g. aggregations of breeding females in Kaipara Harbour) and whether females return to the area in which they were born are unknown.

The current stock management units are a precautionary measure to spread fishing effort; amalgamation of all QMAs into one QMA for the whole EEZ could create unacceptable risks to stock sustainability.

4. STOCK ASSESSMENT

4.1 Estimates of fishery parameters and abundance

Fishery characterisations and CPUE analyses for SCH 1, SCH2, SCH3, SCH 5, SCH 7 and SCH 8 were undertaken in 2010 as part of the review of AMP stocks. Although SCH 1 and SCH 2 are not AMP stocks they were included by Industry to obtain a better understanding of the status of New Zealand school shark.

SCH 1

SCH 1 are primarily taken by bottom trawl while targeting tarakihi and snapper, with smaller catches when targeting trevally and red gurnard. The bottom longline SCH 1 fishery is primarily directed at

school shark, with hapuku and snapper being other important targets. The setnet fishery is also primarily targeted at school shark, with some targeting of rig, trevally, gurnard and snapper.

The previously accepted indices for SCH 1 were based on bottom longline snapper (1E) and a bottom trawl mixed (1W) catches. The 2010 assessment explored a wide range of alternative fishery definitions and the AMP FAWG accepted indices based on SN and BLL catches on both the east and west coasts. These indices were based on Generalized Linear Models of positive catches with log normal error distribution. Models of bottom trawl catch were not explored.

Standardised CPUE abundance indices for SCH 1 show different trends west and east of North Cape (Fig. 2).

SCH 1 W

Discounting the last two years of the analysis (2007/08 and 2008/09) for setnet (which are poorly estimated), the SN and BLL indices for SCH 1W are flat, indicating no change in abundance over the past 20 years (Fig. 2). Analysis of the spatial distribution of catches revealed that the BLL catches were concentrated around North Cape and the SN catches were mostly made in the North Taranaki Bight; near the SCH 8 boundary line. The SN index shows very high uncertainty over the last two years of the analysis (2007/08 and 2008/09), potentially being affected by recent setnet closures on the west coast. There are now only two vessels in this west coast SN fishery and the index may become unreliable in future.

SCH 1E

Since 1998-99 the SCH 1E index shows an increasing trend to above the long-term average, peaking in 2003-04, and then dropping to just above the average by 2005-06 and remained at about that level to 2008/09(Fig. 2).

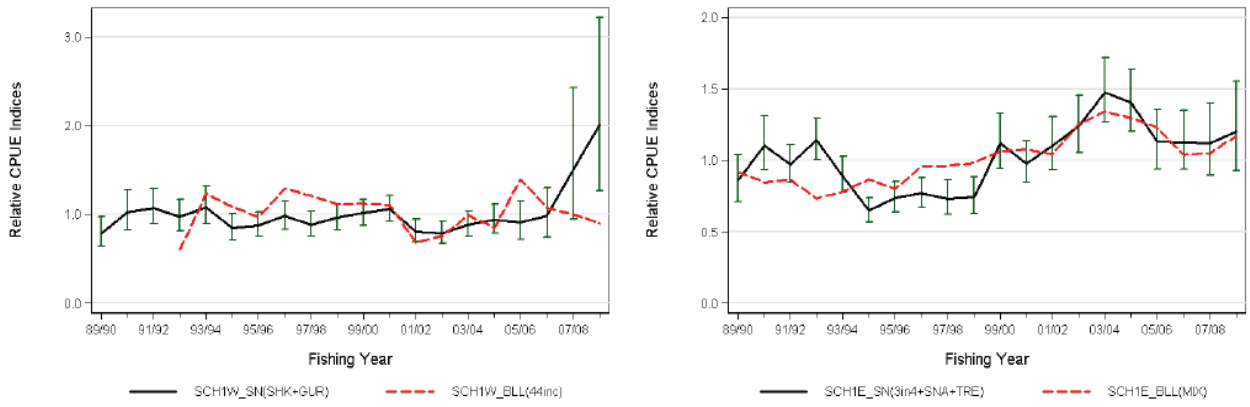


Figure 2: [left panel] comparison of the two SCH 1W standardised series: SCH 1W_SN(SHK+GUR) and SCH 1W_BLL(44inc); [right panel] comparison of the two SCH 1E standardised series: SCH 1E_SN(3in4+SNA+TRE) and SCH 1W_BLL(MIX). (Each series is scaled so that the geometric mean = 1). (Starr and Kendrick 2010a)

SCH 2

SCH 2 are caught primarily in the bottom trawl fishery (46%) targeting tarakihi, hoki, gemfish and gurnard; and the bottom longline fishery (30%) targeting school shark, ling, hapuku/bass and bluenose. Sixteen per cent of the catch is taken in setnet targeting school shark, blue warehou and blue moki.

The 2010 analyses used setnet and bottom longline (no bottom trawl index was attempted), based on a broader range of target fisheries than previously. The previous assessment used tarakihi bottom trawl index.

Two indices were considered for SCH 2 in 2010: one based on setnet catches with a range of target (SN[MIX]) and the other based on bottom longline catches, also with a range of targets. These two

indices present conflicting trends, the setnet index generally increasing over the series and the bottom longline index decreasing steadily (Fig. 3). The AMP FAWG noted particular concerns with the bluenose targeted bottom longline index, related to suggestions of a steady shift towards mid-water targeting of bluenose. There is a substantial correspondence between the standardised setnet index for SCH 2 with setnet and bottom longline indices for SCH 1E, which together indicate a slow but steady increase in CPUE to 2005-06, levelling off since then.

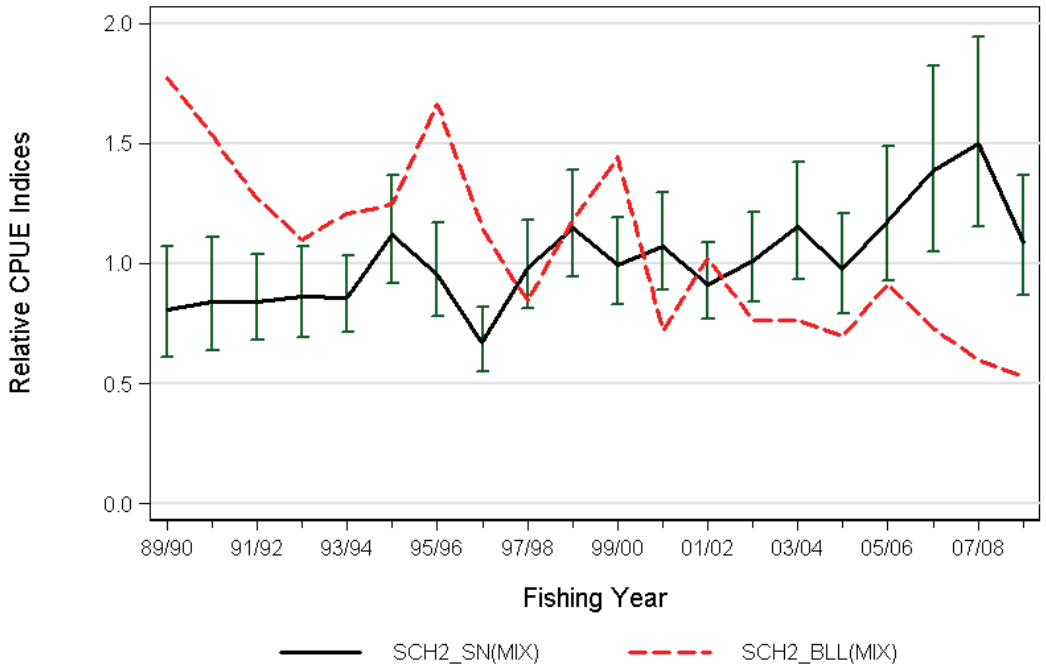


Figure 3: Comparison of the lognormal indices from the two fisheries operating in SCH 2: a) SN[MIX]: mixed target species; b) BLL[MIX]: mixed target species (Starr & Kendrick 2010b).

SCH 3

SCH 3 is predominantly caught in the setnet fishery (56%) targeting school shark and rig, with some targeting of spiny dogfish and tarakihi; and in the bottom trawl fishery (36%) targeting red cod, with some targeting of flatfish, barracouta and tarakihi. Mixed targeted bottom longline takes 7% of the catch.

The mixed shark target SN(SHK) standardised CPUE is the accepted index of abundance for SCH 3. The 2010 CPUE analysis is an update of the shark-targeted setnet CPUE analysis conducted in 2003 and 2007, with no extension to other target species or other model changes. This index shows a sharp decline of almost 60% from a peak in 1989-90 to its lowest point over the 20 year series in 1992-93 (Fig. 4). Thereafter the index shows a steady and continual increase through to 2003-04 / 2004-05 to a level about 10% above the long-term average and about 40% above the lowest level, fluctuating around this level thereafter.

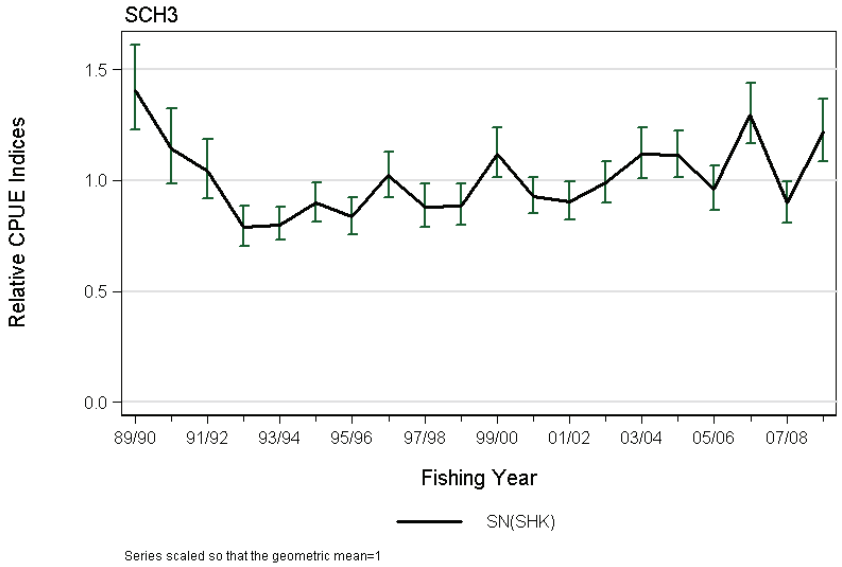


Figure 4: Lognormal SCH 3_SN(SHK) standardised indices with core vessel criteria of at least 10 trips in a minimum of 6 years) (series is scaled so that the geometric mean = 1). (Starr et al. 2010a)

SCH 5

SCH 5 is almost entirely caught in the school shark targeted setnet fishery (83%), with some minor targeting of rig. Seven percent is taken by bottom trawl primarily targeting stargazer and squid, and 5% by bottom longline primarily targeting hapuku/bass and ling.

The targeted SN(SCH) standardised CPUE index is the accepted indicator of SCH 5 abundance. The 2010 CPUE analysis is an update of previous analyses conducted in 2003 and 2007, with no substantial changes to the fishery definitions or standardisation models. The index fluctuated around long-term average levels through to 2005-06 (Fig. 5). Thereafter the index declines to slightly below average levels over 2006-07 / 2007-08, and then steeply to about half average levels in 2008-09. The index is considered to be less reliably estimated in the final year, due to changes in fleet size and structure.

There is close correspondence in the declining indices for SCH 5 and SCH 7, except in the final year. Both indices monitor mature fish caught around Southland and the WCSI, raising some concern about the declines in both these areas.

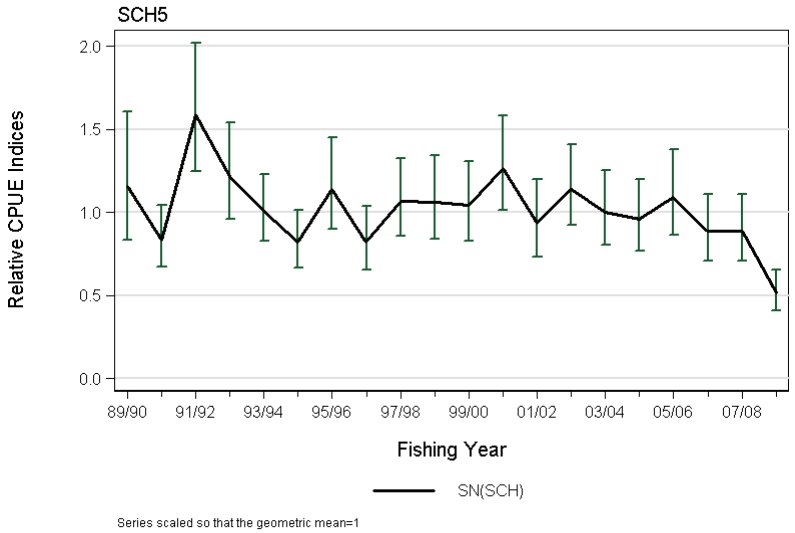


Figure 5: Lognormal SCH 5_SN(SCH) standardised index (Starr et al. 2010b).

SCH 7

SCH 7 are caught about one-third each by setnet targeting school shark, rig and spiny dogfish; bottom longline targeting school shark, hapuku/bass and ling; and bottom trawl targeting barracouta, tarakihi, flatfish, hoki, red cod and others.

The mixed shark target SN(SHK) standardised CPUE index is the accepted indicator of SCH 7 abundance. The 2010 CPUE analysis updates previous analyses conducted in 2003 and 2007, with no substantial changes to the fishery definitions or standardisation models. The index remained stable around long-term average levels over 1989-90 to 1995-96 and then increased to a peak about 50% above average levels in 1999-00, then declined steadily to its lowest value over the 20 year period by 2007-08 (Figure 6). There was a sharp increase in the final year; however, the working group considered the last data point to be less reliably estimated, due to changes in fleet size and structure.

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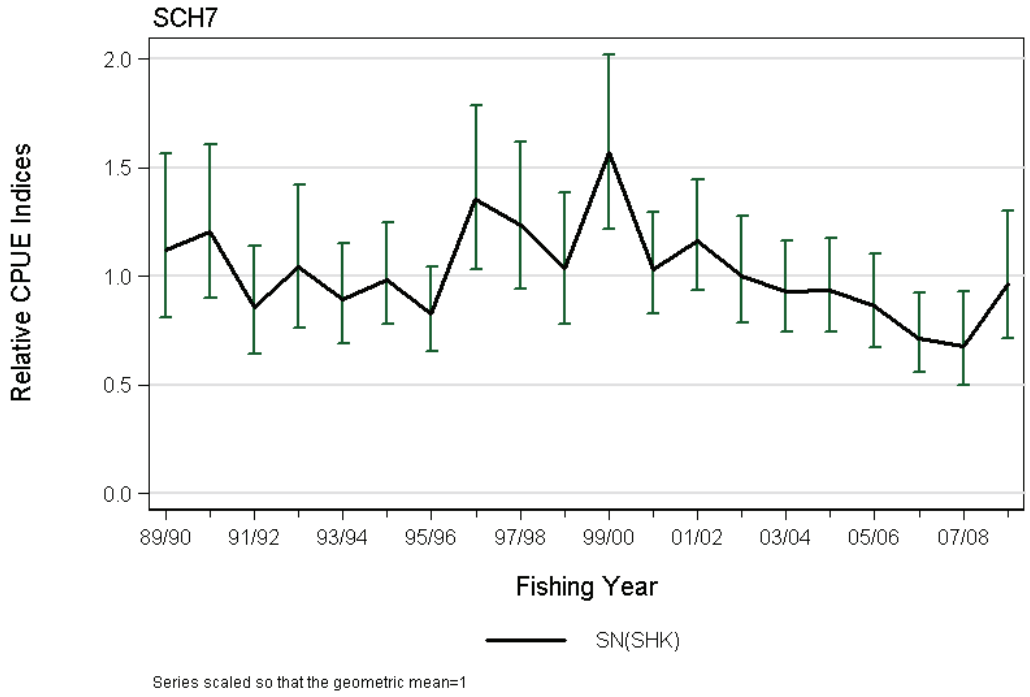


Figure 6: Lognormal indices from the setnet target shark CPUE series for SCH 7 (Starr et al 2010c).

SCH 8

SCH 8 are caught mainly (66%) by setnet targeting school shark and rig; and by bottom longline (22%) targeting school shark and hapuku/bass. Ten percent is caught by bottom trawl targeting gurnard, tarakihi and trevally.

The mixed shark target SN(SHK) standardised CPUE index is the accepted indicator of SCH 8 abundance. The 2010 CPUE analysis is an update of previous analyses conducted in 2003 and 2007, with no substantial changes to the fishery definitions or standardisation models. The index remains flat at the long-term average, apart from a drop to lower levels over 1997-98 to 2000-01 (Fig. 7). The Working Group concluded that the SCH 8 index showed no change in abundance over the series. There was an inverse relationship between the SCH 7 and SCH 8 indices over this period, suggesting a possible shift in stock distribution between these areas.

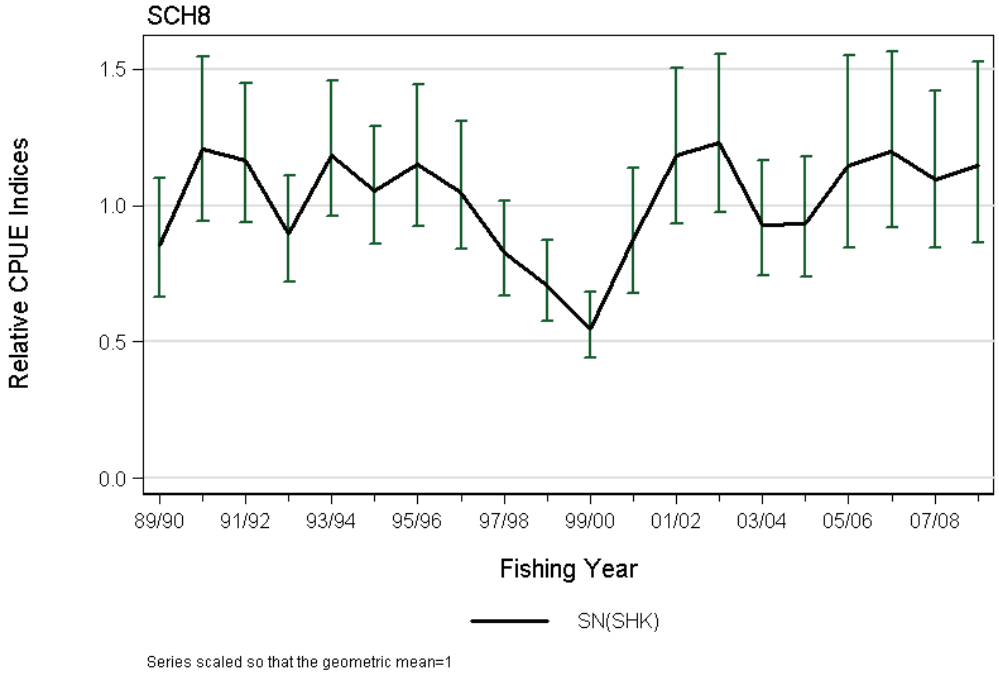


Figure 7: Lognormal indices from the setnet target shark CPUE series for SCH 8. (Starr *et al.* 2010c)

SCH overview

SCH are mainly caught in setnet fisheries targeting sharks (school shark, rig, elephantfish and spiny dogfish); in bottom trawl fisheries targeting red cod, tarakihi, gurnard and snapper and others; and in bottom longline fisheries targeting school shark, hapuku/bass and ling.

In SCH 3, 5, 7 and 8, CPUE indices have been conducted using the same, or similar, models since entry into AMPs. In some areas, additional target species have been added to fishery definitions, particularly for bottom longline indices. New analyses were developed for SCH 1 and 2. Bottom trawl indices previously produced for SCH 1 and 2 were not updated in 2010.

There is a close similarity in trends in the indices for 1E, 2 and 3; SCH 5 and SCH 7; and SCH 8 and 1W. The indices show higher recent CPUE for SCH 1E, 2 and 3; stable CPUE for SCH 1W and 8; and declining CPUE for SCH 5 and 7. The Working Group noted that SCH 5 and 7 have accounted for 41% of the SCH catch over the past 20 years, and are the areas in which the highest proportion of mature fish are caught. SCH 1E, 2 and 3, have accounted for 26% of the SCH catch over the past 20 years. Areas 1W and 8 have accounted for 30% of the catch.

Recent setnet closures have potentially compromised the continuity of setnet indices for SCH 1W, 3, 5 and 7.

4.2 Biomass estimates

Estimates of current and reference biomass are not available.

4.3 Estimation of Maximum Constant Yield (MCY)

The estimates of MCY are no longer considered valid.

4.4 Estimation of Current Annual Yield (CAY)

Current biomass cannot be estimated, so CAY cannot be determined.

4.5 Other yield estimates and stock assessment results

No information is available.

4.6 Other factors

In Australia, recruitment overfishing has occurred to such an extent that the stock is considered seriously threatened and a series of conservative management measures (TAC reductions) have been

progressively imposed between 1996 and 2007 (Wilson et al. 2008). The Australian modelling work indicates that the stock is overfished. Wilson et al. (2008) note that the stock has been in an overfished state and overfishing was occurring from 1992 to 2004. While the stock was still listed as overfished since then, they are uncertain as to whether overfishing is still occurring.

The most important conclusion from this for New Zealand is that fishing pressure on large mature females should be minimised to maintain the productivity of this species.

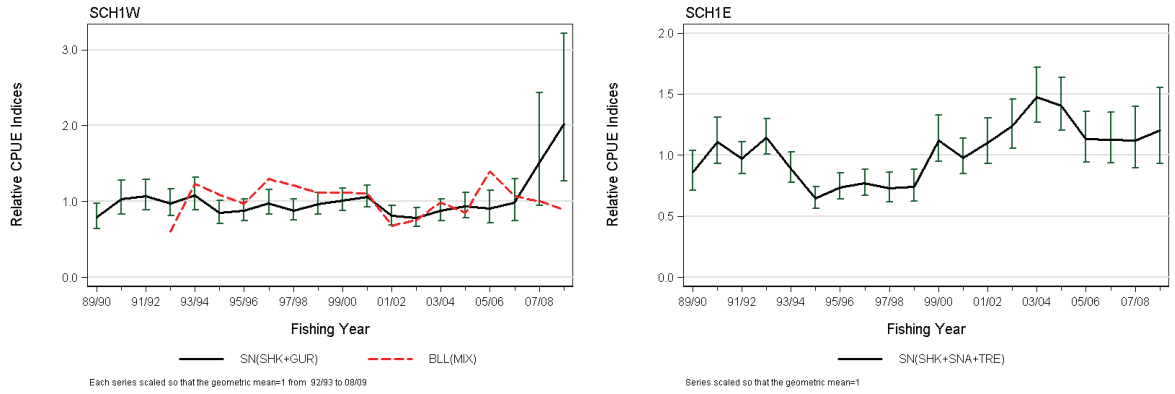
5. STATUS OF THE STOCKS

Stock Structure Assumptions

SCH are known from tagging studies to be highly mobile, moving between the North and South Islands, and as far as Australia. From the tagging evidence, there is probably a single biological SCH stock in the New Zealand EEZ. However, differences in average modal length and CPUE trends between FMAs indicate that movement between areas may be viscous, and that components of the stock may aggregate in different areas. Larger females predominate in catches around Southland and west coast of the South Island. Therefore, the current stock management units are a precautionary measure to spread fishing effort and mortality across components of the stock.

SCH 1

Stock Status	
Year of Most Recent Assessment	2010 (Fishery characterisation and CPUE standardisation)
Reference Points	Target(s): Not established but B_{MSY} assumed Soft Limit: 20% B_0 Hard Limit: 10%B_0
Status in relation to Target	Unknown
Status in relation to Limits	Unknown
Historical Stock Status Trajectory and Current Status	



Left: Comparison of the two SCH 1W standardised series: SCH 1W_SN(SHK+GUR) and SCH 1W_BLL(44inc); Right: The SN (SHK+SNA+TRE) index for SCH 1E.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Standardised CPUE abundance indices for SCH 1 show different trends west and east of North Cape. Discounting the last two years for setnet (which are poorly estimated), the SN and BLL indices for SCH 1W are flat, indicating no change in abundance over the past 20 years. The index for SCH 1E shows higher than long-term average abundance since 1999-00. From 1999-00 the SCH 1E index shows an increasing trend to above the long-term average, peaking in 2003-04, and then dropping to just above the average by 2006-07.

Recent Trend in Fishing Mortality or Proxy	

Projections and Prognosis	
Stock Projections or Prognosis	SCH 1E: Stock size is Likely (> 60%) to remain near current levels or increase under current catches and TACCs SCH 1W: Stock size is Likely (> 60%) to remain near current levels under current catches and TACCs.
Probability of Current Catch or TACC causing decline below Limits	Soft Limit: Unknown Hard Limit: Unlikely (< 40%)

Assessment Methodology		
Assessment Type	Level 2: Standardised CPUE abundance index.	
Assessment Method	Evaluation of agreed standardised CPUE indices thought to index SCH 1 abundance.	
Main data inputs	Catch and effort data derived from the Ministry of Fisheries catch returns	
Period of Assessment	Latest assessment: 2010	Next assessment: 2013
Changes to Model Structure and Assumptions	The previously accepted indices were based on bottom longline snapper (1E) and a bottom trawl mixed (1W). This assessment explored a wide range of alternative fishery definitions. Four credible indices were selected: setnet (SN) and bottom longline (BLL) on both the east and west coasts.	
Major Sources of Uncertainty	Setnet closures have jeopardised the continuity of the west coast setnet index in recent years. The BLL(W) index is considered to index the top of the North Island and lacks data.	

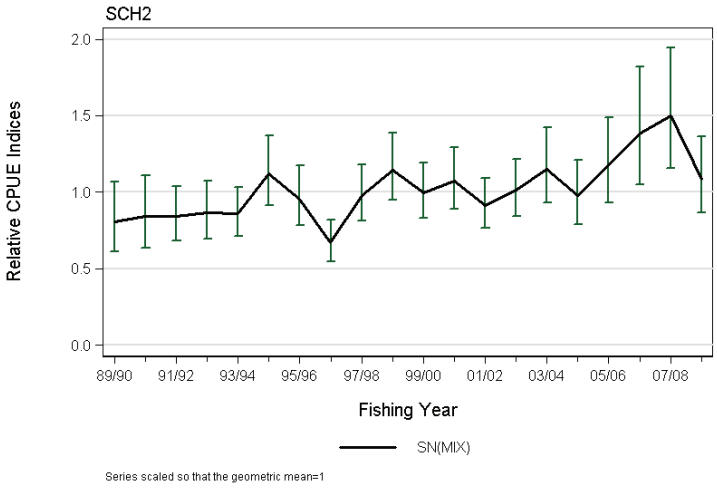
Qualifying Comments
Recent setnet closures designed to protect Maui's dolphin have affected setnet fisheries which take school shark off the west coast of the North Island. These closures have resulted in changes in fleet deployment and jeopardised the setnet indices.

Fishery Interactions
SCH 1 are primarily taken by bottom trawl while targeting tarakihi and snapper, with smaller catches when targeting trevally and red gurnard. The bottom longline SCH 1 fishery is primarily directed at school shark, with hapuku and snapper being other important targets. The setnet fishery is also primarily targeted at school shark, with some targeting of rig, trevally, gurnard and snapper. The bottom pair trawl fishery is almost entirely directed at snapper and trevally, with tarakihi becoming more important in recent years.

SCH 2

Stock Status	
Year of Most Recent Assessment	2010 (Fishery characterisation and CPUE standardisation)
Reference Points	Target(s): Not established but B_{MSY} assumed Soft Limit: 20% B_0 Hard Limit: 10%B_0
Status in relation to Target	Unknown
Status in relation to Limits	Unknown

Historical Stock Status Trajectory and Current Status



The lognormal index for SCH 2: SN[MIX]: mixed target species (scaled so that the geometric mean = 1).

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	The CPUE index generally increases over the series. There is a substantial correspondence between the standardised SN index for SCH 2 with SN and BLL indices for SCH 1E, which together indicate a slow but steady increase in CPUE to 2005-06, levelling off since then.
Recent Trend in Fishing Mortality or Proxy	

Projections and Prognosis	
Stock Projections or Prognosis	Correspondence between SN indices for SCH 1E, SCH 2 and SCH 3 indicates that. SCH 2 stock size is Likely to remain near current levels or increase under current catches and TACCs.
Probability of Current Catch or TACC causing decline below Limits	Soft Limit: Unknown Hard Limit: Unlikely (< 40%)

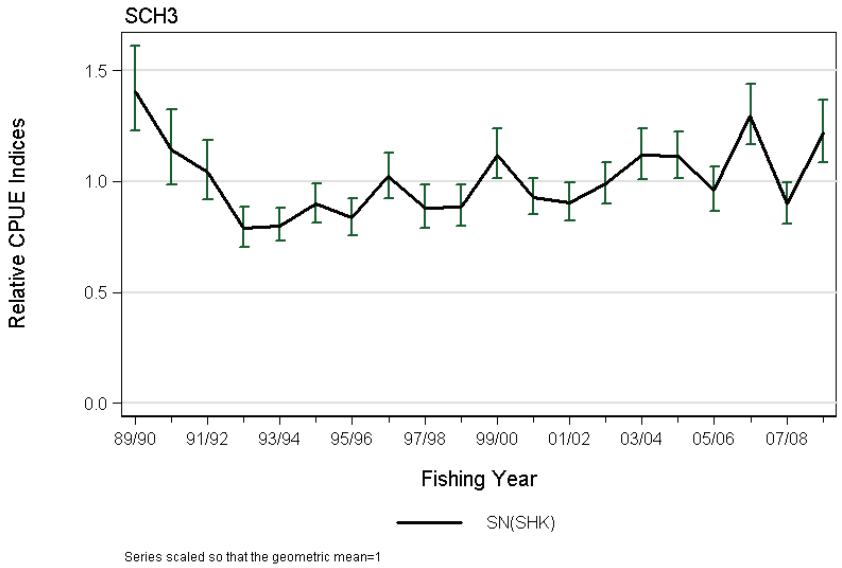
Assessment Methodology		
Assessment Type	Level 2: Standardised CPUE abundance index.	
Assessment Method	Evaluation of agreed standardised CPUE indices thought to index SCH 2 abundance.	
Main data inputs	- Catch and effort data derived from the Ministry of Fisheries compulsory catch reporting.	
Period of Assessment	Latest assessment: 2010	Next assessment: 2013
Changes to Model Structure and Assumptions	The previous assessment used tarakihi bottom trawl index. The 2010 analyses used setnet and bottom longline (no bottom trawl index was attempted), based on a broader range of target fisheries than previously.	
Major Sources of Uncertainty		

Qualifying Comments
There have been no regulation changes affecting SCH 2 in recent years.

Fishery Interactions
SCH 2 are caught primarily in the bottom trawl fishery (46%) targeting tarakihi, hoki, gemfish and gurnard; and the bottom longline fishery (30%) targeting school shark, ling, hapuku/bass and bluenose. 16% of the catch is taken in setnet targeting school shark, blue warehou and blue moki.

SCH 3

Stock Status	
Year of Most Recent Assessment	2010 (Fishery characterisation and CPUE standardisation)
Reference Points	Target(s): Not established but B_{MSY} assumed Soft Limit: 20% B_0 Hard Limit: 10%B_0
Status in relation to Target	Unknown
Status in relation to Limits	Unknown
Historical Stock Status Trajectory and Current Status	



Lognormal SCH 3_SN(SHK) standardised indices with core vessel criteria of at least 10 trips in a minimum of 6 years) (series is scaled so that the geometric mean = 1).

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	The mixed shark target SN(SHK) standardised CPUE is the accepted index of abundance. This index shows a sharp decline of almost 60% from a peak in 1989-90 to its lowest point over the 20 year series in 1992-93. Thereafter the index shows a steady and continual increase through to 2003-04 / 2004-05 to a level about 10% above the long-term average and about 40% above the lowest level, fluctuating around this level thereafter.
Recent Trend in Fishing Mortality or Proxy	Unknown.

Projections and Prognosis	
Stock Projections or Prognosis	Quantitative stock projections are unavailable. The long period of increase in the SN(SHK) index for SCH 3 since 1992-93, over a period when catches have increased steadily from about 200t to an average of 366t over the recent five years, indicates that stock size is Likely to remain near current levels or increase under current catches.
Probability of Current Catch or TACC causing decline below Limits	Soft Limit: Unknown Hard Limit: Unlikely (< 40%)

Assessment Methodology		
Assessment Type	Level 2: Standardised CPUE abundance index, and a review of length data.	
Assessment Method	Evaluation of agreed standardised CPUE indices thought to index SCH 3 abundance.	
Main data inputs	- Catch and effort data derived from the Ministry of Fisheries reporting requirements. - Length frequency data summarised from logbooks compiled under the industry Adaptive Management Programme.	
Period of Assessment	Latest assessment: 2010	Next assessment: 2013
Changes to Model Structure and Assumptions	The 2010 CPUE analysis is an update of the shark-targeted setnet CPUE analysis conducted in 2003 and 2007, with no extension to other target species or other model changes.	
Major Sources of Uncertainty	Recent setnet closures have affected fleet distribution patterns, potentially jeopardising setnet indices in this area. These changes may have contributed to the strong fluctuations in the SCH 3 SN indices in recent years.	

Qualifying Comments
Like other setnet abundance indices, the SCH 3 setnet indices have been affected, and possibly compromised, by setnet closures.

Fishery Interactions
SCH 3 is predominantly caught in the setnet fishery (56%) targeting school shark and rig, with some targeting of spiny dogfish and tarakihi; and in the bottom trawl fishery (36%) targeting red cod, with some targeting of flatfish, barracouta and tarakihi. Mixed targeted bottom longline takes 7% of the catch.

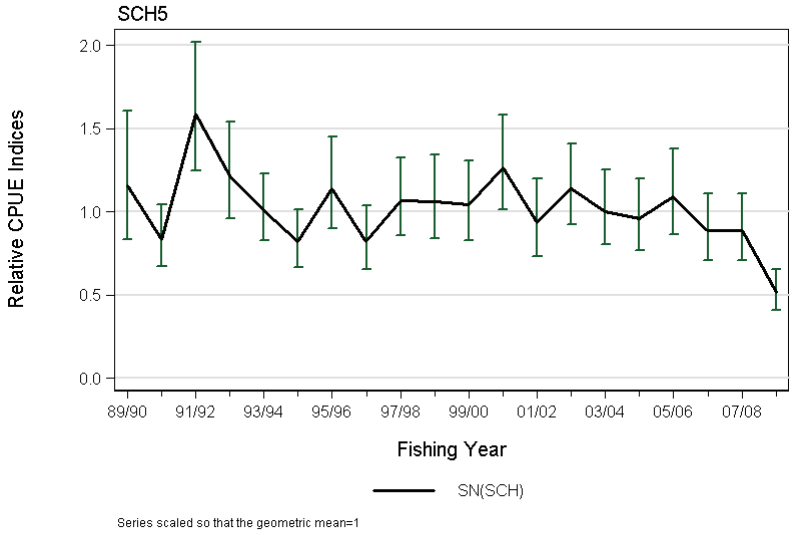
SCH 4

The status of SCH 4 relative to B_{MSY} is unknown.

SCH 5

Stock Status	
Year of Most Recent Assessment	2010 (Fishery characterisation and CPUE standardisation)
Reference Points	Target(s): Not established but B_{MSY} assumed Soft Limit: 20% B_0 Hard Limit: 10%B_0
Status in relation to Target	Unknown
Status in relation to Limits	Unknown

Historical Stock Status Trajectory and Current Status



Lognormal SCH 5_SN(SCH) standardised index.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	The targeted SN(SCH) CPUE index fluctuated around long-term average levels through to 2005-06. Thereafter the index declines to slightly below average levels over 2006-07 / 2007-08, and then steeply to about half average levels in 2008-09. The value of the index is considered to be less reliably estimated in the final year.
Recent Trend in Fishing Mortality or Proxy	-

Projections and Prognosis	
Stock Projections or Prognosis	The SCH5 SN(SHK) abundance index has declined steadily since 2005-06, reaching the lowest level over the 20 year period of the index in 2008-09, at about half of long-term average levels. This gives rise to concern that current catches, and the current TACC, may not be sustainable. This concern is prompted mainly by the steep decline in the most recent year, which is less reliably estimated than previous years. The working group therefore concluded that the SCH 5 stock is About as Likely as Not to remain near current levels under current catches and TACCs in the short-term and Likely to decline under current catches and TACCs in the medium- to long-term, but that this conclusion needs to be reviewed in 2011.
Probability of Current Catch or TACC causing decline below Limits	Soft Limit: Unknown Hard Limit: Unknown

Assessment Methodology	
Assessment Type	Level 2: Standardised CPUE abundance index, and a review of length data.
Assessment Method	Evaluation of agreed standardised CPUE indices thought to index SCH 5 abundance.

Main data inputs	- Catch and effort data derived from the Ministry of Fisheries catch reporting. - Length frequency data summarised from logbooks compiled under the industry Adaptive Management Programme.	
Period of Assessment	Latest assessment: 2010	Next assessment: 2011
Changes to Model Structure and Assumptions	The 2010 CPUE analysis is an update of previous analyses conducted in 2003 and 2007, with no substantial changes to the fishery definitions or standardisation models.	
Major Sources of Uncertainty	Recent setnet closures have affected fleet distribution patterns, potentially jeopardising setnet indices in this area.	

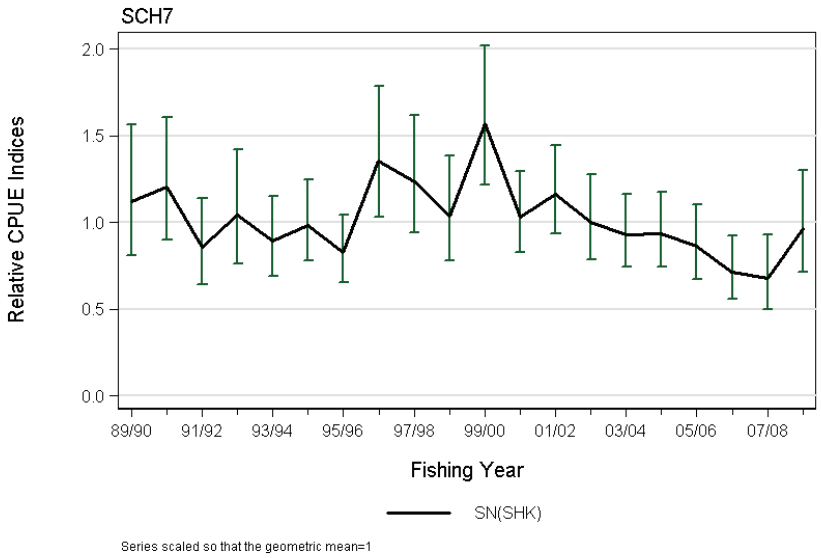
Qualifying Comments
Concerns regarding the status of this stock are prompted by the steep decline in CPUE in the most recent year, which is less well estimated than previous years. However, there is close correspondence in the declining indices for SCH 5 and SCH 7, except in the final year. Both indices monitor mature fish caught around Southland and the WCSI, raising some concern for both these areas.

Fishery Interactions
SCH 5 is almost entirely caught in the school shark targeted setnet fishery (83%), with some minor targeting of rig. Seven percent is taken by bottom trawl primarily targeting stargazer and squid, and 5% by bottom longline primarily targeting hapuku/bass and ling.

SCH 7

Stock Status	
Year of Most Recent Assessment	2010
Reference Points	Target(s): Not established but B_{MSY} assumed Soft Limit: 20% B_0 Hard Limit: 10%B_0
Status in relation to Target	Unknown
Status in relation to Limits	Unknown

Historical Stock Status Trajectory and Current Status



Lognormal indices from the setnet target shark CPUE series for SCH 7.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	The mixed shark target SN(SHK) standardised CPUE index remained stable around long-term average levels over 1989-90 to 1995-96 and then increased to a peak about 50% above average levels in 1999-00, then declined steadily to its lowest value over the 20 year period by 2007-08. There was a sharp increase in the final year; however, the working group considered the last data point to be less reliably estimated.
Recent Trend in Fishing Mortality or Proxy	

Projections and Prognosis	
Stock Projections or Prognosis	The SCH 7 SN(SHK) abundance index declined steadily from 1999-00 to its lowest level over the 20 year period of the index in 2007-08. The upturn in the most recent year is considered to be less reliably estimated than previous years. The WG concluded that the SCH 7 Fishstock stock size is About as Likely as Not to remain near current levels under current catches and TACCs in the short-term and Likely to decline under current catches and TACCs in the medium- to long-term, but noted that this conclusion needs to be reviewed in 2011.
Probability of Current Catch or TACC causing decline below Limits	Soft Limit: Unknown Hard Limit: Unknown

Assessment Methodology		
Assessment Type	Level 2: Standardised CPUE abundance index, and review of length frequency data.	
Assessment Method	Evaluation of agreed standardised CPUE indices thought to index SCH 7 abundance.	
Main data inputs	- Catch and effort data derived from the Ministry of Fisheries catch reporting. - Length frequency data summarised from logbooks compiled under the industry Adaptive Management Programme.	
Period of Assessment	Latest assessment: 2010	Next assessment: SCH 7: 2011
Changes to Model Structure and Assumptions	The 2010 CPUE analysis are updates of previous analyses conducted in 2003 and 2007, with no substantial changes to the fishery definitions or standardisation models.	
Major Sources of Uncertainty	SCH 7: The fleet distribution has changed in the last 2-3 years. Furthermore, setnet closures have potentially jeopardised setnet indices in the last year.	

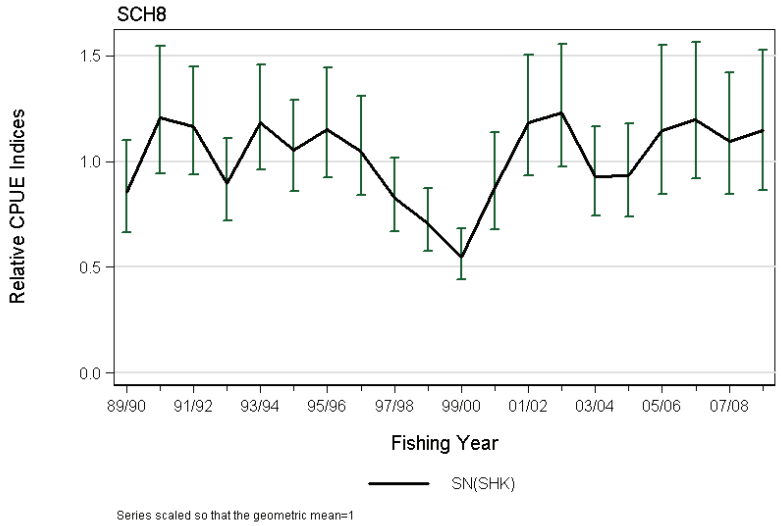
Qualifying Comments
There is close correspondence in the declining indices for SCH 5 and SCH 7, except in the final year. Both indices monitor mature fish caught around Southland and the WCSI, raising some concern for both these areas.

Fishery Interactions
SCH 7 are caught about one-third each by setnet targeting school shark, rig and spiny dogfish; bottom longline targeting school shark, hapuku/bass and ling; and bottom trawl targeting barracuda, tarakihi, flatfish, hoki, red cod and others.

SCH 8

Stock Status	
Year of Most Recent Assessment	2010
Reference Points	Target(s): Not established but B_{MSY} assumed Soft Limit: 20% B_0 Hard Limit: 10%B_0
Status in relation to Target	Unknown
Status in relation to Limits	Soft limit: Unknown Hard Limit: Unlikely (< 40%) to be below.

Historical Stock Status Trajectory and Current Status



Lognormal indices from the setnet target shark CPUE series for SCH 8

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	The SCH 8:SN(SHK) index remains flat at the long-term average, apart from a drop to lower levels over 1997-98 to 2000-01. The WG concluded that the SCH 8 index showed no change in abundance over the series. There is an inverse relationship between the SCH 7 and SCH 8 indices over this period, suggesting a possible shift in stock distribution between these areas.
Recent Trend in Fishing Mortality or Proxy	

Projections and Prognosis	
Stock Projections or Prognosis	Lack of any trend in the SCH 8 CPUE index indicates the stock size is Likely to remain near current levels under current catches and TACCs.
Probability of Current Catch or TACC causing decline below Limits	Soft Limit: Unknown Hard Limit: Unknown
Assessment Methodology	
Assessment Type	Level 2: Standardised CPUE abundance index, and review of length frequency data.
Assessment Method	Evaluation of agreed standardised CPUE indices thought to index SCH 8 abundance.
Main data inputs	- Catch and effort data derived from the Ministry of Fisheries catch reporting. - Length frequency data summarised from logbooks compiled under the industry Adaptive Management Programme.

Period of Assessment	Latest assessment: 2010	Next assessment: 2013
Changes to Model Structure and Assumptions	The 2010 CPUE analysis are updates of previous analyses conducted in 2003 and 2007, with no substantial changes to the fishery definitions or standardisation models.	
Major Sources of Uncertainty		

Qualifying Comments

Fishery Interactions
SCH 8 are caught mainly (66%) by setnet targeting school shark and rig; and by bottom longline (22%) targeting school shark and hapuku/bass. Ten percent is caught by bottom trawl targeting gurnard, tarakihi and trevally.

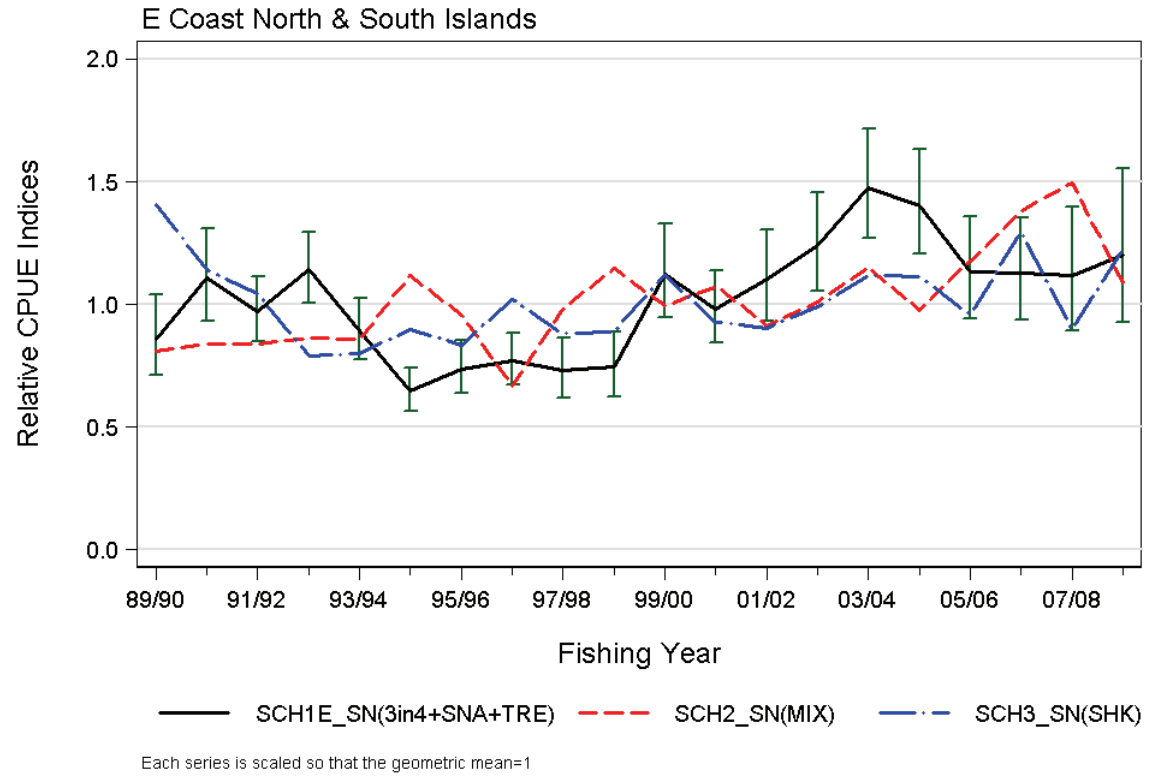
Combined SCH Stocks

School shark are believed to be a single biological stock around the North and South Islands. It may therefore be appropriate for management responses to be consistent across areas broader than single QMAs.

Stock Status	
Year of Most Recent Assessment	2010
Reference Points	Target(s): Not established but B_{MSY} assumed Soft Limit: 20% B_0 Hard Limit: 10% B_0
Status in relation to Target	Unknown
Status in relation to Limits	Unknown

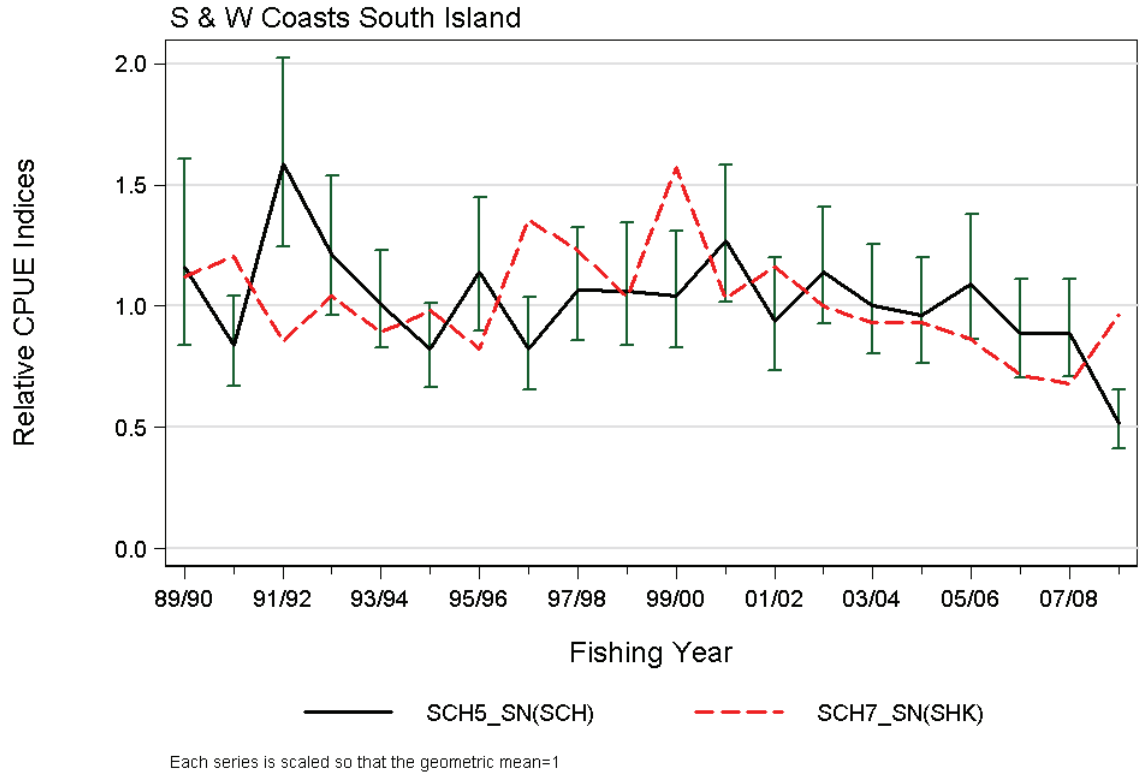
Historical Stock Status Trajectory and Current Status

SCH 1E, 2 and 3



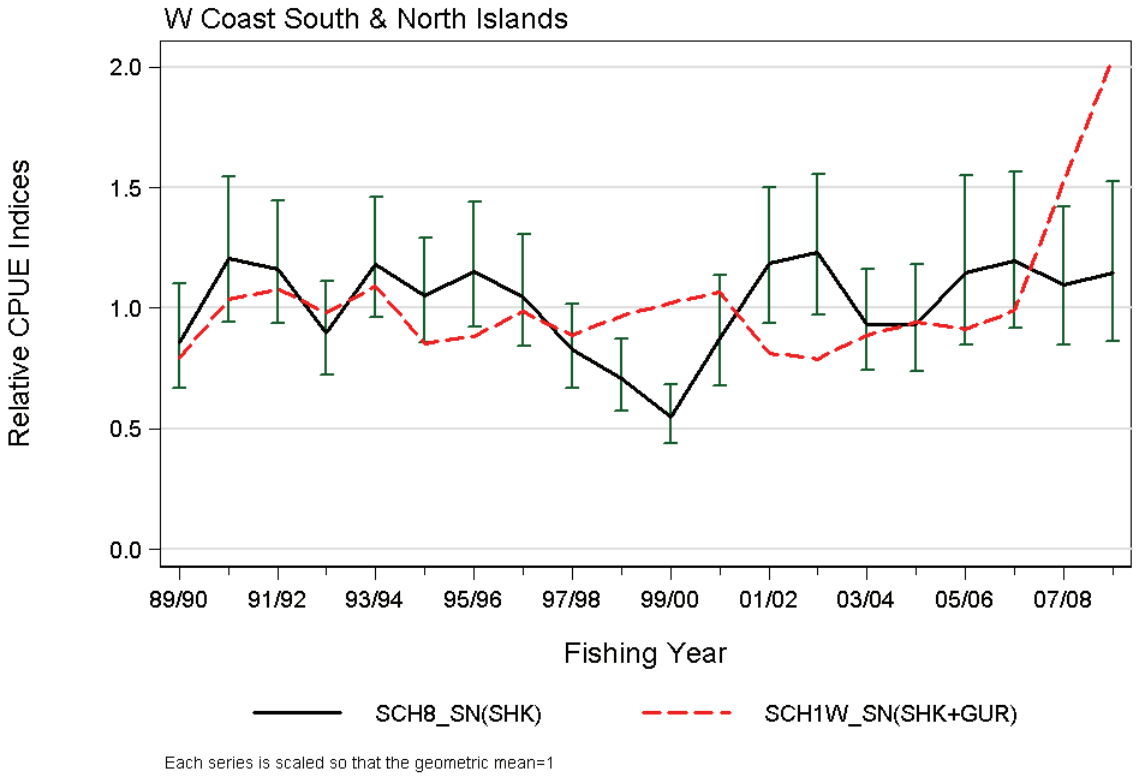
Comparison of three lognormal indices from a) the SCH 1E setnet series: [SCH 1E_SN(3in4+SNA=TRE)]; b) a setnet series from SCH 2: [SCH2_SN(MIX)]; c) a setnet series from SCH 3: [SCH3_SN(SHK)]

SCH 5 and 7



Comparison of the selected SCH 5 [SCH5_SN(SCH)] series with the equivalent series selected for the SCH 7 [SCH7_SN(SHK)] CPUE evaluation. Confidence intervals only shown for one series.

SCH 8 and 1W



Comparison of the selected SCH 8 [SCH8_SN(SHK)] series with the equivalent series selected for the SCH1W [SCH1W_SN(SHK+GUR)] CPUE evaluation.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	There is a close similarity in trends in the indices for 1E, 2 and 3; SCH 5 and SCH 7; and SCH 8 and 1W. The indices show an increase or higher recent CPUE for SCH 1E, 2 and 3; and stable CPUE for SCH 1W and 8; SCH 5 and 7 show CPUE declining. The Working Group noted that SCH 5 and 7 have accounted for 41% of the SCH catch over the past 20 years, and are the areas in which the largest females are caught. SCH 1E, 2 and 3, have accounted for 26% of the SCH catch over the past 20 years. Areas 1W and 8 have accounted for 30% of the catch.
Recent Trend in Fishing Mortality or Proxy	Not estimated, but likely varies between different FMAs.

Projections and Prognosis	
Stock Projections or Prognosis	• SCH 1E, 2, 3: Stock size is Likely to remain near current levels or increase under current catches and TACCs. • SCH 1W, 8: Stock size is Likely to remain near current levels under current catches and TACCs. • SCH 5&7: Stock size is About as Likely as Not to remain near current levels under current catches and TACCs in the short-term. Stock size is Likely to decline under current catches and TACCs in the medium- to long-term.
Probability of Current Catch or TACC causing decline below Limits	Combined stocks: Soft Limit: Unknown Hard Limit: Unknown

Assessment Methodology		
Assessment Type	Level 2: Standardised CPUE abundance index, and length frequency analysis.	
Assessment Method	Evaluation of a range of agreed standardised CPUE indices thought to index abundance of the SCH fishstocks in each FMA. Comparison of length frequencies from SCH 3, 5, 7 and 8.	
Main data inputs	- Catch and effort data derived from the Ministry of Fisheries catch reporting. - Length frequency data summarised from logbooks compiled under the industry Adaptive Management Programme.	
Period of Assessment	Latest assessment: 2010	Next assessment: 2011 (5 and 7) and 2013 (SCH 1 , 2, 3 and 8)
Changes to Model Structure and Assumptions	In SCH 3, 5, 7 and 8, CPUE indices have been conducted using the same, or similar, models since entry into AMPs. In some areas, additional target species have been added to fishery definitions, particularly for bottom longline indices. New analyses were developed for SCH 1 and 2. Bottom trawl indices previously produced for SCH 1 and 2 were not updated in 2010.	
Major Sources of Uncertainty	Recent setnet closures have potentially compromised the continuity of setnet indices for SCH 1W, 3, 5 and 7.	

Qualifying Comments
See individual Fishstock stock status summaries.

Fishery Interactions
SCH are predominantly caught in setnet fisheries targeting sharks (school shark, rig, elephantfish and spiny dogfish); in bottom trwl fisheries targeting red cod, tarakihi, gurnard and snapper and others; and in bottom longline fisheries targeting school shark, hapuku/bass and ling.

Yield estimates, reported landings and TACCs for the 2008–09 fishing year are summarised in Table 7.

Table 7: Summary of yield estimates (t), TACCs (t) and reported landings (t) of school shark for the most recent fishing year.

Fishstock		QMA	MCY Estimates	2008–09 Actual TACC	2008–09 Reported Landings
SCH 1	Auckland (East) (West)	1 & 9		689	713
SCH 2	Central (East)	2		199	232
SCH 3	South-east (Coast)	3		387	364
SCH 4	South-east (Chatham)	4		239	145
SCH 5	Southland and Sub-Antarctic	5 & 6		743	741
SCH 7	Challenger	7		641	694
SCH 8	Central (West)	8		529	588
SCH 10	Kermadec	10		10	0
Total				3 437	3 478

6. FOR FURTHER INFORMATION

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